



August 30, 2016

REF: 16LET019

Address: BAE Systems, San Francisco Ship Repair  
Foot of 20<sup>th</sup> Street  
San Francisco, CA 94107

Attention: Mr. Justin Gleaton, Dockmaster

Subject: Dry Dock No. 2 Dolphin & Stair Tower Inspection

Dear Justin,

In accordance with our agreement we have completed our field investigation of the dolphin structures and steel stair access tower at Dry Dock No. 2. The work was performed by Triton Engineers on August 17, 2016. Vessel support was provided by BAE Systems.

#### **SUMMARY**

The above water structural inspections of the four (4) concrete mooring dolphins which serve to secure the position of Dry Dock No. 2 revealed no major changes to their condition since our last inspection (November 2015). The concrete extensions to the mooring dolphins were first observed to have hairline cracks in 2014 (Inspection and Evaluation of Dry Dock #2 Mooring Dolphins, Triton Engineers, dated 8/20/14). Our current inspection showed that these cracks have not changed condition during the past year.

It was also noted in 2014 that closed corrosion spalls exist on the east face of dolphin structures. It was expected that these areas would continue to deteriorate over time due to corrosion of reinforcing steel. The deterioration in these areas was observed to have advanced resulting in open spalls at several locations. Continued monitoring of the cracks and concrete spalls should occur on an annual basis. Repairs to the concrete spalls identified should be repaired within the next 2 to 3 years to stop progression of the deterioration further in the dolphin deck structure.

Structural inspection of the steel stair tower at Dry Dock No. 2 found the upper levels of the tower frame and stairway to be in good condition. Several deficiencies were noted at the base level at columns and horizontal and diagonal braces. Partial to complete loss of the structural section is evident at these locations, strongly affecting the integrity of the tower frame against design loads. The location of the deterioration appears to coincide with proximity to the waterline and position at the predominant wind side of the dock.

It is recommended that repairs be undertaken to bring these steel connections back to original design strength on a priority basis.

## OVERVIEW

### Dry Dock Dolphin Structures

The dolphin structures secure the position of Dry Dock #2. Dry Dock #2 measures over 900 ft in length, excluding aprons and is located at the east end of the high water platform (HWP). Alignment of the dolphins is in a north-south direction, each separated by a distance of approximately 240 ft. The mooring dolphins are designated as D1, D2, D3 and D4 with D1 being the in-board most structure which abuts the north edge of the east end of the HWP. Dolphin D4 is the furthest offshore structure and is located close to the end of the dry dock. The dolphins were constructed from a set of plans dated 1969 (Bethlehem Steel Corporation).

Dolphin D1 is 26 ft long and 18 ft wide and is supported by a series of steel pipe piles. The reinforced concrete deck is 8 ft thick. The other three dolphins (D2 – D4) are of similar configuration and construction, each measuring 34 ft long x 18 ft wide. Each deck structure has an extension at its east face, which serves to provide a mount for the steel gripper assembly. The gripper assembly attaches to a 2-1/2" thick steel mounting plate (2'-8" x 4'-0" in dimension) which is embedded into the face of the dolphin and secured with twenty (20) 1-3/8" dia. x 4 ft long anchor bolts.

### Dry Dock Stair Tower

The steel stair tower was designed to extend off the north end of dolphin D1 and provide support to the upper end of the second flight of access stairs and landing (Figure 11 & 12). In addition, the tower provides a landing for a short brow extending across to the floating dry dock. The tower is framed from paint coated structural tee and angle sections comprised of 0.375" and 0.565" thick steel plate (ASTM A36). Several large wide flange beams support the tower at the dolphin deck and cantilever outward. Diagonal beams below the dolphin deck level serve as struts to support the cantilevered beams at the far ends. Design drawings for the tower were provided by BAE (Figures 9 & 10).

## SCOPE OF WORK

The scope of the inspections and subsequent evaluation is to confirm the overall condition and fitness for purpose of the subject structures. The effort included an above water inspection of the dolphins for the purpose of monitoring their general condition and to identify concerns and structural deficiencies which limit their use since the last inspection performed. In addition, a detailed inspection of the stair tower was performed to determine its structural condition and required repairs.

## FIELD INVESTIGATIONS AND FINDINGS

### Dry Dock Dolphin Structures

A visual inspection of the concrete dolphin structures was performed. Based on previous findings, the visual inspection was limited to the dockside face of each dolphin structure including extensions at gripper base plates.

#### *Summary of Findings:*

The dockside face at each of the four dolphins was inspected. In general, each dolphin structure was found to be in fair to good condition. Open and closed corrosion spalls were consistently observed at the dockside (east) face of the dolphins. These areas appear to

have grown since previous inspections with delaminated surface areas failing at certain locations (Figures 5 through 8). Cracks found to occur at the face of concrete extensions at edge of each gripper base plate which extend upward to flat portions of the concrete extensions appear to be unchanged (Figures 2 through 4). More specifically, the following was observed the following:

Dolphin D1: Several localized closed corrosion spalls exist along the east face of deck structure and at top of extension. Cracks occur at both sides of the gripper steel mounting plate, originating from the top corner and extending upwards. A crack extends horizontally nearly full length along the east face of deck near top corner. Concrete at extension determined to be sound.

Dolphin D2: Closed corrosion spalls exist along the east face of deck structure, above and to each side of the gripper extension. Cracks occur at the top edge of the gripper steel mounting plate extending upwards to the horizontal surface. A horizontal crack occurs at the extension alongside a closed corrosion spall on the flat surface. Remaining concrete regions outside of observed spalls determined to be sound.

Dolphin D3: Several open and closed corrosion spall exist along the east face of deck structure, directly above the gripper extension mount. A crack occurs at the south edge of the gripper steel mounting plate, originating from the top corner and extending upwards. Except for dockside face (east) concrete is sound.

Dolphin D4: A closed corrosion spall and horizontal crack exists at the east face near the top corner of deck. Cracks occur at both edges of the concrete extension, originating from gripper plate and extending. Concrete outside region of spall determined to be sound.

### **Stair Tower**

Visual inspections were performed and notes taken regarding observations made at accessible areas of the tower steel frame.

The upper regions of framing of the stair tower appear in good condition (Figures 14 through 16). Lower portions of the frame nearer to the deck surface of the wharf and dolphin structure are heavily scaled due to corrosion and in poor condition (Figure 13).

Connections (approximately 8 locations) between columns, diagonal and horizontal brace connections have undergone significant deterioration leaving little or no original cross section remaining (Figures 17 – 22). These connections are susceptible to failure.

The lower regions of the steel stringers located at each side of the stairs were observed to be heavily corroded leaving webs at the 12" channels with considerable reduction in thickness and shear tab connections between sheet metal treads and steel channel stringers susceptible to failure (Figures 23 & 24). Several tread connections near the base have been previously repaired.

Two columns (waterside) at the tower frame were observed to have been previously repaired with splice plates (Figure 26). The spliced connections appear sound, although some deterioration of the splice plates has occurred. Similar regions further up the frame appear buckled, likely from impact. These areas have not been repaired.

Two large beams (W10x66) extend out horizontally from the concrete deck surface to carry the tower frame. Two diagonal struts of the same section extend downward from the far end of the horizontal beams at an approx. 45-degree angle to provide support. The wide flange

sections at beam and strut locations are heavily scaled (Figure 25). Measurements made on site following removal of scale reveal approximately 0.375" thickness remaining on an original 0.680" thick section (or approx. 55% of original section remains).

*Summary of Findings:*

The majority of the stair tower appears in good condition, however numerous connections and several structural members were observed to have undergone significant damage due to corrosion and require immediate repair.

**RECOMMENDATIONS**

**Dry Dock Dolphins:**

The integrity of the gripper base plates and surrounding concrete appears to remain intact. Spalled regions of dockside face of all four of the dry dock dolphin structures should be considered for repair in the next 2 to 3 years as the deterioration in these regions continues to grow and extend towards the gripper plates.

**Stair Tower:**

The failed connections (8 ea.) require immediate attention to reinstate their original design strength. The tower in its current condition is susceptible to base failure under a significant seismic event or wind load.

The heavily corroded beams and struts which support the tower at the concrete deck have lost nearly half of their original cross section and will require replacement in the next 2 to 3 years.

Numerous connections between stair treads and stringers were observed to have been previously repaired at lower regions of the stairs. Other connections will continue to fail above this region and will require similar repair as this occur.

We appreciate the opportunity to be of assistance in this matter. If you have any questions in regards to this information, please do not hesitate to call.

Sincerely,  
TRITON ENGINEERS, INC.



Troy Gillum, P.E.  
Principal



Figure 1 – General view of dry dock gripper assembly mounted at concrete extension at face of concrete dolphin (D4).



Figure 2 – Close-up view of crack extending from top corner of gripper plate to side face and upwards at dolphin (D2).

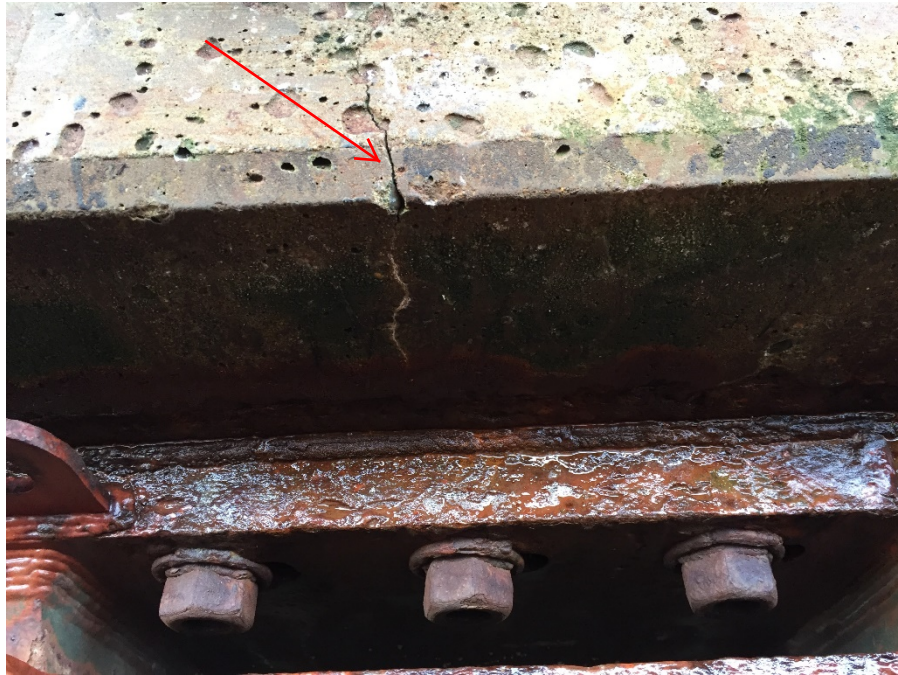


Figure 3 – View of typical crack in concrete extending from gripper plate at dolphin (D2).



Figure 4 - View of typical crack in concrete extending from gripper plate at dolphin (D3).



Figure 5 – Location of concrete spalls at east face of dolphin (D2).



Figure 6 – Close-up view of spalling and soft concrete observed at east face of dolphin (D2).



Figure 7 – Close-up view of open corrosion spall at east face of dolphin (D3). Note exposed steel reinforcing.



Figure 8 – Close-up view of horizontal crack near top corner of dolphin deck structure (D4).



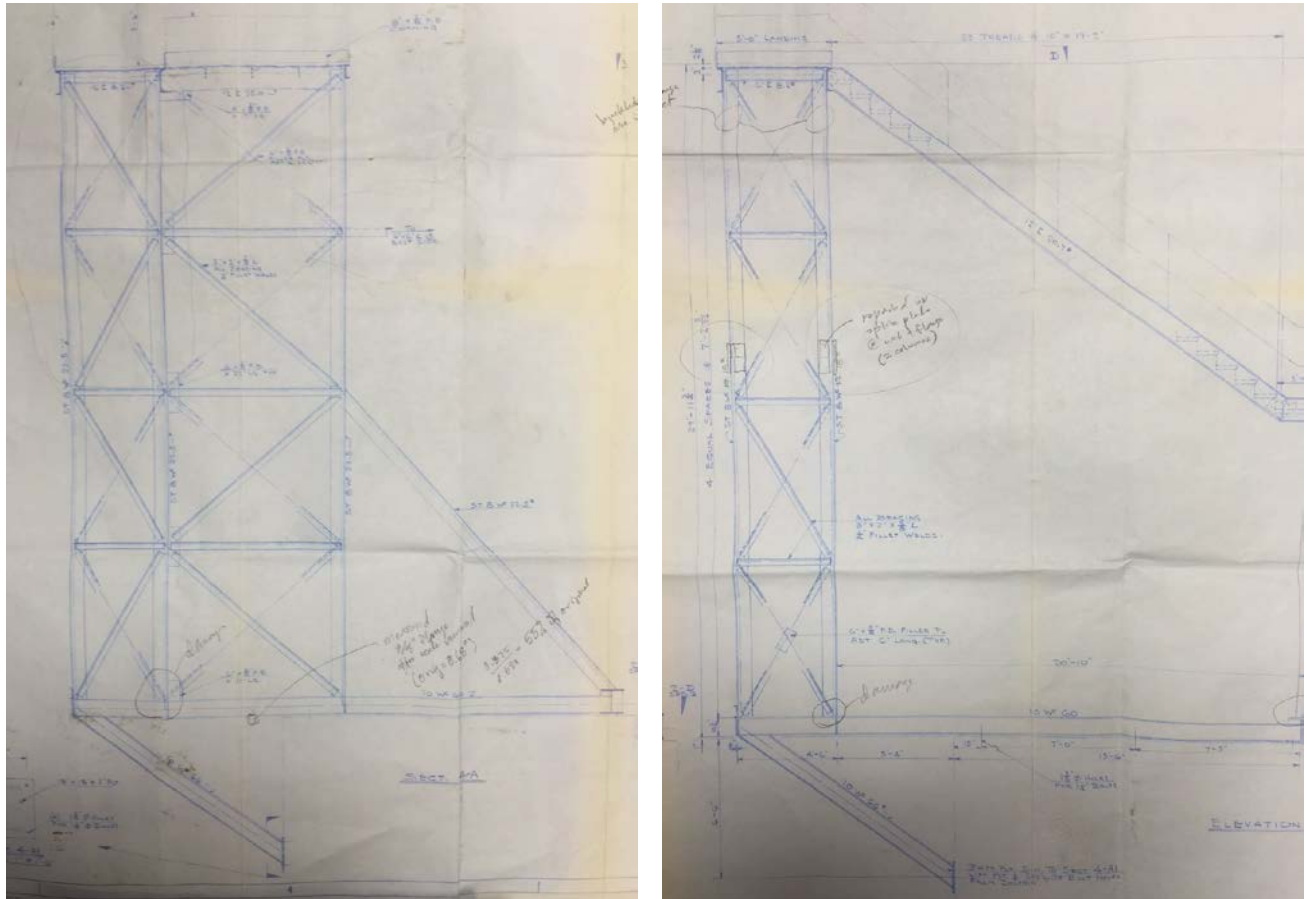


Figure 9 – Original drawing cross section of stair tower at brow (left) and stair landing (right).

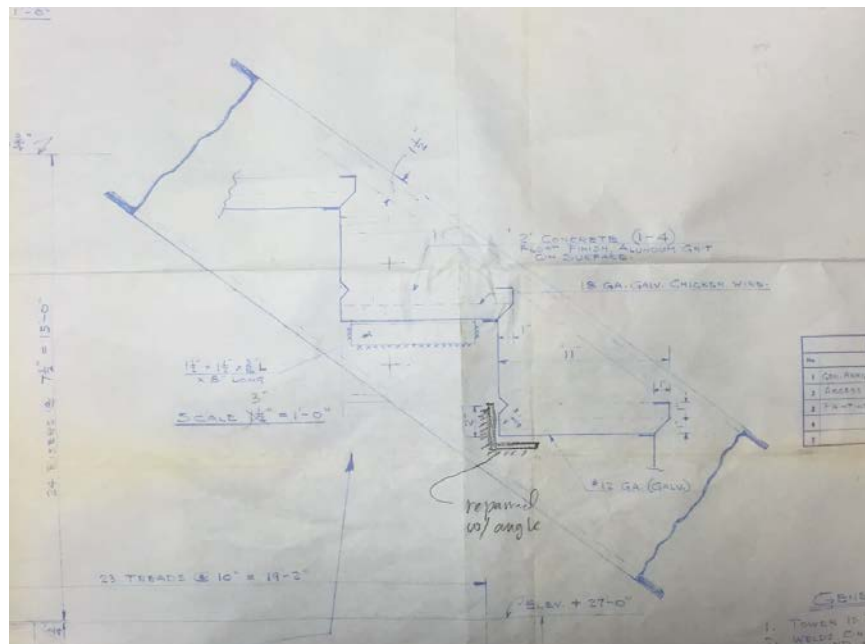


Figure 10 – Original drawing showing stair tread detail.



Figure 11 – Full view of stair tower framing.



Figure 12 – View of lower frame and support framing at dolphin D1.



Figure 13 – View of heavily corroded base region of steel frame.

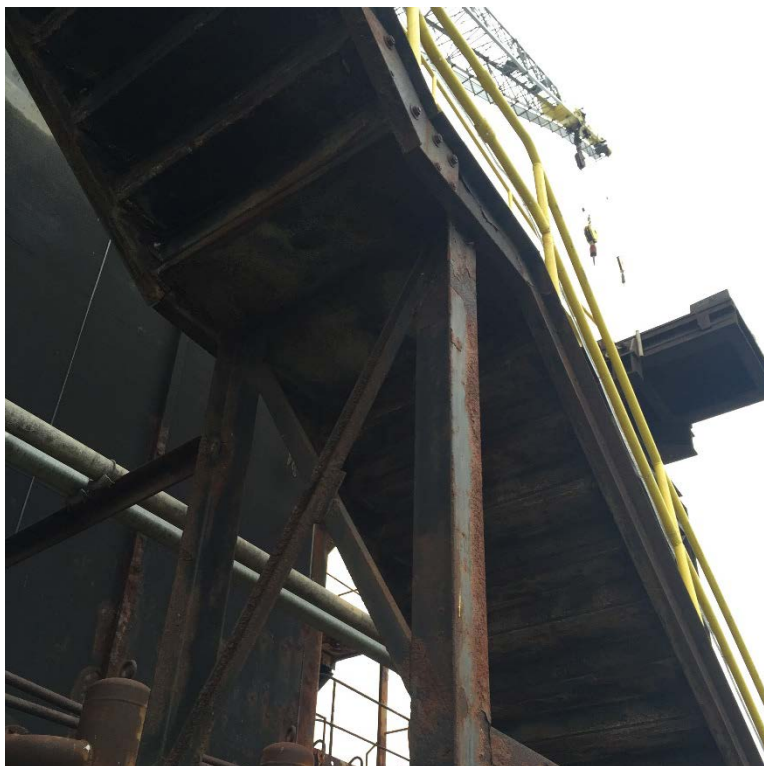


Figure 14 – View of intermediate stair landing steel frame support.



Figure 15 – View of upper portions of steel frame in good condition.



Figure 16 – Upper region of tower frame in excellent condition. Paint coating remains in good condition.



Figure 17 – Deteriorated base connection at braced column.



Figure 18 – Complete loss of cross section at angled brace support.



Figure 19 – Complete loss of section at diagonal brace.



Figure 20 – Deteriorated base connection at corner column.



Figure 21- Complete loss of cross section due to corrosion at corner column base connection.



Figure 22 - Heavily scaled connection at braced column connection.



Figure 23 – Complete loss of cross section at web of stair stringer.



Figure 24 – View of deterioration at shear tab support between stringer and stair tread (upper). Repaired stair tread connection (bottom right).





Figure 25 – Heavily corroded base horizontal beams and diagonal struts. Approximately 50% to 60% of original cross section remains.

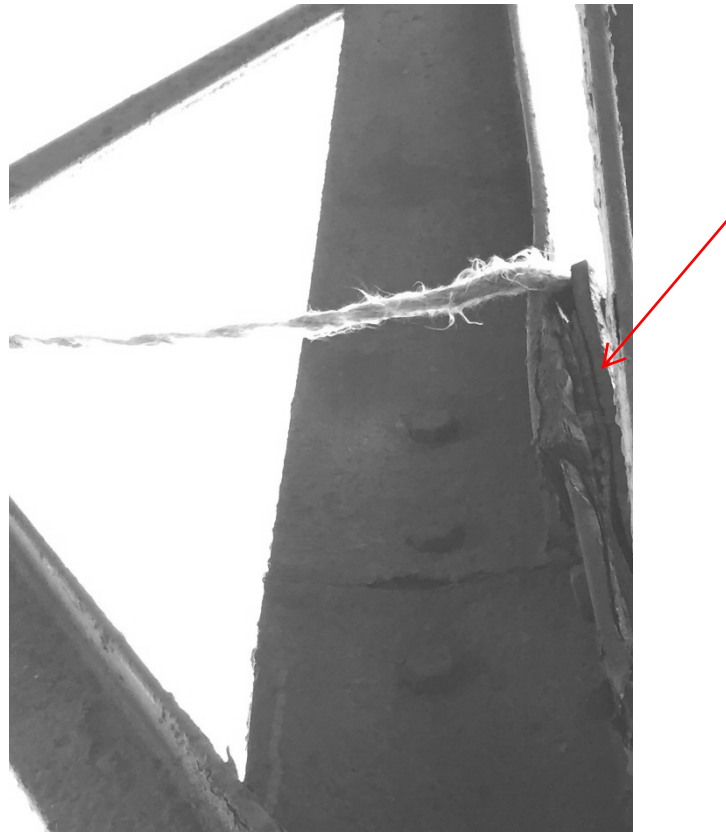


Figure 26 – View of condition of splice plates at previously repaired column damage.