Port of San Francisco

Dry Dock #2

Structural Assessment Report

August 2017

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1. Executive Summary

In its current condition, Dry Dock #2 cannot be rated to safely lift the design capacity vessel load of 55,800 LT. At numerous locations, the pontoon deck plate and wing wall shell plates exhibit significant section loss due to corrosion and general use, along with cracks and through holes in plates. Because of the holes, the dock cannot hold draft without periodic ballast pumping. The thinned shell plating limits the dock’s ability to resist differential head pressure between the external water level and ballast during submergence. Our finding is in general agreement with conclusions stated in the 2016 “Control Inspection” conducted by Heger Dry Dock, Inc. (Ref. 1)

2. Introduction

2.1 Scope of Work

GHD-Telamon Engineering Consultants, Inc (TECI) Joint Venture was retained by the Port of San Francisco (Port) to perform an independent inspection and analysis of Dry Dock #2 to estimate its lifting capacity and confirm necessary repairs. The inspection and analysis would consist of a limited visual review of the above-water dock areas, confirmation of ultrasonic thickness (UT) meter readings at selected locations on the pontoon deck, a dive team for underwater assessments, and structural engineers analyzing the structure using finite element modelling. Additionally, GHD-TECI was tasked to review and summarize the previous reports and certifications.

The Port owns two floating dry docks at Pier 68/70 that are included in long term lease agreements with ship repair contractors (tenant). Dry Dock #2 is an 800-foot by 186-foot by 69-foot steel floating dry dock originally designed by Earl and Wright Consulting Engineers and built by Bethlehem Steel in 1969-1970. It was most recently certified to MIL-STD-1625D (SH) for a 54,800 long ton capacity. This certification is based on a 2014 technical audit by the US Navy Sea Systems Command (NAVSEA) and subsequent ultrasonic (UT) gauging and finite element analysis work performed in 2016 and reviewed by NAVSEA. The NAVSEA certification expired July 31st, 2017.

Currently the Port is soliciting proposals for a new shipyard operator. As part of the Port’s negotiations with the new operator for a long term operating agreement, the Port requested an independent evaluation of the short term and long term maintenance needs of Dry Dock #2, and associated estimated costs. The independent evaluation relied upon the extensive inspection work previously performed by the shipyard and accepted by NAVSEA, but independently evaluated maintenance needs and repair costs.

The Port’s main goals / needs for the task order work are the following:

1. Verification of repair scope and estimated cost for immediate repairs required for dock certification.
2. Recommendations for coatings and cathodic protection (CP) systems needed to extend the service life of dock.
3. Identify potential structural issues and concerns beyond immediate repair needs.

Figure 1: View from Pontoon Deck

2.2 Description

Dry Dock #2 is a single section steel floating dry dock. The structural analysis and design of the dry dock was performed by Earl and Wright, Consulting Engineers of San Francisco and was constructed by the Bethlehem Steel Corporation at their San Francisco Yard in 1970.This dry dock can best be described as a rigid unit type dock with continuous pontoon and wing walls. An 18-foot wide buoyancy chamber runs full length down the centerline of the pontoon, and a safety deck is located port and starboard at a height of 58'-6" in each wingwall. At 40-foot intervals down the length of the dock are located watertight transverse bulkheads, running from buoyancy chamber to safety deck. These subdivide the pontoon and wingwall into forty (40) ballast compartments, twenty (20) on each side. The comparatively close spacing of transverse watertight bulkheads allows for a close correlation between ship-load and dry dock lift, with consequent reduced bending in both dock and ship.

At 10-foot intervals between watertight bulkheads are non-watertight transverse bulkheads. The combination of pontoon deck and bottom plating plus pairs of transverse bulkheads spaced 10 feet apart from what is in effect a series of box girders. These girders distribute the concentrated centerline load of the ship transversely so that the lift of the entire pontoon can be utilized. The plate-girder design was chosen over the more conventional open truss design because of considerations of both weight and cost. The open truss would have required massive members with difficult end connections. Bulkheads are cross stiffened, with vertical stiffeners on one side and horizontal or sloping stiffening on the other, in order to keep the bulkhead plating as flat as possible.

In addition to the longitudinal bulkheads forming the buoyancy chamber and the wing walls, an additional non-watertight longitudinal bulkhead running full length, is located 42 feet off the centerline.

Longitudinal framing is used throughout the bottom, decks and wing walls with continuity maintained through the transverse bulkheads. Bottom longitudinals are serrated from longitudinals being cut from a single channel in order to ensure good drainage.

The watertight bulkhead stiffeners are constructed of flanged plate, with the end brackets made integral with the stiffeners. Non-tight bulkheads and watertight bulkheads in the wingwall spaces have "T" bar and flat bar stiffening.

The entire pontoon deck, plus certain highly stressed areas of the transverse bulkheads are constructed of Mayari R steel. This steel has a yield of 50,000psi and tensile strength of 70,000psi. The remainder of the drydock is A-36 steel.

In 2008 Dry Dock #2 was modified to allow several classes of large cruise ships to be docked. Six sponsons were added to provide additional transverse stability required due to the cruise ships' relatively high center of gravity. Pockets were built into the interior wing walls to accommodate maintenance on fin stabilizers utilized by these cruise ships. A significant amount of ½" doubler plate was added to the entire length of the pontoon deck and slot welded to the original deck plating along stiffener lines.

Dry Dock #2 is moored to four dolphins at the Pier 70 Shipyard owned by the Port of San Francisco. Mooring dolphins are located on the west face of the dock. Access between the dock and the shipyard's piers is provided by an articulating ramp at the south end of the dock.

Dry Dock #2 is one of two floating dry docks owned by the Port of San Francisco and located at the San Francisco Shipyard at Pier 70. Both dry docks are included in long-term lease agreements with ship repair contractors (tenant). In the past, the operator-tenants have been responsible for the maintenance and upkeep of the dry docks, along with bi-annual inspection and certification. The most recent inspection took place in January through February 2016. The recommended repair work was not completed prior to the closure of the shipyard in May 2017 and the dock's certification has expired.

Principal Characteristics of Dry Dock #2:

- Length Overall: 900'-0
- Length of Pontoon: 800'-0"
- Breadth overall: 186'-0"
- Width Between Wing Walls: 150'-0"
- Height Overall: 86'-0"
- Height of Wing Deck above Pontoon Deck: 66'-0"
- Height of Pontoon Deck at Centerline: 20'-0"
- Design Draft over Pontoon Deck: 41'-9"
- Maximum Submergence Draft[1]: 59'-6"
- Current Maximum Draft over Pontoon Deck[1]: 39'-6"
- Most Recent Certification Loads: 68 long tons (LT[2]) per foot or 55,800 LT total

Note 1: The shipyard noted that the maximum achievable submergence draft of the dock has decreased to about 39.5ft over the pontoon deck due to sediment accumulation in the submergence pit.

Note 2: Long Ton (LT) represents 2,240 lbs.

A plan of the deck and compartments is shown below as Figure 2. Watertight bulkheads are shown as red dashed lines.

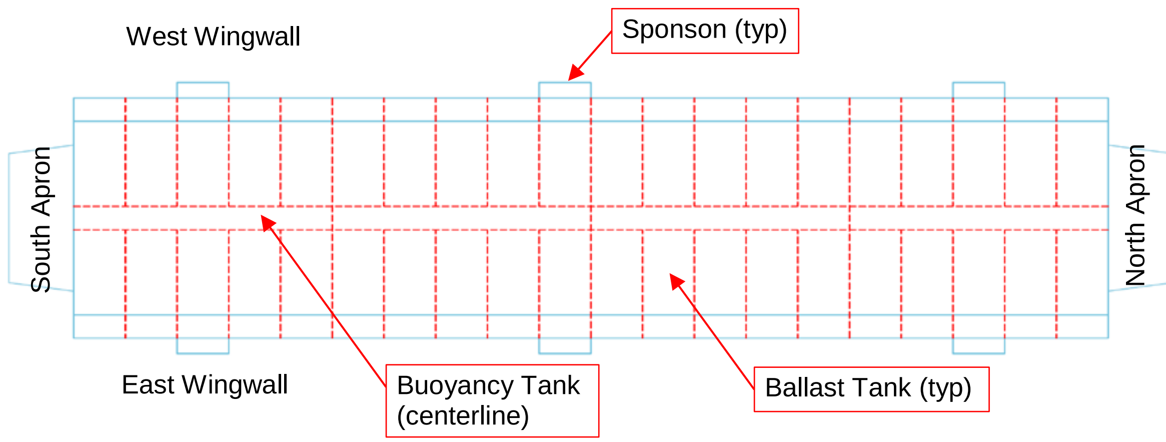

Figure 2: Dry Dock #2 Plan

A typical floating dry dock is shown in section as Figure 3 below.

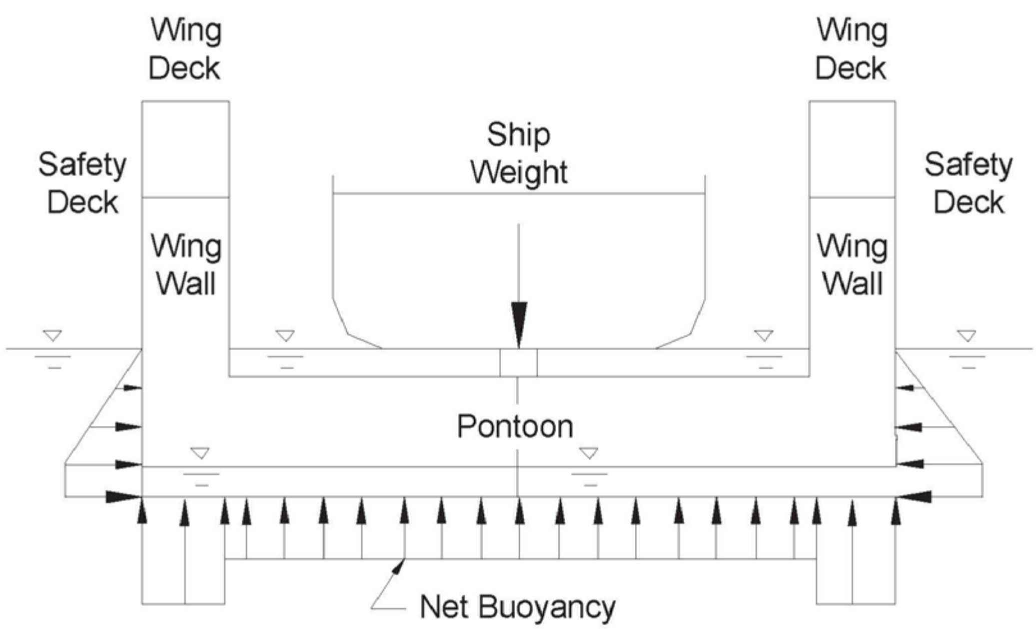

Figure 3: Typical Floating Dry Dock Section

An isometric cross section of Dry Dock #2 with key components labelled is shown in Figure 4.

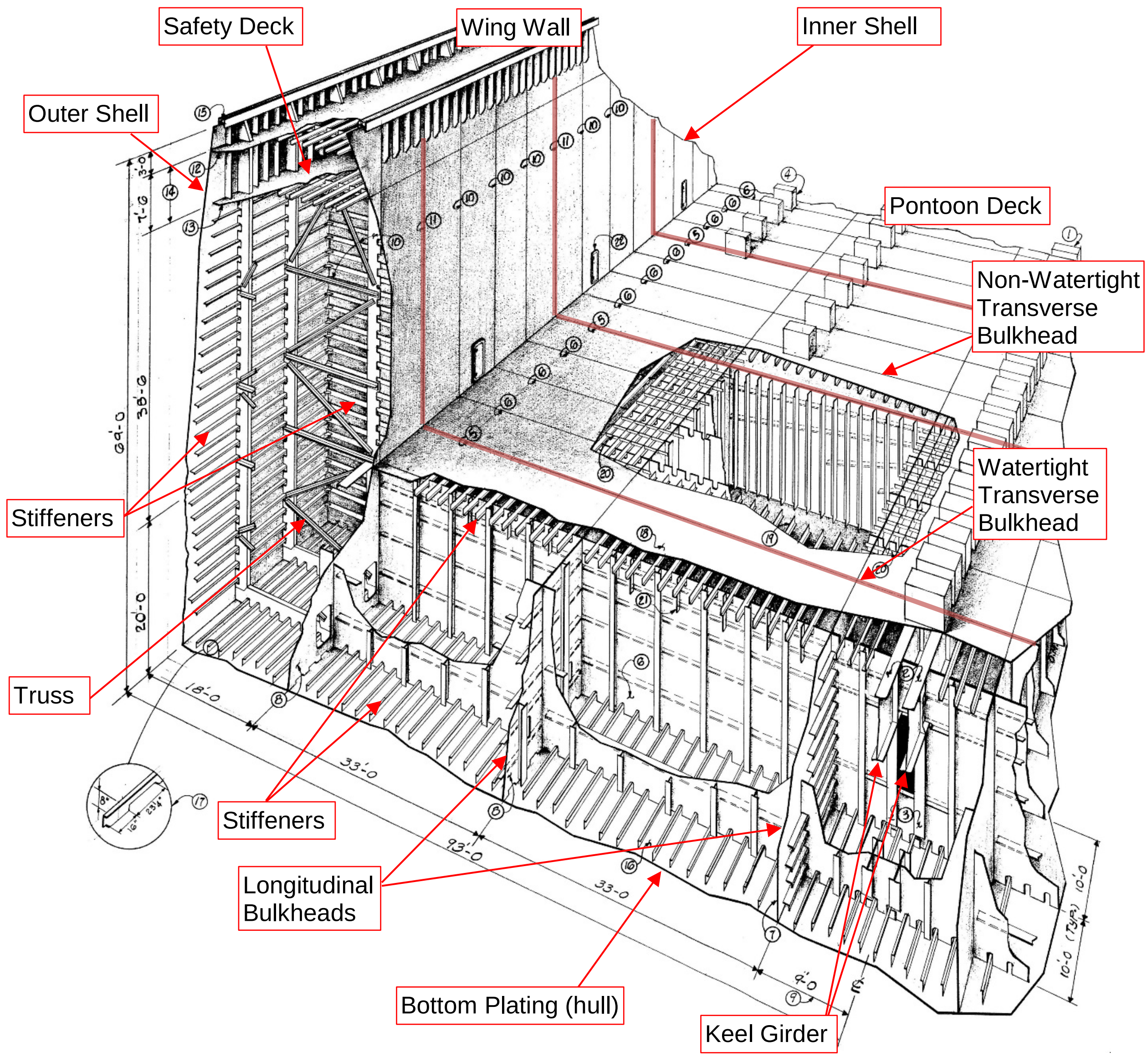

Figure 4: Isometric Cross Section View

Floating Dry Dock Displacement

Displacement of a floating vessel is equivalent to the weight of the water it displaces; therefore, displacement is another way of expressing the weight of the vessel itself. The displacement of a floating dry dock without a ship in dock equals the gross weight of the dock. The displacement of a loaded dock equals the gross weight of the dock plus the weight of the ship.

Table 1 below indicates the displacement of Dry Dock #2 at various pontoon freeboards and corresponding drafts (pontoon freeboard is measured at the lowest point of pontoon deck, which occurs at the sidewall.

Dry Dock #2 would have a current buoyant lift capacity of approximately 57,700 LT with an 18” pontoon deck freeboard based on Table 1 below.

Table 1: Dry Dock #2 Displacement

Pontoon Freeboard	Dock Draft	Displacement (long tons)
16’-0”	4’-0”	15,410
14’-0”	6’-0”	23,910
12’-0”	8’-0”	32,410
10’-0”	10’-0”	40,915
8’-0”	12’-0”	49,915
6’-0”	14’-0”	57,915
4’-0”	16’-0”	66,420
2’-0”	18’-0”	75,010
1’-6”	18’-6”	77,020
0’-0”	20’-0”	83,860
-2’-0”	22’-0”	87,025
-4’-0”	24’-0”	88,830
-6’-0”	26’-0”	90,635
-8’-0”	28’-0”	92,430
-10’-0”	30’-0”	94,230
-12’-0”	32’-0”	96,030
-14’-0”	34’-0”	97,825
-16’-0”	36’-0”	99,485
-18’-0”	38’-0”	101,130
-20’-0”	40’-0”	102,775
-22’-0”	42’-0”	104,420
-24’-0”	44’-0”	106,065
-26’-0”	46’-0”	107,710
-28’-0”	48’-0”	109,355
-30’-0”	50’-0”	111,000
-32’-0”	52’-0”	112,650

-34’-0”	54’-0”	114,290
-35’-0”	55’-0”	115,115

Source: Elliott Bay Design Group 2008

2.3 Basis of Condition Assessment

The following documents were referenced in the condition assessment of Dry Dock #2.

References:

1. Structural Design of 68,000 L.T. Floating Drydcok for Bethlehem Steel San Francisco Yard, Earl and Wright consulting Engineers, June 1969
2. Facility Certification Report (FCR) for Drydock No. 2, Southwest Marine, revisions 1986 to 1988
3. Dockmaster Training Manual, Heger Dry Dock, June 2005
4. Global Strength Analysis for Lifting Princess Class Cruise Ships, Elliott Bay Design Group, July 31, 2008
5. Finite Element Analysis, Bruce S. Rosenblatt and Associates, November 2012
6. Ultrasonic Gauging Survey, International Inspection, January 2016
7. Dry Dock 2 Ultra Sonic Thickness Gauging, DRS Marine, July 2016
8. Structural and Mechanical/Electrical Control Inspection Report, Heger Dry Dock, Inc, August 2016
9. Dry Dock 2 UT Readings Inspection Report, C&W Underwater, August 2016
10. Finite Element Analysis, Bruce S. Rosenblatt and Associates, August 2016
11. Letter 16-87L Request for HEGER Certification of Dry Dock No. 2 located in BAE San Francisco, CA, Heger Dry Dock, December 2016
12. Analysis of Wingwall Shell Plate as Surveyed Thicknesses, Bruce S. Rosenblatt and Associates, December 2016

Drawings

1. Structural Steel, Earl and Wright, 1969
2. Pontoon Deck Doubler Plate for Princess Cruises Vessels, Elliott Bay Design Group, August 1, 2008
3. Commercial Certification of Floating Dry Dock #2, Heger Dry Dock, December 2016
4. Repair Drawings, San Francisco Ship Repair / Puglia Engineering, May 3, 2017

3. Timeline of Dry Dock #2

Table 2: Summary of Condition and Ratings

Year	Condition	Rating	Notes
1969-1970	New	65,000 to 68,000 LT	Designed by Earl and Wright Consulting Engineers and constructed by Bethlehem Steel. Design capacity was 68,000 LT at zero freeboard. Operating capacity was 65,000 LT at 12" freeboard. (Ref. 1)
1979-1988	'Satisfactory'	59,600 LT	Southwest Marine's 1988 revision of the *Facility Certification Report* describes the certified capacity as 59,600 LT at 18" pontoon deck freeboard. Per the report: "the reduction in capacity is largely due to the change from 12" to 18" freeboard and the accumulation of residue". (Ref. 2)
Various	Pontoon deck requires repairs		Doubler plates installed on pontoon deck.
2008-2009		56,690 LT	Upgrades for Princess Cruise Ships: Additional doubler plates installed on pontoon deck and sponsons added for transverse stability. (Ref. 4)
2012	Corrosion reduces capacity	54,800 LT	FEA analysis considering measured corrosion is performed by Bruce S. Rosenblatt and Associates. A capacity downgrade is recommended and accepted by NAVSEA. (Ref. 5)
2014		54,800 LT	NAVSEA audit is passed and certification issued, expires Jan. 31, 2017
2016		54,800 LT	NAVSEA certification is extended to July 31, 2017
2016	Repairs recommended		Heger Letter 16-87L recommends replacement of wing wall and pontoon deck plate
2011-2017			Outer shell and pontoon deck panel replacements by Shipyard

4. Dry Dock Visual Observations

Previous inspections and condition assessment of Dry Dock #2 observed that the dry dock has extensive deterioration in the pontoon deck and wingwall plates due to corrosion and heavy use. Steel hulled dry docks typically deteriorate at varying rates throughout the hull. Many times badly corroded steel will be found near steel with little to no corrosion.

In general, certain areas of the dock generally corrode faster than other locations. These areas of greater corrosion rates typically found on a steel floating dock include:

1. Pontoon deck, usually one of the first areas to show heavy corrosion.
2. Intersection of the inboard wing wall and the pontoon deck.
3. Intersection of the safety deck and the wing wall side shell plate and/or vertical frames (from the safety deck up about 6 inches)
4. Internal portion of the wing wall from the pontoon deck level up to about 10 feet below the safety deck.

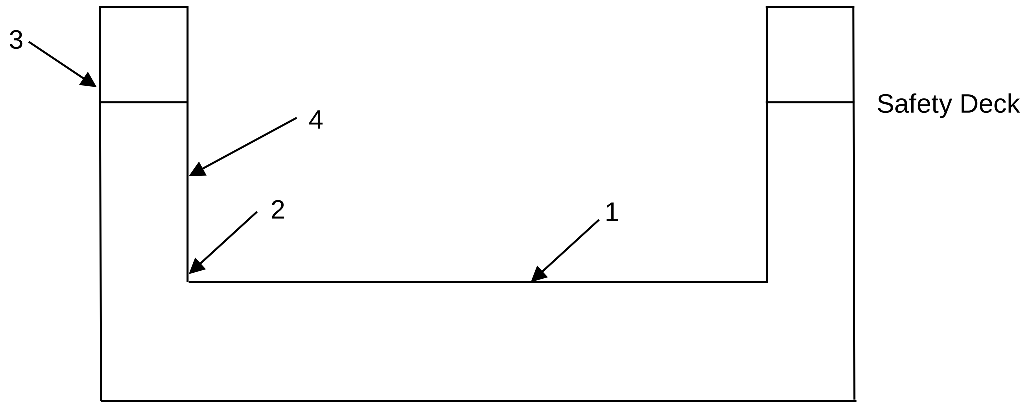

Figure 5: Section of Drydock

4.1 Pontoon Exterior Observations

GHD-TECI engineers observed that the top surface of the pontoon deck exhibits numerous locations of failed coating and loss of steel. A typical photo is shown as Figure 6 below.

Figure 6: Typical Pontoon Deck Corrosion

GHD-TECI surveyed the pontoon deck surface on June 13, 2017 along with RES Engineers to perform spot UT readings, available in Appendix D. Generally, the surface is divided into three distinct conditions: original steel, doubler plates, and new steel panels.

The original steel exhibits the worst condition with regions of significant steel loss and pockmarks of through-holes. Many holes have been patched with epoxy or thin steel plates, but much of those have already deteriorated. Additionally, the deck plate has permanently deflected between stiffeners, creating a grid-like pattern of deflections that pond water and accelerate corrosion. UT readings at the middle of the deflected steel show steel plates thinner than the minimum allowable thickness.

To strengthen the pontoon deck, 1/2 inch doubler plates have been welded to the top of the deck at two times over the dock's history over the majority of the pontoon deck. The doubler is attached in most cases using slot welds at the transverse and longitudinal stiffener locations. Generally, the top surface of the doubler plates is in good condition with spot UT readings showing very little corrosion. However, the original coating system has flaked off and is no longer adequately protecting the steel. UT readings at the top deck show the doubler plates have not deteriorated much. The International Inspection UT readings were collected from the inside of the tank and thus show the original plate thickness, not the doubler plate.

At regions outside of the doubler plates, the Shipyard operator has been periodically replacing 10-foot x 40-foot panels of stiffened plates. Generally, these panels are at the pontoon deck closest to the inner wall of the wing walls. The replacement panels and doubler plates are shown on Figure 7 along with an approximate map of through-holes.

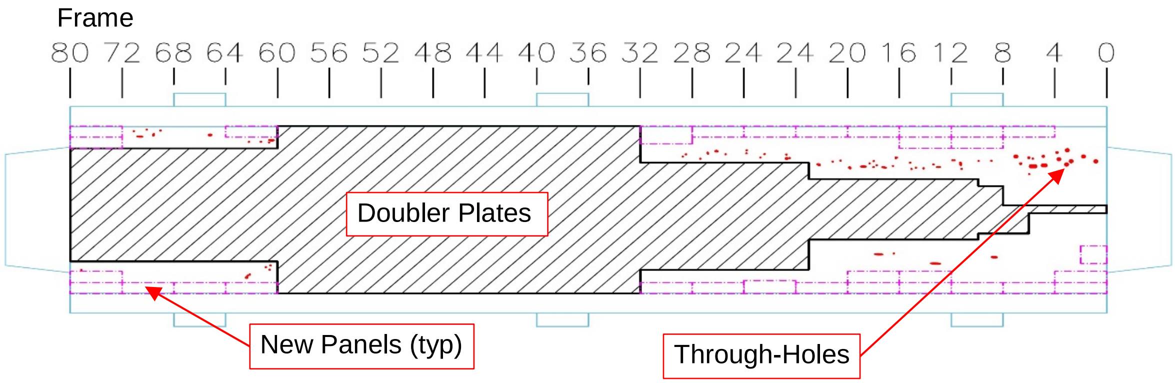

Figure 7: Deck Plan of Repairs and Holes

4.2 Interior Compartment Conditions

GHD-TECI engineers were not able to enter the dock internal compartments to conduct a condition assessment or to take confirmation UT readings. All observations and recommendations made are based on previous reports. Photos below are obtained from the structural inspection by Heger Dry Dock dated August 2016 and the UT survey data was is obtained from International Inspection's report dated January 2016. Typically, the Heger Dry Dock report notes that the interior ballast tanks contain up to 18 inches of mud and sediment. Per the design documentation, the bottom 10 feet was not coated and depended on sacrificial anodes and 10 feet of water in the ballast tanks.

Figure 8: Typical condition of pontoon ballast tanks (Heger Dry Dock Inc.)

Figure 9: Mud and sediment in the ballast tanks (Heger Dry Dock Inc.)

Figure 10: Looking up at the wing wall. Note extensive corrosion on maintenance platform (Heger Dry Dock Inc.)

Figure 11: Typical condition of a buoyancy chamber. Paint failure and rust film beginning in lower 10 feet of tank with paint 70% intact in upper 10 feet (Heger Dry Dock Inc.)

4.3 Hull Condition

An underwater condition assessment of Dry Dock #2 was conducted from June 12 to June 15, 2017 to evaluate the condition of the hull. The assessment was performed by four engineer-divers from Collins Engineers. Overall, the hull was estimated to be in satisfactory to fair condition with minor deterioration consisting of section loss as ascertained by ultrasonic thickness (UT) gauge measurement. The complete underwater condition assessment report along with photographs is included in Appendix B.

The underwater inspection consisted of Level I, II and III level investigation. A Level I visual-tactile inspection was performed on the entire hull. Level II cleanings to gather Level III UT gauge readings were taken along “belt lines” as shown in Figure 12 below.

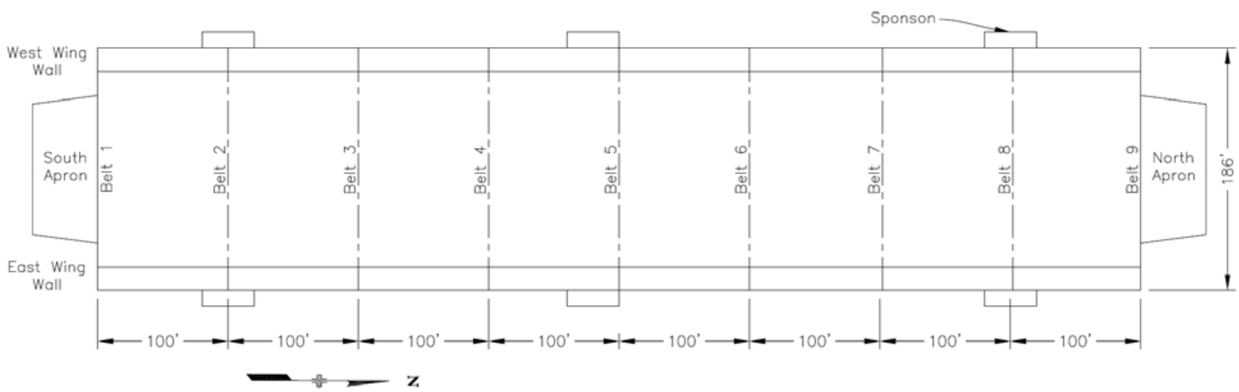

Figure 12: Dry Dock #2 Plan for Underwater Inspection

Overall, the submerged portion of the hull of Dry Dock #2 was deemed to be in satisfactory to fair condition, based on the established rating criteria presented in the ASCE Manual for Underwater Investigations, and there were no deterioration levels or other conditions observed during the underwater inspection of the hull that would warrant immediate concern. In general, the submerged surfaces of the hull exhibited 100% coverage of a dense layer of marine growth, which consisted of a 1 to 2 in. thick layer of harder shell growth directly on the steel, overlaid by a 3 to 4 in. thick layer of softer sponge and anemone growth.

Based on original design drawings the dock was constructed with 1/2 in. thick plate along a 32-foot wide strip down (north/south) the center of the hull and the remaining hull constructed of 7/16 in. Readings from the UT survey were compared to original design thicknesses and tabulated in Appendix C. The 1/2 in. thick mid-portion of the dry dock hull has an average remaining thickness in the range of 0.460 in., which suggests on average that approximately 9% of original steel thickness has been lost to corrosion-related deterioration. The 7/16 in. thick plate has an average remaining thickness in the range of 0.405 in., indicating an approximate 8% of original steel thickness has been lost to corrosion related deterioration.

At various locations UT readings indicated that 1/2 in. plate was used at locations where 7/16 in. plate was specified. This plate was located outside the 32-foot wide centerline strip, but measured thicker than 7/16 in. and thinner than 1/2 in. Assuming this plate was originally 1/2 in., the percent thickness loss is consistent with the rest of the UT survey.

During this survey, the range of steel loss observed can be estimated that 10% and 20% of the original steel thickness has been lost to corrosion-related deterioration over a timeframe of around 48 years. This in turn equates to between 0.001 in. (1 mil) and 0.002 in. (2 mil) of steel thickness loss per year. These values tend to be on the low side of what could be expected based on the recently published ASCE Waterfront Facilities Inspection and Assessment Standard Practice Manual. However, the values do tend to be in the neighborhood of suggested values for steel with adequate cathodic protection, such as the impressed current system installed at Dry Dock #2. Using a linear regression for future corrosion rates and assuming that future corrosion influences and deterrents will be same as to what has been present throughout the past, it can be suggested that another 40 years or so could transpire before remaining underwater steel thicknesses begin to pose concerns, provided cathodic protection system is maintained.

5. Structural Assessment

5.1 Structural Assessment Summary

The inability to recertify Dry Dock No. 2 is primarily related to corrosion of external plating at the wing walls and pontoon deck, and loss of strength to resist the differential pressure during submergence and ship lifting. While there has been significant corrosion throughout the dock, repairing these external plate elements is critical to regaining certification.

A maximum external differential pressure of 28 ft head will enable to dock to lift vessels of the draft, length and weight near its maximum capacity. Exterior ballast tank plate thicker than 0.35 in. has sufficient strength to resist 28 ft head. Exterior plate thinner than 0.35 in. is recommended to be replaced in order to restore the dock to its rated capacity without tank-by-tank pressure restrictions.

5.2 Load Cases

The “certified capacity” of a floating dry dock represents only one of several load cases that should be checked to ensure the dock has the strength and stability required for certification. This assessment does not seek to evaluate the dock for all relevant design load cases, but instead evaluates the two load cases most affected by observed damage to the dock: maximum differential pressure in ballast tanks and maximum vessel load / maximum rated load. These two cases occur at different phases of the docking operation, as shown in Figure 13.

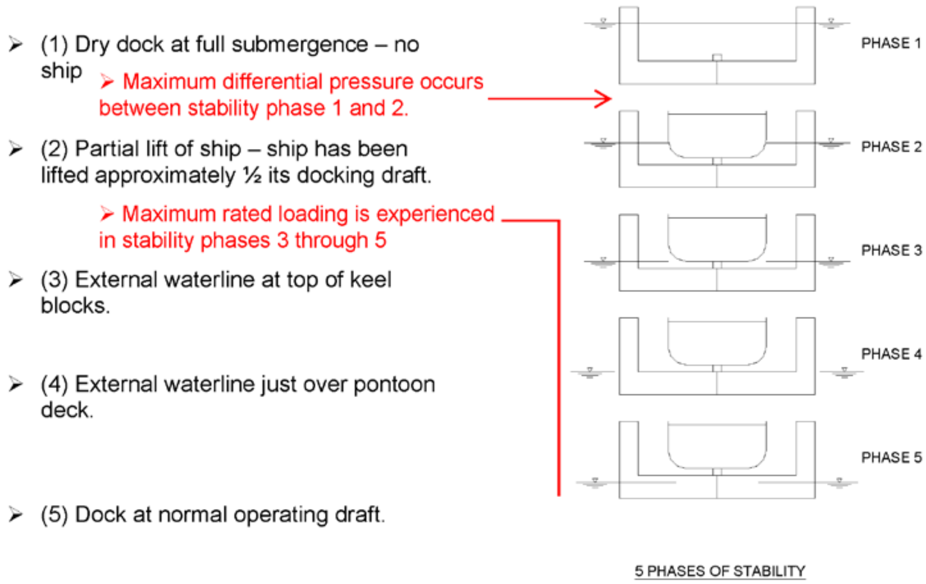

Figure 13: Max Load Cases (Figure from Heger Dockmaster's Training Manual Fig. 5.14, red annotations added for clarification)

Case 1: Maximum differential pressure

During the first phase of docking, the dock is filled with ballast and sunk in order for the vessel to move into position. The ballast is pumped out and the dock rises until it makes contact with the floating vessel's keel. Most of the dock is still underwater at this point, especially if the vessel has a deep draft. As ballast continues to be pumped out the dock and vessel keep moving up, but at a slower rate than the ballast levels in the wing walls are moving down. As the ballast levels move further down relative to the external waterline the external walls of the dock must resist the increasing difference in hydraulic head. If difference in water levels becomes too large, the pressure will deform the wall plates inward and could eventually cause a failure in the ballast tank bulkhead.

Once ballast levels fall below the pontoon deck there is a much larger ballast compartment and the volume of water in every 1 ft. increment of ballast dramatically increases. The dock and vessel will start to move upward at a faster rate than the ballast is drawn down. Further de-ballasting will decrease the differential pressure.

Figure 14 shows the typical trend of ballast level vs differential pressure. Dry Dock #2 has a 20 ft. tall pontoon, so the maximum differential pressure occurs when the ballast level is at 20 ft.

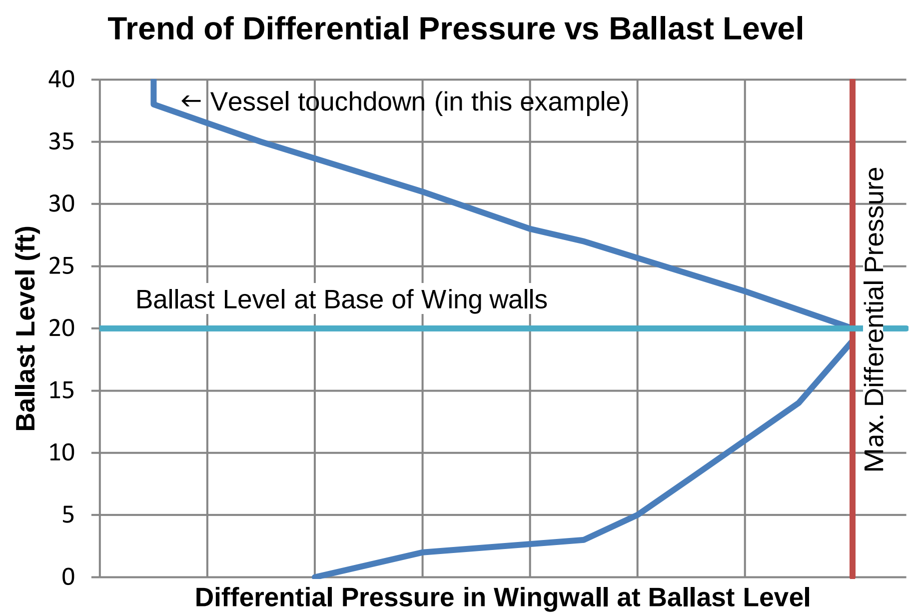

Figure 14: Typical relationship between head pressure and ballast level generated from near-capacity vessel

Case 2: Maximum vessel load

The capacity of a floating dry dock is normally described by a total load rating and a maximum load per foot. These are the values stated on the dock's certification paperwork. Dry Dock #2 was most recently certified for a total load rating of 54,800 LT and a maximum keel load per foot of 68 LT/ft. The maximum vessel loading case occurs when the vessel is fully lifted out of the water and its weight is fully supported by the buoyancy of the dry dock.

The vessel load is typically concentrated along the centerline of the dock while the buoyancy force is distributed evenly across the entire hull bottom. This results in transverse bending of the dock with is resisted by transverse bulkheads and top and bottom deck plating acting together as a beam member. The top plating is in compression and the bottom plating is in tension. The thickness of the top plating in compression and its resistance to buckling tend to govern the overall transverse strength of the dock. Figure 15 shows the maximum bending moment diagram in the transverse direction.

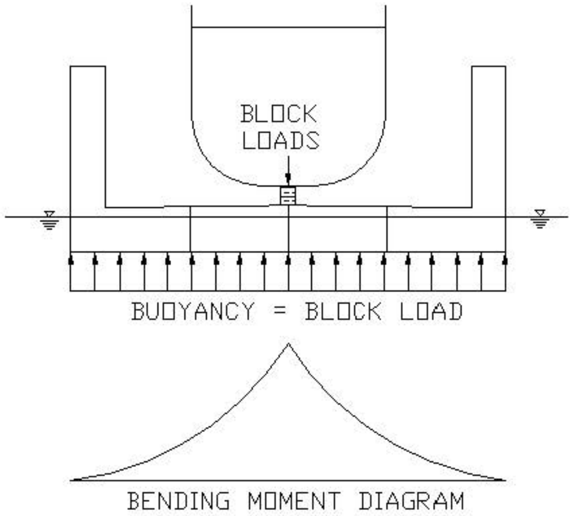

Figure 15: Transverse Bending Moment Diagram

5.3 Structural System Summary

Dry Dock #2 was originally designed in 1969 based on a capacity of 68,000 long tons (LT) total capacity with a design keel load of 84 LT per foot. See Figure 4 for a cross section of the dock and its construction in combination with discussion below.

Over time, the total rated capacity has been reduced due to a variety of effects such as corrosion of metal plate and increases in the dock's own self weight. Increases in weight have resulted from the addition of doubler plating, addition of sponsons, changes in equipment such as cranes, and sedimentation within the pontoon internal compartments resulting in always-present ballast. The NAVSEA requirement for an 18" minimum pontoon deck freeboard also reduces the rated capacity.

Most recently, Dry Dock #2 had a NAVSEA certification of 54,800 LT which expired July 31, 2017. A keel load of 68 LT per foot is used to represent this capacity. Based on calculations by Heger Dry Dock, using best estimates of the current lightship weight, Dry Dock #2 has a buoyant capacity of 55,800 LT with 18" freeboard.

Since constructed circa 1970, there has been a significant amount of corrosion, varying in degree, to most parts of the dock. A summary is discussed within this report in the Corrosion Evaluation section. Corrosion reduces the vessel lifting capacity of the dock requiring repair in order to continue achieving commercial or NAVSEA certifications.

The dry dock is built of transverse and longitudinal bulkheads that divide the pontoon into chambers and tanks. Transverse bulkheads are typically spaced at 10 feet on center, which span across the 186 foot pontoon width. The 79 transverse bulkheads combined with the top deck plating and hull bottom plating provide the transverse girders which possess strength required to lift vessels from the water.

Six longitudinal bulkheads and girders divide the dock lengthwise and serve to distribute load longitudinally when keel load varies along the length of the ship.

Every fourth transverse bulkhead, at 40 feet on center, is sealed top and bottom to form separate tanks that can be emptied at different rates to keep the keel trimmed during vessel lifting. There are a total of forty tanks, twenty on each side of the dock. There are two watertight bulkheads longitudinally offset from the vessel centerline 9 feet. This creates a buoyant chamber the full length of the dock that is never filled with water. This chamber divides the 20 ballast tanks on each side of the dock.

The pontoon top deck plate and bottom hull plate and support stiffeners are significant structural elements resisting both hydrostatic pressure when submerged and high compressive and tensile stresses in the plane of the plates when a vessel is lifted, as shown in Figure 16.

Shell plates forming the inside and external surfaces of the wing walls are also significate structural elements required to resist hydrostatic pressures when submerging and lifting vessels.

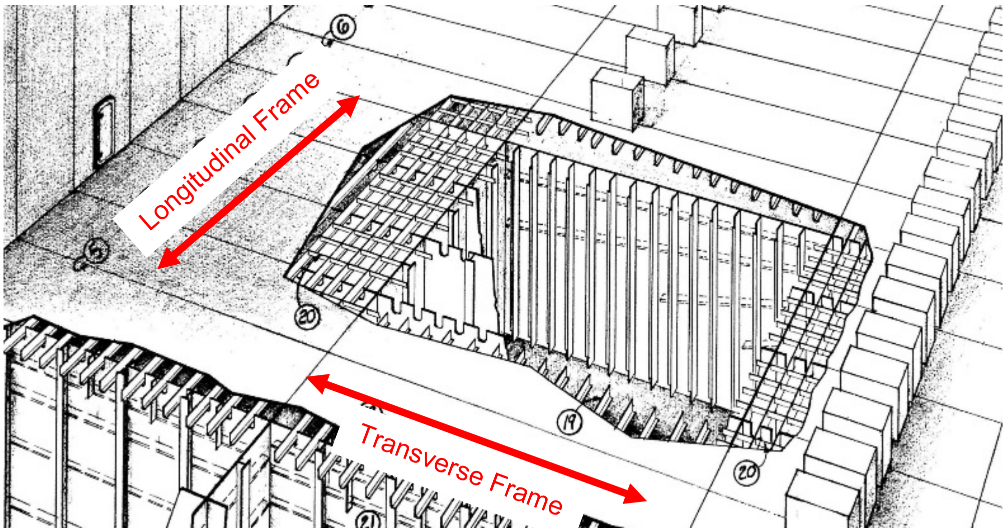

Figure 16: Pontoon Deck Framing–Transverse and Longitudinally Stiffened Panels

5.4 Maximum Differential Pressure

The reduced capacity of thinned external ballast tank plating to resist differential pressure was flagged as an issue by Heger's December 2016 letter and was the subject of a finite element analysis by Bruce S Rosenblatt and Associates, also in December 2016. This known issue was independently evaluated by GHD-TECI.

5.4.1 Determining the Maximum Differential Pressure

There are several factors that affect the maximum differential pressure experienced by the dock, including vessel weight, vessel hydrostatic properties, and keel block configuration. These factors are discussed more in Section 5.4.2. As a result it is difficult to propose a limit on maximum differential pressure without a detailed study of the larger vessels the operator wishes to dock at Dry Dock #2. Instead of performing such a study, past calculations and evaluations of Dry Dock #2 were reviewed. The maximum differential pressure from the "capacity vessel" assumed by these studies is tabulated in Table 3 below.

Table 3: Dry Dock #2 maximum differential pressure for capacity vessels

Source Document	Year	Max. Differential Pressure (ft, head)
Structural Design of 68,000 LT Floating Drydock for Bethlehem Steel – Earl and Wright Consulting Engineers	1969	**30 feet**
Dry Dock #2 Global Strength Analysis for Lifting Princess Class Cruise Ships Rev A – Elliott Bay Design Group	2008	**26.7 feet**
Dry Dock No. 2 – Finite Element Analysis – Bruce S. Rosenblatt and Associates	2012 & 2016	**26.75 feet**
Request for HEGER Certification of Dry Dock No. 2 located in BAE San Francisco, CA – Heger Dry Dock Inc.	2016	**"About 28 feet"**

Because the maximum pressure was fairly consistent, especially for recent studies, it was decided to use 28 feet of head as the maximum allowable differential pressure. Plate was checked to see if it had sufficient thickness to resist 28 feet of head.

5.4.2 Determining the Maximum Plate Thickness

The capacity of the top deck plate and wing wall plate, where significantly reduced by corrosion, to resist submerged hydrostatic pressures remains the limiting factor preventing certification of the dock. Plate loading used in the analysis is shown in Figure 17. Typically the design head pressure for deck plating above ballast tanks and wind wall plating is based a maximum differential water height of 28 feet (12.44 psi). GHD-TECI analysis indicates that areas where less than 0.33 inch plate remains cannot support this required pressure. Some areas of the deck and wing walls considerably thinner than this and must be replaced. Typical evaluation of plate for head pressure loading is done by checking plate bending stresses using a standard formula for a beam element spanning between supports. In this case, stiffeners are typically spaced at about 25 inches on center in most locations. A closer spacing is used near the vessel centerline where plate was designed to support head pressure over buoyancy chambers.

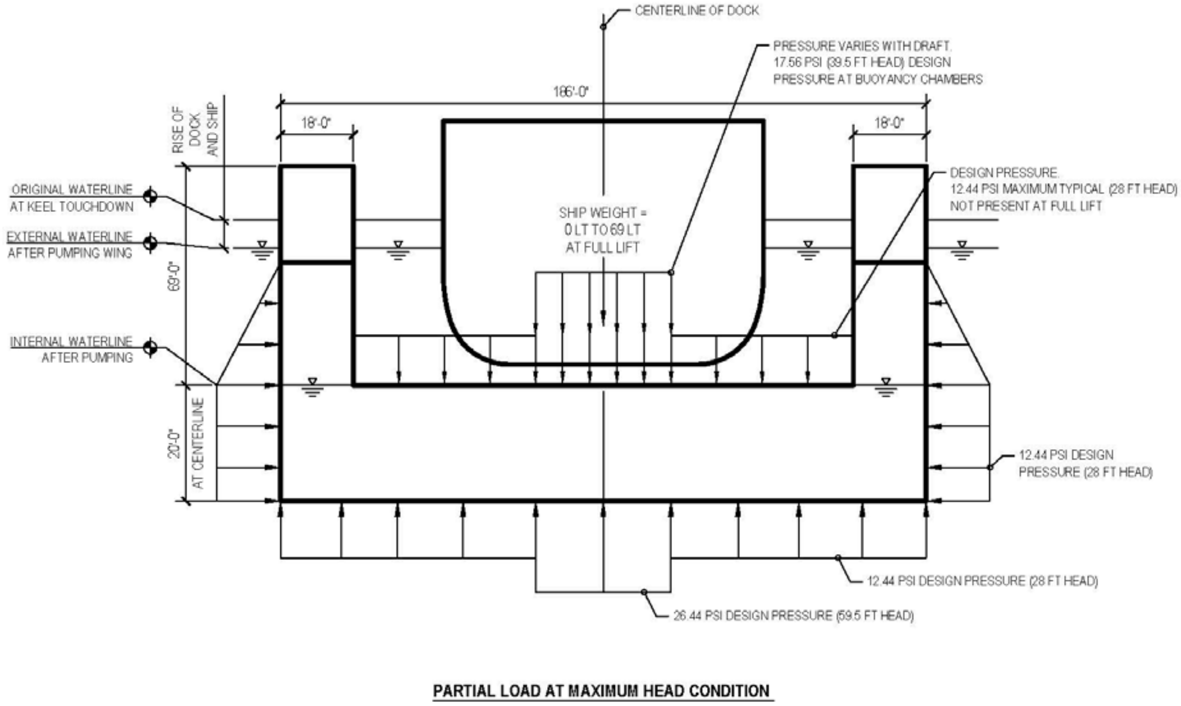

Figure 17: Partial Load with Max Hydrostatic Head

The calculation for maximum allowable head pressure given reduced plate thickness is as shown below.

$$M_{capacity} = 36000psi\ x\ \left(\frac{1in(0.33^2)}{6}\right) = 653\ in - lbs$$

$$Pressure\ Allowable = \frac{12(653in - lbs)}{(25.0)^2} = 12.5\ psi$$

$$Equivalent\ Head = \frac{12.5\ psi\ x\ (144\ sqin)}{64pcf} = 28.0\ ft\ head$$

GHD-TECI also evaluated the section modulus required for typical stiffeners used to support deck plating and wing wall plating. A section loss of up to 38% is typically acceptable for angle stiffeners assuming essentially no allowance for future corrosion. Stiffeners are used for wing walls are 7”x4” angles welded to the hull plate. Stiffeners for pontoon top deck are 9”x4” angles welded to the deck plate. Both were originally 1/2” plates. Considering the allowed reduction, sections with a remaining thickness of 0.3125 inches (5/16”) are acceptable. Stiffeners with less thickness should be considered for replacement prior to certification.

Stiffeners in the pontoon deck with reduced section and remaining deck plating that meets the 0.35” thickness requirement must be limited for vehicle carrying capacity. GHD-TECI calculations indicate that a vehicle with a wheel load up to 12,000 pounds may be acceptable for dual tire axles and half that for single tire axles. This equates approximately to a 15 ton truck with duals on a single rear axle or a truck of about 7.5 tons max with a single tire on a single rear axle.

It should be noted that the difference in thickness of plate needed to resist 26 feet of head vs 28 feet is only about 1/100 of an inch. The difference between the three recent studies was deemed to be insignificant in determining what plate should be replaced. An even larger change in the maximum allowable head pressure, say 18 feet vs. 28 feet only changes the thickness requirements by about 5/100 of an inch. As a result, it was decided that having a second, more restrictive head pressure limitation would still not significantly reduce the scope of plate replacement work, and would impose onerous limitations on the dock's future operator.

Partial repairs, described as 1st Priority by Heger Dry Dock, Inc. in their letter dated December 7, 2016, will only allow limited use of the dock by limiting the external differential water level on a tank-by-tank basis and restricting the lift capacity to 60% of the dock's rated capacity unless additional analysis is performed for each docking. At the request of the Port, the recommendations contained herein are based on providing repairs that will allow the vessel to be certified for 28 feet of differential water pressure. Plate thicknesses less than 0.35 inch remaining in thickness will need to be replaced on both the wing walls and pontoon deck in light of these recommendations.

5.4.3 Implications of 28 foot differential head limit

The 28 foot differential head limit appears to have been adequate for past operators and allowed docking of large ships near the dock's rated capacity. However, a new operator should have a clear understanding of this limit. There may be vessels lighter than dock's rated lift capacity that exceed 28 foot external differential pressure during a docking sequence.

The maximum differential pressure for a U-shaped floating dry dock always occurs when the ballast level is at the base of the wing walls. For Dry Dock #2 the maximum allowable differential pressure of 28 foot head will occur when the dock is at 48 feet draft and the pontoon ballast level is at 20 feet.

At 48 foot draft, the dock displaces approximately 109,000 LT of sea water. 20 feet of seawater ballast weighs approximately 77,000 LT. The dock's lightweight was most recently estimated at approximately 19,000 LT. The remaining dock displacement capable of supporting keel blocks and vessel loads is 109,000 LT – 77,000 LT – 19,000 LT = ±13,000 LT. All illustration of the load and ballast conditions that generate a differential pressure of 28 foot head is shown in Figure 18.

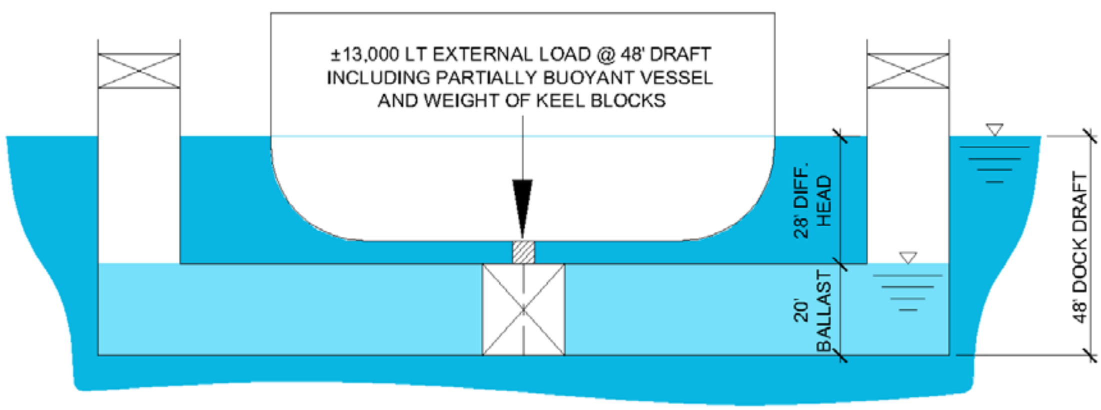

Figure 18: Dry Dock #2 vessel load and ballast conditions that generate a differential pressure of 28 feet

If combined keel block and vessel loading is 13,000 LT at < 48 foot draft the dock will continue to move upward before reaching equilibrium and differential pressure will be less than 28 foot head. If combined keel block and vessel loading is 13,000 LT at > 48 foot draft the dock will reach hydrostatic equilibrium below 48 foot draft, and the differential pressure will exceed the 28 foot head limit.

For each planned docking the weight and height of keel blocks and the vessel's hydrostatic properties should be checked to confirm that the ±13,000 LT limit is not exceeded at 48 foot dock draft. Prospective operators are advised to obtain or estimate the hydrostatic properties of potential vessels to be docked at Dry Dock #2 to confirm that the 28 foot differential head limit is not exceeded. Section 10.2 of the Heger Drydock Inc. Dockmaster's Training Manual (Reference 1) outlines the procedure for performing this check with known or approximated vessel hydrostatic properties. As a general rule, the Heger Manual states that "the deeper the draft and wider the beam of the vessel being docked, the higher the maximum hydrostatic head will be."

It should be noted that this simplified analysis assumes the same ballast level in all tanks (i.e. a relatively uniform load over the entire dock length). It also does not consider trim in the dock or the upward camber of Dry Dock #2's pontoon. A more detailed analysis considering these factors could be performed by a naval architect if desired by a future operator.

5.5 Maximum Vessel Load

Although it was not specifically flagged as a problem by recent evaluations, the transverse bending case under maximum vessel load was evaluated by GHD-TECI due to concerns about the pontoon decks ability to resist compressive loads under this load case. The transverse strength of the dry dock is provided by the transverse bulkheads (watertight and non-watertight) in the pontoon. The pontoon structure must distribute the concentrated load of the ship along the dock's centerline to the buoyant support of the water over its entire width by its transverse strength.

As described in Section 5.2 the maximum positive transverse bending moment occurs at the point when the exterior water is at the top of the keel blocks. At this time, there is 100% of the vessel weight on the floating dock while the pontoon and the submerged section of the wing walls provide lift.

GHD-TECI structural evaluation and recommendations primarily rely on previous reports prepared by Bruce S. Rosenblatt and Associates, Heger Dry Dock, and Elliott Bay Design Group. Rosenblatt and Elliott Bay each prepared comprehensive finite element analysis models of the entire dry dock. They typically included all parts of the dock including plate, stiffeners, and girders. They each considered multiple loading phases during the evolution of a dry dock lift.

GHD-TECI prepared a simplified analysis model using SAP2000 structural analysis software to evaluate transverse dock loading due to lifting keel-supported vessels where the entire load is assumed placed at the centerline of the dock as shown in Figure 15.

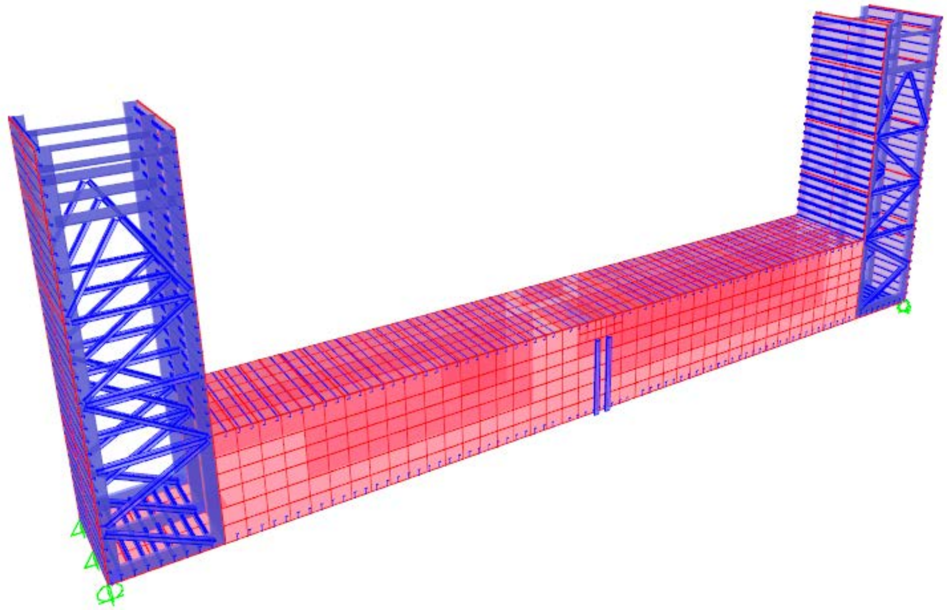

Figure 19: SAP2000 Model of Pontoon Frame

A vessel keel loading of 68 LT per foot was placed on a representative longitudinal section modelled in three dimensions as shown in Figure 19. A reduction of plate thickness of about 38%, to model the effects of corrosion, was used in our analysis to compute compression and plate bending stresses. GHD-TECI did not build analysis models as comprehensive as the previous firms had done. This is intended as a verification of results by Rosenblatt and Elliott Bay Design Group.

Since the original plate thickness for the pontoon deck was 0.5” (1/2”) we used a remaining thickness of 0.3125” (5/16”) for our estimates of stress. Areas of the bottom plate within sixteen feet either side of the centerline were built using 0.5” plate and were also modelled with 0.3125” plate. Remaining areas of bottom hull plate were built with 0.4375 (7/16”) plate. These areas were modelled as 0.375 (3/8”) plate for verification purposes.

GHD-TECI also only considered one representative loading phase as part of the verification process in order to compare stresses to previous reports. The loading used consisted of a load of 55,200 LT placed as a continuous line load along keel girders of 69 LT per foot in order to cover the full desired lift capacity of 55,000 LT. The bottom hull plate was loaded with a pressure of 1,095 psf representing a draft of about 17 feet which balances the 69 LT per foot load.

Compressive and tensile stresses in the top and bottom pontoon plates as a result were in the 30,000 psi range at peak stress locations near the center of the dock. This stress is similar in magnitude to those reported by Rosenblatt. Stresses of this magnitude are considered acceptable for the current condition of the dock. Additional corrosion of the pontoon deck plate, both the original plating and the double plate, may change this evaluation.

5.6 Overall Structural Condition

The exterior vessel hull on the inside and outside of both wing walls has corroded significantly over time. The original 7/16 inch thick plate has been reduced significantly in many places reducing the capacity to resist hull water pressures when submerged and during ship lifting. This is the primary issue affecting lifting capacity and submergence of the dry dock. As described in Section 5.4, repairs are recommended to allow the dock to resist the pressure of a 28 foot differential between the external water level and the internal ballast. Plate thicknesses less than 0.35” remaining in thickness will need to be replaced on both the wing walls and pontoon deck in light of these recommendations.

There has been considerable loss of the original pontoon deck thickness over time. The original deck plate thickness was 1/2 inch. Much of the deck has been plated over using a new 1/2 inch doubler plate welded down to the existing deck. New deck plating has some corrosion loss but for the most part is still nearly full thickness. Some parts of the original deck top plate, where no doubler plate exists, must be replaced to maintain adequate resistance to external differential pressure during submergence and to provide a safe work surface with capacity for work vehicles, equipment and keel or side blocks.

Overall the combination of original deck plate and newer doubler plate together provides enough resistance to compressive stresses in the top plate caused by the desired 68 LT per foot ship keel loading of the transverse frame members. Neither the original plate alone nor doubler plate alone should be relied on to resist compressive stresses due to transvers loading. The original deck plate is the “weak link” in this arrangement since it is already thin, and because it provides the load path between the doubler plate above and the stiffeners below. Future operators are advised to closely monitor the original deck plate for corrosion from inside the ballast tanks and implement a coating program to protect this plate from additional section loss. Preventing corrosion in the void between the original deck and the doubler plate is also essential, and requires that all seal welds at the edges of doubler plates and at manways are carefully inspected and maintained.

The original pontoon bottom hull plate has not experienced as much corrosion as the top deck plate. Overall the bottom plate can resist tensile stresses caused by the desired 68 LT per foot keel loading including some margin for future corrosion loss.

Plate stiffeners are typically 7x4 angles at wing walls, 9x4 angles at the pontoon top deck, and 8 inch deep serrated channels for the bottom plate. Typically where these members have less than 25% thickness loss they are acceptable for the current 28 foot head pressure targeted. Members exceeding 25% loss may become maintenance issues in future cycles of recertification. Many stiffeners will be replaced with hull plate replacement currently being proposed.

Where steel plate remains thicker than 0.35 inches and is not currently recommended for replacement, and the attached stiffener thickness loss is 38% or more (remaining stiffener thickness of 0.31 inches), consideration should be given to replacing stiffeners or adding plates to strengthen stiffeners in those locations.

A pair of 6 foot deep keel support girders runs down the center of the dock along the top of the buoyancy chamber. These girders were originally designed for a very high load of 2 times the original design load of 84 LT per foot to account for potential skipped loading where a section of keel blocks might be left out. The result is that substantial section loss is acceptable for current reduced loading of 68 LT per foot. Losses of up to 50% of girder flange thickness and girder web thickness is tolerable.

Operational limits should be placed on keel girder loading without case by case evaluation. Keel loading at 68 LT per foot should be continuous without skipping or leaving out sections of keel support. If it is necessary to leave out keel support for vessel maintenance, the dock should be evaluated for that vessel at those specific locations where loads will exceed 68 LT per foot.

5.7 Structural Repair Recommendations

The structural evaluations above indicate that Dry Dock #2 that steel plating on the wing walls and pontoon deck with thickness less than 0.35 inches should be replaced with new plating. Panels should be replaced in sections between bulkheads with all new stiffeners attached to match the original. Gussets used to connect existing stiffeners to bulkheads should be replaced at the same time.

Stiffeners with more than 38% thickness loss should be replaced or repaired by adding plate or angles to reinforce the section.

With limited repairs to the plating the dock should be able to re-gain certification, and maintain a certified lift capacity of 55,000 LT vessel loading.

6. Corrosion Evaluation

6.1 Original Design Corrosion Protection

Dry Dock #2's original design for corrosion protection incorporated impressed current, sacrificial anodes, and coating systems as described in the dock's original design documentation from 1970:

The ballast compartments of the drydock normally will contain some salt water, since these compartments will be drained only to make a maximum lift or for maintenance. The usual water depth will be 10 feet. This internal area, from the 10-foot waterline down, will be cathodically protected, using a total of (2,080) 90-lb. aluminum-sacrificial anodes. Design life of the anodes is ten (10) years.

Above the 10-foot waterline the interior steel surfaces will be protected by a coating of polar oil, initially sprayed on, and re-applied by floating on the surface of the water. Openings are provided in the pontoon deck to allow the addition of the oil close to the area to be recoated. Permanently installed catwalks under the safety deck provide access to areas which are otherwise difficult to coat.

The pontoon deck of a floating drydock is subject to a great deal of mechanical abuse from wheeled vehicles, anchor chains being ranged and sandblast sand; with phosphoric-acid washes, as well as salt water contributing to chemical corrosion. For this reason the entire pontoon deck has been constructed of Mayari-R steel. This is a low-alloy, high-tensile steel which meets the requirements of the ASTM A-242 specification for its physical characteristics. It has from 4 to 6 times the atmospheric corrosion resistance e of carbon steel. No protective coating will be applied to this deck except in the deck scupper area and under the keel blocks.

The exterior below the 17 -foot water line will be cathodically protected, using an impressed current system. Sixteen (16) platinized niobium, 3/8" diameter by 8 feet long anode assemblies will be hung from the outboard sides of the wingwall. Four (4) reference cells will be installed at intervals down the centerline to monitor the output of the system. The design current density is 9.5 rna/sq. ft. Current is supplied by four (4) 450-ampere saturable reactor rectifiers.

Above the 1 7-foot waterline, the entire structure with the exception of the pontoon deck will be sandblasted and coated with two coats of a coal-tar epoxy to a thickness of 16 Mils.

Buoyancy chamber and safety deck areas will receive one prime and one finish coat of paint.

In general, the original corrosion protection systems in Dry Dock #2 appear to have been properly designed for its era of construction. The impressed and sacrificial cathodic protection systems appear to have functioned successfully over the dock's lifetime, although GHD-TECI did not verify their current effectiveness. The coating systems have not been maintained and corrosion has occurred as a result. It should be noted that modern environmental, health and safety regulations do not allow the types of coatings that were originally specified.

6.2 Corrosion Zones and Average Loss Calculation

GHD-TECI reviewed available historical Ultrasonic Thickness (UT) reports, various inspection reports, and documentation related to assessment of various structural steel components of the Dry Dock #2. Based on review of the available historical documentation, GHD-TECI designated several zones and averaged the total section loss for selected steel components within these zones. The primary source data for the developed estimates is presented in International Inspection, Inc.'s report "BAE DD #2 Ultrasonic Gauging Survey" dated January 2016. The source of data noted as "external measurement: 2017 dive inspection" is "Port of San Francisco – Dry Dock 2 Underwater Condition Assessment" prepared by Collins Engineers, Inc., dated July 25, 2017.

Corrosion of steel is not typically linear. A significant factor affecting the rate of corrosion include time to corrosion initiation; which is likewise a function of the time to partial or total loss of dielectric coating system integrity. Environmental corrosivity, and dielectric coating efficiency, adherence, and integrity are factors which effect time to corrosion initiation due to degradation of coating integrity. Additionally, the corrosion rate during periods of time where cathodic protection was achieved per NACE criteria on submerged elements should be considered as effectively 0%, suggesting that an overall average of corrosion rate which includes such unknown periods of time is not as high as it would be in the absence of application of cathodic protection. However; the substantial service life of Dry Dock #2, along with the majority of data and analysis of exposure zones not subject to continuous submerged service, enables estimation of corrosion rate based on 2016 and 2017 measured data in consideration of reported nominal element thickness.

Because GHD-TECI was not able to perform independent UT readings inside the tanks, all estimated corrosion rates were analyzed from the January 2016 International Inspection readings. All the data points were assigned into zones as depicted in Figure 20 and summarized in Table 4.

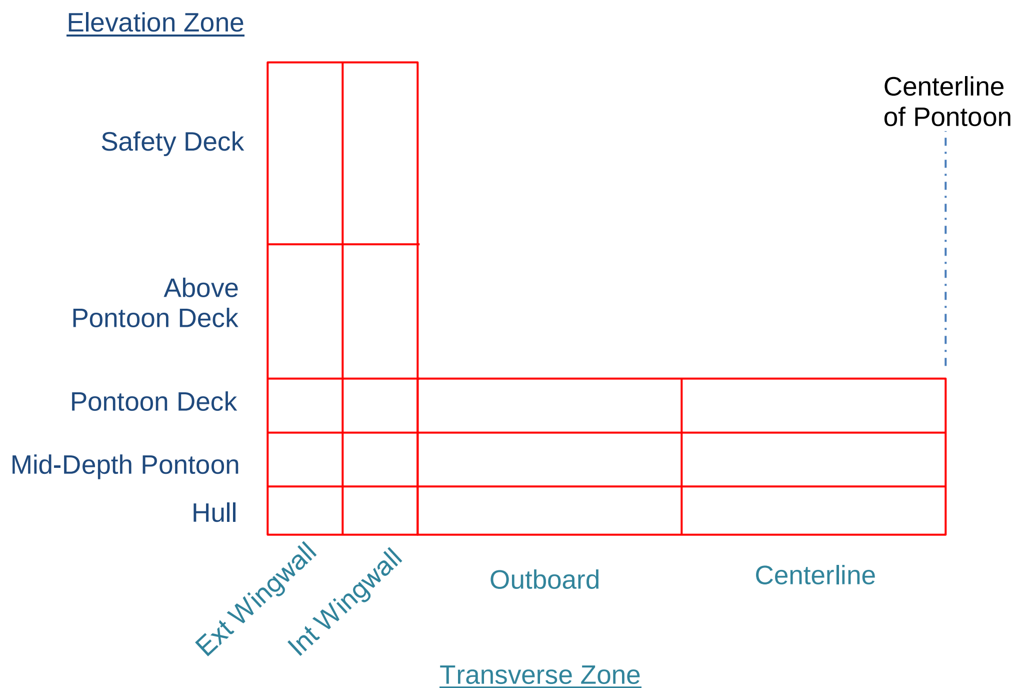

Figure 20: Map of Elevation and Transverse Zones

Table 4: Average Section Loss by Structural Member/Elevation Zone

Structural Member	Elevation Zone	Average Loss Since Original Construction
Girder	**Pontoon Deck**	9.6%
Plate	**Hull**	9.7%
Plate	**Mid-depth Pontoon Deck**	12.0%
Plate	**Pontoon Deck**	20.2%
Plate	**Above Pontoon Deck**	17.9%
Plate	**Safety Deck**	6.6%
Stiffener	**Hull**	8.5%
Stiffener	**Mid-depth Pontoon Deck**	9.7%
Stiffener	**Pontoon Deck**	12.3%

Stiffener	**Above Pontoon Deck**	17.3%
Stiffener	**Safety Deck**	16.4%
Truss	**Hull**	9.0%
Truss	**Mid-depth Pontoon Deck**	11.0%
Truss	**Pontoon Deck**	12.6%
Truss	**Above Pontoon Deck**	12.7%
Truss	**Safety Deck**	15.7%

The five (5) structural member types, of those listed, exhibiting the highest average cross sectional losses (greater than 15%) correspond to Elevation Zones of the Pontoon Deck and above: namely Pontoon Deck, Above Pontoon Deck and Safety Deck. This is consistent with the corrosive nature of the exposure zone and the use of protective dielectric coatings as the sole means of corrosion control. Structural members located within the Elevation Zone designated as Hull exhibited an average cross sectional loss of less than 10%, which suggests that the corrosion related degradation of some of the structural members assessed within the Hull zone may have been reduced by application of cathodic protection.

6.3 Corrosion Protection Recommendations

6.3.1 External Hull Cathodic Protection

Impressed current cathodic protection will serve as the primary mechanism for corrosion control of continuously submerged external hull surfaces. Impressed current cathodic protection refers to the sourcing of DC current, converted from AC to DC current by cathodic protection rectifier units, through impressed current anodes located by hanging mechanisms around the dry dock hull.

Continuously submerged portions of the external dry dock hull shall be cathodically protected in accordance with cathodic protection criteria per NACE SP0-176: namely a negative (cathodic) voltage of -0.80 V or more negative measured between the structure surface in the submerged zone and a silver/silver chloride/seawater reference electrode (Ag/AgCl) contacting the seawater.

The original external cathodic protection system consisted of sixteen (16) platinized/niobium 3/8" diameter by 8 foot long anodes powered by four (4) 450 Ampere rectifiers. The current integrity and functionality of the cathodic protection is unknown, as is the status of interim supplementations, modifications or replacements. If existing and determined viable, the original cathodic protection facilities may continue to be used, supplemented, repurposed or abandoned. Means and methods for achieving and maintaining cathodic protection of external submerged hull surfaces shall be the sole responsibility of the lease holder.

Cathodic protection shall be demonstrated to achieve conformance with NACE SP0-176 criteria based on testing to be commissioned and performed by a certified NACE Cathodic Protection Specialist. Ongoing conformance with NACE criteria for cathodic protection shall be demonstrated by testing and reporting, to be commissioned and performed by a NACE Cathodic Protection Specialist, on an annual basis.

6.3.2 Internal Ballast Tank Cathodic Protection

Galvanic cathodic protection will serve as the primary mechanism for corrosion control of continuously submerged external hull surfaces. Galvanic cathodic protection refers to the sourcing of DC current provided through consumption of a galvanic anode, typically zinc or aluminum for use in seawater. Continuously submerged portions of the internal compartments, shall be cathodically protected using galvanic anodes in accordance with cathodic protection criteria per NACE SP0-176: namely a negative (cathodic) voltage of -0.80 V or more negative measured between the structure surface in the submerged zone and a silver/silver chloride/seawater reference electrode (Ag/AgCl) contacting the water within each tank.

The original ballast tank cathodic protection system consisted of 2080 (total) 90-lb aluminum galvanic anodes. The current integrity and functionality of the existing cathodic protection system, if any, is unknown, as is the status of interim supplementations, modifications or replacements. Means and methods for achieving and maintaining cathodic protection of internal submerged ballast tank surfaces shall be the sole responsibility of the lease holder.

Cathodic protection shall be demonstrated to achieve conformance with NACE SP0-176 criteria based on testing to be commissioned and performed by a certified NACE Cathodic Protection Specialist. Ongoing conformance with NACE criteria for cathodic protection shall be demonstrated by testing and reporting, to be commissioned and performed by a NACE Cathodic Protection Specialist, on an annual basis.

6.3.3 Dielectric Coating Systems

Dielectric coating references an applied protective coating which serves as an insulator to the flow of electricity. As corrosion is an electrochemical phenomena, use of dielectric coating systems will be the primary means of corrosion control for steel and metallic elements in splash zone and atmospheric exposure zones; and used in combination with cathodic protection for continually submerged exposure zones.

Recommended coating systems, to be used on any new steel elements, steel repairs, or areas designated for re-coating, include ultra-high (98%+) solids epoxy coatings applied to a minimum dry film thickness (DFT) of 45 mils. Minor coating repairs shall be conducted using high build brush grade epoxy repair coatings, identical to, or compatible with, the primary epoxy coating used per the coating manufacturer’s recommendations. Surface preparation; coating mixing and preparation; application processes, procedures and protocols; and product storage shall be in strict accordance with the coating manufacturer’s recommendations.

7. Recommended Repairs

GHD-TECI reviewed repairs required for Dry Dock #2. The recommend repairs for the dry dock are presented below.

7.1 Repair Description

Recommended primary repairs include replacing and patching steel plating with thickness less than 0.35 inches at wing wall external shell and pontoon deck locations in order to allow submergence of the dry dock and withstand differential hydrostatic pressures during vessel lifting phases. These repairs will restore the structure's watertight integrity and also allow safe traffic and personnel use of the pontoon deck. With properly completed repairs, the Dry Dock #2 can be certified for lifting vessels in the 55,000 LT displacement range.

Quantities of steel plate replacement were estimated from the following:

- Available UT readings from International Inspection, January 2016 (Reference 6)
- Visual observations of pontoon deck surface on July 2017, with particular attention to through-holes
- Scope of repairs that the shipyard has completed, per drawings (Drawing Reference 4) and visual confirmation

Corrosion is an ongoing nonlinear process and it is recommended that an updated detailed investigation be performed prior to any work. Note that the UT readings from International Inspection are taken along one belt line per 40-foot tank.

7.2 Recommended Inspection and Maintenance Program

GHD-TECI recommends the following items be conducted as part of a regular inspection and maintenance program.

7.2.1 Steel Inspection

Visual inspection and UT gauging of steel plate and primary structural framing elements should be conducted at 12 month intervals. The thickness gauging should occur at consistent, marked and documented locations. The pontoon deck doubler plate should be inspection using visual observations and UT gauging of original deck plate and supporting stiffeners from within the internal compartments. Inspection of the slot welds attaching the doubler plate to the original plate is also important as this connection strengthens the plate against buckling due to compressive stresses.

7.2.2 Cathodic Protection

Cathodic protection systems should be assessed on an annual basis for conformance with NACE SP0-176 by a certified NACE Cathodic Protection Specialist. Adjustment of rectifier tap settings, controlling DC current output of impressed current cathodic protection systems, may be necessary as a part of the annual survey.

Rectifiers should be assessed on a monthly basis to confirm that the rectifier is powered and DC voltage and current output should be read from the rectifier gauges. The Cathodic Protection Specialist should be notified if monthly gauge reading deviate by more than 10% from the readings of the previous month or more than 20% from the readings recorded per the most recent annual survey.

Periodic anode replacement, of both impressed current and galvanic anodes, may be required based on the results of the annual surveys and per the recommendations of the Cathodic Protection Specialist.

7.2.3 Dielectric Coating Systems

Dielectric coating systems should be assessed on an annual basis for indications of failure including cracking, delamination, blistering or other visible mechanisms of degradation. Field coating repairs should be conducted as a part of the annual assessments using high build brush grade epoxy repair coatings, identical to, or compatible with, the primary epoxy coating used per the coating manufacturer's recommendations. Surface preparation for areas to be field repair shall be in accordance with the coating manufacturer's recommendations.

8. Cost Estimates for Recommended Repairs

The cost estimates developed for the recommended repairs assume that all work will be self-performed by the Shipyard's labor force. The steel plating replacement and repairs described in Section 7 is estimated to cost approximately $5,205,774 for materials, labor and equipment.

In addition, a range of estimated unit costs were developed coating of the dry dock internal compartments and external surfaces. The high and low end of the unit cost range reflects smaller and larger surface areas for preparation and recoating, respectively.

The regular replacement of sacrificial aluminum anodes will also be a maintenance expense necessary to maintain the dock. A cost estimate to replace all anodes in one ballast tank is provided. Replacement of anodes should be prioritized based on the findings of regular recommended inspections.

A 30% contingency factor for design development and estimating was used for the cost estimate.

Preliminary cost estimates for the repair concepts were developed by GHD-TECI's subconsultant, M. Lee Corporation and the report is included in Appendix A.

9. Conclusions and Recommendations

It is GHD-TECI's recommendation that steel plating with thickness less than 0.35 inches at the wing walls, pontoon deck and other locations be repaired or replaced. Plate elements with holes and other damage should also be replaced or patched. Repair of this damage at the locations noted will allow certification of the dry dock for lifting vessels in the 55,000 LT displacement range. Replacement of the deficient deck and shell plating will allow up to 28 foot differential head pressure.

Based on the UT readings in the 2016 International Inspection report, GHD-TECI has estimated approximately 25,000 square feet of wing wall plate replacement and 5,600 square feet of deck plate replacement. Typical replacements are performed in 10 ft. x 40 ft. sections of plate. These quantities are the basis of the cost estimate. It should be noted that the recommendation to replace one 10 ft. x 40 ft. section typically relies on a single UT reading. Future operators should strongly consider performing additional UT inspection at replacement locations to determine a more representative thickness of the plate. Similar additional inspection recommended by Rosenblatt in 2016 found that some plates were thicker on average than the initial UT reading suggested (Ref 12).

Implementation of the recommended structural repairs will allow certification for lifting of vessels with displacement of up to 55,000 LT.

Following replacement and repair of the damaged plating, appropriate coating should be applied to external and internal surfaces as noted in a previous section.

It is also important that a regular inspection and monitoring program be established by the shipyard operator with specific attention paid to the following critical items:

- Pontoon deck and hull near the centerline of the dock, including stiffeners welded to plate.
- Wing wall external shell with stiffeners welded to plate.
- Transverse bulkhead plate, especially near the centerline of the dock and especially near the top and bottom of the bulkheads.
- Wing wall plate near interface with pontoon deck, including the stiffeners welded to this plate.
- Two keel girders at the dock centerline.

Appendix A

Preliminary Estimate of Probable Repair Costs Report

PORT OF SAN FRANCISCO
DRY DOCK #2 REPAIR

PRELIMINARY ESTIMATE OF PROBABLE REPAIR COSTS
BASED ON CONCEPTUAL DESIGN INFORMATION

Owner:
PORT OF SAN FRANCISCO

Prepared for
GHD
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Prepared by
M LEE CORPORATION
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Cost Estimating and Project Scheduling
311 California Street, Suite 610
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Certified Estimating Professional
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Email: flee@mleecorp.com

Date: 7/31/2017 R1

1266 Dry Dock 2 Repair Estimate 20170731 r1

PORT OF SAN FRANCISCO
DRY DOCK #2 REPAIR

PRELIMINARY ESTIMATE OF PROBABLE REPAIR COSTS BASED ON CONCEPTUAL DESIGN INFORMATION

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Date: 7/31/2017 R1

1266 Dry Dock 2 Repair Estimate 20170731 r1

Port of San Francisco, Dry Dock #2 Repairs
Preliminary Estimate of Probable Repair Costs
Based on Conceptual Design Information
1) Basis of Estimate

Date: 7/31/2017 R1

1 **Purpose of the Estimate**

This estimate has been prepared for the purpose of establishing a preliminary estimate of probable cost of construction for steel plate replacement and marine coatings in Dry Dock #2. The quantity of marine coatings is TBD; as such a range of probable construction unit cost in $/SF is provided for coatings. A cost to replace all sacrificial anodes in one of the dock's 40 ballast tanks is provided, which should be considered an ongoing maintenance expense.

2 **Content of the Estimate**

This construction cost estimate, which represents our opinion of probable construction cost, consists of the following integral sections:

- a Preamble (Basis of Estimate)
- b Estimate Summary
- c Estimate Details

Basis of Estimate

3 The scope of estimate is based on the following:

- a Dry Dock #2 - Cost Estimating Scope, dated 7/18/17, file name: 1266 Dry Dock #2 Repair Mtg Handout 20170718
- b Discussion per meeting with Port of San Francisco, GHD, and M Lee Corp on 7/18/17
- c Quantities from GHD, received 7/26/17, file name: Quantity Takeoff
- d Commercial Certification of Floating Dry Dock #2 Drawings, by Heger Dry Dock, dated December 2016, a total of 13 pages, file name: Heger December 2016 drawings, for reference only
- e Bulkhead and Stiffener Arrangement: Typical Segment, by Earl and Wright, undated, file name: DD2 Typical Section, for reference only
- f Drydock 2 2012 Pontoon Deck Repairs, by the Port of San Francisco, dated 5/3/17, file name: Repair Drawings for Port Rev 170513, for reference only
- g Structural and Mechanical/Electrical Control Inspection Report for Floating Dry Dock No. 2, by Heger Dry Dock, dated August 2016, file name: Control Inspection - Heger August 2016, for reference only
- h Dry Dock #2 Design Summary and Schematics, dated 1970, file name: DD2 Design Summary and Schematics (1970), for reference only
- i Email clarifications from designers
- j Verbal clarifications with designers
- j Incorporation of relevant comments from designer and Port on draft estimate

4 **Scope of Estimate**

The estimate includes the following general scope of work:

- a Replace the pontoon deck. Deck plate will be removed in sections and replaced with new prefabricated 10'x40' units, which include new deck plates and stiffeners.
- b Replace external wall plates with 10'x40' prefabricated units.
- c Install large plates using existing crane to rotate them into place.
- d Install small plates, assumed to be 2'x2', as needed on the pontoon deck and wing walls.
- e Install bent insert plates at corners where the pontoon deck and wing walls join.
- f Cathodic protection, 90 lb aluminum anodes within ballast tanks
- g Coat wing walls to prevent corrosion.
- h Coat top deck with protective wearing surface to prevent future corrosion.
- i Coat the interior of compartments (floor, wall, and ceiling).

Port of San Francisco, Dry Dock #2 Repairs
Preliminary Estimate of Probable Repair Costs
Based on Conceptual Design Information
1) Basis of Estimate

Date: 7/31/2017 R1

5 **<u>Exclusions</u>**

The estimate specifically excludes the following items:

- a Legal fees and finance costs
- b Permit & plan check fees
- c Utility connection fees
- d Owner's administration costs
- e Design services
- f Other soft costs
- g Survey services, materials lab
- h Project/Construction management
- i Change orders during construction
- j Cost escalation beyond the date of this estimate
- k Abatement of lead-based paint per Port; there is no LBP in sections of dock that are being replaced

It is assumed that the above items, if needed, are included elsewhere in the owner's overall project budget.

6 **<u>Construction Schedule</u>**

All work to be performed during regular working hours. No overtime work allowed in the estimate.
Actual durations may vary depending on labor and crew availability and sequencing.

7 **<u>Procurement Method</u>**

The estimate reflects probable construction costs obtainable in the project locality on the date of this estimate assuming that work will be performed by shipyard's own labor forces.

8 **<u>Bid Conditions - N/A</u>**

9 **<u>Basis of Quantities</u>**

Quantities used in this estimate are provided by GHD.

10 **<u>Basis of Direct Cost Pricing</u>**

- a The unit prices used in the direct cost estimate section are composite unit prices which include costs for material, labor, equipment and subcontractor's/supplier's mark-ups.
- b Subcontractor’s overhead and profit is included in each line item unit cost.
- c Labor costs are based on labor rates provided by the Shipyard.

Based on the above cost sources, our analysis of the project specific requirements and our judgment of the current market conditions, we have determined the unit costs specifically for this project.

11 **<u>Markups</u>**

Markups are added to the direct estimated cost to cover the following markups based on a self-performed contract:
General Contractor's general conditions and general requirements - N/A
General contractor's overhead and profit, bonds and insurance - N/A
Design phase and estimating contingency

12 **<u>Cost Escalation</u>**

The estimate is based on current July 2017 dollars. No cost escalation is included.

Based on current market conditions, we recommend an allowance for cost escalation at 6% per year for the next two years, compounded annually from today to the mid-point of construction.

13 **Items Impacting Costs**

The following is a list of some items that may affect the cost estimate:

- a Modifications to the scope of work or assumptions included in this estimate
- b Special phasing requirements
- c Restrictive technical specifications or excessive contract conditions
- d Any specified item of equipment, material, or product that cannot be obtained from at least three different sources
- e Any other non-competitive bid situations.

14 **Limitations**

- a Client acknowledges that our estimating service is consistent with and limited to the standard of care applicable to such services, which is that we provide our services consistent with the professional skill and care ordinarily provided by consultants practicing in the same or similar locality under the same or similar circumstances. The estimate is intended to be a determination of fair market value for the project construction. Since we have no control over market conditions, costs of labor, materials, equipment and other factors which may affect the bid prices, we cannot and do not warrant or guarantee that bids or ultimate construction costs will not vary from the cost estimate. We make no other warranties, either expressed or implied, and are not responsible for the interpretation by others of the contents herein the cost estimate.

- b It should be noted that the cost estimate is a "snapshot in time" and that the reliability of this opinion of probable construction cost will inherently degrade over time. The estimate should be updated as design progresses or when market condition has been changed.

- c Please note that the estimate has been prepared based on very preliminary information and design assumptions which are subject to verifications and changes as the design progresses. An updated estimate should be prepared when more specific and detailed design information is available.

15 **Abbreviations used in the estimate:**

CY = cubic yard
EA= each
GSF = gross square foot
LB = pound
LBP = lead-based paint
LF = linear foot
LOC=location
LS = lump sum
SF = square foot
ROM = rough order of magnitude

Port of San Francisco, Dry Dock #2 Repairs
Preliminary Estimate of Probable Repair Costs **Date: 7/31/2017 R1**
Based on Conceptual Design Information
2.1) Estimate Summary - Steel Replacement

Items	**Repair Estimated Amount**
Steel Replacement *From attached details:*	
Material Cost	$3,611,252
Labor Cost	$1,559,698
Equipment Cost	$34,824
Estimated Total Construction Cost (Hard Cost)	**$5,205,774**

All in 2017 dollars, no cost escalation included above

Hard cost includes design development and estimating contingency at 30%.

Based on shipyard self-performing all work and based on labor rates provided by Shipyard on 4/25/2017.

Please read the attached "Basis of Estimate" and 'Estimate Details" for assumptions, exclusions, qualifications and scope of work.

Port of San Francisco, Dry Dock #2 Repairs
Preliminary Estimate of Probable Repair Costs **Date: 7/31/2017 R1**
Based on Conceptual Design Information
2.2) Estimate Summary - Range of Unit Cost for Coating

	Items *From attached details:*	**Estimated Unit Cost $/SF**	
Item	**Item Description**	**Low End**	**High End**
B	**Interior marine coating work**		
B.1	Under pontoon deck and stiffeners	$19	$23
B.2	Ballast tank with bulkheads, stiffeners, bulkhead plate, and bulkhead stiffener	$23	$26
B.3	Buoyancy tank with girders, columns, frame webs, bulkheads, and stiffeners	$23	$26
B.4	Outer shell with plates and stiffeners	$35	$51
B.5	Inner shell with plates and stiffeners	$35	$51
B.6	Wing wall truss & under safety deck with bulkheads and stiffeners	$19	$23
C	**Exterior marine coating work**		
C.1	Horizontal decking including the pontoon, safety, and wing wall decks	$13	$15
C.2	Exterior hull and exterior outer shell	$15	$21
C.3	Exterior inner shell	$13	$15

All in 2017 dollars, no cost escalation included above

Low End is based on 1,100 SF interior section and 20'x800' exterior section to be coated.

High End is based on 10'x30' interior section and 20'x40' exterior section to be coated.

Based on shipyard self-performing all work and based on labor rates provided by Shipyard on 4/25/2017.

Please read the attached "Basis of Estimate" and 'Estimate Details" for assumptions, exclusions,

qualifications and scope of work.

Port of San Francisco, Dry Dock #2 Repairs
Preliminary Estimate of Probable Repair Costs **Date: 7/31/2017 R1**
Based on Conceptual Design Information
2.3) Estimate Summary - Sacrificial Anode Replacement

Items	**Repair Estimated Amount**
Sacrificial Anode Replacement at One Ballast Tank *From attached details:*	
Material Cost	$23,838
Labor Cost	$148,342
Equipment Cost	$3,380
Estimated Total Construction Cost (Hard Cost)	**$175,560**

Sacrificial Anode Replacement at all Ballast Tanks	**40**	**$7,022,400**

All in 2017 dollars, no cost escalation included above

Hard cost includes design development and estimating contingency at 30%.

52 90-lb aluminum anodes per ballast tank, 2,080 total over 40 ballast tanks

Sacrificial anode design life is approximately 10 years, replacement should be prioritized based on inspection and testing of existing anodes.

Based on shipyard self-performing all work and based on labor rates provided by Shipyard on 4/25/2017.

Please read the attached "Basis of Estimate" and 'Estimate Details" for assumptions, exclusions, qualifications and scope of work.

Port of San Francisco, Dry Dock #2 Repairs
Preliminary Estimate of Probable Repair Costs
Based on Conceptual Design Information
3.1) Estimate Details - Steel Replacement

Date: 7/31/2017 R1

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	MH PER UNIT	TOTAL MH	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
1	**A**	**Steel panel replacement**												
2	A.1	Outer shell steel panel replacement												
3		Key quantities												
4		Replace corroded outer shell with pre-fabricated panels and stiffeners	13,700	sf										
5		Each pre-fab unit is a 7/16" plate having 10'Wx40'L, with L7x4x1/2 stiffeners @ ~25" spacing, 10,840 lb/each, 50 ksi	35	ea										
6														
7		Estimate per pre-fab unit in outer shell												
8		Cut and remove corroded deck plate and attached stiffeners	1	EA			24.00	24.00	1,594.00	1,594	150.00	150	1,744.00	1,744
9		Pre-fabricated plate, 7/16" thick with L7x4x1/2 stiffener @ 25" spacing, FOB jobsite, 10,840 lb, 50 ksi	1	EA	27,100.00	27,100							27,100.00	27,100
10		Shop coating for pre-fabricated plate assembly	400	SF	2.50	1,000	0.02	8.00	2.00	800			4.50	1,800
11		Crane operator	1	EA			8.00	8.00	508.00	508	42.97	43	550.97	551
12		Crane rigger	1	EA			8.00	8.00	508.00	508	42.97	43	550.97	551
13		Weld pre-fabricated section to existing stiffeners & deck	100	LF	1.50	150	1.12	112.00	74.00	7,400			75.50	7,550
14		Field coating of joints after completion of welding	100	LF	2.50	250	0.32	32.00	27.00	2,700			29.50	2,950
15														
16		Total per one typical location	1	EA		28,500		192.00		13,510		236		42,246
17														
18	A.1	Total repair outer shell assuming 35 units, 14,000 SF	35	EA	28,500.00	997,500	192.00	6720.00	13,510.00	472,850	236.00	8,260	42,246.00	1,478,610
19														
20	A.2	Inner shell steel panel replacement												
21		Replace corroded inner shell with pre-fabricated panels and stiffeners	10,980	sf										
22		Each pre-fab unit is a 7/16" plate having 10'Wx40'L, with L7x4x1/2 stiffeners @ ~25" spacing, 10,840 lb/each, 50 ksi	28	ea										
23														
24		Estimate per pre-fab unit in inner shell												
25		Cut and remove fractured corroded deck plate and attached stiffeners	1	EA			24.00	24.00	1,594.00	1,594	150.00	150	1,744.00	1,744
26		Pre-fabricated plate, 7/16" thick with L7x4x1/2 stiffener @ 25" spacing, FOB jobsite, 10,840 lb, 50 ksi	1	EA	27,100.00	27,100							27,100.00	27,100

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	MH PER UNIT	TOTAL MH	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
27		Shop coating for pre-fabricated plate assembly	400	SF	2.50	1,000	0.02	8.00	2.00	800			4.50	1,800
28		Crane operator	1	EA			8.00	8.00	508.00	508	42.97	43	550.97	551
29		Crane rigger	1	EA			8.00	8.00	508.00	508	42.97	43	550.97	551
30		Weld pre-fabricated section to existing stiffeners & deck	100	LF	1.50	150	0.96	96.00	64.00	6,400			65.50	6,550
31		Field coating of joints after completion of welding	100	LF	2.50	250	0.32	32.00	27.00	2,700			29.50	2,950
32														
33		Total per one typical location	1	EA		28,500		176.00		12,510		236		41,246
34														
35	A.2	Total repair inner shell assuming 28 units, 11,200 SF	28	EA	28,500.00	798,000	176.00	4928.00	12,510.00	350,280	236.00	6,608	41,246.00	1,154,888
36														
37	A.3	Pontoon deck steel panel replacement												
38		Replace corroded pontoon deck with pre-fabricated panels and stiffeners	5,600	sf										
39		Each pre-fab unit is a 1/2" plate having 10'Wx40'L, with L9x4x1/2 stiffeners @ ~25" spacing, 12,560 lb/each, 50 ksi	14	ea										
40		Use	20	ea										
41		Estimate per pre-fab unit in pontoon deck												
42		Cut and remove corroded deck plate and attached stiffeners	1	EA			20.00	20.00	1,328.00	1,328	150.00	150	1,478.00	1,478
43		Pre-fabricated plate, 1/2" thick with L9x4x1/2 stiffener @ 25" spacing, FOB jobsite, 12,560 lb, 50 ksi steel	1	EA	31,400.00	31,400							31,400.00	31,400
44		Shop coating for pre-fabricated deck assembly	400	SF	2.50	1,000	0.02	8.00	2.00	800			4.50	1,800
45		Crane operator	1	EA			2.00	2.00	127.00	127	42.97	43	169.97	170
46		Crane rigger	1	EA			2.00	2.00	127.00	127	42.97	43	169.97	170
47		Weld pre-fabricated section to existing stiffeners & deck	100	LF	1.50	150	0.32	32.00	21.00	2,100			22.50	2,250
48		Field coating of joints after completion of welding	100	LF	2.50	250	0.16	16.00	14.00	1,400			16.50	1,650
49														
50		Total per one typical location	1	EA		32,800		80.00		5,882		236		38,918
51														
52	A.3	Total repair pontoon deck assuming 20 units, 8,000 SF	20	EA	32,800.00	656,000	80.00	1600.00	5,882.00	117,640	236.00	4,720	38,918.00	778,360

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	MH PER UNIT	TOTAL MH	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
53														
54	A.4	Kick plate replacement where the pontoon deck and wing walls join												
55		Replace corroded inner shell at pontoon deck with pre-fabricated panels, assume 50% of total	800	lf										
56		Each kick plate is 1'x1'x6' L x 7/16" thick	134	ea										
57														
58		Estimate per pre-fab panel in inner shell at pontoon deck												
59		Cut and remove corroded deck plate and attached stiffeners	1	EA			8.00	8.00	531.00	531	50.00	50	581.00	581
60		Pre-fabricated 7/16" thick kick plate, 1'x1'x6' L	1	EA	424.00	424							424.00	424
61		Weld kick plate to existing steel plate	16	LF	1.50	24	0.40	6.40	27.00	432			28.50	456
62		Field coating of kick plate	12	SF	4.00	48	0.67	8.04	57.00	684			61.00	732
63														
64		Total per one typical location	1	EA		496		22.44		1,647		50		2,193
65														
66	A.4	Total kick plate replacement	134	EA	496.00	66,464	22.44	3007.00	1,647.00	220,698	50.00	6,700	2,193.00	293,862
67														
68	A.5	Pontoon deck patches												
69		Cut out old plate and weld in new 2'x2' insert plate at miscellaneous locations on the corroded pontoon deck	50	ea										
70		Use	50	ea										
71		Estimate per patch location in pontoon deck												
72		Cut and remove corroded deck plate	1	EA			4.00	4.00	266.00	266	10.00	10	276.00	276
73		2'x2' deck patch	1	EA	808.00	808							808.00	808
74		Shop coating for pre-fabricated deck assembly	4	SF	2.50	10	0.02	0.08	2.00	8			4.50	18
75		Weld to deck	8	LF	1.50	12	0.50	4.00	33.00	264			34.50	276
76		Field coating of joints after completion of welding	4	SF	4.00	16	0.67	2.68	57.00	228			61.00	244
77														
78		Total per one typical location	1	EA		846		10.76		766		10		1,622
79														

LINE	ITEM		QUANTITY		MATERIAL $		MH	TOTAL	LABOR $		EQUIPMENT $		TOTAL	TOTAL
REF.	NO.	DESCRIPTION		UNIT	U.C.	TOTAL	PER UNIT	MH	U.C.	TOTAL	U.C.	TOTAL	UNIT COST	ESTIMATE $
80	A.5	Total repair pontoon deck assuming 50 patches	50	EA	846.00	42,300	10.76	538.00	766.00	38,300	10.00	500	1,622.00	81,100
81														
82		Subtotal Direct Cost				2,560,264		16,793		1,199,768		26,788		3,786,820
83														
84		Sales Tax @ 8.50%				217,622								217,622
85														
86		Subtotal				2,777,886				1,199,768		26,788		4,004,442
87		Design Development And Estimating Contingency @ 30%				833,366				359,930		8,036		1,201,332
88														
89		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews				3,611,252				1,559,698		34,824		5,205,774
90		General Conditions/Requirements		**N/A**										
91														
92		Subtotal												
93		Bonds & Insurance @ 2%		**N/A**										
94														
95		Subtotal												
96		General Contractor's Overhead And Profit @ 10%		**N/A**										
97														
98		**Total Estimated Repair Costs base on Self-Performed work by Shipyard Crews**				**3,611,252**				**1,559,698**		**34,824**		**5,205,774**

Port of San Francisco, Dry Dock #2 Repairs
Preliminary Estimate of Probable Repair Costs
Based on Conceptual Design Information
3.2) Estimate Details - Unit Cost for Coating

Date: 7/31/2017 R1

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
1	**B**	**Interior marine coating work**										
2	B.1A	Under pontoon deck and stiffeners										
3		Key quantities										
4		Assume coating in 1,100 SF sections	1,100	sf								
5												
6		Watchman for confined space work	1	LS			3,763.00	3,763			3,763.00	3,763
7		Fixed platform, setup and demob	1	EA	1,000.00	1,000	537.00	537			1,537.00	1,537
8		Prepare surface to receive new coating	1,100	SF			2.50	2,750	0.10	110	2.60	2,860
9		Coating at surface	1,100	SF	2.50	2,750	4.20	4,620			6.70	7,370
10												
11			1,100	SF		3,750		11,670		110	14.12	15,530
12		Sales Tax @ 8.50%				319						319
13												
14		Subtotal				4,069		11,670		110		15,849
15		Design Development And Estimating Contingency @ 30%				1,221		3,501		33		4,755
16												
17		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	1,100	SF		5,290		15,171		143	18.73	20,604
18										USE	19.00	
19												
20	B.1B	Under pontoon deck and stiffeners										
21		Key quantities										
22		10'Wx30'L	300	sf								
23												

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
24		Watchman for confined space work	1	LS			1,254.00	1,254			1,254.00	1,254
25		Fixed platform, setup and demob	1	EA	500.00	500	537.00	537			1,037.00	1,037
26		Prepare surface to receive new coating	300	SF			2.50	750	0.10	30	2.60	780
27		Coating at surface	300	SF	2.50	750	4.20	1,260			6.70	2,010
28												
29			300	SF		1,250		3,801		30	16.94	5,081
30		Sales Tax @ 8.50%				106						106
31	------------	------------------------------	----------------	---------	---------------	------------------------------		----------------	------------	--------------	----------------	----------------
32		Subtotal				1,356		3,801		30		5,187
33		Design Development And Estimating Contingency @ 30%				407		1,140		9		1,556
34	------------	------------------------------	----------------	---------	---------------	----------------	--------------	----------------	------------	--------------	----------------	----------------
35		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	300	SF		1,763		4,941		39	22.48	6,743
36										USE	23.00	
37												
38	B.2A	Ballast tank with bulkheads, stiffeners, bulkhead plate, and bulkhead stiffener										
39		Key quantities										
40		Upper 10 ft of a 10'Wx30'Lx20'H ballast compartment will be coated in 1,100 SF sections	1,100	sf								
41												
42		Watchman for confined space work	1	LS			4,626.00	4,626			4,626.00	4,626
43		Fixed platform, setup and demob	1	EA	1,000.00	1,000	537.00	537			1,537.00	1,537
44		Prepare surface to receive new coating	1,100	SF			3.40	3,740	0.10	110	3.50	3,850
45		Coating at surface	1,100	SF	2.50	2,750	5.10	5,610			7.60	8,360

LINE	ITEM		QUANTITY		MATERIAL $		LABOR $		EQUIPMENT $		TOTAL	TOTAL
REF.	NO.	DESCRIPTION		UNIT	U.C.	TOTAL	U.C.	TOTAL	U.C.	TOTAL	UNIT COST	ESTIMATE $
46												
47			1,100	SF		3,750		14,513		110	16.70	18,373
48		Sales Tax @ 8.50%				319						319
49	------	------	------	------	------	------	------	------	------	------	------	------
50		Subtotal				4,069		14,513		110		18,692
51		Design Development And Estimating Contingency @ 30%				1,221		4,354		33		5,608
52	------	------	------	------	------	------	------	------	------	------	------	------
53		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	1,100	SF		5,290		18,867		143	22.09	24,300
54										USE	23.00	
55												
56	B.2B	Ballast tank with bulkheads, stiffeners, bulkhead plate, and bulkhead stiffener										
57		Key quantities										
58		10'Wx30'L	300	sf								
59												
60		Watchman for confined space work	1	LS			1,490.00	1,490			1,490.00	1,490
61		Fixed platform, setup and demob	1	EA	500.00	500	537.00	537			1,037.00	1,037
62		Prepare surface to receive new coating	300	SF			3.40	1,020	0.10	30	3.50	1,050
63		Coating at surface	300	SF	2.50	750	5.10	1,530			7.60	2,280
64												
65			300	SF		1,250		4,577		30	19.52	5,857
66		Sales Tax @ 8.50%				106						106
67	------	------	------	------	------	------	------	------	------	------	------	------
68		Subtotal				1,356		4,577		30		5,963

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
69		Design Development And Estimating Contingency @ 30%				407		1,373		9		1,789
70	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------
71		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	300	SF		1,763		5,950		39	25.84	7,752
72										USE	26.00	
73												
74	B.3A	Buoyancy tank with girders, columns, frame webs, bulkheads, and stiffeners										
75		Key quantities										
76		Assume coating in 1,100 SF sections	1,100	sf								
77												
78		Watchman for confined space work	1	LS			4,626.00	4,626			4,626.00	4,626
79		Fixed platform, setup and demob	1	EA	1,000.00	1,000	537.00	537			1,537.00	1,537
80		Prepare surface to receive new coating	1,100	SF			3.40	3,740	0.10	110	3.50	3,850
81		Coating at surface	1,100	SF	2.50	2,750	5.10	5,610			7.60	8,360
82												
83			1,100	SF		3,750		14,513		110	16.70	18,373
84		Sales Tax @ 8.50%				319						319
85	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------
86		Subtotal				4,069		14,513		110		18,692
87		Design Development And Estimating Contingency @ 30%				1,221		4,354		33		5,608
88	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------
89		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	1,100	SF		5,290		18,867		143	22.09	24,300
90										USE	23.00	
91	B.3B	Buoyancy tank with girders, columns, frame webs, bulkheads, and stiffeners										

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
92		Key quantities										
93		10'Wx30'L	300	sf								
94												
95		Watchman for confined space work	1	LS			1,490.00	1,490			1,490.00	1,490
96		Fixed platform, setup and demob	1	EA	500.00	500	537.00	537			1,037.00	1,037
97		Prepare surface to receive new coating	300	SF			3.40	1,020	0.10	30	3.50	1,050
98		Coating at surface	300	SF	2.50	750	5.10	1,530			7.60	2,280
99												
100			300	SF		1,250		4,577		30	19.52	5,857
101		Sales Tax @ 8.50%				106						106
102	------------	--	-----------------	---------	----------------	---------------------------------		-----------------	-------------	---------------	-----------------	-----------------
103		Subtotal				1,356		4,577		30		5,963
104		Design Development And Estimating Contingency @ 30%				407		1,373		9		1,789
105	------------	--	-----------------	---------	----------------	-----------------	---------------	-----------------	-------------	---------------	-----------------	-----------------
106		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	300	SF		1,763		5,950		39	25.84	7,752
107										USE	26.00	
108												
109	B.4A	Outer shell with plates and stiffeners										
110		Key quantities										
111		Assume coating in 1,100 SF sections	1,100	sf								
112												
113		Watchman for confined space work	1	LS			6,899.00	6,899			6,899.00	6,899
114		Scaffolding, setup and demob	1,100	SF	5.00	5,500	5.00	5,500			10.00	11,000

LINE	ITEM		QUANTITY		MATERIAL $		LABOR $		EQUIPMENT $		TOTAL	TOTAL
REF.	NO.	DESCRIPTION		UNIT	U.C.	TOTAL	U.C.	TOTAL	U.C.	TOTAL	UNIT COST	ESTIMATE $
115		Prepare surface to receive new coating	1,100	SF			2.50	2,750	0.10	110	2.60	2,860
116		Coating at surface	1,100	SF	2.50	2,750	4.20	4,620			6.70	7,370
117												
118			1,100	SF		8,250		19,769		110	25.57	28,129
119		Sales Tax @ 8.50%				701						701
120	------------	--	----------------	---------	---------------	--------------------------------		----------------	------------	--------------	----------------	----------------
121		Subtotal				8,951		19,769		110		28,830
122		Design Development And Estimating Contingency @ 30%				2,685		5,931		33		8,649
123	------------	--	----------------	---------	---------------	----------------	--------------	----------------	------------	--------------	----------------	----------------
124		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	1,100	SF		11,636		25,700		143	34.07	37,479
125										USE	35.00	
126	B.4B	Outer shell with plates and stiffeners										
127		Key quantities										
128		10'Wx30'L	300	sf								
129												
130		Watchman for confined space work	1	LS			3,293.00	3,293			3,293.00	3,293
131		Scaffolding, setup and demob	300	SF	5.00	1,500	13.00	3,900			18.00	5,400
132		Prepare surface to receive new coating	300	SF			2.50	750	0.10	30	2.60	780
133		Coating at surface	300	SF	2.50	750	4.20	1,260			6.70	2,010
134												
135			300	SF		2,250		9,203		30	38.28	11,483
136		Sales Tax @ 8.50%				191						191
137	------------	--	----------------	---------	---------------	--------------------------------		----------------	------------	--------------	----------------	----------------

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
138		Subtotal				2,441		9,203		30		11,674
139		Design Development And Estimating Contingency @ 30%				732		2,761		9		3,502
140	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------
141		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	300	SF		3,173		11,964		39	50.59	15,176
142										USE	51.00	
143												
144	B.5A	Inner shell with plates and stiffeners										
145		Key quantities										
146		Assume coating in 1,100 SF sections	1,100	sf								
147												
148		Watchman for confined space work	1	LS			6,899.00	6,899			6,899.00	6,899
149		Scaffolding, setup and demob	1,100	SF	5.00	5,500	5.00	5,500			10.00	11,000
150		Prepare surface to receive new coating	1,100	SF			2.50	2,750	0.10	110	2.60	2,860
151		Coating at surface	1,100	SF	2.50	2,750	4.20	4,620			6.70	7,370
152												
153			1,100	SF		8,250		19,769		110	25.57	28,129
154		Sales Tax @ 8.50%				701						701
155	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------
156		Subtotal				8,951		19,769		110		28,830
157		Design Development And Estimating Contingency @ 30%				2,685		5,931		33		8,649
158	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------
159		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	1,100	SF		11,636		25,700		143	34.07	37,479
160										USE	35.00	

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
161	B.5B	Inner shell with plates and stiffeners										
162		Key quantities										
163		10'Wx30'L	300	sf								
164												
165		Watchman for confined space work	1	LS			3,293.00	3,293			3,293.00	3,293
166		Scaffolding, setup and demob	300	SF	5.00	1,500	13.00	3,900			18.00	5,400
167		Prepare surface to receive new coating	300	SF			2.50	750	0.10	30	2.60	780
168		Coating at surface	300	SF	2.50	750	4.20	1,260			6.70	2,010
169												
170			300	SF		2,250		9,203		30	38.28	11,483
171		Sales Tax @ 8.50%				191						191
172	------------	------------------------------	----------	------	----------	----------	----------	----------	----------	----------	----------	----------
173		Subtotal				2,441		9,203		30		11,674
174		Design Development And Estimating Contingency @ 30%				732		2,761		9		3,502
175	------------	------------------------------	----------	------	----------	----------	----------	----------	----------	----------	----------	----------
176		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	300	SF		3,173		11,964		39	50.59	15,176
177										USE	51.00	
178												
179	B.6A	Wing wall truss & under safety deck with bulkheads and stiffeners										
180		Key quantities										
181		Assume coating in 1,100 SF sections	1,100	sf								
182												
183		Watchman for confined space work	1	LS			3,763.00	3,763			3,763.00	3,763

Port of San Francisco, Dry Dock #2 Repairs
Preliminary Estimate of Probable Repair Costs
Based on Conceptual Design Information
3.2) Estimate Details - Unit Cost for Coating

Date: 7/31/2017 R1

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
184		Fixed platform, setup and demob	1	EA	1,000.00	1,000	537.00	537			1,537.00	1,537
185		Prepare surface to receive new coating	1,100	SF			2.50	2,750	0.10	110	2.60	2,860
186		Coating at surface	1,100	SF	2.50	2,750	4.20	4,620			6.70	7,370
187												
188			1,100	SF		3,750		11,670		110	14.12	15,530
189		Sales Tax @ 8.50%				319						319
190	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------
191		Subtotal				4,069		11,670		110		15,849
192		Design Development And Estimating Contingency @ 30%				1,221		3,501		33		4,755
193	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------
194		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	1,100	SF		5,290		15,171		143	18.73	20,604
195										USE	19.00	
196	B.6B	Wing wall truss & under safety deck with bulkheads and stiffeners										
197		Key quantities										
198		10'Wx30'L	300	sf								
199												
200		Watchman for confined space work	1	LS			1,254.00	1,254			1,254.00	1,254
201		Fixed platform, setup and demob	1	EA	500.00	500	537.00	537			1,037.00	1,037
202		Prepare surface to receive new coating	300	SF			2.50	750	0.10	30	2.60	780
203		Coating at surface	300	SF	2.50	750	4.20	1,260			6.70	2,010
204												
205			300	SF		1,250		3,801		30	16.94	5,081

Port of San Francisco, Dry Dock #2 Repairs
Preliminary Estimate of Probable Repair Costs
Based on Conceptual Design Information
3.2) Estimate Details - Unit Cost for Coating

Date: 7/31/2017 R1

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
206		Sales Tax @ 8.50%				106						106
207	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------
208		Subtotal				1,356		3,801		30		5,187
209		Design Development And Estimating Contingency @ 30%				407		1,140		9		1,556
210	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------
211		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	300	SF		1,763		4,941		39	22.48	6,743
212										USE	23.00	
213												
214	**C**	**Exterior marine coating work**										
215	C.1A	Horizontal decking including the pontoon, safety, and wing wall decks										
216		Key quantities										
217		20'Wx800'L	16,000	sf								
218												
219		Prepare surface to receive new coating	16,000	SF			2.50	40,000	0.10	1,600	2.60	41,600
220		Coating at surface	16,000	SF	2.50	40,000	4.20	67,200			6.70	107,200
221												
222			16,000	SF		40,000		107,200		1,600	9.30	148,800
223		Sales Tax @ 8.50%				3,400						3,400
224	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------
225		Subtotal				43,400		107,200		1,600		152,200
226		Design Development And Estimating Contingency @ 30%				13,020		32,160		480		45,660
227	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------	------------
228		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	16,000	SF		56,420		139,360		2,080	12.37	197,860

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
229										USE	13.00	
230	C.1B	Exterior horizontal surfaces including pontoon deck, safety deck, and wing wall decks										
231		Key quantities										
232		20'Wx40'L	800	sf								
233												
234		Prepare surface to receive new coating	800	SF			3.20	2,560	0.10	80	3.30	2,640
235		Coating at surface	800	SF	2.50	2,000	5.30	4,240			7.80	6,240
236												
237			800	SF		2,000		6,800		80	11.10	8,880
238		Sales Tax @ 8.50%				170						170
239	------------	--	----------------	---------	---------------	--------------------------------		----------------	------------	--------------	----------------	----------------
240		Subtotal				2,170		6,800		80		9,050
241		Design Development And Estimating Contingency @ 30%				651		2,040		24		2,715
242	------------	--	----------------	---------	---------------	----------------	--------------	----------------	------------	--------------	----------------	----------------
243		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	800	SF		2,821		8,840		104	14.71	11,765
244										USE	15.00	
245												
246	C.2A	Exterior hull and exterior outer shell										
247		Key quantities										
248		20'Wx800'L	16,000	sf								
249												
250		Setup and demob exterior work platform	1	EA	1,500.00	1,500	537.00	537			2,037.00	2,037
251		Prepare surface to receive new coating	16,000	SF			3.40	54,400	0.10	1,600	3.50	56,000

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
252		Coating at surface	16,000	SF	2.50	40,000	5.10	81,600			7.60	121,600
253												
254			16,000	SF		41,500		136,537		1,600	11.23	179,637
255		Sales Tax @ 8.50%				3,528						3,528
256	------------	------------	------------	---------	------------	------------	------------	------------	------------	------------	------------	------------
257		Subtotal				45,028		136,537		1,600		183,165
258		Design Development And Estimating Contingency @ 30%				13,508		40,961		480		54,949
259	------------	------------	------------	---------	------------	------------	------------	------------	------------	------------	------------	------------
260		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	16,000	SF		58,536		177,498		2,080	14.88	238,114
261										USE	15.00	
262	C.2B	Exterior hull and exterior outer shell										
263		Key quantities										
264		20'Wx40'L	800	sf								
265												
266		Setup and demob exterior work platform	1	EA	1,500.00	1,500	537.00	537			2,037.00	2,037
267		Prepare surface to receive new coating	800	SF			4.20	3,360	0.10	80	4.30	3,440
268		Coating at surface	800	SF	2.50	2,000	5.90	4,720			8.40	6,720
269												
270			800	SF		3,500		8,617		80	15.25	12,197
271		Sales Tax @ 8.50%				298						298
272	------------	------------	------------	---------	------------	------------	------------	------------	------------	------------	------------	------------
273		Subtotal				3,798		8,617		80		12,495
274		Design Development And Estimating Contingency @ 30%				1,139		2,585		24		3,748

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
275												
276		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	800	SF		4,937		11,202		104	20.30	16,243
277										USE	21.00	
278												
279	C.3A	Exterior inner shell										
280		Key quantities										
281		20'Wx800'L	16,000	sf								
282												
283		Fixed platform, setup and demob	1	EA	1,000.00	1,000	537.00	537			1,537.00	1,537
284		Prepare surface to receive new coating	16,000	SF			2.50	40,000	0.10	1,600	2.60	41,600
285		Coating at surface	16,000	SF	2.50	40,000	4.20	67,200			6.70	107,200
286												
287			16,000	SF		41,000		107,737		1,600	9.40	150,337
288		Sales Tax @ 8.50%				3,485						3,485
289												
290		Subtotal				44,485		107,737		1,600		153,822
291		Design Development And Estimating Contingency @ 30%				13,346		32,321		480		46,147
292												
293		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	16,000	SF		57,831		140,058		2,080	12.50	199,969
294										USE	13.00	
295	C.3B	Exterior inner shell										
296		Key quantities										
297		20'Wx40'L	800	sf								

Port of San Francisco, Dry Dock #2 Repairs
Preliminary Estimate of Probable Repair Costs
Based on Conceptual Design Information
3.2) Estimate Details - Unit Cost for Coating

Date: 7/31/2017 R1

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
298												
299		Fixed platform, setup and demob	1	EA	500.00	500	537.00	537			1,037.00	1,037
300		Prepare surface to receive new coating	800	SF			2.50	2,000	0.10	80	2.60	2,080
301		Coating at surface	800	SF	2.50	2,000	4.20	3,360			6.70	5,360
302												
303			800	SF		2,500		5,897		80	10.60	8,477
304		Sales Tax @ 8.50%				213						213
305	------------	--	-----------------	---------	----------------	----------------------------------		-----------------	-------------	---------------	-----------------	-----------------
306		Subtotal				2,713		5,897		80		8,690
307		Design Development And Estimating Contingency @ 30%				814		1,769		24		2,607
308	------------	--	-----------------	---------	----------------	-----------------	---------------	-----------------	-------------	---------------	-----------------	-----------------
309		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews	800	SF		3,527		7,666		104	14.12	11,297
310										USE	15.00	

Port of San Francisco, Dry Dock #2 Repairs
Preliminary Estimate of Probable Repair Costs
Based on Conceptual Design Information
3.3) Estimate Details - Anodes

Date: 7/31/2017 R1

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	MH PER UNIT	TOTAL MH	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
1	**D**	**Cathodic Protection - Anodes**												
2	D.1	Cathodic protection - 90 lb aluminum anodes at ballast tank												
3		Key quantities												
4		Anodes for one ballast tank	52	ea										
5		Ballast Tanks	40	ea										
6														
7		Cathodic protection for one tank												
8		Watchman for confined space work	1	EA			312.00	312.00	24,461.00	24,461			24,461.00	24,461
9		Cathodic protection - 90 lb aluminum anodes	52	EA	325.00	16,900	12.00	624.00	1,724.00	89,648	50.00	2,600	2,099.00	109,148
10														
11		Total per one typical tank	1	EA		16,900		936.00		114,109		2,600		133,609
12														
13	D.1	Cathodic protection - 90 lb aluminum anodes at ballast tank	1	EA	16,900.00	16,900	936.00	936.00	114,109.00	114,109	2,600.00	2,600	133,609.00	133,609
14														
15		Subtotal Direct Cost				16,900		936		114,109		2,600		133,609
16														
17		Sales Tax @ 8.50%				1,437								1,437
18														
19		Subtotal				18,337				114,109		2,600		135,046
20		Design Development And Estimating Contingency @ 30%				5,501				34,233		780		40,514
21														
22		Subtotal - Estimated Repair Costs Self-Perform by Shipyard Crews				23,838				148,342		3,380		175,560
23		General Conditions/Requirements		**N/A**										
24														
25		Subtotal												
26		Bonds & Insurance @ 2%		**N/A**										
27														

LINE REF.	ITEM NO.	DESCRIPTION	QUANTITY	UNIT	MATERIAL $ U.C.	MATERIAL $ TOTAL	MH PER UNIT	TOTAL MH	LABOR $ U.C.	LABOR $ TOTAL	EQUIPMENT $ U.C.	EQUIPMENT $ TOTAL	TOTAL UNIT COST	TOTAL ESTIMATE $
28		Subtotal												
29		General Contractor's Overhead And Profit @ 10%		**N/A**										
30	------------	--	----------------	----------	----------------	-----------------	----------------	---------------	-----------------	-----------------	-------------	---------------	-----------------	-----------------
31		**Total Estimated Repair Costs base on Self-Performed work by Shipyard Crews**				**23,838**				**148,342**		**3,380**		**175,560**

M Lee Corporation

Project Query Sheet

TO: **Craig Lewis of GHD**

FROM: **Franklin Lee of M Lee Corp**

MLC Job No.	***1266***	*Sheet No.*
Job Name:	**Dry Dock 2 Repair**	*Date: 7/26/2017*

Item	Drwg/Spec	Queries	Answers
1		Coating - what areas should we assume for large and small areas to be coated?	10'x30' for large areas, 5'x15' for small areas; MBell - I think these are both too small and unit costs are too high as a result. Interior: Small should be 10'x30' (one overhead or transverse panel in one ballast compartment). Large should be 1,100 SF (do all surfaces in upper 10 ft of a 10' W x 30' L x 20' H ballast compartment). Exterior: Small exterior should be 20' x 40' (painting lower 20' of one tank) Large exterior could be 20' x 800' (paint the lower half of one interior wing wall) or even more.
2		Cathodic protection - will zinc and magnesium anodes be needed to provided additional cathodic protection?	No added anodes are required; current coating is enough; MBell - Assume that 1,000 anodes will be replaced for cost estimate.
3		Timing - will the repairs be divided into short-term and long-term time periods?	No, these distinctions are not necessary;
4		Repair - how many 2'x2' sections need to be patched up?	Assume 50 sections for now. MBell - Seems about right considering wing walls and pontoon deck. Cost is not high. Leave as is unless GHD wants to change.
5		Scope - how many bent insert plates (kick plates) will be installed?	CLewis - assume 50% of 1600 LF, 6'L per section

	M Lee Corporation		
	<u>Project Query Sheet</u>		
TO:	**Craig Lewis of GHD**		
FROM:	**Franklin Lee of M Lee Corp**		
MLC Job No.	***1266***	*Sheet No.*	
Job Name:	**Dry Dock 2 Repair**	*Date: 7/26/2017*	

Item	Drwg/Spec	Queries	Answers
6		Kick plates - what are the dimensions of the kick plates?	CLewis - Assume 6' sections each, 7/16" thick, 1' per leg
7		Kick plates - will the kick plates be coated in the shop or in the field?	kick plates will be coated in the field after being welded in place

Appendix B

Underwater Inspection Report

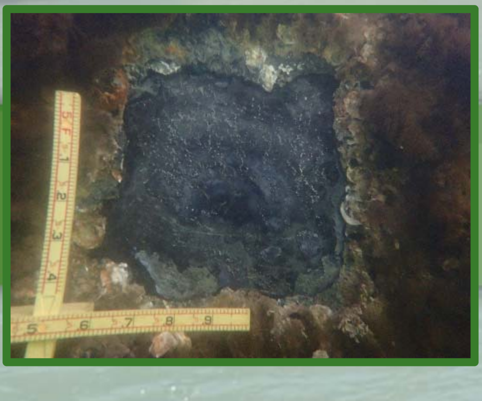
GHD, Inc.
Port of San Francisco
Dry Dock 2 Underwater Condition Assessment

FINAL REPORT

San Francisco, CA

June 2017

Safeco Plaza, 1001 Fourth Avenue, Suite 4305
Seattle, Washington 98154
206.682.2140 • www.collinsengr.com



COLLINS
ENGINEERS INC.

July 25, 2017
Collins Job No. 45-10474

Mr. Craig Lewis
Facilities Service Line Leader
GHD, Inc.
655 Montgomery Street, Suite 1010
San Francisco, CA 94111

RE: Port of San Francisco – Dry Dock 2 Underwater Condition Assessment

Dear Mr. Lewis,

Collins Engineers, Inc. (Collins) is pleased to submit this FINAL document: Dry Dock 2 Underwater Condition Assessment FINAL Report. This document is in accordance with the scope of services contained in the Agreement for Professional Services with GHD, Inc., dated April 26, 2017.

This report includes: condition assessment for the underwater hull components of Dry Dock 2, project drawings, ultrasonic thickness gauge measurement results, typical photographs, and definitions.

Thank you for the opportunity to participate in the execution of this important project.

Very truly yours,

COLLINS ENGINEERS, INC.

Daniel Stromberg, P.E.
Engineer of Record

LICENSED PROFESSIONAL ENGINEER
DANIEL GERARD STROMBERG
75133
Exp. 12/31/17
CIVIL
STATE OF CALIFORNIA

I hereby certify that this engineering document was prepared by me or under my direct supervision and that I am duly Licensed Professional Engineer under the laws of the State of California.

Daniel G. Stromberg, P.E. #C75133

My license renewal date is 12/31/2017

Pages or sheets covered by this seal: <u>Entire Report</u>

Safeco Plaza • 1001 4th Avenue • Suite 4305 • Seattle, WA 98154 • Phone 206.682.2140 • Fax 206.682.2146 • www.collinsengr.com

Page

APPENDICES

EXECUTIVE SUMMARY

INSPECTION DATA

Date	June 12 -15, 2017	Total Dive Time	14.25 hours
Daily Start Time	07:30	Number of Dives	11
Daily Finish Time	17:00	Water Temp.	60˚F
Total Site Time	40 hours	Ambient Temp.	73 ˚F
Water Velocity	1 fps	Dive Mode	Surface Supplied Air
Maximum Depth	50 ft @ Dolphin 4		
Underwater Visibility	3 ft		
Location Latitude: Longitude:	 N 37˚ 45’ 46” W 122˚ 22’ 54”		
Substructure Units Inspected	Dry Dock Hull and Mooring Dolphin Piles		
Inspection Personnel	Dive Supervisor: Daniel Stromberg/Richard Hunt Diver/Tender: Adam Cox Diver/Tender: John Strub Diver/Tender: Michael Spencer		

CRITICAL FINDINGS

- None

SIGNIFICANT OBSERVATIONS

- Dry Dock 2 hull, below water, average section loss of 9% and a maximum section loss of approximately 16% for the steel plates originally 1/2 in. thick.
- Dry Dock 2 hull, below water, average section loss of 8% and a maximum section loss of approximately 15% for the steel plates originally 7/16 in. thick.

MAINTENANCE WORK RECOMMENDATIONS

- Monitor the steel section loss below water for the hull of Dry Dock 2 and the mooring dolphin piles.

1.0 INTRODUCTION

An Underwater Condition Assessment of Dry Dock 2 was conducted from June 12th to June 15th, 2017 at the Port of San Francisco Pier 70 to evaluate the current underwater condition of the Dry Dock 2 hull. Overall, the Dry Dock 2 hull was found to be in SATISFACTORY to FAIR condition with primarily just minor corrosion-related deterioration that consisted of section loss as ascertained by ultrasonic thickness gauge measurements. The inspection was performed in accordance with the ASCE Manual for Underwater Investigations, including the associated rating guidelines and definitions, which are located in Appendix D. Currently, Dry Dock 2 is positioned and held in place by four mooring dolphins (labeled D1 through D4 from south to north) with an access platform to the dry dock at the Puglia Shipyard (Pier 70) at the Port of San Francisco. The dry dock is orientated with its longitudinal axis from south to north with an apron for access at the south end of the dry dock. Refer to Photographs 1 through 3 in Appendix B for overall views of Dry Dock 2 and to Photographs 4 through 7 in Appendix B for views of the four mooring dolphins. A map with an approximate location of the limits of inspection is shown below in Figure 1.0-1.

Figure 1.0-1 Facility Vicinity Map

Source: Google Earth

1.1 PROJECT PERSONNEL

The underwater inspection was performed by a four-person team consisting of four engineer-divers, two of whom were registered California Professional Engineers (P.E.). At any given time during the inspection process, the team makeup consisted of a dive supervisor, an inspection diver, a backup (safety) diver, and a tender. The primary points of contact for the project are presented in Table 1.1-1 Project Representatives.

Table 1.1-1 Project Representatives

Entity	Name	Contact Information
Port of San Francisco	Matthew Bell, P.E., S.E. Civil Engineer Engineering Division	Pier 1, The Embarcadero San Francisco, CA 94111 matthew.n.bell@sfport.com (415) 274-0457
GHD - TECI	Craig Lewis, P.E., S.E. Senior Project Manager	655 Montgomery Street, Suite 1010 San Francisco, CA 94111 craig.lewis@ghd.com (415) 296-3605
Collins Engineers, Inc.	Daniel Stromberg, P.E. Team Leader and Project Manger	1001 Fourth Ave, Suite 4305 Seattle, WA 98154 dstromberg@collinsengr.com (312) 236-4182
Collins Engineers, Inc.	Adam Cox Assistant Project Manager	1001 Fourth Ave, Suite 4305 Seattle, WA 98154 acox@collinsengr.com (206) 455-9737

Source: Collins Engineers, Inc.

1.2 INSPECTION PROCEDURES

The underwater inspection consisted of Level I, II and III level inspection intensities, as defined by the ASCE Manual for Underwater Investigations and included in Appendix D. At the time of the inspection, the dry dock ballast tanks were emptied of water such that Dry Dock 2 had a vertical draft of approximately 7 ft. Level II cleanings to gather Level III ultrasonic thickness (UT) gauge readings (measurements) of remaining steel thickness were taken along “belt lines” spaced every 100 ft along the longitudinal (north/south) axis of the dry dock as shown in Appendix A, Sheet S-01. A fixed line was placed along each belt line to guide the engineer-diver while taking UT readings and to ensure that UT readings could be gathered along the same line during future inspections for comparison purposes. Level I visual/tactile inspection for the entire submerged portion of the hull was performed by using a tether line linking the engineer-diver to each of the belt lines to the guide line to facilitate sweeping of the hull for 50 ft in both directions away from the belt line parallel to the longitudinal (north/south) axis of the hull. Engineer-divers were deployed from the D/V James Eads which was moored to the starboard (west) side of the dry dock at each belt line.

2.0 UNDERWATER CONDITION ASSESSMENT

2.1 DRY DOCK 2 HULL

Overall, the submerged portion of the hull of Dry Dock 2 was deemed to be in satisfactory to fair condition, based on the established rating criteria presented in the ASCE Manual for Underwater Investigations, and there were no deterioration levels or other conditions observed during the underwater inspection of the hull that would warrant immediate concern. In general, the submerged surfaces of the hull exhibited 100% coverage of a dense layer of marine growth, which consisted of a 1 to 2 in. thick layer of harder shell growth directly on the steel, overlaid by a 3 to 4 in. thick layer of softer sponge and anemone growth. On the underside of the hull, the extent and thickness of the marine growth was fairly consistent throughout, and the Level I underwater inspection of the hull did not reveal any inconsistencies in the growth uniformity that would suggest any deformation or other localized damage in the underlying steel hull surface. As for the submerged sides of the hull (generally 6 to 7 ft of vertical surface based on the dry dock draft), the marine growth tailed off to mostly just include the harder shell growth layer, which was again generally uniform with no evidence of any localized hull damage. As previously indicated, the layer of marine growth was quite dense overall, and typically was difficult to remove during the Level II and III inspection efforts, with the shell growth anchorage membranes strongly adhered to the steel surfaces. Between the marine growth and the remaining competent steel of the hull, there was typically between 1/16 and 1/4 in. of dark grey corrosion by-product that was also strongly adhered and added to the marine growth removal difficulty. Removal of the marine growth and corrosion by-product to the extent typically possible revealed steel hull surfaces that were at times rather smooth, although the majority of the time, the removal process revealed steel surfaces that were rough due to pitting of the steel. In general, the coverage of the pitting ranged between 25% and 100% of the cleaned steel surface, and the pitting was mostly light in extent with typical penetrations up to 1/32 in. and some 1/16 in. deep pits in rare instances. Refer to Photographs 8 and 9 in Appendix B for some typical views of the submerged Dry Dock 2 hull conditions.

During the underwater inspection of the submerged Dry Dock 2 hull surfaces, a large number of ultrasonic remaining steel thickness measurements were taken as part of the Level II and III inspections. These included measurements taken along transverse (east/west) belt lines at specific locations along the dry dock, to provide a consistent sampling set of measurements for assessing the average and range of remaining steel thicknesses, as well as taken at many arbitrary locations during the overall Level I inspection process, for comparison purposes with the specific data set and to possibly identify any out-of-range measurements (lower than typical) that could warrant further investigation. Overall, the specific thickness measurements taken, as well as the arbitrary measurements for that matter, were fairly consistent throughout with regard to the amount of steel section loss that has occurred due to corrosion-related deterioration.

Based on available original design plans and other information for Dry Dock 2 provided by the Port of San Francisco, the dry dock hull is believed to have been originally constructed with a mix of 1/2 and 7/16 in. thick steel plate, with design plans and/or other information indicating 1/2 in. thick plate along a 32 ft wide strip down (north/south) the center of the hull and the remaining hull constructed of 7/16 in. thick steel. Based on this presumed hull plate thickness layout, where the original thickness was purported to have been 1/2 in. thick, the remaining steel thicknesses generally ranged between 0.500 in., suggesting no appreciable loss of original section to date, and 0.420 in., indicating an approximate 16% loss of original steel section. Overall, for the 1/2 in. thick mid-portion of the dry dock hull, the average remaining thickness was in the range of 0.460 in., which suggests on average that approximately 9% of original steel thickness has been lost to corrosion-related deterioration. As for the portions of hull that were purported to have been originally 7/16 in. thick, similar corrosion-related loss measurement results were obtained, although there were also some measurements gathered that were larger than the believed original, suggesting that 1/2 in. thick steel plate may have used instead. Where measurements were consistent with a 7/16 in. original thickness, the remaining steel thicknesses generally ranged between 0.435 in., again suggesting no appreciable loss of original section to date, and 0.370 in., indicating an approximate 15% loss of original steel section. Overall, for the 7/16 in. thick portions of the dry dock hull, the average remaining thickness was in the range of 0.405 in., indicating an approximate 8% of original steel thickness has been lost to corrosion-related deterioration.

Regarding the portions of hull that were purported to have been originally constructed with 7/16 in. thick plate, it should again be mentioned that some measurements were obtained in excess of 7/16 in., which could be an indication that thicker plate was used as part of the actual as-built condition. In particular, many of the larger-than-expected were very consistent with the measurements obtained from known 1/2 in. thick plate; that is, those measurements from the centerline of the dry dock, suggesting that 1/2 in. thick plate may have ultimately been used in lieu of 7/16 in. thick plate. Assuming this to be the case, where 1/2 in. thick plate may have been used, the overall amount of section loss percentages was very similar to what was derived for the 1/2 in. thick center portion of the dry dock hull, with maximum losses of approximately 16% and on average losses of approximately 9%. The exact locations and thickness measurements of the assumed thicker than expected plates are tabulated in Appendix C.

Regarding the current measured amounts of section loss for the underwater dry dock hull steel, it can be taken that a range of between approximately 10% and 20% of the original steel thickness has been lost to corrosion-related deterioration over a timeframe of around 48 years. This in turn equates to between 0.001 in. (I mil) and 0.002 in. (2 mil) of steel thickness loss per year. These values tend to be on the low side of what could be expected based on the recently published ASCE Waterfront Facilities Inspection & Assessment Standard Practice Manual. However, the values do tend to be in the neighborhood of suggested values for steel with adequate cathodic protection, which it is believed could be the case for Dry Dock 2 (port representatives indicated that an impressed current cathodic protection system is in place and operational for Dry Dock 2). Nonetheless, using a linear regression for future corrosion rates and assuming that future corrosion influences and deterrents will be same as to what has been present throughout the past, it can be suggested that another 40 years or so could transpire before remaining underwater steel thicknesses begin to pose concerns.

2.2 MOORING DOLPHINS

The mooring dolphin piles were found to be in mostly satisfactory condition with no notable defects observed at the time of the inspection and minor to isolated areas of moderate section loss measured. The mooring dolphins along the west side of Dry Dock 2 are labeled D1 through D4 from south to north. It should be noted that the the inspection of the underwater condition of the steel piles at the mooring dolphins was not outlined in the scope of services agreed upon prior to dive operations; however, the inspection of the submerged portions of the mooring dolphin piles was added to the original scope during an on-site pre-inspection meeting with representatives from the Port of San Francisco. Each mooring dolphins consists between 14 or 16 20 in. diameter plumb and 24 in. battered steel pipe piles that are located under a concrete cap. The dolphins are position south to north along the west side of the dry dock at approximately 200 ft intervals. Refer to Appendix A, Sheets S1 and S2 for details on the locations and pile layouts of the mooring dolphins.

Typically, the steel piles had 100% marine growth coverage that consisted of a 2 in. thick layer of hard marine growth, overlaid with 1 in. of soft marine growth from top of the pile down 15 ft. The marine growth from 15 ft below the top of pile to the channel bottom consisted of a 1 in. thick layer of hard marine growth and a sporadic 1/2 in. thick layer of soft growth over the top of the hard growth. Also similar to the dry dock hull, the layer of marine growth was difficult to remove during the Level II and III inspection efforts, with the shell growth anchorage membranes strongly adhered to the steel surfaces. Between the marine growth and the remaining competent steel of the shell piles, there was typically between 1/16 and 1/4 in. of dark grey corrosion by-product that was also strongly adhered and added to the marine growth removal difficulty. Removal of the marine growth and corrosion by-product to the extent typically possible revealed the steel surfaces of the shell piles to be mostly rough due to varying degrees of pitting of the steel. In general, the coverage of the pitting ranged between 25% and 100% of the cleaned steel surface, and the pitting was generally light to moderate in extent with typical penetrations of up to 1/32 in. and maximum penetrations of 1/16 in. Refer to Photographs 10 and 11 in Appendix B for some typical views of the submerged mooring shell pile conditions

During the underwater inspection of the submerged portions of the mooring dolphin shell piles, ultrasonic remaining steel thickness measurements were taken as part of the Level II and III inspections. These included measurements taken at representative piles at each of the dolphins at three specific elevations including within in the tidal zone, at mid water column depth, and near the channel bottom. Overall, it should be noted that the specific thickness measurements taken were fairly consistent throughout with regard to the amount of steel section loss that has occurred due to corrosion-related deterioration. From the mooring dolphin design information available, it is believed that originally the shell piles supporting the dolphins had a 1/2 in. pile wall thickness. Based on this presumed pile wall thickness, the remaining steel thicknesses measured for the submerged portion of the piles generally ranged between 0.500 in., suggesting no appreciable loss of original section to date, and 0.350 in., indicating an approximate 30% loss of original steel section. It should be noted that one measurement of lesser thickness; that is, 0.300 in., was recorded; however, it was deemed to be an abnormality and highly inconsistent with all of the other measurements. Overall, given the 1/2 in. wall thickness of the mooring dolphin piles, the average remaining thickness was in the range of 0.440 in., which suggests on average that approximately 13% of original steel thickness has been lost to corrosion-related deterioration.

3.0 REPAIR RECOMENDATIONS

As previously indicated, for the submerged portions of the hull of Dry Dock 2, as well as for the submerged portions of the piles of the mooring dolphins, the estimated amount of loss of the original steel sections is to the lower side of what could be expected, given the time in service, and therefore, based on the results of the underwater inspection, these elements are considered to be in satisfactory to fair condition at this time. There were no indications of any excessive general or localized section loss identified for the hull steel, and therefore, there are no concerns or need for repairs for the below water dry dock hull or dolphin pile steel at this time. The only recommendation would be to establish an acceptable schedule for future hull and pile inspections to monitor the rate of corrosion-related section loss. In that regard, the industry standard for underwater inspection at 6 year intervals would be reasonable, unless there is a drastic change in prevailing environmental conditions, including a loss or reduction in cathodic protection capacity, or if significant damage is suspected. It is also recommended that during future inspections the remaining thickness of the steel hull and piles be measured with the use of an ultrasonic thickness measuring device as a means of providing a fairly accurate and reliable way of comparing remaining thickness values and assessing corrosion-related section loss rates.

Appendix A – Inspection Drawings

PORT OF SAN FRANCISCO - DRY DOCK 2

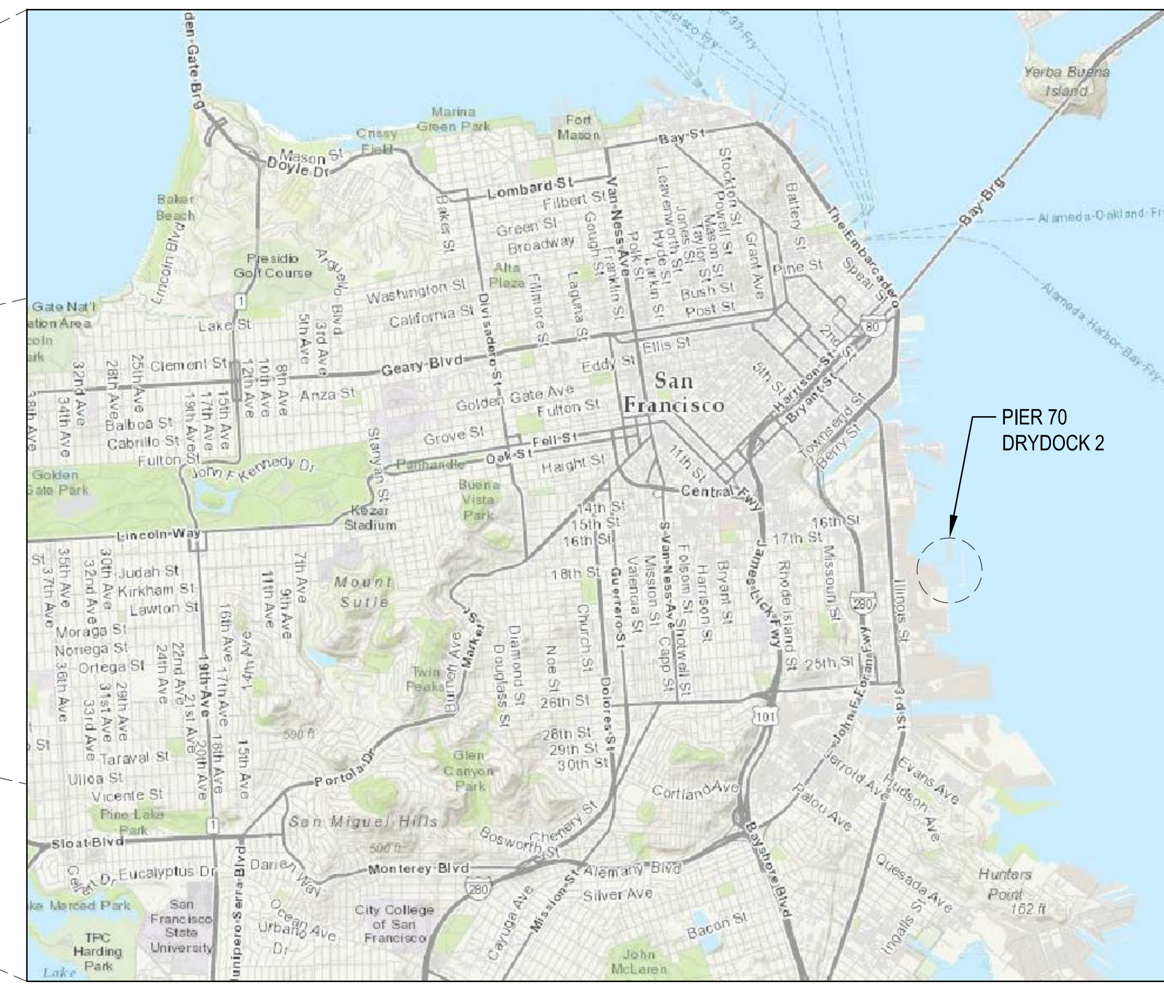
UNDERWATER CONDITION ASSESSMENT REPORT
SAN FRANCISCO, CALIFORNIA

CLIENT:
GHD
CRAIG LEWIS
655 MONTGOMERY ST, SUITE 1010
SAN FRANCISCO, CA 94111
(415) 283-4970
CRAIG.LEWIS@GHD.COM

OWNER:
PORT OF SAN FRANCISCO
MATTHEW BELL
PIER 1, THE EMBARCADERO
SAN FRANCISCO, CA 94111
(415) 274-0400
MATTHEW.N.BELL@SFPORT.COM

ENGINEER OF RECORD:
COLLINS ENGINEERS, INC
DANIEL STROMBERG
1001 4TH AVE, STE. 4305
SEATTLE, WA 98154
(312) 704-9300
DSTROMBERG@COLLINSENGR.COM

INDEX OF DRAWINGS



N
1 VICINITY MAP
SCALE: NOT TO SCALE

N
2 LOCATION MAP
SCALE: NOT TO SCALE

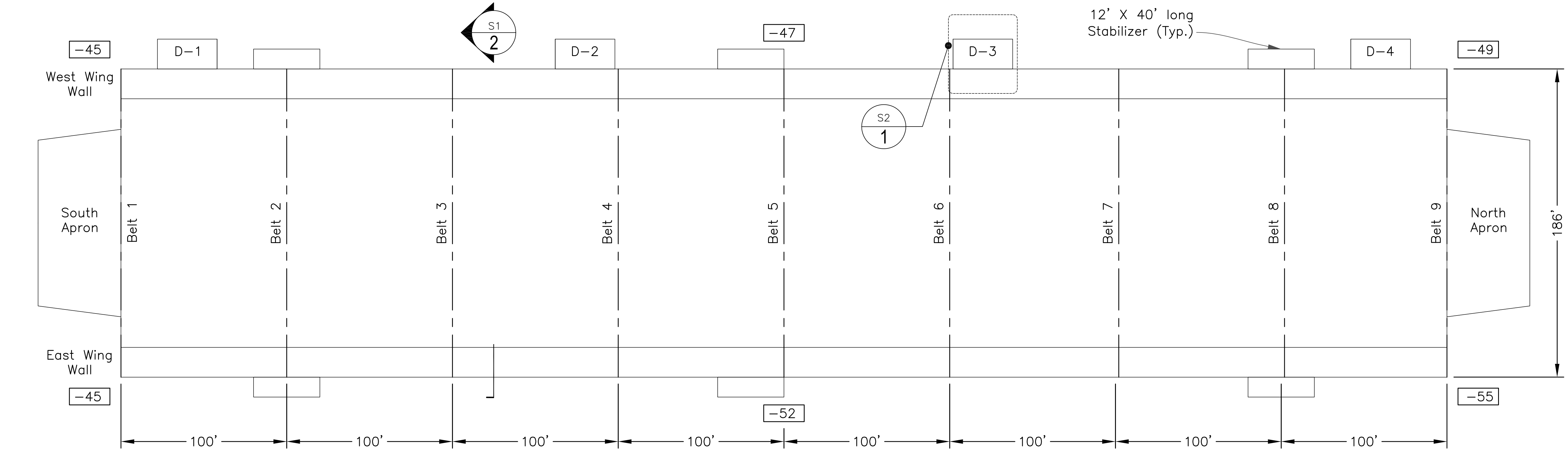
COLLINS ENGINEERS
1001 4th Ave, Suite 4305
Seattle, WA 98154
Phone: 206-682-2140

PORT OF SAN FRANCISCO
PIER 1
THE EMBARCADERO
SAN FRANCISCO, CA 94111

DRY DOCK 2
SHEET INDEX
San Francisco, CA

CEI PROJECT
45-10474
INSPECTED BY:
DGS/AJC/RH/JJS
DRAWN BY:
JJS
CHECKED BY:
DGS
DATE:
06/16/2017
SHEET NO:
C1

W:\PROJECTS\10474 GHD POSF DRY DOCK 2 UWI\05-ENGINEERING\02-CADD\POSF DRY DOCK 2.DWG 07/25/2017 08:14:33 AM

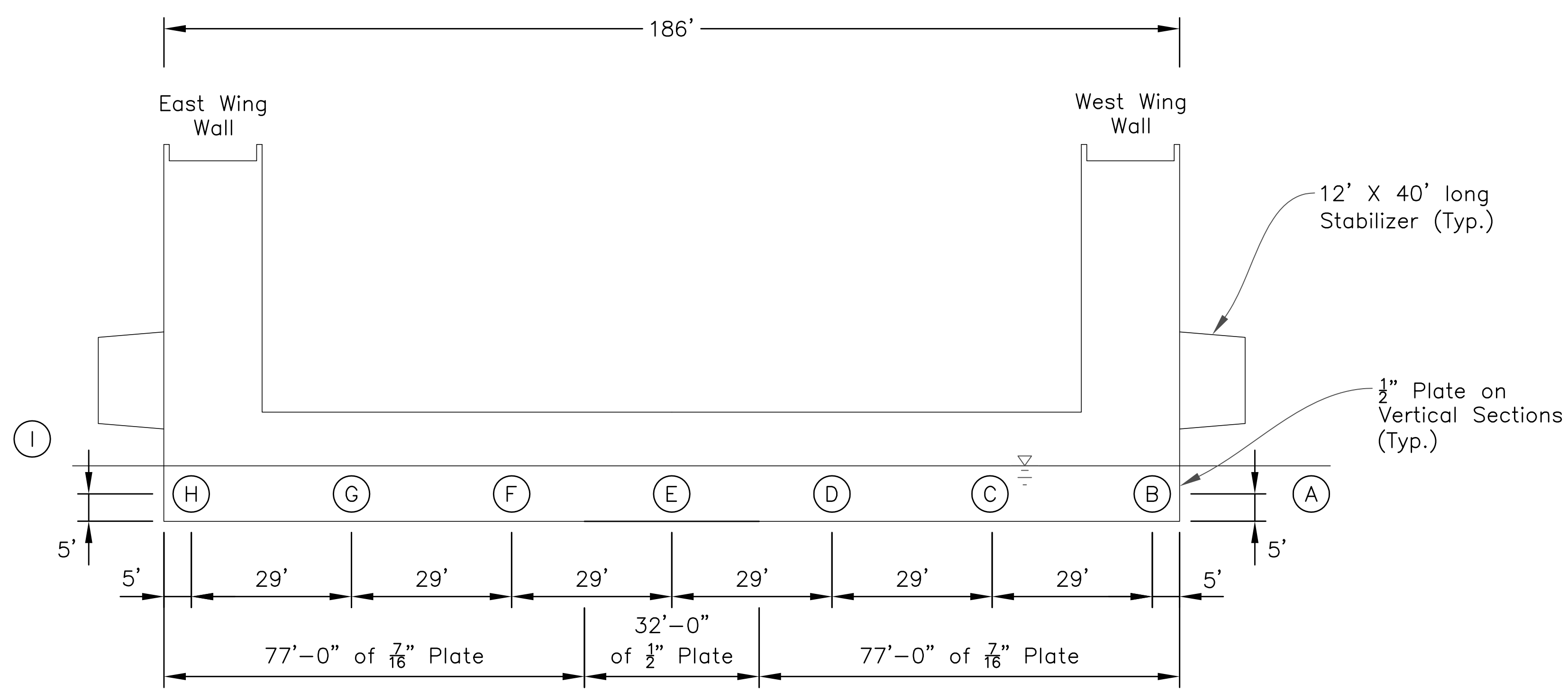


Legend:

-XX	Sounding Depth (MLLW)
(X)	U/T Measurement

A — Dry Dock 2 Overall Plan

Scale: N.T.S.



2 — Dry Dock 2
Typical Section

Scale: N.T.S. Looking South

COLLINS ENGINEERS
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Seattle, WA 98154
Phone: 206-682-2140

PORT OF
SAN FRANCISCO
PIER 1
THE EMBARCADERO
SAN FRANCISCO, CA 94111

PORT OF SAN FRANCISCO

DRY DOCK 2
DRY DOCK 2 & DOLPHINS

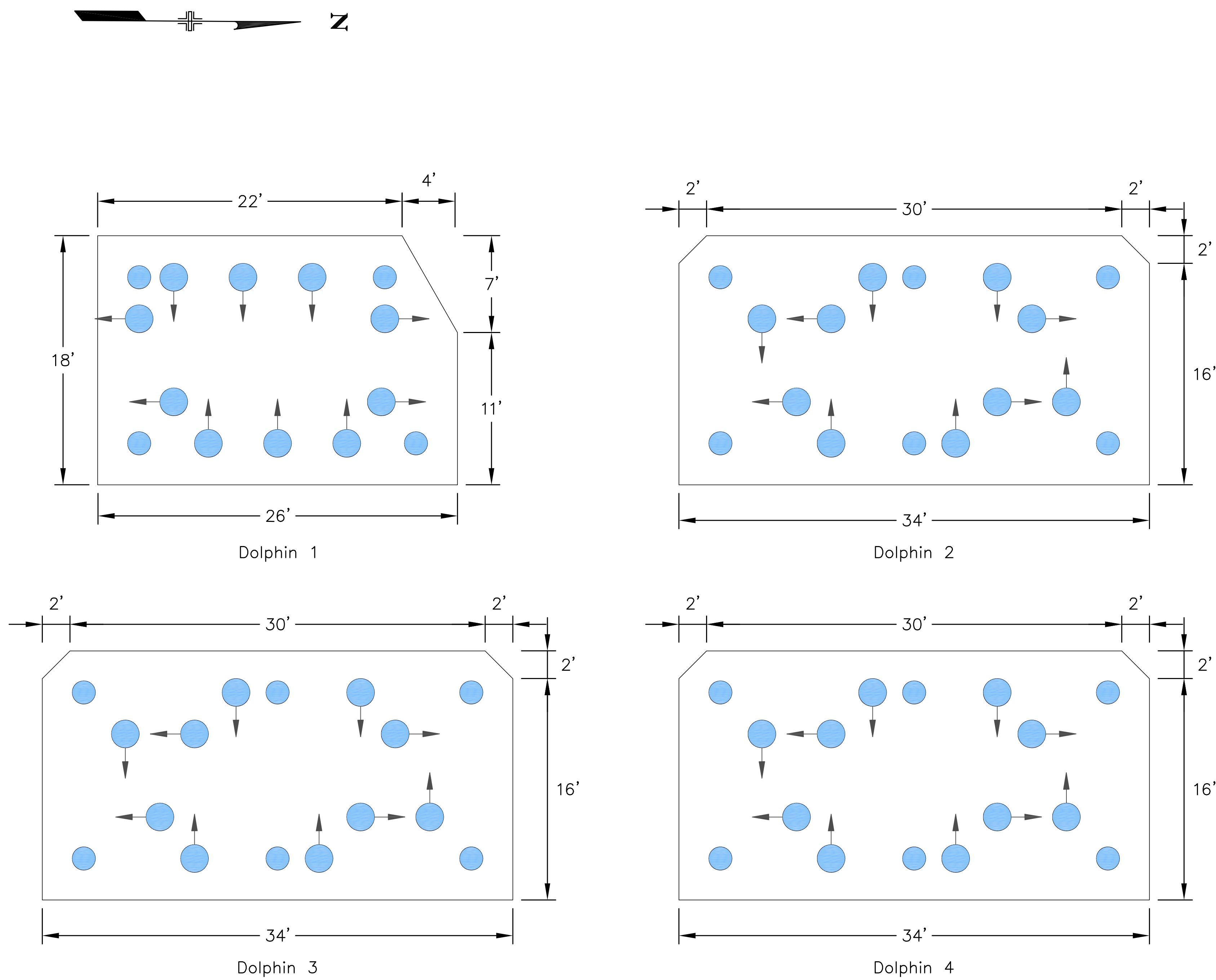
San Francisco, CA

CEI PROJECT	45-10474
INSPECTED BY:	DGS/AJC/RH/JJS
DRAWN BY:	JJS
CHECKED BY:	DGS
DATE:	06/16/2017
SHEET NO:	S1

W:\PROJECTS\10474 GHD POSF DRY DOCK 2 UWI\05-ENGINEERING\02-CADD\POSF DRY DOCK 2.DWG 07/25/2017 08:15:50 AM

Legend:

- 20" ⌀ Pile – No Damage
- 24" ⌀ Batter Pile – No Damage
- Minor Damage
- Moderate Damage
- Major Damage
- Severe Damage
- XX Sounding Depth (MLLW)



GENERAL NOTES

The dolphin piles typically exhibited hard marine growth from the top of the pile to approximately 15 ft below. From 15 below the top of the pile to the channel bottom the piles typically exhibited 1 in. of hard marine growth with ½ in. of soft marine growth.

S1 | 1 | Dolphin Pile Configuration

Scale: N.T.S.

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Seattle, WA 98154
Phone: 206-682-2140

PORT OF SAN FRANCISCO
PIER 1
THE EMBARCADERO
SAN FRANCISCO, CA 94111

DRY DOCK 2
DRY DOCK 2 & DOLPHINS
San Francisco, CA

CEI PROJECT	45–10474
INSPECTED BY:	DGS/AJC/RH/JJS
DRAWN BY:	JJS
CHECKED BY:	DGS
DATE:	06/16/2017
SHEET NO:	S2

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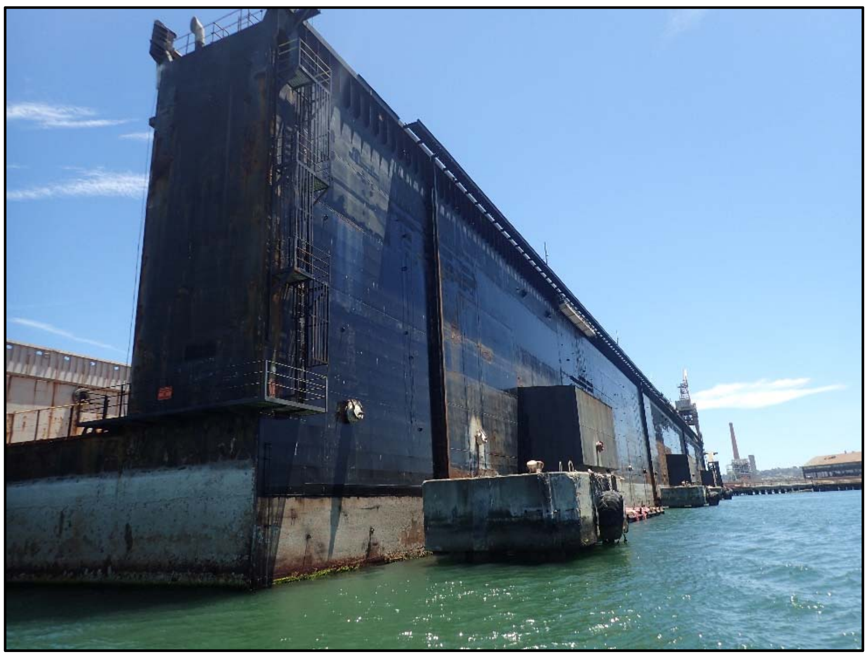
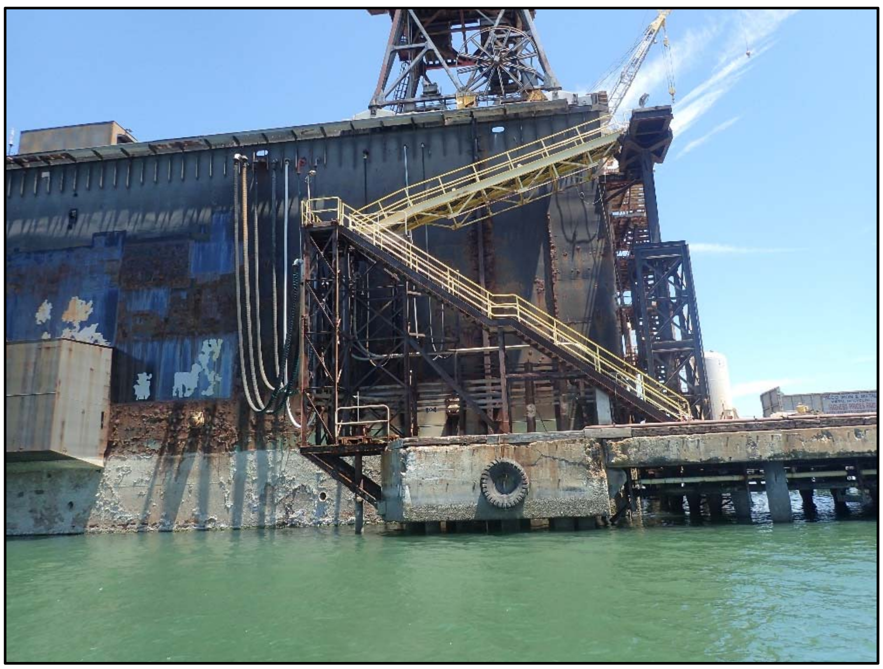
Appendix B – Photographs

Photograph 1 : Overall View of Dry Dock 2, Looking East.

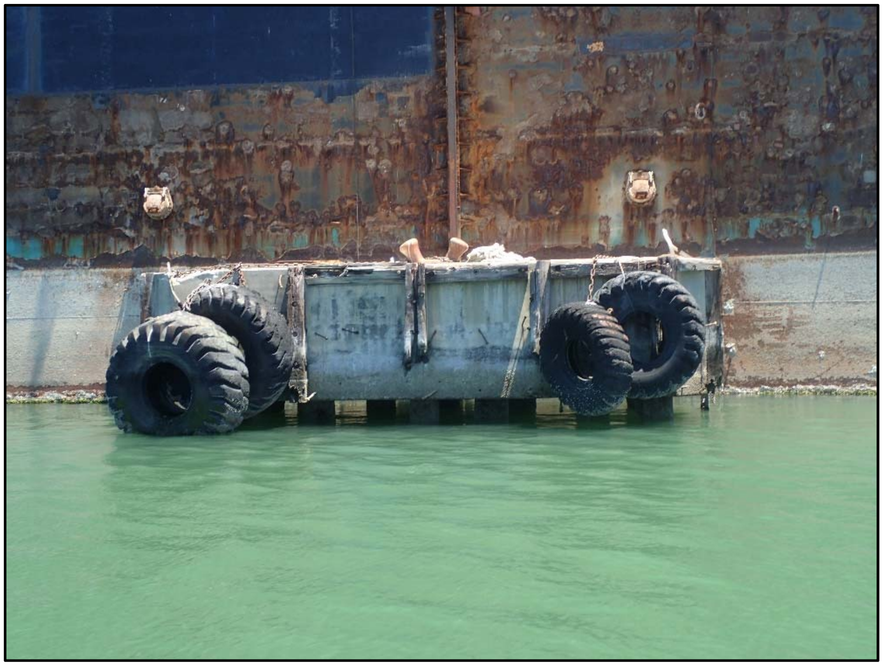


Photograph 2 : Overall View of the West Wingwall of Dry Dock 2, Looking Southeast.

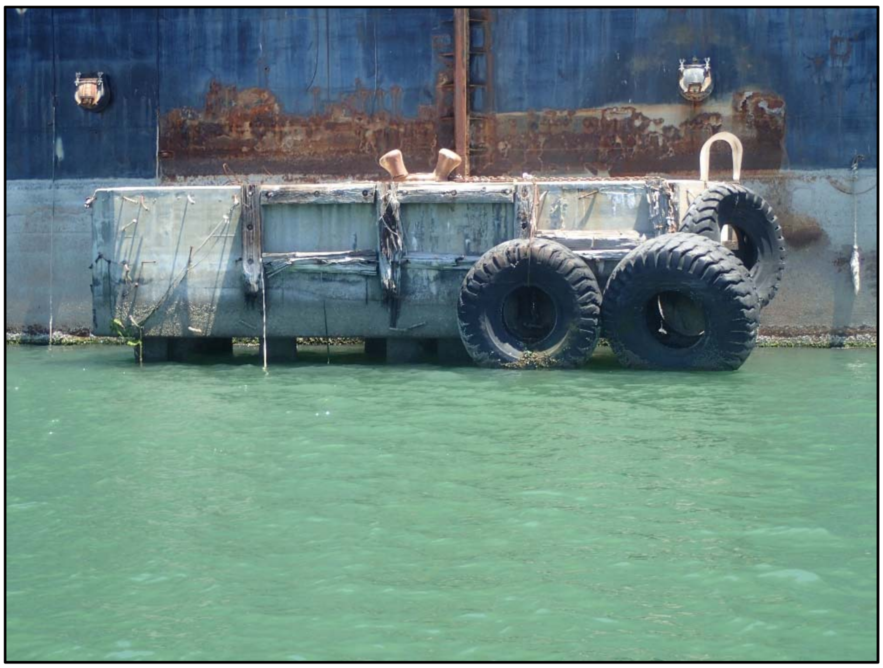
Photograph 3 : Overall View of the East Wingwall of Dry Dock 2, Looking Southwest.



Photograph 4 : Overall View of Mooring Dolphin 1, Looking East.

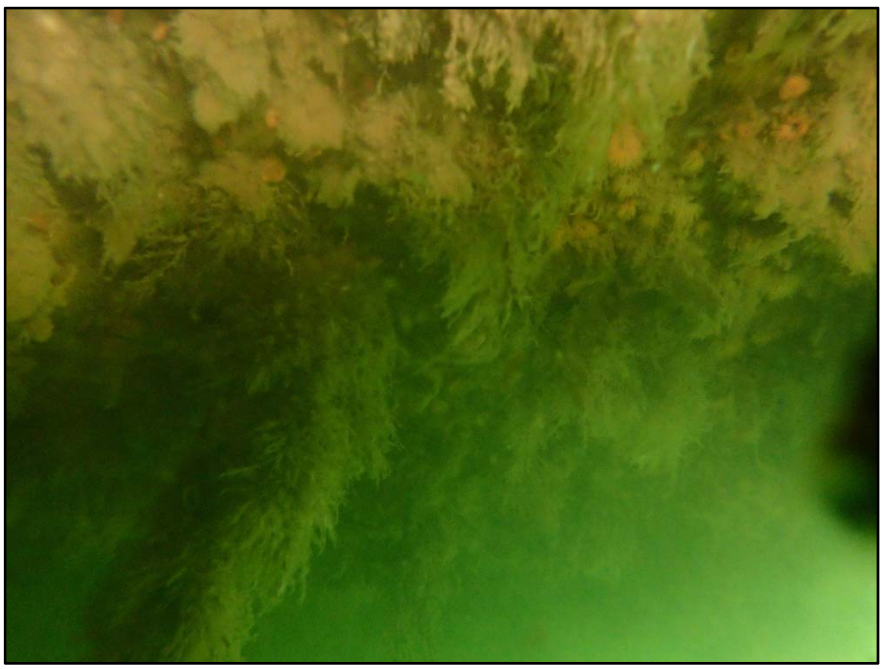


Photograph 5 : Overall View of Mooring Dolphin 2, Looking East.

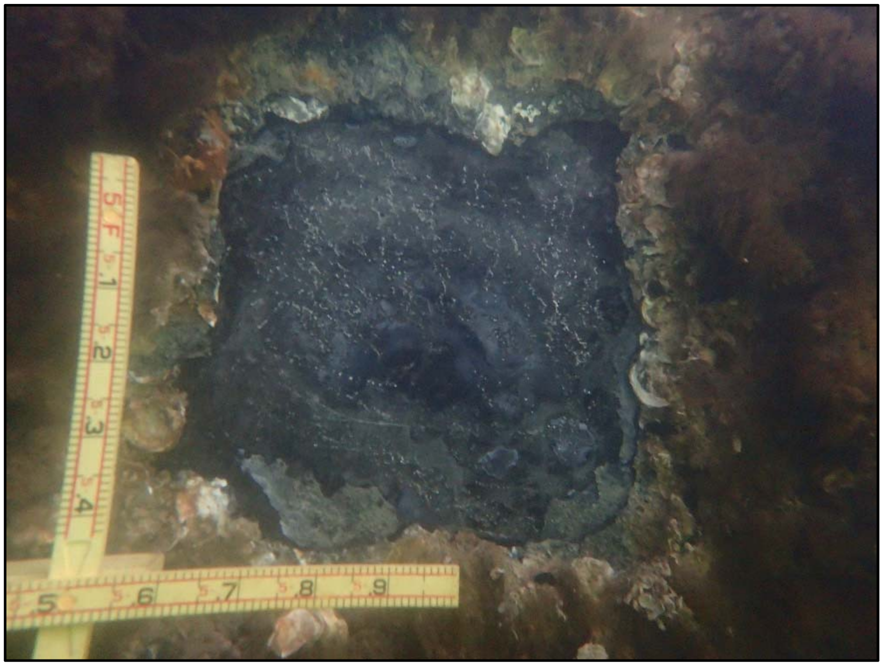


Photograph 6 : Overall View of Mooring Dolphin 3, Looking East.

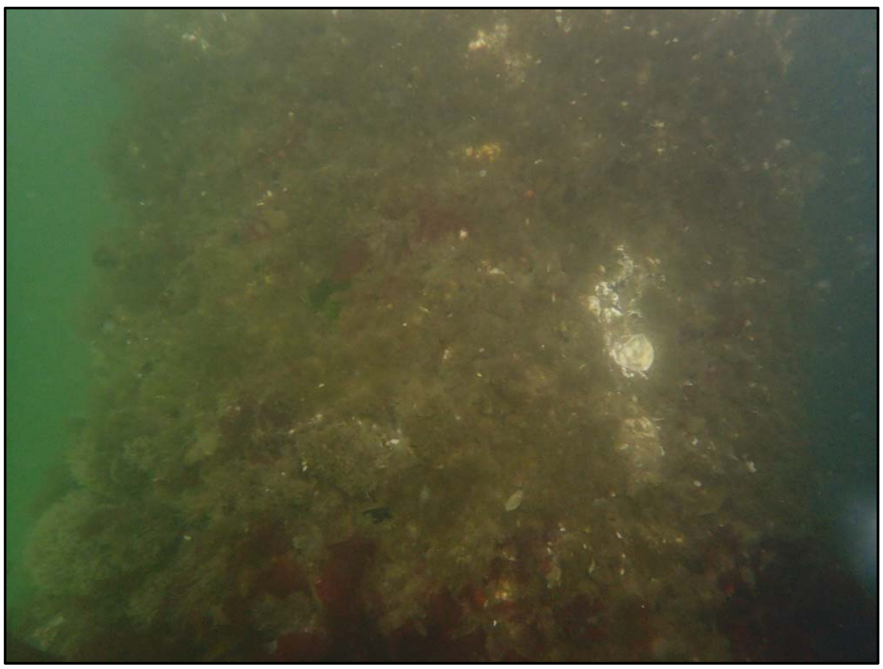
Photograph 7 : Overall View of Mooring Dolphin 4, Looking Southeast.



Photograph 8 : Underwater View of the Typical Marine Growth on the Bottom of the Hull.



Photograph 9 : Underwater View of the Typical Steel Conidtion on the Hull.



Photograph 10 : Underwater View of the Typical Marine Growth on the Steel Pipe Piles (Southeast Pile at Dolphn 4 Shown).

Photograph 11 : Underwater View of the Typical Steel Condition on the Steel Pipe Piles (Southeast Pile at Dolphn 4 Shown).

Appendix C – Ultrasonic Thickness Measurements

Table 1 – C-01 Steel Hull Thickness Measurements

Steel Hull Thickness Measurements						
Belt Line	Location	Design Thickness (in.)	Measured Thickness (in.)	Difference (Δ)	Percent Loss (%)	
	A	0.438	0.430	0.008	2%	
	B	0.438	0.425	0.013	3%	
	C	0.438	0.420	0.018	4%	
	D	0.438	0.430	0.008	2%	
1	E	0.500	0.450	0.050	10%	
	F	0.438	0.415	0.023	5%	
	G	0.438	0.410	0.028	6%	
	H	0.438	0.390	0.048	11%	
	I	0.438	0.430	0.008	2%	
	A	0.438	0.425	0.013	3%	
	B	0.438	0.400	0.038	9%	
	C	0.438	0.395	0.043	10%	
	D	0.438	0.425	0.013	3%	
2	E	0.500	0.435	0.065	13%	
	F	0.438	0.420	0.018	4%	
	G	0.438	0.415	0.023	5%	
	H	0.438	0.400	0.038	9%	
	I	0.438	0.420	0.018	4%	
	A	0.438	0.395	0.043	10%	
	B	0.438	0.450	-0.013	-3%	
	C	0.438	0.430	0.008	2%	
	D	0.438	0.415	0.023	5%	
3	E	0.500	0.425	0.075	15%	
	F	0.438	0.415	0.023	5%	
	G	0.438	0.420	0.018	4%	
	H	0.438	0.435	0.003	1%	
	I	0.438	0.420	0.018	4%	
	A	0.438	0.435	0.003	1%	
	B	0.438	0.460*	-0.023	-5%	(8%)
	C	0.438	0.465*	-0.028	-6%	(7%)
4	D	0.438	0.460*	-0.023	-5%	(8%)
	E	0.500	0.465	0.035	7%	
	F	0.438	0.395	0.043	10%	
	G	0.438	0.420	0.018	4%	

Table 1 – C-01 Steel Hull Thickness Measurements

Belt Line	Location	Design Thickness (in.)	Measured Thickness (in.)	Difference (Δ)	Percent Loss (%)	
4	H	0.438	0.420	0.018	4%	
	I	0.438	0.420	0.018	4%	
5	A	0.438	0.425	0.013	3%	
	B	0.438	0.405	0.033	7%	
	C	0.438	0.425	0.013	3%	
	D	0.438	0.400	0.038	9%	
	E	0.500	0.485	0.015	3%	
	F	0.438	0.395	0.043	10%	
	G	0.438	0.390	0.048	11%	
	H	0.438	0.415	0.023	5%	
	I	0.438	0.400	0.038	9%	
6	A	0.438	0.400	0.038	9%	
	B	0.438	0.380	0.058	13%	
	C	0.438	0.435	0.003	1%	
	D	0.438	0.425	0.013	3%	
	E	0.500	0.495	0.005	1%	
	F	0.438	0.440*	-0.003	-1%	(12%)
	G	0.438	0.445*	-0.008	-2%	(11%)
	H	0.438	0.450*	-0.013	-3%	(10%)
	I	0.438	0.520*	-0.083	-19%	(-4%)
7	A	0.438	0.440*	-0.003	-1%	(12%)
	B	0.438	0.465*	-0.028	-6%	(7%)
	C	0.438	0.450*	-0.013	-3%	(10%)
	D	0.438	0.455*	-0.018	-4%	(9%)
	E	0.500	0.455	0.045	9%	
	F	0.438	0.450*	-0.013	-3%	(10%)
	G	0.438	0.450*	-0.013	-3%	(10%)
	H	0.438	0.440*	-0.003	-1%	(12%)
	I	0.438	0.450*	-0.013	-3%	(10%)
8	A	0.438	0.440*	-0.003	-1%	(12%)
	B	0.438	0.515*	-0.078	-18%	(-3%)
	C	0.438	0.480*	-0.043	-10%	(4%)
	D	0.438	0.485*	-0.048	-11%	(3%)
	E	0.500	0.500	0.000	0%	
	F	0.438	0.400	0.038	9%	
	G	0.438	0.395	0.043	10%	

Table 1 – C-01 Steel Hull Thickness Measurements

Belt Line	Location	Design Thickness (in.)	Measured Thickness (in.)	Difference (Δ)	Percent Loss (%)
8	H	0.438	0.395	0.043	10%
	I	0.438	0.385	0.053	12%
9	A	0.438	0.400	0.038	9%
	B	0.438	0.405	0.033	7%
	C	0.438	0.390	0.048	11%
	D	0.438	0.395	0.043	10%
	E	0.500	0.460	0.040	8%
	F	0.438	0.430	0.008	2%
	G	0.438	0.425	0.013	3%
	H	0.438	0.430	0.008	2%
	I	0.438	0.425	0.013	3%

*Measurement Value suggested that 1/2 in. thick plate may have originally used in lieu of 7/16 in. plate

- Values in the () represents the percentage of section loss assuming a 1/2 in. plate.

Table 2 – C-02 Mooring Dolphin Pile Thickness Measurements

Steel Pipe Pile Thickness Measurements

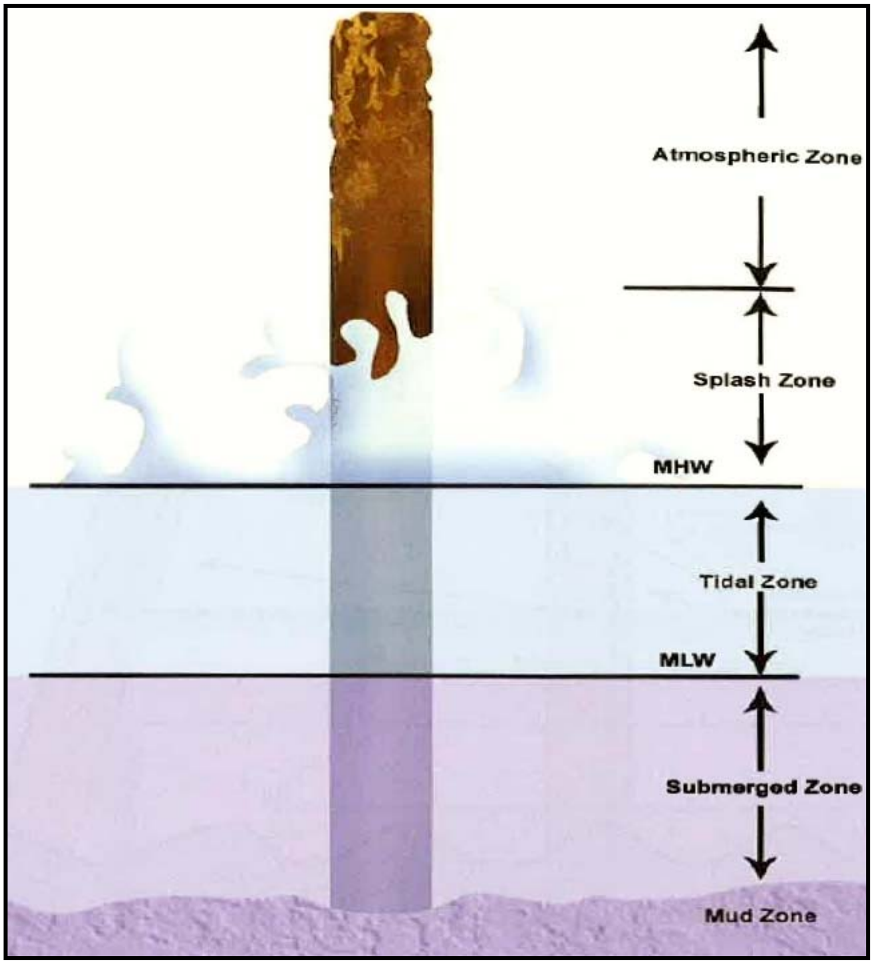
Dolphin	Pile	Design Thickness (in.)	Mudline			Mid-Height			Waterline		
			Measurement (in.)	Difference (Δ)	Percent Loss (%)	Measurement (in.)	Difference (Δ)	Percent Loss (%)	Measurement (in.)	Difference (Δ)	Percent Loss (%)
1	SE	0.500	0.375	0.125	25%	0.455	0.045	9%	0.490	0.010	2%
	NW	0.500	0.500	0.000	0%	0.415	0.085	17%	0.500	0.000	0%
2	SW	0.500	0.450	0.050	10%	0.335	0.165	33%	0.435	0.065	13%
	NE	0.500	0.500	0.000	0%	0.480	0.020	4%	0.450	0.050	10%
3	SE	0.500	0.470	0.030	6%	0.425	0.075	15%	0.350	0.150	30%
	NW	0.500	0.450	0.050	10%	0.400	0.100	20%	0.300	0.200	40%
4	SE	0.500	0.425	0.075	15%	0.475	0.025	5%	0.435	0.065	13%
	NW	0.500	0.425	0.075	15%	0.395	0.105	21%	0.460	0.040	8%

Appendix D – Definitions

DEFINITIONS

Exposure Zones – the five zones along a pile's length as shown in Figure D-1: Atmospheric, Splash, Tidal, Submerged, and Mud.

Figure C-1 - Exposure Zones



USPL-GMS-006-001 Figure 5

Table D-1 – ASCE 130 Waterfront Facilities Inspection & Assessment Table

Table 2-14. Condition Assessment Ratings

Rating		Description
6	Good	No visible damage or only minor damage noted. Structural elements may show very minor deterioration, but no overstressing observed. No repairs are required.
5	Satisfactory	Limited minor to moderate defects or deterioration observed but no overstressing observed. No repairs are required.
4	Fair	All primary structural elements are sound but minor to moderate defects or deterioration observed. Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the load-bearing capacity of the structure. Repairs are recommended, but the priority of the recommended repairs is low.
3	Poor	Advanced deterioration or overstressing observed on widespread portions of the structure but does not significantly reduce the load-bearing capacity of the structure. Repairs may need to be carried out with moderate urgency.
2	Serious	Advanced deterioration, overstressing, or breakage may have significantly affected the load-bearing capacity of primary structural components. Local failures are possible, and loading restrictions may be necessary. Repairs may need to be carried out on a high-priority basis with urgency.
1	Critical	Very advanced deterioration, overstressing, or breakage has resulted in localized failure(s) of primary structural components. More widespread failures are possible or likely to occur, and load restrictions should be implemented as necessary. Repairs may need to be carried out on a very high-priority basis with strong urgency.

Figure D-2 – ASCE 130 Waterfront Facilities Inspection & Assessment Figure

STANDARDS OF PRACTICE 35

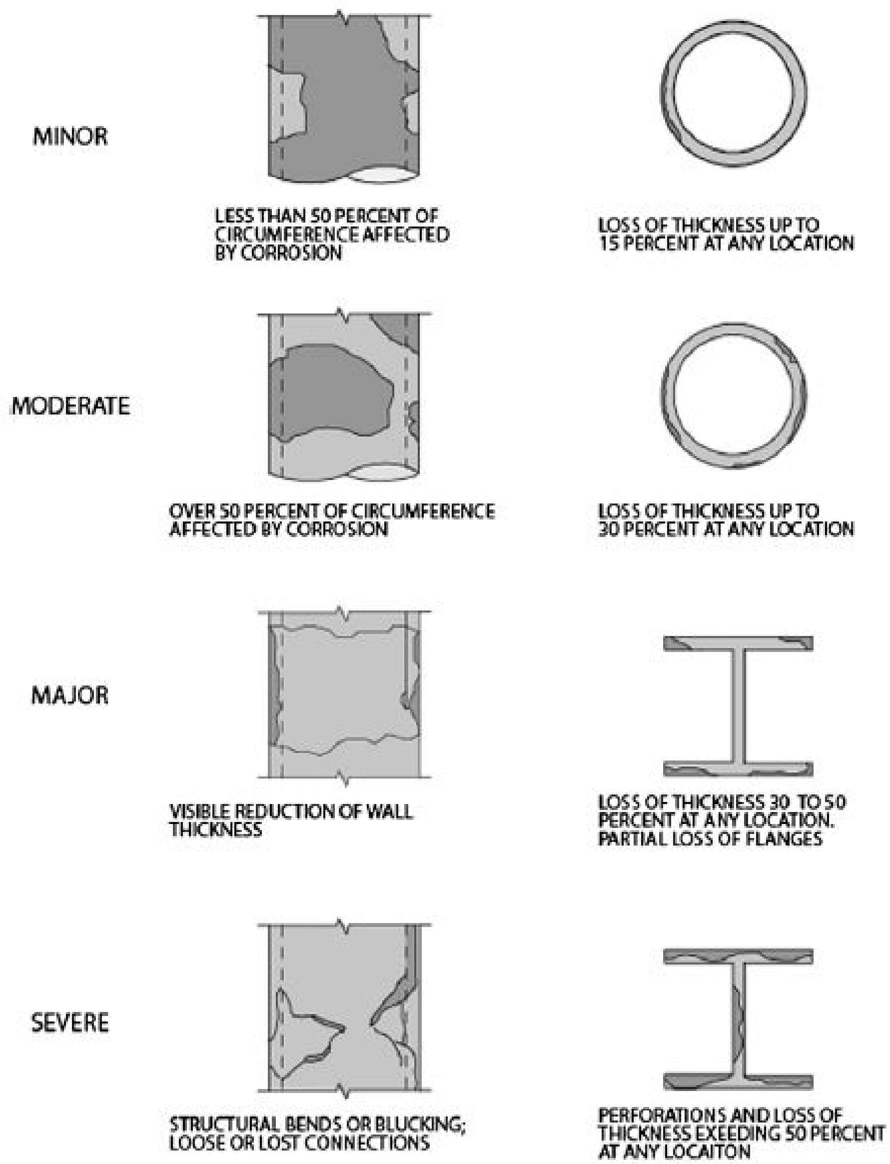
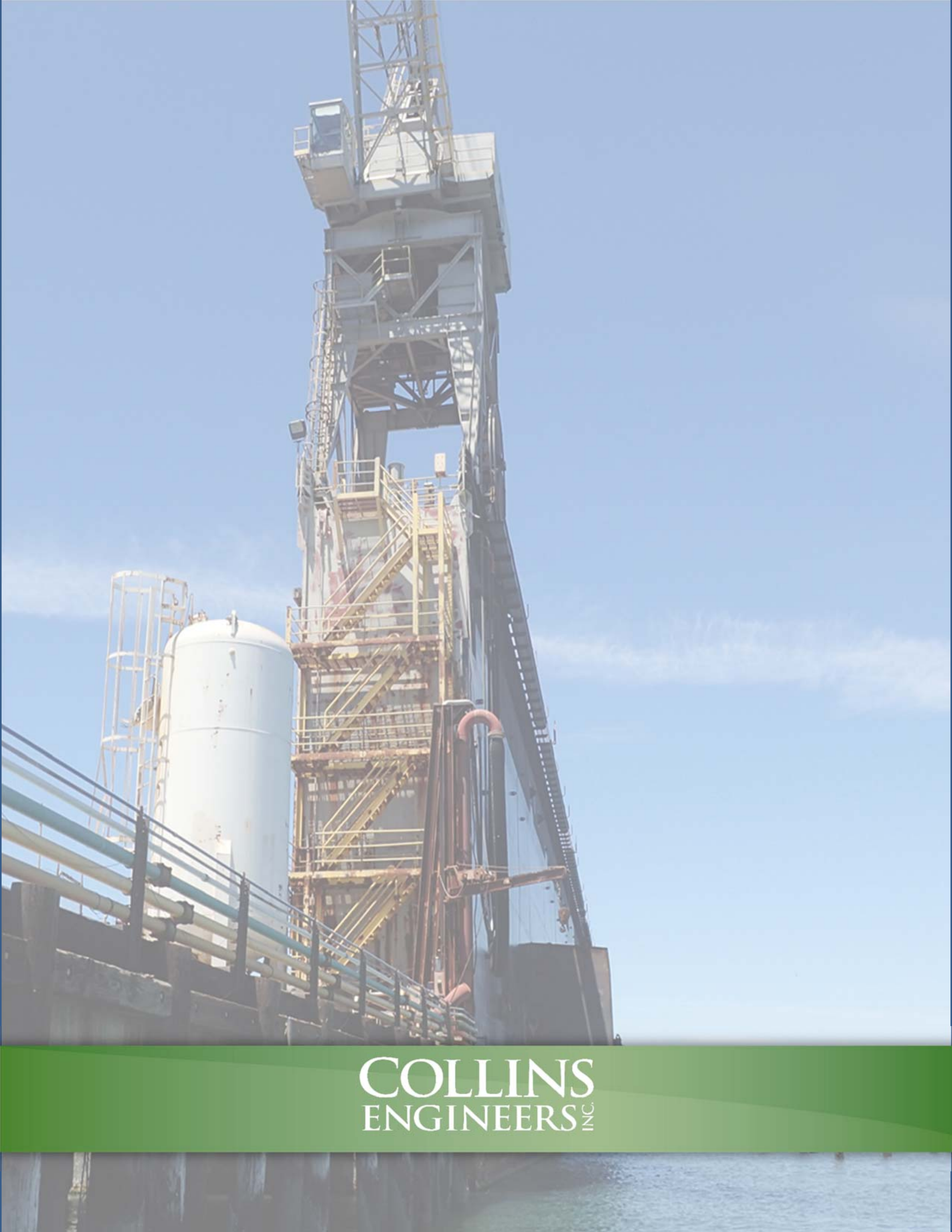


Fig. 2-3. Damage ratings for steel elements
Source: Courtesy of CH2M HILL, Inc. and COWI, Inc., reproduced with permission.

Figure D-2 – ASCE 130 Waterfront Facilities Inspection & Assessment Figure

Inspection Level	Scope of Work Overview	Detectable Defects in Steel
Level I	Visual or tactile inspection of underwater components without removal of marine growth	Extensive corrosion and holes Severe mechanical damage
Level II	Partial marine growth removal of a statistically representative sample – typically 10% of all components.	Moderate mechanical damage Corrosion pitting and loss of section
Level III	Nondestructive testing (NDT) or partially destructive testing (PDT) of a statistically sample – typically 5% of all components. May consist of PDT of wood and remaining thickness measurements of steel components.	Thickness of material Electrical potentials for cathodic protection

Source: ASCE Manual, Underwater Investigations Standard Practice Manual, 2001.

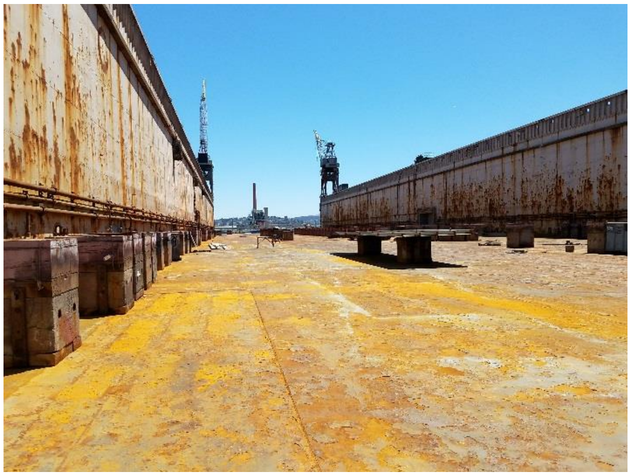


COLLINS
ENGINEERS INC.

Appendix C

Photos

Pontoon Deck Photos



1. On pontoon deck, looking north

2. Pontoon deck and keel blocks

3. Close up of deflection and pitting

4. Numerous through holes

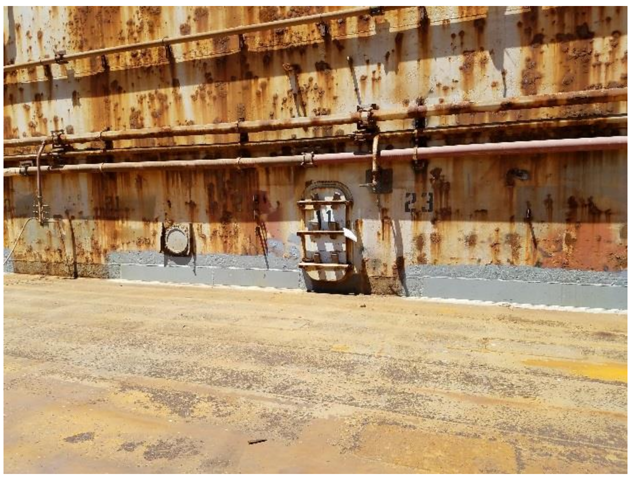
5. Failed epoxy repair of sheared plate at stiffeners

6. Failed coating at doubler plates

Wingwall Photos

7. East wingwall

8. Inner shell at pontoon level with through hole



9. Inner shell with repaired kick plates

10. South end of west wingwall

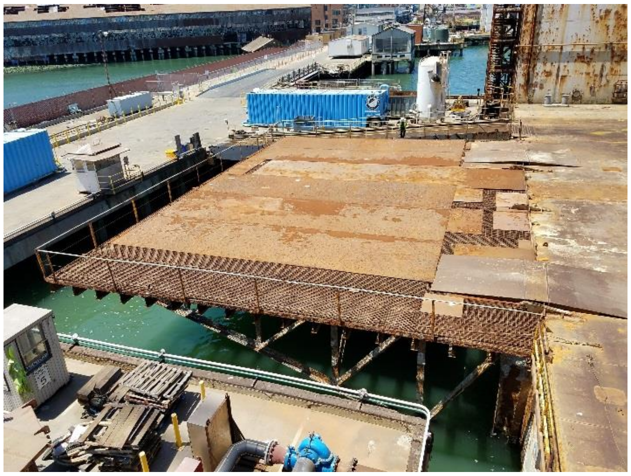
11. Sponson at west wingwall

12. Recently replaced outer shell panels

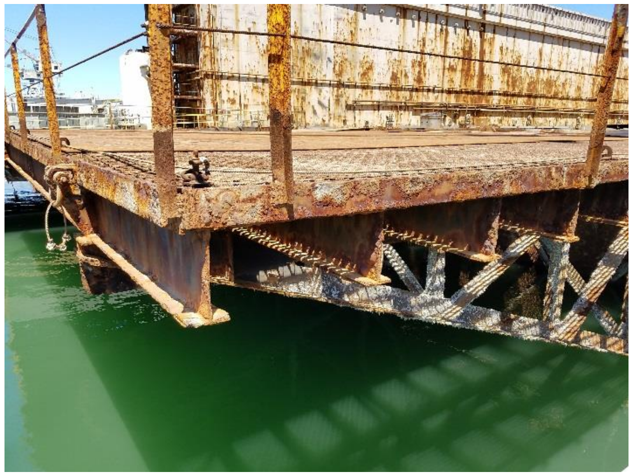
13. Outer shell panels – note recently replaced plates and corroding existing plates

14. Outer shell panels ready for installation

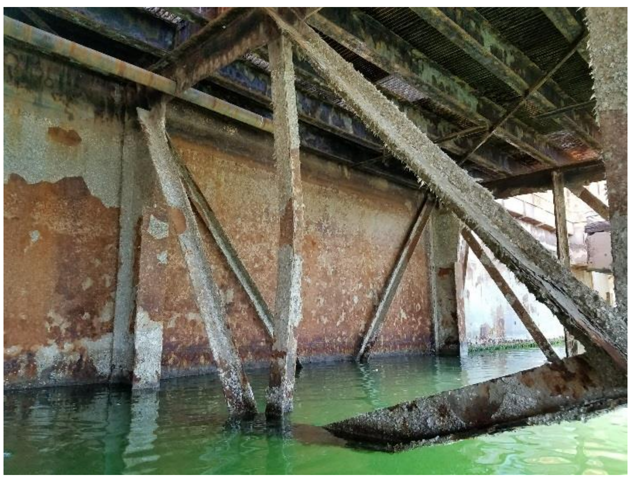
Apron Photos



15. South apron, above



16. South apron, level



17. South apron, below

18. South apron, below

19. North apron

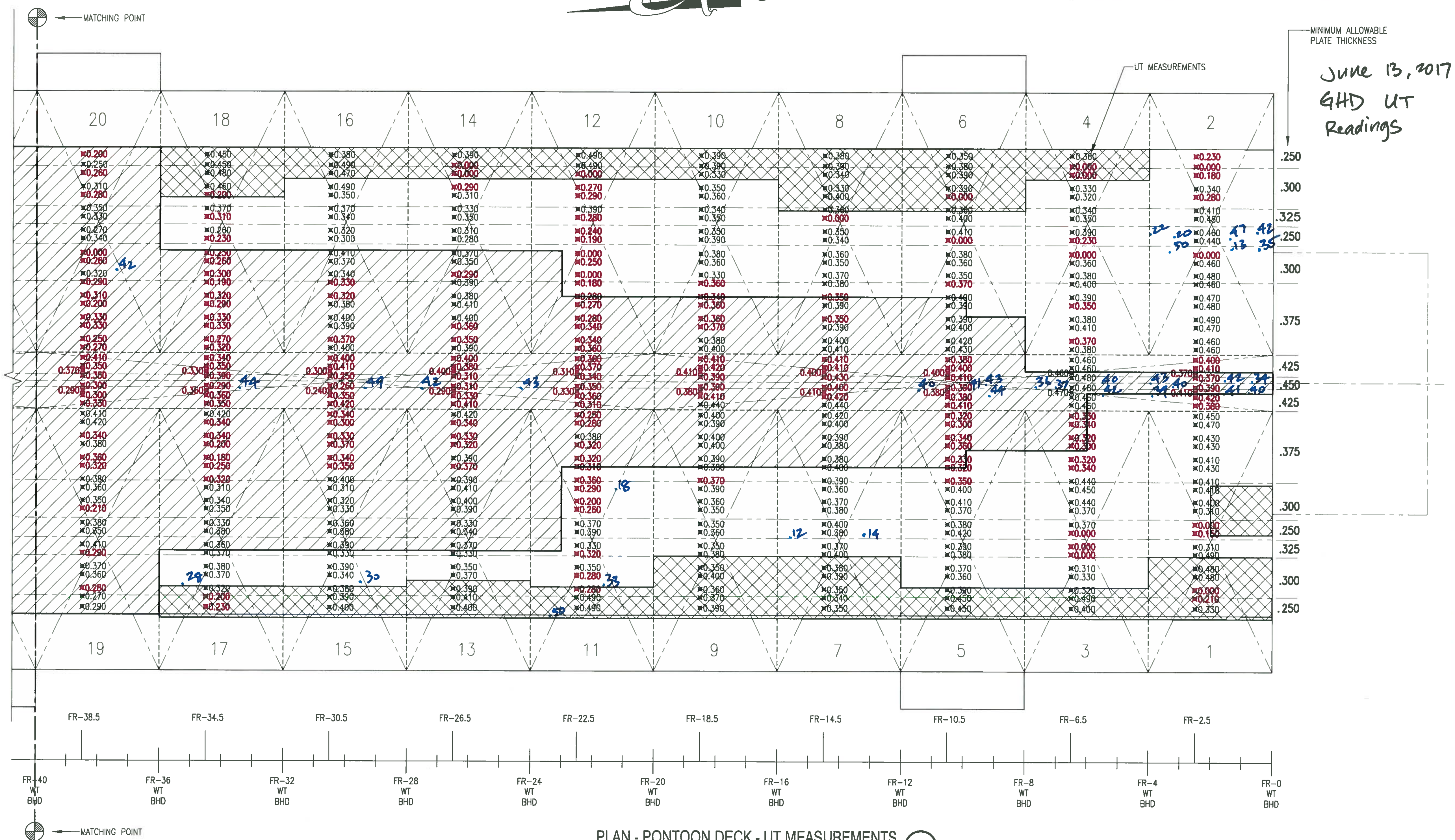
20. North apron, below

Appendix D

Pontoon Deck Inspection Field Notes

NOTES:

1.) DRAWING REFLECTS DATA COLLECTED BY INTERNATIONAL INSPECTION IN JANUARY 2016
2.) UT MEASUREMENTS HIGHLIGHTED IN RED ARE LESS THAN MINIMUM ALLOWED PLATE THICKNESS



PLAN - PONTOON DECK - UT MEASUREMENTS (A1)

SCALE: 1/16"=1'-0"

ORIGINAL PONTOON DECK PLATE NO REPAIRS

INSERTED PONTOON DECK PLATE REPAIR

DOUBLER PONTOON DECK PLATE REPAIR

SYMBOLS KEY

N.T.S.

1/16" = 1'-0" 0 4 8 16 32 FT

HEGER DRY DOCK, Inc.

DRY DOCK ENGINEERS

DESIGN, INSPECTION AND CERTIFICATION

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CHIEF ENG. WALLY SAYED

DATE: 8/11/2016

CLIENT NAME AND ADDRESS: BAE SYSTEMS SHIP REPAIR, SAN FRANCISCO, CALIFORNIA

PROJECT TITLE: CONTROL INSPECTION OF FDD #2

DRAWING TITLE: UT MEASUREMENTS - PONTOON DECK - 2 OF 2

SCALE: AS NOTED

PROJECT NO.: 3917-D

CONSTR. CONTR. NO.

SHEET 3 OF 9

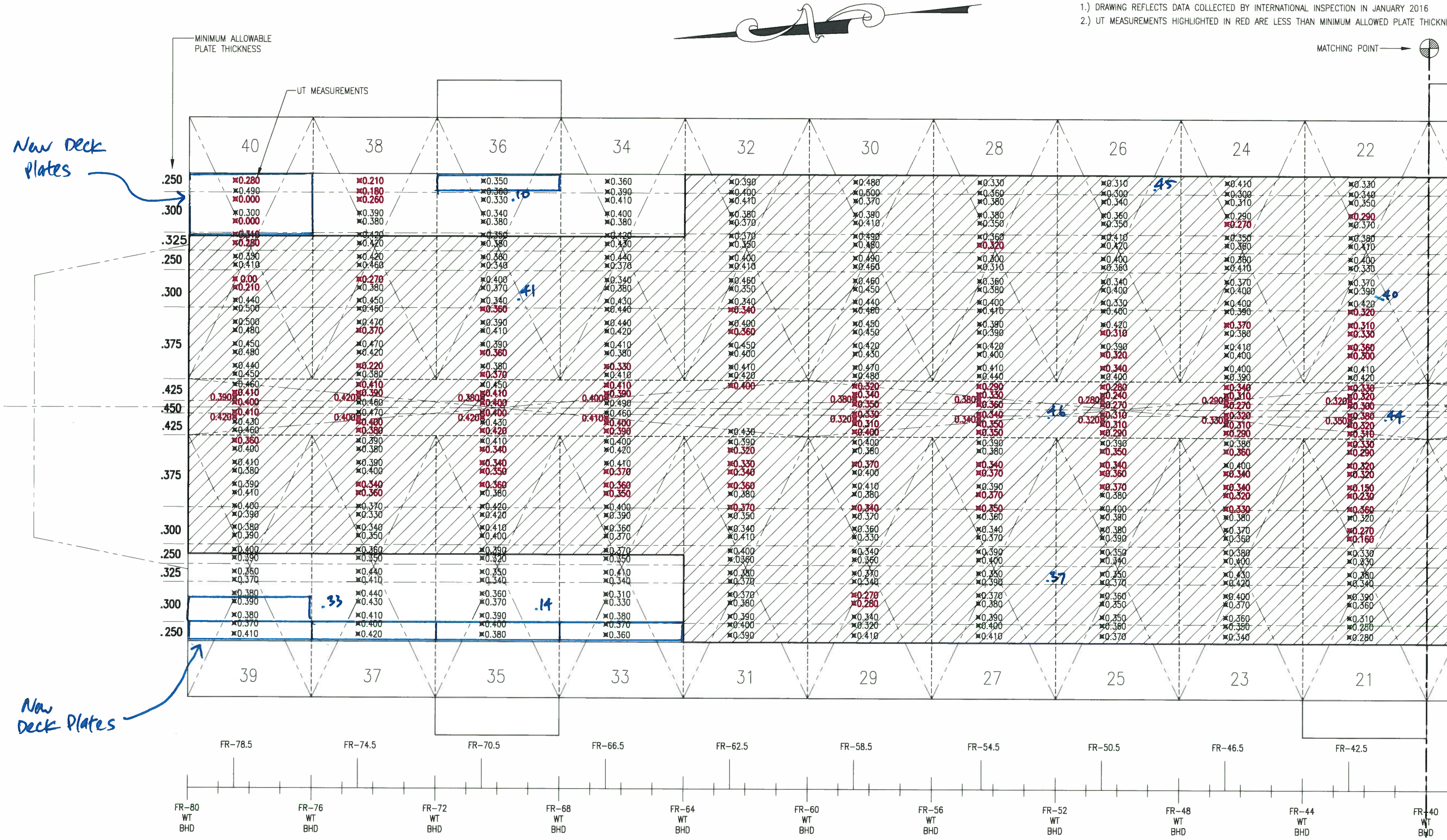
A-003

FILE NAME: L:\CLIENTS\BAE\bae san francisco\3917-d nassco control inspect odd2\Dwgs\3917-d current heger design drawings\A-003.dwg LAYOUT NAME: A-003 PLOTTED: Monday, August 22, 2016 - 2:55pm USER: Jason

NOTES:

1.) DRAWING REFLECTS DATA COLLECTED BY INTERNATIONAL INSPECTION IN JANUARY 2016

2.) UT MEASUREMENTS HIGHLIGHTED IN RED ARE LESS THAN MINIMUM ALLOWED PLATE THICKNESS



PLAN - PONTOON DECK - UT MEASUREMENTS (A1)

SCALE: 1/16"=1'-0"

MATCHING POINT

SYMBOLS KEY

N.T.S.

- ORIGINAL PONTOON DECK PLATE NO REPAIRS
- INSERTED PONTOON DECK PLATE REPAIR
- DOUBLER PONTOON DECK PLATE REPAIR

1/16" = 1'-0" 0 4 8 16 32 FT

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DATE: 8/11/2016

BAE SYSTEMS SHIP REPAIR
SAN FRANCISCO, CALIFORNIA

CONTROL INSPECTION OF FDD #2

UT MEASUREMENTS - PONTOON DECK - 1 OF 2

SCALE: AS NOTED

PROJECT NO.: 3917-D

SHEET 2 OF 9

A-002

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