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November 23rd, 2021

Attention: Vincent Magers, Dockmaster, NASSCO San Diego

Subject: Memo – BUILDER FDD Revised Operational Limits and Repair Plan (2021)

Enclosures: (1) Detailed Wind-Water Strake UT survey results, dated 2021
(2) HEGER's Repair Plan Drawing Package, dated 16 November 2021
(3) HEGER's Revised Operational Limitations Report, dated 22 November 2021

1.0 Introduction

HEGER DRY DOCK, Inc. (HDD) has been tasked by NASSCO SAN DIEGO to conduct an engineering review of the aging BUILDER dry dock, revise operational limitations, and develop a repair plan, as needed.

In 2020, a routine gauging survey of the pontoon deck plating identified areas of high wastage (in excess of 25%) in the dock's driving lanes; the driving lane is defined as the outboard areas of the deck extending from the inner wing shell inboard 20-ft. Following an independent review of the survey, HEGER developed a repair plan to fortify these corroded areas with engineered doubler plates welded to underlying structure to properly develop required structural strength.

In 2021, moderate to heavy pitting was identified on the dock's wind-water strake; the wind-water strake is defined as the outboard shell of the dock approximately 5-ft above and below the pontoon deck level. To investigate the amount of degradation in this area, NASSCO conducted a detailed UT survey taking shots above and below the pontoon deck level at 128 locations along the docks length, on both port and starboard sides, for a total of approximately 1,300 data points. The surveyed results are attached in Enclosure 1.

Based on the surveyed levels of corrosion along the dock's wind-water strake, it was determined a doubler plate type repair plan, similar to the one executed on the pontoon deck in 2020, was needed to repair large areas of the dock's outer shell. Additionally, required repairs were identified along the offshore end bulkhead and in certain sally ports. HEGER's developed repair plan is attached in Enclosure 2.

Furthermore, HEGER investigated and evaluated the current condition of the dock using 2020 gauging results. Based on HEGER's review of the dock's current condition, revised down rated operational limitations in regards to keel line loading capacity and differential head pressure allowances were determined. For the down rated limitations, HEGER developed corresponding corrosion tolerances or repair criteria for maintaining adequate factors of safety and upholding future NAVSEA certifications. The analysis report is attached in Enclosure 3.

2.0 Differential Head Pressure Operational Limitations and Repair Criteria

Based on HEGER's review of the most recently conducted UT survey, the dock structure is generally in good condition with low levels of corrosion (5% wastage or less); there are some isolated readings that may approach 8-10% wastage, but there is generally better steel surrounding the localized corrosion reading. The exception is the driving lanes of the pontoon deck and wind-water strake of the dock which have higher levels of corrosion approaching 25% wastage or more in large areas.

After HEGER conducted a detailed structural analysis of the hull plating (in accordance with ABS guidelines), it was discovered that the dock was originally not designed to accommodate corrosion of the hull plating. Therefore, even given the dock's current levels of minimal corrosion, the hull plating cannot withstand the original 34-ft of design differential head pressure without exceeding normally prescribed factors of safety. Considering both the current levels of corrosion throughout the hull and the range of vessels intended to be docked, **HEGER recommends down rating the dock's differential head pressure allowance from 34-ft to 28-f**t.

If the dock's head pressure limitation is revised to 28-ft, the following shall be implemented as repair criteria for the dock's hull plating:

Pontoon bottom - minimum thickness = 10.6mm or 0.416 inches
Pontoon deck - minimum thickness = 10.6mm or 0.416 inches
Pontoon side shell (wind-water strake) - minimum thickness = 10.0mm or 0.395 inches
Lower 9-ft of wingwalls (INBD & OTBD) - minimum thickness = 10.0mm or 0.395 inches
Typical wingwall shell (INBD & OTBD) - minimum thickness = 9.0mm or 0.355 inches

NOTE: The internal scantlings were generally designed with sufficient factors of safety such that it can accommodate 25% corrosion, in combination with the above minimum plating thicknesses, and still be capable of resisting 28-ft of differential head

3.0 Keel Line Loading Capacity

The BUILDER dock is designed such that keel line loading, applied along the dock's centerline, is supported across the pontoon's width by buoyancy. The centerline loading puts the dock into bending, transversely, and the flexural strength in the dock is provided by deep plate girders formed by the pontoon deck and bottom shell acting as the top and bottom flanges respectively, and the transverse bulkheads acting as the girder's web.

The dock is constructed of three (3) different structural designs. The different sections are illustrated below:

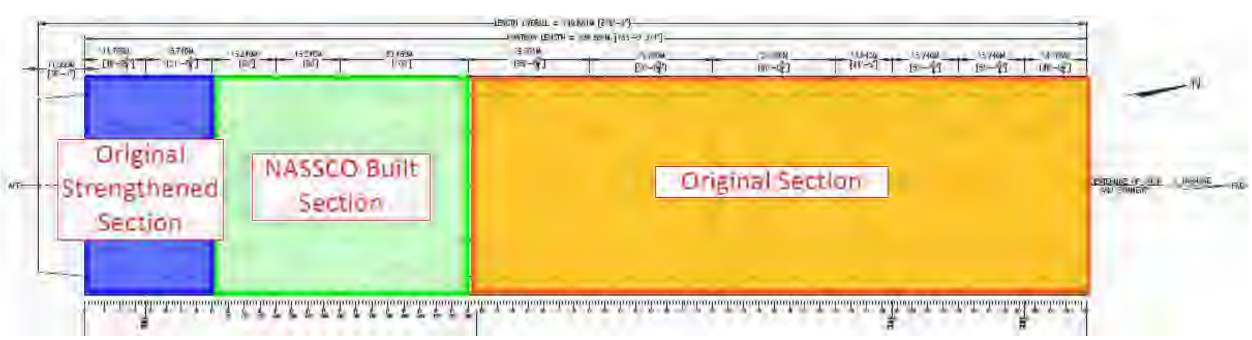

FIGURE 1 - PLAN VIEW OF BUILDER FDD

The offshore/aft section of the dock (300-ft of length extending from Frame 0 to Frame 42) is currently rated for 84 LT/ft while the inshore/fwd section of the dock (484-ft of length extending from Frame 42 to 242) is currently rated for 60 LT/ft. However, HEGER's detailed structural analysis of the dock in its most recently surveyed condition resulted in finding that the transverse structure cannot safety support the certified loading capacity. HEGER instead recommends the certified keel line loading capacity be revised to the following:

- Frame 242 to 42 (484-ft) = 60.0 LT/ft
- Frame 42 to 41 (200-ft)= 72.5 LT/ft
- Frame 41 to 0 (100-ft) = 68 LT/ft

NOTE: HEGER's recommended keel line loading capacity provides limitations on a section by section basis using statistical analysis of data from the most recently conducted UT survey of the dock and considers principal stress and finite element analysis (FEA) computer models to verify adequate factors of safety are maintained.

HEGER's recommended keel line capacity is also provided graphically below as follows:

[redacted]

[redacted]

To determine future keel line loading capacities of the dock, HEGER recommends the following curve which plots pontoon deck corrosion against recommended keel line loading capacity for the three different pontoon section designs:

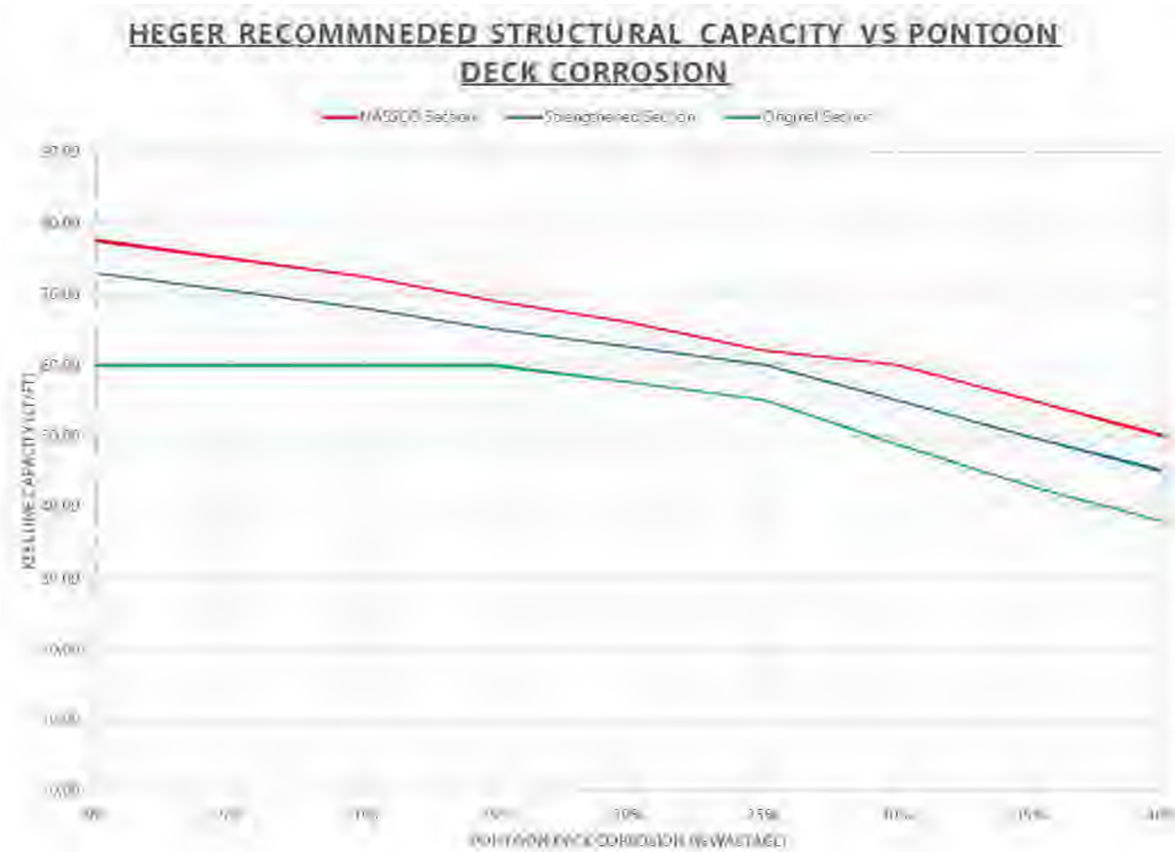

FIGURE 3 - CHART OF KEEL LINE CAPACITY VS PONTOON DECK CORROSION

<u>NOTE:</u> The levels of pontoon deck corrosion only pertain to the middle 80-ft of the dock; plating further outboard does not significantly contribute to the keel line capacity of the dock and it's minimum plating thicknesses is governed by head pressure limitation or vehicular loading demands.

4.0 Repair Plan (2021)

After HEGER established a repair criteria for the down rated 28-ft differential head pressure limitation (see section 3.0), a comprehensive UT survey was conducted to identify areas along the outer shell with corrosion levels exceeding allowable minimum plating thicknesses. UT measurements were taken above and below the pontoon deck level, 4-ft fwd and aft of each major dock frame, along the starboard and port sides of the dock. Plating thicknesses in way of observed 'pits' were specifically investigated. Approximately 650 data points were collected on each side of the dock. The data is attached in Enclosure 1 with any reading not meeting HEGER's recommended plating thickness highlighted in orange. Data points with corrosion levels significantly in exceedance of the minimum plating thickness are highlighted in red.

On sheet A-001 of Enclosure 2, HEGER graphically plotted all data points with corrosion exceeding 10% in yellow, which generally aligns with the repair criteria threshold. Data points with corrosion exceeding 25% were plotted in red. On the same sheet, HEGER plotted a doubler plan for repairing all areas of wasted hull plating. The exception is one localized reading 3-ft above the pontoon deck at Frame 41-24 on the starboard shell which can be repaired by clad welding but is generally an isolated spot surrounded by good steel.

HEGER also developed a repair plan for the inner wing shells of the dock as shown on sheet A-121 of Enclosure 3. Any areas on the inner wing shells that are identified as being locally corroded or pitted in excess of prescribed limits may be repaired by clad welding or the engineered doubler plate solution, at NASSCO's discretion.

Sheets A-126 and A-131 of Enclosure 3, provide repair plan details for corroded areas of the pontoon deck plating (mainly in way of sally ports) and the upper corners of the offshore end bulkhead.

On sheet A-005 and A-006, HEGER provides an engineered pumping plan for ballasting the dock, in two phases, so the repair work can be accomplished, per NASSCO's requirements.

Conclusion

Based on HEGER's detailed review of the BUILDER's recently conducted UT surveys and corresponding engineering analysis, which accounts for the current levels of corrosion, HEGER recommends down rating the dock as follows:

- Differential head pressures on the hull shall be limited to 28-ft
- Keel line loading capacity shall be as follows:
  - Frame 242 to 42 (484-ft) = 60.0 LT/ft
  - Frame 42 to 41 (200-ft)= 72.5 LT/ft
  - Frame 41 to 0 (100-ft) = 68 LT/ft

[redacted]

However, if the pontoon deck continues to corrode beyond current levels, in the middle 80-ft of width along centerline between Frames 0 and 41, the keel line capacity may be reduced such that the dock may not be capable of supporting an [redacted] See Figure 2 of this report for more information.

Based on the 28-ft head pressure limitation, the following plating thicknesses must be upheld:

<u>Pontoon bottom</u> - minimum thickness = 10.6mm or 0.416 inches
<u>Pontoon deck</u> - minimum thickness = 10.6mm or 0.416 inches
<u>Pontoon side shell (wind-water strake)</u> - minimum thickness = 10.0mm or 0.395 inches
<u>Lower 9-ft of wingwalls (INBD & OTBD)</u> - minimum thickness = 10.0mm or 0.395 inches
<u>Typical wingwall shell (INBD & OTBD)</u> - minimum thickness = 9.0mm or 0.355 inches

In order to satisfy the above hull plating thicknesses requirement, HEGER's doubler repair plan for the outer shells, sally port decks, and offshore end bulkhead must be executed. See Enclosure 2 for more information.

Please contact us if you have any questions or comments regarding the analysis summarized in this memorandum.

HEGER DRY DOCK

Enclosure 1 - Detailed Wind-Water Strake UT Survey Results

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETTS

Client : NASSCO San Diego

Subject : BUILDER FDD Analysis and Repair Plan

File Name : **UT Readings**

Data Collected By : **NASSCO**

Date Surveyed: **10/18/2021**

Job No : **4396-D**

STBD OTBD Shell

	DOCK FRAME NO.	0A	0F	6A	6F	11A	11F	16A	16F	21A	21F	26A	26F	31A	31F	36A	36F	41A	41F	41 (5)A	41 (5)F	41 (10)A	41 (10)F	41 (15)A
P.D.	3 ft										0.436	0.434	0.438	0.436	0.436	0.436	0.430	0.430	0.430	0.442	0.444	0.444	0.446	0.432
	0.5 ft										0.380	0.346	0.366	0.134	0.236	0.342	0.264	0.266	0.254	0.392	0.438	0.436	0.438	0.438
	- 0.5 ft		0.426	0.426	0.430	0.428	0.422	0.420	0.366	0.332	0.382	0.308	0.332	0.138	0.250	0.342	0.340	0.284	0.306	0.440	0.422	0.384	0.334	0.436
	- 2 ft		0.246	0.368	0.428	0.432	0.422	0.424	0.424	0.300	0.320	0.428	0.426	0.424	0.426	0.430	0.296	0.356	0.352	0.450	0.446	0.448	0.450	0.450
	- 4 ft		0.362	0.320	0.428	0.428	0.426	0.420	0.426	0.424	0.428	0.428	0.426	0.414	0.426	0.426	0.430	0.426	0.430	0.452	0.438	0.450	0.454	0.450

PORT OTBD Shell

	DOCK FRAME NO.	241F	241A	236F	236A	231F	231A	226F	226A	221F	221A	216F	216A	211F	211A	206F	206A	201F	201A	196F	196A	191F	191A	186F
P.D.	3 ft										0.430	0.432	0.430	0.430	0.432	0.432	0.432	0.432	0.432	0.432	0.434	0.430	0.432	0.432
	0.5 ft										0.428	0.428	0.428	0.396	0.428	0.426	0.422	0.426	0.428	0.430	0.422	0.422	0.427	0.426
	- 0.5 ft		0.422	0.424	0.426	0.426	0.424	0.424	0.426	0.430	0.438	0.426	0.428	0.424	0.428	0.428	0.428	0.428	0.432	0.432	0.428	0.430	0.428	0.432
	- 2 ft		0.422	0.352	0.428	0.428	0.426	0.422	0.428	0.400	0.436	0.428	0.432	0.428	0.430	0.428	0.428	0.430	0.432	0.432	0.432	0.430	0.432	0.430
	- 4 ft		0.380	0.426	0.428	0.432	0.426	0.428	0.426	0.400	0.432	0.432	0.432	0.430	0.424	0.426	0.426	0.432	0.432	0.432	0.432	0.430	0.428	0.432

Key:
- (green) = 0.433 in to 0.395 in (0% to 9% wastage)
- (yellow) = 0.395 in to 0.325 in (9% to 25% Wastage)
- (red) = < 0.325 (25% + Wastage)

Abbreviations:
- **A** = Reading Taken 4-ft Aft of Dock Frame
- **F** = Reading Taken 4-ft Fwd of Dock Frame

HEGER DRY DOCK, Inc.
HOPKINTON, MASSACHUSETTS

Client : NASSCO San Diego
Subject : BUILDER FDD Analysis and Repair Plan

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Data Collected By : **NASSCO**
Date Surveyed: **10/18/2021**
Job No : **4396-D**

STBD OTBD Shell

	41 (15)F	41 (20)A	41 (20)F	41 (25)A	41 (25)F	41 (30)A	41 (30)F	41 (35)A	41 (35)F	41 (40)A	41 (40)F	41 (45)A	41 (45)F	41 (50)A	41 (50)F	41 (55)A	41 (55)F	41 (60)A	41 (60)F	41 (65)A	41 (65)F
3 ft	0.444	0.444	0.450	0.394	0.446	0.448	0.448	0.418			0.452	0.448	0.446	0.448	0.448	0.450	0.444	0.446	0.446	0.446	0.448
0.5 ft	0.438	0.438	0.438	0.444	0.430	0.438	0.444	0.442			0.442	0.440	0.442	0.440	0.442	0.440	0.244	0.440	0.442	0.436	0.438
- 0.5 ft	0.364	0.394	0.382	0.430	0.438	0.440	0.438	0.388	0.358	0.276	0.442	0.444	0.390	0.440	0.442	0.442	0.420	0.274	0.386	0.458	0.454
- 2 ft	0.450	0.408	0.444	0.434	0.394	0.448	0.438	0.446	0.442	0.438	0.444	0.394	0.444	0.442	0.446	0.448	0.442	0.438	0.442	0.204	0.458
- 4 ft	0.450	0.454	0.448	0.448	0.444	0.394	0.444	0.446	0.446	0.392	0.446	0.450	0.444	0.394	0.448	0.304	0.390	0.440	0.442	0.204	0.460

PORT OTBD Shell

	186A	181F	181A	176F	176A	171F	171A	166F	166A	161F	161A	156F	156A	151F	151A	146F	146A	141F	141A	136F	136A
3 ft	0.434	0.432	0.432	0.432	0.430	0.432	0.430	0.432			0.432	0.432	0.432	0.432	0.432	0.434	0.434	0.432	0.430	0.430	0.434
0.5 ft	0.430	0.430	0.428	0.422	0.426	0.428	0.430	0.430			0.428	0.426	0.428	0.428	0.426	0.428	0.426	0.428	0.376	0.426	0.426
- 0.5 ft	0.428	0.430	0.422	0.418	0.426	0.426	0.428	0.426	0.426	0.426	0.426	0.422	0.426	0.424	0.426	0.426	0.430	0.430	0.428	0.424	0.320
- 2 ft	0.426	0.432	0.424	0.426	0.432	0.430	0.424	0.432	0.430	0.430	0.424	0.422	0.428	0.430	0.428	0.430	0.430	0.430	0.428	0.422	0.420
- 4 ft	0.432	0.432	0.424	0.428	0.432	0.432	0.430	0.426	0.432	0.430	0.428	0.426	0.430	0.432	0.426	0.428	0.432	0.432	0.428	0.422	0.426

Key:
- (green) = 0.433 in to 0.395 in (0% to 9% wastage)
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Abbreviations:
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HOPKINTON, MASSACHUSETTS

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STBD OTBD Shell

	41 (70)A	41 (70)F	41 (75)A	41 (75)F	41 (80)A	41 (80)F	46A	46F	51A	51F	56A	56F	61A	61F	66A	66F	71A	71F	76A	76F	81A	81F	86A	86F	91A	91F
3 ft	0.446	0.196	0.198			0.442	0.436	0.430	0.426	0.432	0.432	0.432	0.428	0.430	0.430	0.434	0.430	0.440	0.430			0.436	0.434	0.434	0.434	0.432
0.5 ft	0.392	0.436	0.436			0.436	0.434	0.430	0.360	0.288	0.208	0.180	0.398	0.390	0.426	0.238	0.396	0.338	0.194			0.240	0.360	0.198	0.376	0.424
- 0.5 ft	0.398	0.458	0.458	0.452	0.454	0.450	0.428	0.426	0.424	0.426	0.426	0.202	0.378	0.432	0.472	0.430	0.432	0.434	0.434	0.206	0.302	0.426	0.426	0.432	0.430	0.428
- 2 ft	0.458	0.458	0.462	0.458	0.454	0.454	0.430	0.378	0.426	0.432	0.426	0.228	0.284	0.432	0.430	0.430	0.432	0.432	0.430	0.206	0.348	0.426	0.396	0.424	0.428	0.434
- 4 ft	0.460	0.462	0.458	0.460	0.400	0.402	0.430	0.430	0.334	0.432	0.430	0.430	0.434	0.380	0.430	0.430	0.432	0.432	0.430	0.398	0.448	0.424	0.416	0.424	0.426	0.424

PORT OTBD Shell

	131F	131A	126F	126A	121F	121A	116F	116A	111F	111A	106F	106A	101F	101A	96F	96A	91F	91A	86F	86A	81F	81A	76F	76A	71F	71A
3 ft	0.434	0.428	0.432	0.438	0.434			0.428	0.426	0.428	0.430	0.430	0.424	0.428	0.428	0.430	0.428	0.430	0.430	0.434	0.430			0.476	0.428	0.424
0.5 ft	0.424	0.426	0.420	0.430	0.430			0.422	0.400	0.424	0.422	0.422	0.420	0.420	0.424	0.426	0.268	0.350	0.210	0.418	0.420			0.426	0.378	0.388
- 0.5 ft	0.370	0.422	0.420	0.490	0.492			0.438	0.234	0.434	0.428	0.432	0.428	0.432	0.428	0.426	0.422	0.428	0.426	0.420	0.420			0.420	0.420	0.426
- 2 ft	0.422	0.420	0.420	0.488	0.490			0.430	0.436	0.434	0.430	0.432	0.430	0.434	0.432	0.426	0.424	0.428	0.428	0.424	0.426			0.322	0.394	0.432
- 4 ft	0.422	0.428	0.418	0.490	0.490			0.434	0.438	0.432	0.434	0.432	0.428	0.438	0.432	0.422	0.424	0.428	0.426	0.430	0.428			0.428	0.428	0.426

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HOPKINTON, MASSACHUSETTS

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Date Surveyed: **10/18/2021**
Job No : **4396-D**

STBD OTBD Shell

	96A	96F	101A	101F	106A	106F	111A	111F	116A	116F	121A	121F	126A	126F	131A	131F	136A	136F	141A	141F	146A	146F	151A
3 ft	0.424	0.434	0.432	0.436	0.428	0.430	0.436	0.436	0.434			0.432	0.432	0.438	0.440	0.434	0.438	0.432	0.434	0.434	0.434	0.434	0.434
0.5 ft	0.270	0.428	0.430	0.428	0.426	0.426	0.362	0.324	0.428			0.430	0.430	0.280	0.394	0.434	0.322	0.428	0.428	0.426	0.272	0.426	0.340
- 0.5 ft	0.432	0.434	0.430	0.322	0.426	0.426	0.430	0.434	0.430			0.490	0.490	0.428	0.430	0.434	0.336	0.430	0.426	0.426	0.428	0.426	0.422
- 2 ft	0.428	0.422	0.250	0.434	0.436	0.432	0.432	0.436	0.436			0.492	0.492	0.422	0.424	0.432	0.432	0.428	0.428	0.428	0.428	0.428	0.426
- 4 ft	0.432	0.434	0.434	0.434	0.434	0.430	0.428	0.436	0.432			0.492	0.492	0.422	0.420	0.428	0.430	0.428	0.428	0.430	0.426	0.422	0.424

PORT OTBD Shell

	66F	66A	61F	61A	56F	56A	51F	51A	46F	46A	41 (80)F	41 (80)A	41 (75)F	41 (75)A	41 (70)F	41 (70)A	41 (65)F	41 (65)A	41 (60)F	41 (60)A	41 (55)F	41 (55)A	41 (50)F
3 ft	0.420	0.426	0.472	0.360	0.424	0.430	0.426	0.426	0.426	0.428	0.440			0.440	0.440	0.440	0.440	0.438	0.440	0.440	0.438	0.484	0.442
0.5 ft	0.380	0.420	0.330	0.364	0.370	0.428	0.188	0.176	0.264	0.258	0.260			0.434	0.430	0.432	0.432	0.426	0.432	0.432	0.434	0.432	0.432
- 0.5 ft	0.426	0.422	0.420	0.426	0.420	0.418	0.420	0.424	0.424	0.420	0.422			0.440	0.440	0.440	0.440	0.440	0.438	0.440	0.440	0.438	0.440
- 2 ft	0.428	0.430	0.422	0.428	0.420	0.328	0.422	0.426	0.424	0.428	0.424			0.442	0.442	0.440	0.442	0.436	0.442	0.438	0.444	0.442	0.444
- 4 ft	0.432	0.382	0.416	0.424	0.426	0.378	0.428	0.426	0.424	0.424	0.426			0.440	0.440	0.442	0.446	0.438	0.448	0.446	0.442	0.446	0.448

Key:
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STBD OTBD Shell

	151F	156A	156F	161A	161F	166A	166F	171A	171F	176A	176F	181A	181F	186A	186F	191A	191F	196A	196F	201A	201F	206A	206F
3 ft	0.434	0.426			0.424	0.440	0.428	0.426	0.434	0.430	0.428	0.430	0.432	0.430	0.434	0.432	0.430	0.432	0.432	0.430	0.432	0.436	0.434
0.5 ft	0.428	0.304			0.424	0.338	0.424	0.424	0.280	0.428	0.228	0.360	0.426	0.428	0.430	0.422	0.428	0.318	0.426	0.380	0.280	0.430	0.284
- 0.5 ft	0.426	0.214	0.268	0.424	0.402	0.420	0.422	0.426	0.424	0.422	0.396	0.424	0.426	0.426	0.422	0.416	0.422	0.418	0.420	0.460	0.424	0.424	0.426
- 2 ft	0.428	0.426	0.432	0.422	0.422	0.424	0.430	0.426	0.288	0.414	0.428	0.430	0.428	0.428	0.428	0.424	0.426	0.422	0.424	0.354	0.330	0.426	0.428
- 4 ft	0.428	0.430	0.434	0.422	0.426	0.424	0.430	0.426	0.426	0.432	0.430	0.430	0.430	0.430	0.434	0.428	0.428	0.422	0.426	0.424	0.428	0.432	0.428

PORT OTBD Shell

	41 (50)A	41 (45)F	41 (45)A	41 (40)F	41 (40)A	41 (35)F	41 (35)A	41 (30)F	41 (30)A	41 (25)F	41 (25)A	41 (20)F	41 (20)A	41 (15)F	41 (15)A	41 (10)F	41 (10)A	41 (5)F	41 (5)A	41F	41A	36F	36A
3 ft	0.438	0.438	0.440	0.450			0.452	0.450	0.450	0.452	0.446	0.442	0.442	0.396	0.450	0.448	0.442	0.442	0.444	0.436	0.424	0.432	0.428
0.5 ft	0.434	0.432	0.436	0.438			0.438	0.440	0.436	0.440	0.440	0.440	0.440	0.436	0.438	0.434	0.438	0.438	0.436	0.368	0.220	0.228	0.218
- 0.5 ft	0.440	0.436	0.440	0.442			0.442	0.440	0.444	0.446	0.444	0.440	0.390	0.442	0.384	0.438	0.400	0.446	0.434	0.400	0.420	0.430	0.432
- 2 ft	0.442	0.442	0.442	0.440			0.440	0.440	0.448	0.446	0.442	0.432	0.378	0.384	0.396	0.422	0.420	0.380	0.404	0.420	0.408	0.434	0.436
- 4 ft	0.442	0.444	0.440	0.440			0.442	0.442	0.442	0.448	0.450	0.450	0.446	0.448	0.446	0.448	0.450	0.450	0.440	0.420	0.408	0.424	0.432

Key:
- (green) = 0.433 in to 0.395 in (0% to 9% wastage)
- (yellow) = 0.395 in to 0.325 in (9% to 25% Wastage)
- (red) = < 0.325 (25% + Wastage)

Abbreviations:
A = Reading Taken 4-ft Aft of Dock Frame
F = Reading Taken 4-ft Fwd of Dock Frame

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETTS

Client : NASSCO San Diego
Subject : BUILDER FDD Analysis and Repair Plan

File Name : UT Readings
Data Collected By : NASSCO
Date Surveyed: 10/18/2021
Job No : 4396-D

STBD OTBD Shell

	211A	211F	216A	216F	221A	221F	226A	226F	231A	231F	236A	236F	241A	241F
3 ft	0.432	0.432	0.434											
0.5 ft	0.310	0.428	0.420											
- 0.5 ft	0.424	0.420	0.420	0.226	0.420	0.234	0.422							
- 2 ft	0.426	0.424	0.442	0.244	0.426	0.392	0.416							
- 4 ft	0.428	0.428	0.424	0.428	0.426	0.422	0.422							

PORT OTBD Shell

	31F	31A	26F	26A	21F	21A	16F	16A	11F	11A	6F	6A	0F	0A
3 ft	0.428	0.430	0.430	0.428	0.428									
0.5 ft	0.248	0.326	0.190	0.318	0.340									
- 0.5 ft	0.428	0.428	0.428	0.430	0.430	0.294	0.346	0.402	0.426	0.424	0.424	0.300	0.426	
- 2 ft	0.438	0.434	0.428	0.434	0.330	0.258	0.422	0.426	0.426	0.426	0.428	0.428	0.436	
- 4 ft	0.438	0.434	0.434	0.480	0.432	0.436	0.418	0.470	0.372	0.428	0.430	0.420	0.430	

Key:
- (green) = 0.433 in to 0.395 in (0% to 9% wastage)
- (yellow) = 0.395 in to 0.325 in (9% to 25% Wastage)
- (red) = < 0.325 (25% + Wastage)

Abbreviations:
- **A** = Reading Taken 4-ft Aft of Dock Frame
- **F** = Reading Taken 4-ft Fwd of Dock Frame

Port Side Sally Ports

Readings were taken at 4 ft fwd and aft of each frame. Readings started at 6 inches from shell and every 4 feet going inboard.

Fr 0 — Shell Side — Fr 21

0.422	0.424	0.420	0.420	0.422	0.420	0.426	0.434
0.416	0.420	0.416	0.398	0.422	0.418	0.424	0.424
0.256	**0.240**	**0.336**	0.418	0.426	0.424	0.424	0.424
0.218	**0.214**	0.412	0.426	0.426	0.428	0.424	0.424

Inboard Side

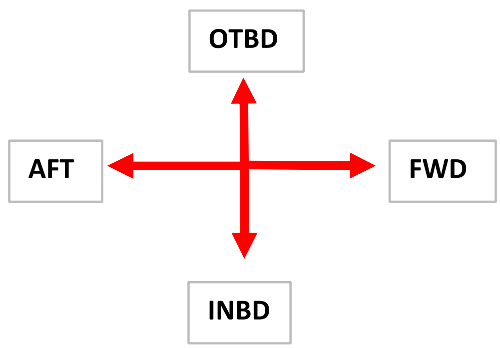
Fr 41 (35)	Fr 41 (40)
0.636	0.624
0.628	0.632
0.636	0.640
0.620	0.644

Fr 41 (75)	Fr 41(80)
0.626	0.614
0.612	0.630
0.644	**0.522**
0.634	0.640

Fr 76	Fr 81
0.430	0.430
0.434	0.428
0.362	**0.376**
0.374	0.472

Fr 116	Fr 121
0.344	0.426
0.282	**0.350**
0.350	0.418
0.420	N/A

Fr 156	Fr 161
0.386	0.426
0.374	0.426
0.424	0.428
0.420	**0.370**



Fr 226 — Shell Side — Fr 241

0.210	0.424	0.430	0.428	0.394	0.428	0.430	0.426
0.430	0.432	0.430	0.430	0.432	0.430	0.432	0.428
0.426	0.424	0.426	0.426	0.424	0.424	N/A	0.424
0.432	0.432	0.420	0.428	0.426	0.430	0.426	0.424

Inboard Side

STBD Side Sally Ports

Readings were taken at 4 ft fwd and aft of each frame. Readings started at 6 inches from shell and every 4 feet going inboard.

Fr 241 — Shell Side — Fr 221

0.430	0.426	0.420	0.422	0.428	0.420	0.426	0.424
0.426	0.428	0.424	0.424	**0.374**	0.424	0.402	0.426
0.426	0.428	0.424	0.424	0.430	0.424	0.424	0.426
0.424	0.430	0.424	0.424	0.432	0.420	0.426	0.430

Inboard Side

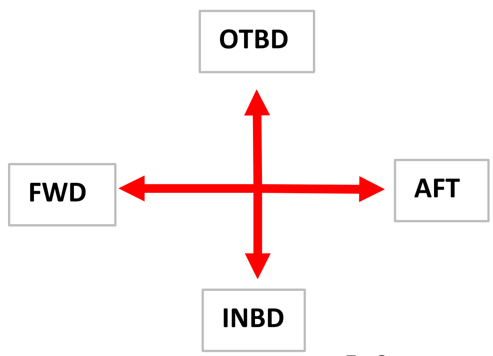
Fr 166	Fr 161
0.432	**0.180**
0.432	**0.260**
0.260	**0.33**
0.314	0.43

Fr 121	Fr 116
0.234	**0.358**
0.256	**0.344**
0.290	**0.352**
0.302	0.422

Fr 81	Fr 76
0.336	**0.286**
0.368	**0.382**
0.338	**0.248**
0.402	0.430

Fr 41(80)	Fr 41(75)
0.568	**0.476**
0.640	**0.414**
0.630	**0.466**
0.632	0.638

Fr 41 (40)	Fr 41 (35)
0.518	0.646
0.590	0.648
0.574	0.622
0.630	**0.580**



Fr 21 — Shell Side — Fr 0

0.380	**0.376**	0.400	**0.382**	N/A	N/A	0.436	0.432
0.432	0.428	0.436	**0.371**	0.430	0.426	**0.328**	**0.362**
0.426	0.422	0.434	0.434	0.398	0.428	**0.348**	**0.234**
0.428	0.424	0.432	**0.380**	0.420	0.424	0.430	0.430

Inboard Side

Port Side

Readings were taken every 3 feet from shell side. 6", 24" and 48" from pontoon deck.

Fr 0 Bulkhead **Pontoon Deck**

Outboard / **Inboard**

6"	**0.340**	**0.330**	**0.338**	0.436
24"	0.440	0.440	0.440	0.440
48"	0.442	0.442	0.442	0.440

Water line

Starboard Side

Readings were taken every 3 feet from shell side. 6", 24" and 48" from pontoon deck.

Pontoon Deck

Fr 0 Bulkhead

Inboard / Outboard

6"	**0.232**	0.444	0.502	**0.348**
24"	**0.292**	0.400	0.442	**0.346**
48"	0.442	**0.322**	0.444	0.442

Water line

Enclosure 2 - HEGER’s Repair Plan Drawing Package

NASSCO

SAN DIEGO, CALIFORNIA

BUILDER REPAIR PLAN (2021)

DRAWING INDEX

GENERAL NOTES

SCOPE

1.) ENGINEERING DESIGN OF DOUBLER PLATES FOR THE 'BUILDER' FDD'S PONTOON SIDE SHELLS AND SALLYPORT

2.) CREATE DESIGN DRAWINGS OF ADEQUATE DETAIL FOR OTHERS TO PRODUCE SHOP LEVEL CONSTRUCTION AND INSTALLATION DRAWINGS.

MATERIALS

1.) UNLESS OTHERWISE SPECIFIED, ALL MATERIALS AND COMPONENTS SHALL BE NEW AND OF THE BEST GRADE AVAILABLE FOR THE PURPOSE INTENDED, UNLESS APPROVED BY THE ENGINEER.

2.) MATERIALS NOT CONFORMING TO THE SPECIFICATION AND DRAWINGS REFERENCED HEREIN SHALL NOT BE SUBSTITUTED UNLESS SPECIFICALLY APPROVED BY THE ENGINEER.

3.) STRUCTURAL COMPONENTS MATERIAL SHALL BE AS FOLLOWS:
PLATES AND BARS — ABS GRADE A OR APPROVED EQUAL

FABRICATION

1.) LOCATIONS AND DIMENSIONS OF EXISTING ELEMENTS AND STRUCTURE SHOWN ON THE DRAWINGS ARE BASED ON RECEIVED DESIGN DRAWINGS AND ARE SUBJECT TO CONSTRUCTION VARIATIONS. THE FABRICATOR SHALL FIELD VERIFY ALL DIMENSIONS AND DETAILS PRIOR TO FABRICATION AND CONSTRUCTION. DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER.

2.) PLUG WELD CUTOUTS ARE INTENDED TO BE ALIGNED WITH THE AXIS OF THE EXISTING DOCK STRUCTURE. PROPER ALIGNMENT WITH THE UNDERLYING DOCK STRUCTURE SHALL BE VERIFIED BEFORE DOUBLER PLATE INSTALLATION.

3.) PLUG WELD CUTOUTS, ON HORIZONTAL SURFACES, ARE TO BE FILLED WITH MARINE GRADE EPOXY OR APPROVED EQUAL AFTER INSTALLATION HAS BEEN COMPLETED.

3.) IN WAY OF EXISTING DOCK EQUIPMENT AND FITTINGS, DOUBLER PLATES ARE TO BE CUT TO FIT. ANY MODIFICATIONS TO WELD DETAILS OR PLUG WELD LAYOUTS FOR FITMENT ARE TO BE APPROVED BY ENGINEER.

4.) FABRICATOR QUALIFICATIONS SHALL CONFORM TO ABS SHIPBUILDING RULES AND REQUIREMENTS (CURRENT EDITION).

3.) SUBMIT SHOP DRAWINGS FOR ALL METAL FABRICATIONS AS REQUIRED BY THE OWNER'S REPRESENTATIVE. SHOP DRAWINGS SHALL SHOW COMPLETE DETAILS NECESSARY FOR FABRICATION AND ERECTION INCLUDING BUT NOT LIMITED TO LOCATION, TYPE, SIZE, AND EXTENT OF ALL WELDS AND BOLTED CONNECTIONS AND MATERIAL TYPES, GRADES, AND FINISHES.

4.) THE REVIEW OF THE SHOP DRAWINGS BY OWNER'S REPRESENTATIVE CONSTITUTES A GENERAL REVIEW OF THE METHODS ONLY AND WILL NOT INCLUDE APPROVAL OF DIMENSIONS, FIGURES, OR QUANTITIES. THE CONTRACTOR IS RESPONSIBLE FOR CORRECT FABRICATION AND PROPER ALIGNMENT OF ALL ITEMS.

5.) PERFORM ALL METAL FABRICATION USING A CONTRACTOR EXPERIENCED IN METAL FABRICATION AND ERECTION, INCLUDING CUTTING, BENDING, FORMING, AND WELDING.

6.) CUT ALL MATERIAL FROM STOCK BY SHEARING OR ALTERNATIVE METHOD APPROVED BY THE OWNER'S REPRESENTATIVE. GRIND OFF CLEAN AND TRUE ALL MATERIALS.

7.) ERECT METAL FABRICATIONS, SQUARE, PLUMB, STRAIGHT, AND TRUE, ACCURATELY FITTED, WITH TIGHT JOINTS AND INTERSECTIONS.

8.) GRIND SMOOTH SHARP EDGES, ANGLES, AND CORNERS.

ERECTION TOLERANCES

1.) ALL STRUCTURE SHALL BE ERECTED IN ACCORDANCE WITH ABS'S "GUIDE FOR SHIPBUILDING AND REPAIR QUALITY STANDARD FOR HULL STRUCTURES DURING CONSTRUCTION", LATEST EDITION.

2.) REPLACEMENT PANELS TO BE INSTALLED AT PLATE SEAMS SUCH THAT NO ORIGINAL DECK PLATING REMAINS BETWEEN TWO ADJACENT REPLACEMENT PANELS.

RIGGING

1.) ALL LIFTING ARRANGEMENTS AND RIGGING GEAR TO BE DETERMINED BY CONTRACTOR

WELDING

1.) ALL FIELD AND SHOP STEEL WELDING SHALL CONFORM TO ABS SHIPBUILDING RULES AND REQUIREMENTS (CURRENT EDITION) OR THE OWNER'S APPROVED WELDING PROCEDURE.

2.) WELDING ELECTRODE SHALL BE E70XX, WITH METALLURGY PER ABS.

3.) WELDING PERSONNEL SHALL BE QUALIFIED FOR WELD PROCEDURES AND WELD POSITIONS NECESSARY FOR THE JOINT DETAILS SPECIFIED HEREWITH.

4.) CLEAN ALL SURFACES TO BE WELDED SUCH THAT THEY ARE FREE OF LOOSE SCALE, RUST, PAINT, OR OTHER FOREIGN MATTER. WHERE WELD MATERIAL IS DEPOSITED IN TWO OR MORE LAYERS, EACH LAYER IS TO BE CLEANED BEFORE THE NEXT LAYER IS DEPOSITED. ENSURE ALL WELDS ARE CONTINUOUS FOR EACH JOINT AND FREE FROM PITS AND HOLES. CARE SHALL BE TAKEN TO MINIMIZE STRESSES DUE TO HEAT EXPANSION, CONTRACTION, AND DISTORTION BY USING APPROVED METHODS AND PROPER SEQUENCE IN WELDING. CARRY OUT FIELD WELDING IN SUCH A MANNER AS TO PREVENT DAMAGE TO ADJACENT SURFACES.

5.) PRE-HEAT SHALL BE BASED ON MATERIAL GRADE AND THICKNESS SHOWN HEREWITH, PER ABS REQUIREMENTS. UNIFORMITY OF PRE-HEAT SHALL CONFORM TO ABS STIPULATIONS.

6.) TAKE SPECIAL CARE WHEN FIELD WELDING NEAR TIMBER ELEMENTS.

7.) WHERE WELD JOINTS ARE INDICATED ON THE DRAWINGS AS CJP (COMPLETE JOINT PENETRATION) BUT WITHOUT A WELD JOINT DETAIL INDICATED, THE CONTRACTOR SHALL PROPOSE PRE-QUALIFIED CJP WELD DETAILS AND SUBMIT THEM FOR OWNER APPROVAL. BACKING BARS SHALL BE REMOVED FROM ALL WELDS UNLESS NOTED OTHERWISE NOTED ON THE DRAWING OR SPECIFICALLY APPROVED BY OWNER'S REPRESENTATIVE.

8.) ALL WELDS SPECIFIED AS BEVEL OR V-GROOVE WELDS SHALL BE CJP (COMPLETE JOINT PENETRATION)

9.) ALL WELDS SHALL BE CONTINUOUS FILLET WELDS WITH A MINIMUM LEG LENGTH OF 5/16" UNLESS OTHERWISE NOTED ON DRAWINGS. WHERE WELDS ARE NOT SHOWN, THE CONNECTION SHALL DEVELOP THE FULL CAPACITY OF THE MEMBERS BEING CONNECTED.

10.) ALL WELDS SHALL BE SEAL WELDS (WATERTIGHT).

11.) WELDING INSPECTIONS SHALL BE CARRIED OUT BY AN CERTIFIED INSPECTOR APPROVED BY THE SHIPYARD. COST OF TESTING WILL BE CONSIDERED INCIDENTAL TO THE WORK.

12.) NO WELDING THROUGH COATING SHALL BE PERFORMED. THE COATING WITHIN 2 INCHES OF THE WELD ROOT SHALL BE REMOVED PRIOR TO WELDING AND REPAIRED AS DISCUSSED IN COATING.

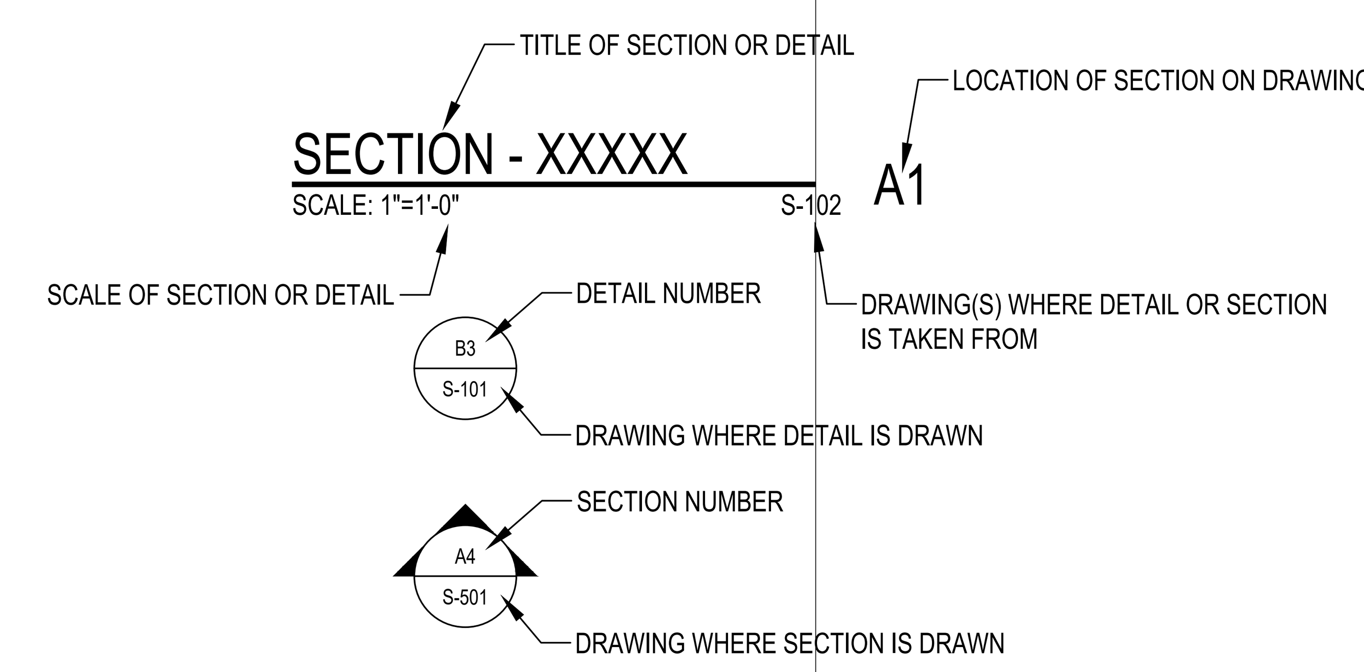
13.) ALL SLAG, WELD SPATTER, GOUGES, NICKS, BURRS, AND CUTS SHALL BE REMOVED AND REPAIRED TO THE SATISFACTION OF THE OWNER AFTER WELDING.

COATING

1.) ALL NEW STEEL SHALL BE BLAST-CLEANED TO SSPC-SP10-85T (Sa 2-1/2): NEAR WHITE METAL BLAST SURFACE FINISH.

2.) PAINT SYSTEM - TO BE SPECIFIED BY THE OWNER

GENERAL DRAWING SYMBOLS



ABBREVIATIONS AND SYMBOLS

⊠	AMIDSHIPS
℄	CENTERLINE
Ø	DIAMETER
ABV	ABOVE
BL	BASELINE
BLW	BELOW
BHD	BULKHEAD
CC	CROSS CONNECT
CONC	CONCRETE
CF	CUBIC FEET
DIA	DIAMETER
DK	DECK
D.O.	DITTO - SAME AS ABOVE AND OR BELOW
DV	DEWATERING VALVE
EL	ELEVATION
FDD	FLOATING DRY DOCK
FLG	FLANGE
FR	FRAME
FT	FEET
FV	FLOOD VALVE
FWD	FORWARD
HORIZ	HORIZONTAL
INBD	INBOARD
INFO	INFORMATION
KG	VERTICAL CENTER OF GRAVITY
KIP	1000 POUNDS
L	ANGLE - STRUCTURAL STEEL SECTION
LB	POUND(S)
LT	LONG TON
LT-FT	LONG TON - FEET
LVL	LEVEL
MAX	MAXIMUM
MIN	MINIMUM
mm	MILLIMETER
NO.	NUMBER
N.S., F.S.	NEAR SIDE, FAR SIDE
NWT	NON WATERTIGHT
OC	ON CENTER
OPS	OPERATIONS
P	PORT
P/S	PORT & STARBOARD
PCF	POUNDS PER CUBIC FOOT
PLCS	PLACES
POS	POSITION
POSD	PRIDE OF SAN DIEGO
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
R	RADIUS
S	STARBOARD
SCH	SCHEDULE
SNDING	SOUNDING
SPC	SPACING
SQ	SQUARE
SS	STAINLESS STEEL
STA	STATION
STBD	STARBOARD
SWL	SAFE WORKING LOAD
SYMM	SYMMETRIC OR SYMMETRY
T	TEE - STRUCTURAL STEEL SECTION
TCG	TRANSVERSE CENTER OF GRAVITY
TBD	TO BE DETERMINED
TYP	TYPICAL
UMHW	ULTRA HIGH MOLECULAR WEIGHT
VCB	VERTICAL CENTER OF BUOYANCY
VCG	VERTICAL CENTER OF GRAVITY
VOL	VOLUME
W/	WITH
WP	WORKING POINT
WT	WATERTIGHT

SYM | DESCRIPTION | DATE | APPR

HEGER
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HOPKINTON, MA 01748
(508) 429-1800

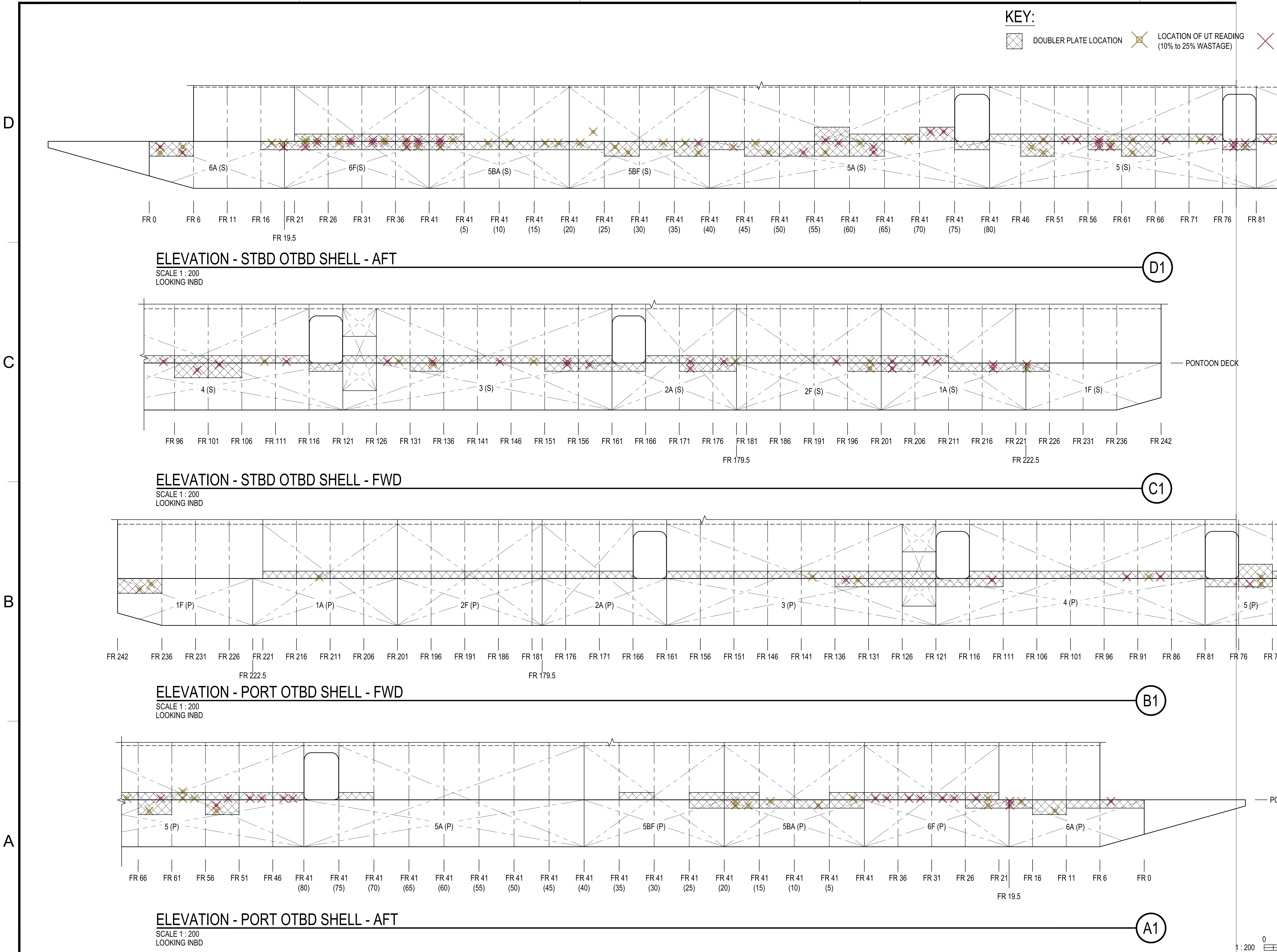
DES PJT | DRW JAH | CHK MDN
CHIEF ENG. M. NAYLOR
DATE: 11-16-2021

CLIENT NAME AND ADDRESS: NASSCO, SAN DIEGO, CALIFORNIA
PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN
DRAWING TITLE: COVER - INDEX SHEET

SCALE: AS NOTED
PROJECT NO.: 4396-D
CONSTR. CONTR. NO.:

SHEET 1 OF 20
G-001

DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING



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(508) 429-1800

DES PJT | DRW PJT | CHK PHS
CHIEF ENG. M. NAYLOR
DATE: 11-16-2021

CLIENT NAME AND ADDRESS: NASSCO
SAN DIEGO, CALIFORNIA

PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN

DRAWING TITLE: UT READINGS - OUTBOARD LONGITUDINALS

SCALE: AS NOTED
PROJECT NO.: 4396-D
CONSTR. CONTR. NO.

SHEET 2 OF 20

A-001

DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

NOTES:

1. ESTIMATED APPLIED BENDING MOMENT = 244,000 LT-FT IN A HOG (~56% OF LIMIT)
2. ESTIMATED APPLIED TORQUE = 115,000 LT-FT (~50% OF LIMIT)
3. PUMPING PLAN IS TO BE USED AS A GUIDELINE ONLY. IN THE FIELD ADJUSTMENTS MAY BE REQUIRED, BY DOCK OPERATORS, TO CORRECT FOR OBSERVED CONDITIONS OF LIST, TRIM, AND BENDING.

Pumping Plan - STBD SIDE REPAIR

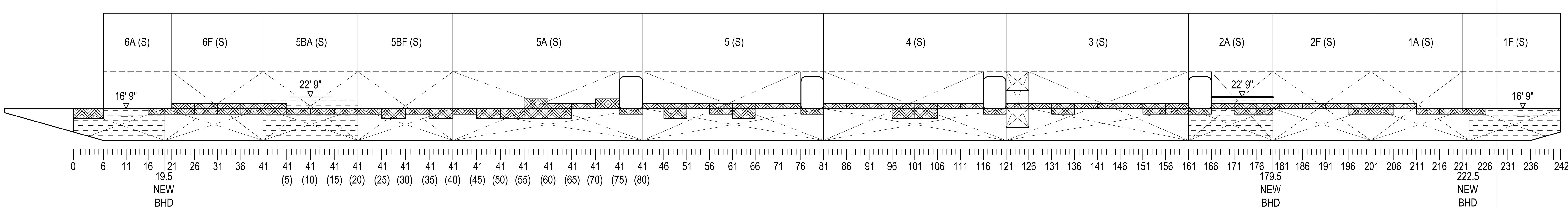
Inshore Dock Draft ([illegible]) (Feet)	Offshore Dock Draft ([illegible]) (Feet)		Tank 1F (Feet)	Tank 1A (Feet)	Tank 2F (Feet)	Tank 3A (Feet)	Tank 3 (Feet)	Tank 4 (Feet)	Tank 5 (Feet)	Tank 5A (Feet)	Tank 5BF (Feet)	Tank 5BA (Feet)	Tank 6F (Feet)	Tank 6A (Feet)
[illegible]	[illegible]	S	16.65	0.00	0.00	32.73	0.00	0.00	0.00	0.00	0.00	32.73	0.00	16.65
@ Inner Draft Marks		SC	16.65	1.00	1.00	16.65	1.00	14.25	14.25	1.00	1.00	[illegible]	1.00	16.65
-7.99	7.99	PC	1.75	1.75	1.47	1.08	1.08	1.08	1.00	1.00	1.00	1.00	1.00	1.00
Trim = 0.00	ft (+ FWD)	P	9.83	9.81	9.58	9.25	9.25	9.25	8.67	8.67	8.67	8.81	9.00	9.00

Inshore — Ballast Tank Water Levels — Offshore

KEY:

DOUBLER PLATE LOCATION

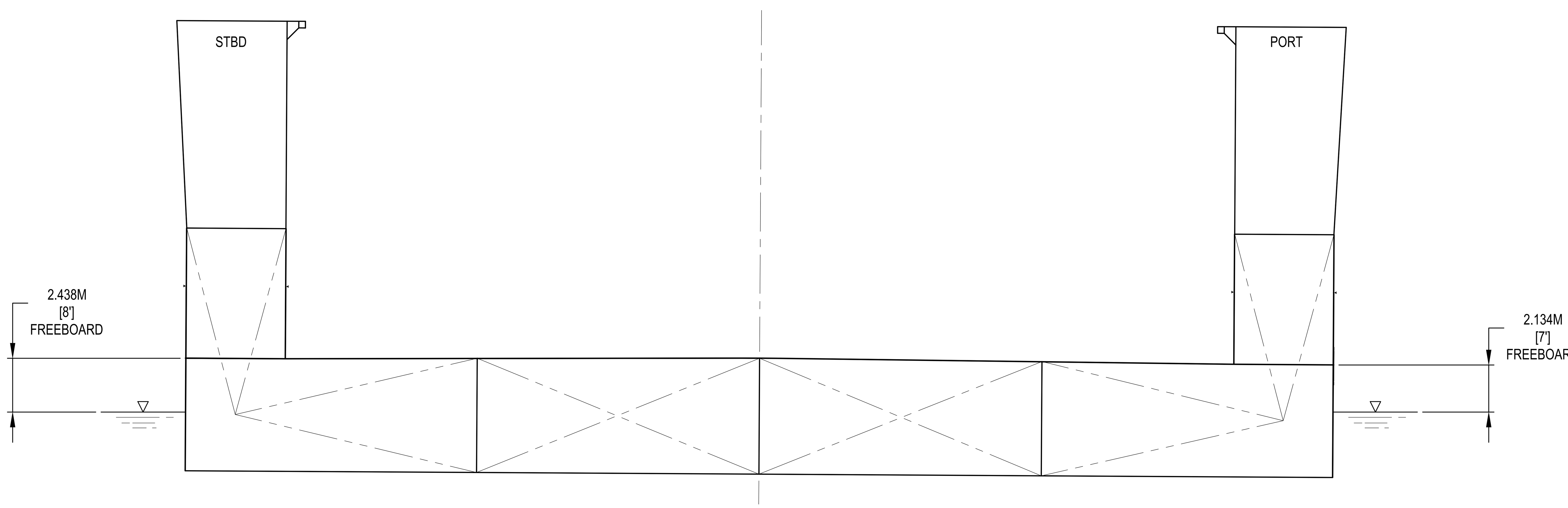
WATER LEVEL



OUTBOARD ELEVATION - TANK SOUNDINGS - STBD SIDE REPAIR

SCALE 1 : 400

B1



TRANSVERSE SECTION - TANK SOUNDINGS - STBD SIDE REPAIR

SCALE 1 : 150
LOOKING AFT

A2

1 : 150 — 0 5.000 10.000M

1 : 400 — 0 5.0 10.000 20.000M

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DES LMR | DRW JAH | CHK PHS
CHIEF ENG. M. NAYLOR
DATE: 11-16-2021

CLIENT NAME AND ADDRESS: NASSCO
SAN DIEGO, CALIFORNIA
PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN
DRAWING TITLE: PUMPING PLAN - STBD REPAIR

SCALE: AS NOTED
PROJECT NO.: 4396-D
CONSTR. CONTR. NO.
SHEET 4 OF 20
A-006

DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

NOTES:

1. ESTIMATED APPLIED BENDING MOMENT = 170,000 LT-FT IN A HOG (~40% OF LIMIT)
2. ESTIMATED APPLIED TORQUE = 100,000 LT-FT (~44% OF LIMIT)
3. PUMPING PLAN IS TO BE USED AS A GUIDELINE ONLY. IN THE FIELD ADJUSTMENTS MAY BE REQUIRED, BY DOCK OPERATORS, TO CORRECT FOR OBSERVED CONDITIONS OF LIST, TRIM, AND BENDING.

Pumping Plan - PORT SIDE REPAIR

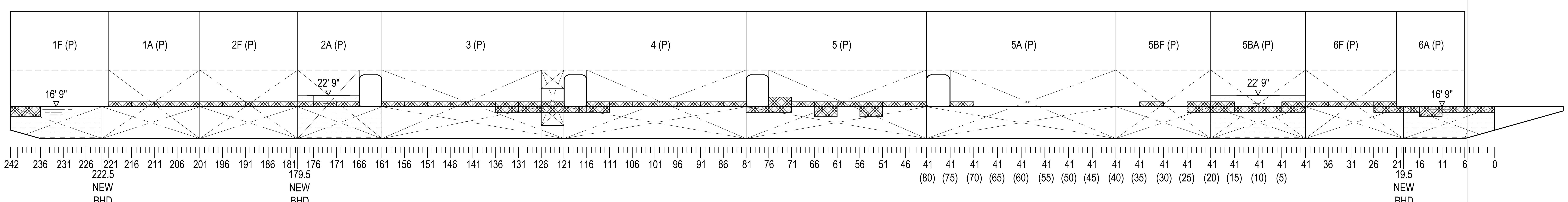
Inshore Dock Draft (Fr 19.5) (Feet)	Offshore Dock Draft (Fr 0) (Feet)		Tank 1F (Feet)	Tank 1A (Feet)	Tank 2F (Feet)	Tank 2A (Feet)	Tank 3 (Feet)	Tank 4 (Feet)	Tank 5 (Feet)	Tank 5A (Feet)	Tank 5BF (Feet)	Tank 5BA (Feet)	Tank 6F (Feet)	Tank 6A (Feet)
[illegible]	[illegible]	S	7.33	7.33	7.08	6.83	[illegible]	6.85	6.40	6.35	[illegible]	[illegible]	[illegible]	[illegible]
@ Inner Draft Marks		SL	[illegible]	1.92	1.67	1.92	1.93	[illegible]	1.00	1.00	1.00	1.00	[illegible]	1.00
-7.38	-7.38	PL	[illegible]	1.00	1.00	[illegible]	8.75	15.75	15.75	8.75	[illegible]	[illegible]	[illegible]	[illegible]
Trim = [illegible]	0 (+ FWD)	P	[illegible]	0.00	0.00	[illegible]	0.00	0.00	0.00	0.00	0.00	[illegible]	0.00	[illegible]

Inshore — Ballast Tank Water Levels — Offshore

KEY:

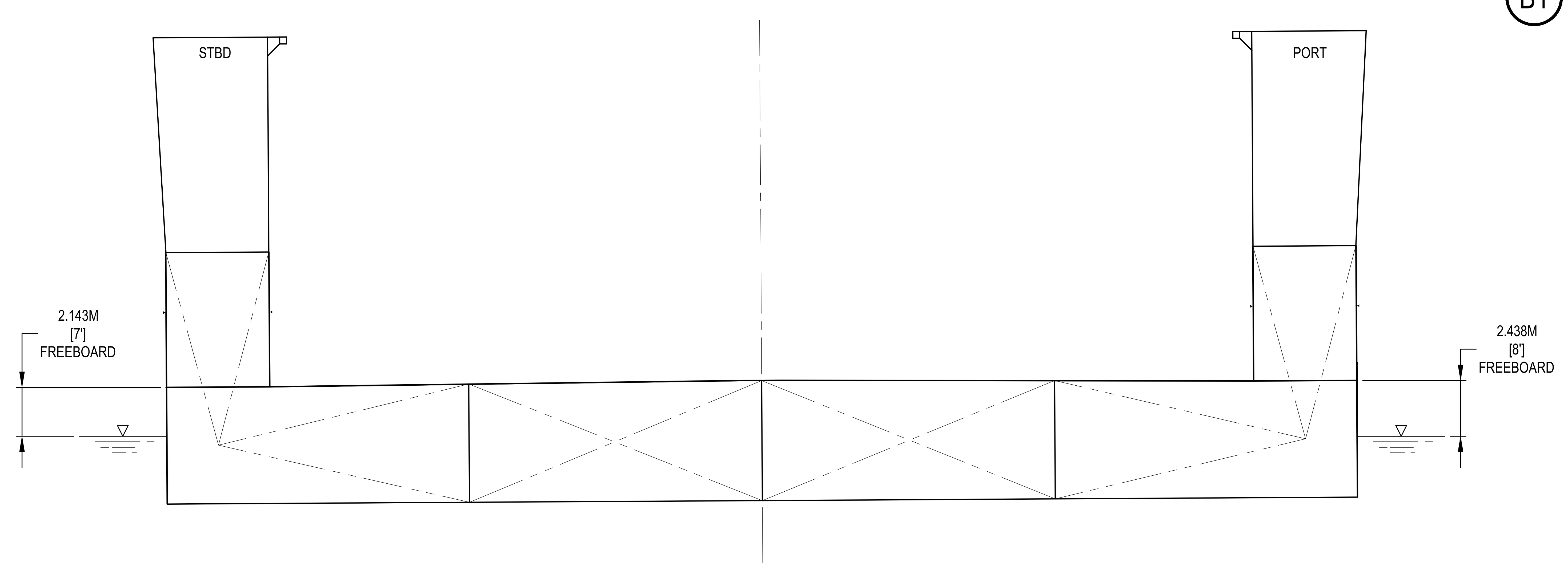
DOUBLER PLATE LOCATION

WATER LEVEL



OUTBOARD ELEVATION - TANK SOUNDINGS - PORT SIDE REPAIR (B1)

SCALE 1 : 400



TRANSVERSE SECTION - TANK SOUNDINGS - PORT SIDE REPAIR (A2)

SCALE 1 : 150
LOOKING AFT

1 : 150 — 0 5.000 10.000M

1 : 400 — 0 5.0 10.000 20.000M

DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

HEGER DRY DOCK, Inc.
DRY DOCK ENGINEERS
DESIGN, INSPECTION AND CERTIFICATION
77 MAIN STREET, SUITE 9
HOPKINTON, MA 01748
(508) 429-1800

DES LMR | DRW APL | CHK PHS
CHIEF ENG. M. NAYLOR
DATE: 11-16-2021

CLIENT NAME AND ADDRESS: NASSCO, SAN DIEGO, CALIFORNIA
PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN
DRAWING TITLE: PUMPING PLAN - PORT REPAIR

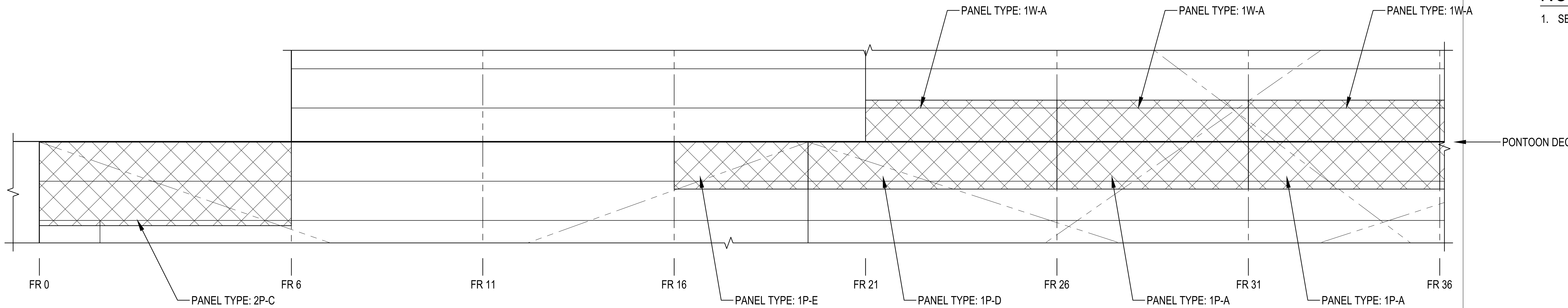
SCALE: AS NOTED
PROJECT NO.: 4396-D
CONSTR. CONTR. NO.
SHEET 5 OF 20
A-007

KEY:

DOUBLER PLATE LOCATION

NOTES:

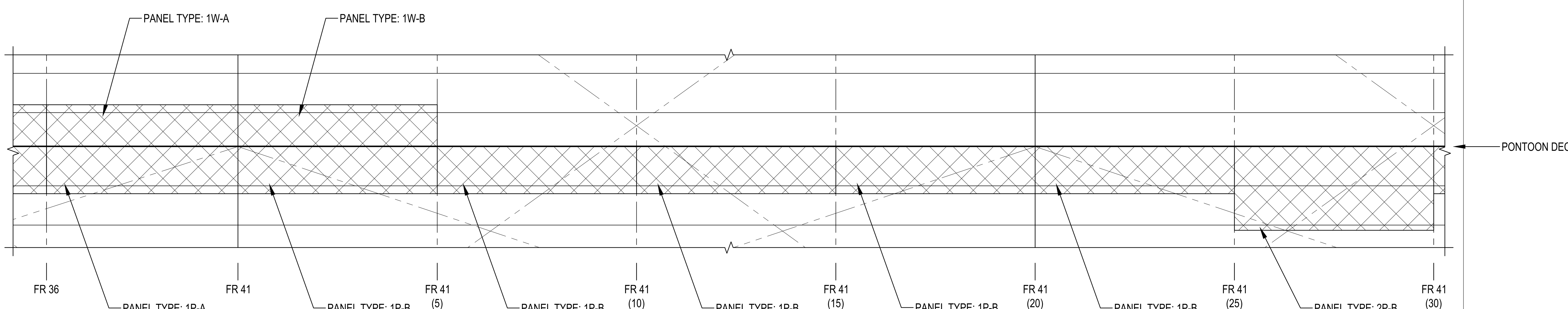
1. SEE S-101 FOR PANEL DETAILS



ELEVATION - STBD OTBD SHELL

SCALE 1 : 50

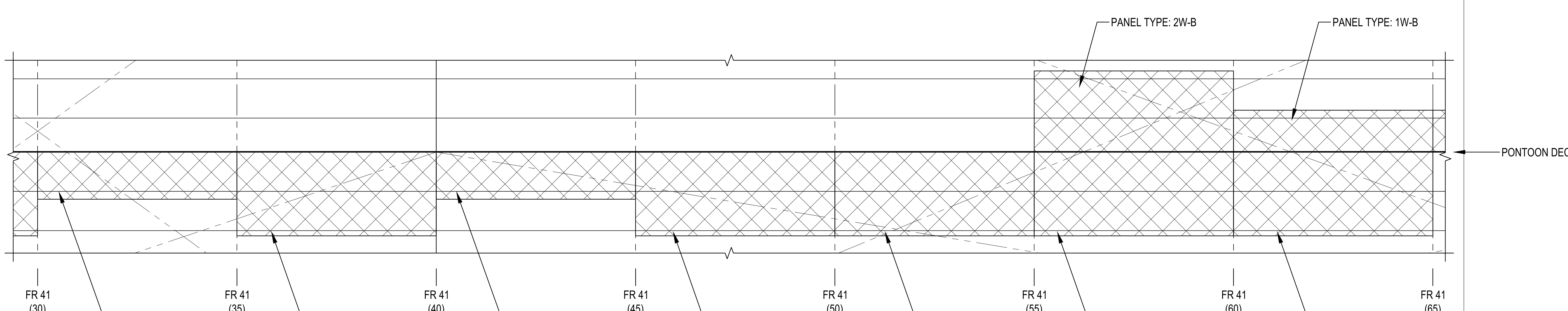
D1



ELEVATION - STBD OTBD SHELL

SCALE 1 : 50

B1



ELEVATION - STBD OTBD SHELL

SCALE 1 : 50

A1

1 : 50 0 0.50 1.000 3.000M

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(508) 429-1800

DES PJT	DRW PJT	CHK PHS
CHIEF ENG.	M. NAYLOR
DATE:	11-16-2021

CLIENT NAME AND ADDRESS: NASSCO, SAN DIEGO, CALIFORNIA

PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN

DRAWING TITLE: REPAIR LAYOUT - STBD OUTBOARD - 1 OF 3

SCALE:	AS NOTED
PROJECT NO.:	4396-D
CONSTR. CONTR. NO.	

SHEET 6 OF 20

A-111

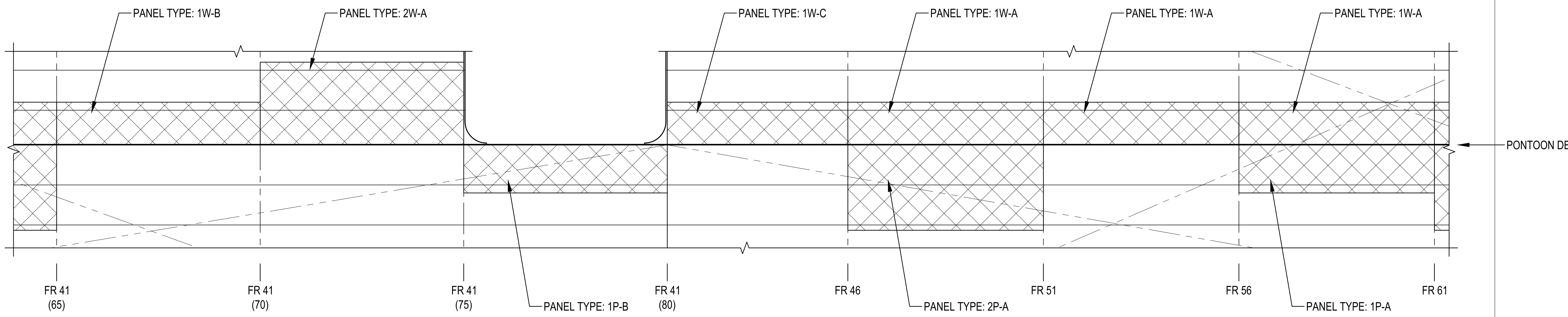
DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

KEY:

DOUBLER PLATE LOCATION

NOTES:

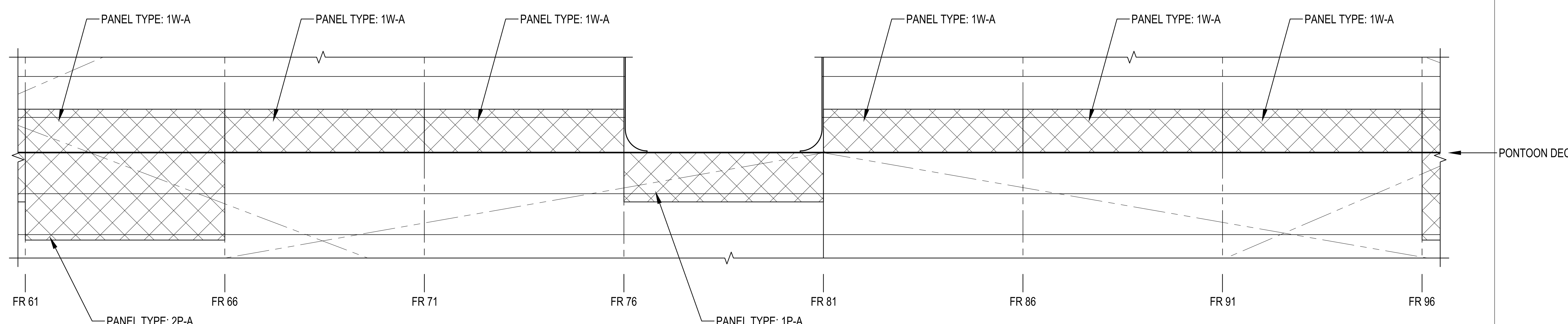
1. SEE S-101 FOR PANEL DETAILS



ELEVATION - STBD OTBD SHELL

SCALE 1 : 50

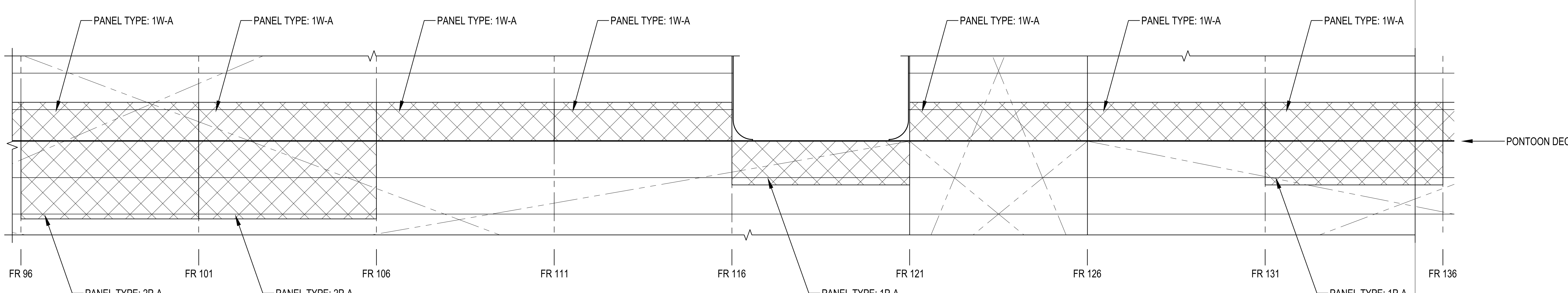
D1



ELEVATION - STBD OTBD SHELL

SCALE 1 : 50

B1



ELEVATION - STBD OTBD SHELL

SCALE 1 : 50

A1

1 : 50 0 0.50 1.000 3.000M

SYM | DESCRIPTION | DATE | APPR

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(508) 429-1800

DES PJT | DRW PJT | CHK PHS
CHIEF ENG. M. NAYLOR
DATE: 11-16-2021

CLIENT NAME AND ADDRESS: NASSCO
SAN DIEGO, CALIFORNIA

PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN

DRAWING TITLE: REPAIR LAYOUT - STBD OUTBOARD - 2 OF 3

SCALE: AS NOTED
PROJECT NO.: 4396-D
CONSTR. CONTR. NO.

SHEET 7 OF 20

A-112

DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

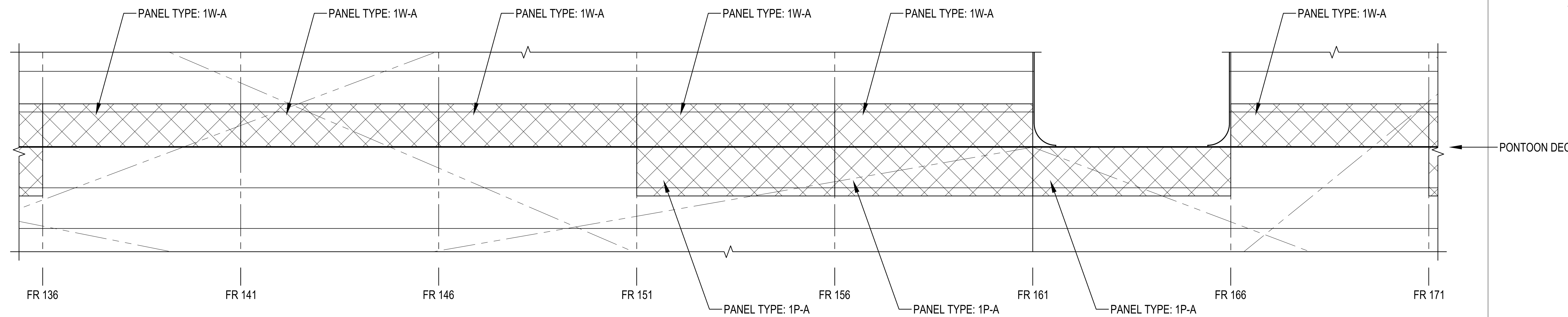
1 2 3 4 5

KEY:

DOUBLER PLATE LOCATION

NOTES:

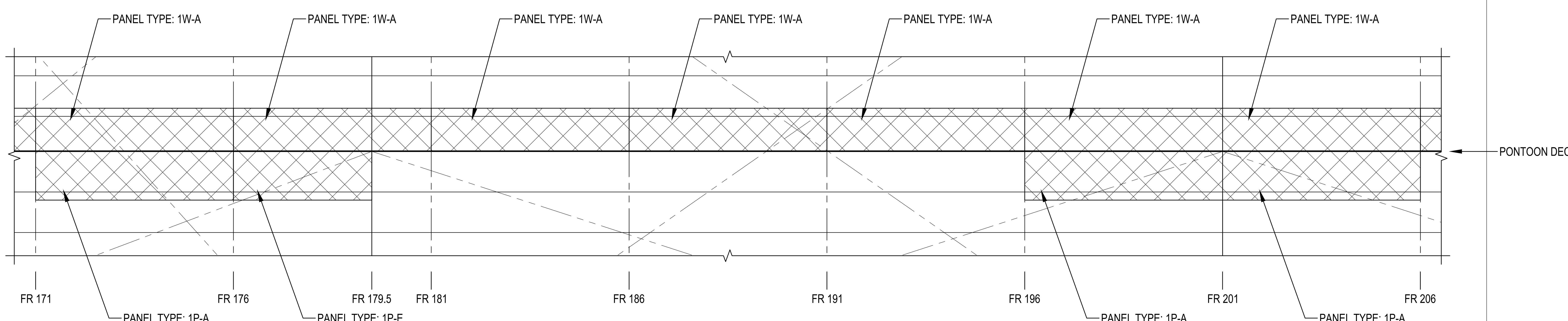
1. SEE S-101 FOR PANEL DETAILS



ELEVATION - STBD OTBD SHELL

SCALE 1 : 50

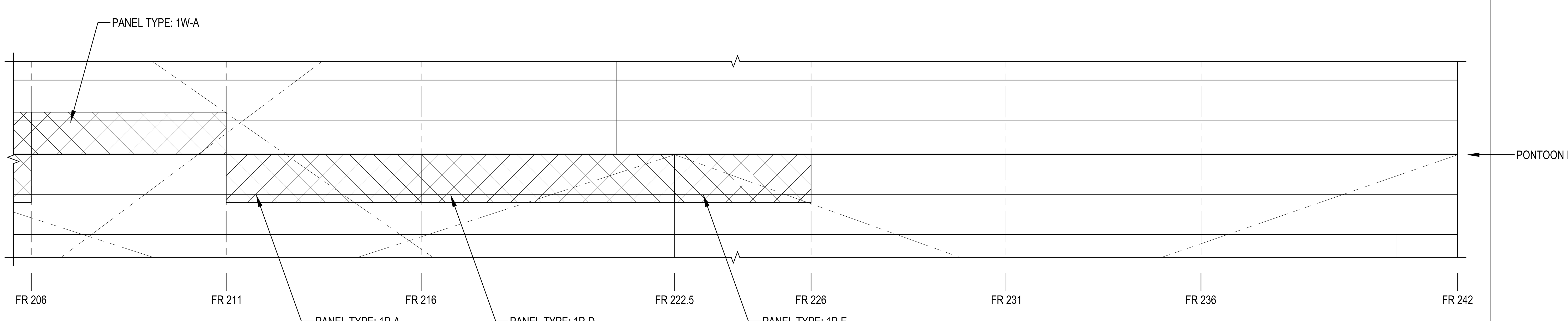
D1



ELEVATION - STBD OTBD SHELL

SCALE 1 : 50

B1



ELEVATION - STBD OTBD SHELL

SCALE 1 : 50

A1

1 : 50 0 0.50 1.000 3.000M

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DES PJT | DRW PJT | CHK PHS
CHIEF ENG. M. NAYLOR
DATE: 11-16-2021

CLIENT NAME AND ADDRESS: NASSCO
SAN DIEGO, CALIFORNIA

PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN

DRAWING TITLE: REPAIR LAYOUT - STBD OUTBOARD - 3 OF 3

SCALE: AS NOTED
PROJECT NO.: 4396-D
CONSTR. CONTR. NO.:

SHEET 8 OF 20

A-113

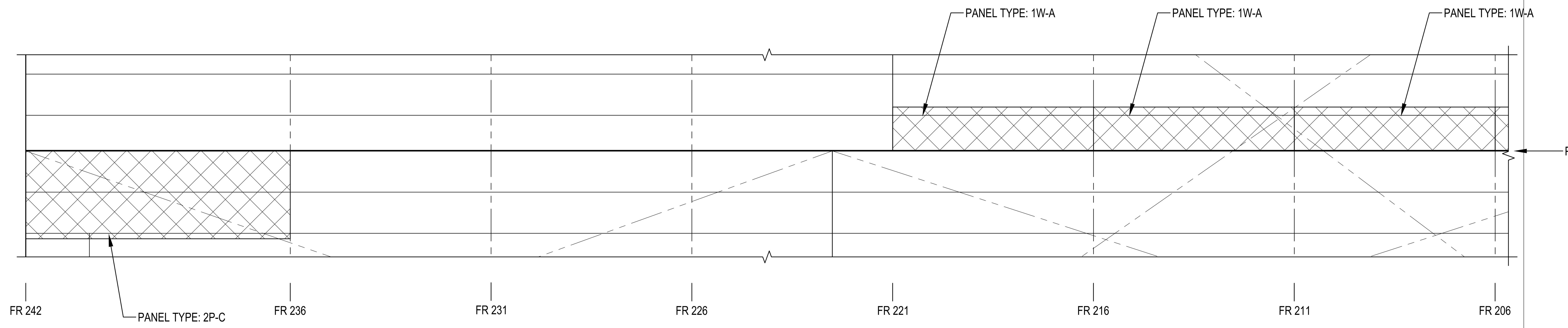
DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

KEY:

DOUBLER PLATE LOCATION

NOTES:

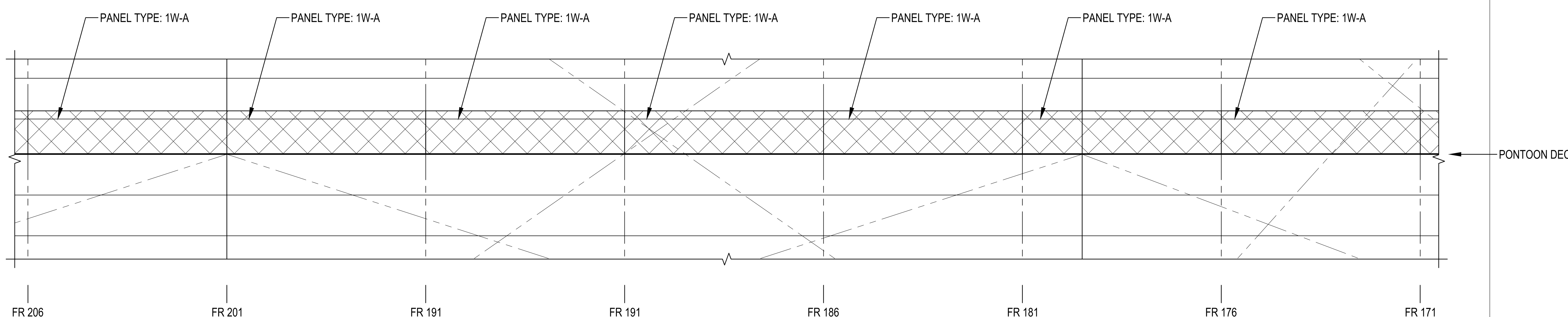
1. SEE S-101 FOR PANEL DETAILS



ELEVATION - PORT OTBD SHELL

SCALE 1 : 50

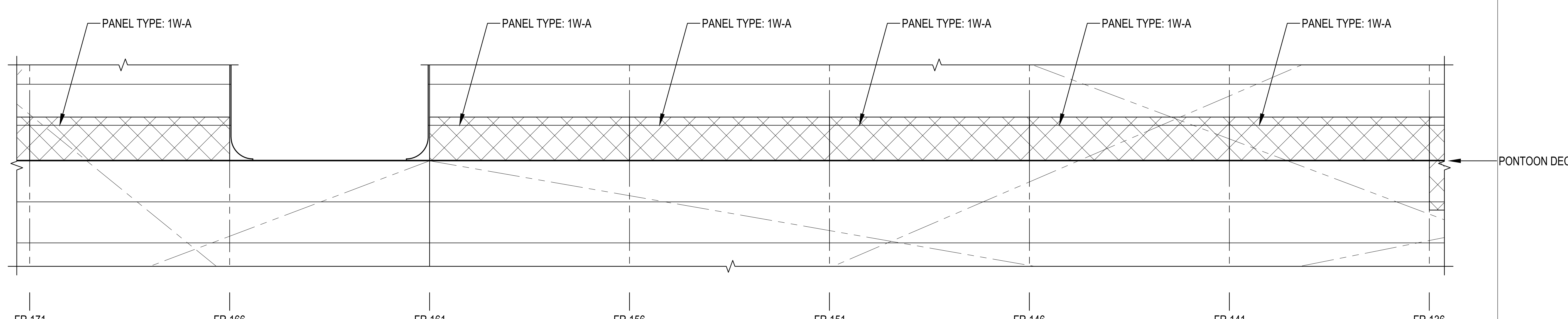
D1



ELEVATION - PORT OTBD SHELL

SCALE 1 : 50

B1



ELEVATION - PORT OTBD SHELL

SCALE 1 : 50

A1

1 : 50 0 0.50 1.000 3.000M

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DES PJT | DRW PJT | CHK PHS

CHIEF ENG. M. NAYLOR

DATE: 11-16-2021

CLIENT NAME AND ADDRESS: NASSCO
SAN DIEGO, CALIFORNIA

PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN

DRAWING TITLE: REPAIR LAYOUT - PORT OUTBOARD - 1 OF 3

SCALE: AS NOTED

PROJECT NO.: 4396-D

CONSTR. CONTR. NO.

SHEET 9 OF 20

A-116

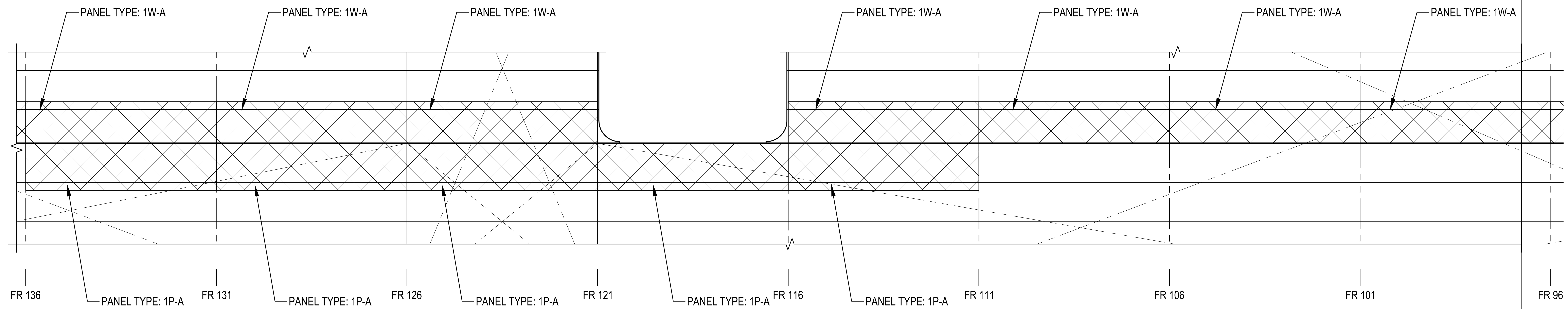
DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

KEY:

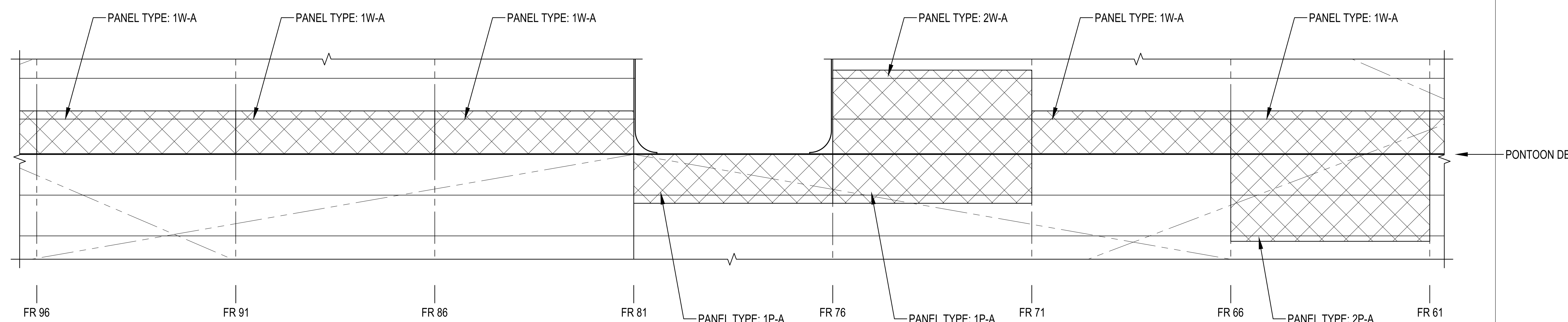
DOUBLER PLATE LOCATION

NOTES:

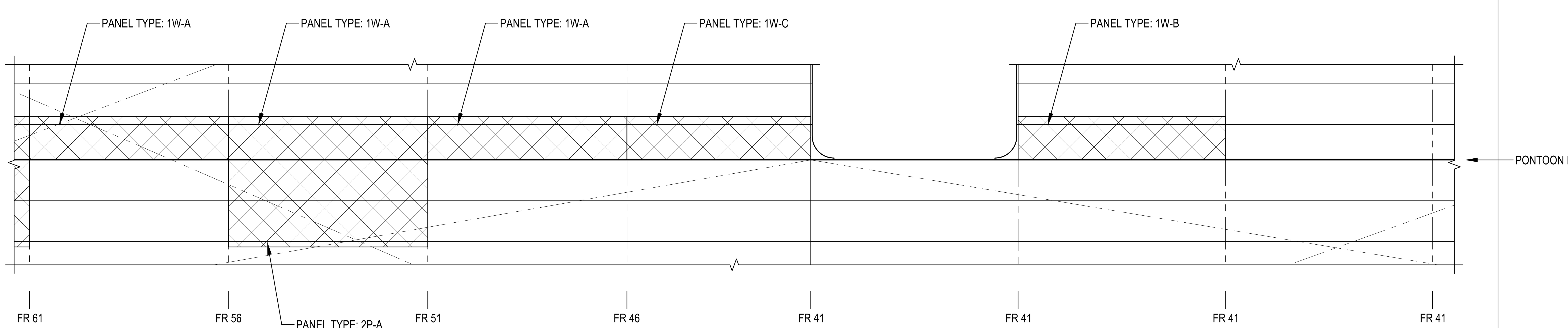
1. SEE S-101 FOR PANEL DETAILS



ELEVATION - PORT OTBD SHELL
SCALE 1 : 50
D1



ELEVATION - PORT OTBD SHELL
SCALE 1 : 50
B1



ELEVATION - PORT OTBD SHELL
SCALE 1 : 50
A1

1 : 50 0 0.50 1.000 3.000M

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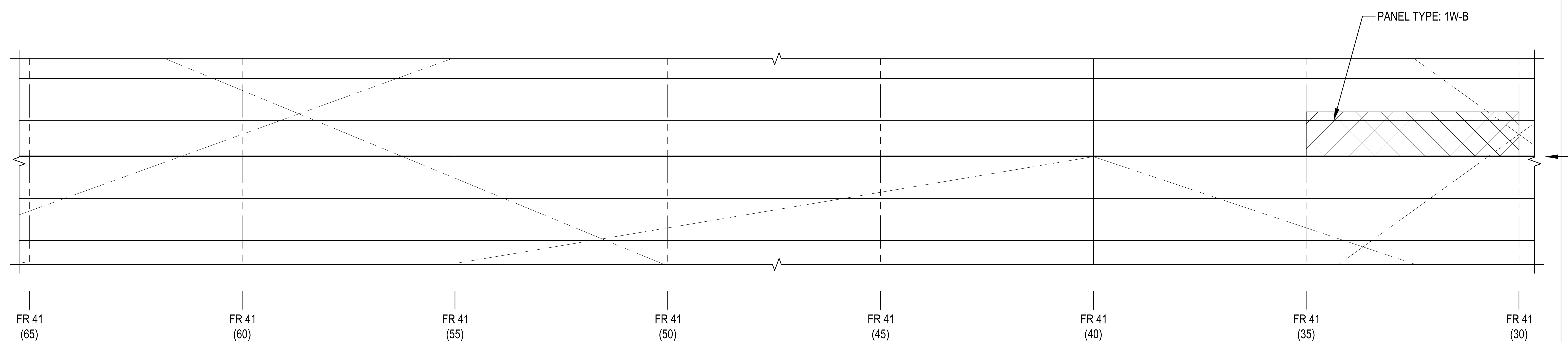
DES	PJT
DRW	PJT
CHK	PHS
CHIEF ENG.	M. NAYLOR
DATE:	11-16-2021
CLIENT NAME AND ADDRESS:	NASSCO, SAN DIEGO, CALIFORNIA
PROJECT TITLE:	BUILDER ANALYSIS & REPAIR PLAN
DRAWING TITLE:	REPAIR LAYOUT - PORT OUTBOARD - 2 OF 3
SCALE:	AS NOTED
PROJECT NO.:	4396-D
CONSTR. CONTR. NO.	
SHEET	10 OF 20
	A-117

DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

KEY:

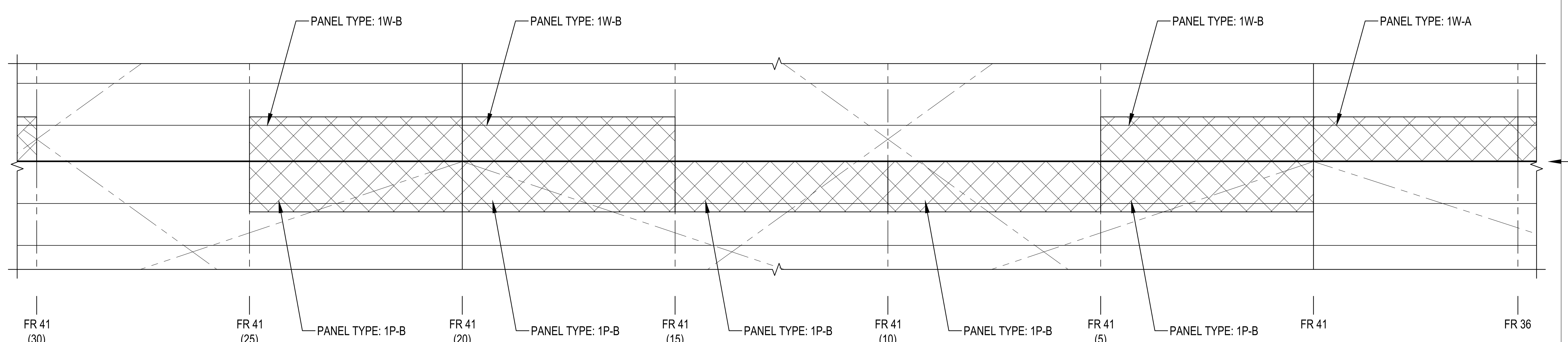
DOUBLER PLATE LOCATION



ELEVATION - PORT OTBD SHELL

SCALE 1 : 50

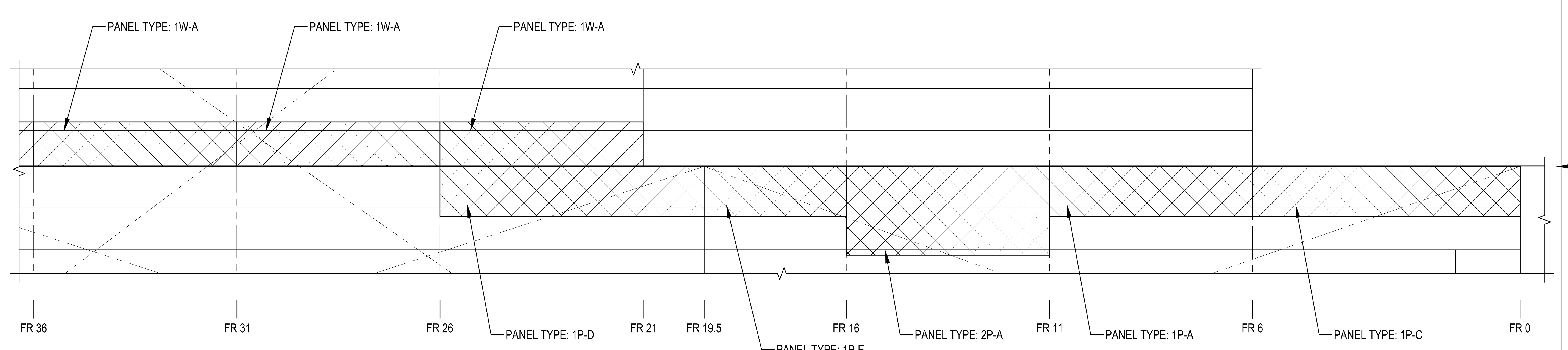
D1



ELEVATION - PORT OTBD SHELL

SCALE 1 : 50

B1



ELEVATION - PORT OTBD SHELL

SCALE 1 : 50

A1

NOTES:

1. SEE S-101 FOR PANEL DETAILS

1 : 50 0 0.50 1.000 3.000M

SYM | DESCRIPTION | DATE | APPR

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DES PJT | DRW PJT | CHK PHS

CHIEF ENG. M. NAYLOR

DATE: 11-16-2021

CLIENT NAME AND ADDRESS: NASSCO
SAN DIEGO, CALIFORNIA

PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN

DRAWING TITLE: REPAIR LAYOUT - PORT OUTBOARD - 3 OF 3

SCALE: AS NOTED

PROJECT NO.: 4396-D

CONSTR. CONTR. NO.

SHEET 11 OF 20

A-118

DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

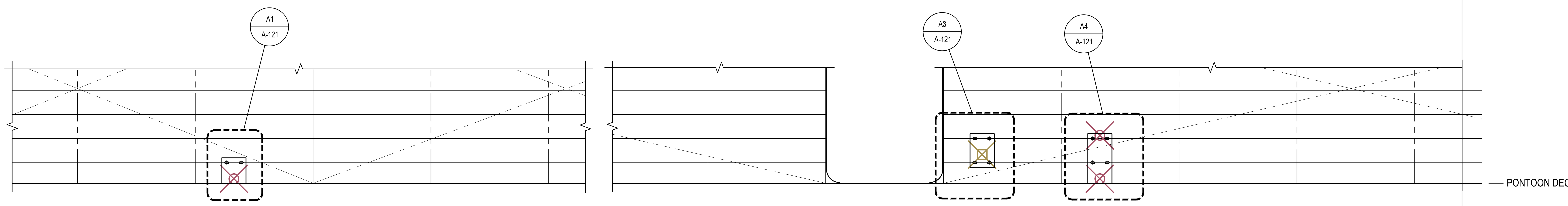
KEY:

LOCATION OF UT READING (10% to 25% WASTAGE)

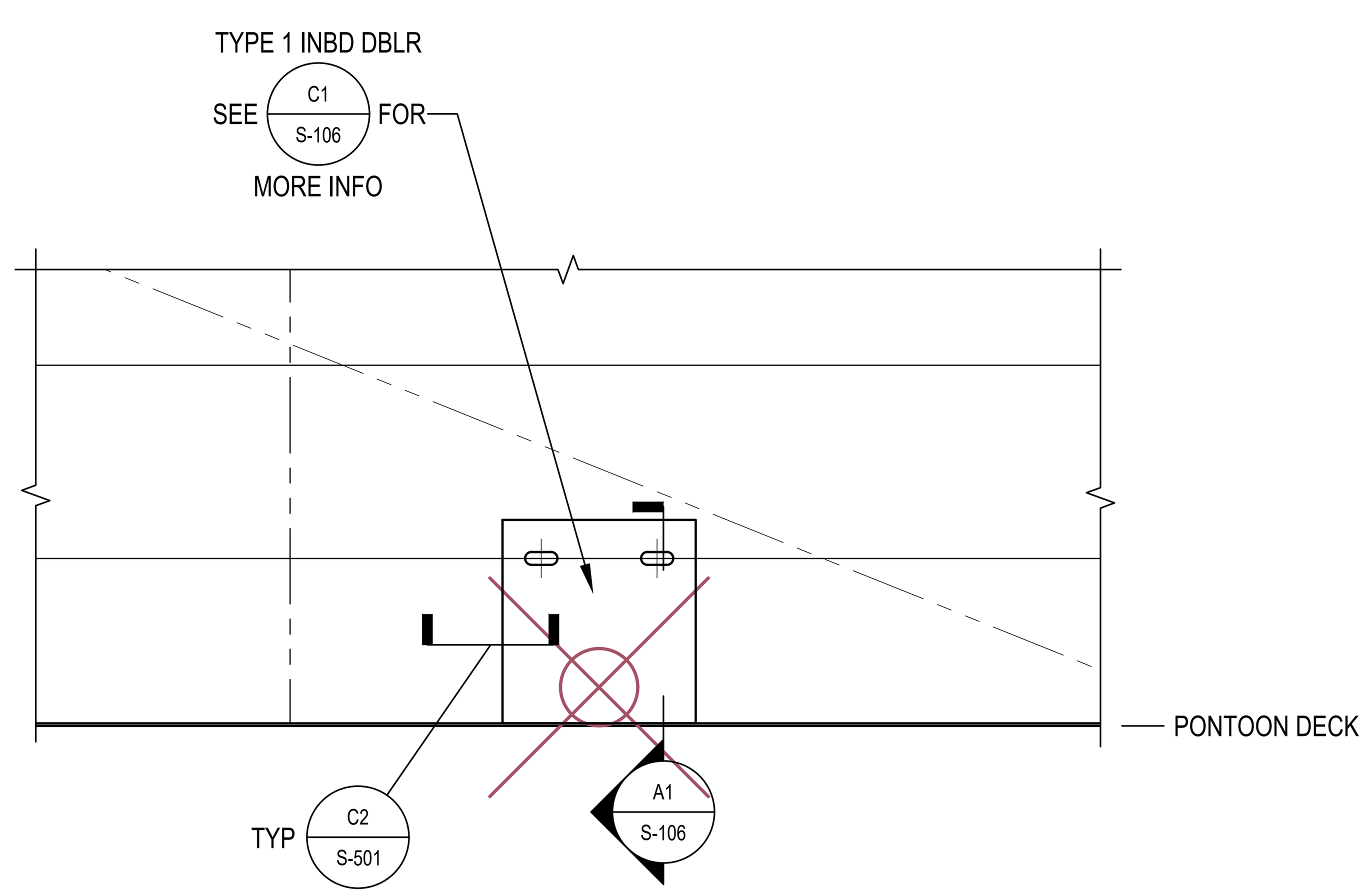
LOCATION OF UT READING (ABOVE 25% WASTAGE)

NOTES:

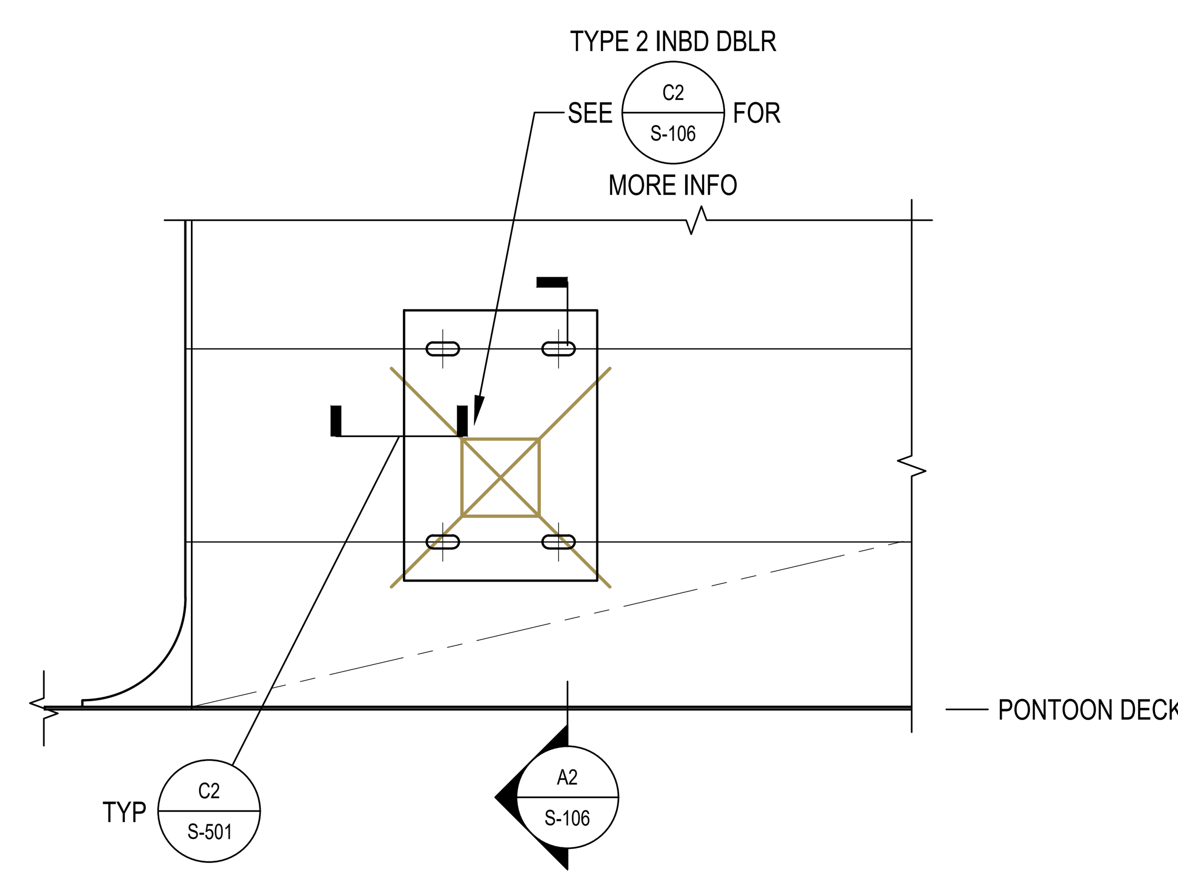
1. AREAS OF PITTING AND PLATE THICKNESS DETERIORATION ON THE PORT AND STARBOARD INBOARD WING SHELLS ARE TO BE REPAIRED BY CLAD WELDING OR USING ONE OF THE THREE TYPES OF DOUBLER PLATE DESIGNS. THE SELECTION AND APPLICATION OF THE DOUBLER PLATE IS TO BE DETERMINED ON A CASE BY CASE BASIS AS DETERMINED BY QUALIFIED NASSCO PERSONNEL.
2. THE LENGTH AND SUBSEQUENT NUMBER OF PLUG CUTOUTS MAY VARY DEPENDING ON THE EXTENT OF THE AREA REQUIRED TO BE REPAIRED. THE FINAL LENGTH SHALL BE DETERMINED BY QUALIFIED NASSCO PERSONNEL FOR EACH INDIVIDUAL REPAIR.
3. INBOARD WING SHELL DOUBLER PLATE REPAIRS TO TO INCLUDE BUT ARE NOT LIMITED TO ALL AREAS WHICH WERE FOUND TO HAVE A PLATE THICKNESS OR PITTING WITH GREATER THAN 25% WASTAGE. ADDITIONAL AREAS MAY BE REPAIRED AT THE DISCRETION OF QUALIFIED NASSCO PERSONNEL.



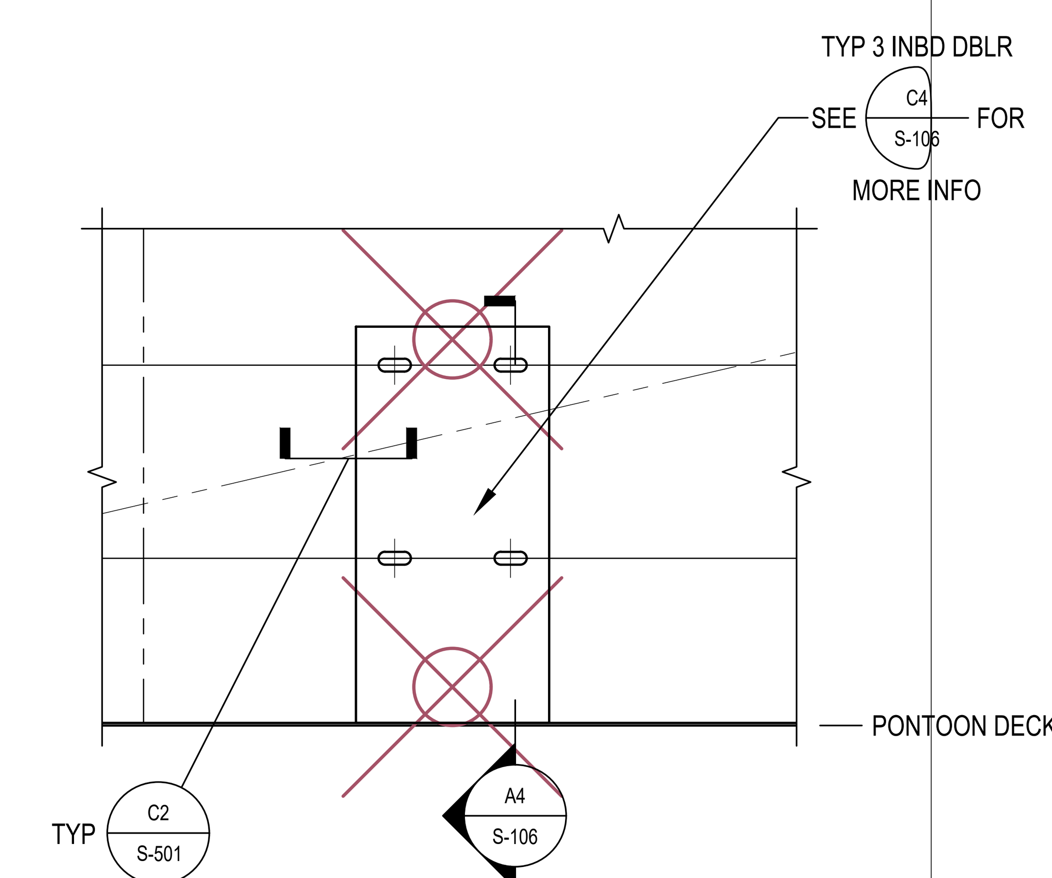
DETAIL - INBOARD DOUBLER PATCHES
SCALE 1 : 75
C1



DETAIL
SCALE 1 : 25
SEE NOTE 1
A-121 A1



DETAIL
SCALE 1 : 25
SEE NOTE 1
A-121 A3



DETAIL
SCALE 1 : 25
SEE NOTE 1
A-121 A4

1 : 25 — 0 0.25 0.50 1.000 1.500M

1 : 75 — 0 1.000 5.000M

SYM DESCRIPTION DATE APPR

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(508) 429-1800

DES PJT | DRW PJT | CHK PHS
CHIEF ENG. M. NAYLOR
DATE: 11-16-2021

CLIENT NAME AND ADDRESS: NASSCO
SAN DIEGO, CALIFORNIA

PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN

DRAWING TITLE: REPAIR LAYOUT - INBOARD LONGITUDINALS

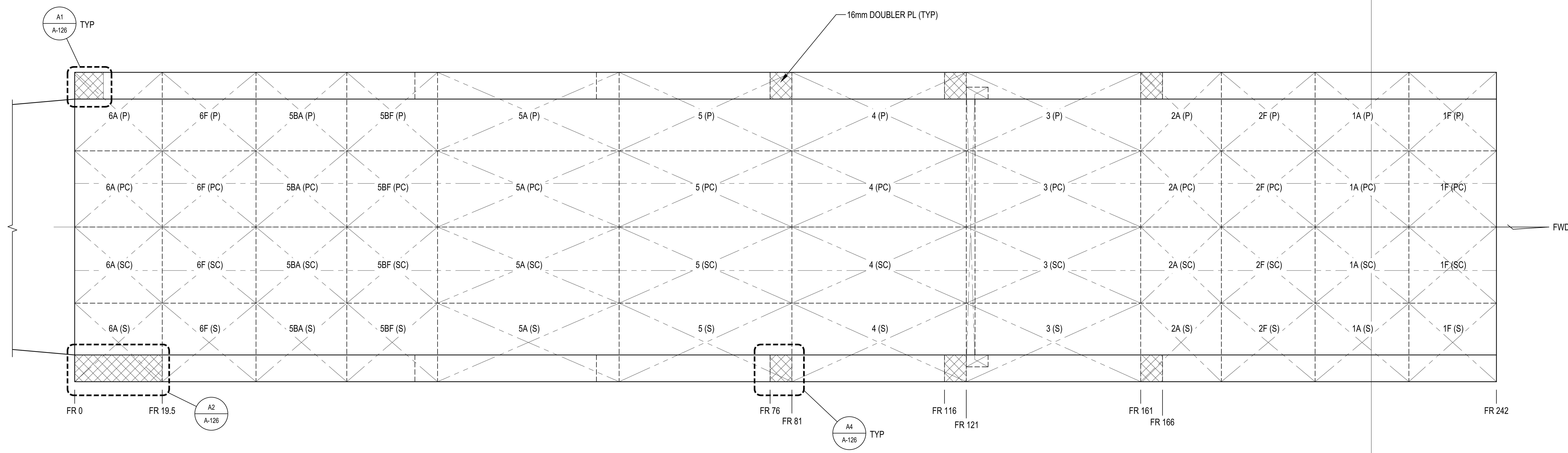
SCALE: AS NOTED
PROJECT NO.: 4396-D
CONSTR. CONTR. NO.

SHEET 12 OF 20
A-121

DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

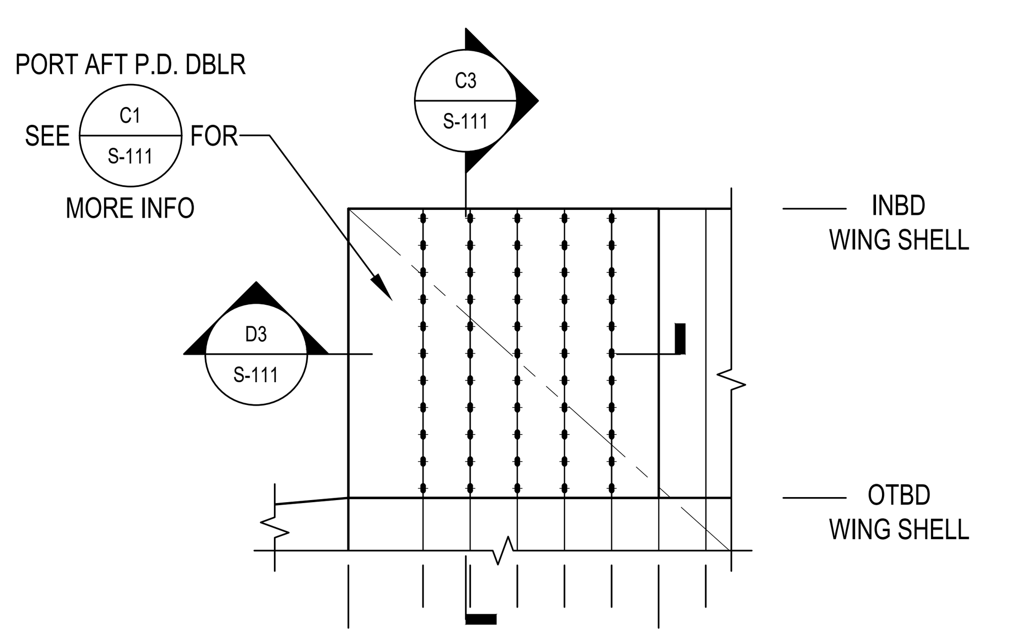
KEY:

DOUBLER PLATE LOCATION



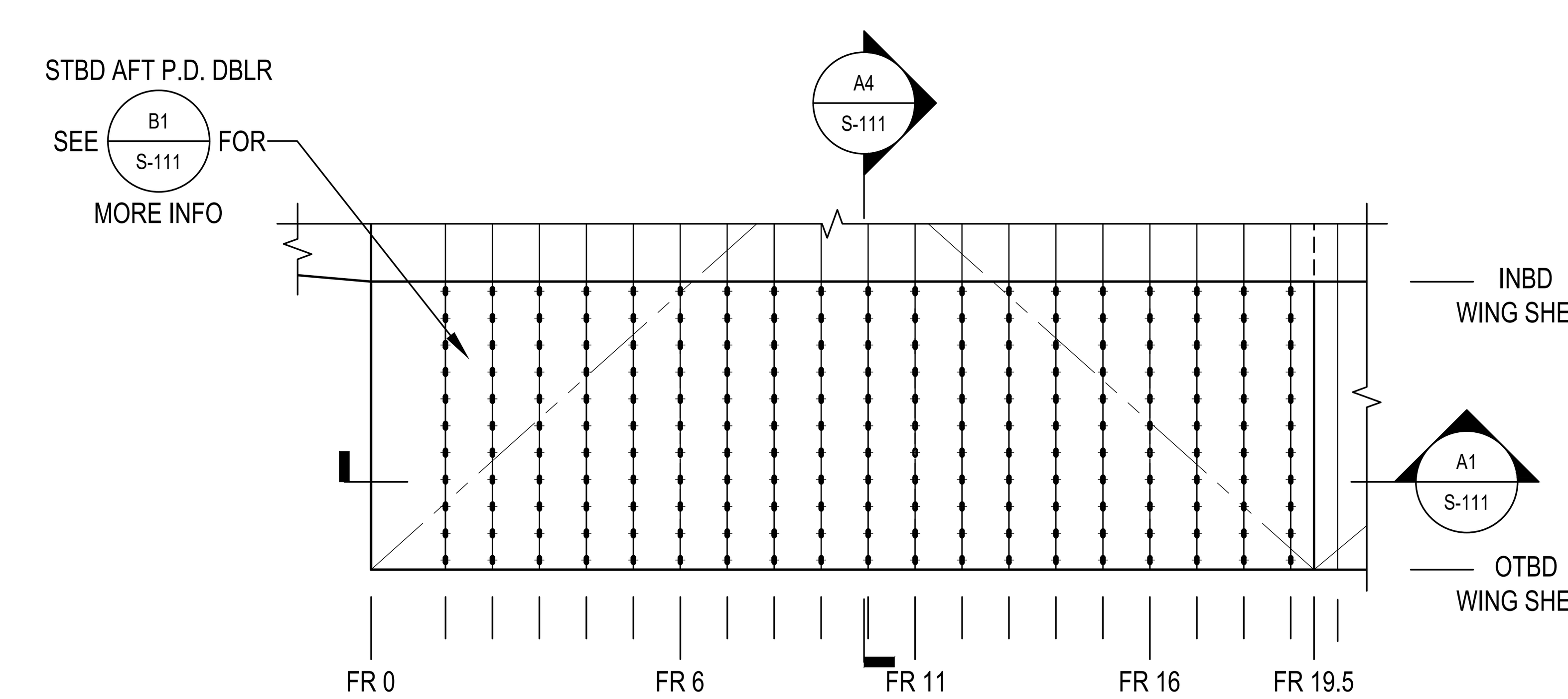
PLAN - PONTOON DECK C1

SCALE 1 : 350



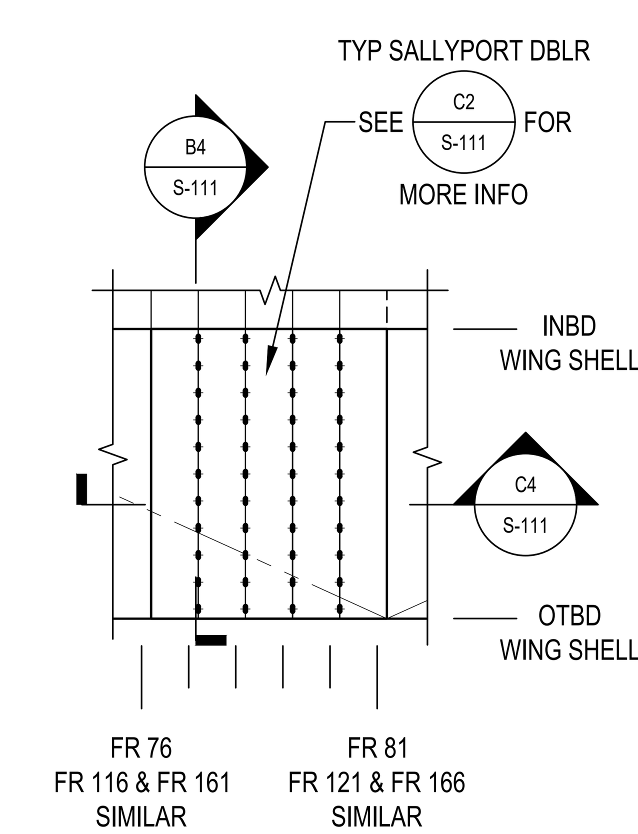
DETAIL - PORT AFT P.D. DOUBLER A1

SCALE 1 : 100 A-126



DETAIL - STBD AFT P.D. DOUBLER A2

SCALE 1 : 100 A-126



DETAIL - TYP SALLYPORT DOUBLER A4

SCALE 1 : 100 A-126

1 : 100 0 1.000 5.000M

1 : 350 0 5.000 20.000M

SYM DESCRIPTION DATE APPR

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DESIGN, INSPECTION AND CERTIFICATION

77 MAIN STREET, SUITE 9

HOPKINTON, MA 01748

(508) 429-1800

DES PJT DRW PJT CHK PHS

CHIEF ENG. M. NAYLOR

DATE: 11-16-2021

CLIENT NAME AND ADDRESS: NASSCO SAN DIEGO, CALIFORNIA

PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN

DRAWING TITLE: REPAIR LAYOUT - PONTOON DECK

SCALE: AS NOTED

PROJECT NO.: 4396-D

CONSTR. CONTR. NO.

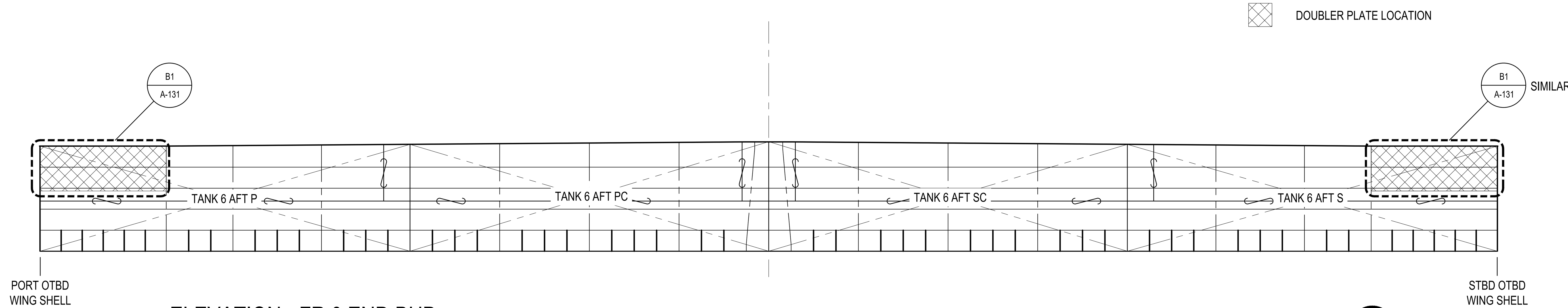
SHEET 13 OF 20

A-126

DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

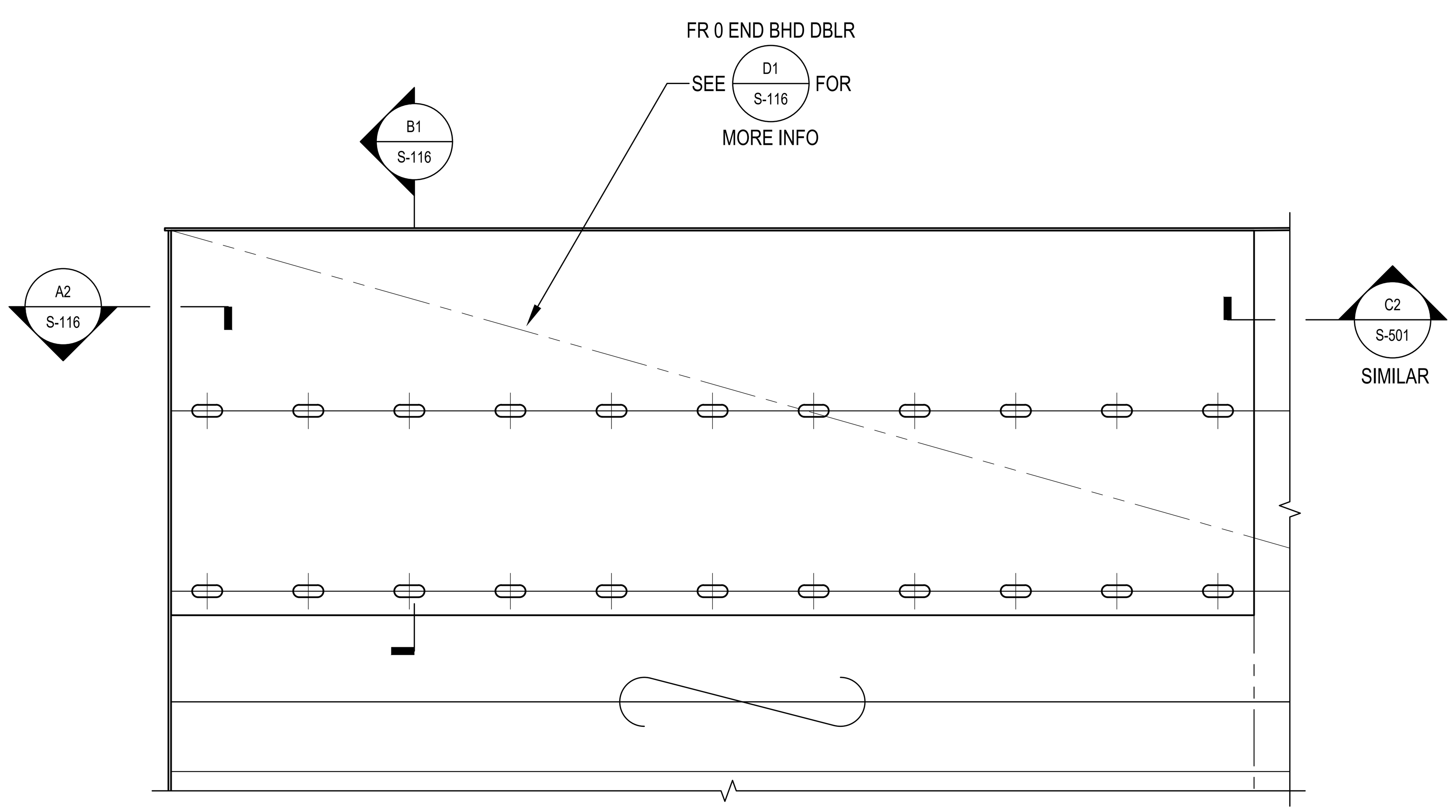
KEY:

DOUBLER PLATE LOCATION



ELEVATION - FR 0 END BHD (D1)

SCALE 1 : 100
LOOKING FWD



ELEVATION - FR 0 END BHD (B1)

SCALE 1 : 20
LOOKING FWD
A-131

1 : 20 — 0 500 1000mm

1 : 100 — 0 1,000 5,000M

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(508) 429-1800

SYM | DESCRIPTION | DATE | APPR

DES PJT | DRW PJT | CHK PHS

CHIEF ENG. M. NAYLOR

DATE: 11-16-2021

CLIENT NAME AND ADDRESS: NASSCO
SAN DIEGO, CALIFORNIA

PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN

DRAWING TITLE: REPAIR LAYOUT - AFT TRANSVERSE END BHD - FR 0

SCALE: AS NOTED

PROJECT NO.: 4396-D

CONSTR. CONTR. NO.

SHEET 14 OF 20

A-131

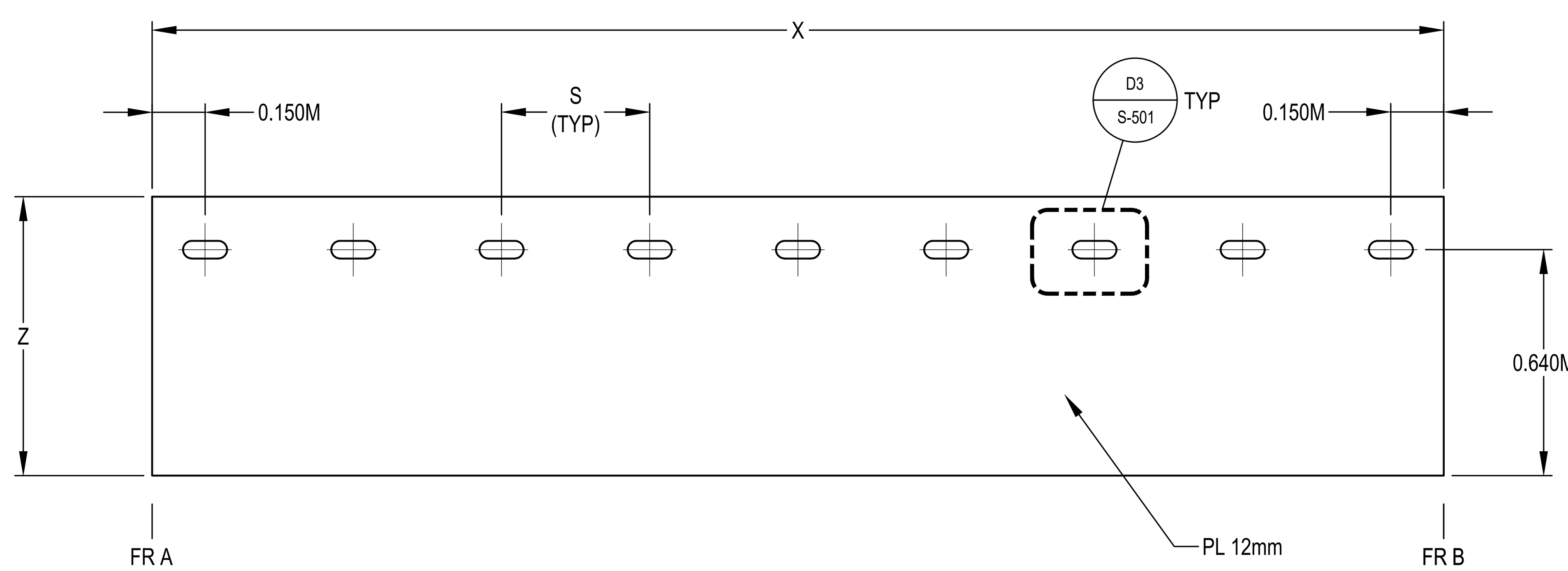
DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

ESTIMATED PLATE AREA:

PORT OTBD (12mm PL)	2167.5 FT²
STBD OTBD (12mm PL)	2997.6 FT²

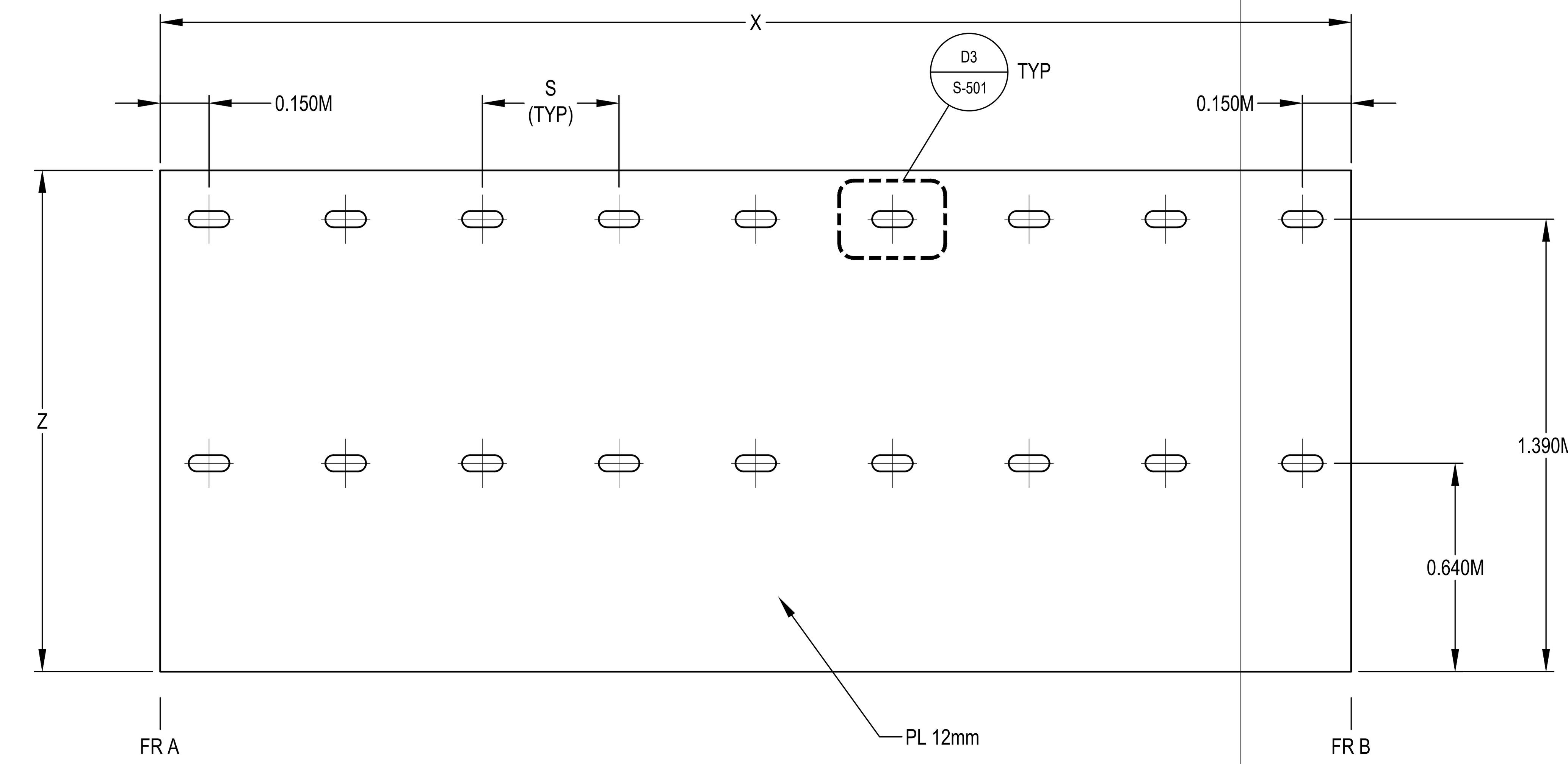
NOTES:

1. SEE D1 ON S-501 FOR TYPICAL WELD DETAILS



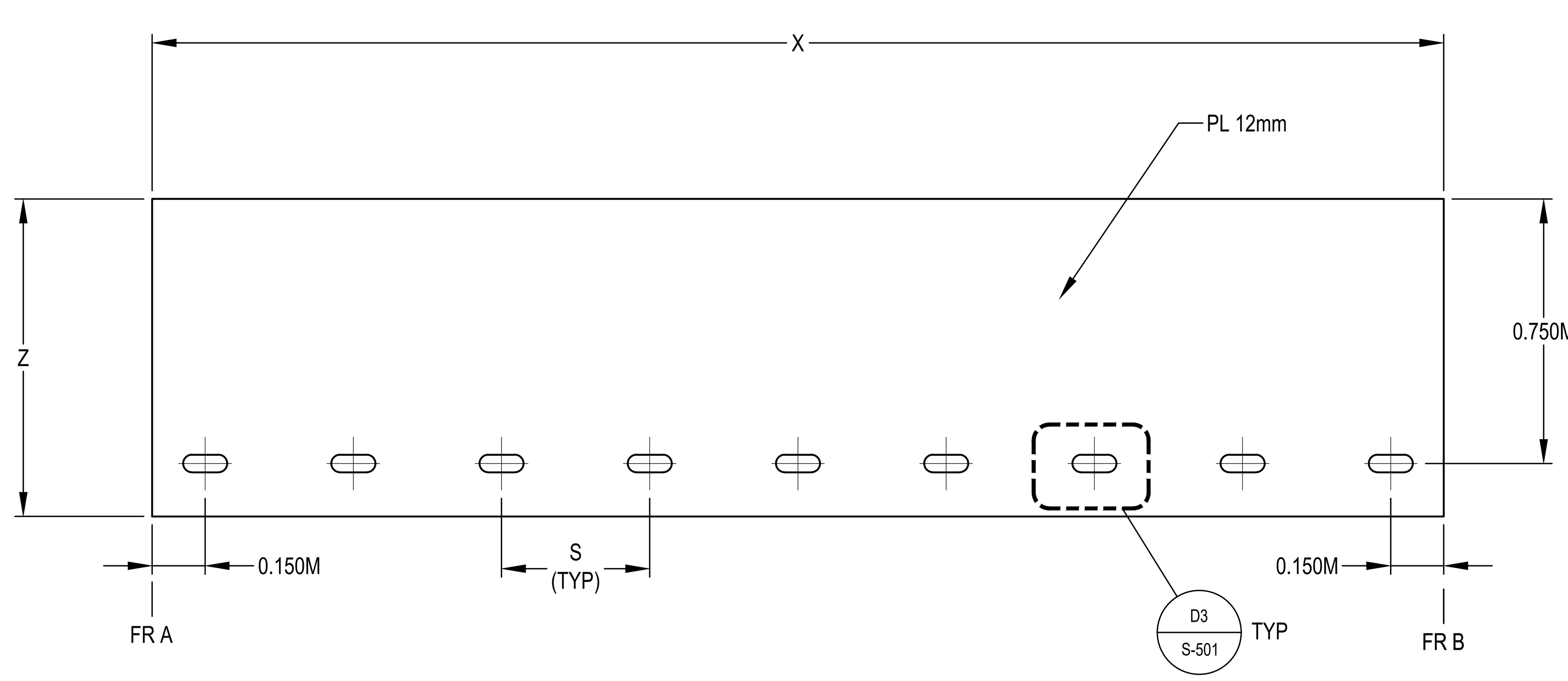
DETAIL - TYP TYPE 1W PL PANEL (C1)

SCALE 1 : 15
SEE TABLE 1 AND 2 ON S-102 FOR VALUES



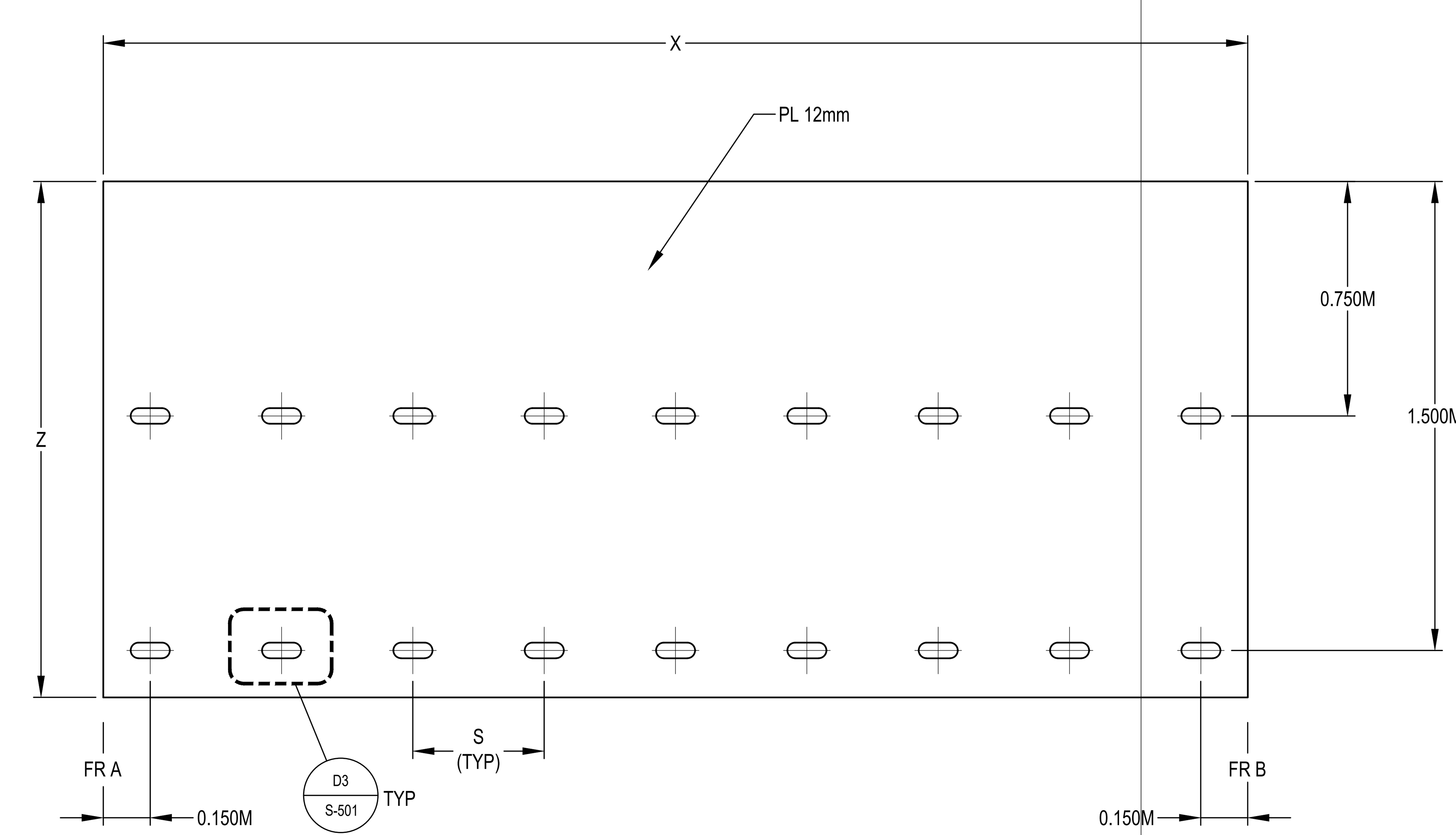
DETAIL - TYP TYPE 2W PL PANEL (C3)

SCALE 1 : 15
SEE TABLE 1 AND 2 ON S-102 FOR VALUES



DETAIL - TYP TYPE 1P PL PANEL (A1)

SCALE 1 : 15
SEE TABLE 1 AND 2 ON S-102 FOR VALUES



DETAIL - TYP TYPE 2P PL PANEL (A3)

SCALE 1 : 15
SEE TABLE 1 AND 2 ON S-102 FOR VALUES

1 : 15 0 250 500 1000mm

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DES PJT | DRW PJT | CHK PHS
CHIEF ENG. M. NAYLOR
DATE: 11-16-2021

CLIENT NAME AND ADDRESS: NASSCO
SAN DIEGO, CALIFORNIA
PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN
DRAWING TITLE: DETAIL - OUTBOARD LONGITUDINAL - DOUBLER PLATE - 1 OF 2

SCALE: AS NOTED
PROJECT NO.: 4396-D
CONSTR. CONTR. NO.:
SHEET 15 OF 20
S-101

DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

TABLE 1 - PORT SIDE OTBD SHELL				FR AFT	FR FWD	PL LENGTH **	PLUG SPACING	PLATE HEIGHT
#	TANK	PORT/STBD	TYPE	A	B	X (mm)	S (mm)	Z (mm)
1	1F	PORT	2P-C	236	242	4820	452	1600
2	1A	PORT	1W-A	216	221	3660	420	790
3	1A	PORT	1W-A	211	216	3660	420	790
4	1A	PORT	1W-A	206	211	3660	420	790
5	1A	PORT	1W-A	201	206	3660	420	790
6	2F	PORT	1W-A	196	201	3660	420	790
7	2F	PORT	1W-A	191	196	3660	420	790
8	2F	PORT	1W-A	186	191	3660	420	790
9	2F	PORT	1W-A	181	186	3660	420	790
10	2A	PORT	1W-A	176	181	3660	420	790
11	2A	PORT	1W-A	171	176	3660	420	790
12	2A	PORT	1W-A	166	171	3660	420	790
13	3	PORT	1W-A	156	161	3660	420	790
14	3	PORT	1W-A	151	156	3660	420	790
15	3	PORT	1W-A	146	151	3660	420	790
16	3	PORT	1W-A	141	146	3660	420	790
17	3	PORT	1W-A	136	141	3660	420	790
18	3	PORT	1W-A	131	136	3660	420	790
19	3	PORT	1W-A	126	131	3660	420	790
20	3	PORT	1W-A	121	126	3660	420	790
21	3	PORT	1P-A	131	136	3660	420	900
22	3	PORT	1P-A	126	131	3660	420	900
23	3	PORT	1P-A	121	126	3660	420	900
24	4	PORT	1W-A	111	116	3660	420	790
25	4	PORT	1W-A	106	111	3660	420	790
26	4	PORT	1W-A	101	106	3660	420	790
27	4	PORT	1W-A	96	101	3660	420	790
28	4	PORT	1W-A	91	96	3660	420	790
29	4	PORT	1W-A	86	91	3660	420	790
30	4	PORT	1W-A	81	86	3660	420	790
31	4	PORT	1P-A	116	121	3660	420	900
32	4	PORT	1P-A	111	116	3660	420	900
33	5	PORT	2W-A	71	76	3660	420	1540
34	5	PORT	1W-A	66	71	3660	420	790
35	5	PORT	1W-A	61	66	3660	420	790
36	5	PORT	1W-A	56	61	3660	420	790
37	5	PORT	1W-A	46	51	3660	420	790
38	5	PORT	1W-C	41 (80)	46	3380	385	790
39	5	PORT	1P-A	76	81	3660	420	900
40	5	PORT	1P-A	71	76	3660	420	900
41	5	PORT	2P-A	61	66	3660	420	1600
42	5	PORT	2P-A	51	56	3660	420	1600
43	5A	PORT	1W-B	41 (70)	41 (75)	3810	390	790
44	5BF	PORT	1W-B	41 (30)	41 (35)	3810	390	790
45	5BF	PORT	1W-B	41 (20)	41 (25)	3810	390	790
46	5BF	PORT	1P-B	41 (20)	41 (25)	3810	390	900
47	5BA	PORT	1W-B	41 (15)	41 (20)	3810	390	790
48	5BA	PORT	1W-B	41	41 (5)	3810	390	790
49	5BA	PORT	1P-B	41 (15)	41 (20)	3810	390	900
50	5BA	PORT	1P-B	41 (10)	41 (15)	3810	390	900
51	5BA	PORT	1P-B	41 (5)	41 (10)	3810	390	900
52	5BA	PORT	1P-B	41	41 (5)	3810	390	900
53	6F	PORT	1W-A	36	41	3660	420	790
54	6F	PORT	1W-A	31	36	3660	420	790
55	6F	PORT	1W-A	26	31	3660	420	790
56	6F	PORT	1W-A	21	26	3660	420	790
57	6F	PORT	1P-D	19.5	26	4760	446	900
58	6A	PORT	1P-E	16	19.5	2560	452	900
59	6A	PORT	2P-A	11	16	3660	420	1600
60	6A	PORT	1P-A	6	11	3660	420	900
61	6A	PORT	1P-C	0	6	4820	452	900

** NOTE: PLATE LENGTH VALUE IS REPRESENTATIVE OF THE LENGTH BETWEEN PANEL SEAMS AND DOES NOT ACCOUNT FOR REQUIRED WELD GAP BETWEEN ADJACENT PLATES.

TABLE 2 - STBD SIDE OTBD SHELL				FR AFT	FR FWD	PL LENGTH	PLUG SPACING	PLATE HEIGHT
#	TANK	PORT/STBD	TYPE	A	B	X (mm)	S (mm)	Z (mm)
1	6A	STBD	2P-C	0	6	4820	452	1600
2	6A	STBD	1P-E	16	19.5	2560	452	900
3	6F	STBD	1W-A	21	26	3660	420	790
4	6F	STBD	1W-A	26	31	3660	420	790
5	6F	STBD	1W-A	31	36	3660	420	790
6	6F	STBD	1W-A	36	41	3660	420	790
7	6F	STBD	1P-D	19.5	26	4760	446	900
8	6F	STBD	1P-A	26	31	3660	420	900
9	6F	STBD	1P-A	31	36	3660	420	900
10	6F	STBD	1P-A	36	41	3660	420	900
11	5BA	STBD	1W-B	41	41 (5)	3810	390	790
12	5BA	STBD	1P-B	41	41 (5)	3810	390	900
13	5BA	STBD	1P-B	41 (5)	41 (10)	3810	390	900
14	5BA	STBD	1P-B	41 (10)	41 (15)	3810	390	900
15	5BA	STBD	1P-B	41 (15)	41 (20)	3810	390	900
16	5BF	STBD	1P-B	41 (20)	41 (25)	3810	390	900
17	5BF	STBD	2P-B	41 (25)	41 (30)	3810	390	1600
18	5BF	STBD	1P-B	41 (30)	41 (35)	3810	390	900
19	5BF	STBD	2P-B	41 (35)	41 (40)	3810	390	1600
20	5A	STBD	2W-B	41 (55)	41 (60)	3810	390	1540
21	5A	STBD	1W-B	41 (60)	41 (65)	3810	390	790
22	5A	STBD	1W-B	41 (65)	41 (70)	3810	390	790
23	5A	STBD	2W-B	41 (70)	41 (75)	3810	390	1540
24	5A	STBD	1P-B	41 (40)	41 (45)	3810	390	900
25	5A	STBD	2P-B	41 (45)	41 (50)	3810	390	1600
26	5A	STBD	2P-B	41 (50)	41 (55)	3810	390	1600
27	5A	STBD	2P-B	41 (55)	41 (60)	3810	390	1600
28	5A	STBD	2P-B	41 (60)	41 (65)	3810	390	1600
29	5A	STBD	1P-B	41 (75)	41 (80)	3810	390	900
30	5	STBD	1W-C	41 (80)	46	3380	385	790
31	5	STBD	1W-A	46	51	3660	420	790
32	5	STBD	1W-A	51	56	3660	420	790
33	5	STBD	1W-A	56	61	3660	420	790
34	5	STBD	1W-A	61	66	3660	420	790
35	5	STBD	1W-A	66	71	3660	420	790
36	5	STBD	1W-A	71	76	3660	420	790
37	5	STBD	2P-A	46	51	3660	420	1600
38	5	STBD	1P-A	56	61	3660	420	900
39	5	STBD	2P-A	61	66	3660	420	1600
40	5	STBD	1P-A	76	81	3660	420	900
41	4	STBD	1W-A	81	86	3660	420	790
42	4	STBD	1W-A	86	91	3660	420	790
43	4	STBD	1W-A	91	96	3660	420	790
44	4	STBD	1W-A	96	101	3660	420	790
45	4	STBD	1W-A	101	106	3660	420	790
46	4	STBD	1W-A	106	111	3660	420	790
47	4	STBD	1W-A	111	116	3660	420	790
48	4	STBD	2P-A	96	101	3660	420	1600
49	4	STBD	2P-A	101	106	3660	420	1600
50	4	STBD	1P-A	116	121	3660	420	900
51	3	STBD	1W-A	121	126	3660	420	790
52	3	STBD	1W-A	126	131	3660	420	790
53	3	STBD	1W-A	131	136	3660	420	790
54	3	STBD	1W-A	136	141	3660	420	790
55	3	STBD	1W-A	141	146	3660	420	790
56	3	STBD	1W-A	146	151	3660	420	790
57	3	STBD	1W-A	151	156	3660	420	790
58	3	STBD	1W-A	156	161	3660	420	790
59	3	STBD	1P-A	131	136	3660	420	900
60	3	STBD	1P-A	151	156	3660	420	900
61	3	STBD	1P-A	156	161	3660	420	900
62	2A	STBD	1W-A	166	171	3660	420	790
63	2A	STBD	1W-A	171	176	3660	420	790
64	2A	STBD	1W-A	176	181	3660	420	790
65	2A	STBD	1P-A	161	166	3660	420	900
66	2A	STBD	1P-A	171	176	3660	420	900
67	2A	STBD	1P-E	176	179.5	2560	452	900
68	2F	STBD	1W-A	181	186	3660	420	790
69	2F	STBD	1W-A	186	191	3660	420	790
70	2F	STBD	1W-A	191	196	3660	420	790
71	2F	STBD	1W-A	196	201	3660	420	790
72	2F	STBD	1P-A	196	201	3660	420	900
73	1A	STBD	1W-A	201	206	3660	420	790
74	1A	STBD	1W-A	206	211	3660	420	790
75	1A	STBD	1P-A	201	206	3660	420	900
76	1A	STBD	1P-A	211	216	3660	420	900
77	1A	STBD	1P-D	216	222.5	4760	446	900
78	1F	STBD	1P-E	222.5	226	2560	452	900

** NOTE: PLATE LENGTH VALUE IS REPRESENTATIVE OF THE LENGTH BETWEEN PANEL SEAMS AND DOES NOT ACCOUNT FOR REQUIRED WELD GAP BETWEEN ADJACENT PLATES.

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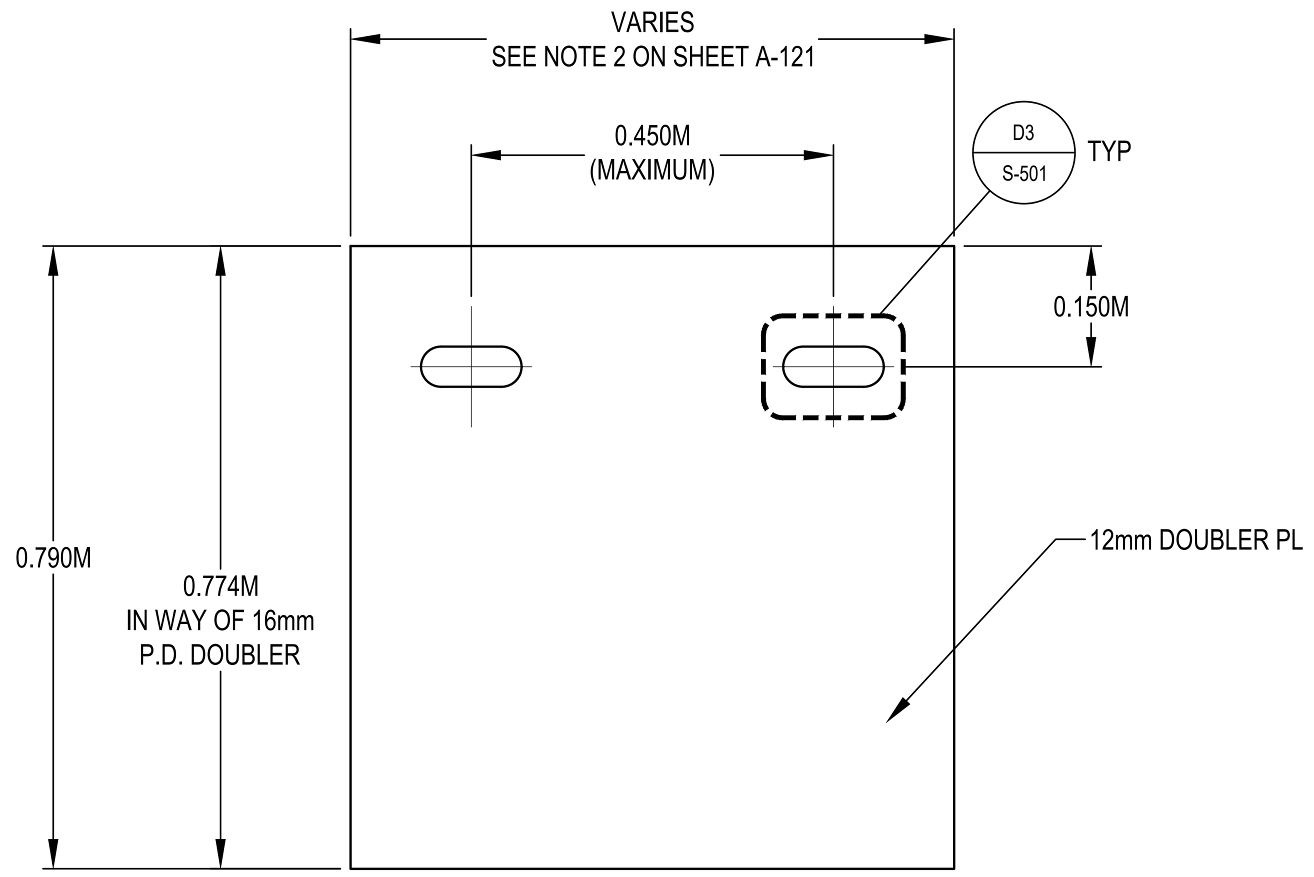
CHIEF ENG. M. NAYLOR
DATE: 11-16-2021

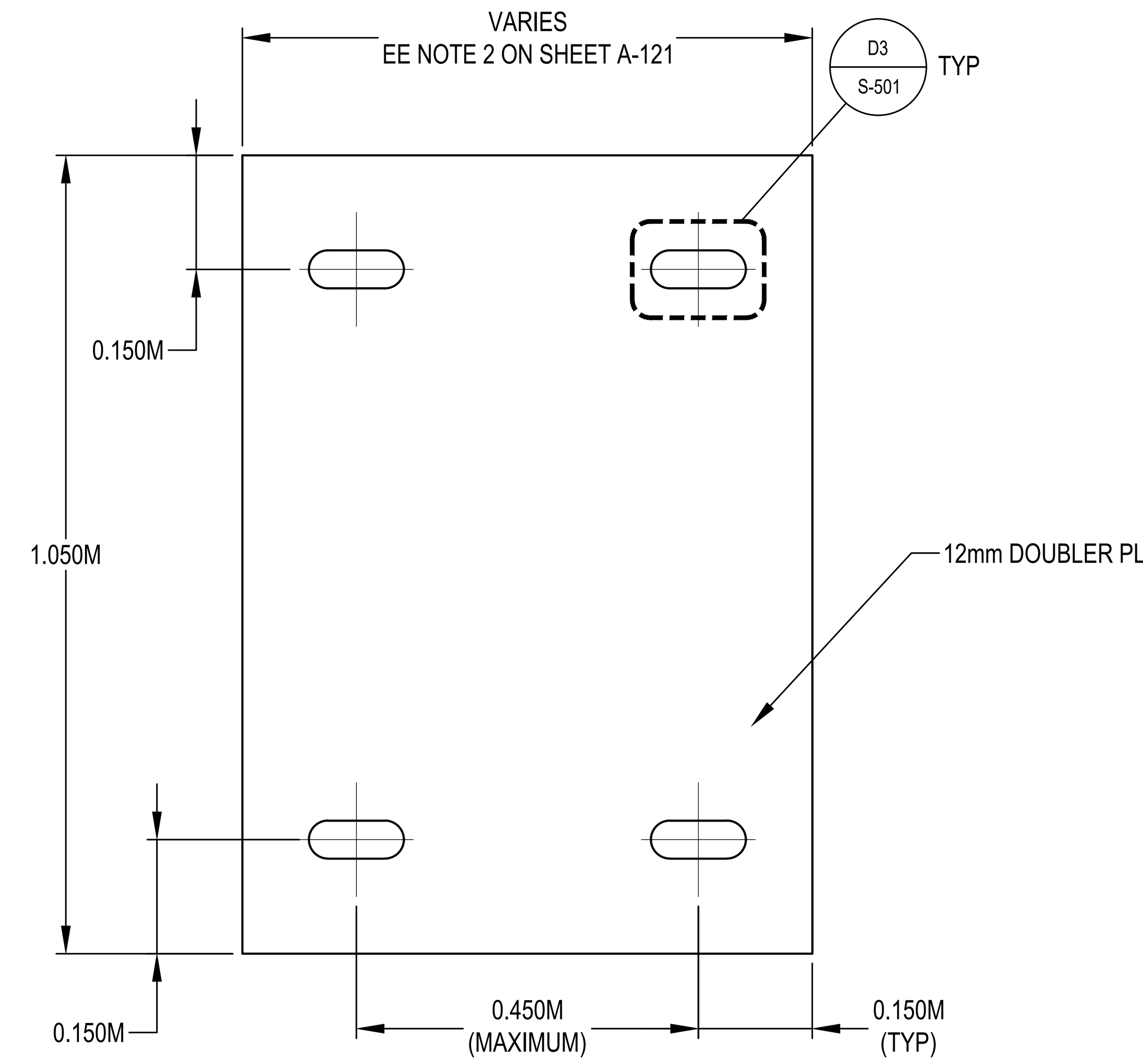
CLIENT NAME AND ADDRESS: NASSCO, SAN DIEGO, CALIFORNIA
PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN
DRAWING TITLE: DETAIL - OUTBOARD LONGITUDINAL - DOUBLER PLATE - 2 OF 2

SCALE: AS NOTED
PROJECT NO.: 4396-D
CONSTR. CONTR. NO.

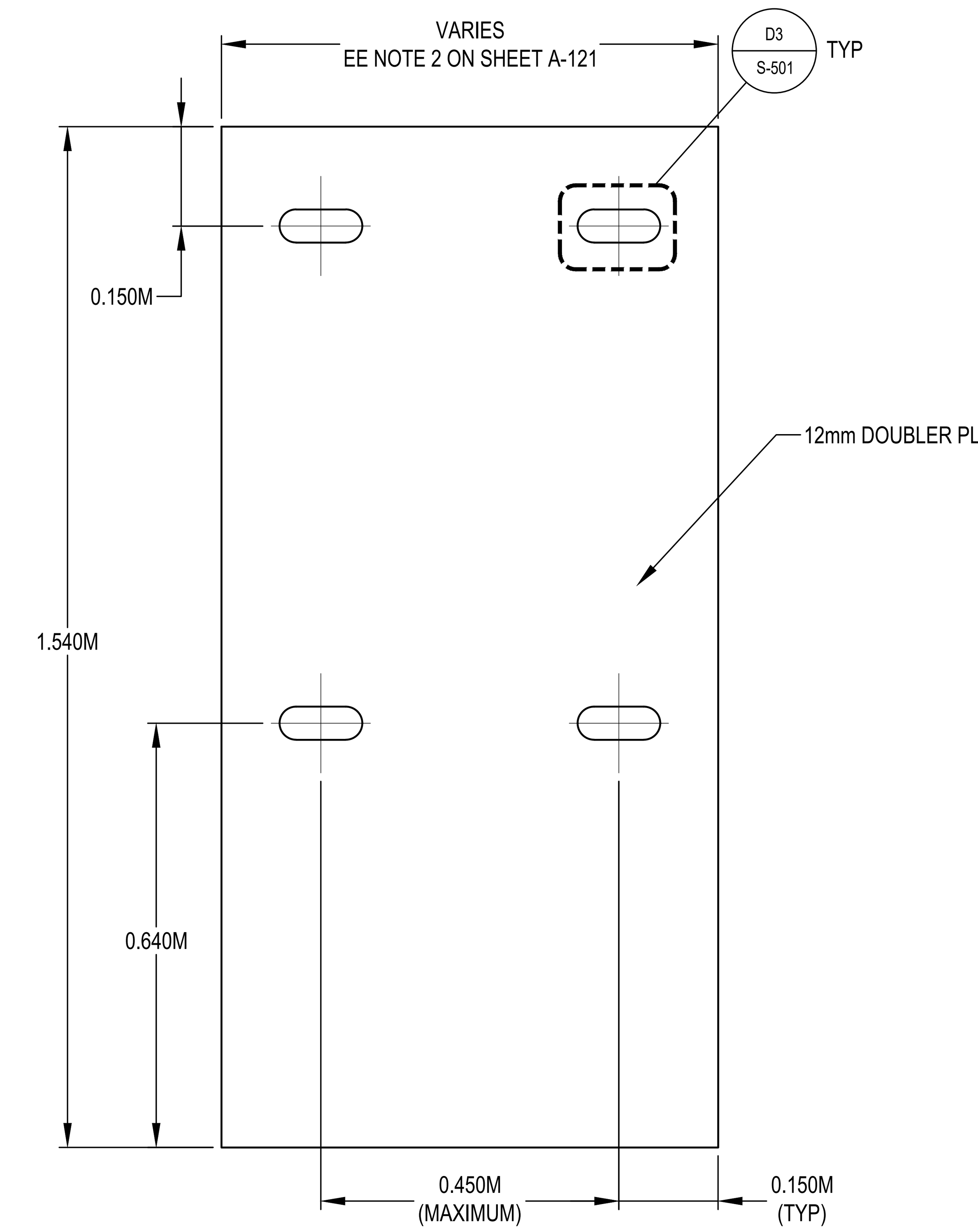
DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING



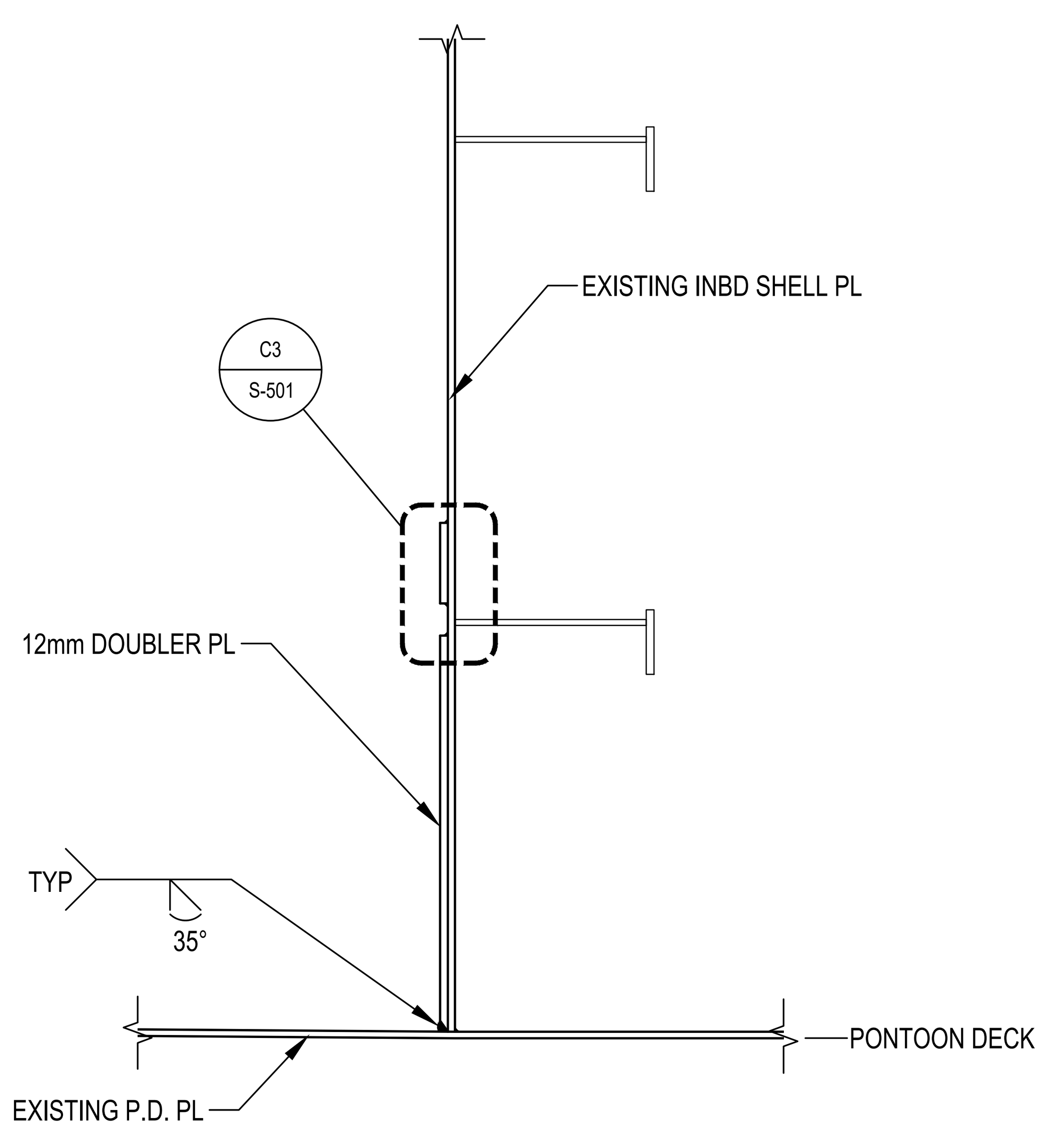
DETAIL - TYP INBD DOUBLER (TYPE 1) C1
SCALE 1 : 8 A-121



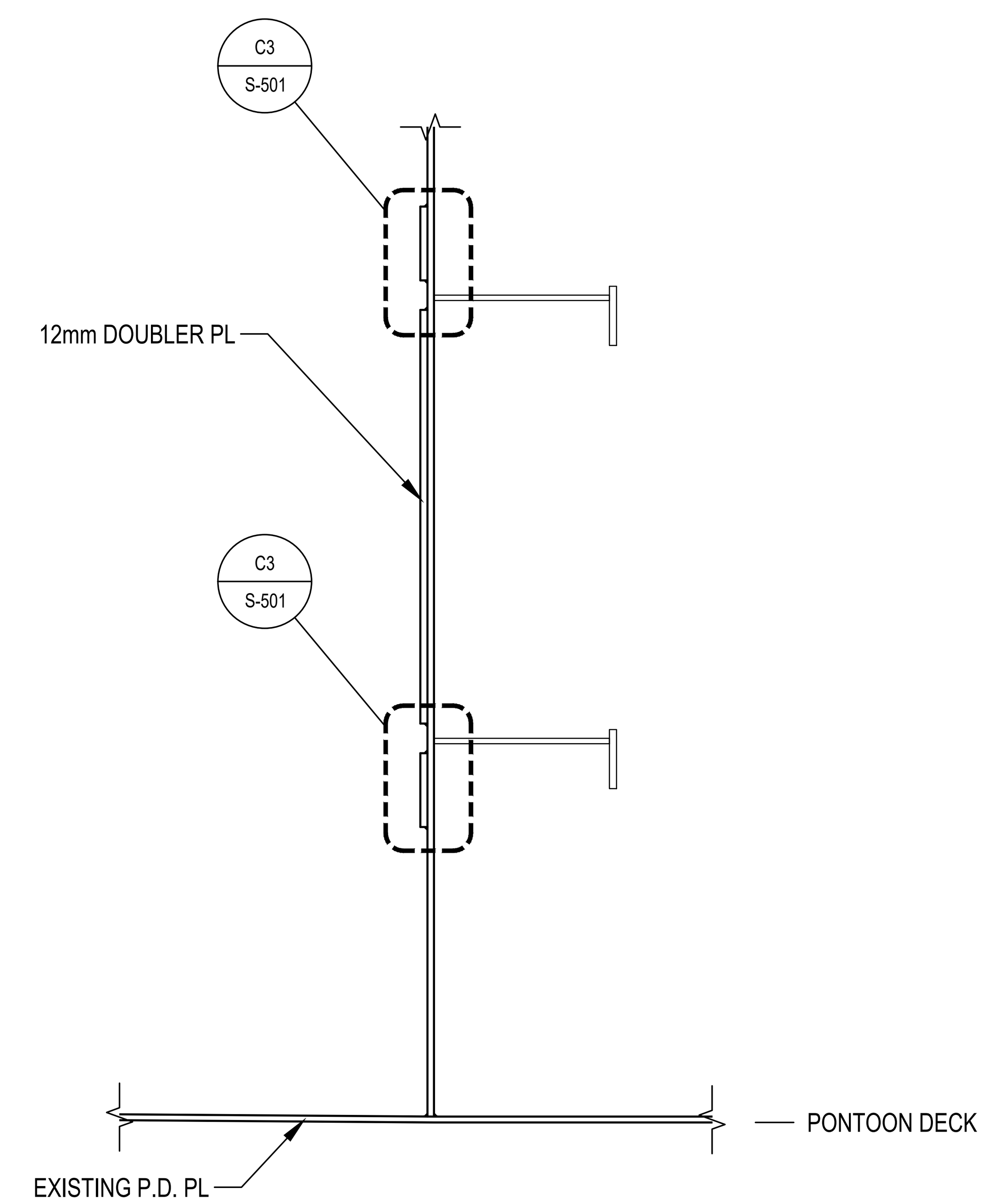
DETAIL - TYP INBD DOUBLER (TYPE 2) C2
SCALE 1 : 8 A-121



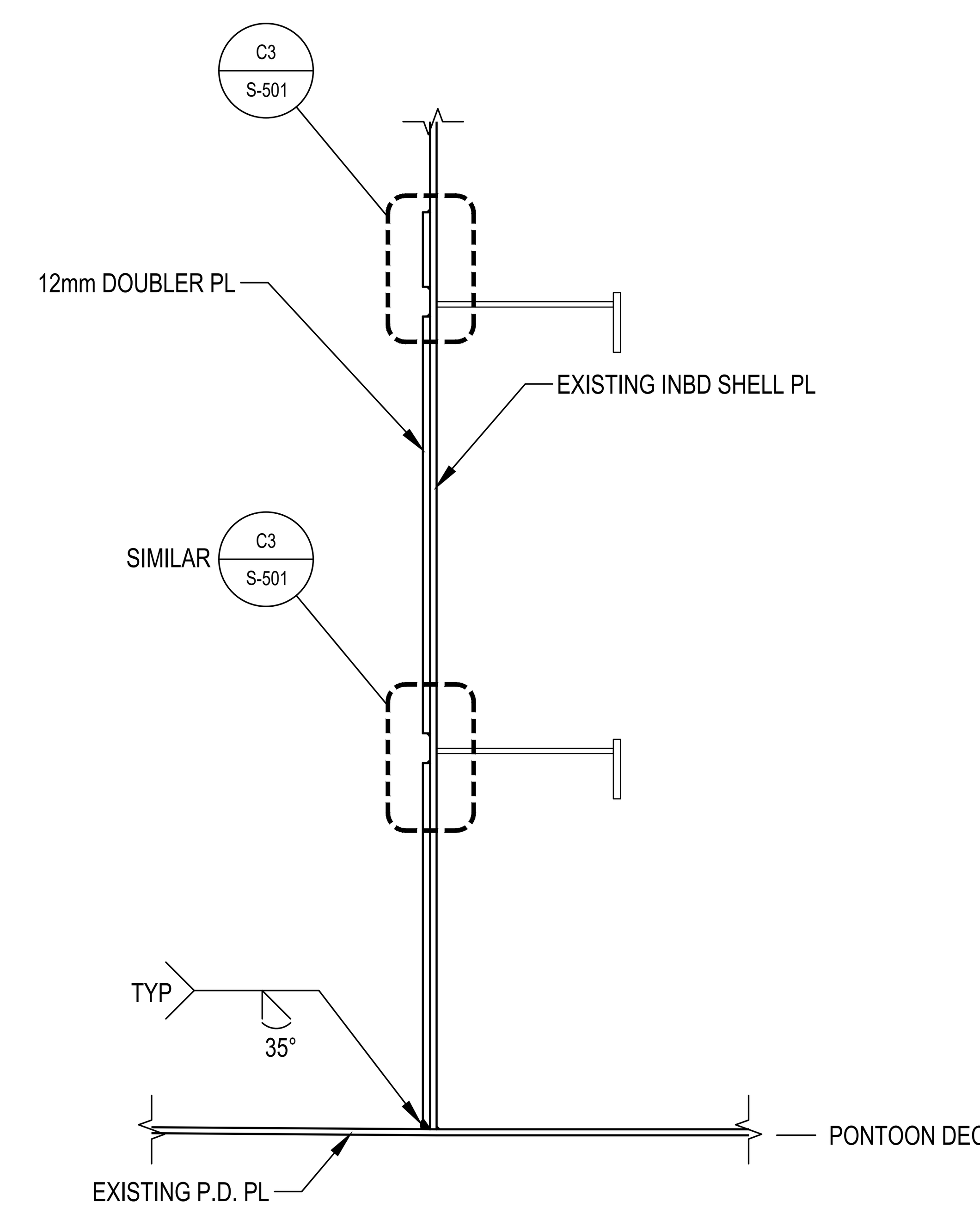
DETAIL - TYP INBD DOUBLER (TYPE 3) C4
SCALE 1 : 8 A-121



SECTION - TYP INBD DOUBLER (TYPE 1) A1
SCALE 1 : 10 A-121



SECTION - TYP INBD DOUBLER (TYPE 2) A2
SCALE 1 : 10 A-121



SECTION - TYP INBD DOUBLER (TYPE 3) A4
SCALE 1 : 10 A-121

1 : 8 — 0 100 200 400mm
1 : 10 — 0 100 200 600mm

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CHIEF ENG. M. NAYLOR
DATE: 11-16-2021

CLIENT NAME AND ADDRESS: NASSCO
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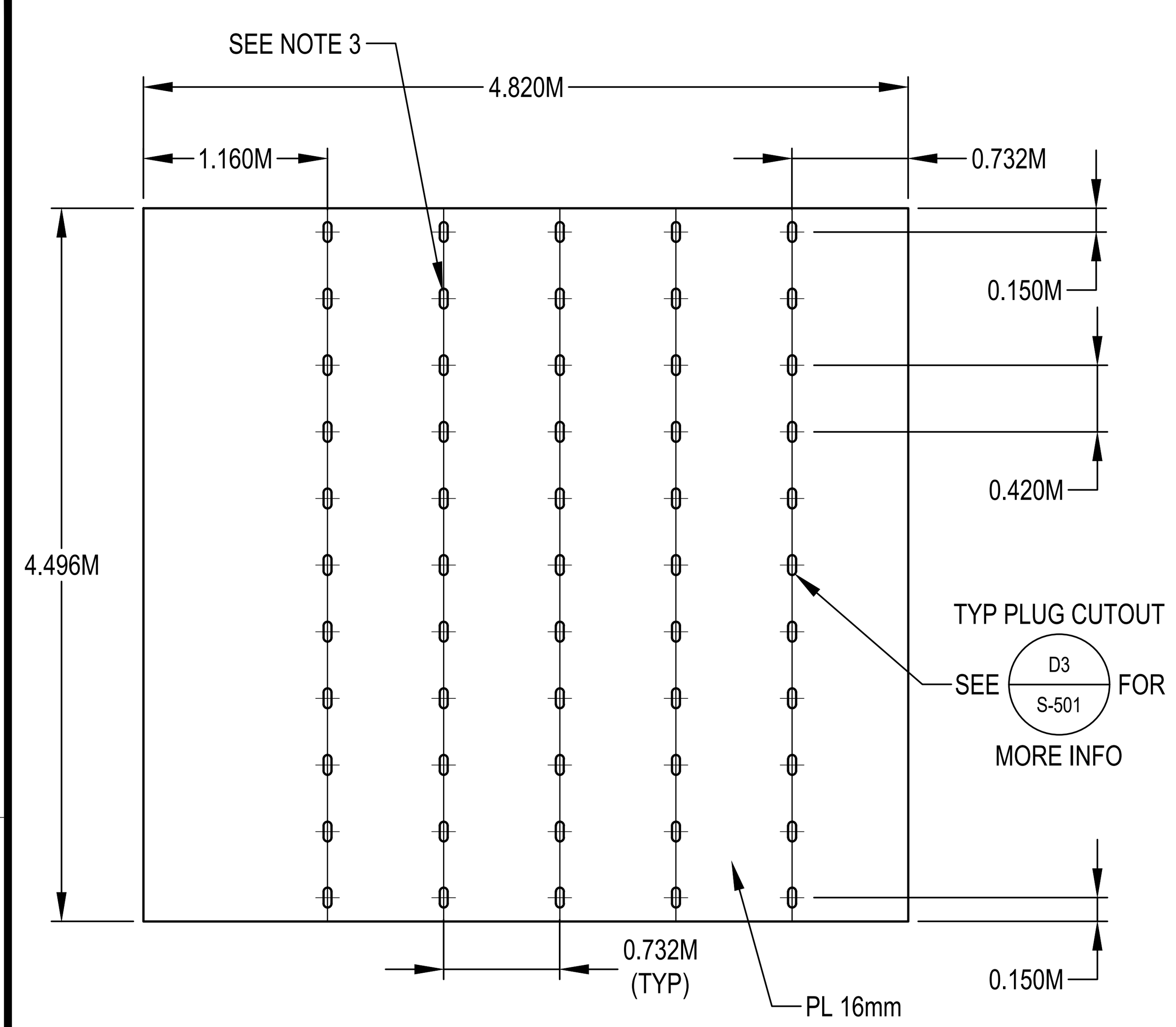
PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN
DRAWING TITLE: DETAIL - INBOARD LONGITUDINAL - DOUBLER PLATE

SCALE: AS NOTED
PROJECT NO.: 4396-D
CONSTR. CONTR. NO.

SHEET 17 OF 20
S-106

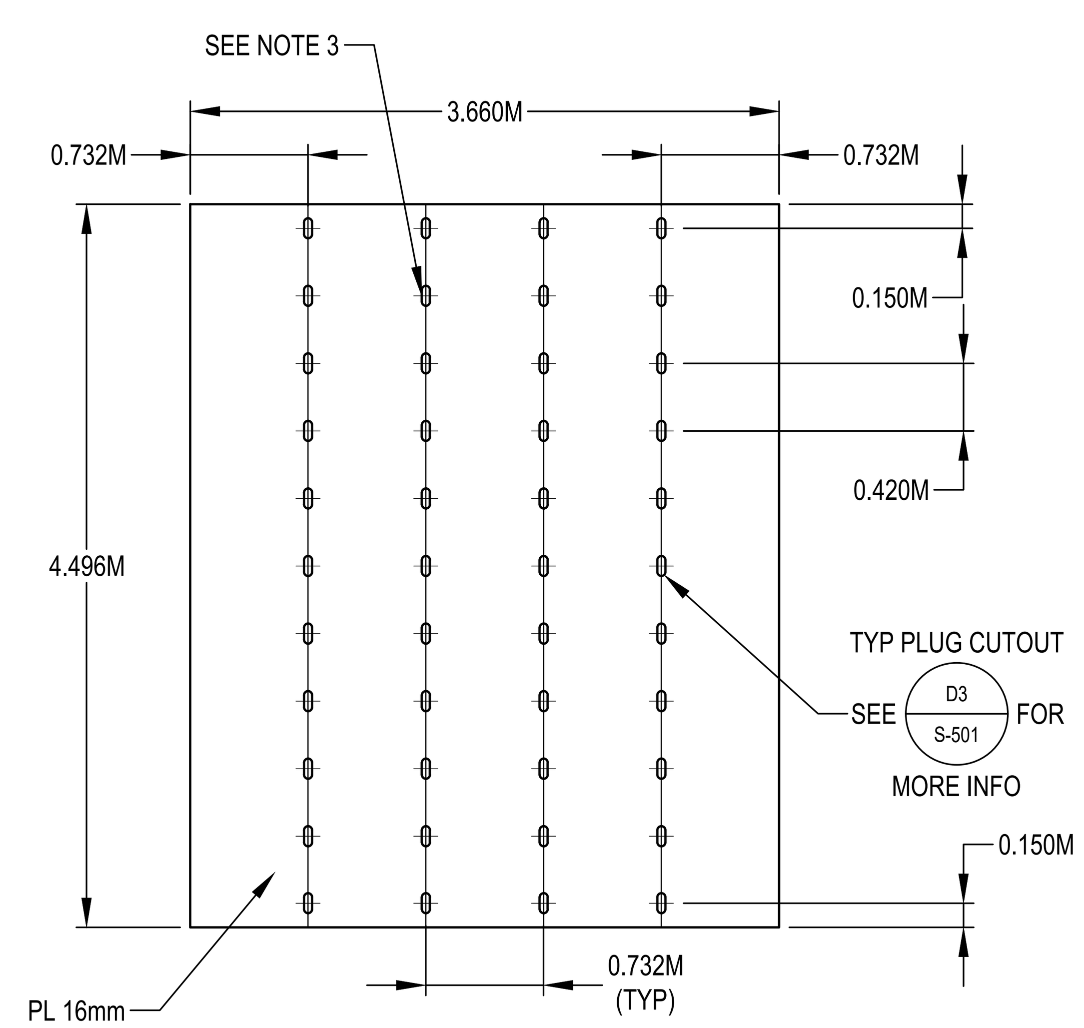
DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING



DETAIL - PORT AFT P.D. DBLR

C1

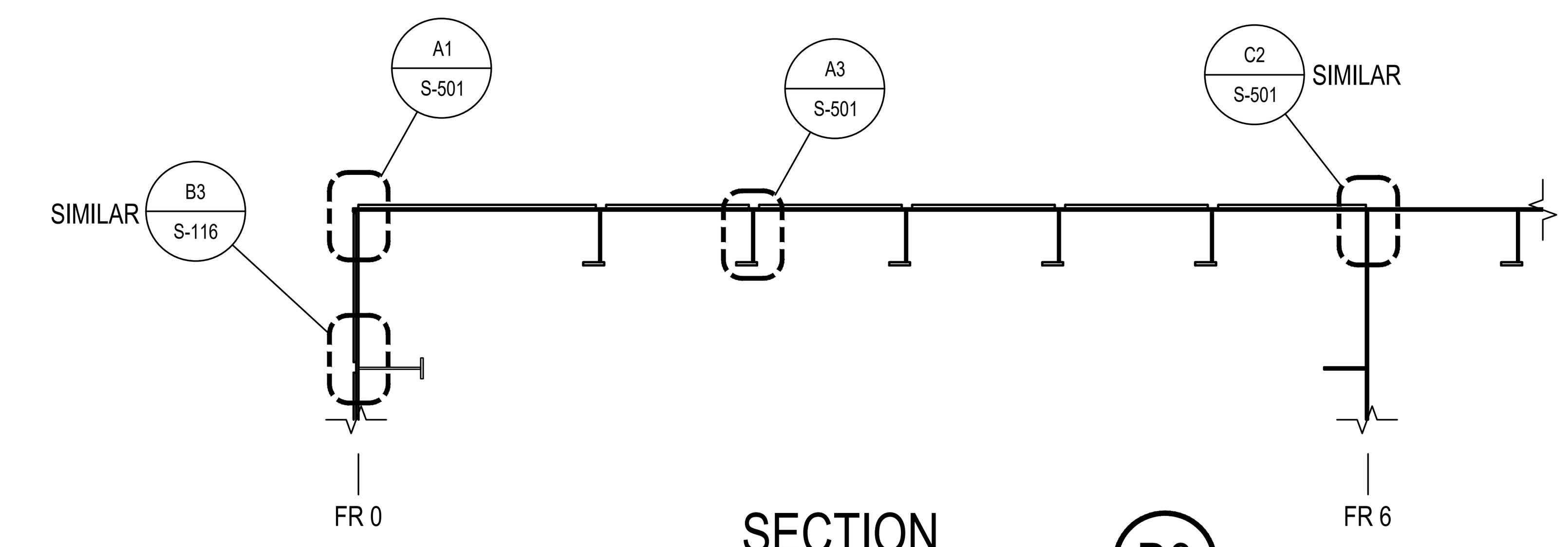
SCALE 1 : 40 A-126
SEE NOTES 1 & 2



DETAIL - TYP SALLY PORT DBLR

C2

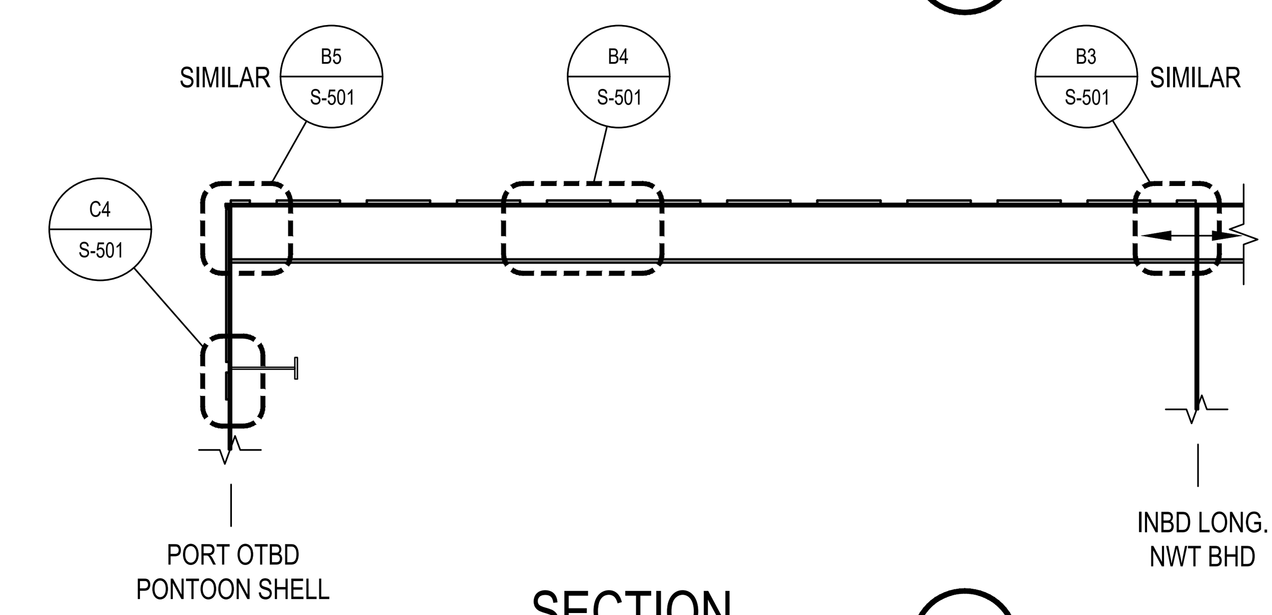
SCALE 1 : 40 A-126
SEE NOTE 1 & 2



SECTION

D3

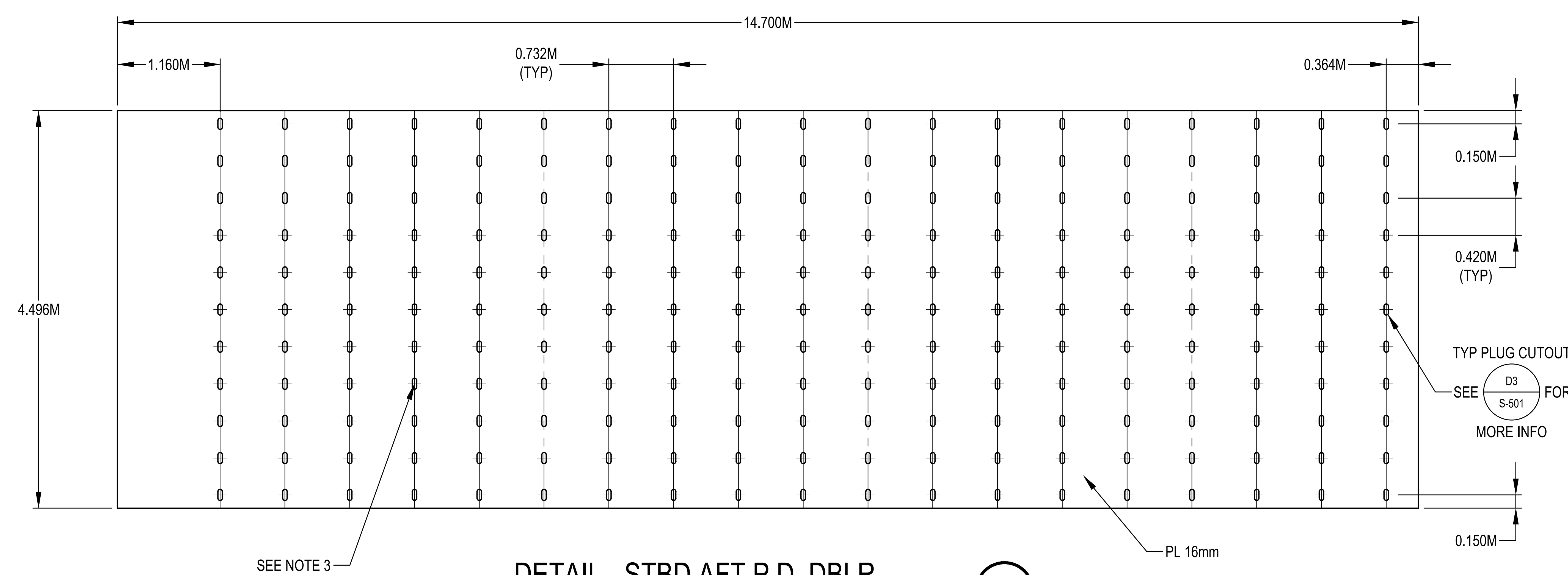
SCALE 1 : 30 A-126



SECTION

C3

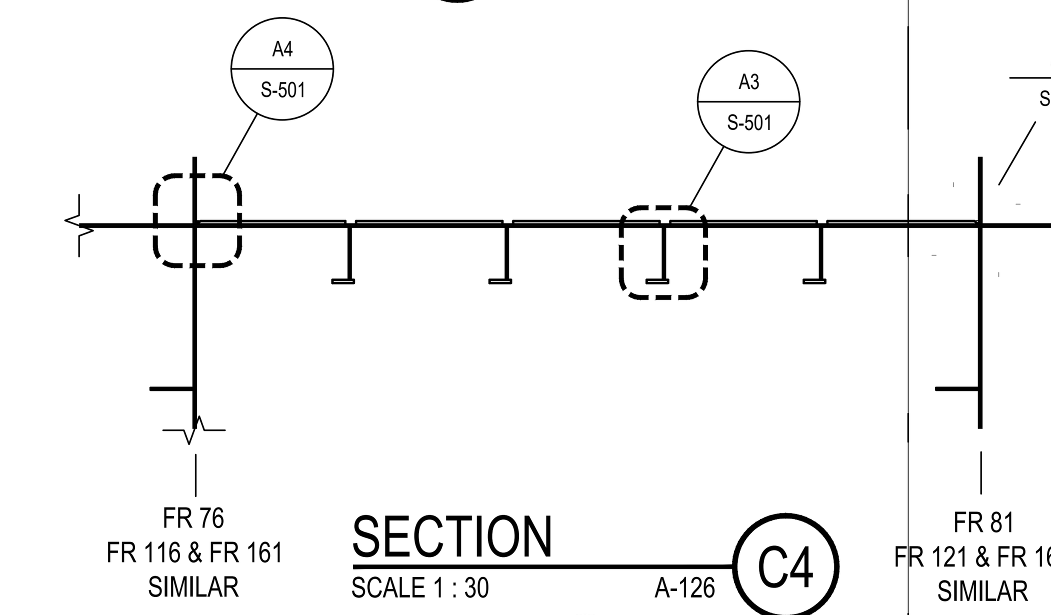
SCALE 1 : 30 A-126



DETAIL - STBD AFT P.D. DBLR

B1

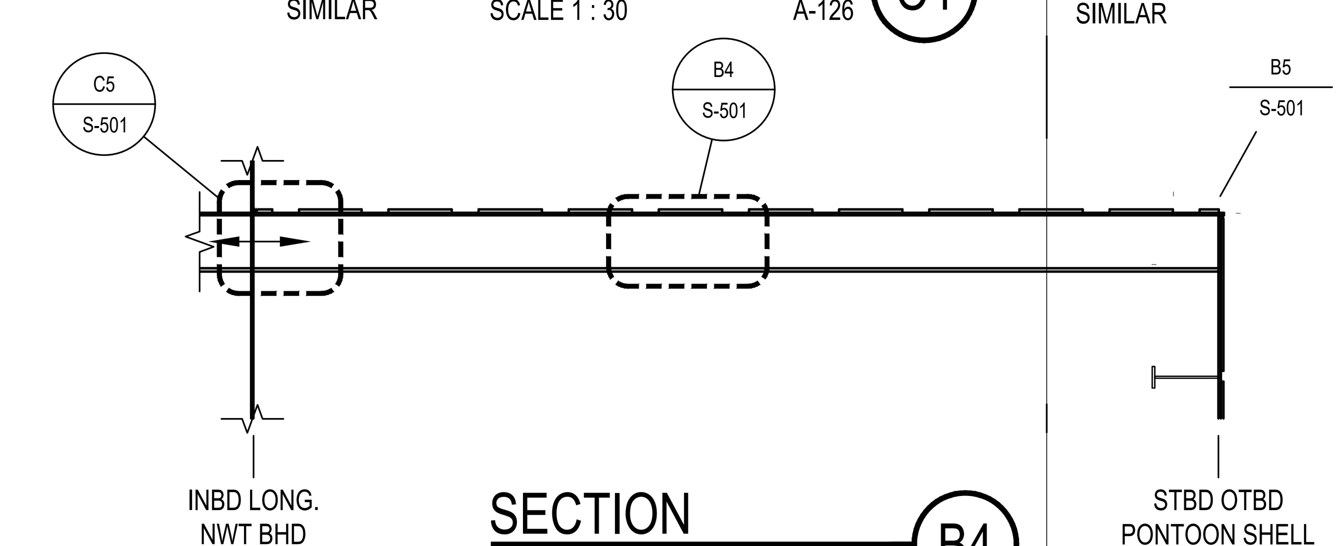
SCALE 1 : 40 A-126
SEE NOTES 1 & 2



SECTION

C4

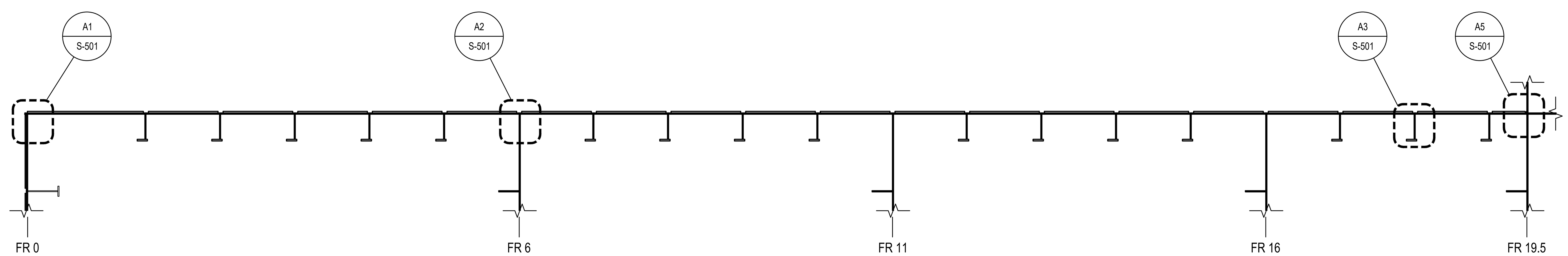
SCALE 1 : 30 A-126



SECTION

B4

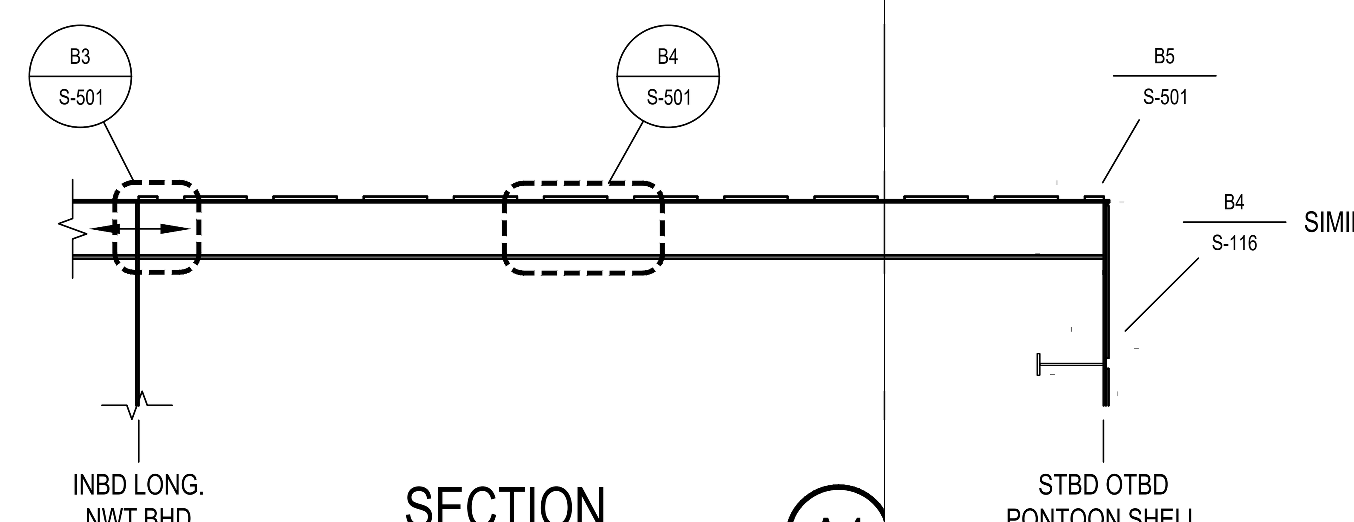
SCALE 1 : 30 A-126
STBD SHOWN, PORT SIMILAR



SECTION

A1

SCALE 1 : 30 A-126



SECTION

A4

SCALE 1 : 30 A-126

NOTES:

1. PONTOON DECK DOUBLER PLATE DIMENSIONS TO BE FIELD VERIFIED BEFORE INSTALLATION.
2. PONTOON DECK AND SALLY PORT DOUBLERS TO BE CUT TO FIT AROUND EXISTING FITTINGS AND EQUIPMENT.
3. AS REQUIRED FOR FABRICATION PURPOSES DUE TO PLATE SIZE LIMITATIONS, A TRANSVERSE LINE OF PLUG WELDS CAN BE REPLACED BY A CONTINUOUS 45° V-GROOVE WELD WITH A 6mm GAP. SEE VIEW B2 ON S-501 FOR WELD DETAIL.

ESTIMATED PLATE AREA:

PORT AFT P.D. (16mm PL)	233.6 FT²
STBD AFT P.D. (16mm PL)	711.4 FT²
SALLYPORTS (16mm PL)	1062.7 FT²

1 : 30 — 0, 500, 1000, 2000mm
1 : 40 — 0, 0.50, 1.000, 2.000M

SYM | DESCRIPTION | DATE | APPR

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DATE: 11-16-2021

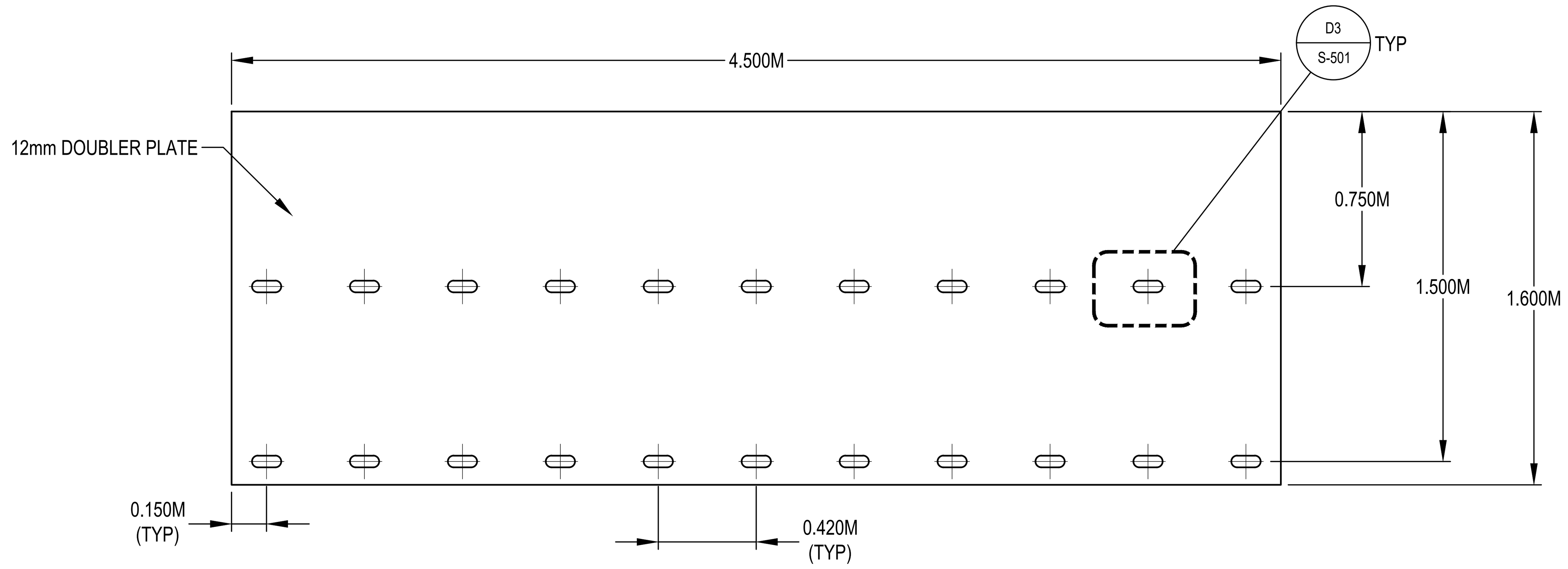
CLIENT NAME AND ADDRESS: NASSCO, SAN DIEGO, CALIFORNIA
PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN
DRAWING TITLE: DETAIL - PONTOON DECK

SCALE: AS NOTED
PROJECT NO.: 4396-D
CONSTR. CONTR. NO.
SHEET 18 OF 20

S-111

DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

1 2 3 4 5



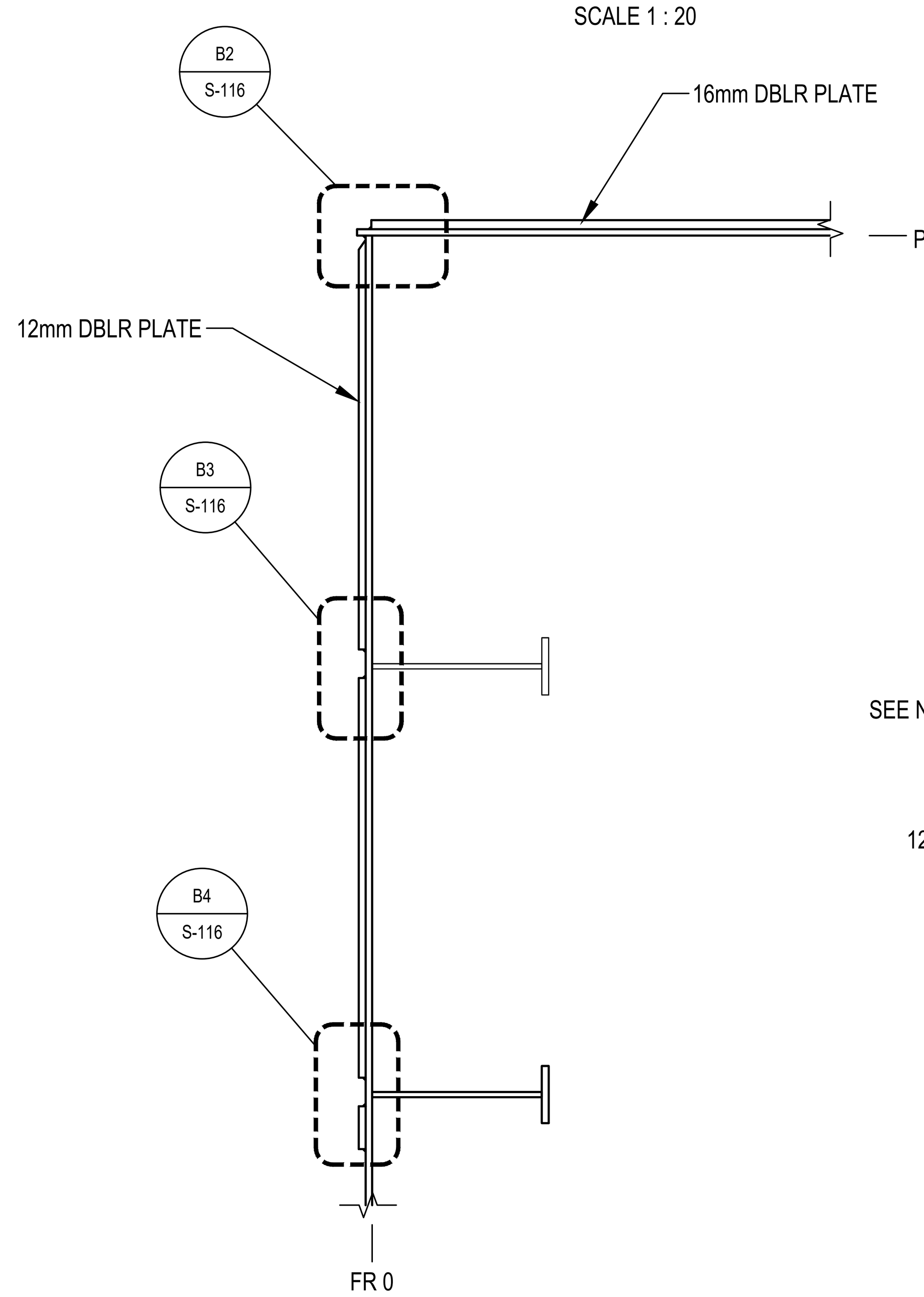
DETAIL - TYP FR 0 END BHD DBLR (D1)
SCALE 1 : 20 A-131

ESTIMATED PLATE AREA:

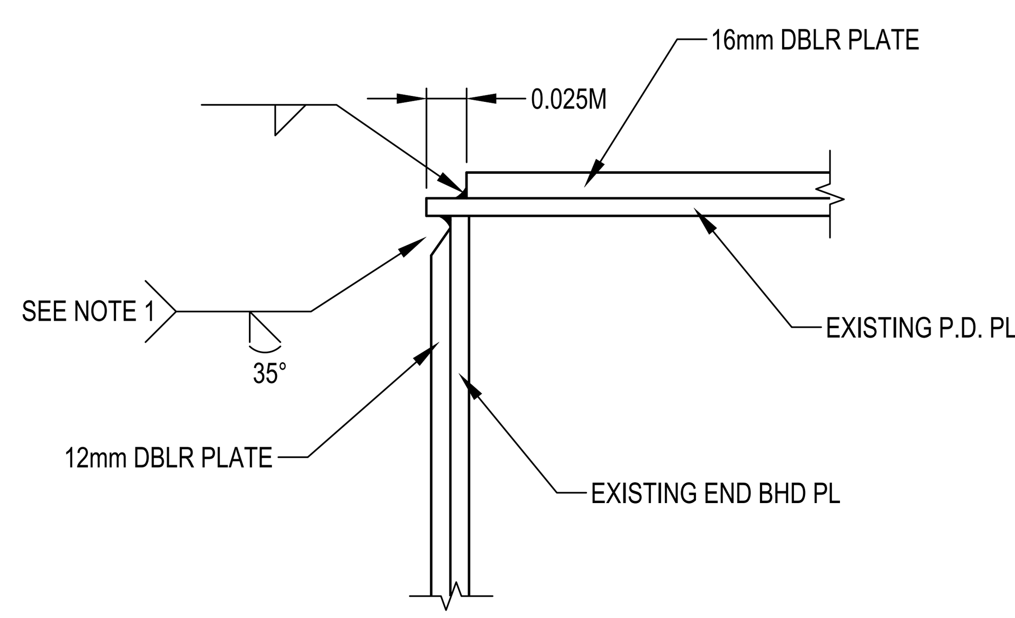
FR 0 - PORT (12mm PL)	77.5 FT²
FR 0 - STBD (12mm PL)	77.5 FT²

NOTES:

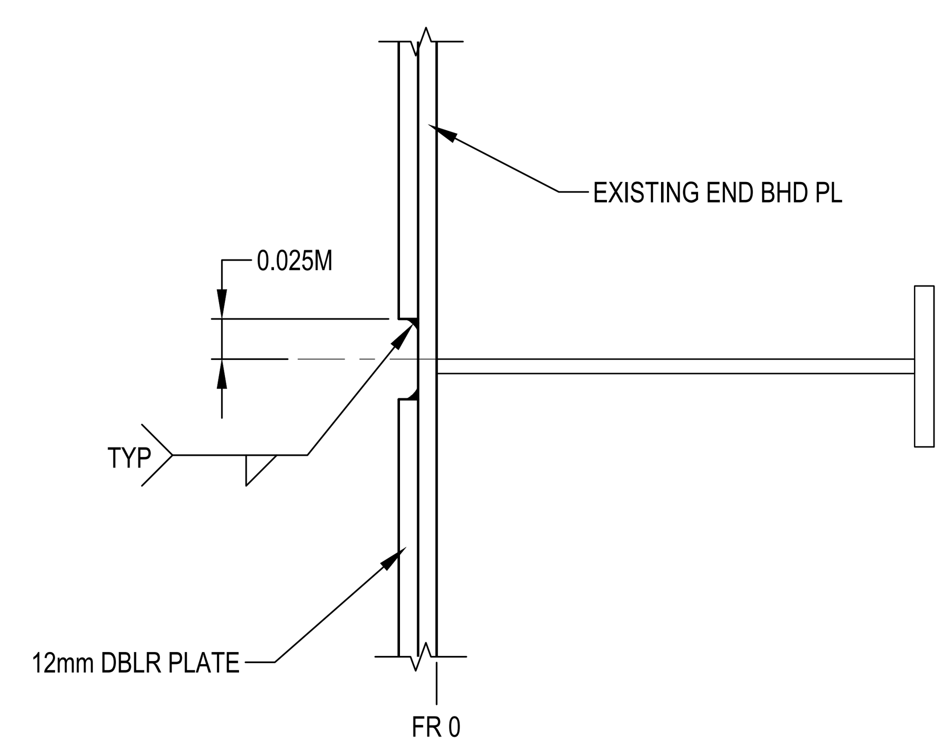
1. FOR FITMENT PURPOSES,WHEN A BEVEL WELD IS SPECIFIED IN WAY OF AN EXISTING FILLED WELD, THE DOUBLER PLATE IS TO BE HELD BACK TO THE TOES OF THE EXISTING WELD.



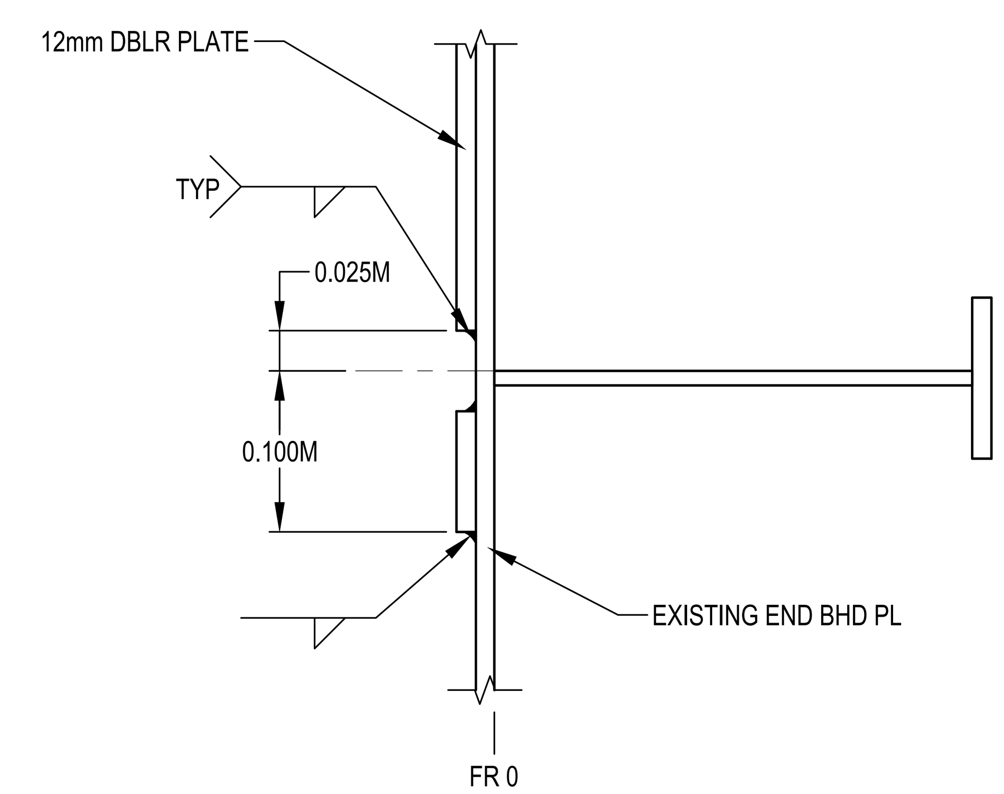
SECTION (B1)
SCALE 1 : 10 A-131



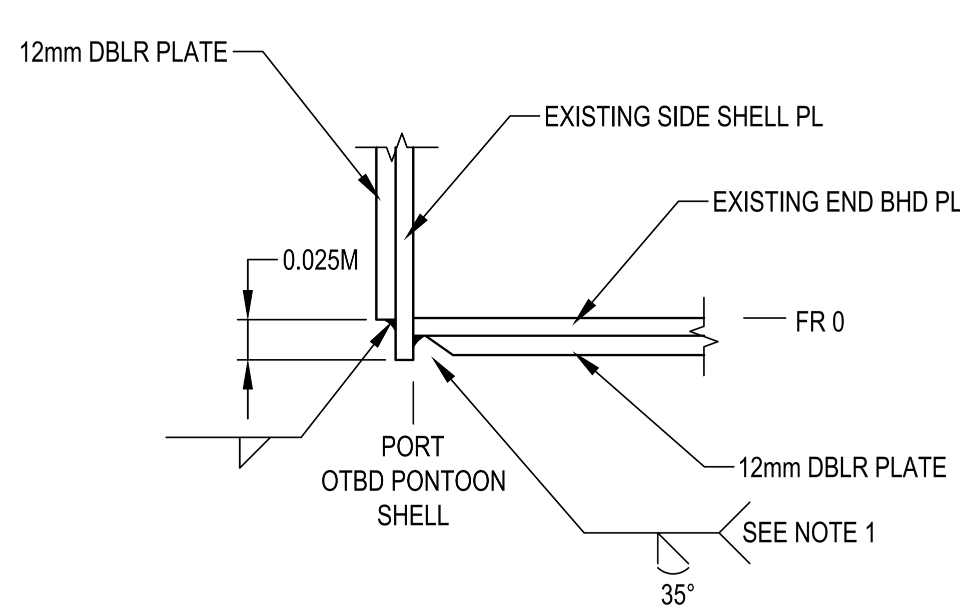
DETAIL (B2)
SCALE 1 : 4 S-116



DETAIL (B3)
SCALE 1 : 4 S-111, S-116



DETAIL (B4)
SCALE 1 : 4 S-111, S-116



SECTION (A2)
SCALE 1 : 4 A-131
PORT SHOWN, STBD SIMILAR

1 : 4 — 0, 100, 200mm
1 : 10 — 0, 100, 200, 600mm
1 : 20 — 0, 500, 1000mm

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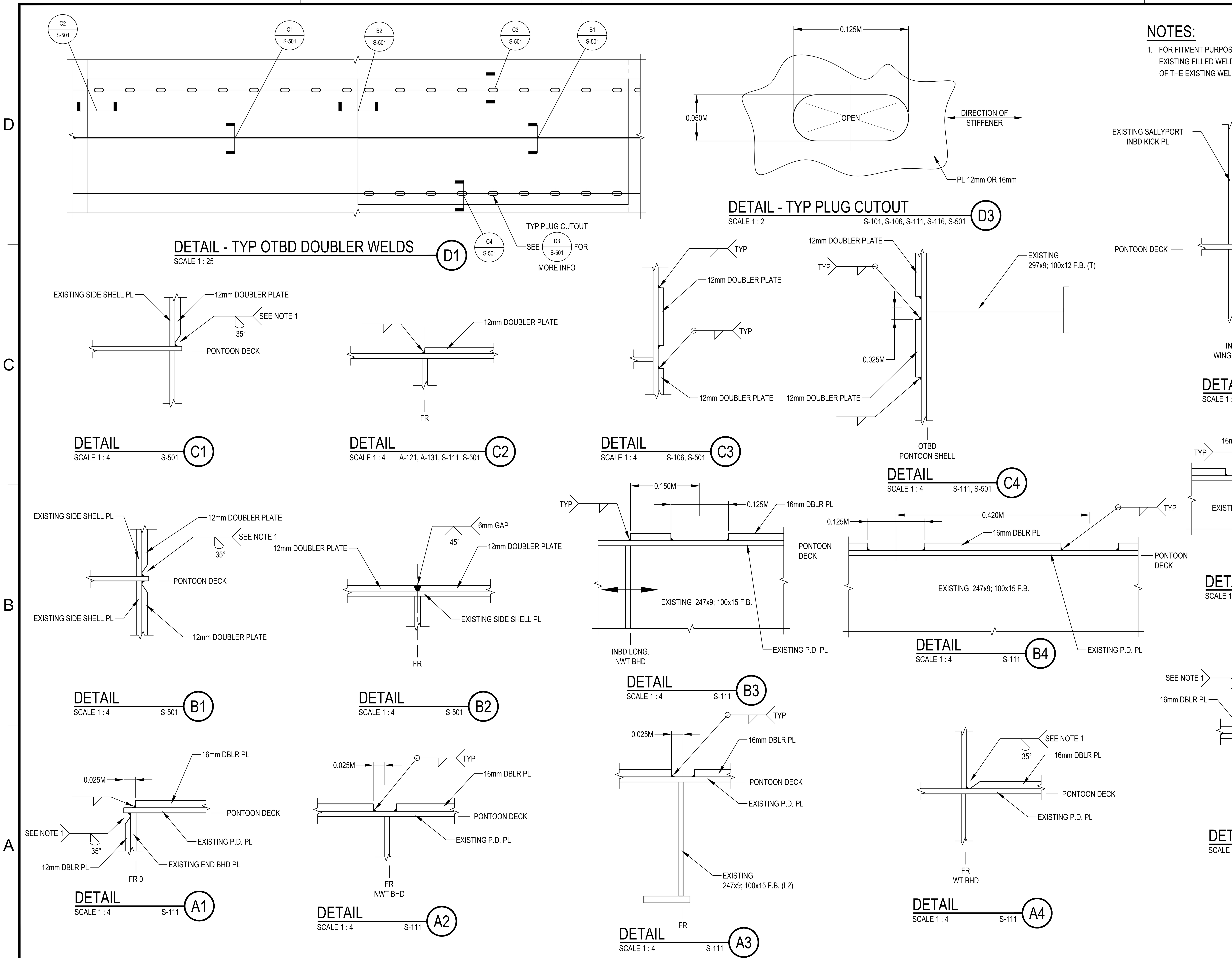
CLIENT NAME AND ADDRESS: NASSCO
SAN DIEGO, CALIFORNIA
PROJECT TITLE: BUILDER ANALYSIS & REPAIR PLAN
DRAWING TITLE: DETAIL - AFT TRANSVERSE END BHD - FR 0

SCALE: AS NOTED
PROJECT NO.: 4396-D
CONSTR. CONTR. NO.:

SHEET 19 OF 20
S-116

DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING



NOTES:

1. FOR FITMENT PURPOSES,WHEN A BEVEL WELD IS SPECIFIED IN WAY OF AN EXISTING FILLED WELD, THE DOUBLER PLATE IS TO BE HELD BACK TO THE TOES OF THE EXISTING WELD.

1 : 2 — 0, 50, 100mm
1 : 4 — 0, 100, 200mm
1 : 25 — 0, 0.25, 0.50, 1.000, 1.500M

HEGER DRY DOCK, Inc.
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DATE: 11-16-2021

NASSCO
SAN DIEGO, CALIFORNIA
BUILDER ANALYSIS & REPAIR PLAN
DETAIL - MISCELLANEOUS

SCALE: AS NOTED
PROJECT NO.: 4396-D
CONSTR. CONTR. NO.
SHEET 20 OF 20
S-501

DRAWING SCALES SHOWN BASED ON 34" x 22" DRAWING

Enclosure 3 - HEGER's Revised Operational Limitations Report

November 2021

Revised Operational Limitations of NASSCO's "BUILDER" Floating Dry Dock

Prepared For:

GENERAL DYNAMICS

Prepared By:

HEGER DRY DOCK, INC
Hopkinton, MA

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MICHAEL D. NAYLOR
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11/22/2021

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1.0 Scope

GENERAL DYNAMICS NASSCO has hired HEGER DRY DOCK INC (HDD) to perform an advanced engineering analysis of the "NASSCO BUILDER" steel floating dry dock located in San Diego, California.

The dock is currently NAVSEA certified at a rated capacity of 35,000 long tons. The aging dock, however, is nearly 40 years old and the pontoon deck is corroding at an accelerated rate. The corroding deck will ultimately require a downgrade in the dock's capacity unless major deck replacement is undertaken. Additionally, corrosion of the dock's watertight boundaries such as pontoon side shell and bottom may require a reduction in differential head pressure limitations.

HEGER's task was to:

A. Review recently conducted Ultrasonic Thickness (UT) measurement data and establish the current condition of the dock.

B. Evaluate the dock's structural capability in the event the pontoon deck continues to corrode and provide chart that correlates pontoon deck corrosion to structural keel line capacity.

C. Analyze the hull's watertight boundaries in support of hydrostatic head pressure loadings that are applied during the process of lifting the various vessels out of the water and provide guidelines for future head pressure limitations and corrosion allowances.

[redacted]

[redacted]

[redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

[redacted]

3.0 Description of Dock

The "NASSCO BUILDER" dry dock was originally constructed in 1983 in Japan by Kawasaki. The dock was originally designed as a 584' long by 170.6' wide dock with 24 ballast tanks and a lifting capacity of 25,000 long tons. The dock was designed with a keel line structural capacity of 60 LT/ft.

In 1998, the dry dock was lengthened at NASSCO's shipyard in San Diego, California. The dock was lengthened by cutting off the aft 98' and inserting a new 200' section constructed on site by NASSCO. The new 200' section was constructed out of higher strength steel (yield strength of 50 ksi versus the dock's original 36 ksi). During the lengthening, the aft 98' of the dock was strengthened by welding doubler plates to the pontoon deck and pontoon bottom along the transverse bulkheads near the dock's centerline. The lengthening work resulted in an increased pontoon length of 784' with the aft 298' having a rated keel line structural capacity of 84 LT/ft and forward 486' of original dock structure having a rated keel line structural capacity of 60 LT/ft. A plan view of the dock's current arrangement, with the various structural designs, is provided below.

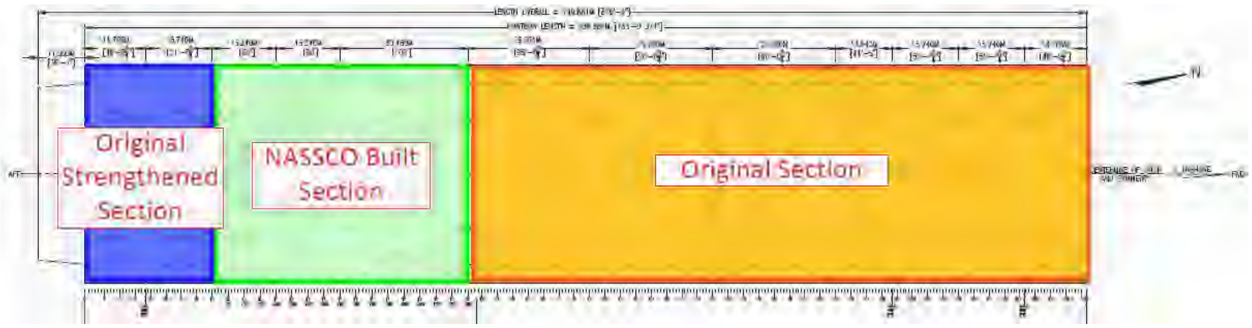


Figure 1 - Plan of NASSCO BUILDER, after 1998 modifications

The dock currently maintains NAVSEA certification for docking vessels displacing up to 35,000 LT.

4.0 Dry Dock Particulars

The dock's principal characteristics are as follows:

Year Built (at Japan)	1983
Year Lengthened (at NASSCO)	1998
Pontoon Length	784.0 FT
Pontoon Width	170.6 FT
Pontoon Height @ CL	17.2 FT
Clear width between fenders	135.7 FT
Available Water over Pontoon Deck	38.1 FT
Maximum Dock Draft	55.3 FT
Dock Light Weight (with blocks)	13,907 LT
NAVSEA Capacity (18" Freeboard)	35,000 LT

A general arrangement of the dock is attached in Appendix A.

5.0 Document Review

HEGER has reviewed the following documents related to the analysis:

1. [redacted]
5. UT gauging survey of BUILDER FDD dated 2020
6. Focused BUILDER UT survey dated 2021
7. NASSCO BUILDER – Facility Recertification Report dated December 1998

6.0 Exclusions

HEGER's review did not consider the following:

- Structural survey of the dock – structural or operational
  - HEGER's review is generally based on reported conditions and historic data from HEGER's 2016 control inspection survey. An on-site inspection of the dock was not included in the scope and hence not performed. The exception is the outboard shell of the dock which was visually surveyed by Michael Naylor P.E. and Preston Trudeau on October 20th, 2021.
- Vehicle loading on pontoon deck
  - HEGER does not know what type of vehicles are used on the dock for day-to-day activities or any vessel-specific lifts. This review does not evaluate the feasibility of usage of any vehicles on the deck i.e. forklifts, cranes, trucks etc.
- Keel block and side block loading
  - HEGER has not evaluated any vessel-specific block loading on the dock's CL or off-CL areas. Corrosion on the pontoon deck (and underneath structure) may impact block capacities or limitations to their placement.
- Longitudinal strength
  - HEGER has not reviewed the impact of corrosion on the dock's longitudinal strength. However, since the keel line loadings of design vessels evaluated in this report are lesser than dock's linear buoyant lift capacity [redacted], a properly engineered ballasting plan can minimize longitudinal stresses and keep deflections within limits.
- Structure in way of the wingwall cranes
  - HEGER has not evaluated the wing shell structure or the open-truss structure (at the ends of the wings), from a corrosion perspective, for impact to crane's capacities or travel restrictions.

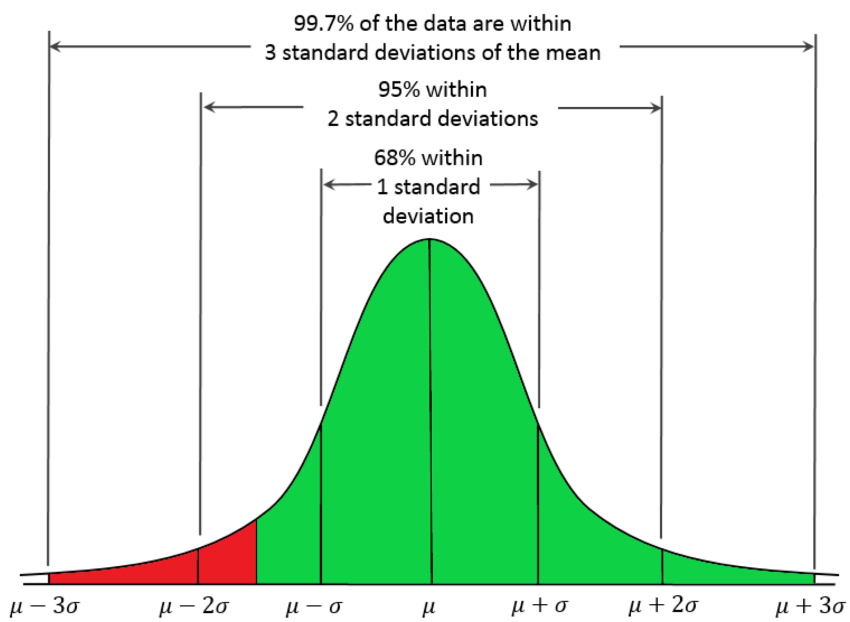
7.0 Major Notable Assumptions

The following are major notable assumption, made by HEGER, during the course of the engineering analysis that directly affect the results and findings:

1. Pontoon deck condition was determined on a section-by-section basis using statistical evaluation of all data collected within a respective section of the dock (i.e. NASSCO plug, Original, or Original Strengthened).

    a. The middle 80-ft of the dock was considered in the analysis. The areas further outboard are considered the "driving lanes" and do not contribute significantly to the structural keel line capacity of the dock. Much of the dock's driving lane was repaired in 2020 by installing doubler plates.

    b. For each section of dock, a representative thickness measurement was assumed to be 1.5 standard deviations below the mathematical mean of all data collected. This established a lower bound plating thickness for the deck plating over the section. The lower bound thickness was used to determine structural capacity of the section. Statistically, this means that 93% of the pontoon deck will be this thickness or greater (probably shown in green) while there may be some localized areas of the pontoon deck that will have corrosion slightly exceeding the assumed value (shown in red below).



2. [redacted]

[redacted]

4. The strength of the pontoon deck is governed by the compressive buckling capacity of the scantlings and associated plating. The buckling capacity limit was determined using the AISC Steel Construction Manual, Fifteenth edition (2017) and utilizes a safety factor of 1.67 against failure.

5. The corrosion levels of the typical dock structure (internal scantlings, pontoon plating, bulkheads, etc.) is assumed to be dependent on and progressive with the levels of corrosion in the pontoon deck:

    a. Pontoon Deck Corrosion of 0-10% = Typical corrosion level of 0%
    b. Pontoon Deck Corrosion of 11-20% = Typical corrosion level of 5%
    c. Pontoon Deck Corrosion of 21-30% = Typical corrosion level of 10%
    d. Pontoon Deck Corrosion of 31-40% = Typical corrosion level of 15%

6. NAVSEA typically limits wastage of a structural member to a maximum of 25% the original design thickness. Analysis assumes that it is OK to exceed a wastage level of 25% if the calculated stresses of the structure, under the maximum operational loading condition, are less than permissible limits.

8.0 Dry Dock Condition

In 2016, HEGER conducted a material condition survey of the dock in order to prepare a comprehensive overhaul specification for the dock. The inspection also satisfied the NAVSEA control inspection requirements. In 2016, HEGER inspections found that the dock was generally in good condition with the exception of the pontoon deck plating which was found to be dishing in the driving lanes and visually appear to be corroding.

8.1 Pontoon Deck – Condition

In review of the 2020 UT Survey, the pontoon deck plating thicknesses of the original dock sections were found to be 9-14% corroded near centerline (middle 80-ft). The driving lanes were notably worse with many areas reaching 25% corrosion. These corroded areas of driving lane, however, were repaired in 2020 by installing doubler plates to reinforce the deck. The plating thicknesses of newly built "NASSSCO" section were generally found to be intact with little to no loss of original thickness. A graphic of the lower bound pontoon deck thickness, as measured in 2020, is provided below on a section-by-section basis:

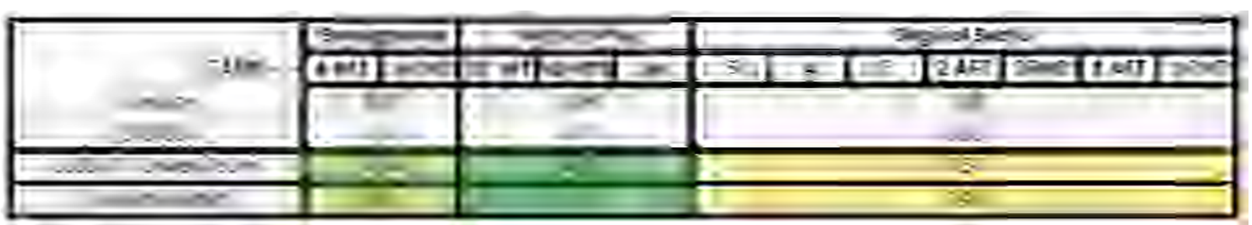


Figure 2 - Summary of 2020 Pontoon Deck Gauging

8.2 Pontoon Bottom – Condition

The 2020 UT survey was additionally used to determine the overall condition of the pontoon bottom. In general the pontoon bottom was found to be in good condition. The conditions of each section were as follows:

- NASSCO Section - The Pontoon Bottom plate on the NASSCO built section was found to be less than 5% corroded throughout its entirety.

- Strengthened Section - The Pontoon Bottom plate on the strengthened section was found to be generally less than 5% corroded with the exception of readings in way of FR 18.5 (44' Aft) which were approaching 10% corroded.

- Original Section - The Original Section was found to be in good condition with corrosion levels generally below 5%, with the exception of isolated areas where increased corrosion levels range from 6.4% to 18.6%.

8.3 Wing Shell – Condition

The 2020 UT data taken on the Inboard and Outboard wing shells was also analyzed in order to determine the global condition of the wing shells and wind water strakes. In general the wing shells were found to be in good condition with less than 5% corrosion, however exceptions were noted in isolated areas of the inboard and outboard wing shells. The condition of each section were as follows.

- NASSCO Section – Similar to the Pontoon Bottom the wing shell plating on the NASSCO built section was generally found to be in good condition and less than 5% corroded with the exception of a strip of plating on the Port OTBD Wing Shell, approx. 27-ft ABV baseline, which was found to be approaching 8% corrosion.

- Strengthened Section – In general the inboard and outboard wing shell plating, on the strengthened section, was found to be in a more deteriorated condition. The inboard and outboard shell plating both port and starboard were typically found to have isolated areas of increased corrosion in the upper half of the wing. Additionally, the port outboard wing shell was found to be in a more globally corroded condition at the aft end of the dock just below the wing deck. This areas was found to be approaching 8% wastage.

- Original Section - The Original Section was found to be in good condition with corrosion levels generally below 5%, with the exception of isolated areas where increased corrosion levels range from 6.4% to 18.6% on the inboard wing shells.

8.4 Internal Structure – Condition

HEGER also reviewed the 2018 UT survey conducted on internal structural members which generally indicated 5% corrosion on majority of the "typical" members in the pontoon.

8.5 2021 Wind Water Strake – Condition

NASSCO provided HEGER with an additional series of focused UT readings taken in 2021. The focused UT survey was conducted after moderate to heavy pitting was visually identified (by NASSCO, during recent operations) just above and below the pontoon deck level on the outboard shell of the dock. The UT data was collected in area that visually appeared to have deteriorated. In review of the collected measurements, wastage levels in the worst areas ranged from 25% to 60%.

9.0 Transverse Bending Strength

HEGER preformed principal stress calculations, assuming various levels of corrosion in the pontoon deck and other typical structural members, to evaluate how the structural capacity of the dock would be affected as the dock continues to corrode. Transverse bending strength of the dock in a Phase 3 and Phase 5 lifting condition were specifically investigated, as these phases in the docking evolution exert the maximum stress in the dock's structure.

The transverse bending calculations assume 100% of the vessel load is supported along the centerline of the dock. The vessel load is supported across the width of the dock using buoyant uplift force which puts the dock's pontoon into bending. The bending action subjects the pontoon deck structure to compression and the pontoon bottom structure to tension. The maximum allowable stress level in the dock is then typically governed by the buckling stress capacity of the pontoon deck plating and scantlings. Furthermore, the buckling strength of the pontoon deck reduces exponentially as the pontoon deck plating corrodes.

The "NASSCO BUILDER" dock has three different structural designs which were individually investigated for structural capacity:

- Original design – as designed and constructed by Kawasaki in Japan in 1983
- NASSCO Section – as designed and constructed by NASSCO in San Diego in 1998
- Strengthened design – as designed and constructed by Kawasaki but strengthened by NASSCO in 1998

The buckling strength of the various "NASSCO BUILDER" pontoon structures, at various levels of corrosion, was determined using AISC Steel Construction Manual, Fifteenth edition (2017) which utilizes a safety factor of 1.67 against failure. Once the allowable buckling strength was determined, HEGER could then reverse engineer the applied load that would produce the maximum allowable stress level in the three different structural designs.

For each structural design, HEGER compiled a chart for recommended keel line loading capacity based on various levels of pontoon deck corrosion. The recommended keel line capacity ensures that the 1.67 factor of safety against failure is always maintained. The recommended limitations are represented graphically as shown in Figure 3, on the next page.

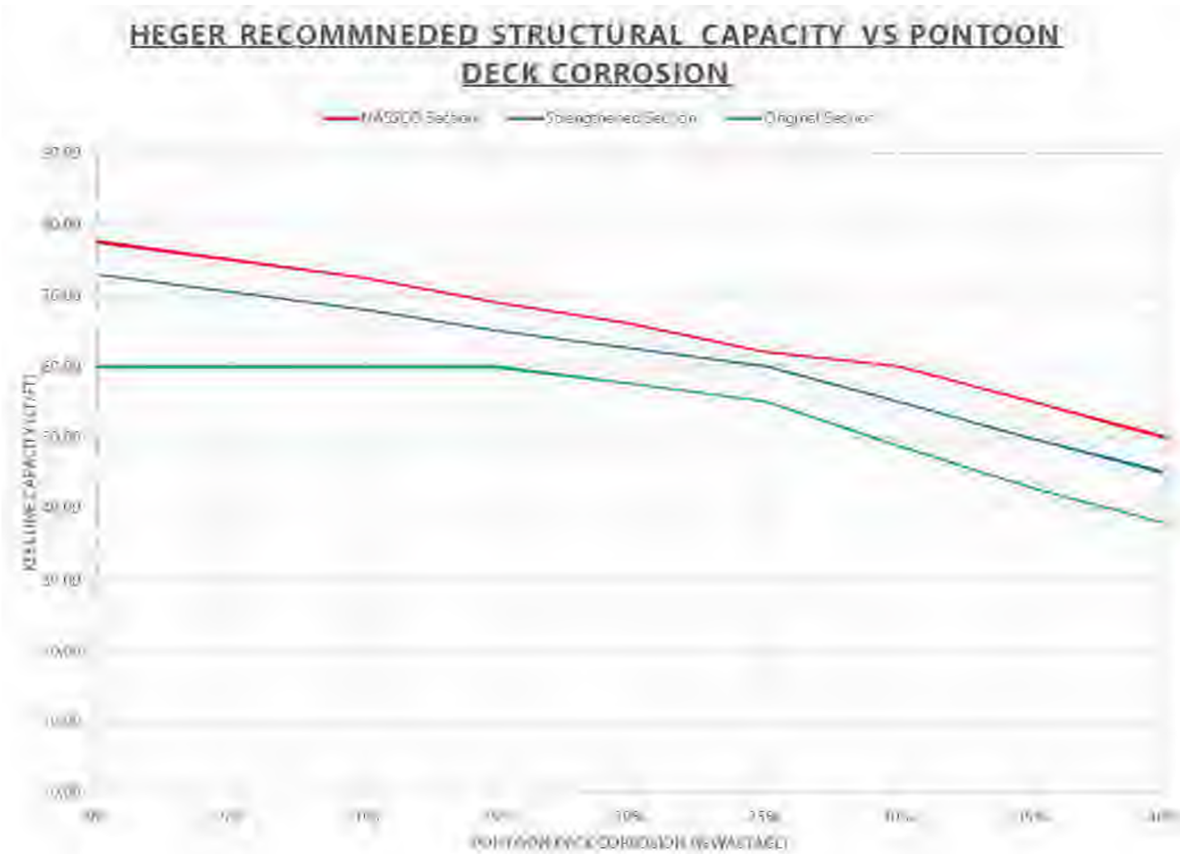


Figure 3 - Structural Capacity vs Pontoon Deck Corrosion

Sample detailed calculations used in the development of Figure 3 are attached in Appendix C, D, and E. The calculations provided, for each of the three different dock sections, is presented with corrosion assumptions which most closely represent the current condition.

Furthermore, the limitations indicated in Figure 3 were further validated by a detailed 3D Finite Element Analysis (FEA) of a typical dock frame. The “original” section and the “strengthened” section were specifically investigated as they represent the older and more corroded dock structure, relative to the newer “NASSO built” section. The findings of the FEA analysis, which include a VonMises stress evaluation against ABS permissible limits, support the keel line loading limitations provided in Figure . See Appendix F for more information.

NOTE: Appendix F also includes the investigation of the “strengthened” dock section, in its assumed current condition, loaded to the current certified keel line loading capacity of 84 LT/ft. In this loading condition, a large extent the dock structure near centerline was found to be in exceedance of permissible stresses with multiple areas reaching the yield point (i.e. permanent deformations and damage).

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

11.0 Allowable Head Pressures Evaluation

Through the process of lifting a vessel out of the water, a large hydrostatic force will be applied the dry dock's hull. As indicated in Table 1, a differential head pressure capacity of at least 28-ft is require to support the docking of [redacted] vessels. HEGER has conducted a study on how corrosion of the hull plating and underlying structure would affect the hull structure's ability to resist the required hydrostatic head pressure. The following structures were specifically investigated:

- Pontoon Deck – A common problem area for the dock as the plating typically corrodes at a significantly faster rate than the rest of the hull.

- Wind-Water Strake – This is the area generally defined as zone 5-ft above and 5-ft below the pontoon deck level. This areas is also a common problem area for docks as corrosion typically occurs at an above average rate than the rest of the hull.

- Pontoon Bottom – Typically not an area of high corrosion rate as the structure is generally always submerged on 2-sides and can be somewhat protect by marine growth and mud. The concern with the pontoon bottom is if corrosion does occur, in exceedance of repair criteria, dry docking is required to repair the structure which can be very expensive.

- Wing Walls – The lower portions of the wing walls are subjected to high hydrostatic head pressures during docking evolutions and corrosion of the structure may affect the capacity of the dock. The mid to upper portions of the wings, in way of the ballast tanks, while not subjected to substantial head pressure, typically see higher rates of corrosion due to high humidity in upper portions of ballast tanks and exposure to direct sun.

HEGER preformed principal stress calculations to evaluate the head pressure limitation on these structures for various combination of hull and stiffener corrosions. All head pressure calculations were completed in accordance with ABS and AISC standards and consider both the stiffener and attached plating. Head pressure limitations were validated with a local FEA evaluation. See Appendix G for additional information.

11.1 Pontoon Deck – Allowable Head Pressures

The original design capacity of the pontoon deck structure, in resistance to head pressure loadings, is 34-ft. The strength of the pontoon deck, in resistance to differential head pressure loadings, is controlled by the bending strength of the transverse scantlings until the original 16mm hull plating corrodes to a level of ~35%; at this point, the stress in the plating begins to control the head pressure limitation. The strength of the longitudinal was checked but does not control over plating or transverse stiffener strength.

The table below charts the allowable head pressure limitations for various combinations of plating and internal framing corrosion. Based on the chart and upholding a differential head pressure capacity of 28-ft, HEGER recommends a corrosion allowance of 35% on the pontoon deck plating and a corrosion allowance of 25% on the internal framing.

Table 2 - Pontoon Deck Allowable Head Pressures

		Stiffener/Girder Corrosion						
		0%	5%	10%	15%	20%	25%	30%
Plating Corrosion	0%	39.23	37.90	36.56	35.21	33.86	32.50	31.13
	5%	39.05	37.73	36.41	35.07	33.73	32.37	31.01
	10%	38.85	37.54	36.22	34.90	33.57	32.23	30.88
	15%	38.56	37.27	35.97	34.66	33.35	32.02	30.69
	20%	38.24	36.97	35.69	34.40	33.11	31.80	30.49
	25%	37.88	36.64	35.38	34.12	32.84	31.56	30.26
	30%	37.48	36.26	35.03	33.79	32.54	31.28	30.01
	35%	32.08	32.08	32.08	32.08	32.08	30.97	29.72
	40%	26.07	26.07	26.07	26.07	26.07	26.07	26.07

11.2 Wind and Water Strake – Allowable Head Pressures

The original design capacity of the wind and water strake structure, in resistance to head pressure loadings, is 34-ft. The strength of the structure, in resistance to differential head pressure loadings, was found to be controlled by the strength of the original 11mm hull plating. Furthermore, this area of the dock does not appear to be designed with any corrosion allowance and as the hull plating corrodes, the allowable head pressure capacity degrades exponentially from its original 34-ft capacity.

The table below charts the allowable head pressure limitations for various combinations of plating and internal framing corrosion. Based on the below chart, with some consideration given to the FEA results, HEGER recommends a corrosion allowance of 8% on the hull plating and a corrosion allowance of 25% on the internal framing for upholding a differential head pressure capacity of 28-ft.

Table 3 - Wind & Water Strake Allowable Head Pressures

		Stiffener Corrosion						
		0%	5%	10%	15%	20%	25%	30%
Plating Corrosion	0%	35.25	34.98	33.58	32.17	30.74	29.31	27.86
	5%	30.94	30.94	30.94	30.94	30.52	29.11	27.67
	10%	26.91	26.91	26.91	26.91	26.91	26.91	26.91
	15%	23.16	23.16	23.16	23.16	23.16	23.16	23.16
	20%	19.70	19.70	19.70	19.70	19.70	19.70	19.70
	25%	16.51	16.51	16.51	16.51	16.51	16.51	16.51
	30%	13.61	13.61	13.61	13.61	13.61	13.61	13.61
	35%	10.98	10.98	10.98	10.98	10.98	10.98	10.98
	40%	8.64	8.64	8.64	8.64	8.64	8.64	8.64

11.3 Pontoon Bottom – Allowable Head Pressures

The original design capacity of the pontoon bottom structure, in resistance to head pressure loadings, is 34-ft. The strength of the structure, in resistance to differential head pressure loadings, was found to be controlled by the strength of the original 11.5mm hull plating. Furthermore, this area of the dock does not appear to be designed with any corrosion allowance and as the hull plating corrodes, the allowable head pressure capacity degrades exponentially from its original 34-ft capacity.

The table below charts the allowable head pressure limitations for various combinations of plating and internal framing corrosion. Based on the below chart, with some consideration given to the FEA results, HEGER recommends a corrosion allowance of 8% on the 11.5mm hull plating and a corrosion allowance of 25% on the internal framing for upholding a differential head pressure capacity of 28-ft.

Table 4 - Pontoon Bottom Allowable Head Pressures

		Stiffener Corrosion						
		0%	5%	10%	15%	20%	25%	30%
Plating Corrosion	0%	34.64	34.64	34.64	34.64	34.64	34.64	34.64
	5%	30.45	30.45	30.45	30.45	30.45	30.45	30.45
	10%	26.53	26.53	26.53	26.53	26.53	26.53	26.53
	15%	22.88	22.88	22.88	22.88	22.88	22.88	22.88
	20%	19.50	19.50	19.50	19.50	19.50	19.50	19.50
	25%	16.39	16.39	16.39	16.39	16.39	16.39	16.39
	30%	13.56	13.56	13.56	13.56	13.56	13.56	13.56
	35%	10.99	10.99	10.99	10.99	10.99	10.99	10.99
	40%	8.69	8.69	8.69	8.69	8.69	8.69	8.69

NOTE: The ends of the original dock and the NASSCO built section of dock are designed with thicker 15mm and 16mm plating. In regards to head pressure capacity, this plating can corrode to 10.6mm (0.416 in), or ~30% for 15mm plate and ~35% for 16mm plate, before head pressure limitation become a concern.

11.4 Wing Shell – Allowable Head Pressures

Similarly to the Wind Water Strake, the original head pressure design capacity of the lower portions of the inboard and outboard wing shell was 34-ft. The head pressure was determined to be controlled by the 11mm and 10mm plating up the inboard and outboard wing walls. Both the stiffener spacing as well as the plating thickness itself varies as the height above baseline increases. As such, despite a plate panel being further above baseline an experiencing less effective head, the panel still has the possibility of controlling the system. Both the inboard and outboard wing shells original design does not appear to have taken corrosion allowance into consideration, and as such even a minor loss of plate thickness can affect the system's capacity.

Figure 5 below indicates the assumed downgraded head pressures on the wing shell, as well as the required plating thickness and allowable corrosion limit for each section of wing shell. The required head pressure capacities were determined through a combination of the requirements for the design vessel as well as the assumed pressures at max draft. HEGER recommends replacement of plate panels that exceed the below corrosion limits.

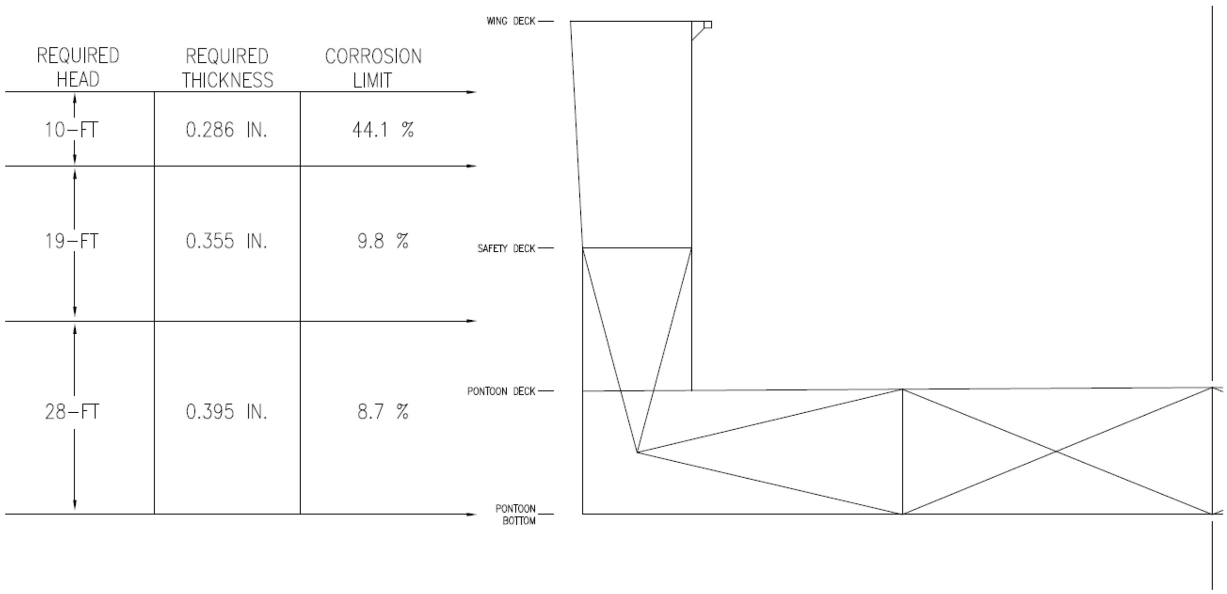


Figure 5 - Wing Shell Corrosion Allowance

Based on the above chart, with some consideration given to the FEA results, HEGER recommends a corrosion allowance of 8% on the hull plating and a corrosion allowance of 25% on the internal framing for upholding a differential head pressure capacity of 28-ft.

15.0 HEGER Recommendations

HEGER recommends the following path forward for maintaining future NAVSEA certification:

1. Based on HEGER's investigation and engineering calculations presented in this report, the dock's pontoon structure cannot safely support its current NAVSEA certified keel line loading capacity (see page 2 of Appendix F for more information).

    a. Submit to NAVSEA an engineering analysis package recommending the dock be certified for a keel line loading capacity depicted in Figure 4 of this report.

    b. Future certified capacities of the dock are recommended to be determined by comparing a statistical analysis of recently collected pontoon deck thickness measurements, on a section-by-section basis, against capacity chart provided in Figure 3 of this report.

2. Downgrade the dock's head pressure limitation from 34-ft to 28-ft and establish the below repair criteria for the hull plating. The provided minimum thicknesses are based on head pressure limitations only; pontoon bottom and pontoon deck plating requirements may be more stringent near centerline of the dock if a specific keel like loading capacity is required to be upheld.

    a. Pontoon bottom - minimum thickness = 10.6mm or 0.416 inches

    b. Pontoon deck - minimum thickness = 10.6mm or 0.416 inches

    c. Pontoon side shell (wind-water strake) - minimum thickness = 10.0mm or 0.395 inches

    d. Lower 9-ft of wingwalls (INBD & OTBD) - minimum thickness = 10.0mm or 0.395 inches

    e. Typical wingwall shell (INBD & OTBD) - minimum thickness = 9.0mm or 0.355 inches

3. Implement a maintenance plan for the following items:

    a. Conduct a detailed inspection of the outboard wind-water strake (i.e. 5-ft below the pontoon deck level to 5-ft above the pontoon deck level, along the outer wing shells and transverse end bulkheads) and the lower portions of the inner wing shell, specifically in way of the areas visually identified as having deep pitting, scaling, and localized corrosion. Investigate if the existing pitting and corrosion is within acceptable limits. If pitting or corrosion has been determined to be unacceptable, create a repair plan which may require clad welding localized pits, installing sufficient doubler plates, or cutting out corroded steel back to satisfactory steel thickness and inserting new plating. HEGER recommends repairing with thicker than designed plating to increase corrosion allowances.

b. Clean and preserve the outboard wind-water strake and lower portions of the inner wing shell in coordination with item #3a, above.

c. Continue to identify and repair local areas of corrosion. Localized corrosion areas shall be identified by routine visual inspection surveys and UT'd to determine if repairs are necessary (compare against limits listed in item #2). Accelerated localized corrosion is most likely to occur on the pontoon deck, along the wind-water strakes, and lower portions of the inner wing shells.

d. Inspect ballast tanks for areas of coating failures. Touch-up any small areas of coating failure. If coating failure becomes widespread, consider blast and paint repair of entire tank.

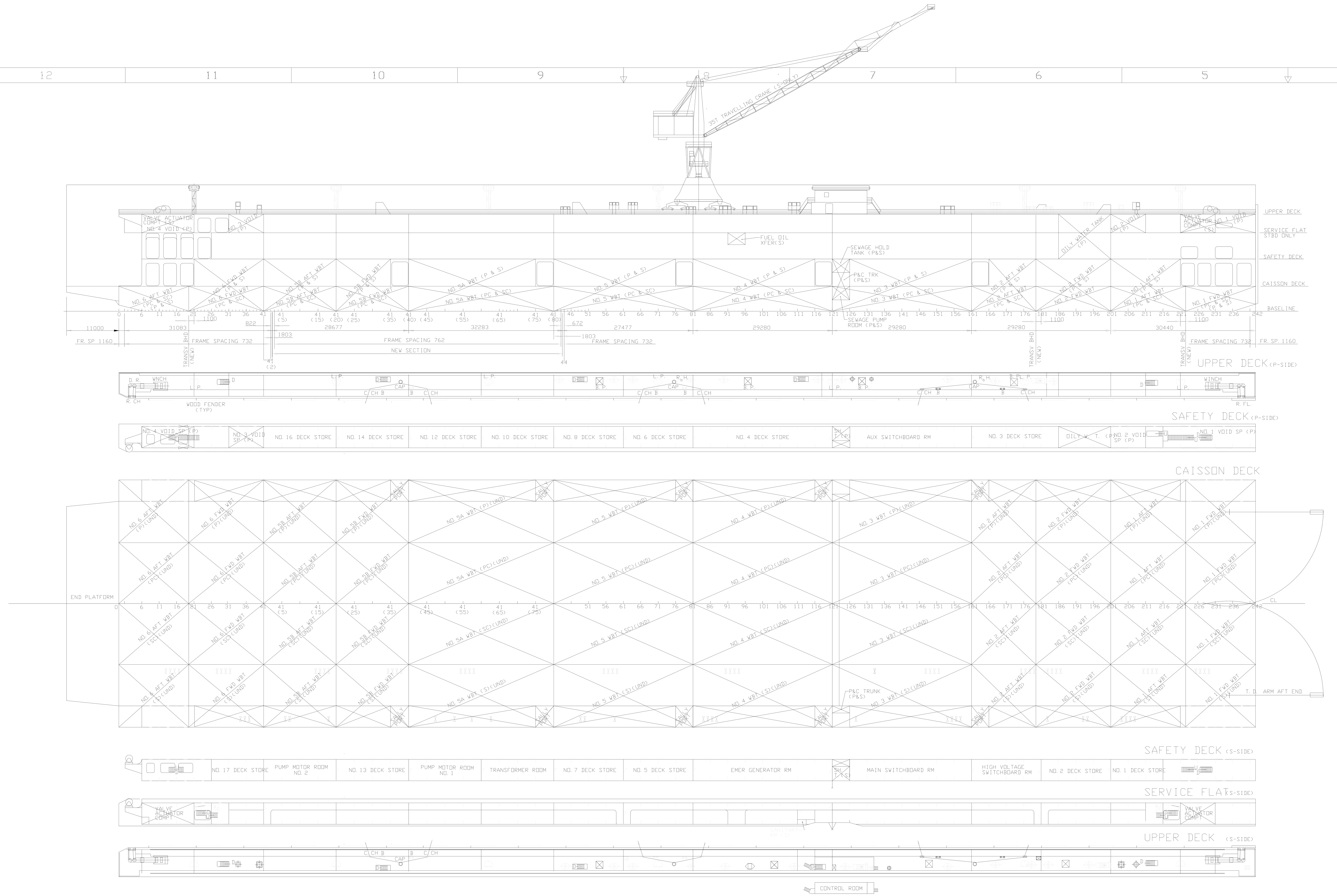
e. Continue to address any other deficiencies that arise from routine preventative maintenance inspections. This may include repairs to critical dock equipment such as ballasting system components and piping.

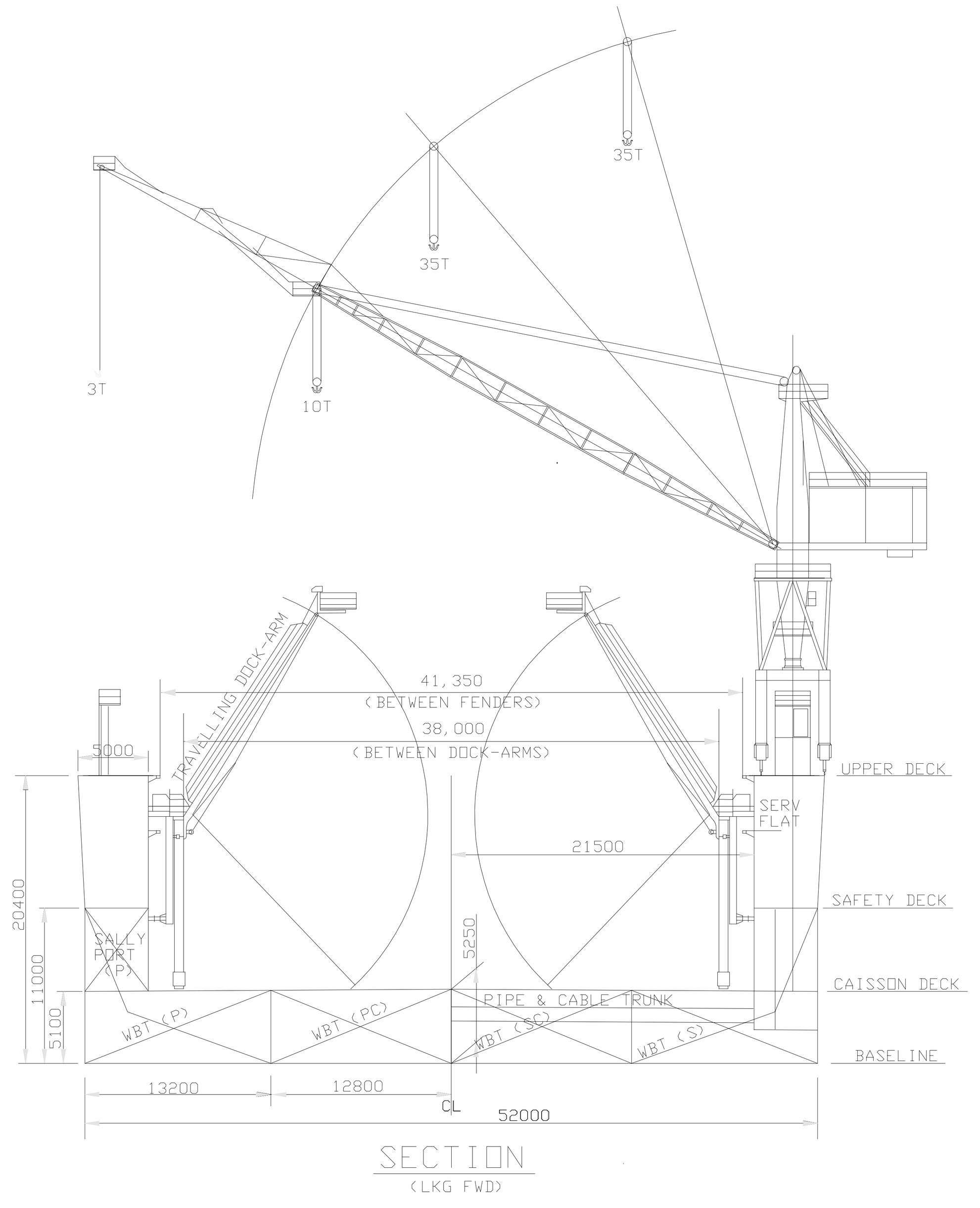
f. Once large areas of the pontoon deck plating reach corrosion levels of 25% wastage (or higher), a NAVSEA waiver may be required to justify certification without replacement. At this time, it may be necessary to implement a repair plan to crop and replace areas of the pontoon deck on an annual basis.

4. Continue to monitor the condition of the pontoon deck, wind-water strake, lower portions of the wing walls, and the pontoon bottom with periodic gauging surveys. Revise structural keel line capacity of the dock, based on results of pontoon deck survey, in accordance with Figure 3 of this report.

5. Coat the middle 80-ft of the pontoon deck with a robust coating system (such as Ceram-Kote) in an attempt to keep corrosion rates low and extend the remaining useful lift of the structure. The pontoon deck plating in the middle 80-ft of dock is the main driver in keel line structural capacity and corrosion in this area will drive requirements for dock capacity downgrades.

Appendix A - General Arrangement





SECTION
(LKG FWD)

PRINCIPAL DIMENSIONS:

LENGTH OVERALL	249.96 M
LENGTH OVER CAISSON (MLD)	238.96 M
BREADTH OVER SIDE WALLS AT CAISSON DK/UPPER DK (MLD)	52.00 M/53.00 M
WIDTH BETWEEN INNER WALLS (MLD)	43.00 M
DEPTH (MLD) (BASE LINE TO UPPER DK)	20.40 M
CAISSON DEPTH(AT INNER WALL/AT CENTER) (MLD)	5.10 M/5.25 M
MAXIMUM AVAILABLE DRAFT (MLD)	16.85 M
WORKING DRAFT(MLD) FOR 33,530 – TONNE	4.64M

CLASSIFICATION A1 FLOATING DRY DOCK

REVISIONS

REV	ITEM	SH	ZONE	DESCRIPTION	DATE	APPROVED
A	1	9-B 10-B		CHANGED NO. 15 DECK STORE TO PUMP MOTOR ROOM, NO. 11 DECK STORE TO PUMP MOTOR ROOM & NO. 9 DECK STORE TO TRANSFORMER RM ON SAFETY DK STBD SIDE.		
	2	5-A 11-A		CHANGED VOIDS TO FWD & AFT VALVE ACTUATOR COMPTS ON SERVICE FLAT STBD SIDE.		
	3	VAR		OUTBD PROFILE, INDICATED TRANSV BHD (NEW) AT 1100 AFT FR. 21 &181, ALSO 1100 FWD FR. 221.		
	4	9-F 11-F		CHANGED LOCATION OF NEW SECTION FROM 1800 TO 1803 FWD OF FR. 41 & FROM 1800 TO 1803 FWD FR. 41(80).		
	5	9-F 10-F		CHANGED LOCATION OF NEW SECTION FWD OF FR. 1 FROM 30440 TO 31083 AND AFT OF BHD FR. 81 FROM 29280 TO 27477		
B	1	3-H		ADDED PRINCIPAL DIMENSIONS TO DWG.		

NO DEVIATION SHALL BE MADE BY PRODUCTION SHOPS IN ANY DIMENSION OR SUBSTITUTION OF MATERIAL WITHOUT PRIOR DESIGN DIVISION APPROVAL.

SUBMITTED TO	SUBMIT DATE	APPROVAL DATE
U. S. P. H. S.		
U. S. C. G.		
A. B. S.		

DRAWING APPROVAL

CONTRACT NUMBER:

NASSCO NATIONAL STEEL AND SHIPBUILDING COMPANY
SAN DIEGO, CA 92138

DESIGNED	W. BLEAKLEY	10/23/97
CHECKED	B. BOSE	10/23/97
APPROVED	A. DAVIDSON	10/23/97

APPROVED DATE

APPROVED DATE

NASSCO BUILDER

GENERAL ARRANGEMENT
(AFTER LENGTHENING)

NASSCO DRAWING NUMBER
H 460-341-7008 B

SCALE: 1:250 SHEET 1 OF 1

Appendix C – Original Section Transverse Bending Calculations

HEGER DRY DOCK, Inc.

HOPKTINTON, MASSACHUSETS

File Name : **Tranvs Bend - Origin**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Environment Conditions

Specific Gravity =	1.0250			
=	35.02	ft^3/LT	0.98	M^3/MT

Floating Dock Dimensions

Pontoon Length =	783.07	ft	238.681	M
Pontoon Width =	170.60	ft	52.000	M
Wing Length =	783.07	ft	238.681	M
Wing Width =	14.75	ft	4.496	M
Pontoon Height @ CL =	17.22	ft	5.250	M
Pontoon Height @ Wing =	16.73	ft	5.100	M
Center Tanks Width =	41.99	ft	12.800	M
Wing Tanks Width =	43.31	ft	13.200	M

Floating Dock Characteristics

Structural Capacity =	60.00	LT/ft	200.05	MT/M	
Keel Block Hieght =	6.00	ft	1.830	M	
Estimated Dock Light Weight =	17,328	LT	17,603	MT	[From FRR]
Estimated Pontoon Weight =	9,496	LT	9,646	MT	
=	0.159	Kips/ft^2			
Estimated Wing Wieght =	7,832	LT	7,957	MT	
=	5.60	Kip/ft per shell			
Ballast Tank Permeability =	0.985				

Phase 3 Lifting Conditions

Dock Draft =	23.23	ft	7.080	M		
Buoyancy Under Wing =	1.49	Kips/ft^2				
Buoyancy Under Pontoon =	1.09	Kips/ft^2				
Ballast Water in Starboard Wing Tank =	1.22	ft	0.371	M	0.08	Kips/ft^2
Ballast Water in Starboard Center Tank =	1.22	ft	0.371	M	0.08	Kips/ft^2
Ballast Water in Port Center Tank =	1.22	ft	0.371	M	0.08	Kips/ft^2
Ballast Water in Port Wing Tank =	1.22	ft	0.371	M	0.08	Kips/ft^2

Phase 3 Forces Per Length of Dock

Buoyancy Under Starboard Wing =	21.91	Kips
Buoyancy Under Port Wing =	21.91	Kips
Buoyancy Under Pontoon =	153.23	Kips
Starboard Wing Weight =	-11.20	Kips
Port Wing Weight =	-11.20	Kips
Pontoon Weight =	-27.16	Kips
Ship Weight =	-134.40	Kips
Ballast Weight=	-13.09	Kips
Total =	0.00	Kips

Shear in Bulkheads Must Equal	0.00	Kips to Achieve Equilibrium
Number of Bulkheads =	4	
Shear Force/BHD =	0.00	Kips/BHD

Phase 5 Lifting Conditions

Dock Draft =	15.23 ft	4.643 M	
Freboard =	1.50 ft	0.457 M	
Buoyancy Under Wing =	0.97 Kips/ft^2		
Buoyancy Under Pontoon =	0.97 Kips/ft^2		
Ballast Water in Starboard Wing Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2
Ballast Water in Starboard Center Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2
Ballast Water in Port Center Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2
Ballast Water in Port Wing Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2

Phase 5 Forces Per Length of Dock

Buoyancy Under Starboard Wing =	14.37 Kips
Buoyancy Under Port Wing =	14.37 Kips
Buoyancy Under Pontoon =	137.47 Kips
Starboard Wing Weight =	-11.20 Kips
Port Wing Weight =	-11.20 Kips
Pontoon Weight =	-27.16 Kips
Ship Weight =	-134.40 Kips
Ballast Weight=	-10.75 Kips
Total =	-28.50 Kips

Shear in Bulkheads Must Equal	28.50 Kips to Achieve Equilibrium
Number of Bulkheads =	4
Shear Force/BHD =	7.13 Kips/BHD

HEGER DRY DOCK, Inc.

HOPKTINTON, MASSACHUSETS

File Name : **Tranvs Bend - Original**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

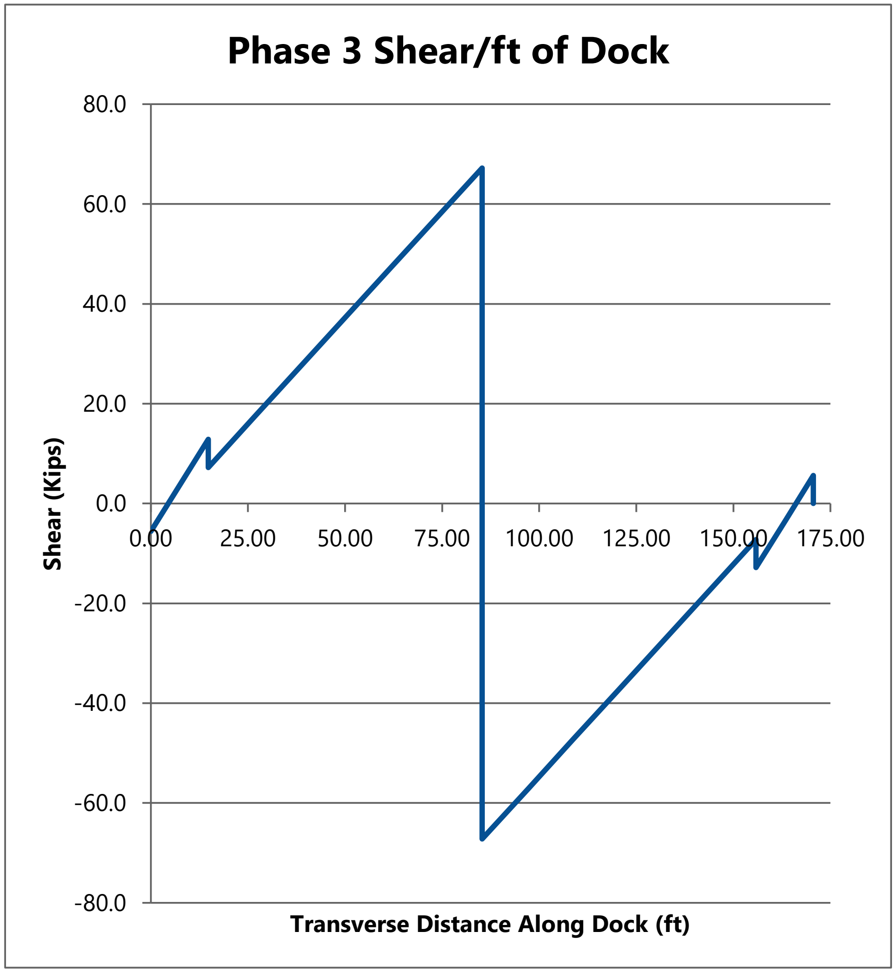
	Phase 3 Transverse Bending - Beam Theory									
Location	X (ft)	Dist. off CL (M)	Buoyancy (Kips)	Pontoon Wt. (Kips)	Ballast Wt. (Kips)	Wing Wt. (Kips)	BHD Shear (Kips)	Ship Wt. (Kips)	Shear (Kips)	Moment (Kip-ft)
Wing Shell	0.00	-26.00	1.49	-0.16	-0.08	-5.60	0.00	0.00	-5.6	0
Tank - Wing	7.38	-23.75	1.49	-0.16	-0.08	0.00	0.00	0.00	3.6	-7
Tank - Wing	14.75	-21.50	1.49	-0.16	-0.08	0.00	0.00	0.00	12.8	53
Wing Shell	14.75	-21.50	1.49	-0.16	-0.08	-5.60	0.00	0.00	7.2	53
Tank - Pontoon	26.51	-17.92	1.09	-0.16	-0.08	0.00	0.00	0.00	17.2	197
Tank - Pontoon	38.27	-14.34	1.09	-0.16	-0.08	0.00	0.00	0.00	27.2	458
Tank - Pontoon	50.03	-10.75	1.09	-0.16	-0.08	0.00	0.00	0.00	37.2	837
Tank - Pontoon	61.78	-7.17	1.09	-0.16	-0.08	0.00	0.00	0.00	47.2	1,334
Tank - Pontoon	73.29	-3.66	1.09	-0.16	-0.08	0.00	0.00	0.00	57.0	1,933
Tank - Pontoon	85.30	0.00	1.09	-0.16	-0.08	0.00	0.00	0.00	67.2	2,679
Centerline	85.30	0.00	1.09	-0.16	-0.08	0.00	0.00	-134.40	-67.2	2,679
Tank - Pontoon	97.31	3.66	1.09	-0.16	-0.08	0.00	0.00	0.00	-57.0	1,933
Tank - Pontoon	108.82	7.17	1.09	-0.16	-0.08	0.00	0.00	0.00	-47.2	1,334
Tank - Pontoon	120.58	10.75	1.09	-0.16	-0.08	0.00	0.00	0.00	-37.2	837
Tank - Pontoon	132.34	14.34	1.09	-0.16	-0.08	0.00	0.00	0.00	-27.2	458
Tank - Pontoon	144.09	17.92	1.09	-0.16	-0.08	0.00	0.00	0.00	-17.2	197
Tank - Pontoon	155.85	21.50	1.09	-0.16	-0.08	0.00	0.00	0.00	-7.2	53
Wing Shell	155.85	21.50	1.49	-0.16	-0.08	-5.60	0.00	0.00	-12.8	53
Tank - Wing	163.23	23.75	1.49	-0.16	-0.08	0.00	0.00	0.00	-3.6	-7
Tank - Wing	170.60	26.00	1.49	-0.16	-0.08	0.00	0.00	0.00	5.6	0
Wing Shell	170.60	26.00	1.49	-0.16	-0.08	-5.60	0.00	0.00	0.0	0

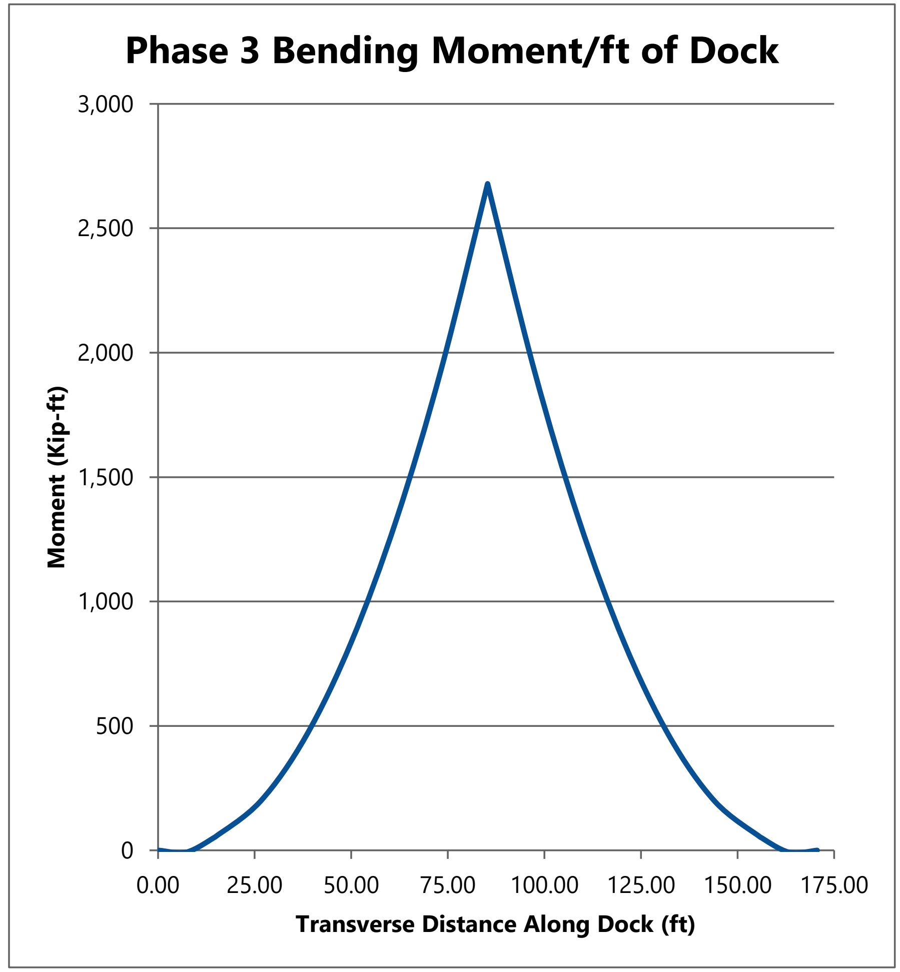
HEGER DRY DOCK, Inc.

HOPKTINTON, MASSACHUSETS

File Name : **Tranvs Bend - Original**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**





HEGER DRY DOCK, Inc.

HOPKTINTON, MASSACHUSETS

Client : **NASSCO - SAN DIEGO**

Subject : **FLOATING DRY DOCK "BUILDER"**

File Name : **Tranvs Bend - Original**

Done By : **M. Naylor**

Date : **8/17/2021**

Job No : **4386-D**

	Phase 5 Transverse Bending - Beam Theory									
Location	X (ft)	Dist. off CL (M)	Buoyancy (Kips)	Pontoon Wt. (Kips)	Ballast Wt. (Kips)	Wing Wt. (Kips)	BHD Shear (Kips)	Ship Wt. (Kips)	Shear (Kips)	Moment (Kip-ft)
Wing Shell	0.00	-26.00	0.97	-0.16	-0.06	-5.60	7.13	0.00	1.5	0
Tank - Wing	7.38	-23.75	0.97	-0.16	-0.06	0.00	0.00	0.00	7.1	32
Tank - Wing	14.75	-21.50	0.97	-0.16	-0.06	0.00	0.00	0.00	12.6	104
Wing Shell	14.75	-21.50	0.97	-0.16	-0.06	-5.60	7.13	0.00	14.1	104
Tank - Pontoon	26.51	-17.92	0.97	-0.16	-0.06	0.00	0.00	0.00	23.0	323
Tank - Pontoon	38.27	-14.34	0.97	-0.16	-0.06	0.00	0.00	0.00	31.8	645
Tank - Pontoon	50.03	-10.75	0.97	-0.16	-0.06	0.00	0.00	0.00	40.7	1,071
Tank - Pontoon	61.78	-7.17	0.97	-0.16	-0.06	0.00	0.00	0.00	49.5	1,601
Tank - Pontoon	73.29	-3.66	0.97	-0.16	-0.06	0.00	0.00	0.00	58.2	2,221
Tank - Pontoon	85.30	0.00	0.97	-0.16	-0.06	0.00	0.00	0.00	67.2	2,974
Centerline	85.30	0.00	0.97	-0.16	-0.06	0.00	0.00	-134.40	-67.2	2,974
Tank - Pontoon	97.31	3.66	0.97	-0.16	-0.06	0.00	0.00	0.00	-58.2	2,221
Tank - Pontoon	108.82	7.17	0.97	-0.16	-0.06	0.00	0.00	0.00	-49.5	1,601
Tank - Pontoon	120.58	10.75	0.97	-0.16	-0.06	0.00	0.00	0.00	-40.7	1,071
Tank - Pontoon	132.34	14.34	0.97	-0.16	-0.06	0.00	0.00	0.00	-31.8	645
Tank - Pontoon	144.09	17.92	0.97	-0.16	-0.06	0.00	0.00	0.00	-23.0	323
Tank - Pontoon	155.85	21.50	0.97	-0.16	-0.06	0.00	0.00	0.00	-14.1	104
Wing Shell	155.85	21.50	0.97	-0.16	-0.06	-5.60	7.13	0.00	-12.6	104
Tank - Wing	163.23	23.75	0.97	-0.16	-0.06	0.00	0.00	0.00	-7.1	32
Tank - Wing	170.60	26.00	0.97	-0.16	-0.06	0.00	0.00	0.00	-1.5	0
Wing Shell	170.60	26.00	0.97	-0.16	-0.06	-5.60	7.13	0.00	0.0	0

HEGER DRY DOCK, Inc.

HOPKTINTON, MASSACHUSETS

File Name : **Tranvs Bend - Original**

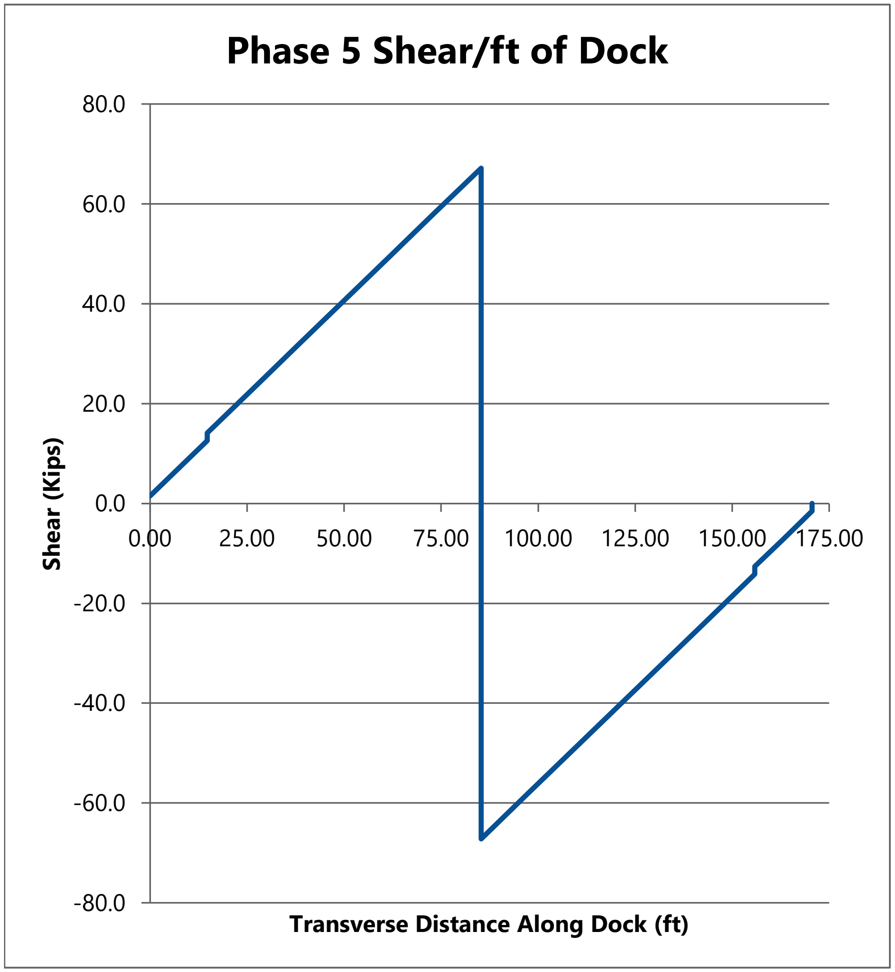
Done By : **M. Naylor**

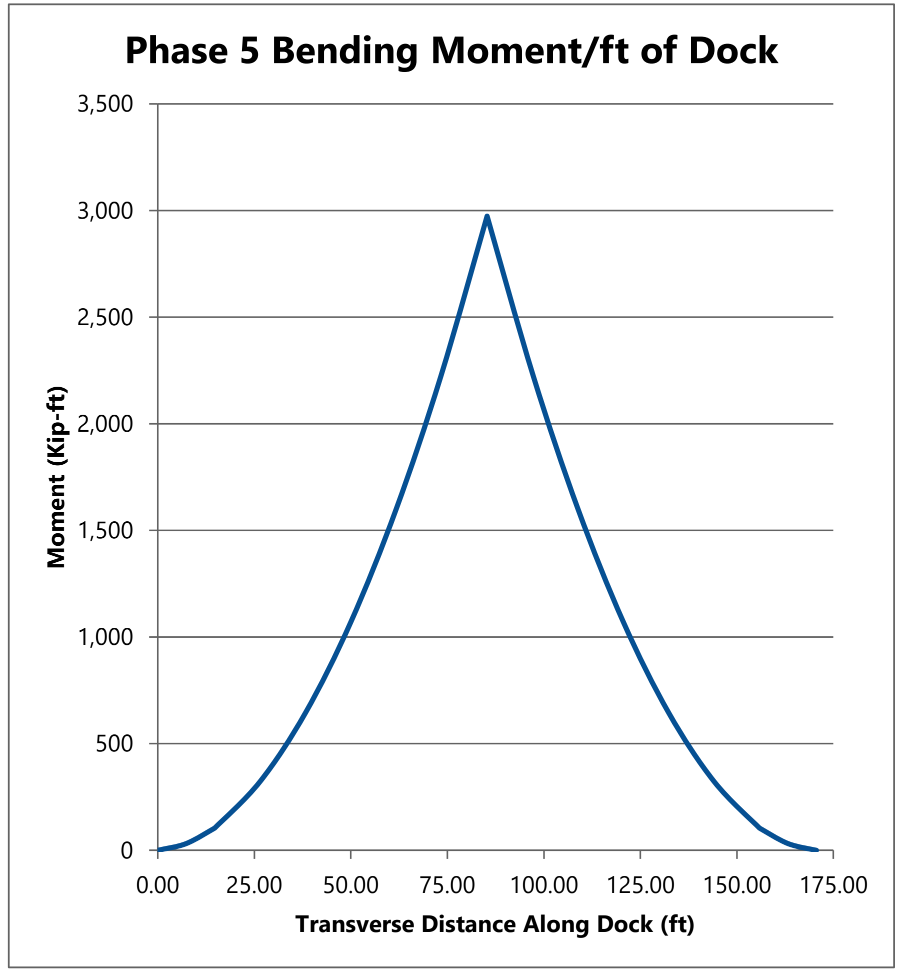
Date : **8/17/2021**

Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**

Subject : **FLOATING DRY DOCK "BUILDER"**





HEGER DRY DOCK, Inc.

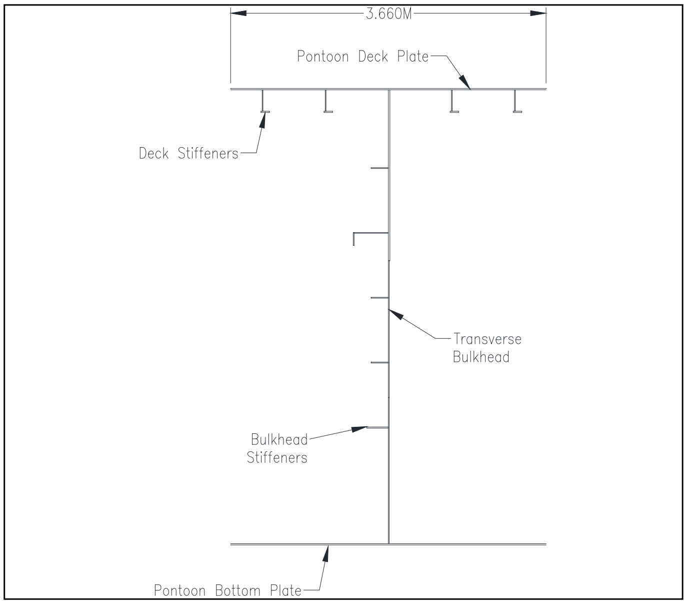
HOPKTINTON, MASSACHUSETS

File Name : **Tranvs Bend - Original**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Transverse Bulkhead Section Properties

Distance off CL = 0.00 ft 0.000 M
Frame Spacing = 12.01 ft 3.660 M



Transverse Section Properites									
Member	Orig. t (in)	Corr. (%)	t corr. (in)	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Deck Pl. 16mm	0.630	15%	0.535	77.15	206.96	15,968	92.35	658,042	2
BHD Pl. 18mm	0.709	5%	0.673	52.35	167.81	8,785	53.21	148,196	26,374
BHD Pl. 11mm	0.433	5%	0.411	25.67	97.74	2,509	-16.87	7,308	8,331
BHD Pl. 10mm	0.394	5%	0.374	24.89	33.27	828	-81.34	164,646	9,181
Bottom Pl. 15mm	0.591	5%	0.561	80.84	-0.28	-23	-114.89	1,067,037	2
(4) Deck Stiff - L 247x9+100x15	-	5%	-	21.93	199.75	4,380	85.15	158,957	244
BHD Stiff (1) - FB 250x114	-	5%	-	5.15	53.15	274	-61.46	19,466	0
BHD Stiff (2) - FB 200x10	-	5%	-	2.95	82.68	243	-31.93	3,003	0
BHD Stiff (3) - FB 200x10	-	5%	-	2.95	112.20	330	-2.40	17	0
BHD Stiff (4) - L 397x10+150x10	-	5%	-	8.05	141.73	1,142	27.12	5,926	0
BHD Stiff (5) - FB 200x10	-	5%	-	2.95	171.26	504	56.65	9,452	0
Totals				304.87		34,940		2,242,051	44,131

Depth of Section = 207.23 in 5.26 M
Neutral Axis = 114.61 in 2.91 M
Net Moment of Inertia = 2,286,182 in^4

y_{top} = 92.62 in y_{bottom} = 114.61 in
S_{top} = 24,683 in^3 S_{bottom} = 19,948 in^3

Shear Area = 102.91 in^2
Axial Area (top) = 142.34 in^2
Axial Area (bottom) = 118.56 in^2

HEGER DRY DOCK, Inc.

HOPKTINTON, MASSACHUSETS

File Name : **Tranvs Bend - Original**

Done By : **M. Naylor**

Date : **8/17/2021**

Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**

Subject : **FLOATING DRY DOCK "BUILDER"**

Pontoon Deck Stiffeners - Local Section Properties

L 247x9+100x15 on 0.63in Plate

Item	Original Dimensions	Corrosion (%)	Assumed Dimensions
Plate Thickness =	0.63 in	15%	0.54 in
Stiffener Height =	10.31 in	-	10.31 in
Stiffener Area =	5.77 in^2	5%	5.48 in^2
Stiffener Ix-x =	64 in^4	5%	61 in^4
Stiffener NA (y) =	6.94 in	-	6.94 in

Spacing of Stiffeners, s = 2.40 ft 0.732 M

Effective Plate Width = 21.42 in [Min(40*t,s)]

Item	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Plate	11.47	0.27	3.07	-2.33	62	0
Stiffener	5.48	7.48	40.98	4.88	130	61
Totals	16.95		44.05		193	61

Depth of Section = 10.85 in

Neutral Axis = 2.60 in

Net Moment of Inertia = 254 in^4

Section Modulous = 31 in^3

HEGER DRY DOCK, Inc.

HOPKTINTON, MASSACHUSETS

File Name : **Tranvs Bend - Original**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 3 Combine Stress Evaulation

Transverse Bending Stress

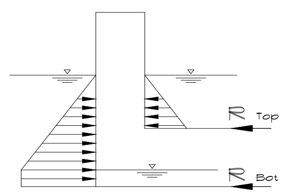
Bending Moment @ 0' off Centerline = 2,679 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 32,169 Kip-ft

S_{top} = 24,683 in^3
Deck Transverse Bending Stess, f_t = **-15.64 Ksi**

S_{bottom} = 19,948 in^3
Bottom Transverse Bending Stess, f_b = **19.35 Ksi**

Axial Squeeze Stress

Draft = 23.23 ft
Head on Pontoon Deck = 6.00 ft   0.38 $Kips/ft^2$
Head on Pontoon Bottom = 22.01 ft   1.41 $Kips/ft^2$
Internal Water Depth = 1.22 ft



R_{top} = 75.54 Kips
Axial Area (top) = 142.34 in^2
Deck Axial Stess, f_t = **-0.53 Ksi**

R_{bottom} = 111.95 Kips
Axial Area (bottom) = 118.56 in^2
Bottom Axial Stess, f_b = **-0.94 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.92 Kip/ft
Unsupported Span, L = 1.64 ft   0.50 M
Maximum Bending Moment = 0 Kip-ft   [$w*L^2/10$]
Deck Section Modulous = 30.76 in^3
Deck Hydrostatic Bending Stess, f_t = **-0.10 Ksi**

	Pontoon Deck			Pontoon Bottom		
Combine Stress	f_t (Ksi)	f_a (Ksi)	f_t/f_a	f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-15.64	17.78	-0.88	19.35	22.60	0.86
Axial Squeeze Stress	-0.53	17.78	-0.03	-0.94	22.60	-0.04
Hydrostatic Bending Stress	-0.10	17.78	-0.01			
			-0.91			**0.81**

HEGER DRY DOCK, Inc.

HOPKTINTON, MASSACHUSETS

File Name : **Tranvs Bend - Original**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 5 Combine Stress Evaulation

Transverse Bending Stress

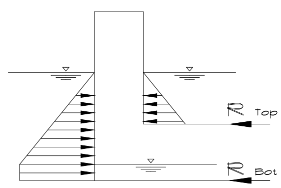
Bending Moment @ 0' off Centerline = 2,974 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 35,708 Kip-ft

S_{top} = 24,683 in^3
Deck Transverse Bending Stess, f_t = **-17.36 Ksi**

S_{bottom} = 19,948 in^3
Bottom Transverse Bending Stess, f_b = **21.48 Ksi**

Axial Squeeze Stress

Draft = 15.23 ft
Head on Pontoon Deck = 0.00 ft   0.00 $Kips/ft^2$
Head on Pontoon Bottom = 14.23 ft   0.91 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 29.69 Kips
Axial Area (top) = 142.34 in^2
Deck Axial Stess, f_t = **-0.21 Ksi**

R_{bottom} = 59.02 Kips
Axial Area (bottom) = 118.56 in^2
Bottom Axial Stess, f_b = **-0.50 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.00 Kip/ft
Unsupported Span, L = 1.64 ft   0.50 M
Maximum Bending Moment = 0 Kip-ft   [$w*L^2/10$]
Deck Section Modulous = 30.76 in^3
Deck Hydrostatic Bending Stess, f_t = **0.00 Ksi**

Combine Stress	Pontoon Deck f_t (Ksi)	f_a (Ksi)	f_t/f_a	Pontoon Bottom f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-17.36	17.78	-0.98	21.48	22.60	0.95
Axial Squeeze Stress	-0.21	17.78	-0.01	-0.50	22.60	-0.02
Hydrostatic Bending Stress	0.00	17.78	0.00			
			-0.99			**0.93**

HEGER DRY DOCK, Inc.

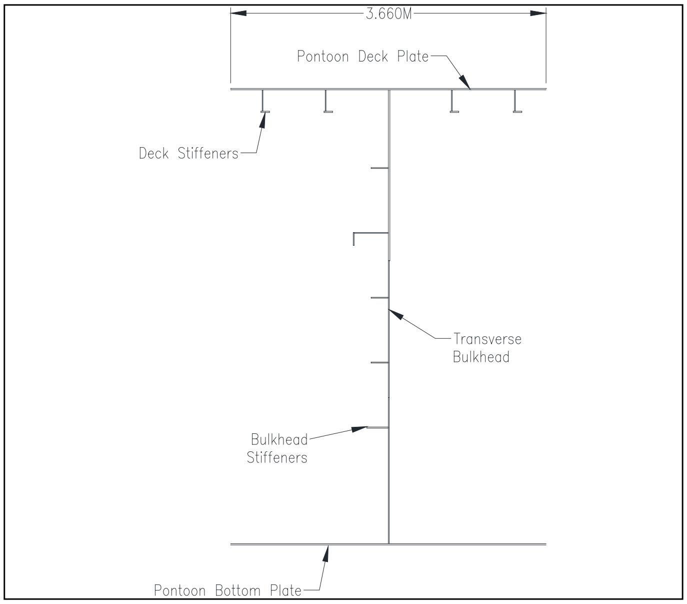
HOPKTINTON, MASSACHUSETS

File Name : **Tranvs Bend - Original**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Transverse Bulkhead Section Properties

Distance off CL = 12.01 ft 3.660 M
Frame Spacing = 12.01 ft 3.660 M



Transverse Section Properites

Member	Orig. t (in)	Corr. (%)	t corr. (in)	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Deck Pl. 16mm	0.630	15%	0.535	77.15	205.96	15,890	84.10	545,748	2
BHD Pl. 18mm	0.709	5%	0.673	52.35	167.81	8,785	45.96	110,595	26,374
BHD Pl. 11mm	0.433	5%	0.411	25.67	97.74	2,509	-24.11	14,929	8,331
BHD Pl. 10mm	0.394	5%	0.374	24.89	33.27	828	-88.58	195,274	9,181
Bottom Pl. 11.5mm	0.453	5%	0.430	61.98	-0.22	-13	-122.07	923,472	1
(4) Deck Stiff - L 247x9+100x15	-	5%	-	21.93	198.75	4,358	76.90	129,651	244
BHD Stiff (1) - FB 250x114	-	5%	-	5.15	53.15	274	-68.70	24,325	0
BHD Stiff (2) - FB 200x10	-	5%	-	2.95	82.68	243	-39.17	4,519	0
BHD Stiff (3) - FB 200x10	-	5%	-	2.95	112.20	330	-9.65	274	0
BHD Stiff (4) - L 397x10+150x10	-	5%	-	8.05	141.73	1,142	19.88	3,184	0
BHD Stiff (5) - FB 200x10	-	5%	-	2.95	171.26	504	49.41	7,190	0
Totals				286.01		34,850		1,959,160	44,132

Depth of Section = 206.22 in 5.24 M
Neutral Axis = 121.85 in 3.10 M
Net Moment of Inertia = 2,003,292 in^4

y_{top} = 84.37 in y_{bottom} = 121.85 in
S_{top} = 23,743 in^3 S_{bottom} = 16,441 in^3

Shear Area = 138.84 in^2
Axial Area (top) = 142.34 in^2
Axial Area (bottom) = 87.26 in^2

Original Dock Design
Frame 236 to 41-80

12' off CL

Pontoon Deck Stiffeners - Local Section Properties

L 247x9+100x15 on 0.63in Plate

Item	Original Dimensions	Corrosion (%)	Assumed Dimensions
Plate Thickness =	0.63 in	15%	0.54 in
Stiffener Height =	10.31 in	-	10.31 in
Stiffener Area =	5.77 in^2	5%	5.48 in^2
Stiffener Ix-x =	64 in^4	5%	61 in^4
Stiffener NA (y) =	6.94 in	-	6.94 in

Spacing of Stiffeners, s = 2.40 ft 0.732 M

Effective Plate Width = 21.42 in [Min(40*t,s]

Item	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Plate	11.47	0.27	3.07	-2.33	62	0
Stiffener	5.48	7.48	40.98	4.88	130	61
Totals	16.95		44.05		193	61

Depth of Section = 10.85 in
Neutral Axis = 2.60 in
Net Moment of Inertia = 254 in^4
Section Modulous = 31 in^3

HEGER DRY DOCK, Inc.

HOPKTINTON, MASSACHUSETS

File Name : **Tranvs Bend - Original**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 3 Combine Stress Evaulation

Transverse Bending Stress

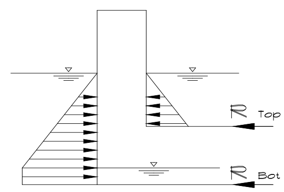
Bending Moment @ 12' off Centerline = 1,933 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 23,215 Kip-ft

S_{top} = 23,743 in^3
Deck Transverse Bending Stess, f_t = **-11.73 Ksi**

S_{bottom} = 16,441 in^3
Bottom Transverse Bending Stess, f_b = **16.94 Ksi**

Axial Squeeze Stress

Draft = 23.23 ft
Head on Pontoon Deck = 6.00 ft   0.38 $Kips/ft^2$
Head on Pontoon Bottom = 22.01 ft   1.41 $Kips/ft^2$
Internal Water Depth = 1.22 ft



R_{top} = 75.54 Kips
Axial Area (top) = 142.34 in^2
Deck Axial Stess, f_t = **-0.53 Ksi**

R_{bottom} = 111.95 Kips
Axial Area (bottom) = 87.26 in^2
Bottom Axial Stess, f_b = **-1.28 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.92 Kip/ft
Unsupported Span, L = 10.50 ft   3.20 M
Maximum Bending Moment = 10 Kip-ft   [$w*L^2/10$]
Deck Section Modulous = 30.76 in^3
Deck Hydrostatic Bending Stess, f_t = **-3.97 Ksi**

	Pontoon Deck			Pontoon Bottom		
Combine Stress	f_t (Ksi)	f_a (Ksi)	f_t/f_a	f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-11.73	17.78	-0.66	16.94	22.60	0.75
Axial Squeeze Stress	-0.53	17.78	-0.03	-1.28	22.60	-0.06
Hydrostatic Bending Stress	-3.97	17.78	-0.22			
			-0.91			**0.69**

HEGER DRY DOCK, Inc.

HOPKTINTON, MASSACHUSETS

File Name : **Tranvs Bend - Original**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 5 Combine Stress Evaulation

Transverse Bending Stress

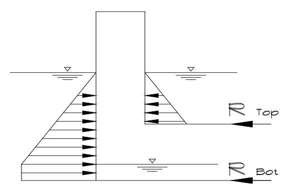
Bending Moment @ 12' off Centerline = 2,221 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 26,670 Kip-ft

S_{top} = 23,743 in^3
Deck Transverse Bending Stess, f_t = **-13.48 Ksi**

S_{bottom} = 16,441 in^3
Bottom Transverse Bending Stess, f_b = **19.47 Ksi**

Axial Squeeze Stress

Draft = 15.23 ft
Head on Pontoon Deck = 0.00 ft 0.00 $Kips/ft^2$
Head on Pontoon Bottom = 14.23 ft 0.91 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 29.69 Kips
Axial Area (top) = 142.34 in^2
Deck Axial Stess, f_t = **-0.21 Ksi**

R_{bottom} = 59.02 Kips
Axial Area (bottom) = 87.26 in^2
Bottom Axial Stess, f_b = **-0.68 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.00 Kip/ft
Unsupported Span, L = 10.50 ft 3.20 M
Maximum Bending Moment = 0 Kip-ft [$w*L^2/10$]
Deck Section Modulous = 30.76 in^3
Deck Hydrostatic Bending Stess, f_t = **0.00 Ksi**

Combine Stress	Pontoon Deck			Pontoon Bottom		
	f_t (Ksi)	f_a (Ksi)	f_t/f_a	f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-13.48	17.78	-0.76	19.47	22.60	0.86
Axial Squeeze Stress	-0.21	17.78	-0.01	-0.68	22.60	-0.03
Hydrostatic Bending Stress	0.00	17.78	0.00			
			-0.77			**0.83**

HEGER DRY DOCK, Inc.

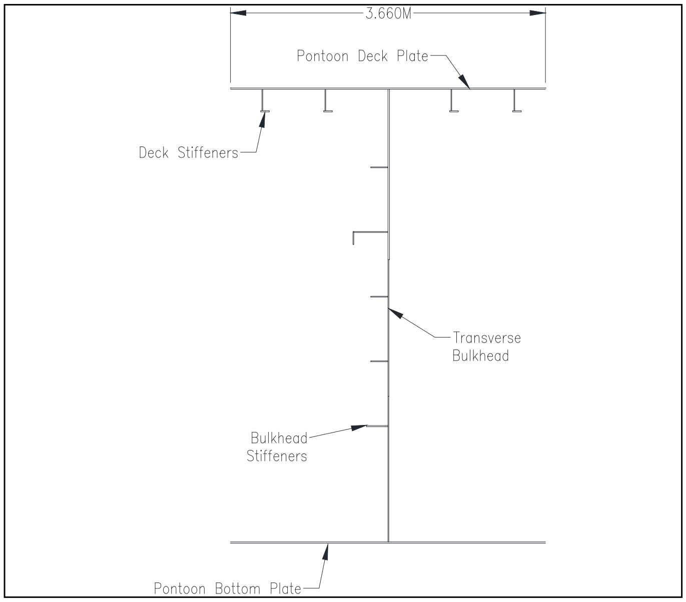
HOPKTINTON, MASSACHUSETS

File Name : **Tranvs Bend - Original**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Transverse Bulkhead Section Properties

Distance off CL = 23.56 ft 7.180 M
Frame Spacing = 12.01 ft 3.660 M



Transverse Section Properites

Member	Orig. t (in)	Corr. (%)	t corr. (in)	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Deck Pl. 16mm	0.630	15%	0.535	77.15	204.99	15,815	83.99	544,267	2
BHD Pl. 18mm	0.709	5%	0.673	52.35	167.81	8,785	46.82	114,735	26,374
BHD Pl. 11mm	0.433	5%	0.411	25.67	97.74	2,509	-23.26	13,892	8,331
BHD Pl. 10mm	0.394	5%	0.374	24.89	33.27	828	-87.73	191,534	9,181
Bottom Pl. 11.5mm	0.453	5%	0.430	61.98	-0.22	-13	-121.21	910,620	1
(4) Deck Stiff - L 247x9+100x15	-	5%	-	21.93	197.78	4,337	76.78	129,267	244
BHD Stiff (1) - FB 250x114	-	5%	-	5.15	53.15	274	-67.85	23,725	0
BHD Stiff (2) - FB 200x10	-	5%	-	2.95	82.68	243	-38.32	4,325	0
BHD Stiff (3) - FB 200x10	-	5%	-	2.95	112.20	330	-8.79	228	0
BHD Stiff (4) - L 397x10+150x10	-	5%	-	8.05	141.73	1,142	20.73	3,463	0
BHD Stiff (5) - FB 200x10	-	5%	-	2.95	171.26	504	50.26	7,440	0
Totals				283.06		34,250		1,936,055	44,132

Depth of Section = 205.26 in 5.21 M
Neutral Axis = 121.00 in 3.07 M
Net Moment of Inertia = 1,980,187 in^4

y_{top} = 84.26 in y_{bottom} = 121.00 in
S_{top} = 23,501 in^3 S_{bottom} = 16,365 in^3

Shear Area = 138.18 in^2
Axial Area (top) = 142.34 in^2
Axial Area (bottom) = 99.70 in^2

HEGER DRY DOCK, Inc.

HOPKTINTON, MASSACHUSETS

Client : **NASSCO - SAN DIEGO**

Subject : **FLOATING DRY DOCK "BUILDER"**

File Name : **Tranvs Bend - Original**

Done By : **M. Naylor**

Date : **8/17/2021**

Job No : **4386-D**

Pontoon Deck Stiffeners - Local Section Properties

L 247x9+100x15 on 0.63in Plate

Item	Original Dimensions	Corrosion (%)	Assumed Dimensions
Plate Thickness =	0.63 in	15%	0.54 in
Stiffener Height =	10.31 in	-	10.31 in
Stiffener Area =	5.77 in^2	5%	5.48 in^2
Stiffener Ix-x =	64 in^4	5%	61 in^4
Stiffener NA (y) =	6.94 in	-	6.94 in

Spacing of Stiffeners, s = 2.40 ft 0.732 M

Effective Plate Width = 21.42 in [Min(40*t,s]

Item	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Plate	11.47	0.27	3.07	-2.33	62	0
Stiffener	5.48	7.48	40.98	4.88	130	61
Totals	16.95		44.05		193	61

Depth of Section = 10.85 in

Neutral Axis = 2.60 in

Net Moment of Inertia = 254 in^4

Section Modulous = 31 in^3

Phase 3 Combine Stress Evaulation

Transverse Bending Stress

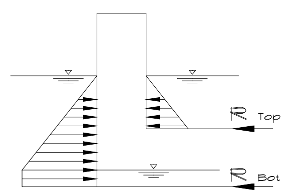
Bending Moment @ 24' off Centerline = 1,334 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 16,015 Kip-ft

S_{top} = 23,501 in^3
Deck Transverse Bending Stess, f_t = **-8.18 Ksi**

S_{bottom} = 16,365 in^3
Bottom Transverse Bending Stess, f_b = **11.74 Ksi**

Axial Squeeze Stress

Draft = 23.23 ft
Head on Pontoon Deck = 6.00 ft 0.38 Kips/ft^2
Head on Pontoon Bottom = 22.01 ft 1.41 Kips/ft^2
Internal Water Depth = 1.22 ft



R_{top} = 75.54 Kips
Axial Area (top) = 142.34 in^2
Deck Axial Stess, f_t = **-0.53 Ksi**

R_{bottom} = 111.95 Kips
Axial Area (bottom) = 99.70 in^2
Bottom Axial Stess, f_b = **-1.12 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.92 Kip/ft
Unsupported Span, L = 10.50 ft 3.20 M
Maximum Bending Moment = 10 Kip-ft [w*L^2/10]
Deck Section Modulous = 30.76 in^3
Deck Hydrostatic Bending Stess, f_t = **-3.97 Ksi**

Combine Stress	Pontoon Deck			Pontoon Bottom		
	f_t (Ksi)	**f_a** (Ksi)	**f_t/f_a**	**f_b** (Ksi)	**f_a** (Ksi)	**f_b/f_a**
Transverse Bending Stress	-8.18	17.78	-0.46	11.74	22.60	0.52
Axial Squeeze Stress	-0.53	17.78	-0.03	-1.12	22.60	-0.05
Hydrostatic Bending Stress	-3.97	17.78	-0.22			
			-0.71			**0.47**

File Name : **Tranvs Bend - Original**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 5 Combine Stress Evaulation

Transverse Bending Stress

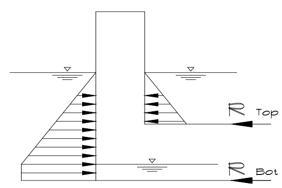
Bending Moment @ 24' off Centerline = 1,601 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 19,229 Kip-ft

S_{top} = 23,501 in^3
Deck Transverse Bending Stess, f_t = **-9.82 Ksi**

S_{bottom} = 16,365 in^3
Bottom Transverse Bending Stess, f_b = **14.10 Ksi**

Axial Squeeze Stress

Draft = 15.23 ft
Head on Pontoon Deck = 0.00 ft 0.00 $Kips/ft^2$
Head on Pontoon Bottom = 14.23 ft 0.91 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 29.69 Kips
Axial Area (top) = 142.34 in^2
Deck Axial Stess, f_t = **-0.21 Ksi**

R_{bottom} = 59.02 Kips
Axial Area (bottom) = 99.70 in^2
Bottom Axial Stess, f_b = **-0.59 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.00 Kip/ft
Unsupported Span, L = 10.50 ft 3.20 M
Maximum Bending Moment = 0 Kip-ft [$w*L^2/10$]
Deck Section Modulous = 30.76 in^3
Deck Hydrostatic Bending Stess, f_t = **0.00 Ksi**

Combine Stress	Pontoon Deck f_t (Ksi)	f_a (Ksi)	f_t/f_a	Pontoon Bottom f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-9.82	17.78	-0.55	14.10	22.60	0.62
Axial Squeeze Stress	-0.21	17.78	-0.01	-0.59	22.60	-0.03
Hydrostatic Bending Stress	0.00	17.78	0.00			
			-0.56			**0.60**

Column Buckling Check

Assumed Plating Corrosion = 15%

Assumed Stiffener Corrosion = 5%

Spacing of Stiffener = 732 mm 28.8 In.

Effective Span of Stiffener, l = 3200 mm 126.0 In.

Item	Original Dimensions	Units	Assumed Dimensions	Units	
Plate t =	0.63	In.	0.54	In.	15% corroded

Shape = L 247x9+100x15

Web Height =	247	mm	9.72	In.	
Web Thickness =	9	mm	0.34	In.	5% corroded
Flange Width =	100	mm	3.94	In.	
Flange Thickness =	15	mm	0.56	In.	5% corroded

I of Stiffener on Plate						
Item	Area	Arm	Area*Arm	Dist.	Area*D^2	I (Initial)
Plate	15.43	0.27	4.13	1.89	55	0
Web	3.27	5.40	17.67	-3.24	34	26
Flange	2.21	10.54	23.28	-8.38	155	0
Totals	20.91		45.08		245	26

Neutral Axis = 2.16 In.

Moment of Inertia, Ix-x (Total) = 271 $In.^4$

Area, A = 20.91 $In.^2$

Radius of Gyration, r = SQRT(I/A) = 3.60 In.

Column Buckling Check

Effective Length Factor, K =	1.00	[Pinned-Pinned]
Slenderness, KL/r =	35.0	
F_e =	233.6	ksi
F_y =	34.0	ksi
Buckling Type =	Inelastic	
F_{cr} =	32.0	Ksi
Plating Slenderness Width, b_{max} =	43.5	*t
=	23.30	in
	81%	
c1 =	0.22	
c2 =	1.49	
F_{el} =	49.3	ksi
Effective Width, b_e =	26.01	in
	90%	
Effective Area, A_e =	19.41	$In.^2$
	93%	
F_{cr}/Ω =	17.78	ksi

Appendix D – Strengthened Section Transverse Bending Calculations

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Environment Conditions

Specific Gravity =	1.0250			
=	35.02	ft^3/LT	0.98	M^3/MT

Floating Dock Dimensions

Pontoon Length =	783.07	ft	238.681	M
Pontoon Width =	170.60	ft	52.000	M
Wing Length =	783.07	ft	238.681	M
Wing Width =	14.75	ft	4.496	M
Pontoon Height @ CL =	17.22	ft	5.250	M
Pontoon Height @ Wing =	16.73	ft	5.100	M
Center Tanks Width =	41.99	ft	12.800	M
Wing Tanks Width =	43.31	ft	13.200	M

Floating Dock Characteristics

Structural Capacity =	68.00	LT/ft	226.72	MT/M	
Keel Block Hieght =	6.00	ft	1.830	M	
Estimated Dock Light Weight =	17,328	LT	17,603	MT	[From FRR]
Estimated Pontoon Weight =	9,496	LT	9,646	MT	
=	0.159	$Kips/ft^2$			
Estimated Wing Wieght =	7,832	LT	7,957	MT	
=	5.60	Kip/ft per shell			
Ballast Tank Permeability =	0.985				

Phase 3 Lifting Conditions

Dock Draft =	23.23 ft	7.080 M	
Buoyancy Under Wing =	1.49 Kips/ft^2		
Buoyancy Under Pontoon =	1.09 Kips/ft^2		
Ballast Water in Starboard Wing Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2
Ballast Water in Starboard Center Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2
Ballast Water in Port Center Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2
Ballast Water in Port Wing Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2

Phase 3 Forces Per Length of Dock

Buoyancy Under Starboard Wing =	21.91 Kips
Buoyancy Under Port Wing =	21.91 Kips
Buoyancy Under Pontoon =	153.23 Kips
Starboard Wing Weight =	-11.20 Kips
Port Wing Weight =	-11.20 Kips
Pontoon Weight =	-27.16 Kips
Ship Weight =	-152.32 Kips
Ballast Weight=	-10.75 Kips
Total =	-15.58 Kips

Shear in Bulkheads Must Equal	15.58 Kips to Achieve Equilibrium
Number of Bulkheads =	4
Shear Force/BHD =	3.89 Kips/BHD

Phase 5 Lifting Conditions

Dock Draft =	15.23 ft	4.643 M	
Freboard =	1.50 ft	0.457 M	
Buoyancy Under Wing =	0.97 Kips/ft^2		
Buoyancy Under Pontoon =	0.97 Kips/ft^2		
Ballast Water in Starboard Wing Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2
Ballast Water in Starboard Center Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2
Ballast Water in Port Center Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2
Ballast Water in Port Wing Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2

Phase 5 Forces Per Length of Dock

Buoyancy Under Starboard Wing =	14.37 Kips
Buoyancy Under Port Wing =	14.37 Kips
Buoyancy Under Pontoon =	137.47 Kips
Starboard Wing Weight =	-11.20 Kips
Port Wing Weight =	-11.20 Kips
Pontoon Weight =	-27.16 Kips
Ship Weight =	-152.32 Kips
Ballast Weight=	-10.75 Kips
Total =	-46.42 Kips

Shear in Bulkheads Must Equal	46.42 Kips to Achieve Equilibrium
Number of Bulkheads =	4
Shear Force/BHD =	11.61 Kips/BHD

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

Client : **NASSCO - SAN DIEGO**

Subject : **FLOATING DRY DOCK "BUILDER"**

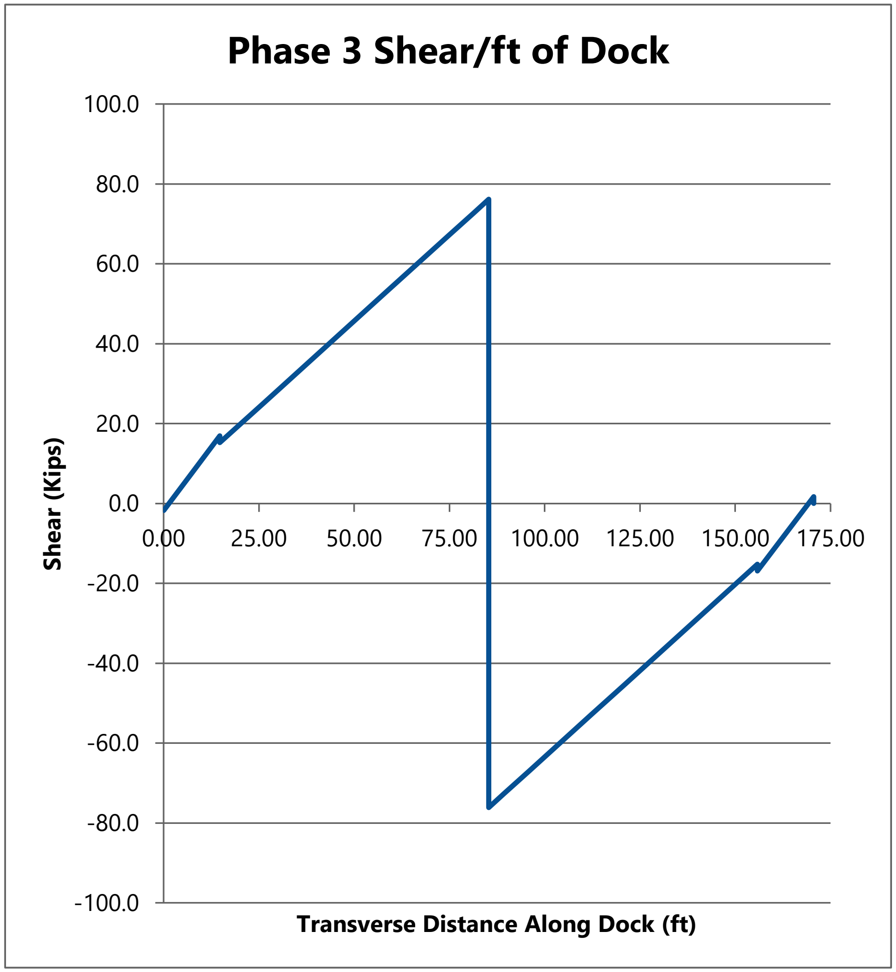
File Name : **Trans Bend - Strength**

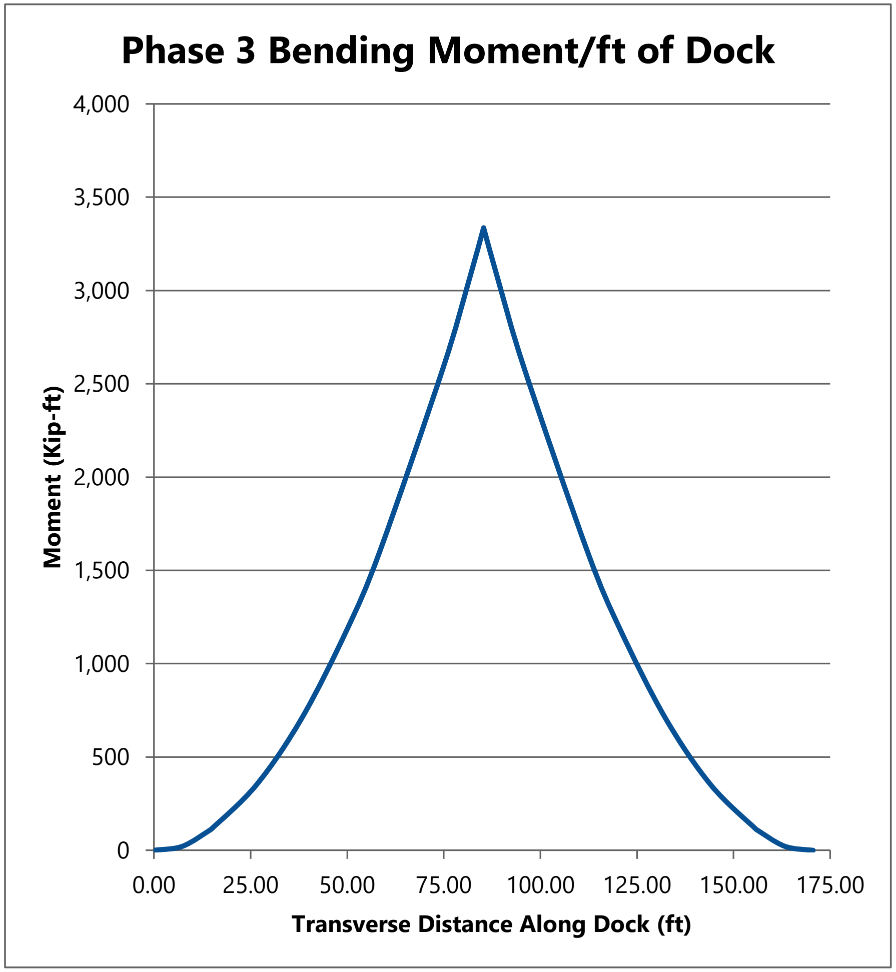
Done By : **M. Naylor**

Date : **8/17/2021**

Job No : **4386-D**

	Phase 3 Transverse Bending - Beam Theory									
Location	X	Dist. off CL	Buoyancy	Pontoon Wt.	Ballast Wt.	Wing Wt.	BHD Shear	Ship Wt.	Shear	Moment
	(ft)	(M)	(Kips)	(Kips)	(Kips)	(Kips)	(Kips)	(Kips)	(Kips)	(Kip-ft)
Wing Shell	0.00	-26.00	1.49	-0.16	-0.06	-5.60	3.89	0.00	-1.7	0
Tank - Wing	7.38	-23.75	1.49	-0.16	-0.06	0.00	0.00	0.00	7.6	22
Tank - Wing	14.75	-21.50	1.49	-0.16	-0.06	0.00	0.00	0.00	16.9	112
Wing Shell	14.75	-21.50	1.49	-0.16	-0.06	-5.60	3.89	0.00	15.2	112
Tank - Pontoon	26.51	-17.92	1.09	-0.16	-0.06	0.00	0.00	0.00	25.4	351
Tank - Pontoon	38.27	-14.34	1.09	-0.16	-0.06	0.00	0.00	0.00	35.5	709
Tank - Pontoon	50.03	-10.75	1.09	-0.16	-0.06	0.00	0.00	0.00	45.7	1,187
Tank - Pontoon	58.30	-8.23	1.09	-0.16	-0.06	0.00	0.00	0.00	52.8	1,594
Tank - Pontoon	74.80	-3.20	1.09	-0.16	-0.06	0.00	0.00	0.00	67.1	2,584
Tank - Pontoon	81.33	-1.21	1.09	-0.16	-0.06	0.00	0.00	0.00	72.7	3,040
Tank - Pontoon	85.30	0.00	1.09	-0.16	-0.06	0.00	0.00	0.00	76.2	3,336
Centerline	85.30	0.00	1.09	-0.16	-0.06	0.00	0.00	-152.32	-76.2	3,336
Tank - Pontoon	89.27	1.21	1.09	-0.16	-0.06	0.00	0.00	0.00	-72.7	3,040
Tank - Pontoon	95.80	3.20	1.09	-0.16	-0.06	0.00	0.00	0.00	-67.1	2,584
Tank - Pontoon	112.30	8.23	1.09	-0.16	-0.06	0.00	0.00	0.00	-52.8	1,594
Tank - Pontoon	120.58	10.75	1.09	-0.16	-0.06	0.00	0.00	0.00	-45.7	1,187
Tank - Pontoon	132.34	14.34	1.09	-0.16	-0.06	0.00	0.00	0.00	-35.5	709
Tank - Pontoon	144.09	17.92	1.09	-0.16	-0.06	0.00	0.00	0.00	-25.4	351
Tank - Pontoon	155.85	21.50	1.09	-0.16	-0.06	0.00	0.00	0.00	-15.2	112
Wing Shell	155.85	21.50	1.49	-0.16	-0.06	-5.60	3.89	0.00	-16.9	112
Tank - Wing	163.23	23.75	1.49	-0.16	-0.06	0.00	0.00	0.00	-7.6	22
Tank - Wing	170.60	26.00	1.49	-0.16	-0.06	0.00	0.00	0.00	1.7	0
Wing Shell	170.60	26.00	1.49	-0.16	-0.06	-5.60	3.89	0.00	0.0	0


Phase 3 Shear/ft of Dock
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
Shear (Kips)
0.00
25.00
50.00
75.00
100.00
125.00
150.00
175.00
Transverse Distance Along Dock (ft)


Phase 3 Bending Moment/ft of Dock
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Moment (Kip-ft)
0.00
25.00
50.00
75.00
100.00
125.00
150.00
175.00
Transverse Distance Along Dock (ft)

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

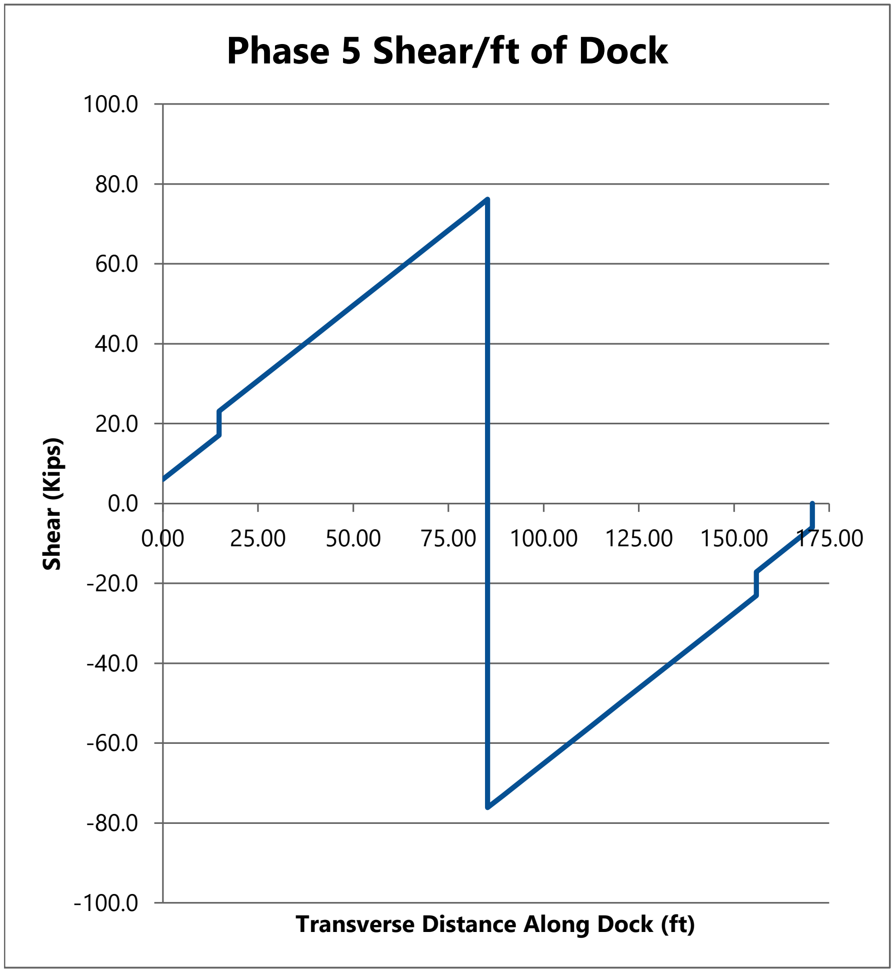
	Phase 5 Transverse Bending - Beam Theory									
Location	X (ft)	Dist. off CL (M)	Buoyancy (Kips)	Pontoon Wt. (Kips)	Ballast Wt. (Kips)	Wing Wt. (Kips)	BHD Shear (Kips)	Ship Wt. (Kips)	Shear (Kips)	Moment (Kip-ft)
Wing Shell	0.00	-26.00	0.97	-0.16	-0.06	-5.60	11.61	0.00	6.0	0
Tank - Wing	7.38	-23.75	0.97	-0.16	-0.06	0.00	0.00	0.00	11.6	65
Tank - Wing	14.75	-21.50	0.97	-0.16	-0.06	0.00	0.00	0.00	17.1	170
Wing Shell	14.75	-21.50	0.97	-0.16	-0.06	-5.60	11.61	0.00	23.1	170
Tank - Pontoon	26.51	-17.92	0.97	-0.16	-0.06	0.00	0.00	0.00	31.9	494
Tank - Pontoon	38.27	-14.34	0.97	-0.16	-0.06	0.00	0.00	0.00	40.8	922
Tank - Pontoon	50.03	-10.75	0.97	-0.16	-0.06	0.00	0.00	0.00	49.6	1,453
Tank - Pontoon	58.30	-8.23	0.97	-0.16	-0.06	0.00	0.00	0.00	55.9	1,890
Tank - Pontoon	74.80	-3.20	0.97	-0.16	-0.06	0.00	0.00	0.00	68.3	2,914
Tank - Pontoon	81.33	-1.21	0.97	-0.16	-0.06	0.00	0.00	0.00	73.2	3,376
Tank - Pontoon	85.30	0.00	0.97	-0.16	-0.06	0.00	0.00	0.00	76.2	3,672
Centerline	85.30	0.00	0.97	-0.16	-0.06	0.00	0.00	-152.32	-76.2	3,672
Tank - Pontoon	89.27	1.21	0.97	-0.16	-0.06	0.00	0.00	0.00	-73.2	3,376
Tank - Pontoon	95.80	3.20	0.97	-0.16	-0.06	0.00	0.00	0.00	-68.3	2,914
Tank - Pontoon	112.30	8.23	0.97	-0.16	-0.06	0.00	0.00	0.00	-55.9	1,890
Tank - Pontoon	120.58	10.75	0.97	-0.16	-0.06	0.00	0.00	0.00	-49.6	1,453
Tank - Pontoon	132.34	14.34	0.97	-0.16	-0.06	0.00	0.00	0.00	-40.8	922
Tank - Pontoon	144.09	17.92	0.97	-0.16	-0.06	0.00	0.00	0.00	-31.9	494
Tank - Pontoon	155.85	21.50	0.97	-0.16	-0.06	0.00	0.00	0.00	-23.1	170
Wing Shell	155.85	21.50	0.97	-0.16	-0.06	-5.60	11.61	0.00	-17.1	170
Tank - Wing	163.23	23.75	0.97	-0.16	-0.06	0.00	0.00	0.00	-11.6	65
Tank - Wing	170.60	26.00	0.97	-0.16	-0.06	0.00	0.00	0.00	-6.0	0
Wing Shell	170.60	26.00	0.97	-0.16	-0.06	-5.60	11.61	0.00	0.0	0

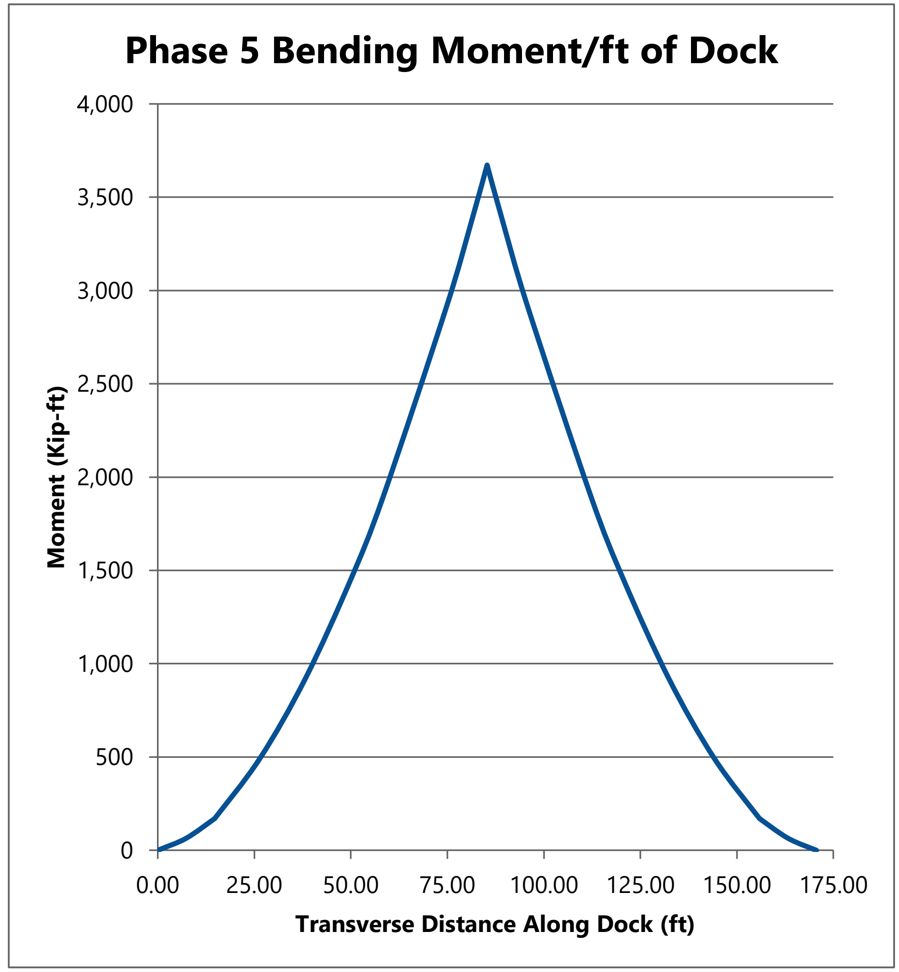
HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**





HEGER DRY DOCK, Inc.

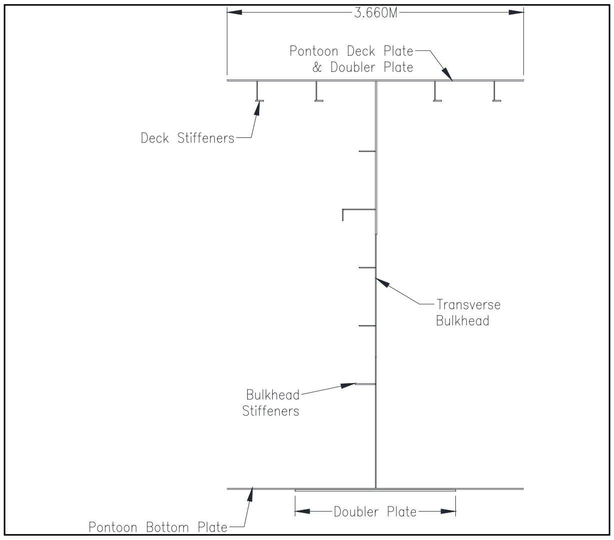
HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Transverse Bulkhead Section Properties

Distance off CL = 0.00 ft 0.000 M
Frame Spacing = 12.01 ft 3.660 M



Transverse Section Properites									
Member	Orig. t (in)	Corr. (%)	t corr. (in)	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Deck Pl. 16mm	0.630	10%	0.567	81.69	206.98	16,908	96.74	764,501	2
BHD Pl. 18mm	0.709	0%	0.709	55.10	167.81	9,247	57.58	182,674	27,762
BHD Pl. 11mm	0.433	0%	0.433	27.02	97.74	2,641	-12.50	4,223	8,769
BHD Pl. 10mm	0.394	0%	0.394	26.20	33.27	871	-76.97	155,189	9,664
Bottom Pl. 15mm	0.591	0%	0.591	85.10	-0.30	-25	-110.53	1,039,650	2
Deck Doubler Pl. 11mm	0.433	0%	0.433	62.40	207.48	12,947	97.24	590,046	1
Bottom Doubler Pl. 22mm	0.866	0%	0.866	67.56	-1.02	-69	-111.26	836,317	4
(4) Deck Stiff - L 247x9+100x15	-	0%	-	23.08	199.75	4,610	89.52	184,940	256
BHD Stiff (1) - FB 250x114	-	0%	-	5.43	53.15	288	-57.09	17,680	0
BHD Stiff (2) - FB 200x10	-	0%	-	3.10	82.68	256	-27.56	2,355	0
BHD Stiff (3) - FB 200x10	-	0%	-	3.10	112.20	348	1.97	12	0
BHD Stiff (4) - L 397x10+150x10	-	0%	-	8.48	141.73	1,202	31.49	8,410	0
BHD Stiff (5) - FB 200x10	-	0%	-	3.10	171.26	531	61.02	11,544	0
Totals				451.35		49,756		3,797,541	46,462

Depth of Section = 207.26 in 5.26 M
Neutral Axis = 110.24 in 2.80 M
Net Moment of Inertia = 3,844,003 in^4

y_{top} = 97.02 in y_{bottom} = 110.24 in
S_{top} = 39,620 in^3 S_{bottom} = 34,870 in^3

Shear Area = 108.32 in^2
Axial Area (top) = 235.79 in^2
Axial Area (bottom) = 192.36 in^2

Pontoon Deck Stiffeners - Local Section Properties

L 247x9+100x15 on 0.63in Plate

Item	Original Dimensions	Corrosion (%)	Assumed Dimensions
Plate Thickness =	0.63 in	10%	0.57 in
Stiffener Height =	10.31 in	-	10.31 in
Stiffener Area =	5.77 in^2	0%	5.77 in^2
Stiffener Ix-x =	64 in^4	0%	64 in^4
Stiffener NA (y) =	6.94 in	-	6.94 in

Spacing of Stiffeners, s = 2.40 ft 0.732 M

Effective Plate Width = 22.68 in [Min(40*t,s)]

Item	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Plate	12.86	0.28	3.64	-2.24	64	0
Stiffener	5.77	7.51	43.31	4.99	143	64
Totals	18.63		46.96		208	64

Depth of Section = 10.88 in
Neutral Axis = 2.52 in
Net Moment of Inertia = 272 in^4
Section Modulous = 33 in^3

__HEGER DRY DOCK, Inc.__

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 3 Combine Stress Evaulation

Transverse Bending Stress

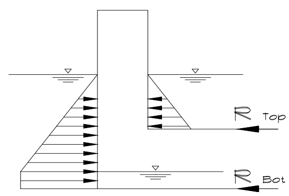
Bending Moment @ 0' off Centerline = 3,336 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 40,057 Kip-ft

S_{top} = 39,620 in^3
Deck Transverse Bending Stess, f_t = **-12.13 Ksi**

S_{bottom} = 34,870 in^3
Bottom Transverse Bending Stess, f_b = **13.78 Ksi**

Axial Squeeze Stress

Draft = 23.23 ft
Head on Pontoon Deck = 6.00 ft — 0.38 $Kips/ft^2$
Head on Pontoon Bottom = 22.23 ft — 1.42 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 75.53 Kips
Axial Area (top) = 235.79 in^2
Deck Axial Stess, f_t = **-0.32 Ksi**

R_{bottom} = 112.11 Kips
Axial Area (bottom) = 192.36 in^2
Bottom Axial Stess, f_b = **-0.58 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.92 Kip/ft
Unsupported Span, L = 1.64 ft — 0.50 M
Maximum Bending Moment = 0 Kip-ft — [w*L^2/10]
Deck Section Modulous = 32.56 in^3
Deck Hydrostatic Bending Stess, f_t = **-0.09 Ksi**

Combine Stress	Pontoon Deck f_t (Ksi)	f_a (Ksi)	f_t/f_a	Pontoon Bottom f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-12.13	18.23	-0.67	13.78	22.60	0.61
Axial Squeeze Stress	-0.32	18.23	-0.02	-0.58	22.60	-0.03
Hydrostatic Bending Stress	-0.09	18.23	-0.01			
			-0.69			**0.58**

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 5 Combine Stress Evaulation

Transverse Bending Stress

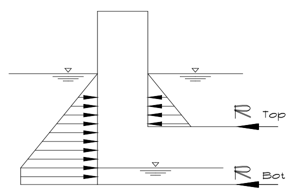
Bending Moment @ 0' off Centerline = 3,672 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 44,092 Kip-ft

S_{top} = 39,620 in^3
Deck Transverse Bending Stess, f_t = **-13.35 Ksi**

S_{bottom} = 34,870 in^3
Bottom Transverse Bending Stess, f_b = **15.17 Ksi**

Axial Squeeze Stress

Draft = 15.23 ft
Head on Pontoon Deck = 0.00 ft 0.00 $Kips/ft^2$
Head on Pontoon Bottom = 14.23 ft 0.91 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 29.69 Kips
Axial Area (top) = 235.79 in^2
Deck Axial Stess, f_t = **-0.13 Ksi**

R_{bottom} = 59.02 Kips
Axial Area (bottom) = 192.36 in^2
Bottom Axial Stess, f_b = **-0.31 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.00 Kip/ft
Unsupported Span, L = 1.64 ft 0.50 M
Maximum Bending Moment = 0 Kip-ft [$w*L^2/10$]
Deck Section Modulous = 32.56 in^3
Deck Hydrostatic Bending Stess, f_t = **0.00 Ksi**

	Pontoon Deck			Pontoon Bottom		
Combine Stress	**f_t** (Ksi)	**f_a** (Ksi)	**f_t/f_a**	**f_b** (Ksi)	**f_a** (Ksi)	**f_b/f_a**
Transverse Bending Stress	-13.35	18.23	-0.73	15.17	22.60	0.67
Axial Squeeze Stress	-0.13	18.23	-0.01	-0.31	22.60	-0.01
Hydrostatic Bending Stress	0.00	18.23	0.00			
			-0.74			**0.66**

HEGER DRY DOCK, Inc.

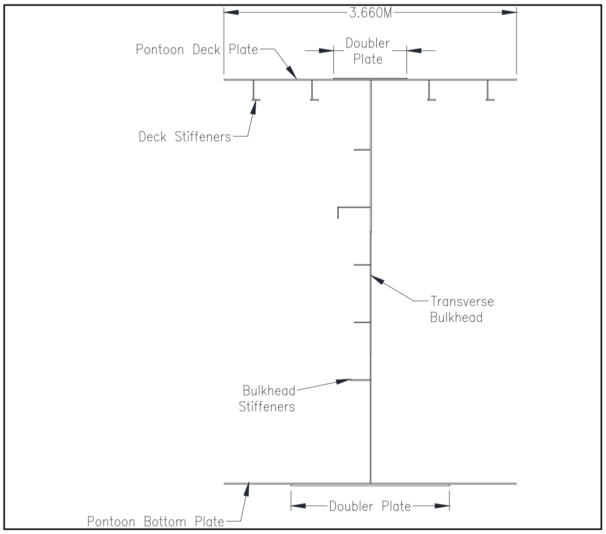
HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Transverse Bulkhead Section Properties

Distance off CL = 4.00 ft 1.219 M
Frame Spacing = 12.01 ft 3.660 M



Transverse Section Properites

Member	Orig. t (in)	Corr. (%)	t corr. (in)	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Deck Pl. 16mm	0.630	10%	0.567	81.69	206.64	16,881	107.76	948,546	2
BHD Pl. 18mm	0.709	0%	0.709	55.10	167.81	9,247	68.93	261,806	27,762
BHD Pl. 11mm	0.433	0%	0.433	27.02	97.74	2,641	-1.15	36	8,769
BHD Pl. 10mm	0.394	0%	0.394	26.20	33.27	871	-65.62	112,788	9,664
Bottom Pl. 15mm	0.591	0%	0.591	85.10	-0.30	-25	-99.18	837,069	2
Deck Doubler Pl. 11mm	0.433	0%	0.433	15.59	207.14	3,229	108.26	182,711	1
Bottom Doubler Pl. 22mm	0.866	0%	0.866	67.56	-1.02	-69	-99.91	674,366	4
(4) Deck Stiff - L 247x9+100x15	-	0%	-	23.08	199.42	4,603	100.53	233,264	256
BHD Stiff (1) - FB 250x114	-	0%	-	5.43	53.15	288	-45.74	11,348	0
BHD Stiff (2) - FB 200x10	-	0%	-	3.10	82.68	256	-16.21	814	0
BHD Stiff (3) - FB 200x10	-	0%	-	3.10	112.20	348	13.32	550	0
BHD Stiff (4) - L 397x10+150x10	-	0%	-	8.48	141.73	1,202	42.85	15,565	0
BHD Stiff (5) - FB 200x10	-	0%	-	3.10	171.26	531	72.37	16,238	0
Totals				404.54		40,003		3,295,101	46,462

Depth of Section = 206.93 in 5.26 M
Neutral Axis = 98.89 in 2.51 M
Net Moment of Inertia = 3,341,563 in^4

y_{top} = 108.04 in y_{bottom} = 98.89 in
S_{top} = 30,929 in^3 S_{bottom} = 33,792 in^3

Shear Area = 108.32 in^2
Axial Area (top) = 188.98 in^2
Axial Area (bottom) = 192.36 in^2

Pontoon Deck Stiffeners - Local Section Properties

L 247x9+100x15 on 0.63in Plate

Item	Original Dimensions	Corrosion (%)	Assumed Dimensions
Plate Thickness =	0.63 in	10%	0.57 in
Stiffener Height =	10.31 in	-	10.31 in
Stiffener Area =	5.77 in^2	0%	5.77 in^2
Stiffener Ix-x =	64 in^4	0%	64 in^4
Stiffener NA (y) =	6.94 in	-	6.94 in

Spacing of Stiffeners, s = 2.40 ft 0.732 M

Effective Plate Width = 22.68 in [Min(40*t,s]

Item	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Plate	12.86	0.28	3.64	-2.24	64	0
Stiffener	5.77	7.51	43.31	4.99	143	64
Totals	18.63		46.96		208	64

Depth of Section = 10.88 in
Neutral Axis = 2.52 in
Net Moment of Inertia = 272 in^4
Section Modulous = 33 in^3

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Phase 3 Combine Stress Evaulation

Transverse Bending Stress

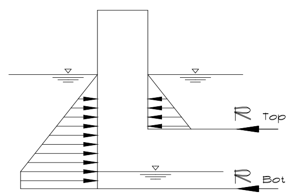
Bending Moment @ 4' off Centerline = 3,040 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 36,508 Kip-ft

S_{top} = 30,929 in^3
Deck Transverse Bending Stess, f_t = **-14.16 Ksi**

S_{bottom} = 33,792 in^3
Bottom Transverse Bending Stess, f_b = **12.96 Ksi**

Axial Squeeze Stress

Draft = 23.23 ft
Head on Pontoon Deck = 6.00 ft   0.38 $Kips/ft^2$
Head on Pontoon Bottom = 22.23 ft   1.42 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 75.53 Kips
Axial Area (top) = 188.98 in^2
Deck Axial Stess, f_t = **-0.40 Ksi**

R_{bottom} = 112.11 Kips
Axial Area (bottom) = 192.36 in^2
Bottom Axial Stess, f_b = **-0.58 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.92 Kip/ft
Unsupported Span, L = 8.86 ft   2.70 M
Maximum Bending Moment = 7 Kip-ft   [$w*L^2/10$]
Deck Section Modulous = 32.56 in^3
Deck Hydrostatic Bending Stess, f_t = **-2.67 Ksi**

	Pontoon Deck			Pontoon Bottom		
Combine Stress	f_t (Ksi)	f_a (Ksi)	f_t/f_a	f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-14.16	18.23	-0.78	12.96	22.60	0.57
Axial Squeeze Stress	-0.40	18.23	-0.02	-0.58	22.60	-0.03
Hydrostatic Bending Stress	-2.67	18.23	-0.15			
			-0.95			**0.55**

Phase 5 Combine Stress Evaulation

Transverse Bending Stress

Bending Moment @ 4' off Centerline = 3,376 Kip-ft per Foot of Dock

Bending Moment per Bulkhead = 40,533 Kip-ft

S_{top} = 30,929 in^3

Deck Transverse Bending Stess, f_t = **-15.73 Ksi**

S_{bottom} = 33,792 in^3

Bottom Transverse Bending Stess, f_b = **14.39 Ksi**

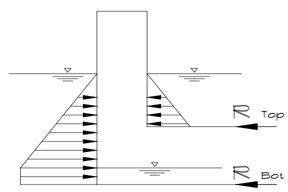
Axial Squeeze Stress

Draft = 15.23 ft

Head on Pontoon Deck = 0.00 ft — 0.00 $Kips/ft^2$

Head on Pontoon Bottom = 14.23 ft — 0.91 $Kips/ft^2$

Internal Water Depth = 1.00 ft



R_{top} = 29.69 Kips

Axial Area (top) = 188.98 in^2

Deck Axial Stess, f_t = **-0.16 Ksi**

R_{bottom} = 59.02 Kips

Axial Area (bottom) = 192.36 in^2

Bottom Axial Stess, f_b = **-0.31 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.00 Kip/ft

Unsupported Span, L = 8.86 ft — 2.70 M

Maximum Bending Moment = 0 Kip-ft — [w*L²/10]

Deck Section Modulous = 32.56 in^3

Deck Hydrostatic Bending Stess, f_t = **0.00 Ksi**

	Pontoon Deck			Pontoon Bottom		
Combine Stress	**f_t** (Ksi)	**f_a** (Ksi)	**f_t/f_a**	**f_b** (Ksi)	**f_a** (Ksi)	**f_b/f_a**
Transverse Bending Stress	-15.73	18.23	-0.86	14.39	22.60	0.64
Axial Squeeze Stress	-0.16	18.23	-0.01	-0.31	22.60	-0.01
Hydrostatic Bending Stress	0.00	18.23	0.00			
			-0.87			**0.62**

HEGER DRY DOCK, Inc.

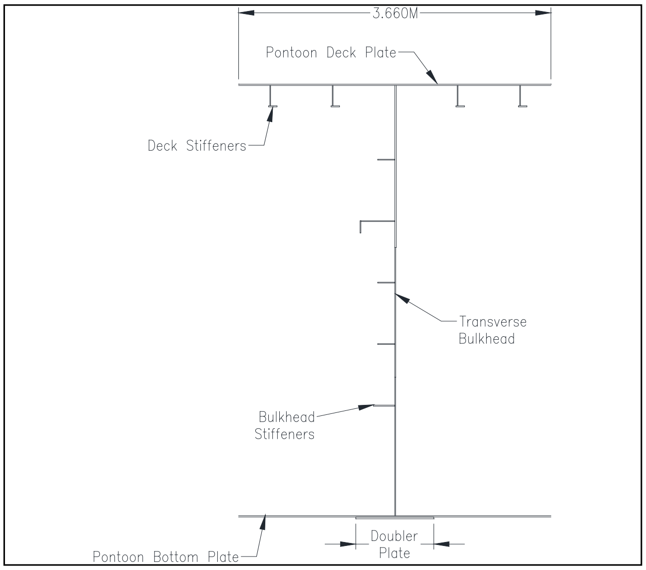
HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Transverse Bulkhead Section Properties

Distance off CL = 12.01 ft 3.660 M
Frame Spacing = 12.01 ft 3.660 M



Transverse Section Properites									
Member	Orig. t (in)	Corr. (%)	t corr. (in)	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Deck Pl. 16mm	0.630	10%	0.567	81.69	205.97	16,826	95.50	745,053	2
BHD Pl. 18mm	0.709	0%	0.709	55.10	167.81	9,247	57.34	181,197	27,762
BHD Pl. 11mm	0.433	0%	0.433	27.02	97.74	2,641	-12.73	4,383	8,769
BHD Pl. 10mm	0.394	0%	0.394	26.20	33.27	871	-77.20	156,131	9,664
Bottom Pl. 11.5mm	0.453	0%	0.453	65.24	-0.23	-15	-110.70	799,438	1
Bottom Doubler Pl. 22mm	0.866	0%	0.866	31.18	-0.89	-28	-111.36	386,655	4
(4) Deck Stiff - L 247x9+100x15	-	0%	-	23.08	198.75	4,587	88.28	179,858	256
BHD Stiff (1) - FB 250x114	-	0%	-	5.43	53.15	288	-57.32	17,825	0
BHD Stiff (2) - FB 200x10	-	0%	-	3.10	82.68	256	-27.79	2,395	0
BHD Stiff (3) - FB 200x10	-	0%	-	3.10	112.20	348	1.73	9	0
BHD Stiff (4) - L 397x10+150x10	-	0%	-	8.48	141.73	1,202	31.26	8,286	0
BHD Stiff (5) - FB 200x10	-	0%	-	3.10	171.26	531	60.79	11,455	0
Totals				332.72		36,756		2,492,685	46,459

Depth of Section = 206.25 in 5.24 M
Neutral Axis = 110.47 in 2.81 M
Net Moment of Inertia = 2,539,144 in^4

y_{top} = 95.78 in y_{bottom} = 110.47 in
S_{top} = 26,509 in^3 S_{bottom} = 22,985 in^3

Shear Area = 108.32 in^2
Axial Area (top) = 150.31 in^2
Axial Area (bottom) = 136.13 in^2

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - Strength**

Done By : **M. Naylor**

Date : **8/17/2021**

Client : **NASSCO - SAN DIEGO**

Job No : **4386-D**

Subject : **FLOATING DRY DOCK "BUILDER"**

Pontoon Deck Stiffeners - Local Section Properties

L 247x9+100x15 on 0.63in Plate

Item	Original Dimensions	Corrosion (%)	Assumed Dimensions
Plate Thickness =	0.63 in	10%	0.57 in
Stiffener Height =	10.31 in	-	10.31 in
Stiffener Area =	5.77 in^2	0%	5.77 in^2
Stiffener Ix-x =	64 in^4	0%	64 in^4
Stiffener NA (y) =	6.94 in	-	6.94 in

Spacing of Stiffeners, s = 2.40 ft 0.732 M

Effective Plate Width = 22.68 in [Min(40*t,s]

Item	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Plate	12.86	0.28	3.64	-2.24	64	0
Stiffener	5.77	7.51	43.31	4.99	143	64
Totals	18.63		46.96		208	64

Depth of Section = 10.88 in

Neutral Axis = 2.52 in

Net Moment of Inertia = 272 in^4

Section Modulous = 33 in^3

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 3 Combine Stress Evaulation

Transverse Bending Stress

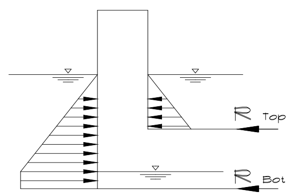
Bending Moment @ 12' off Centerline = 2,584 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 31,027 Kip-ft

S_{top} = 26,509 in^3
Deck Transverse Bending Stess, f_t = **-14.05 Ksi**

S_{bottom} = 22,985 in^3
Bottom Transverse Bending Stess, f_b = **16.20 Ksi**

Axial Squeeze Stress

Draft = 23.23 ft
Head on Pontoon Deck = 6.00 ft 0.38 $Kips/ft^2$
Head on Pontoon Bottom = 22.23 ft 1.42 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 75.53 Kips
Axial Area (top) = 150.31 in^2
Deck Axial Stess, f_t = **-0.50 Ksi**

R_{bottom} = 112.11 Kips
Axial Area (bottom) = 136.13 in^2
Bottom Axial Stess, f_b = **-0.82 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.92 Kip/ft
Unsupported Span, L = 8.86 ft 2.70 M
Maximum Bending Moment = 7 Kip-ft [w*L²/10]
Deck Section Modulous = 32.56 in^3
Deck Hydrostatic Bending Stess, f_t = **-2.67 Ksi**

Combine Stress	Pontoon Deck f_t (Ksi)	Pontoon Deck f_a (Ksi)	Pontoon Deck f_t/f_a	Pontoon Bottom f_b (Ksi)	Pontoon Bottom f_a (Ksi)	Pontoon Bottom f_b/f_a
Transverse Bending Stress	-14.05	18.23	-0.77	16.20	22.60	0.72
Axial Squeeze Stress	-0.50	18.23	-0.03	-0.82	22.60	-0.04
Hydrostatic Bending Stress	-2.67	18.23	-0.15			
			-0.94			**0.68**

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 5 Combine Stress Evaulation

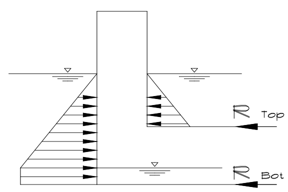
Transverse Bending Stress

Bending Moment @ 12' off Centerline = 2,914 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 34,989 Kip-ft

S_{top} = 26,509 in^3 | S_{bottom} = 22,985 in^3
Deck Transverse Bending Stess, f_t = **-15.84 Ksi** | Bottom Transverse Bending Stess, f_b = **18.27 Ksi**

Axial Squeeze Stress

Draft = 15.23 ft
Head on Pontoon Deck = 0.00 ft   0.00 $Kips/ft^2$
Head on Pontoon Bottom = 14.23 ft   0.91 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 29.69 Kips | R_{bottom} = 59.02 Kips
Axial Area (top) = 150.31 in^2 | Axial Area (bottom) = 136.13 in^2
Deck Axial Stess, f_t = **-0.20 Ksi** | Bottom Axial Stess, f_b = **-0.43 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.00 Kip/ft
Unsupported Span, L = 8.86 ft   2.70 M
Maximum Bending Moment = 0 Kip-ft   [w*L²/10]
Deck Section Modulous = 32.56 in^3
Deck Hydrostatic Bending Stess, f_t = **0.00 Ksi**

Combine Stress	Pontoon Deck			Pontoon Bottom		
	f_t (Ksi)	**f_a** (Ksi)	**f_t/f_a**	**f_b** (Ksi)	**f_a** (Ksi)	**f_b/f_a**
Transverse Bending Stress	-15.84	18.23	-0.87	18.27	22.60	0.81
Axial Squeeze Stress	-0.20	18.23	-0.01	-0.43	22.60	-0.02
Hydrostatic Bending Stress	0.00	18.23	0.00			
			-0.88			**0.79**

HEGER DRY DOCK, Inc.

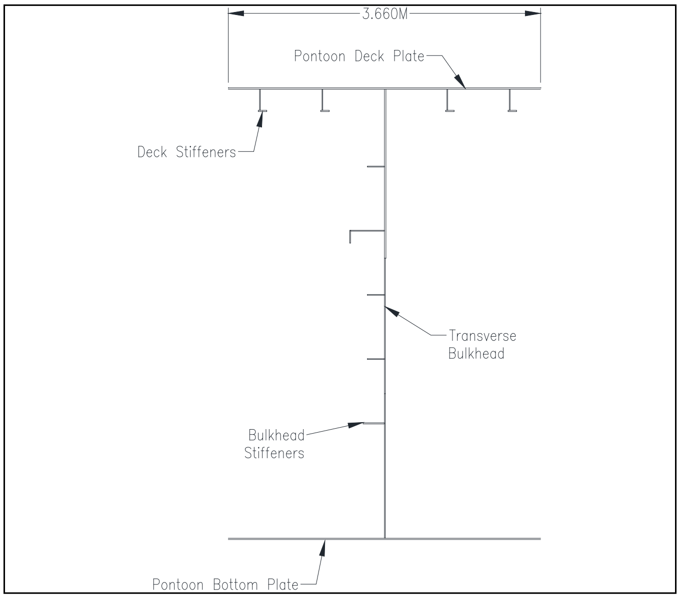
HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Transverse Bulkhead Section Properties

Distance off CL = 27.00 ft 8.230 M
Frame Spacing = 12.01 ft 3.660 M



Transverse Section Properites									
Member	Orig. t (in)	Corr. (%)	t corr. (in)	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Deck Pl. 16mm	0.630	10%	0.567	81.69	204.72	16,724	83.17	565,031	2
BHD Pl. 18mm	0.709	0%	0.709	55.10	167.81	9,247	46.27	117,945	27,762
BHD Pl. 11mm	0.433	0%	0.433	27.02	97.74	2,641	-23.81	15,325	8,769
BHD Pl. 10mm	0.394	0%	0.394	26.20	33.27	871	-88.28	204,157	9,664
Bottom Pl. 11.5mm	0.453	0%	0.453	65.24	-0.23	-15	-121.78	967,468	1
(4) Deck Stiff - L 247x9+100x15	-	0%	-	23.08	197.49	4,558	75.94	133,110	256
BHD Stiff (1) - FB 250x114	-	0%	-	5.43	53.15	288	-68.40	25,381	0
BHD Stiff (2) - FB 200x10	-	0%	-	3.10	82.68	256	-38.87	4,684	0
BHD Stiff (3) - FB 200x10	-	0%	-	3.10	112.20	348	-9.35	271	0
BHD Stiff (4) - L 397x10+150x10	-	0%	-	8.48	141.73	1,202	20.18	3,454	0
BHD Stiff (5) - FB 200x10	-	0%	-	3.10	171.26	531	49.71	7,660	0
Totals				301.54		36,652		2,044,488	46,455

Depth of Section = 205.00 in 5.21 M
Neutral Axis = 121.55 in 3.09 M
Net Moment of Inertia = 2,090,943 in^4

y_{top} = 83.45 in y_{bottom} = 121.55 in
S_{top} = 25,056 in^3 S_{bottom} = 17,202 in^3

Shear Area = 108.32 in^2
Axial Area (top) = 150.31 in^2
Axial Area (bottom) = 104.95 in^2

27' off CL

Strengthed Design
Frame 41 to 6

Pontoon Deck Stiffeners - Local Section Properties

L 247x9+100x15 on 0.63in Plate

Item	Original Dimensions	Corrosion (%)	Assumed Dimensions
Plate Thickness =	0.63 in	10%	0.57 in
Stiffener Height =	10.31 in	-	10.31 in
Stiffener Area =	5.77 in^2	0%	5.77 in^2
Stiffener Ix-x =	64 in^4	0%	64 in^4
Stiffener NA (y) =	6.94 in	-	6.94 in

Spacing of Stiffeners, s = 2.40 ft 0.732 M

Effective Plate Width = 22.68 in [Min(40*t,s]

Item	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Plate	12.86	0.28	3.64	-2.24	64	0
Stiffener	5.77	7.51	43.31	4.99	143	64
Totals	18.63		46.96		208	64

Depth of Section = 10.88 in
Neutral Axis = 2.52 in
Net Moment of Inertia = 272 in^4
Section Modulous = 33 in^3

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 3 Combine Stress Evaulation

Transverse Bending Stress

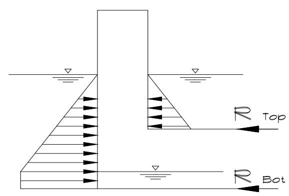
Bending Moment @ 27' off Centerline = 1,594 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 19,145 Kip-ft

S_{top} = 25,056 in^3
Deck Transverse Bending Stess, f_t = **-9.17 Ksi**

S_{bottom} = 17,202 in^3
Bottom Transverse Bending Stess, f_b = **13.36 Ksi**

Axial Squeeze Stress

Draft = 23.23 ft
Head on Pontoon Deck = 6.00 ft   0.38 $Kips/ft^2$
Head on Pontoon Bottom = 22.23 ft   1.42 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 75.53 Kips
Axial Area (top) = 150.31 in^2
Deck Axial Stess, f_t = **-0.50 Ksi**

R_{bottom} = 112.11 Kips
Axial Area (bottom) = 104.95 in^2
Bottom Axial Stess, f_b = **-1.07 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.92 Kip/ft
Unsupported Span, L = 10.50 ft   3.20 M
Maximum Bending Moment = 10 Kip-ft   [$w*L^2/10$]
Deck Section Modulous = 32.56 in^3
Deck Hydrostatic Bending Stess, f_t = **-3.75 Ksi**

Combine Stress	Pontoon Deck f_t (Ksi)	f_a (Ksi)	f_t/f_a	Pontoon Bottom f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-9.17	18.23	-0.50	13.36	22.60	0.59
Axial Squeeze Stress	-0.50	18.23	-0.03	-1.07	22.60	-0.05
Hydrostatic Bending Stress	-3.75	18.23	-0.21			
			-0.74			**0.54**

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - Strength**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 5 Combine Stress Evaulation

Transverse Bending Stress

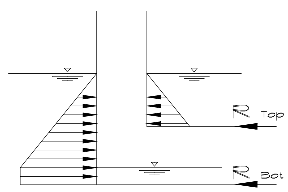
Bending Moment @ 27' off Centerline = 1,890 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 22,692 Kip-ft

S_{top} = 25,056 in^3
Deck Transverse Bending Stess, f_t = **-10.87 Ksi**

S_{bottom} = 17,202 in^3
Bottom Transverse Bending Stess, f_b = **15.83 Ksi**

Axial Squeeze Stress

Draft = 15.23 ft
Head on Pontoon Deck = 0.00 ft 0.00 $Kips/ft^2$
Head on Pontoon Bottom = 14.23 ft 0.91 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 29.69 Kips
Axial Area (top) = 150.31 in^2
Deck Axial Stess, f_t = **-0.20 Ksi**

R_{bottom} = 59.02 Kips
Axial Area (bottom) = 104.95 in^2
Bottom Axial Stess, f_b = **-0.56 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.00 Kip/ft
Unsupported Span, L = 10.50 ft 3.20 M
Maximum Bending Moment = 0 Kip-ft [w*L²/10]
Deck Section Modulous = 32.56 in^3
Deck Hydrostatic Bending Stess, f_t = **0.00 Ksi**

	Pontoon Deck			Pontoon Bottom		
Combine Stress	**f_t** (Ksi)	**f_a** (Ksi)	**f_t/f_a**	**f_b** (Ksi)	**f_a** (Ksi)	**f_b/f_a**
Transverse Bending Stress	-10.87	18.23	-0.60	15.83	22.60	0.70
Axial Squeeze Stress	-0.20	18.23	-0.01	-0.56	22.60	-0.02
Hydrostatic Bending Stress	0.00	18.23	0.00			
			-0.61			**0.68**

Column Buckling Check

Assumed Plating Corrosion = 10%
Assumed Stiffener Corrosion = 0%

Spacing of Stiffener = 732 mm 28.8 In.
Effective Span of Stiffener, l = 3200 mm 126.0 In.

Item	Original Dimensions	Units	Assumed Dimensions	Units	
Plate t =	0.63	In.	0.57	In.	10% corroded

Shape = L 247x9+100x15

Web Height =	247	mm	9.72	In.	
Web Thickness =	9	mm	0.35	In.	0% corroded
Flange Width =	100	mm	3.94	In.	
Flange Thickness =	15	mm	0.59	In.	0% corroded

I of Stiffener on Plate						
Item	Area	Arm	Area*Arm	Dist.	Area*D^2	I (Initial)
Plate	16.34	0.28	4.63	1.89	58	0
Web	3.45	5.43	18.71	-3.26	37	27
Flange	2.33	10.59	24.61	-8.42	165	0
Totals	22.11		47.95		259	28

Neutral Axis = 2.17 In.
Moment of Inertia, Ix-x (Total) = 287 $In.^4$
Area, A = 22.11 $In.^2$
Radius of Gyration, r = SQRT(I/A) = 3.60 In.

Column Buckling Check

Effective Length Factor, K =	1.00	[Pinned-Pinned]
Slenderness, KL/r =	35.0	
F_e =	234.2	ksi
F_y =	34.0	ksi
Buckling Type =	Inelastic	
F_{cr} =	32.0	Ksi
Plating Slenderness Width, b_{max} =	43.5	*t
=	24.67	in
	86%	
c1 =	0.22	
c2 =	1.49	
F_{el} =	55.3	ksi
Effective Width, b_e =	26.93	in
	93%	
Effective Area, A_e =	21.04	$In.^2$
	95%	
F_{cr}/Ω =	18.23	ksi

Appendix E – NASSCO Section Transverse Bending Calculations

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name :	**Trans Bend - NASSCO**
Done By :	**M. Naylor**
Date :	**8/17/2021**
Job No :	**4386-D**

Client : **NASSCO - SAN DIEGO**

Subject : **FLOATING DRY DOCK "BUILDER"**

Environment Conditions

Specific Gravity =	1.0250				
=	35.02	ft^3/LT	0.98	M^3/MT	

Floating Dock Dimensions

Pontoon Length =	783.07	ft	238.681	M
Pontoon Width =	170.60	ft	52.000	M
Wing Length =	783.07	ft	238.681	M
Wing Width =	14.75	ft	4.496	M
Pontoon Height @ CL =	17.22	ft	5.250	M
Pontoon Height @ Wing =	16.73	ft	5.100	M
Center Tanks Width =	41.99	ft	12.800	M
Wing Tanks Width =	43.31	ft	13.200	M

Floating Dock Characteristics

Structural Capacity =	72.50	LT/ft	241.73	MT/M	
Keel Block Hieght =	6.00	ft	1.830	M	
Estimated Dock Light Weight =	17,328	LT	17,603	MT	[From FRR]
Estimated Pontoon Weight =	9,496	LT	9,646	MT	
=	0.159	$Kips/ft^2$			
Estimated Wing Wieght =	7,832	LT	7,957	MT	
=	5.60	Kip/ft per shell			
Ballast Tank Permeability =	0.985				

Phase 3 Lifting Conditions

Dock Draft =	23.23	ft	7.080	M		
Buoyancy Under Wing =	1.49	$Kips/ft^2$				
Buoyancy Under Pontoon =	1.09	$Kips/ft^2$				
Ballast Water in Starboard Wing Tank =	1.00	ft	0.305	M	0.06	$Kips/ft^2$
Ballast Water in Starboard Center Tank =	1.00	ft	0.305	M	0.06	$Kips/ft^2$
Ballast Water in Port Center Tank =	1.00	ft	0.305	M	0.06	$Kips/ft^2$
Ballast Water in Port Wing Tank =	1.00	ft	0.305	M	0.06	$Kips/ft^2$

Phase 3 Forces Per Length of Dock

Buoyancy Under Starboard Wing =	21.91	Kips
Buoyancy Under Port Wing =	21.91	Kips
Buoyancy Under Pontoon =	153.23	Kips
Starboard Wing Weight =	-11.20	Kips
Port Wing Weight =	-11.20	Kips
Pontoon Weight =	-27.16	Kips
Ship Weight =	-162.40	Kips
Ballast Weight=	-10.75	Kips
Total =	-25.66	Kips

Shear in Bulkheads Must Equal	25.66	Kips to Achieve Equilibrium
Number of Bulkheads =	4	
Shear Force/BHD =	6.41	Kips/BHD

Phase 5 Lifting Conditions

Dock Draft =	15.23 ft	4.643 M	
Freboard =	1.50 ft	0.457 M	
Buoyancy Under Wing =	0.97 Kips/ft^2		
Buoyancy Under Pontoon =	0.97 Kips/ft^2		
Ballast Water in Starboard Wing Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2
Ballast Water in Starboard Center Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2
Ballast Water in Port Center Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2
Ballast Water in Port Wing Tank =	1.00 ft	0.305 M	0.06 Kips/ft^2

Phase 5 Forces Per Length of Dock

Buoyancy Under Starboard Wing =	14.37 Kips
Buoyancy Under Port Wing =	14.37 Kips
Buoyancy Under Pontoon =	137.47 Kips
Starboard Wing Weight =	-11.20 Kips
Port Wing Weight =	-11.20 Kips
Pontoon Weight =	-27.16 Kips
Ship Weight =	-162.40 Kips
Ballast Weight=	-10.75 Kips
Total =	-56.50 Kips

Shear in Bulkheads Must Equal	56.50 Kips to Achieve Equilibrium
Number of Bulkheads =	4
Shear Force/BHD =	14.13 Kips/BHD

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - NASSCO**

Done By : **M. Naylor**

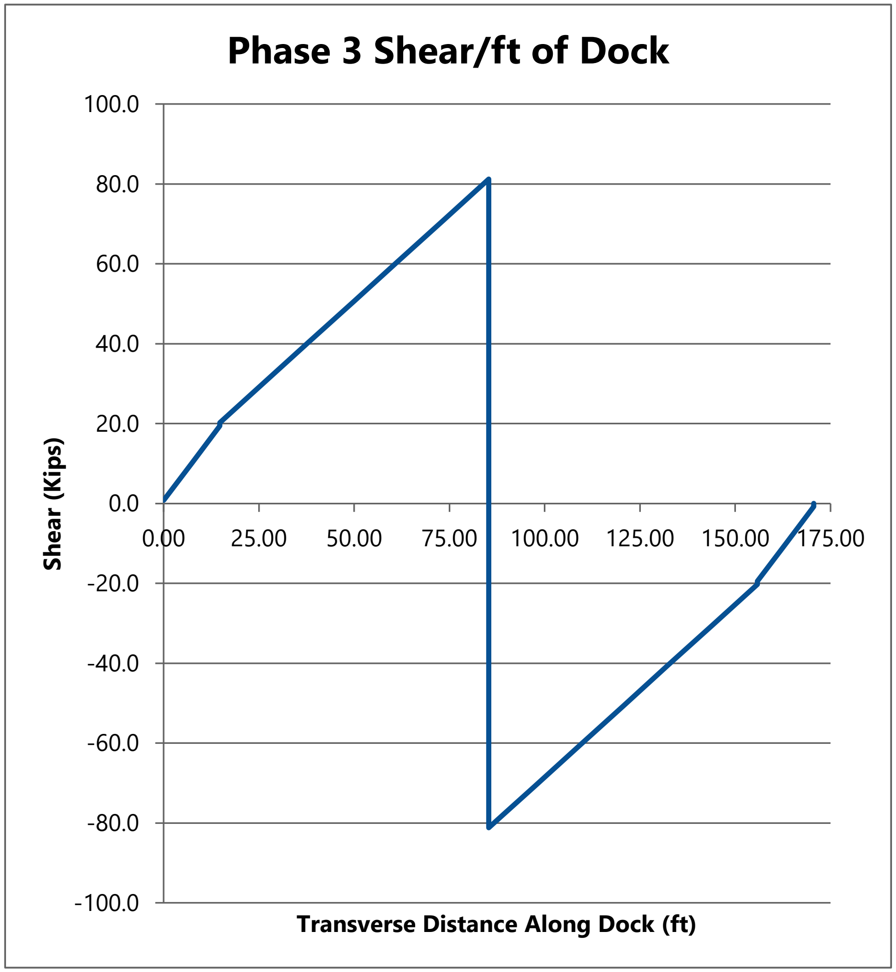
Date : **8/17/2021**

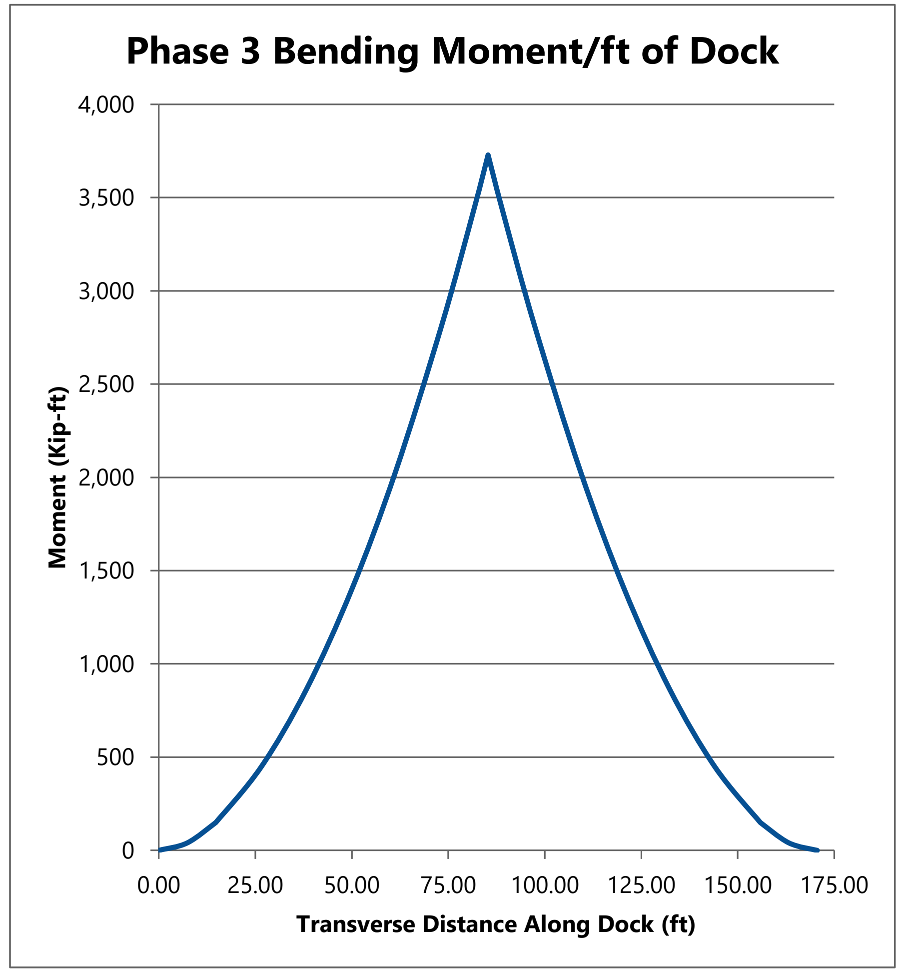
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**

Subject : **FLOATING DRY DOCK "BUILDER"**

	Phase 3 Transverse Bending - Beam Theory									
Location	X (ft)	Dist. off CL (M)	Buoyancy (Kips)	Pontoon Wt. (Kips)	Ballast Wt. (Kips)	Wing Wt. (Kips)	BHD Shear (Kips)	Ship Wt. (Kips)	Shear (Kips)	Moment (Kip-ft)
Wing Shell	0.00	-26.00	1.49	-0.16	-0.06	-5.60	6.41	0.00	0.8	0
Tank - Wing	7.38	-23.75	1.49	-0.16	-0.06	0.00	0.00	0.00	10.1	40
Tank - Wing	14.75	-21.50	1.49	-0.16	-0.06	0.00	0.00	0.00	19.5	149
Wing Shell	14.75	-21.50	1.49	-0.16	-0.06	-5.60	6.41	0.00	20.3	149
Tank - Pontoon	26.51	-17.92	1.09	-0.16	-0.06	0.00	0.00	0.00	30.4	447
Tank - Pontoon	38.27	-14.34	1.09	-0.16	-0.06	0.00	0.00	0.00	40.6	865
Tank - Pontoon	50.03	-10.75	1.09	-0.16	-0.06	0.00	0.00	0.00	50.7	1,402
Tank - Pontoon	61.30	-7.32	1.09	-0.16	-0.06	0.00	0.00	0.00	60.5	2,029
Tank - Pontoon	73.29	-3.66	1.09	-0.16	-0.06	0.00	0.00	0.00	70.8	2,816
Tank - Pontoon	81.63	-1.12	1.09	-0.16	-0.06	0.00	0.00	0.00	78.0	3,436
Tank - Pontoon	85.30	0.00	1.09	-0.16	-0.06	0.00	0.00	0.00	81.2	3,729
Centerline	85.30	0.00	1.09	-0.16	-0.06	0.00	0.00	-162.40	-81.2	3,729
Tank - Pontoon	88.97	1.12	1.09	-0.16	-0.06	0.00	0.00	0.00	-78.0	3,436
Tank - Pontoon	97.31	3.66	1.09	-0.16	-0.06	0.00	0.00	0.00	-70.8	2,816
Tank - Pontoon	109.30	7.32	1.09	-0.16	-0.06	0.00	0.00	0.00	-60.5	2,029
Tank - Pontoon	120.58	10.75	1.09	-0.16	-0.06	0.00	0.00	0.00	-50.7	1,402
Tank - Pontoon	132.34	14.34	1.09	-0.16	-0.06	0.00	0.00	0.00	-40.6	865
Tank - Pontoon	144.09	17.92	1.09	-0.16	-0.06	0.00	0.00	0.00	-30.4	447
Tank - Pontoon	155.85	21.50	1.09	-0.16	-0.06	0.00	0.00	0.00	-20.3	149
Wing Shell	155.85	21.50	1.49	-0.16	-0.06	-5.60	6.41	0.00	-19.5	149
Tank - Wing	163.23	23.75	1.49	-0.16	-0.06	0.00	0.00	0.00	-10.1	40
Tank - Wing	170.60	26.00	1.49	-0.16	-0.06	0.00	0.00	0.00	-0.8	0
Wing Shell	170.60	26.00	1.49	-0.16	-0.06	-5.60	6.41	0.00	0.0	0


Phase 3 Shear/ft of Dock
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
Shear (Kips)
0.00
25.00
50.00
75.00
100.00
125.00
150.00
175.00
Transverse Distance Along Dock (ft)


Phase 3 Bending Moment/ft of Dock
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Moment (Kip-ft)
0.00
25.00
50.00
75.00
100.00
125.00
150.00
175.00
Transverse Distance Along Dock (ft)

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - NASSCO**

Done By : **M. Naylor**

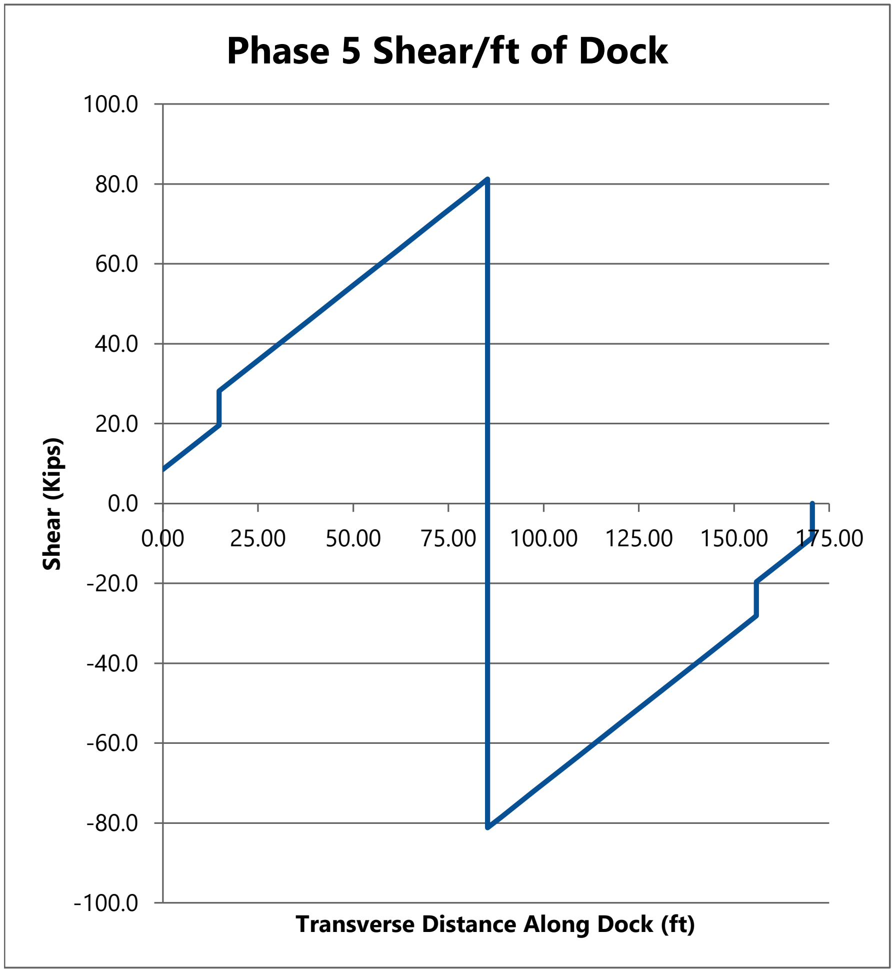
Date : **8/17/2021**

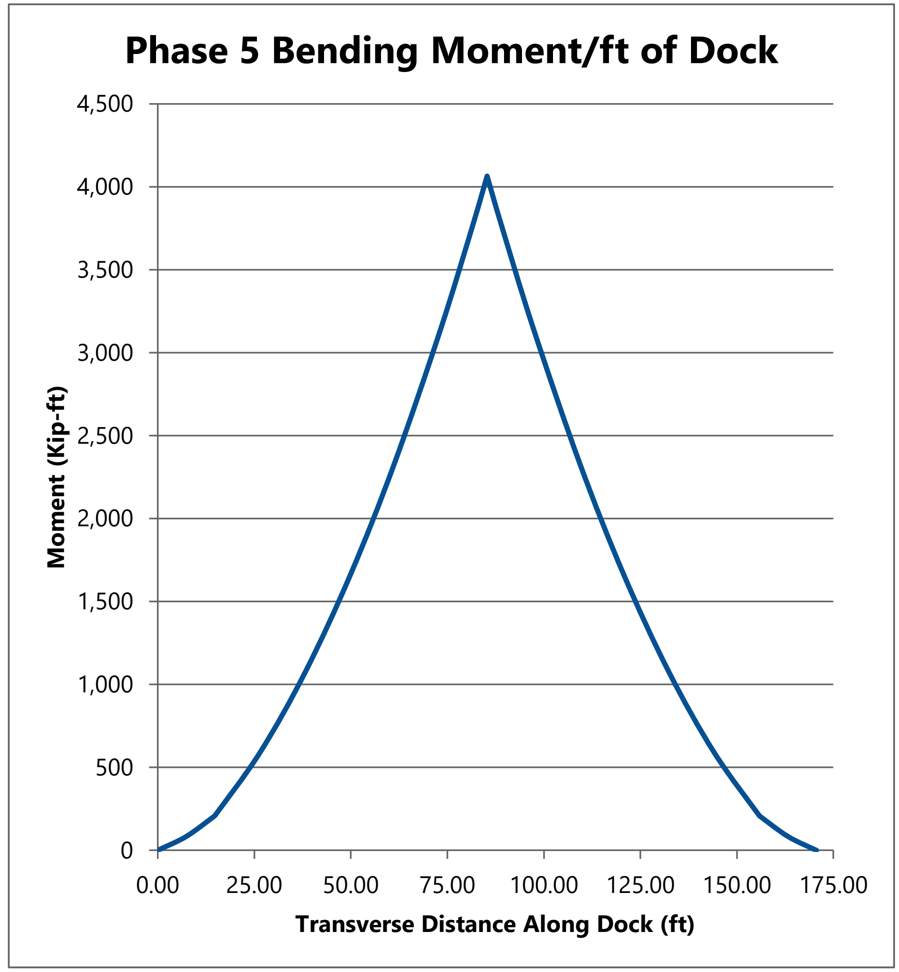
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**

Subject : **FLOATING DRY DOCK "BUILDER"**

	Phase 5 Transverse Bending - Beam Theory									
Location	X	Dist. off CL	Buoyancy	Pontoon Wt.	Ballast Wt.	Wing Wt.	BHD Shear	Ship Wt.	Shear	Moment
	(ft)	(M)	(Kips)	(Kips)	(Kips)	(Kips)	(Kips)	(Kips)	(Kips)	(Kip-ft)
Wing Shell	0.00	-26.00	0.97	-0.16	-0.06	-5.60	14.13	0.00	8.5	0
Tank - Wing	7.38	-23.75	0.97	-0.16	-0.06	0.00	0.00	0.00	14.1	83
Tank - Wing	14.75	-21.50	0.97	-0.16	-0.06	0.00	0.00	0.00	19.6	208
Wing Shell	14.75	-21.50	0.97	-0.16	-0.06	-5.60	14.13	0.00	28.1	208
Tank - Pontoon	26.51	-17.92	0.97	-0.16	-0.06	0.00	0.00	0.00	37.0	590
Tank - Pontoon	38.27	-14.34	0.97	-0.16	-0.06	0.00	0.00	0.00	45.8	1,077
Tank - Pontoon	50.03	-10.75	0.97	-0.16	-0.06	0.00	0.00	0.00	54.7	1,668
Tank - Pontoon	61.30	-7.32	0.97	-0.16	-0.06	0.00	0.00	0.00	63.2	2,332
Tank - Pontoon	73.29	-3.66	0.97	-0.16	-0.06	0.00	0.00	0.00	72.2	3,144
Tank - Pontoon	81.63	-1.12	0.97	-0.16	-0.06	0.00	0.00	0.00	78.4	3,772
Tank - Pontoon	85.30	0.00	0.97	-0.16	-0.06	0.00	0.00	0.00	81.2	4,065
Centerline	85.30	0.00	0.97	-0.16	-0.06	0.00	0.00	-162.40	-81.2	4,065
Tank - Pontoon	88.97	1.12	0.97	-0.16	-0.06	0.00	0.00	0.00	-78.4	3,772
Tank - Pontoon	97.31	3.66	0.97	-0.16	-0.06	0.00	0.00	0.00	-72.2	3,144
Tank - Pontoon	109.30	7.32	0.97	-0.16	-0.06	0.00	0.00	0.00	-63.2	2,332
Tank - Pontoon	120.58	10.75	0.97	-0.16	-0.06	0.00	0.00	0.00	-54.7	1,668
Tank - Pontoon	132.34	14.34	0.97	-0.16	-0.06	0.00	0.00	0.00	-45.8	1,077
Tank - Pontoon	144.09	17.92	0.97	-0.16	-0.06	0.00	0.00	0.00	-37.0	590
Tank - Pontoon	155.85	21.50	0.97	-0.16	-0.06	0.00	0.00	0.00	-28.1	208
Wing Shell	155.85	21.50	0.97	-0.16	-0.06	-5.60	14.13	0.00	-19.6	208
Tank - Wing	163.23	23.75	0.97	-0.16	-0.06	0.00	0.00	0.00	-14.1	83
Tank - Wing	170.60	26.00	0.97	-0.16	-0.06	0.00	0.00	0.00	-8.5	0
Wing Shell	170.60	26.00	0.97	-0.16	-0.06	-5.60	14.13	0.00	0.0	0


Phase 5 Shear/ft of Dock
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
-80.0
-100.0
0.00
25.00
50.00
75.00
100.00
125.00
150.00
175.00
Shear (Kips)
Transverse Distance Along Dock (ft)


Phase 5 Bending Moment/ft of Dock
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0.00
25.00
50.00
75.00
100.00
125.00
150.00
175.00
Moment (Kip-ft)
Transverse Distance Along Dock (ft)

HEGER DRY DOCK, Inc.

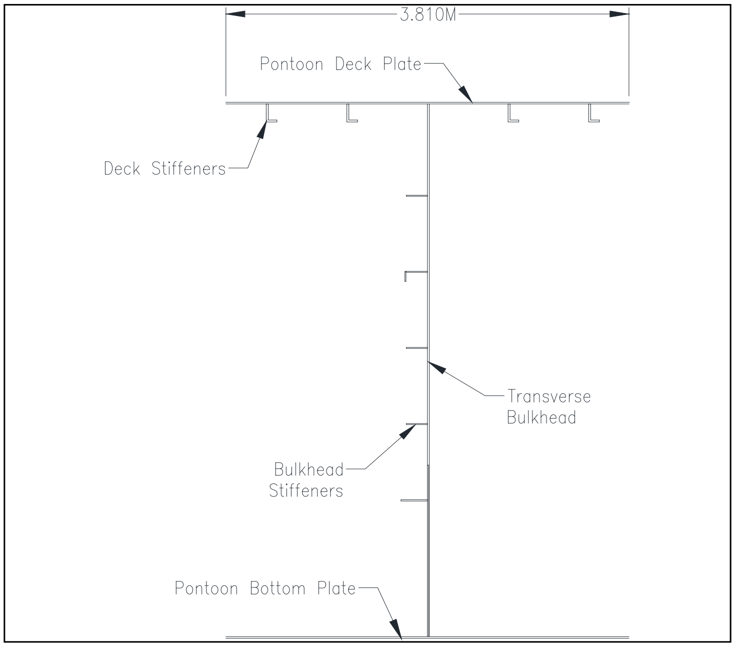
HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - NASSCO**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Transverse Bulkhead Section Properties

Distance off CL =	0.00 ft	0.000 M
Frame Spacing =	12.50 ft	3.810 M



Transverse Section Properites									
Member	Orig. t (in)	Corr. (%)	t corr. (in)	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Deck Pl. 16mm	0.630	5%	0.598	89.76	206.99	18,580	97.02	844,981	3
BHD Pl. 18mm	0.709	0%	0.709	146.48	103.35	15,138	-6.62	6,425	521,476
Bottom Pl. 16mm	0.630	0%	0.630	94.49	-0.31	-30	-110.28	1,149,228	3
(4) Deck Stiff - L 7"x4"x3/4"	-	0%	-	30.96	202.19	6,260	92.22	263,320	151
BHD Stiff (1) - FB 254x16	-	0%	-	6.30	53.15	335	-56.82	20,337	0
BHD Stiff (2) - FB 203x9.5	-	0%	-	2.99	82.68	247	-27.29	2,227	0
BHD Stiff (3) FB 203x9.5	-	0%	-	2.99	112.20	335	2.24	15	0
BHD Stiff (4) - L 382x10+152x9.5	-	0%	-	8.16	141.73	1,156	31.76	8,232	0
BHD Stiff (5) - FB 203x9.5	-	0%	-	2.99	171.26	512	61.29	11,229	0
Totals				382.12		42,022		2,294,765	521,633

Depth of Section =	207.29 in	5.27 M
Neutral Axis =	109.97 in	2.79 M
Net Moment of Inertia =	2,816,397 in^4	

y_{top} =	97.32 in	y_{bottom} =	109.97 in
S_{top} =	28,939 in^3	S_{bottom} =	25,611 in^3

Shear Area =	146.48 in^2
Axial Area (top) =	193.96 in^2
Axial Area (bottom) =	167.73 in^2

Pontoon Deck Stiffeners - Local Section Properties

L 7"x4"x3/4" on 0.63in Plate

Item	Original Dimensions	Corrosion (%)	Assumed Dimensions
Plate Thickness =	0.63 in	5%	0.60 in
Stiffener Height =	7.00 in	-	7.00 in
Stiffener Area =	7.74 in^2	0%	7.74 in^2
Stiffener Ix-x =	38 in^4	0%	38 in^4
Stiffener NA (y) =	4.50 in	-	4.50 in

Spacing of Stiffeners, s = 2.50 ft 0.762 M

Effective Plate Width = 23.94 in [Min(40*t,s)]

Item	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Plate	14.32	0.30	4.29	-1.68	41	0
Stiffener	7.74	5.10	39.46	3.12	75	38
Totals	22.06		43.75		116	38

Depth of Section = 7.60 in
Neutral Axis = 1.98 in
Net Moment of Inertia = 154 in^4
Section Modulous = 27 in^3

Phase 3 Combine Stress Evaulation

Transverse Bending Stress

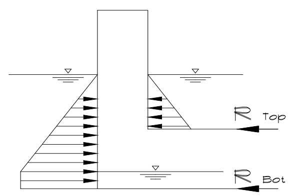
Bending Moment @ 0' off Centerline = 3,729 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 46,608 Kip-ft

S_{top} = 28,939 in^3
Deck Transverse Bending Stess, f_t = **-19.33 Ksi**

S_{bottom} = 25,611 in^3
Bottom Transverse Bending Stess, f_b = **21.84 Ksi**

Axial Squeeze Stress

Draft = 23.23 ft
Head on Pontoon Deck = 6.00 ft   0.38 $Kips/ft^2$
Head on Pontoon Bottom = 22.23 ft   1.42 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 78.62 Kips
Axial Area (top) = 193.96 in^2
Deck Axial Stess, f_t = **-0.41 Ksi**

R_{bottom} = 116.70 Kips
Axial Area (bottom) = 167.73 in^2
Bottom Axial Stess, f_b = **-0.70 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.96 Kip/ft
Unsupported Span, L = 1.64 ft   0.50 M
Maximum Bending Moment = 0 Kip-ft   [$w*L^2/10$]
Deck Section Modulous = 27.42 in^3
Deck Hydrostatic Bending Stess, f_t = **-0.11 Ksi**

	Pontoon Deck			Pontoon Bottom		
Combine Stress	f_t (Ksi)	f_a (Ksi)	f_t/f_a	f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-19.33	22.90	-0.84	21.84	31.42	0.70
Axial Squeeze Stress	-0.41	22.90	-0.02	-0.70	31.42	-0.02
Hydrostatic Bending Stress	-0.11	22.90	0.00			
			-0.87			**0.67**

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - NASSCO**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 5 Combine Stress Evaulation

Transverse Bending Stress

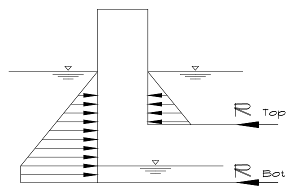
Bending Moment @ 0' off Centerline = 4,065 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 50,809 Kip-ft

S_{top} = 28,939 in^3
Deck Transverse Bending Stess, f_t = **-21.07 Ksi**

S_{bottom} = 25,611 in^3
Bottom Transverse Bending Stess, f_b = **23.81 Ksi**

Axial Squeeze Stress

Draft = 15.23 ft
Head on Pontoon Deck = 0.00 ft   0.00 $Kips/ft^2$
Head on Pontoon Bottom = 14.23 ft   0.91 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 30.91 Kips
Axial Area (top) = 193.96 in^2
Deck Axial Stess, f_t = **-0.16 Ksi**

R_{bottom} = 61.44 Kips
Axial Area (bottom) = 167.73 in^2
Bottom Axial Stess, f_b = **-0.37 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.00 Kip/ft
Unsupported Span, L = 1.64 ft   0.50 M
Maximum Bending Moment = 0 Kip-ft   [$w*L^2/10$]
Deck Section Modulous = 27.42 in^3
Deck Hydrostatic Bending Stess, f_t = **0.00 Ksi**

Combine Stress	Pontoon Deck f_t (Ksi)	Pontoon Deck f_a (Ksi)	Pontoon Deck f_t/f_a	Pontoon Bottom f_b (Ksi)	Pontoon Bottom f_a (Ksi)	Pontoon Bottom f_b/f_a
Transverse Bending Stress	-21.07	22.90	-0.92	23.81	31.42	0.76
Axial Squeeze Stress	-0.16	22.90	-0.01	-0.37	31.42	-0.01
Hydrostatic Bending Stress	0.00	22.90	0.00			
			-0.93			**0.75**

HEGER DRY DOCK, Inc.

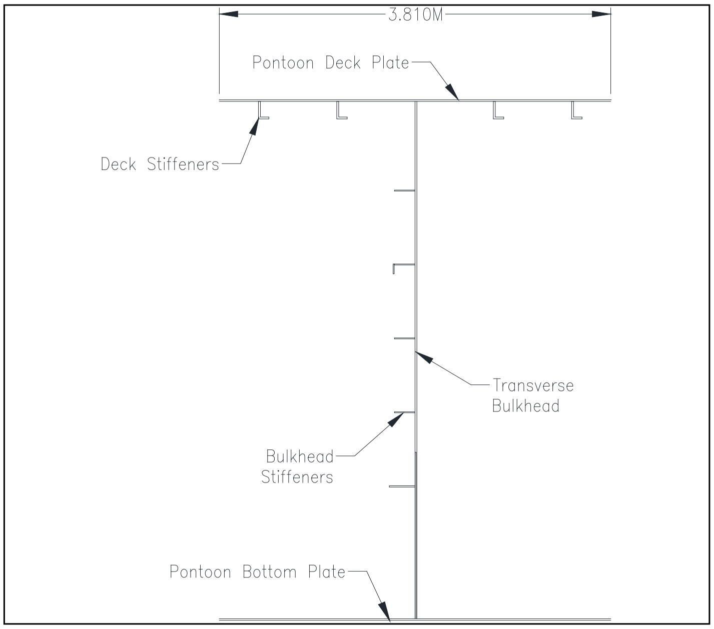
HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - NASSCO**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Transverse Bulkhead Section Properties

Distance off CL = 3.67 ft 1.120 M
Frame Spacing = 12.50 ft 3.810 M



Transverse Section Properites									
Member	Orig. t (in)	Corr. (%)	t corr. (in)	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Deck Pl. 16mm	0.630	5%	0.598	89.76	206.68	18,553	95.61	820,637	3
BHD Pl. 18mm	0.709	0%	0.709	77.20	151.91	11,728	40.84	128,791	76,361
BHD Pl. 16mm	0.630	0%	0.630	61.38	48.72	2,990	-62.35	238,611	48,566
Bottom Pl. 16.0mm	0.630	0%	0.630	94.49	-0.31	-30	-111.38	1,172,273	3
(4) Deck Stiff - L 7"x4"x3/4"	-	0%	-	30.96	201.89	6,250	90.82	255,342	151
BHD Stiff (1) - FB 254x16	-	0%	-	6.30	53.15	335	-57.92	21,132	0
BHD Stiff (2) - FB 203x9.5	-	0%	-	2.99	82.68	247	-28.39	2,410	0
BHD Stiff (3) FB 203x9.5	-	0%	-	2.99	112.20	335	1.13	4	0
BHD Stiff (4) - L 382x10+152x9.5	-	0%	-	8.16	141.73	1,156	30.66	7,671	0
BHD Stiff (5) - FB 203x9.5	-	0%	-	2.99	171.26	512	60.19	10,829	0
Totals				374.23		41,566		2,646,872	125,084

Depth of Section = 206.98 in 5.26 M
Neutral Axis = 111.07 in 2.82 M
Net Moment of Inertia = 2,771,956 in^4

y_{top} = 95.91 in y_{bottom} = 111.07 in
S_{top} = 28,900 in^3 S_{bottom} = 24,957 in^3

Shear Area = 138.58 in^2
Axial Area (top) = 197.93 in^2
Axial Area (bottom) = 155.87 in^2

44" off CL

NASSCO Section
Frame 41-80 to 41

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - NASSCO**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Pontoon Deck Stiffeners - Local Section Properties

L 7"x4"x3/4" on 0.63in Plate

Item	Original Dimensions	Corrosion (%)	Assumed Dimensions
Plate Thickness =	0.63 in	5%	0.60 in
Stiffener Height =	7.00 in	-	7.00 in
Stiffener Area =	7.74 in^2	0%	7.74 in^2
Stiffener Ix-x =	38 in^4	0%	38 in^4
Stiffener NA (y) =	4.50 in	-	4.50 in

Spacing of Stiffeners, s = 2.50 ft 0.762 M

Effective Plate Width = 23.94 in [Min(40*t,s]

Item	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Plate	14.32	0.30	4.29	-1.68	41	0
Stiffener	7.74	5.10	39.46	3.12	75	38
Totals	22.06		43.75		116	38

Depth of Section = 7.60 in
Neutral Axis = 1.98 in
Net Moment of Inertia = 154 in^4
Section Modulous = 27 in^3

44" off CL

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 3 Combine Stress Evaulation

Transverse Bending Stress

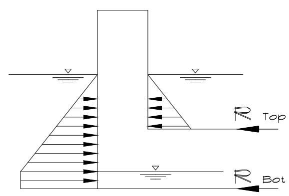
Bending Moment @ 4' off Centerline = 3,436 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 42,954 Kip-ft

S_{top} = 28,900 in^3
Deck Transverse Bending Stess, f_t = **-17.84 Ksi**

S_{bottom} = 24,957 in^3
Bottom Transverse Bending Stess, f_b = **20.65 Ksi**

Axial Squeeze Stress

Draft = 23.23 ft
Head on Pontoon Deck = 6.00 ft — 0.38 $Kips/ft^2$
Head on Pontoon Bottom = 22.23 ft — 1.42 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 78.62 Kips
Axial Area (top) = 197.93 in^2
Deck Axial Stess, f_t = **-0.40 Ksi**

R_{bottom} = 116.70 Kips
Axial Area (bottom) = 155.87 in^2
Bottom Axial Stess, f_b = **-0.75 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.96 Kip/ft
Unsupported Span, L = 8.86 ft — 2.70 M
Maximum Bending Moment = 8 Kip-ft — [$w*L^2/10$]
Deck Section Modulous = 27.42 in^3
Deck Hydrostatic Bending Stess, f_t = **-3.30 Ksi**

	Pontoon Deck			Pontoon Bottom		
Combine Stress	f_t (Ksi)	f_a (Ksi)	f_t/f_a	f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-17.84	22.90	-0.78	20.65	31.42	0.66
Axial Squeeze Stress	-0.40	22.90	-0.02	-0.75	31.42	-0.02
Hydrostatic Bending Stress	-3.30	22.90	-0.14			
			-0.94			**0.63**

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - NASSCO**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 5 Combine Stress Evaulation

Transverse Bending Stress

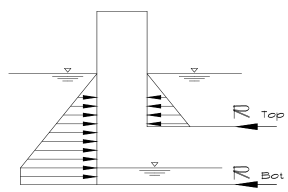
Bending Moment @ 4' off Centerline = 3,772 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 47,146 Kip-ft

S_{top} = 28,900 in^3
Deck Transverse Bending Stess, f_t = **-19.58 Ksi**

S_{bottom} = 24,957 in^3
Bottom Transverse Bending Stess, f_b = **22.67 Ksi**

Axial Squeeze Stress

Draft = 15.23 ft
Head on Pontoon Deck = 0.00 ft 0.00 $Kips/ft^2$
Head on Pontoon Bottom = 14.23 ft 0.91 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 30.91 Kips
Axial Area (top) = 197.93 in^2
Deck Axial Stess, f_t = **-0.16 Ksi**

R_{bottom} = 61.44 Kips
Axial Area (bottom) = 155.87 in^2
Bottom Axial Stess, f_b = **-0.39 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.00 Kip/ft
Unsupported Span, L = 8.86 ft 2.70 M
Maximum Bending Moment = 0 Kip-ft [$w*L^2/10$]
Deck Section Modulous = 27.42 in^3
Deck Hydrostatic Bending Stess, f_t = **0.00 Ksi**

	Pontoon Deck			Pontoon Bottom		
Combine Stress	f_t (Ksi)	f_a (Ksi)	f_t/f_a	f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-19.58	22.90	-0.85	22.67	31.42	0.72
Axial Squeeze Stress	-0.16	22.90	-0.01	-0.39	31.42	-0.01
Hydrostatic Bending Stress	0.00	22.90	0.00			
			-0.86			**0.71**

HEGER DRY DOCK, Inc.

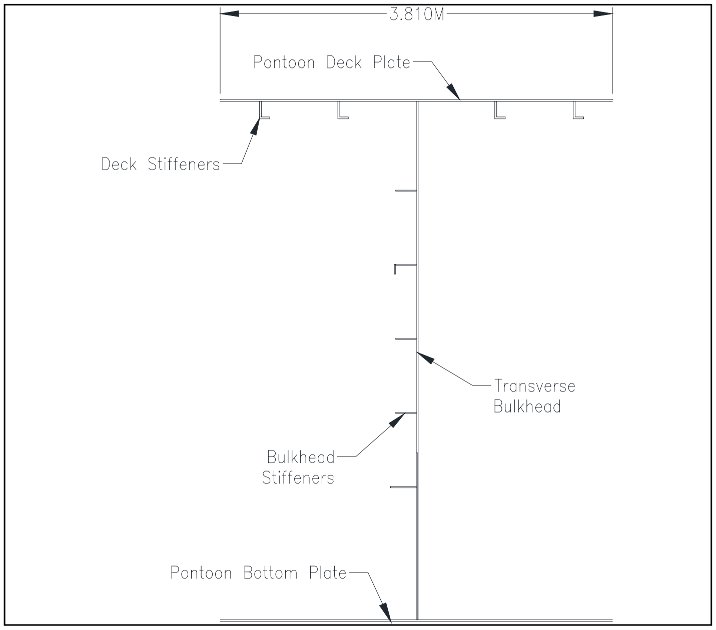
HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - NASSCO**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Transverse Bulkhead Section Properties

Distance off CL = 12.01 ft 3.660 M
Frame Spacing = 12.50 ft 3.810 M



Transverse Section Properites

Member	Orig. t (in)	Corr. (%)	t corr. (in)	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Deck Pl. 16mm	0.630	5%	0.598	89.76	205.99	18,490	95.27	814,697	3
BHD Pl. 18mm	0.709	0%	0.709	76.71	151.56	11,627	40.85	127,980	74,903
BHD Pl. 16mm	0.630	0%	0.630	61.38	48.72	2,990	-62.00	235,932	48,566
Bottom Pl. 16mm	0.630	0%	0.630	94.49	-0.31	-30	-111.03	1,164,897	3
(4) Deck Stiff - L 7"x4"x3/4"	-	0%	-	30.96	201.19	6,229	90.47	253,396	151
BHD Stiff (1) - FB 254x16	-	0%	-	6.30	53.15	335	-57.57	20,877	0
BHD Stiff (2) - FB 203x9.5	-	0%	-	2.99	82.68	247	-28.04	2,350	0
BHD Stiff (3) FB 203x9.5	-	0%	-	2.99	112.20	335	1.49	7	0
BHD Stiff (4) - L 382x10+152x9.5	-	0%	-	8.16	141.73	1,156	31.01	7,848	0
BHD Stiff (5) - FB 203x9.5	-	0%	-	2.99	171.26	512	60.54	10,956	0
Totals				373.74		41,380		2,627,985	123,626

Depth of Section = 206.29 in 5.24 M
Neutral Axis = 110.72 in 2.81 M
Net Moment of Inertia = 2,751,611 in^4

y_{top} = 95.57 in y_{bottom} = 110.72 in
S_{top} = 28,792 in^3 S_{bottom} = 24,852 in^3

Shear Area = 138.09 in^2
Axial Area (top) = 197.43 in^2
Axial Area (bottom) = 155.87 in^2

12' off CL

NASSCO Section
Frame 41-80 to 41

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - NASSCO**

Done By : **M. Naylor**

Date : **8/17/2021**

Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**

Subject : **FLOATING DRY DOCK "BUILDER"**

Pontoon Deck Stiffeners - Local Section Properties

L 7"x4"x3/4" on 0.63in Plate

Item	Original Dimensions	Corrosion (%)	Assumed Dimensions
Plate Thickness =	0.63 in	5%	0.60 in
Stiffener Height =	7.00 in	-	7.00 in
Stiffener Area =	7.74 in^2	0%	7.74 in^2
Stiffener Ix-x =	38 in^4	0%	38 in^4
Stiffener NA (y) =	4.50 in	-	4.50 in

Spacing of Stiffeners, s = 2.50 ft 0.762 M

Effective Plate Width = 23.94 in [Min(40*t,s]

Item	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Plate	14.32	0.30	4.29	-1.68	41	0
Stiffener	7.74	5.10	39.46	3.12	75	38
Totals	22.06		43.75		116	38

Depth of Section = 7.60 in

Neutral Axis = 1.98 in

Net Moment of Inertia = 154 in^4

Section Modulous = 27 in^3

Phase 3 Combine Stress Evaulation

Transverse Bending Stress

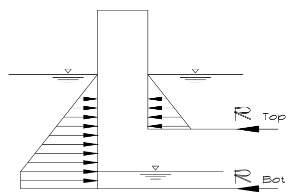
Bending Moment @ 12' off Centerline = 2,816 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 35,198 Kip-ft

S_{top} = 28,792 in^3
Deck Transverse Bending Stess, f_t = **-14.67 Ksi**

S_{bottom} = 24,852 in^3
Bottom Transverse Bending Stess, f_b = **17.00 Ksi**

Axial Squeeze Stress

Draft = 23.23 ft
Head on Pontoon Deck = 6.00 ft 0.38 $Kips/ft^2$
Head on Pontoon Bottom = 22.23 ft 1.42 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 78.62 Kips
Axial Area (top) = 197.43 in^2
Deck Axial Stess, f_t = **-0.40 Ksi**

R_{bottom} = 116.70 Kips
Axial Area (bottom) = 155.87 in^2
Bottom Axial Stess, f_b = **-0.75 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.96 Kip/ft
Unsupported Span, L = 10.50 ft 3.20 M
Maximum Bending Moment = 11 Kip-ft [$w*L^2/10$]
Deck Section Modulous = 27.42 in^3
Deck Hydrostatic Bending Stess, f_t = **-4.63 Ksi**

	Pontoon Deck			Pontoon Bottom		
Combine Stress	f_t (Ksi)	f_a (Ksi)	f_t/f_a	f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-14.67	22.90	-0.64	17.00	31.42	0.54
Axial Squeeze Stress	-0.40	22.90	-0.02	-0.75	31.42	-0.02
Hydrostatic Bending Stress	-4.63	22.90	-0.20			
			-0.86			**0.52**

Phase 5 Combine Stress Evaulation

Transverse Bending Stress

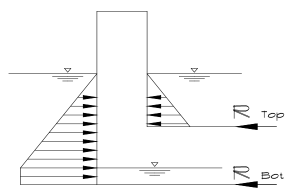
Bending Moment @ 12' off Centerline = 3,144 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 39,298 Kip-ft

S_{top} = 28,792 in^3
Deck Transverse Bending Stess, f_t = **-16.38 Ksi**

S_{bottom} = 24,852 in^3
Bottom Transverse Bending Stess, f_b = **18.98 Ksi**

Axial Squeeze Stress

Draft = 15.23 ft
Head on Pontoon Deck = 0.00 ft   0.00 $Kips/ft^2$
Head on Pontoon Bottom = 14.23 ft   0.91 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 30.91 Kips
Axial Area (top) = 197.43 in^2
Deck Axial Stess, f_t = **-0.16 Ksi**

R_{bottom} = 61.44 Kips
Axial Area (bottom) = 155.87 in^2
Bottom Axial Stess, f_b = **-0.39 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.00 Kip/ft
Unsupported Span, L = 10.50 ft   3.20 M
Maximum Bending Moment = 0 Kip-ft   [w*L^2/10]
Deck Section Modulous = 27.42 in^3
Deck Hydrostatic Bending Stess, f_t = **0.00 Ksi**

	Pontoon Deck			Pontoon Bottom		
Combine Stress	f_t (Ksi)	f_a (Ksi)	f_t/f_a	f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-16.38	22.90	-0.72	18.98	31.42	0.60
Axial Squeeze Stress	-0.16	22.90	-0.01	-0.39	31.42	-0.01
Hydrostatic Bending Stress	0.00	22.90	0.00			
			-0.72			**0.59**

HEGER DRY DOCK, Inc.

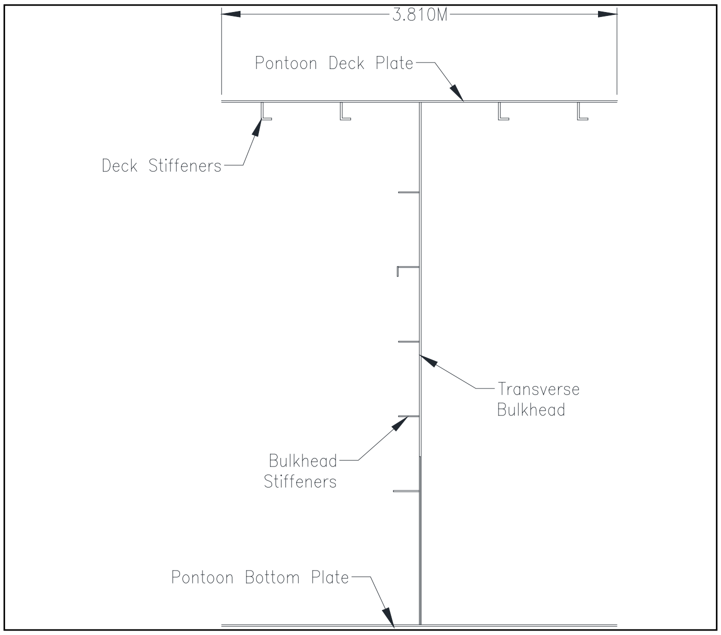
HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - NASSCO**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Transverse Bulkhead Section Properties

Distance off CL = 24.00 ft 7.315 M
Frame Spacing = 12.50 ft 3.810 M



Transverse Section Properites									
Member	Orig. t (in)	Corr. (%)	t corr. (in)	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Deck Pl. 16mm	0.630	5%	0.598	89.76	204.98	18,400	94.77	806,190	3
BHD Pl. 18mm	0.709	0%	0.709	76.00	151.06	11,481	40.85	126,813	72,839
BHD Pl. 16mm	0.630	0%	0.630	61.38	48.72	2,990	-61.49	232,105	48,566
Bottom Pl. 16mm	0.630	0%	0.630	94.49	-0.31	-30	-110.53	1,154,326	3
(4) Deck Stiff - L 7"x4"x3/4"	-	0%	-	30.96	200.18	6,198	89.97	250,610	151
BHD Stiff (1) - FB 254x16	-	0%	-	6.30	53.15	335	-57.06	20,512	0
BHD Stiff (2) - FB 203x9.5	-	0%	-	2.99	82.68	247	-27.54	2,267	0
BHD Stiff (3) FB 203x9.5	-	0%	-	2.99	112.20	335	1.99	12	0
BHD Stiff (4) - L 382x10+152x9.5	-	0%	-	8.16	141.73	1,156	31.52	8,105	0
BHD Stiff (5) - FB 203x9.5	-	0%	-	2.99	171.26	512	61.05	11,140	0
Totals				373.03		41,113		2,600,939	121,562

Depth of Section = 205.28 in 5.21 M
Neutral Axis = 110.21 in 2.80 M
Net Moment of Inertia = 2,722,501 in^4

y_{top} = 95.07 in y_{bottom} = 110.21 in
S_{top} = 28,637 in^3 S_{bottom} = 24,702 in^3

Shear Area = 137.38 in^2
Axial Area (top) = 196.72 in^2
Axial Area (bottom) = 155.87 in^2

Pontoon Deck Stiffeners - Local Section Properties

L 7"x4"x3/4" on 0.63in Plate

Item	Original Dimensions	Corrosion (%)	Assumed Dimensions
Plate Thickness =	0.63 in	5%	0.60 in
Stiffener Height =	7.00 in	-	7.00 in
Stiffener Area =	7.74 in^2	0%	7.74 in^2
Stiffener Ix-x =	38 in^4	0%	38 in^4
Stiffener NA (y) =	4.50 in	-	4.50 in

Spacing of Stiffeners, s = 2.50 ft 0.762 M

Effective Plate Width = 23.94 in [Min(40*t,s]

Item	A (in^2)	y (in)	A x y (in^3)	d (in)	A x d^2 (in^4)	I_o (in^4)
Plate	14.32	0.30	4.29	-1.68	41	0
Stiffener	7.74	5.10	39.46	3.12	75	38
Totals	22.06		43.75		116	38

Depth of Section = 7.60 in
Neutral Axis = 1.98 in
Net Moment of Inertia = 154 in^4
Section Modulous = 27 in^3

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETS

File Name : **Trans Bend - NASSCO**
Done By : **M. Naylor**
Date : **8/17/2021**
Job No : **4386-D**

Client : **NASSCO - SAN DIEGO**
Subject : **FLOATING DRY DOCK "BUILDER"**

Phase 3 Combine Stress Evaulation

Transverse Bending Stress

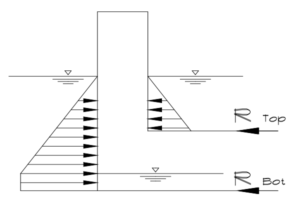
Bending Moment @ 24' off Centerline = 2,029 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 25,357 Kip-ft

S_{top} = 28,637 in^3
Deck Transverse Bending Stess, f_t = **-10.63 Ksi**

S_{bottom} = 24,702 in^3
Bottom Transverse Bending Stess, f_b = **12.32 Ksi**

Axial Squeeze Stress

Draft = 23.23 ft
Head on Pontoon Deck = 6.00 ft   0.38 $Kips/ft^2$
Head on Pontoon Bottom = 22.23 ft   1.42 $Kips/ft^2$
Internal Water Depth = 1.00 ft



R_{top} = 78.62 Kips
Axial Area (top) = 196.72 in^2
Deck Axial Stess, f_t = **-0.40 Ksi**

R_{bottom} = 116.70 Kips
Axial Area (bottom) = 155.87 in^2
Bottom Axial Stess, f_b = **-0.75 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.96 Kip/ft
Unsupported Span, L = 10.50 ft   3.20 M
Maximum Bending Moment = 11 Kip-ft $[w*L^2/10]$
Deck Section Modulous = 27.42 in^3
Deck Hydrostatic Bending Stess, f_t = **-4.63 Ksi**

	Pontoon Deck			Pontoon Bottom		
Combine Stress	f_t (Ksi)	f_a (Ksi)	f_t/f_a	f_b (Ksi)	f_a (Ksi)	f_b/f_a
Transverse Bending Stress	-10.63	22.90	-0.46	12.32	31.42	0.39
Axial Squeeze Stress	-0.40	22.90	-0.02	-0.75	31.42	-0.02
Hydrostatic Bending Stress	-4.63	22.90	-0.20			
			-0.68			**0.37**

Phase 5 Combine Stress Evaulation

Transverse Bending Stress

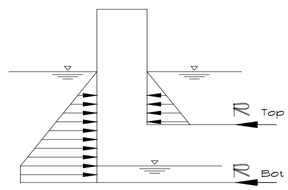
Bending Moment @ 24' off Centerline = 2,332 Kip-ft per Foot of Dock
Bending Moment per Bulkhead = 29,156 Kip-ft

S_{top} = 28,637 in^3
Deck Transverse Bending Stess, f_t = **-12.22 Ksi**

S_{bottom} = 24,702 in^3
Bottom Transverse Bending Stess, f_b = **14.16 Ksi**

Axial Squeeze Stress

Draft = 15.23 ft
Head on Pontoon Deck = 0.00 ft 0.00 Kips/ft^2
Head on Pontoon Bottom = 14.23 ft 0.91 Kips/ft^2
Internal Water Depth = 1.00 ft



R_{top} = 30.91 Kips
Axial Area (top) = 196.72 in^2
Deck Axial Stess, f_t = **-0.16 Ksi**

R_{bottom} = 61.44 Kips
Axial Area (bottom) = 155.87 in^2
Bottom Axial Stess, f_b = **-0.39 Ksi**

Local Hydostatic Stress

Uniform Hydrostaic Load on Deck Stiffener, w = 0.00 Kip/ft
Unsupported Span, L = 10.50 ft 3.20 M
Maximum Bending Moment = 0 Kip-ft [w*L²/10]
Deck Section Modulous = 27.42 in^3
Deck Hydrostatic Bending Stess, f_t = **0.00 Ksi**

Combine Stress	Pontoon Deck f_t (Ksi)	Pontoon Deck f_a (Ksi)	Pontoon Deck f_t/f_a	Pontoon Bottom f_b (Ksi)	Pontoon Bottom f_a (Ksi)	Pontoon Bottom f_b/f_a
Transverse Bending Stress	-12.22	22.90	-0.53	14.16	31.42	0.45
Axial Squeeze Stress	-0.16	22.90	-0.01	-0.39	31.42	-0.01
Hydrostatic Bending Stress	0.00	22.90	0.00			
			-0.54			**0.44**

Column Buckling Check

Assumed Plating Corrosion = 5%
Assumed Stiffener Corrosion = 0%

Spacing of Stiffener = 762 mm 30.0 In.
Effective Span of Stiffener, l = 3200 mm 126.0 In.

Item	Original Dimensions	Units	Assumed Dimensions	Units	
Plate t =	0.63	In.	0.60	In.	5% corroded

Shape = L 7"x4"x3/4"

Web Height =	6.25	In.	6.25	In.	
Web Thickness =	0.75	In.	0.75	In.	0% corroded
Flange Width =	4	In.	4.00	In.	
Flange Thickness =	0.75	In.	0.75	In.	0% corroded

I of Stiffener on Plate						
Item	Area	Arm	Area*Arm	Dist.	Area*D^2	I (Initial)
Plate	17.95	0.30	5.37	1.44	37	1
Web	4.69	3.72	17.45	-1.99	19	15
Flange	3.00	7.22	21.67	-5.49	90	0
Totals	25.64		44.50		146	16

Neutral Axis = 1.74 In.
Moment of Inertia, Ix-x (Total) = 162 $In.^4$
Area, A = 25.64 $In.^2$
Radius of Gyration, r = SQRT(I/A) = 2.51 In.

Column Buckling Check

Effective Length Factor, K =	1.00	[Pinned-Pinned]
Slenderness, KL/r =	50.1	
F_e =	113.8	ksi
F_y =	51.0	ksi
Buckling Type =	Inelastic	
F_{cr} =	42.3	Ksi
Plating Slenderness Width, b_{max} =	35.5	*t
=	21.26	in
	71%	
c1 =	0.22	
c2 =	1.49	
F_{el} =	56.9	ksi
Effective Width, b_e =	25.92	in
	86%	
Effective Area, A_e =	23.20	$In.^2$
	90%	
F_{cr}/Ω =	22.90	ksi

Appendix F – FEA Check of Transverse Bending

HEGER developed the following keel line capacity chart for the BUILDER dock with principle stress calculations done in accordance with AISC's steel conduction manual. The chart provides recommended allowable keel line capacities for the three different structural designs in the dock (Original, Strengthened, and NASSCO Plug) for various levels of assumed pontoon deck corrosion.

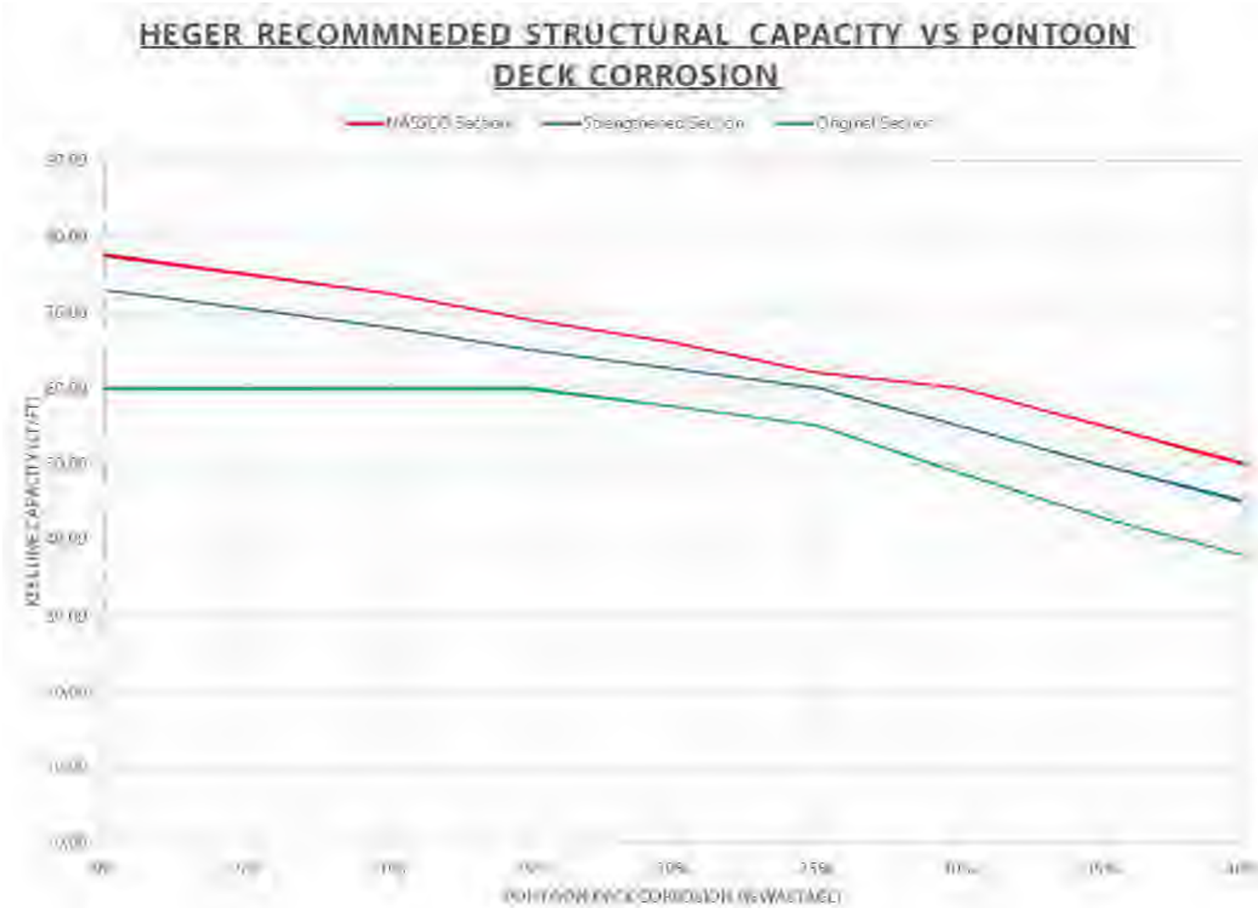


Figure 1 - Structural Capacity vs Pontoon Deck Corrosion

NOTE: To develop the chart the corrosion of dock structure is assumed to be tied to the levels of corrosion in the pontoon deck as follows:

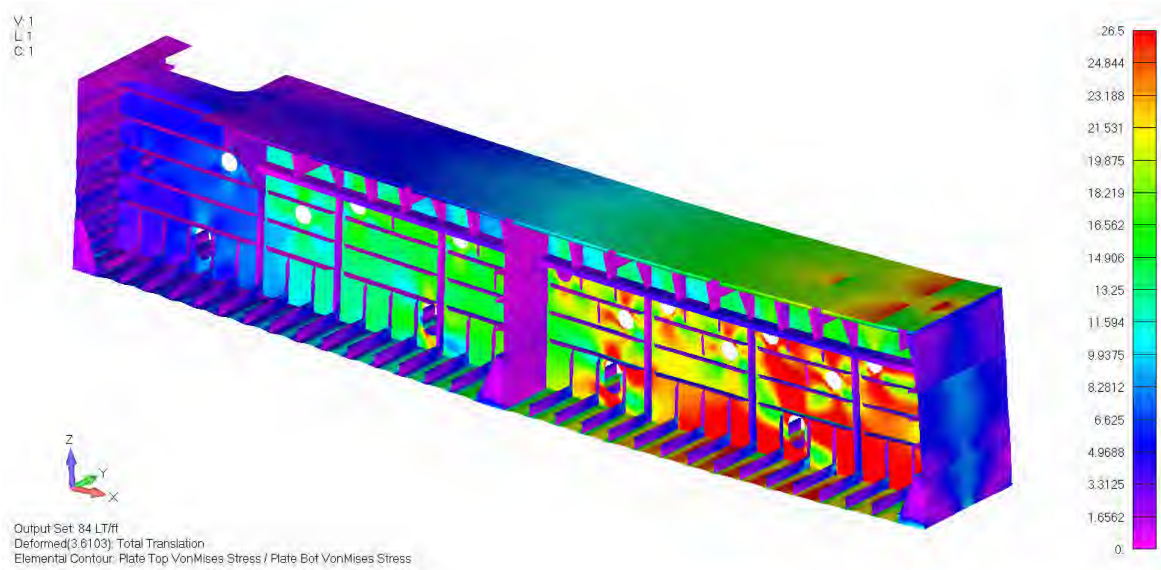
a. Pontoon Deck Corrosion of 0-10% = Typical corrosion level of 0%
b. Pontoon Deck Corrosion of 11-20% = Typical corrosion level of 5%
c. Pontoon Deck Corrosion of 21-30% = Typical corrosion level of 10%
d. Pontoon Deck Corrosion of 31-40% = Typical corrosion level of 15%

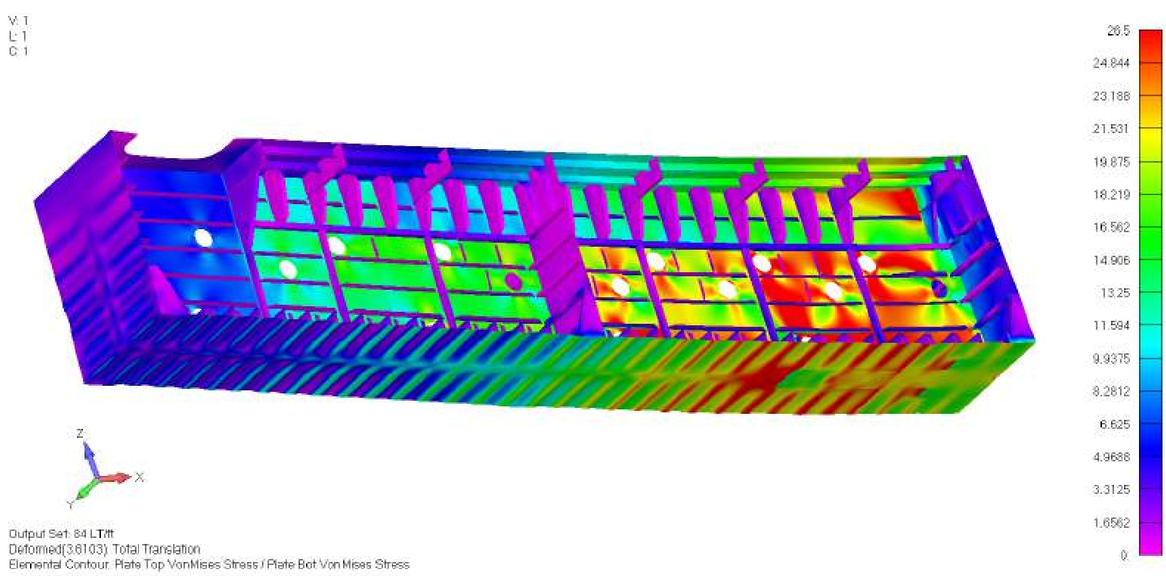
To further validate the chart, HEGER constructed a 3D structural model of a dock section in FEMAP computer software to conduct a detailed Finite Element Analysis (FEA) of the structure. The strengthened sections and original section were specifically analyzed.

Strengthened Section – 84 LT/ft – Current Condition

- Pontoon Deck Corrosion = 10%
- Corrosion of all other members = 5%

This assumed condition of the structure best matches the current condition of the dock, as surveyed in recent gauging surveys. HEGER applied 84 LT/ft along the centerline of the strengthened section, as this is the current rated capacity of the dock. Stress plots for the analysis are provided below and plotted against a stress limit of 26.5 ksi for mild steel (ABS VonMises stress limit for FEA is 78% of yield).



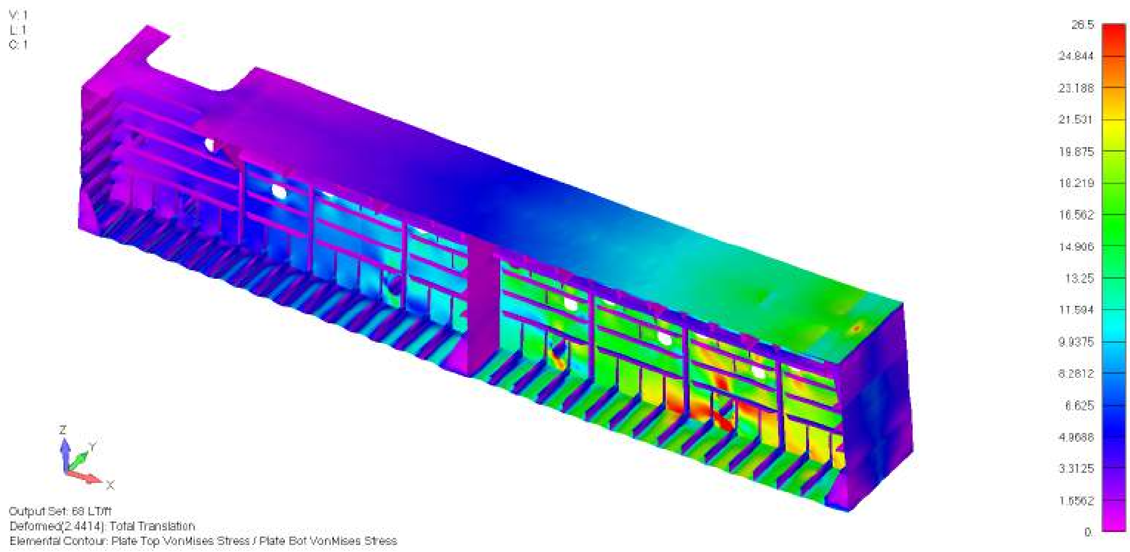


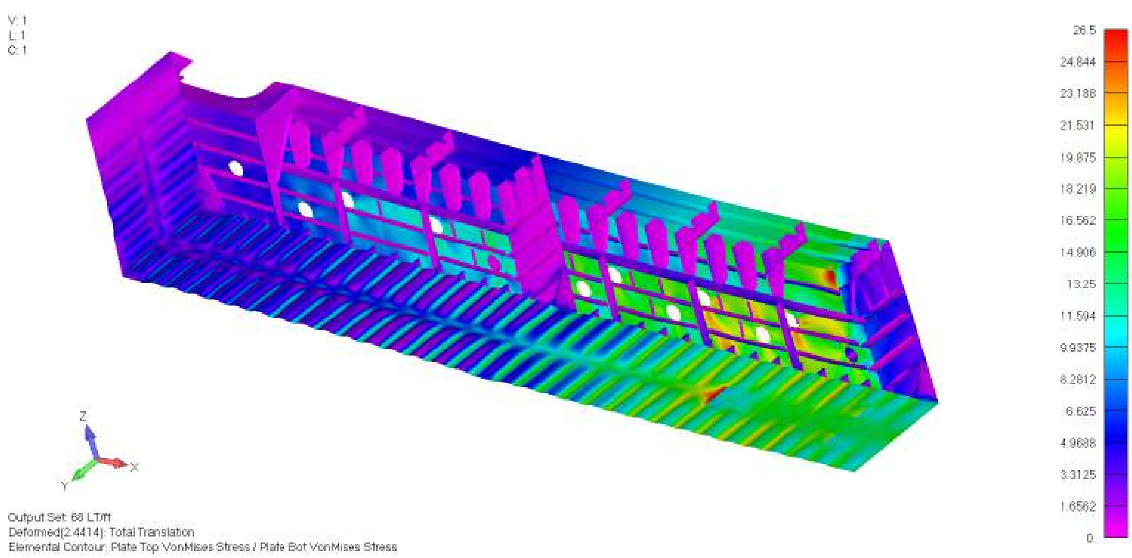
The plots show that large areas of the pontoon deck, bulkhead, and pontoon bottom plating have exceeded the stress limit and have reached yield.

Strengthened Section – 68 LT/ft – Current Condition

- Pontoon Deck Corrosion = 10%
- Corrosion of all other members = 5%

Again, this assumed condition of the structure best matches the current condition of the dock, as surveyed in recent gauging surveys. HEGER applied 68 LT/ft along the centerline of the strengthened section, as this is the allowable capacity for the assumed condition as HEGER calculated in principle stress calculations. Stress plots for the analysis are provided below and plotted against a stress limit of 26.5 ksi for mild steel (ABS VonMises stress limit for FEA is 78% of yield).



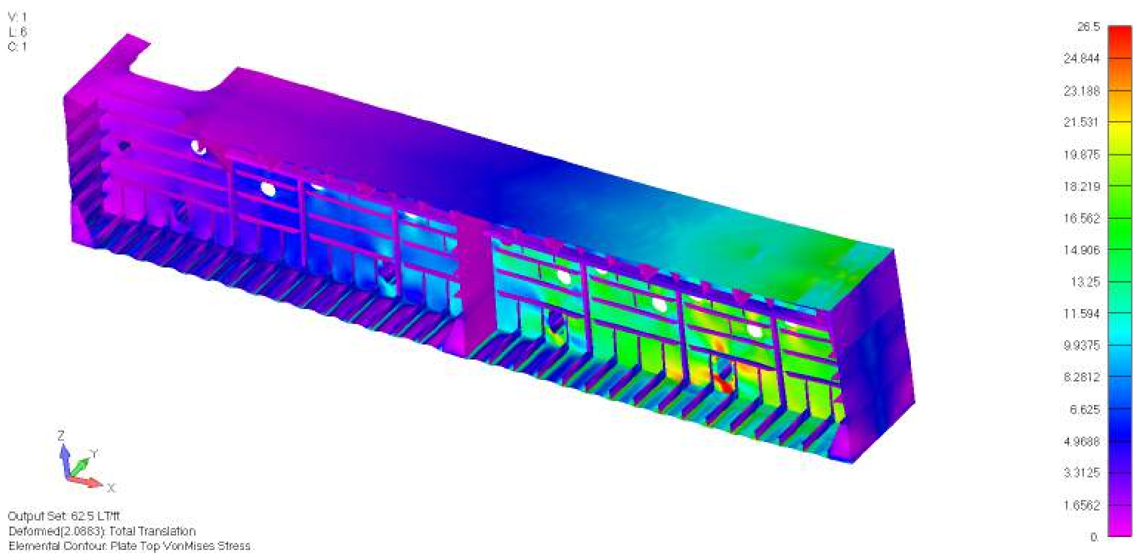


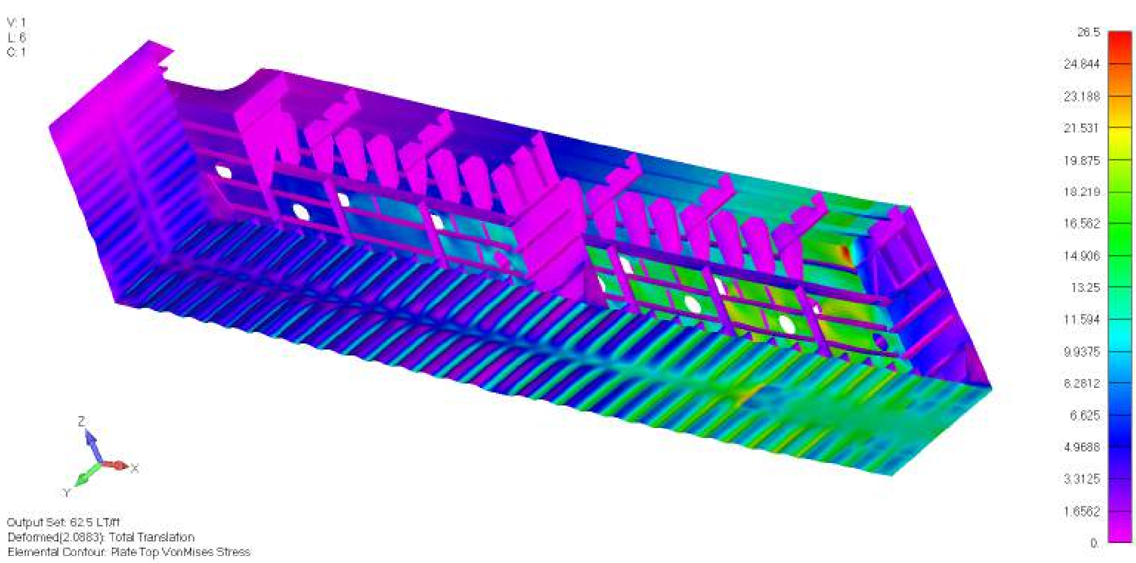
The plots show that the dock structure is generally within permissible stress limits with the exception of small localized areas of the pontoon deck, bulkhead, and pontoon bottom plating. These localized stresses are acceptable as small “hotspots”.

<u>Strengthened Section – 62.5 LT/ft – Future Condition</u>

- Pontoon Deck Corrosion = 20%
- Corrosion of all other members = 5%

This assumed condition of the structure may represent the dock's condition in 5-10 years as the pontoon deck continues to corrode and assumes minimal corrosion occurs to all other areas of the dock. HEGER applied 62.5 LT/ft along the centerline of the strengthened section, as this is the allowable capacity for the assumed condition as HEGER calculated in principle stress calculations. Stress plots for the analysis are provided below and plotted against a stress limit of 26.5 ksi for mild steel (ABS VonMises stress limit for FEA is 78% of yield).



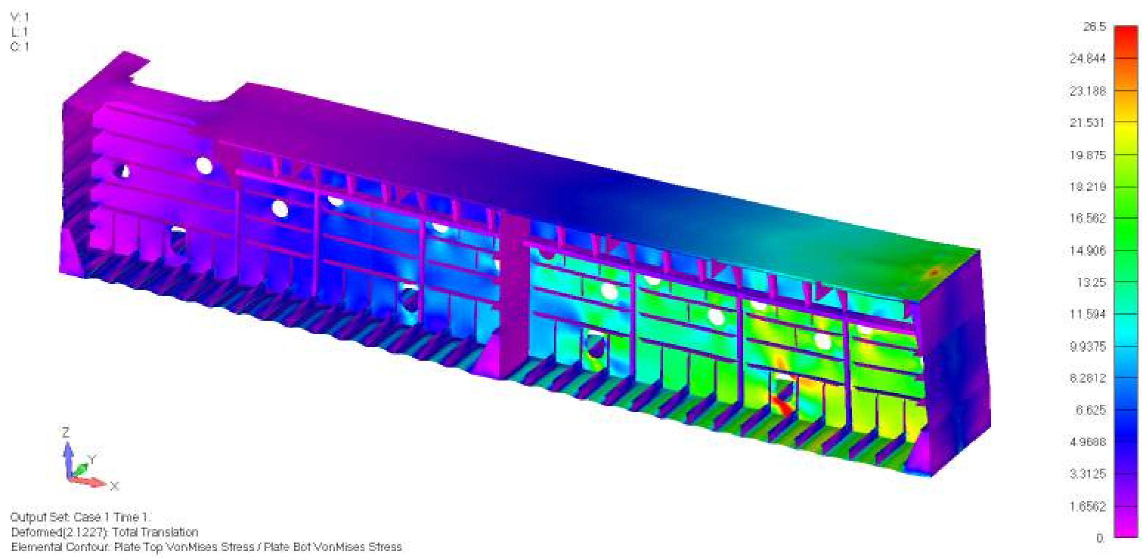


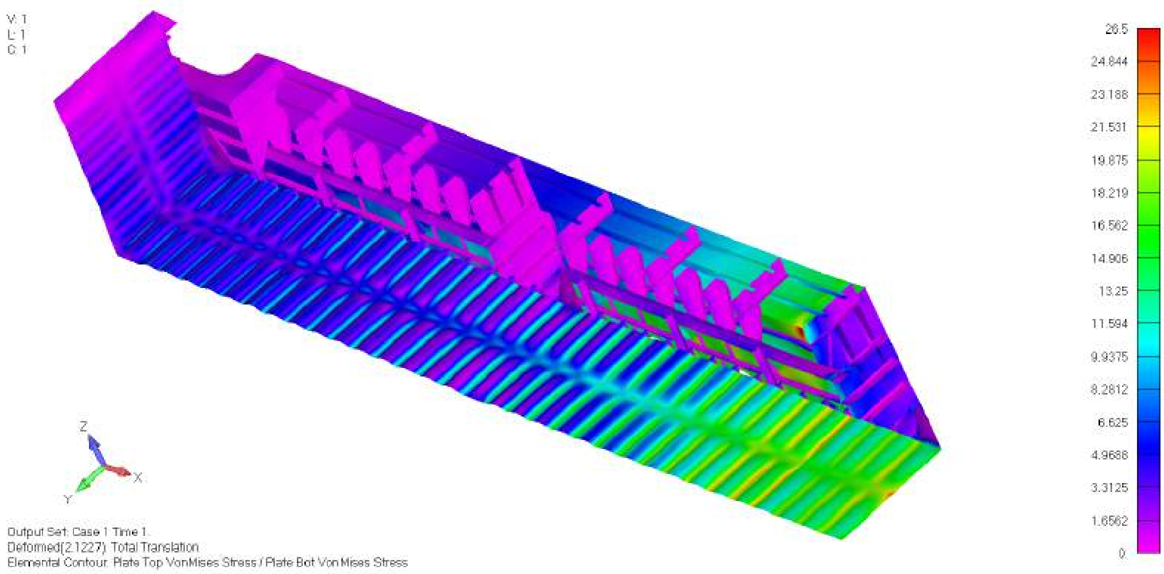
The plots show that the dock structure is generally within permissible stress limits with the exception of small localized areas of the bulkhead and pontoon bottom plating. These localized stresses are acceptable as small "hotspots".

<u>Original Section – 60.0 LT/ft – Current Condition</u>

- Pontoon Deck Corrosion = 15%
- Corrosion of all other members = 5%

This assumed condition of the structure best matches the current condition of the dock, as surveyed in recent gauging surveys. HEGER applied 60 LT/ft along the centerline of the strengthened section, as this is the current rated capacity of the dock. HEGER also calculated a 60 LT/ft capacity, for the assumed condition, in principle stress calculations. Stress plots for the analysis are provided below and plotted against a stress limit of 26.5 ksi for mild steel (ABS VonMises stress limit for FEA is 78% of yield).



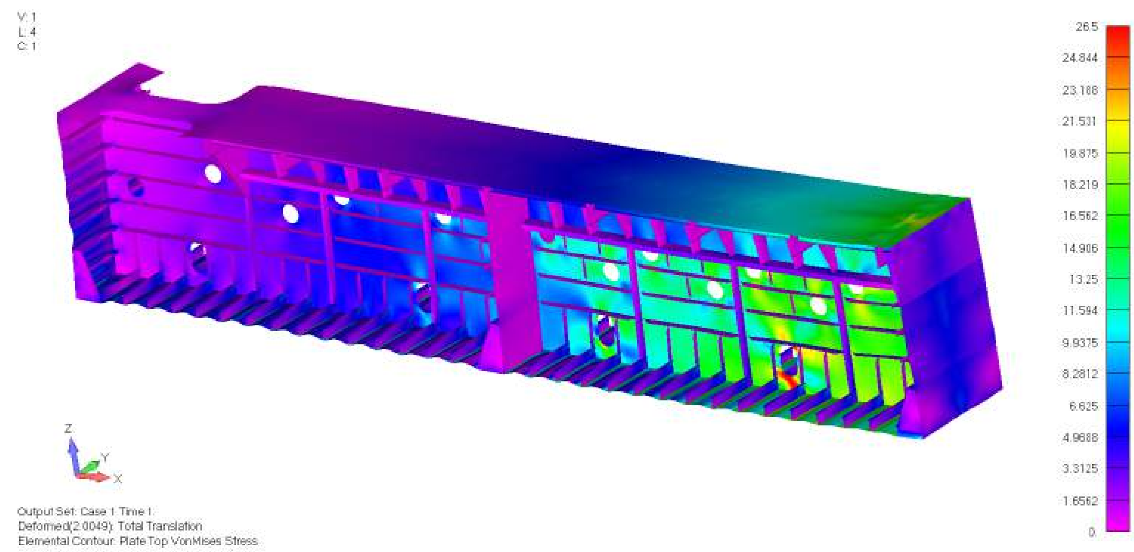


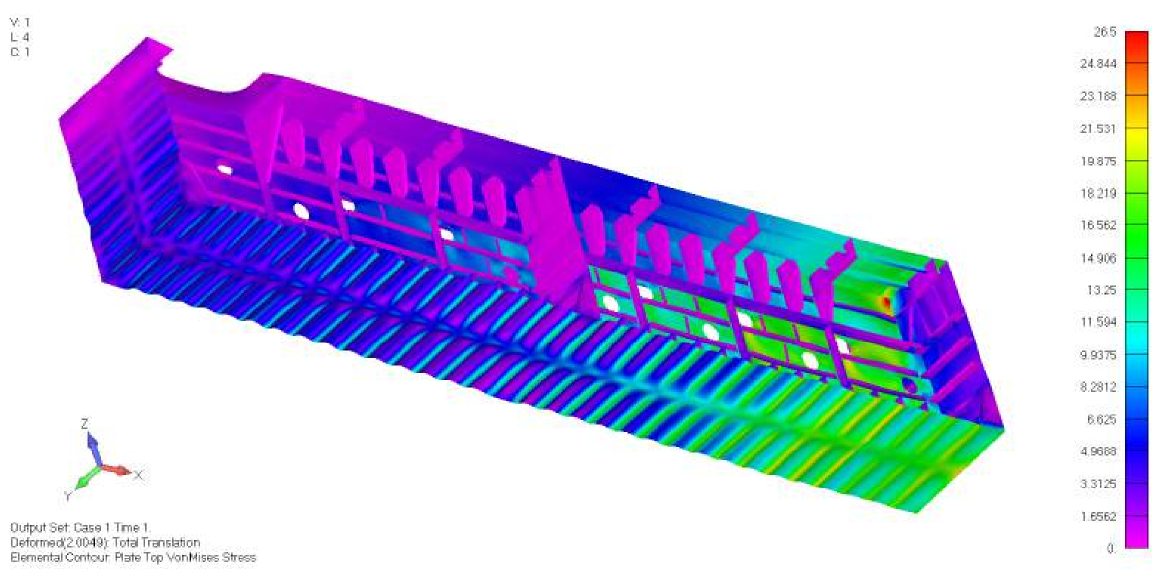
The plots show that the dock structure is generally within permissible stress limits with the exception of small localized areas of the pontoon deck, bulkhead, and pontoon bottom plating. These localized stresses are acceptable as small "hotspots".

<u>Original Section – 55.0 LT/ft – Future Condition</u>

- Pontoon Deck Corrosion = 25%
- Corrosion of all other members = 10%

This assumed condition of the structure may represent the dock's condition in 5-10 years as the pontoon deck continues to corrode and assumes some corrosion occurs to all other areas of the dock. HEGER applied 55.0 LT/ft along the centerline of the strengthened section, as this is the allowable capacity for the assumed condition as HEGER calculated in principle stress calculations. Stress plots for the analysis are provided below and plotted against a stress limit of 26.5 ksi for mild steel (ABS VonMises stress limit for FEA is 78% of yield).





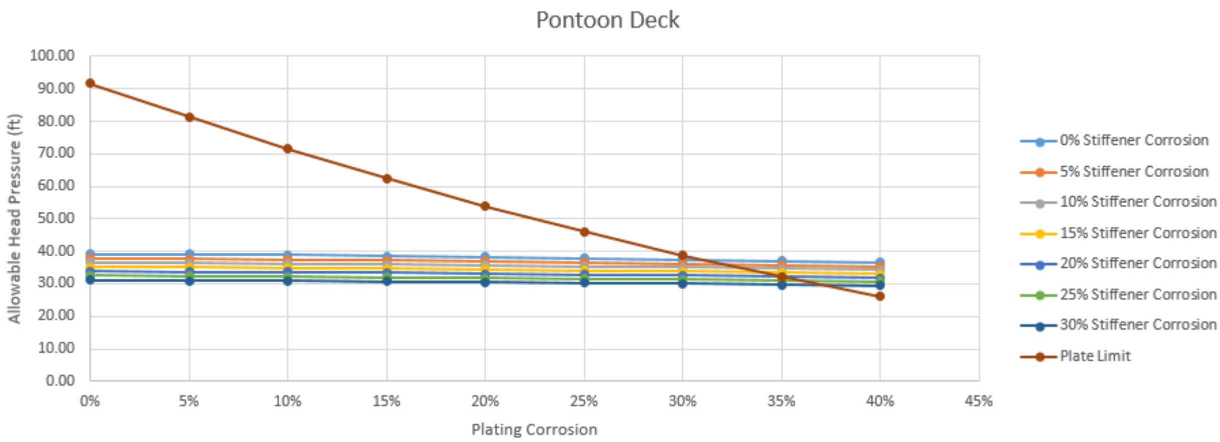
The plots show that the dock structure is generally within permissible stress limits with the exception of small localized areas of the bulkhead and pontoon bottom plating. These localized stresses are acceptable as small "hotspots".

Appendix G – Local Strength Analysis

<u>Pontoon Deck, Design Capacity = 34-ft</u>

The strength of the pontoon deck, in resistance to differential head pressure loadings, is controlled by the bending strength of the transverse scantlings until the original 16mm hull plating corrodes to a level of ~35%; at this point, the stress in the plating begins to control the head pressure limitation. The strength of the longitudinal was checked but does not control over plating or transverse stiffener strength.

See graphic below which plots assumed hull plating corrosion across the X-axis against allowable head pressures on the Y-axis. Data plots are provided to depict the strength of stiffener, at are various levels of corrosion, and the plating.

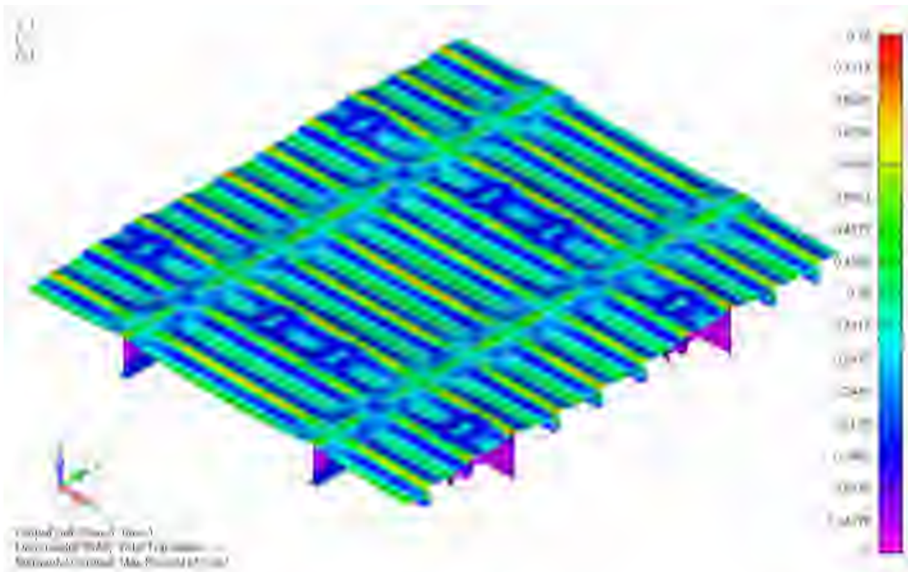


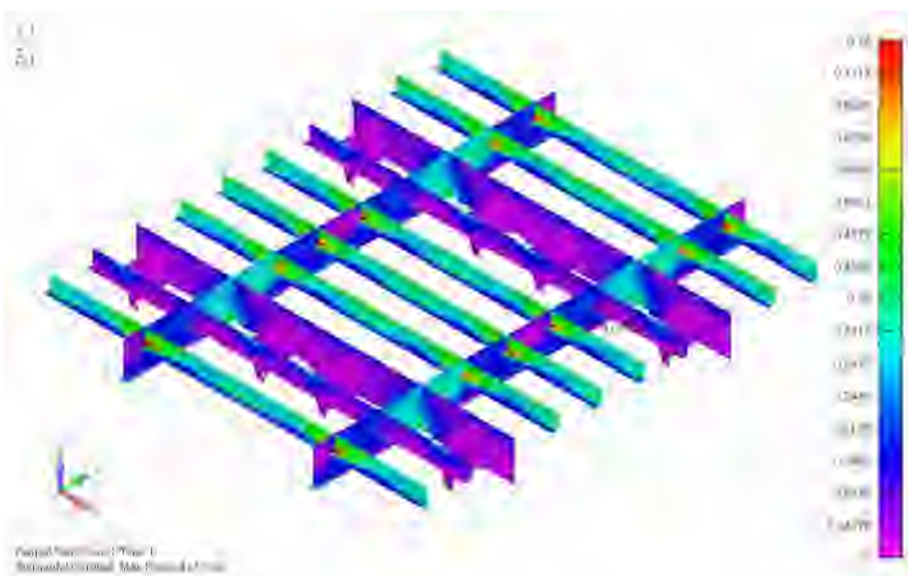
The table below charts the allowable head pressure limitations for various combinations of plating and internal framing corrosion.

		Stiffener/Girder Corrosion						
		0%	5%	10%	15%	20%	25%	30%
Plating Corrosion	0%	39.23	37.90	36.56	35.21	33.86	32.50	31.13
	5%	39.05	37.73	36.41	35.07	33.73	32.37	31.01
	10%	38.85	37.54	36.22	34.90	33.57	32.23	30.88
	15%	38.56	37.27	35.97	34.66	33.35	32.02	30.69
	20%	38.24	36.97	35.69	34.40	33.11	31.80	30.49
	25%	37.88	36.64	35.38	34.12	32.84	31.56	30.26
	30%	37.48	36.26	35.03	33.79	32.54	31.28	30.01
	35%	32.08	32.08	32.08	32.08	32.08	30.97	29.72
	40%	26.07	26.07	26.07	26.07	26.07	26.07	26.07

Pontoon Deck (Cont.), Downgraded Capacity = 28-ft

A localized Finite Element Model (FEM) was constructed of the typical pontoon deck structure to check the stress levels in the structure. A corrosion level of 25% was assumed for the internal structure (stiffeners and tees) while a corrosion level of 35% was assumed for the pontoon deck plating. The stress plots, displaying calculated stress as a percentage of material yield stress for 28.0-ft of applied head pressure, are provided below. The calculated stress levels are generally within the ABS limit of 78% of material yield stress. The highest stress point was found to be in the transverse stiffeners in way of the connection to the girders, as expected.

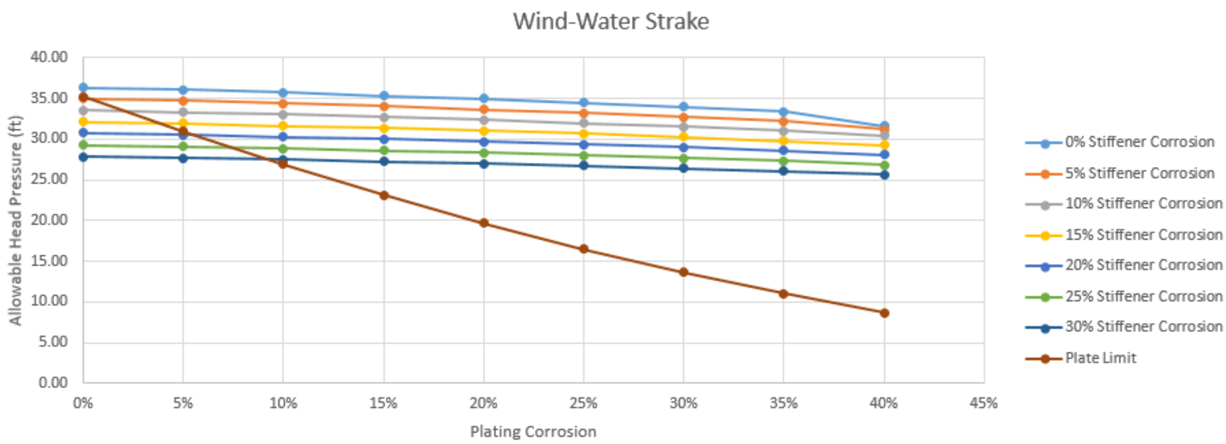




Wind-Water Strake, Design Capacity = 34-ft

The strength of the wind-water strake, in resistance to differential head pressure loadings, is generally controlled by the strength of the hull plating. It does not appear the plating in this zone was designed with a "corrosion allowance" as the allowable head pressure, according to ABS rules, decreases to ~27-ft if the plating corrodes only 8%.

See graphic below which plots assumed hull plating corrosion across the X-axis against allowable head pressures on the Y-axis. Data plots are provided to depict the strength of scantling, at are various levels of corrosion, and the plating.



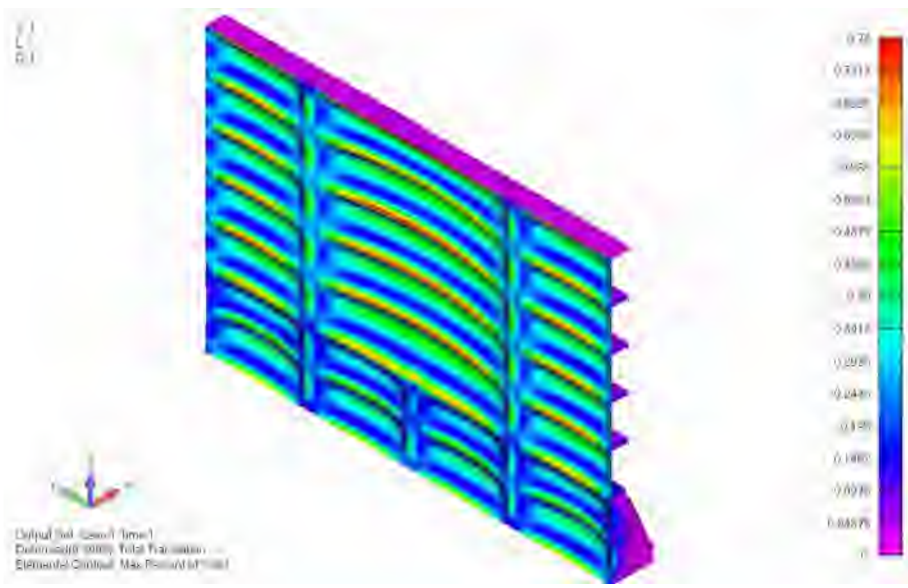
The table below charts the allowable head pressure limitations for various combinations of plating and internal framing corrosion.

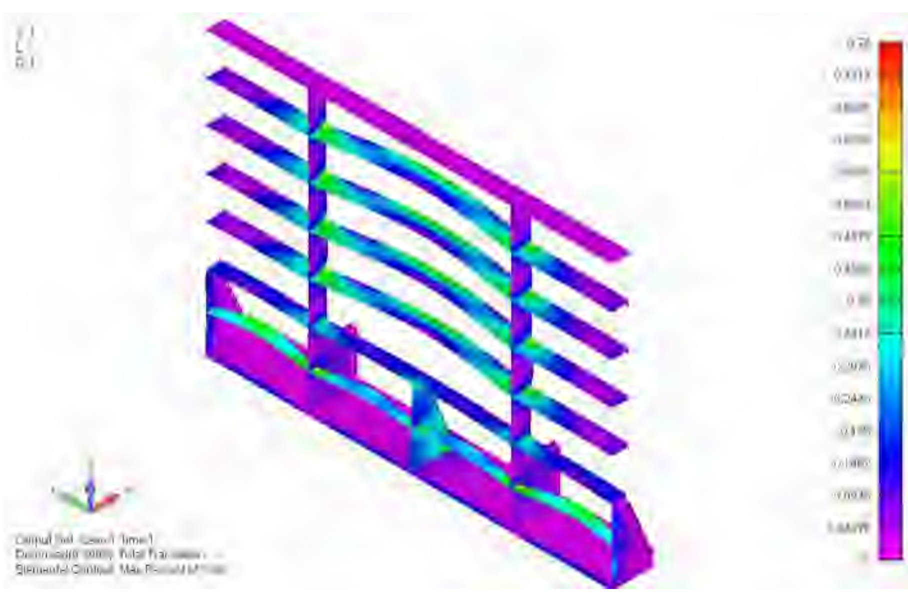
		Stiffener Corrosion						
		0%	5%	10%	15%	20%	25%	30%
Plating Corrosion	0%	35.25	34.98	33.58	32.17	30.74	29.31	27.86
	5%	30.94	30.94	30.94	30.94	30.52	29.11	27.67
	10%	26.91	26.91	26.91	26.91	26.91	26.91	26.91
	15%	23.16	23.16	23.16	23.16	23.16	23.16	23.16
	20%	19.70	19.70	19.70	19.70	19.70	19.70	19.70
	25%	16.51	16.51	16.51	16.51	16.51	16.51	16.51
	30%	13.61	13.61	13.61	13.61	13.61	13.61	13.61
	35%	10.98	10.98	10.98	10.98	10.98	10.98	10.98
	40%	8.64	8.64	8.64	8.64	8.64	8.64	8.64

As shown in the table above, the plating in this area must be kept in a less than 10% wasted condition in order to safely resist the hydrostatic head pressures expected during a docking of a destroyer or cruiser.

Wind-Water Strake (Cont.), Downgraded Capacity = 28-ft

A localized Finite Element Model (FEM) was constructed of the typical wind-water strake structure to check the stress levels in the structure. A corrosion level of 25% was assumed for the internal structure (stiffeners) while a corrosion level of 8% was assumed for the shell plating. The stress plots, which display calculated stress as a percentage of material yield stress, for 28.0-ft of applied head pressure, are provided below. The calculated stress levels are generally within the ABS limit of 78% of material yield stress. The highest stress point was found to be in way of the horizontal edges of the pontoon shell plate panels. In these areas the calculated stress was found to reach or slightly exceed the established limit of 78% of the materials yield stress.

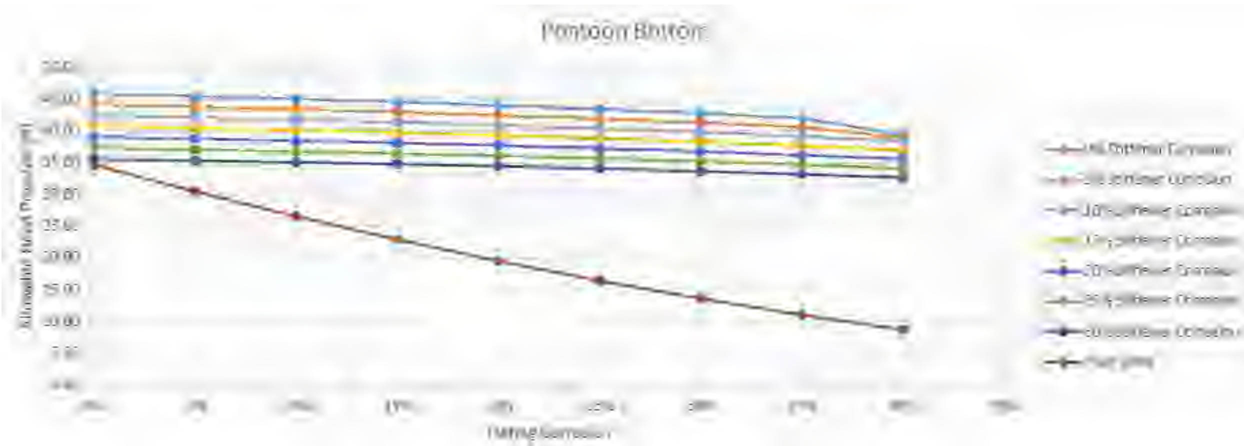




Pontoon Bottom, Design Capacity = 34-ft

The strength of the pontoon bottom structure, in resistance to differential head pressure loadings, is controlled by the strength of the hull plating. It does not appear the plating in this zone was designed with a “corrosion allowance” as the allowable head pressure, according to ABS rules, decreases to ~27-ft if the plating corrodes only 8%.

See graphic below which plots assumed hull plating corrosion across the X-axis against allowable head pressures on the Y-axis. Data plots are provided to depict the strength of scantling, at are various levels of corrosion, and the plating.



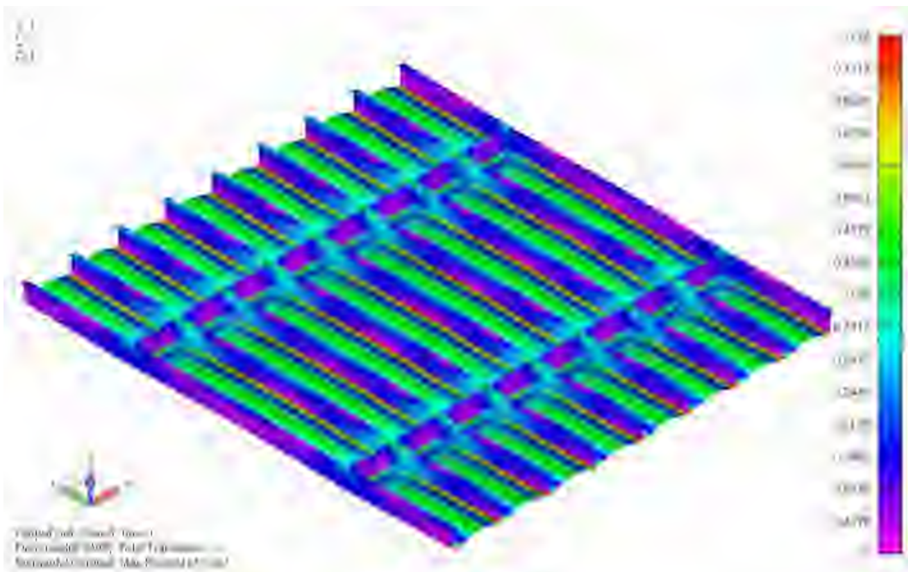
The table below charts the allowable head pressure limitations for various combinations of plating and internal framing corrosion.

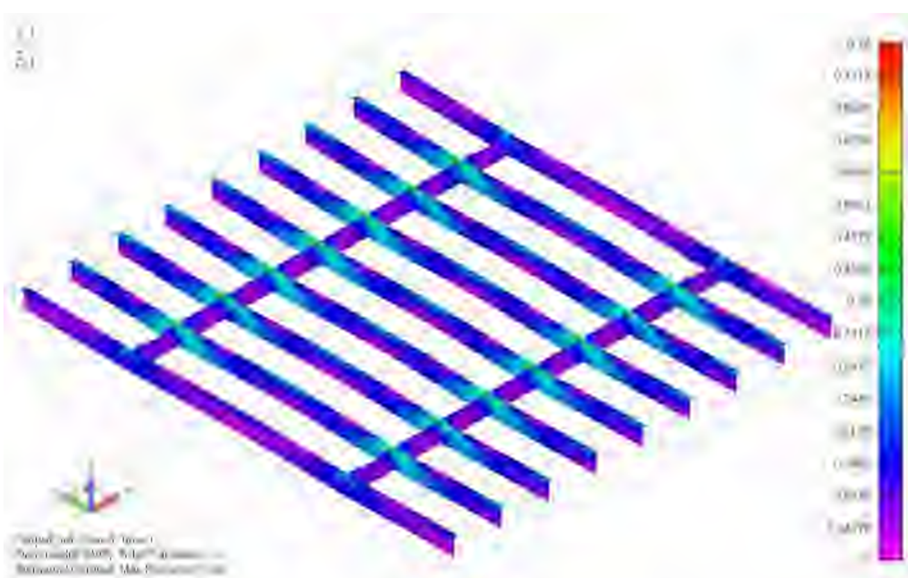
		Stiffener Corrosion						
		0%	5%	10%	15%	20%	25%	30%
Plating Corrosion	0%	34.64	34.64	34.64	34.64	34.64	34.64	34.64
	5%	30.45	30.45	30.45	30.45	30.45	30.45	30.45
	10%	26.53	26.53	26.53	26.53	26.53	26.53	26.53
	15%	22.88	22.88	22.88	22.88	22.88	22.88	22.88
	20%	19.50	19.50	19.50	19.50	19.50	19.50	19.50
	25%	16.39	16.39	16.39	16.39	16.39	16.39	16.39
	30%	13.56	13.56	13.56	13.56	13.56	13.56	13.56
	35%	10.99	10.99	10.99	10.99	10.99	10.99	10.99
	40%	8.69	8.69	8.69	8.69	8.69	8.69	8.69

As shown in the table above, the plating in this area must be kept in a less than 10% wasted condition in order to safely resist the hydrostatic head pressures expected during a docking of a destroyer or cruiser.

Pontoon Bottom (Cont.), Downgraded Capacity = 28-ft

A localized Finite Element Model (FEM) was constructed of the typical pontoon bottom structure to check the stress levels in the structure. A corrosion level of 25% was assumed for the internal structure (stiffeners) while a corrosion level of 8% was assumed for the pontoon bottom plating. The stress plots, for 28.0-ft of applied head pressure, is provided below. The calculated stress levels are generally within the ABS limit of 78% of material yield stress. The highest stress point was found to be in way of the longitudinal edges of the pontoon bottom plate panels. In these areas the calculated stress was found to reach or slightly exceed the established limit of 78% of the materials yield stress.





HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETTS

Done By :	M. Naylor
Checked By :	P. Shah
Date :	9/17/2021
Job No :	4386-D

Client : NASSCO - San Diego

Project : Advanced Analysis of BUILDER FDD

Local Strength - Pontoon Deck Structure

Design Parameters

Plate Spacing =	28.82	in	732	mm
Stiffener Spacing =	28.82	in	732	mm
Girder Spacing =	125.98	in	3,200	mm
Stiffener Span =	10.50	ft	3.200	M
Girder Span =	9.61	ft	2.928	M
Plate Design Head =	34.00	ft	10.363	M
Stiffener Design Head =	34.00	ft	10.363	M
Girder Design Head =	34.00	ft	10.363	M

Structural Members

Plating

Plate Thickness =	0.63	in	16	mm
Yield Point =	34.0	ksi	234	Mpa

Stiffener: L 247 x 9 Web ; 100 x 15 FLG

Stiffener Web Height =	9.72	in	247	mm
Stiffener Web Thickness =	0.35	in	9	mm
Stiffener Flange Width =	3.94	in	100	mm
Stiffener Flange Thickness =	0.59	in	15	mm
Yield Point =	34.0	ksi	234	Mpa

Girder: T 597 x 14 Web ; 125 x 18 FLG

Girder Web Height =	23.50	in	597	mm
Girder Web Thickness =	0.55	in	14	mm
Girder Flange Width =	4.92	in	125	mm
Girder Flange Thickness =	0.71	in	18	mm
Yield Point =	51.0	ksi	351	Mpa
Web Opening for pass-thru =	9.72	in	247	mm

Corrosion Assumptions

Member	Percent	in	mm
Plate	0%	0.00	0.00
Stiffener Web	0%	0.00	0.00
Stiffener FLG	0%	0.00	0.00
Girder Wed	0%	0.00	0.00
Girder FLG	0%	0.00	0.00

HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETTS

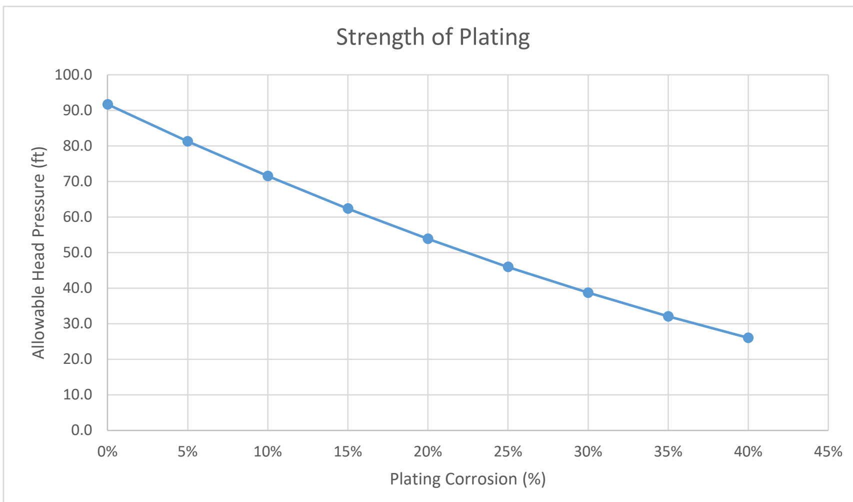
Done By : **M. Naylor**
Checked By : **P. Shah**
Date : **9/17/2021**
Job No : **4386-D**

Client : NASSCO - San Diego
Project : Advanced Analysis of BUILDER FDD

Local Strength - Pontoon Deck Structure

Structural Evaluation of Plating

Original Thickness =	0.63 in	
Assumed Corrosion =	0.00 in	0%
Assumed Thickness =	0.63 in	
Plating Spacing, s =	28.82 in	732 mm
Head limit based on strength, per ABS =	**91.65 ft**	27.94 M



HEGER DRY DOCK, Inc.
HOPKINTON, MASSACHUSETTS

Done By : M. Naylor
Checked By : P. Shah
Date : 9/17/2021
Job No : 4386-D

Client : NASSCO - San Diego
Project : Advanced Analysis of BUILDER FDD

Local Strength - Pontoon Deck Structure

Structural Evaluation of Stiffener

Stiffener Spacing = 28.82 in — 732 mm

Item	Original Dimension	Assumed Corrosion	Assumed Dimension
Plate Thickness, t =	0.63 in	0.00 in	0.63 in
Web Height =	9.72 in	N/A	9.72 in
Web Thickness =	0.35 in	0.00 in	0.35 in
Flange Width =	3.94 in	N/A	3.94 in
Flange Thickness =	0.59 in	0.00 in	0.59 in

Effective width of Pl. = t x 46 — 28.82 in

I of Stiffener on Plate						
Item	Area	Arm	Area*Arm	Dist.	Area*D^2	I (Initial)
Plate	18.15	0.31	5.7	1.75	56	1
Web	3.45	5.49	18.9	-3.43	40	27
Flange	2.33	10.65	24.8	-8.58	171	0
Totals	23.92		49.4		267	28

Neutral Axis = 2.06 In.
Section Height = 10.94 In.
I (Total) = 295 $In.^4$

Shear Area = 3.88 $In.^2$
S_{plate} = 143.0 $In.^3$
S_{flange} = 33.2 $In.^3$

Design Head Pressure = 34.00 ft — 10.36 M
Distributed Loading Along Stiffener, w = 5.22 k/ft

Span, l = 10.50 ft — 3.20 M

Applied Moment = 48.99 k-ft — =w*l^2/11.75
Applied Shear = 27.42 kips — =w*l/2

Applied Bending Stress (plate) = 4.11 ksi
AISC Limit = 20.40 ksi — =0.6*fy
Check = OK — 20%

Applied Bending Stress (stiffener) = 17.68 ksi
AISC Limit = 20.40 ksi — =0.6*fy
Check = OK — 87%

Applied Shear Stress = 7.07 ksi
AISC Limit = 13.60 ksi — =0.4*fy
Check = OK — 52%

Head limit based on strength = **39.23 ft** — 11.96 M

Local Strength - Pontoon Deck Structure

Structural Evaluation of Girder

Girder Spacing = 125.98 in   3,200 mm

Item	Original Dimension	Assumed Corrosion	Assumed Dimension
Plate Thickness, t =	0.63 in	0.00 in	0.63 in
Web Height =	23.50 in	N/A	23.50 in
Web Thickness =	0.55 in	0.00 in	0.55 in
Flange Width =	4.92 in	N/A	4.92 in
Flange Thickness =	0.71 in	0.00 in	0.71 in

Effective width of Pl. = t x 50   31.50 in

Web Opening for pass-thru = 9.72 in   247 mm

I of Stiffener on Plate						
Item	Area	Arm	Area*Arm	Dist.	Area*D^2	I (Initial)
Plate	19.84	0.31	6.2	6.88	940	1
Web	12.95	12.38	160.4	-5.18	348	596
Web Opening	-5.36	5.49	-29.4	1.71	-16	-42
Flange	3.49	24.49	85.4	-17.29	1,042	0
Totals	30.92		222.6		2,315	555

Neutral Axis = 7.20 In.
Section Height = 24.84 In.
I (Total) = 2,870 In.^{4}

Shear Area = 8.33 In.^{2}
S_{plate} = 398.7 In.^{3}
S_{flange} = 162.7 In.^{3}

Design Head Pressure = 34.00 ft   10.36 M
Distributed Loading Along Girder, w = 22.83 k/ft

Span, l = 9.61 ft   2.93 M

Applied Moment = 179.31 k-ft   =w*l^2/11.75
Applied Shear = 109.66 kips   =w*l/2

Applied Bending Stress (plate) = 5.40 ksi
AISC Limit = 20.40 ksi   =0.6*fy
Check = OK   26%

Applied Bending Stress (girder) = 13.23 ksi
AISC Limit = 30.60 ksi   =0.6*fy
Check = OK   43%

Applied Shear Stress = 13.16 ksi
AISC Limit = 20.40 ksi   =0.4*fy
Check = OK   65%

Head limit based on strength = **52.71 ft**   16.06 M

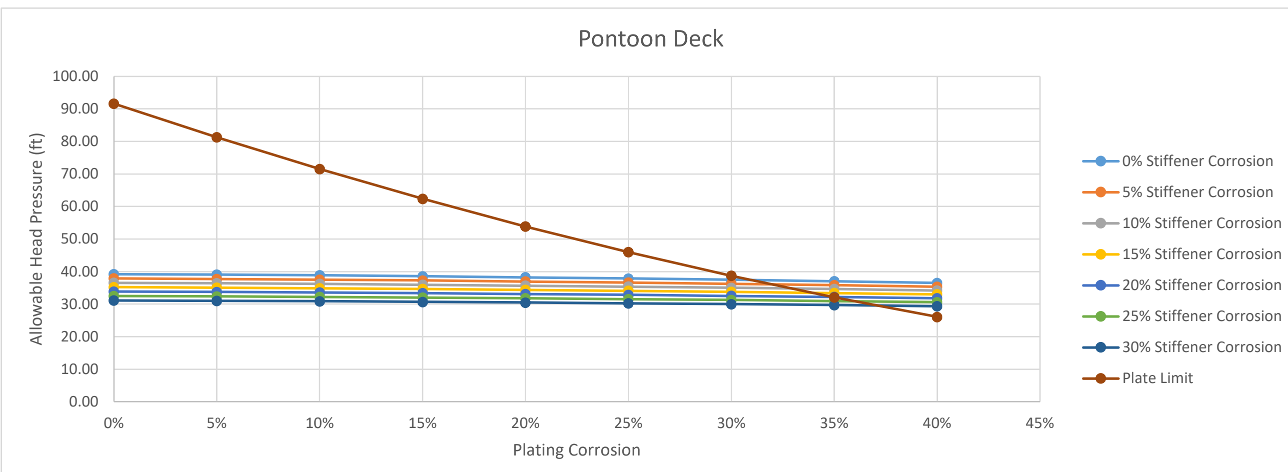
Done By : M. Naylor
Checked By : P. Shah
Date : 9/17/2021
Job No : 4386-D

Client : NASSCO - San Diego
Project : Advanced Analysis of BUILDER FDD

Local Strength - Pontoon Deck Structure

Allowable Head Pressure in Feet

		Stiffener/Girder Corrosion						
		0%	5%	10%	15%	20%	25%	30%
Plating Corrosion	0%	39.23	37.90	36.56	35.21	33.86	32.50	31.13
	5%	39.05	37.73	36.41	35.07	33.73	32.37	31.01
	10%	38.85	37.54	36.22	34.90	33.57	32.23	30.88
	15%	38.56	37.27	35.97	34.66	33.35	32.02	30.69
	20%	38.24	36.97	35.69	34.40	33.11	31.80	30.49
	25%	37.88	36.64	35.38	34.12	32.84	31.56	30.26
	30%	37.48	36.26	35.03	33.79	32.54	31.28	30.01
	35%	32.08	32.08	32.08	32.08	32.08	30.97	29.72
	40%	26.07	26.07	26.07	26.07	26.07	26.07	26.07



Done By : M. Naylor
Checked By : P. Shah
Date : 9/17/2021
Job No : 4386-D

Client : NASSCO - San Diego
Project : Advanced Analysis of BUILDER FDD

Local Strength - Wind/Water Strake Structure

Design Parameters

Plate Spacing =	29.53	in	750	mm
Stiffener Spacing =	29.53	in	750	mm
Stiffener Span =	12.01	ft	3.660	M
Plate Design Head =	34.00	ft	10.363	M
Stiffener Design Head =	34.00	ft	10.363	M

Structural Members

Plating

Plate Thickness =	0.43	in	11	mm
Yield Point =	34.0	ksi	234	Mpa

Stiffener: L 247 x 9 Web ; 100 x 12 FLG

Stiffener Web Height =	9.72	in	247	mm
Stiffener Web Thickness =	0.35	in	9	mm
Stiffener Flange Width =	3.94	in	100	mm
Stiffener Flange Thickness =	0.47	in	12	mm
Yield Point =	51.0	ksi	351	Mpa

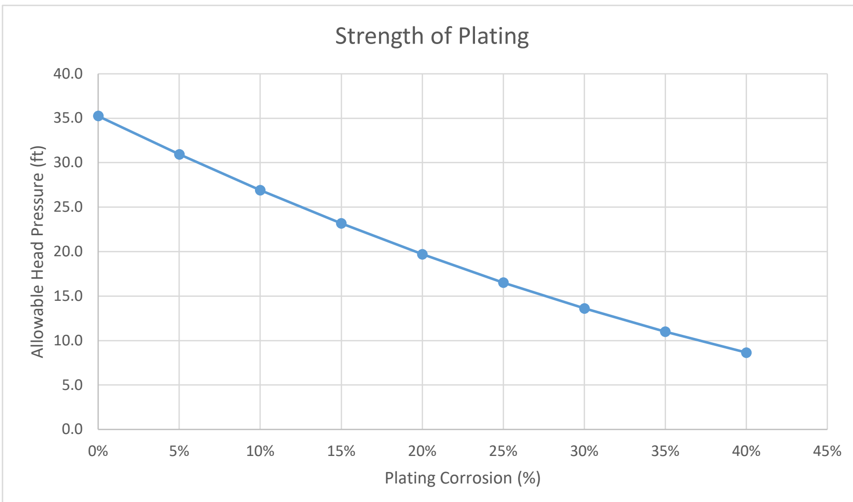
Corrosion Assumptions

Member	Percent	in	mm
Plate	0%	0.00	0.00
Stiffener Web	0%	0.00	0.00
Stiffener FLG	0%	0.00	0.00

Local Strength - Wind/Water Strake Structure

Structural Evaluation of Plating

Original Thickness =	0.43 in	
Assumed Corrosion =	0.00 in	0%
Assumed Thickness =	0.43 in	
Plating Spacing, s =	29.53 in	750 mm
Head limit based on strength, per ABS =	**35.25 ft**	10.74 M



HEGER DRY DOCK, Inc.
HOPKINTON, MASSACHUSETTS

Done By : M. Naylor
Checked By : P. Shah
Date : 9/17/2021
Job No : 4386-D

Client : NASSCO - San Diego
Project : Advanced Analysis of BUILDER FDD

Local Strength - Wind/Water Strake Structure

Structural Evaluation of Stiffener

Stiffener Spacing = 29.53 in   750 mm

Item	Original Dimension	Assumed Corrosion	Assumed Dimension
Plate Thickness, t =	0.43 in	0.00 in	0.43 in
Web Height =	9.72 in	N/A	9.72 in
Web Thickness =	0.35 in	0.00 in	0.35 in
Flange Width =	3.94 in	N/A	3.94 in
Flange Thickness =	0.47 in	0.00 in	0.47 in

Effective width of Pl. = t x 50   21.65 in

I of Stiffener on Plate						
Item	Area	Arm	Area*Arm	Dist.	Area*D^2	I (Initial)
Plate	9.38	0.22	2.0	2.48	58	0
Web	3.45	5.30	18.2	-2.60	23	27
Flange	1.86	10.39	19.3	-7.70	110	0
Totals	14.68		39.6		191	27

Neutral Axis = 2.70 In.
Section Height = 10.63 In.
I (Total) = 218 $In.^4$

Shear Area = 3.77 $In.^2$
S_{plate} = 81.0 $In.^3$
S_{flange} = 27.5 $In.^3$

Design Head Pressure = 34.00 ft   10.36 M
Distributed Loading Along Stiffener, w = 5.35 k/ft

Span, l = 12.01 ft   3.66 M

Applied Moment = 65.66 k-ft   =w*l^2/11.75
Applied Shear = 32.13 kips   =w*l/2

Applied Bending Stress (plate) = 9.73 ksi
AISC Limit = 20.40 ksi   =0.6*fy
Check = OK   48%

Applied Bending Stress (stiffener) = 28.61 ksi
AISC Limit = 30.60 ksi   =0.6*fy
Check = OK   93%

Applied Shear Stress = 8.53 ksi
AISC Limit = 20.40 ksi   =0.4*fy
Check = OK   42%

Head limit based on strength = **36.37 ft**   11.08 M

HEGER DRY DOCK, Inc.
HOPKINTON, MASSACHUSETTS

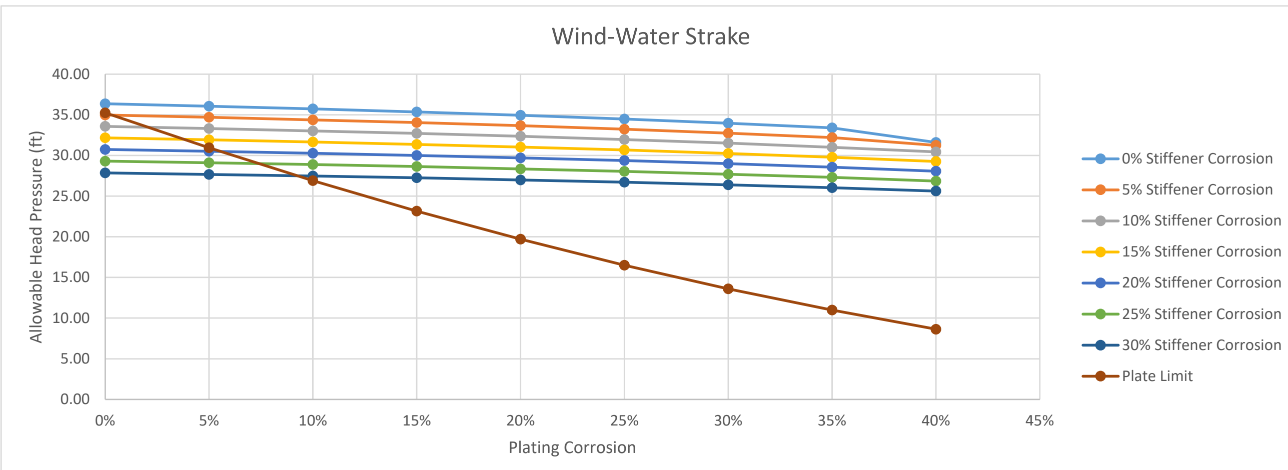
Done By : **M. Naylor**
Checked By : **P. Shah**
Date : **9/17/2021**
Job No : **4386-D**

Client : NASSCO - San Diego
Project : Advanced Analysis of BUILDER FDD

Local Strength - Wind/Water Strake Structure

Allowable Head Pressure in Feet

		Stiffener Corrosion						
		0%	5%	10%	15%	20%	25%	30%
Plating Corrosion	0%	35.25	34.98	33.58	32.17	30.74	29.31	27.86
	5%	30.94	30.94	30.94	30.94	30.52	29.11	27.67
	10%	26.91	26.91	26.91	26.91	26.91	26.91	26.91
	15%	23.16	23.16	23.16	23.16	23.16	23.16	23.16
	20%	19.70	19.70	19.70	19.70	19.70	19.70	19.70
	25%	16.51	16.51	16.51	16.51	16.51	16.51	16.51
	30%	13.61	13.61	13.61	13.61	13.61	13.61	13.61
	35%	10.98	10.98	10.98	10.98	10.98	10.98	10.98
	40%	8.64	8.64	8.64	8.64	8.64	8.64	8.64



HEGER DRY DOCK, Inc.

HOPKINTON, MASSACHUSETTS

Done By : M. Naylor
Checked By : P. Shah
Date : 9/17/2021
Job No : 4386-D

Client : NASSCO - San Diego
Project : Advanced Analysis of BUILDER FDD

Local Strength - Pontoon Bottom Structure

Design Parameters

Plate Spacing =	31.50	in	800	mm
Stiffener Spacing =	31.50	in	800	mm
Stiffener Span =	12.01	ft	3.660	M
Plate Design Head =	34.00	ft	10.363	M
Stiffener Design Head =	34.00	ft	10.363	M

Structural Members

Plating

Plate Thickness =	0.45	in	11.5	mm
Yield Point =	34.0	ksi	234	Mpa

Stiffener: L 297 x 9 Web ; 100 x 13 FLG

Stiffener Web Height =	11.69	in	297	mm
Stiffener Web Thickness =	0.35	in	9	mm
Stiffener Flange Width =	3.94	in	100	mm
Stiffener Flange Thickness =	0.51	in	13	mm
Yield Point =	51.0	ksi	351	Mpa

Corrosion Assumptions

Member	Percent	in	mm
Plate	0%	0.00	0.00
Stiffener Web	0%	0.00	0.00
Stiffener FLG	0%	0.00	0.00

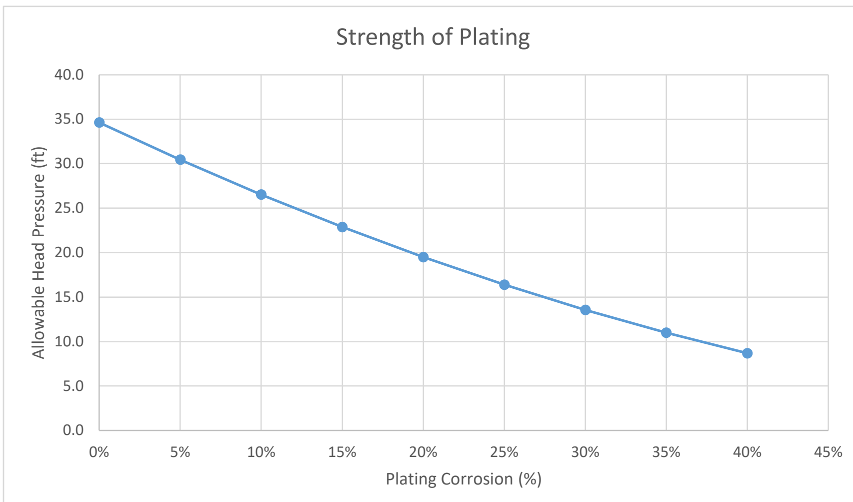
Done By : M. Naylor
Checked By : P. Shah
Date : 9/17/2021
Job No : 4386-D

Client : NASSCO - San Diego
Project : Advanced Analysis of BUILDER FDD

Local Strength - Pontoon Bottom Structure

Structural Evaluation of Plating

Original Thickness =	0.45 in		
Assumed Corrosion =	0.00 in	0%	
Assumed Thickness =	0.45 in		
Plating Spacing, s =	31.50 in	800	mm
Head limit based on strength, per ABS =	**34.64 ft**	10.56	M



Local Strength - Pontoon Bottom Structure

Structural Evaluation of Stiffener

Stiffener Spacing = 31.50 in   800 mm

Item	Original Dimension	Assumed Corrosion	Assumed Dimension
Plate Thickness, t =	0.45 in	0.00 in	0.45 in
Web Height =	11.69 in	N/A	11.69 in
Web Thickness =	0.35 in	0.00 in	0.35 in
Flange Width =	3.94 in	N/A	3.94 in
Flange Thickness =	0.51 in	0.00 in	0.51 in

Effective width of Pl. = t x 50   22.64 in

I of Stiffener on Plate						
Item	Area	Arm	Area*Arm	Dist.	Area*D^2	I (Initial)
Plate	10.25	0.23	2.3	3.03	94	0
Web	4.14	6.30	26.1	-3.04	38	47
Flange	2.02	12.40	25.0	-9.15	169	0
Totals	16.41		53.4		301	47

Neutral Axis = 3.26 In.
Section Height = 12.66 In.
I (Total) = 348 In.^{4}

Shear Area = 4.48 In.^{2}
S_{plate} = 107.0 In.^{3}
S_{flange} = 37.1 In.^{3}

Design Head Pressure = 34.00 ft   10.36 M
Distributed Loading Along Stiffener, w = 5.71 k/ft

Span, l = 12.01 ft   3.66 M

Applied Moment = 70.04 k-ft   =w*l^2/11.75
Applied Shear = 34.27 kips   =w*l/2

Applied Bending Stress (plate) = 7.85 ksi
AISC Limit = 20.40 ksi   =0.6*fy
Check = OK   38%

Applied Bending Stress (stiffener) = 22.68 ksi
AISC Limit = 30.60 ksi   =0.6*fy
Check = OK   74%

Applied Shear Stress = 7.64 ksi
AISC Limit = 20.40 ksi   =0.4*fy
Check = OK   37%

Head limit based on strength = **45.87 ft**   13.98 M

HEGER DRY DOCK, Inc.
HOPKINTON, MASSACHUSETTS

Done By : M. Naylor
Checked By : P. Shah
Date : 9/17/2021
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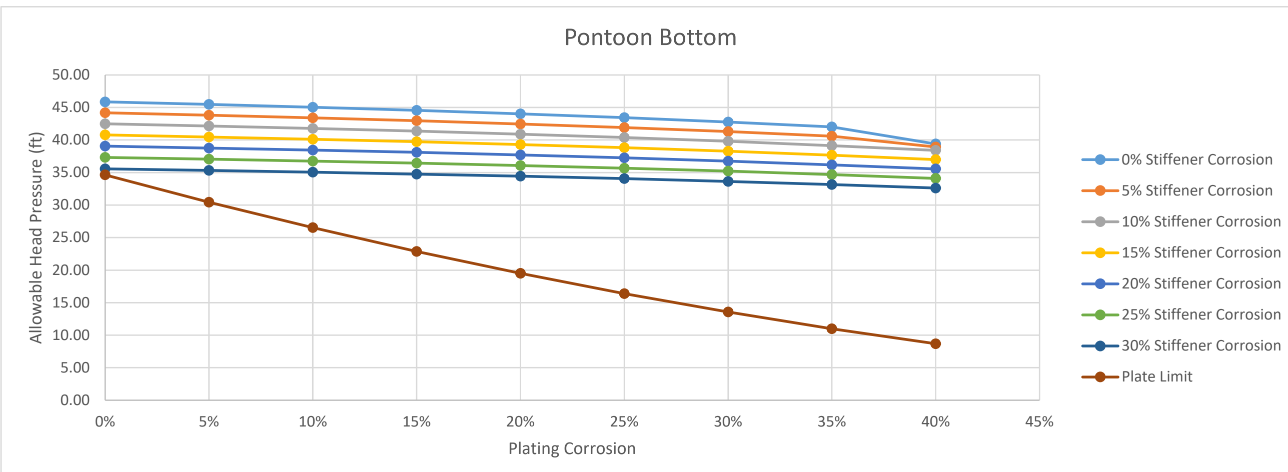
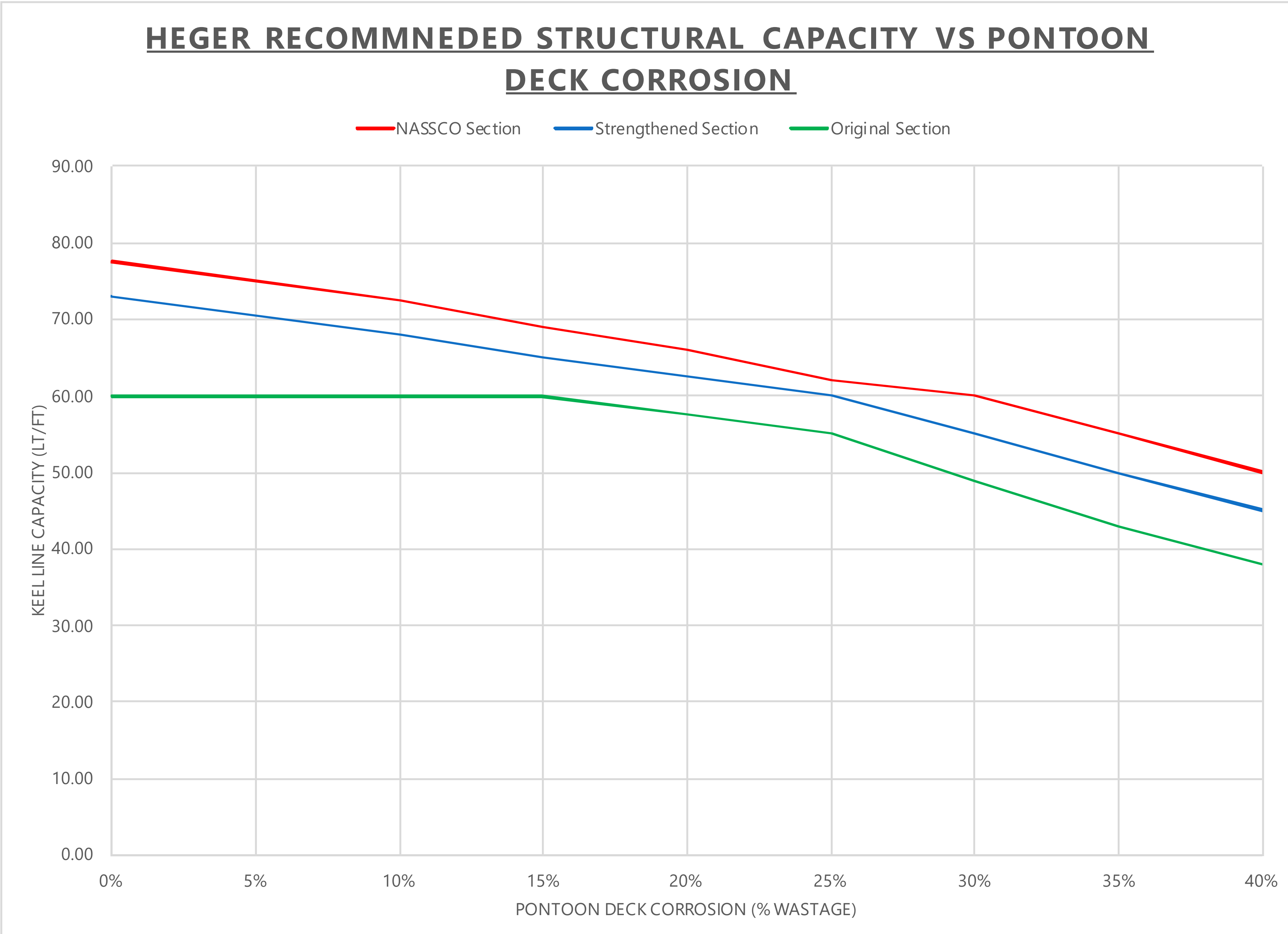
Local Strength - Pontoon Bottom Structure

Allowable Head Pressure in Feet

		Stiffener Corrosion						
		0%	5%	10%	15%	20%	25%	30%
Plating Corrosion	0%	34.64	34.64	34.64	34.64	34.64	34.64	34.64
	5%	30.45	30.45	30.45	30.45	30.45	30.45	30.45
	10%	26.53	26.53	26.53	26.53	26.53	26.53	26.53
	15%	22.88	22.88	22.88	22.88	22.88	22.88	22.88
	20%	19.50	19.50	19.50	19.50	19.50	19.50	19.50
	25%	16.39	16.39	16.39	16.39	16.39	16.39	16.39
	30%	13.56	13.56	13.56	13.56	13.56	13.56	13.56
	35%	10.99	10.99	10.99	10.99	10.99	10.99	10.99
	40%	8.69	8.69	8.69	8.69	8.69	8.69	8.69



Appendix H – HEGER Analysis Capacity Curves



HEGER RECOMMNEDED STRUCTURAL CAPACITY VS PONTOON DECK CORROSION
NASSCO Section
Strengthened Section
Original Section
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
KEEL LINE CAPACITY (LT/FT)
0%
5%
10%
15%
20%
25%
30%
35%
40%
PONTOON DECK CORROSION (% WASTAGE)