Base Load Power Hub (BLPH)

BARGE STABILITY AND BOLLARD PULL CALCULATION

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1 INTRODUCTION

1.1 PROJECT OVERVIEW

Crosswind, a Shell and Eneco joint venture, was awarded the tender to develop the offshore Hollandse Kust Noord (HKN) wind farm, located 18.5km off the coast of Netherlands near the town of Egmond aan Zee. The consortium plans to have HKN operational in 2023 with an installed capacity of 759MW generating at least 3.3TWh per year. This is sufficient renewable power to supply more than 1 million Dutch households with green electricity.

Offshore wind farms produce intermittent electricity and balancing these dips and peaks and integrating this electricity into the national energy system requires new technologies. For this reason, the offshore wind farm will include several new technologies that could be implemented at full-scale in the future. The new technologies being explored include a floating solar park, a short-duration battery storage as well as long-term storage via green hydrogen produced by water electrolysis and subsequently consumed in a fuel cell. The combination of these individual measures, herein referred to as the Base Load Power Hub (BLPH) will ensure a continuous power supply regardless of the wind situation.

1.1.1 Project Location

The Hollandse Kust Noord (HKN) wind farm is located 18.5km off the coast of the Netherlands near the town of Egmond aan Zee.

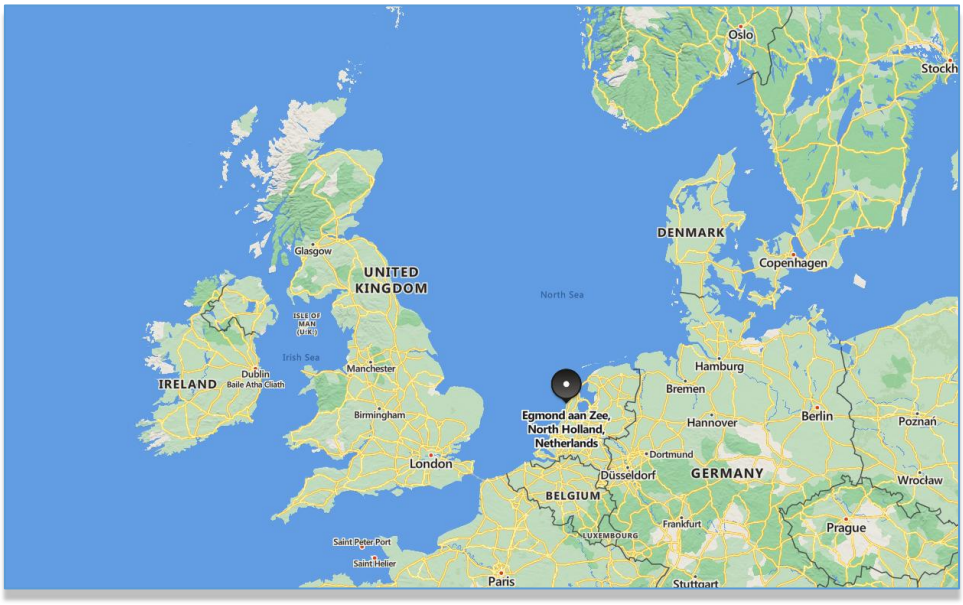


Figure 1.1 - HOLLANDSE KUST NOORD WIND PARK Location Map

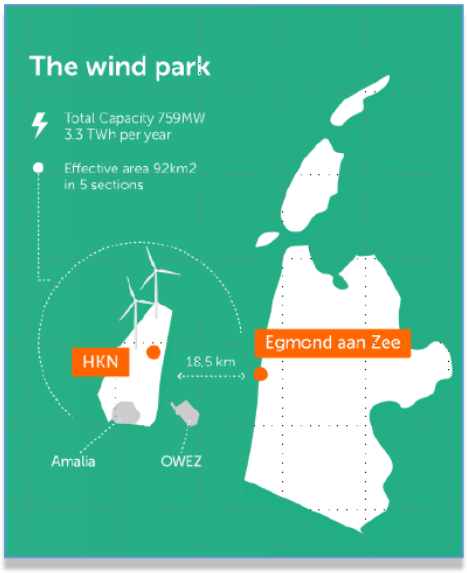


Figure 1.2 - Wind Park Details

The wind farm will consist of No. 69 x 11.5MW wind turbine generators each to be installed on a dedicated monopile structure. A 70th monopile located on coordinates E 590719.1, N 5841602.3 is reserved for installing the platform accommodating the BLPH. The monopile structure was designed and installed by Van Oord Offshore Wind (VooW) and therefore not part of the BLPH scope.

1.1.2 Project Concept

All components included in the BLPH will be integrated onshore on a topsides and installed in an offshore location within the boundaries of the HKN wind farm. At its simplest, the BLPH will store energy during periods of high electricity generation from renewable sources (a wind turbine generator and the floating solar PV farm) and release it during periods of low generation. In practice. It is expected that the energy stored will supplement generation from renewable sources to ensure that at least 1.0MW of power is exported to the electrical grid regardless of wind/solar availability.

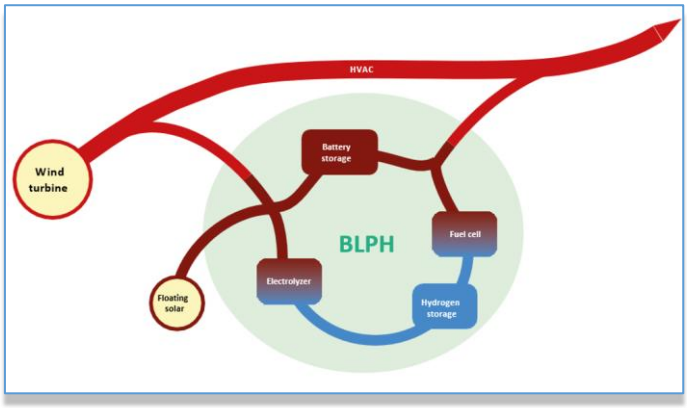


Figure 1.3 – BLPH Concept

Electricity in the BLPH will be stored in the form of electrons in a battery energy storage system (BESS) as well as converted into green hydrogen via water electrolysis. When the power output from the connecting wind turbine drops to below 1 MWe, the BLPH will return its stored energy to supplement the remaining power output. This will be by discharging the BESS, while stored hydrogen will be converted back into electricity using a fuel cell to extend the discharge duration.

The purpose of the BLPH s to function as a testbed for the integration of energy storage technologies with renewable generation. It is expected that equipment installed on the BLPH will operate as Normally Unmanned Installation for at least two (2) years with no or minimal maintenance and it will have its own independent control room with the ability to communicate with Crosswind's control room.

2 DOCUMENT SCOPE

This report deals with the naval analysis performed for the transportation from Rosetti Marino Piomboni yard (Italy) to Eemshaven Port (NL) of the Topside, TP and Caisson Frame, and other minor components, part of the BLPH project.

The cargo barge is the VERVECE having the following main characteristics:

- Barge Name: Vervece
- LOA: 91.44 m
- Breadth: 27.43 m
- Depth: 6.1 m
- Frame Spacing: 2.286 m

The scope of the document is to define the ballast pattern for towing and to check the loaded barge stability in intact and damaged conditions.

The report includes also:

- Longitudinal strength of the loaded barge
- Calculation of the minimum required bollard pull.

Details of marine spread is presented in /27/.

Transportation is carried out in accordance with DNV-ST-N001, Ref./9/ and in compliance with the requirements, criteria and parameters reported in the Structural Design Premises, Ref./19/.

All naval analyses are performed using the MOSES program developed by Bentley, ref. /54/.

The International System of Units (SI) has been used in all engineering assessments and calculations.

3 REFERENCES

3.1 CODES AND STANDARDS

Doc. No.	Description
/1/ BS EN ISO 19900	General requirements for offshore structures - 2019
/2/ BS EN ISO 19901-1	Specific requirements for offshore structures - Part 1: Metocean design and operating considerations - 2015
/3/ BS EN ISO 19901-3	Specific requirements for offshore structures – Part 3: Topsides structure - 2014
/4/ BS EN ISO 19901-5	Specific requirements for offshore structures – Part 5: Weight Management - 2021
/5/ BS EN ISO 19901-6	Specific requirements for offshore structures – Part 6: Marine Operations – 2009
/6/ BS EN ISO 19902	Petroleum and natural gas industries - Fixed steel offshore structures – 2020
/7/ ISO 19906:2019	Petroleum and natural gas industries – Arctic offshore structures
/8/ UNI EN 1993-1-1	Design of steel structures - Part 1-1: General rules and rules for buildings
/9/ DNV-ST-N001	DNV - Marine operation and marine warranty - 2021
/10/ DNV-ST-0145	DNV, Offshore substations
/11/ DNV-RP-C201	DNV, Buckling Strength of Plated Structures, October 2010.
/12/ DNV-RP-C203	DNV, Fatigue design of offshore steel structures, September 2019 and Amendment January 2020
/13/ DNV-RP-C204	DNV-RP-C204 Design against accidental loads – 2019
/14/ DNV-RP-C205	DNV - Environmental conditions and environmental loads - September 2019, amended September 2021.
/15/ DNV-ST-0126	Support structures for wind turbine, 2018

3.2 COMPANY SPECIFICATIONS

Doc. No.	Description
/16/ DEP 37.19.00.12	Gen - Offshore Topsides Structures
/17/ DEP 37.19.00.30	Gen - Fixed Steel Offshore Structures (Adoption of IOGP S-631-11, Amendments / Supplements to ISO 19902:2020).

/18/ DEP 37.81.10.19	Gen - Marine Operations Requirements – Loadout, Transportation and Installation of Offshore Structures (Amendments / Supplements to ISO 19901-6)

3.3 PROJECT DOCUMENTS

Doc. No.	Description
/19/ 123A90-DDL-ST-SP-90017	Structural Design Basis
/20/ 123A90-DDL-MD-RE-01006	Monthly Weight Report – rev. July 24
/21/ 123A90-DDL-PP-DS-70070	BLPH Platform - Plot Plan Lower & Upper Deck
/22/ 123A90-DDL-ST-SP-90018	Structural Material Specification for Topside and TP
/23/ 123A90-DDL-ST-SP-90118	Structural Material Specification for Flange and Bolts
/24/ 123A90-DDL-TI-SP-99014	Specification for TP, Topside and Caissons Transportation and Installation
/25/ 123A90-DDL-TI-DD-99015	BLPH Platform – Barge Layout
/26/ 123A90-DDL-ST-TN-90119	Evaluating ISO and DNV Approaches
/27/ 123A90-DDL-TI-RE-99011	Transport Manual
/28/ 123A90-DDL-TI-DD-99021	BLPH – Topside – Grillage Assembly
/29/ 123A90-DDL-TI-DD-99023	BLPH – Topside – Grillage – Plan and Section
/30/ 123A90-DDL-TI-DD-99024	BLPH – Sea Fastening - Assembly
/31/ 123A90-DDL-TI-DD-99025	BLPH – Sea Fastening - Details
/32/ 123A90-DDL-ST-RE-90001	BLPH – Topside Loadout Analysis
/33/ 123A90-DDL-ST-RE-90002	BLPH – Topside Transportation Analysis
/34/ 123A90-DDL-ST-RE-90003	BLPH – Topside Fatigue Transportation Analysis
/35/ 123A90-DDL-TI-RE-99001	BLPH – Topside Grillage and Sea Fastening Design Report
/36/ 123A90-DDL-TI-RE-99003	Validation of TP Grillage and SF on barge Vervece
/37/ 123A90-DDL-TI-RE-99004	TP – Grillage and Sea Fastening Design Report
/38/ 123A90-DDL-TI-DD-99036	BLPH - TP - Upper Grillage - Plan View
/39/ 123A90-DDL-TI-DD-99037	BLPH - TP - Upper Grillage - Sections
/40/ 123A90-DDL-TI-DD-99038	BLPH - TP - Upper Grillage - Sections and Details
/41/ 123A90-DDL-TI-DD-99039	TP - Sea Fastening Drawing – Assembly
/42/ 123A90-DDL-TI-DD-99040	TP - Sea Fastening Drawing - Details
/43/ 123A90-DDL-ST-RE-90008	TP – Loadout Analysis

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/44/ 123A90-DDL-ST-RE-90010	TP – Transportation Fatigue Analysis
/45/ 123A90-DDL-ST-RE-90015	Caisson Frame – In service, Lifting and transportation design report
/46/ 123A90-DDL-ST-RE-90014	Caisson Frame – Loadout Analysis
/47/ 123A90-DDL-ST-DD-90094	Caisson frame – Elevations
/48/ 123A90-DDL-ST-DD-90095	Caisson frame - Details
/49/ 123A90-DDL-ST-DD-90096	Caisson frame - Details
/50/ 123A90-DDL-TI-DD-99047	CF – Grillage drawing
/51/ 123A90-DDL-TI-DD-99007	Caisson – Grillage and Sea fastening Design report
/52/ 123A90-DDL-TI-DD-99048	CF – Sea fastening drawing
/53/	Vervece Stability booklet

3.4 SOFTWARE

Doc. No.	Description
/54/ MOSES	Hydrostatic and Hydrodynamic Analysis Software for Offshore Installation and Platform Design– BENTLEY Inc, v.12

4 DEFINITIONS AND ABBREVIATIONS

COMPANY or Client (CPY)	Crosswind
CONTRACTOR (CTR)	ROSETTI MARINO S.p.A.
PROJECT	HOLLANDSE KUST NOORD WIND PARK Project
T&I CONTRACTOR	DEME
ALS	Accidental Limit State
BLPH	Base Load Power Hub
BESS	BATTERY ENERGY STORAGE SYSTEM
BLPH	Base Load Power Hub
Ce	Snow Exposure Coefficient
CF	Caisson Frame
CL	Concentrated Load
CoG	Centre of Gravity
CTV	Crew Transfer Vessel
CW	CrossWind
DAF	Dynamic Amplification Factor
DFF	Damage Fatigue Factors
DNV	Det Norske Veritas
DP	Dynamic Positioning
El.	Elevation
EPCI	Engineering Procurement Construction and Installation
FEED	Front End Engineering Design
HAT	Highest Astronomical Tide
HKN	Hollandse Kust Noord
LAT	Lowest Astronomical Tide
LRFD	Load and Resistance Factor Design
MSL	Mean Sea Level
NTE	Not-to-Exceed
OD	Outside Diameter

PAU	Pre-Assembled Unit (H2 Vessels)
PG	Plate Girder
SHL	Static Hook Load
T&I	Transport & Installation
ToS	Top of Steel
TP	Transition Piece
UC	Unity Check
UDL	Uniformly Distributed Load
VIV	Vortex Induced Vibration
VOOW	Van Oord Offshore Wind
WTG	Wind Turbine Generator
W2W	Walk to Work

Table 4.1 - Definitions and Abbreviations

5 SUMMARY AND CONCLUSIONS

The performed naval analyses lead to the following conclusions:

- The intact stability requirements are satisfied.
- As far as barge strength check concerns, the maximum usage factor, i.e. the ratio between calculated and allowable bending stress, is 0.46 in the sagging position.
- The maximum shear stress is 0.17.
- The maximum hull deflection is 3 cm in sagging condition
- The minimum required bollard pull is 75 t.

The ballast plan was selected to have a barge mean draft of 2.75m with trim 0.30deg. by stern. Draft Bow = 2.50m, stern =3.0m

The foreseen ballast plan is the following:

- Tank 1SC 83.5% ullage = 0.65m
- Tank 1SW 83.5% ullage = 0.65m
- Tank 5PW 87.5% ullage = 0.70m
- Tank 5SW 90.5% ullage = 0.50m
- All remaining tanks 3%

6 TRANSPORTATION ARRANGEMENT

An overview of the Transportation Layout is shown in the following figure:

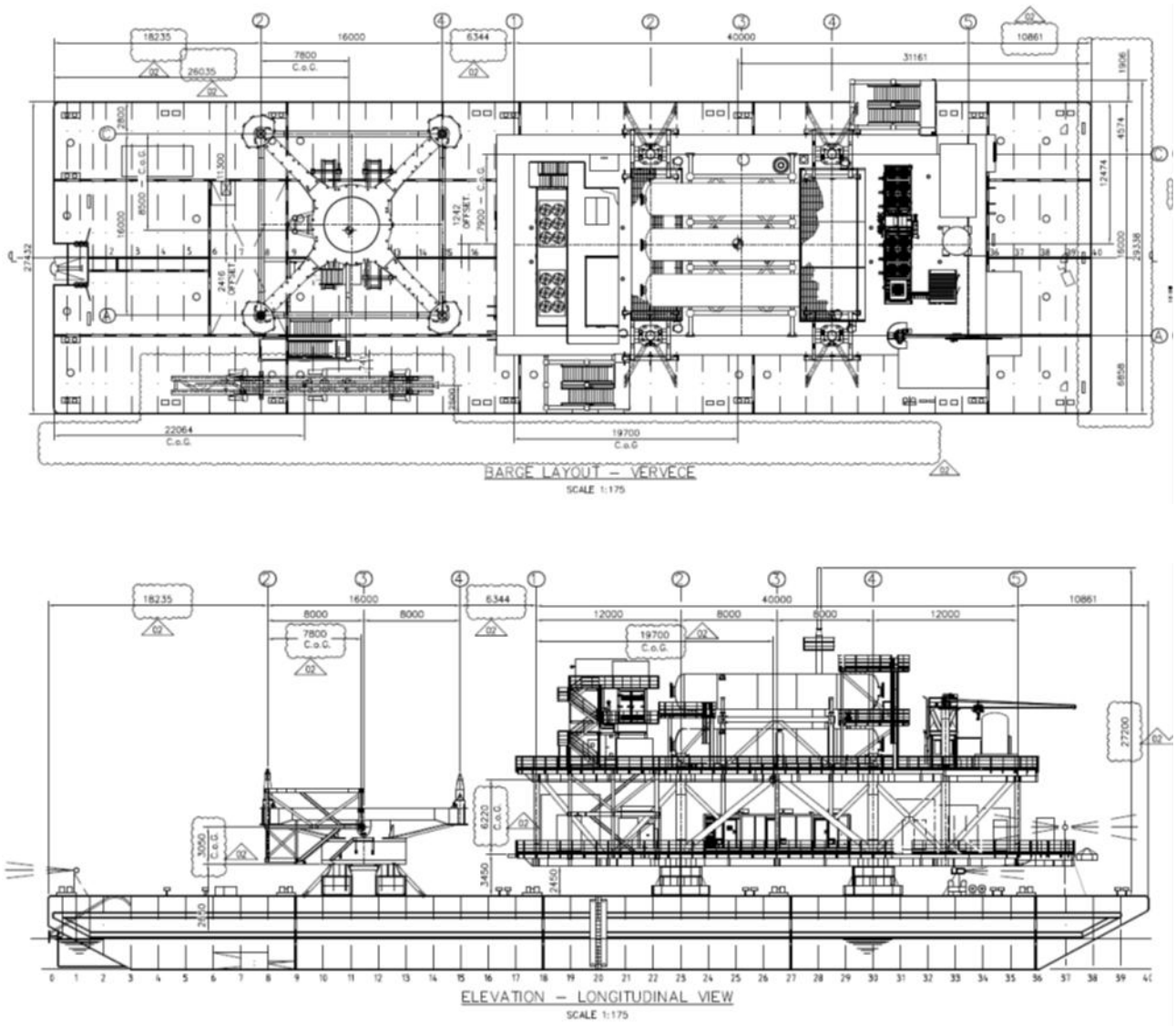


Figure 6.1 – Transportation Arrangement – plan and side view

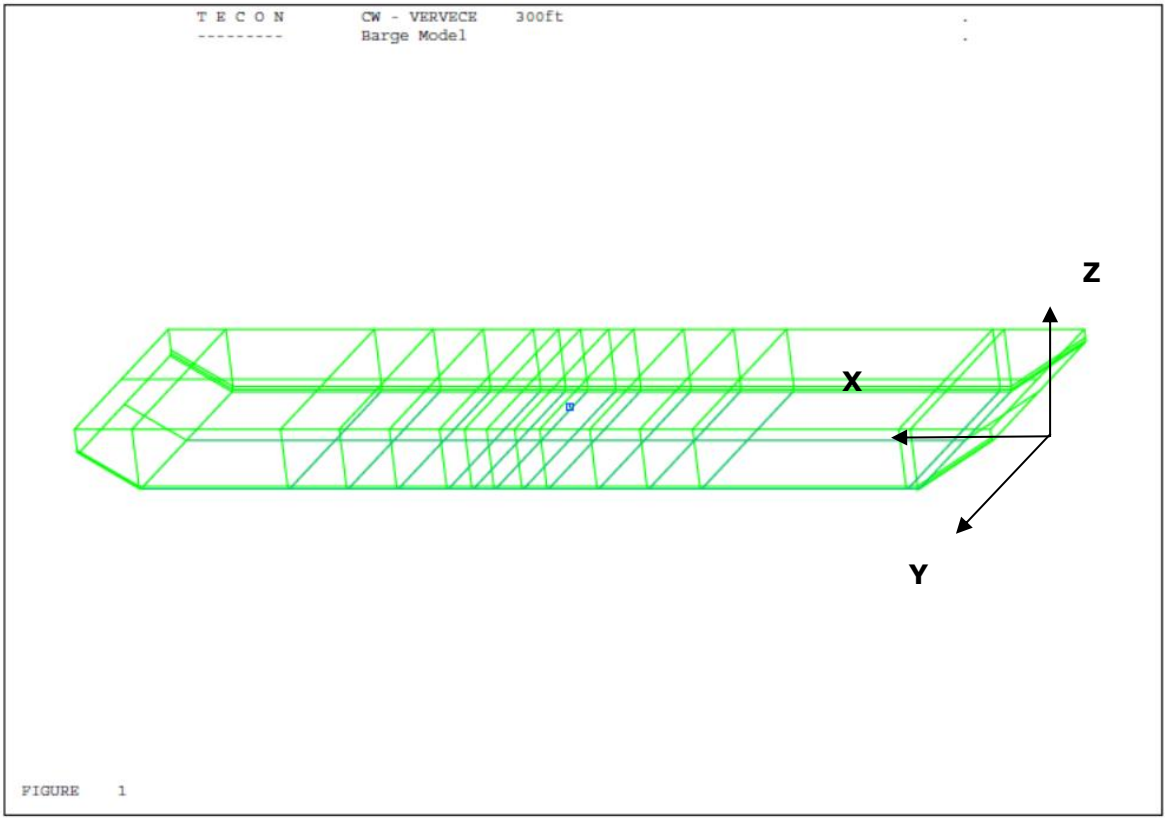
7 CARGO BARGE

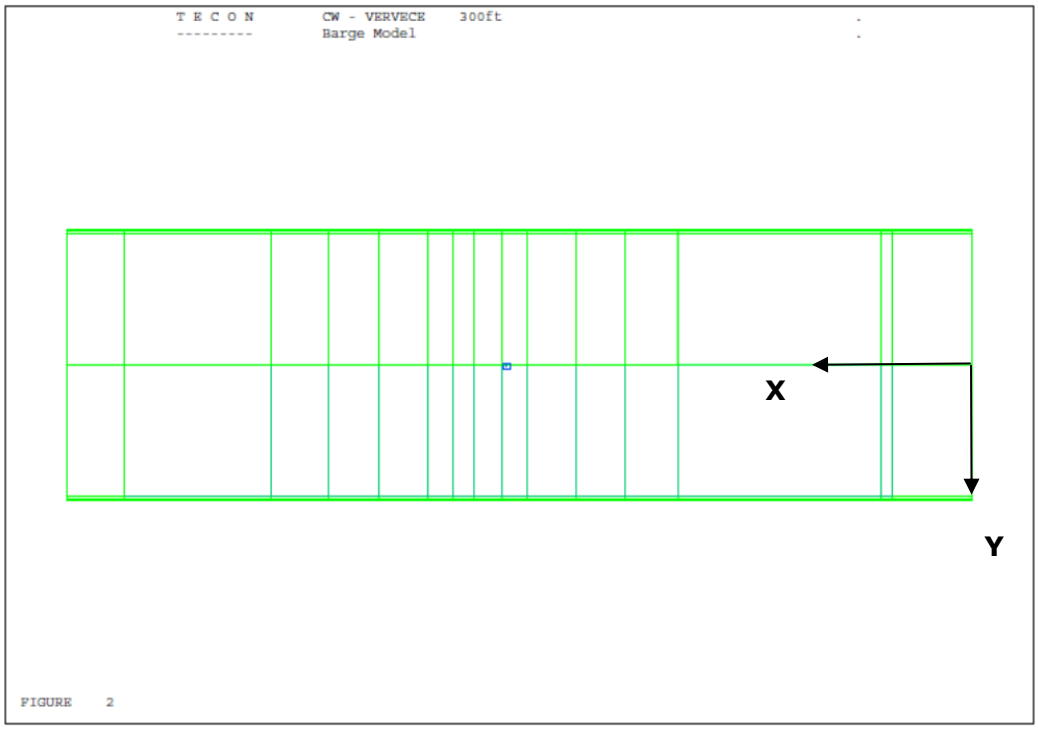
7.1 MOSES MODEL

AMT Carrier model was set out in MOSES language based on the hull drawings and on the tanks capacities and weight distribution included in the barge documents.

The standard Moses reference system has the origin at the bow of the barge, on the centreline and at keel elevation, the X axis positive from bow to stern, the Y axis positive to starboard and the Z axis positive upwards.

The Moses barge hull model is shown in the following figures:





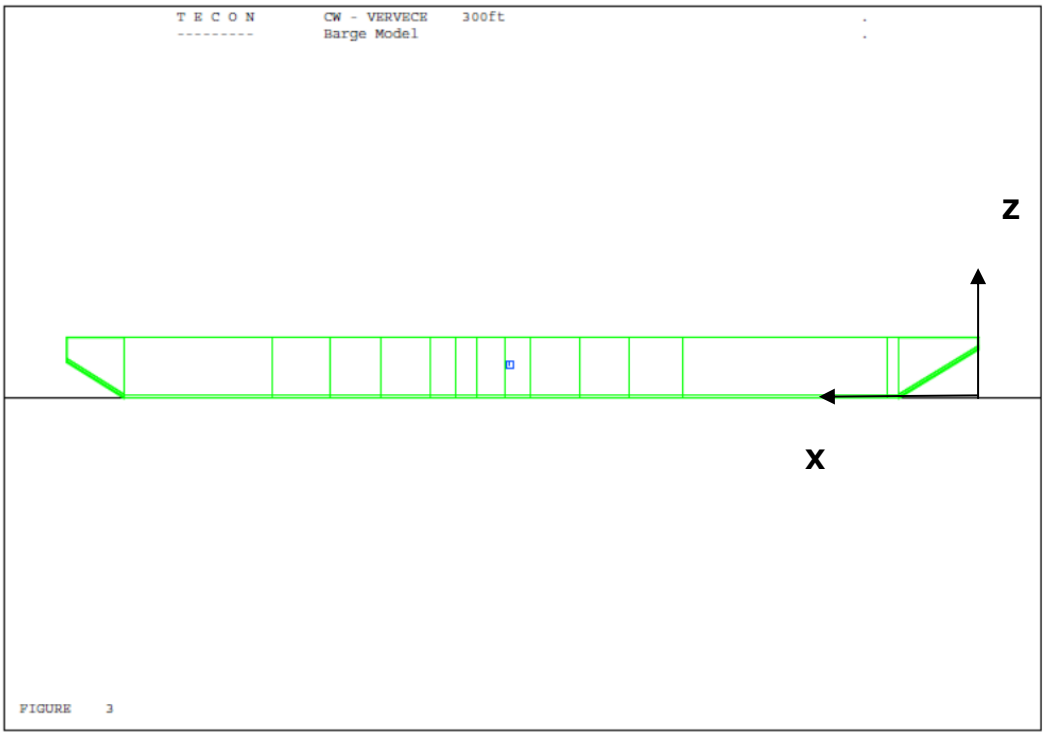


Figure 7.1 – Barge MOSES model and ref. system

The Barge hydrostatic properties are summarised in the following tables.

The density used for sea water is 1.025 t/m3.

```
*****************************************************************************************************************
*                                          *** MOSES   ***                                                      *
*                                          ----------------                        25 March, 2025               *
*          T E C O N       CW - VERVECE    300ft                                   .                            *
*          ---------       Hydrostatic Curves                                      .                            *
*                                                                                                               *
*****************************************************************************************************************

                              +++ H Y D R O S T A T I C   P R O P E R T I E S +++
                              ==================================================

                Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

                                        Results are in the Body System

                                              For Body VERVECE
```

/--- Condition ---/			/- Displac-/	/-- Center Of Buoyancy --/			/ W.P. /	/C. Flotation /		/---- Metacentric Heights ----/			
Draft	Trim	Roll	M-Tons	---X---	---Y---	---Z---	Area	---X---	---Y---	-KMT-	-KML-	-BMT-	-BML-
0.10	0.00	0.00	211.04	46.85	0.00	0.05	2081.674	46.85	0.00	619.45	5128.82	619.40	5128.77
0.20	0.00	0.00	425.67	46.85	-0.00	0.10	2101.925	46.85	-0.00	313.63	2588.77	313.53	2588.67
0.30	0.00	0.00	641.89	46.85	0.00	0.15	2116.956	46.84	0.00	210.82	1743.33	210.67	1743.18
0.40	0.00	0.00	859.65	46.85	0.00	0.20	2132.015	46.84	0.00	159.57	1321.77	159.37	1321.57
0.50	0.00	0.00	1078.63	46.84	-0.00	0.25	2140.752	46.84	0.00	127.79	1066.52	127.54	1066.27
0.60	0.00	0.00	1298.50	46.84	0.00	0.30	2149.490	46.84	0.00	106.68	896.91	106.37	896.61
0.70	0.00	0.00	1519.27	46.84	-0.00	0.35	2158.227	46.83	0.00	91.64	776.06	91.29	775.70
0.80	0.00	0.00	1740.94	46.84	0.00	0.40	2166.965	46.83	0.00	80.39	685.59	79.99	685.19
0.90	0.00	0.00	1963.50	46.84	-0.00	0.45	2175.702	46.83	0.00	71.66	615.36	71.20	614.90
1.00	0.00	0.00	2186.96	46.84	0.00	0.50	2184.439	46.83	0.00	64.69	559.26	64.19	558.75
1.10	0.00	0.00	2411.31	46.84	-0.00	0.56	2193.177	46.83	0.00	59.00	513.42	58.45	512.87
1.20	0.00	0.00	2636.56	46.84	-0.00	0.61	2201.914	46.82	0.00	54.27	475.29	53.67	474.68
1.30	0.00	0.00	2862.70	46.84	-0.00	0.66	2210.652	46.82	0.00	50.28	443.07	49.62	442.41
1.40	0.00	0.00	3089.74	46.83	0.00	0.71	2219.389	46.82	0.00	46.87	415.49	46.16	414.78
1.50	0.00	0.00	3317.68	46.83	0.00	0.76	2228.126	46.82	0.00	43.92	391.62	43.16	390.86
1.60	0.00	0.00	3546.51	46.83	-0.00	0.81	2236.864	46.81	0.00	41.34	370.77	40.53	369.96
1.70	0.00	0.00	3776.23	46.83	-0.00	0.86	2245.601	46.81	0.00	39.07	352.40	38.21	351.54
1.80	0.00	0.00	4006.86	46.83	-0.00	0.91	2254.339	46.81	0.00	37.07	336.10	36.15	335.19
1.90	0.00	0.00	4238.37	46.83	-0.00	0.96	2263.076	46.81	0.00	35.28	321.54	34.31	320.58
2.00	0.00	0.00	4470.79	46.83	0.00	1.01	2271.813	46.81	0.00	33.67	308.46	32.65	307.45
2.10	0.00	0.00	4704.09	46.83	0.00	1.07	2280.551	46.80	0.00	32.22	296.65	31.15	295.58
2.20	0.00	0.00	4938.30	46.83	0.00	1.12	2289.288	46.80	0.00	30.91	285.93	29.79	284.81
2.30	0.00	0.00	5173.40	46.82	0.00	1.17	2298.026	46.80	0.00	29.71	276.17	28.54	275.00
2.40	0.00	0.00	5409.40	46.82	-0.00	1.22	2306.763	46.80	0.00	28.62	267.23	27.40	266.01
2.50	0.00	0.00	5646.29	46.82	-0.00	1.27	2315.500	46.79	0.00	27.63	259.03	26.35	257.76
2.60	0.00	0.00	5884.07	46.82	0.00	1.32	2324.238	46.79	0.00	26.71	251.48	25.38	250.15
2.70	0.00	0.00	6122.75	46.82	-0.00	1.38	2332.975	46.79	0.00	25.86	244.50	24.49	243.12
2.80	0.00	0.00	6362.33	46.82	0.00	1.43	2341.713	46.79	0.00	25.08	238.03	23.65	236.60
2.90	0.00	0.00	6602.80	46.82	0.00	1.48	2350.450	46.79	0.00	24.35	232.03	22.88	230.55
3.00	0.00	0.00	6844.17	46.82	0.00	1.53	2359.188	46.78	0.00	23.68	226.44	22.15	224.91
3.10	0.00	0.00	7086.44	46.81	0.00	1.58	2367.925	46.78	0.00	23.06	221.22	21.47	219.64
3.20	0.00	0.00	7329.60	46.81	0.00	1.63	2376.663	46.78	-0.00	22.47	216.35	20.84	214.71
3.30	0.00	0.00	7573.65	46.81	0.00	1.69	2385.400	46.78	0.00	21.93	211.78	20.24	210.10
3.40	0.00	0.00	7818.61	46.81	-0.00	1.74	2394.138	46.77	0.00	21.42	207.50	19.68	205.76
3.50	0.00	0.00	8064.45	46.81	0.00	1.79	2402.875	46.77	-0.00	20.94	203.47	19.15	201.68
3.60	0.00	0.00	8311.19	46.81	0.00	1.84	2411.444	46.77	-0.00	20.49	199.63	18.65	197.79
3.70	0.00	0.00	8558.60	46.81	0.00	1.90	2415.958	46.69	-0.00	20.04	195.05	18.14	193.15
3.80	0.00	0.00	8806.47	46.80	0.00	1.95	2420.419	46.61	-0.00	19.61	190.71	17.66	188.76
3.90	0.00	0.00	9054.78	46.80	0.00	2.00	2424.867	46.52	-0.00	19.21	186.60	17.21	184.60
4.00	0.00	0.00	9303.56	46.79	0.00	2.05	2429.302	46.44	-0.00	18.83	182.70	16.78	180.65
4.10	0.00	0.00	9552.79	46.78	-0.00	2.10	2433.730	46.36	0.00	18.48	179.00	16.37	176.90
4.20	0.00	0.00	9802.47	46.77	-0.00	2.16	2438.159	46.28	0.00	18.14	175.49	15.99	173.34
4.30	0.00	0.00	10052.61	46.75	0.00	2.21	2442.588	46.20	-0.00	17.82	172.15	15.62	169.95
4.40	0.00	0.00	10303.21	46.74	0.00	2.26	2447.017	46.11	0.00	17.52	168.98	15.26	166.72
4.50	0.00	0.00	10554.25	46.72	-0.00	2.31	2451.446	46.03	-0.00	17.24	165.95	14.93	163.64
4.60	0.00	0.00	10805.76	46.70	-0.00	2.36	2455.874	45.95	-0.00	16.97	163.06	14.61	160.69
4.70	0.00	0.00	11057.71	46.69	-0.00	2.42	2460.303	45.87	-0.00	16.72	160.30	14.30	157.88
4.80	0.00	0.00	11310.12	46.67	0.00	2.47	2464.732	45.79	-0.00	16.47	157.66	14.01	155.20
4.90	0.00	0.00	11562.96	46.65	0.00	2.52	2468.126	45.72	-0.00	16.24	154.95	13.72	152.43
5.00	0.00	0.00	11815.95	46.63	-0.00	2.57	2468.198	45.72	-0.00	16.00	151.75	13.43	149.18
5.10	0.00	0.00	12068.95	46.61	0.00	2.62	2468.228	45.72	-0.00	15.77	148.68	13.15	146.06
5.20	0.00	0.00	12321.94	46.59	-0.00	2.68	2468.245	45.72	0.00	15.55	145.74	12.88	143.06
5.30	0.00	0.00	12574.93	46.57	-0.00	2.73	2468.249	45.72	-0.00	15.34	142.91	12.62	140.18
5.40	0.00	0.00	12827.93	46.56	0.00	2.78	2468.249	45.72	-0.00	15.15	140.20	12.37	137.42
5.50	0.00	0.00	13080.93	46.54	0.00	2.83	2468.249	45.72	-0.00	14.96	137.59	12.13	134.76
5.60	0.00	0.00	13333.92	46.52	-0.00	2.88	2468.249	45.72	-0.00	14.78	135.09	11.90	132.20
5.70	0.00	0.00	13586.92	46.51	-0.00	2.93	2468.249	45.72	-0.00	14.61	132.68	11.68	129.74
5.80	0.00	0.00	13839.91	46.49	-0.00	2.99	2468.249	45.72	-0.00	14.45	130.36	11.46	127.37

5.90	0.00	0.00	14092.91	46.48	0.00	3.04	2468.249	45.72	-0.00	14.30	128.12	11.26	125.08
6.00	0.00	0.00	14345.91	46.47	-0.00	3.09	2468.249	45.72	-0.00	14.15	125.97	11.06	122.88

+++ H Y D R O S T A T I C C O E F F I C I E N T S +++

Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

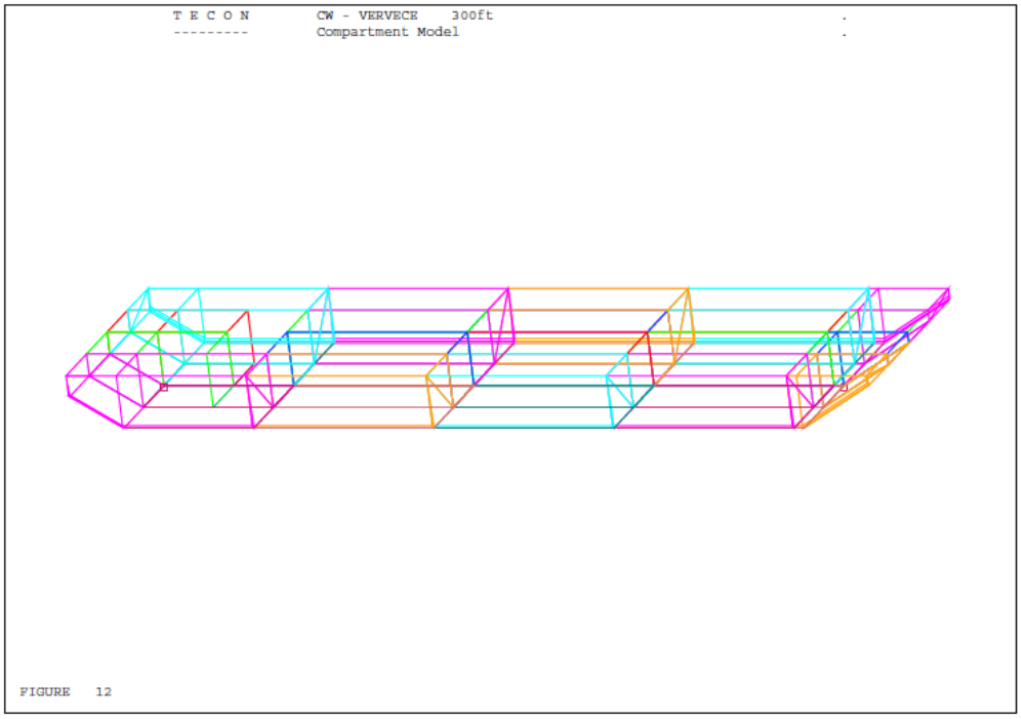
Results are in the Body System

For Body VERVECE

/--- Condition ---/			Displacement	Wetted Surface	Load To Change Draft 1 MM	/--- For KG = KB ----/ Moment To Change .01 Deg	
Draft	Trim	Roll				--- Heel ---	--- Trim ---
0.10	0.00	0.00	211.04	2120.1	2.13	22.81	188.91
0.20	0.00	0.00	425.67	2151.4	2.15	23.29	192.32
0.30	0.00	0.00	641.89	2178.7	2.17	23.60	195.29
0.40	0.00	0.00	859.65	2206.1	2.19	23.91	198.28
0.50	0.00	0.00	1078.63	2232.2	2.19	24.01	200.73
0.60	0.00	0.00	1298.50	2258.4	2.20	24.11	203.20
0.70	0.00	0.00	1519.27	2284.7	2.21	24.21	205.69
0.80	0.00	0.00	1740.94	2311.0	2.22	24.30	208.20
0.90	0.00	0.00	1963.50	2337.4	2.23	24.40	210.72
1.00	0.00	0.00	2186.96	2363.9	2.24	24.50	213.27
1.10	0.00	0.00	2411.31	2390.4	2.25	24.60	215.84
1.20	0.00	0.00	2636.56	2417.0	2.26	24.70	218.43
1.30	0.00	0.00	2862.70	2443.6	2.27	24.79	221.04
1.40	0.00	0.00	3089.74	2470.3	2.27	24.89	223.67
1.50	0.00	0.00	3317.68	2497.1	2.28	24.99	226.33
1.60	0.00	0.00	3546.51	2524.0	2.29	25.09	229.00
1.70	0.00	0.00	3776.23	2550.9	2.30	25.19	231.69
1.80	0.00	0.00	4006.86	2577.9	2.31	25.28	234.41
1.90	0.00	0.00	4238.37	2604.9	2.32	25.38	237.15
2.00	0.00	0.00	4470.79	2632.0	2.33	25.48	239.90
2.10	0.00	0.00	4704.09	2659.2	2.34	25.58	242.68
2.20	0.00	0.00	4938.30	2686.4	2.35	25.68	245.48
2.30	0.00	0.00	5173.40	2713.7	2.36	25.77	248.30
2.40	0.00	0.00	5409.40	2741.1	2.36	25.87	251.15
2.50	0.00	0.00	5646.29	2768.5	2.37	25.97	254.01
2.60	0.00	0.00	5884.07	2796.0	2.38	26.07	256.90
2.70	0.00	0.00	6122.75	2823.6	2.39	26.17	259.80
2.80	0.00	0.00	6362.33	2851.2	2.40	26.26	262.73
2.90	0.00	0.00	6602.80	2878.9	2.41	26.36	265.69
3.00	0.00	0.00	6844.17	2906.7	2.42	26.46	268.66
3.10	0.00	0.00	7086.44	2934.5	2.43	26.56	271.66
3.20	0.00	0.00	7329.60	2962.4	2.44	26.66	274.67
3.30	0.00	0.00	7573.65	2990.3	2.45	26.75	277.71
3.40	0.00	0.00	7818.61	3018.4	2.45	26.85	280.78
3.50	0.00	0.00	8064.45	3046.4	2.46	26.95	283.86
3.60	0.00	0.00	8311.19	3074.5	2.47	27.05	286.91
3.70	0.00	0.00	8558.60	3100.3	2.48	27.10	288.53
3.80	0.00	0.00	8806.47	3126.2	2.48	27.15	290.13
3.90	0.00	0.00	9054.78	3152.1	2.49	27.20	291.73
4.00	0.00	0.00	9303.56	3178.0	2.49	27.25	293.33
4.10	0.00	0.00	9552.79	3204.0	2.49	27.30	294.94
4.20	0.00	0.00	9802.47	3230.0	2.50	27.35	296.55
4.30	0.00	0.00	10052.61	3256.0	2.50	27.40	298.17
4.40	0.00	0.00	10303.21	3282.0	2.51	27.45	299.80
4.50	0.00	0.00	10554.25	3308.1	2.51	27.50	301.43
4.60	0.00	0.00	10805.76	3334.3	2.52	27.55	303.06
4.70	0.00	0.00	11057.71	3360.4	2.52	27.60	304.71
4.80	0.00	0.00	11310.12	3386.6	2.53	27.65	306.35
4.90	0.00	0.00	11562.96	3412.3	2.53	27.69	307.62
5.00	0.00	0.00	11815.95	3436.0	2.53	27.69	307.65
5.10	0.00	0.00	12068.95	3459.8	2.53	27.69	307.66
5.20	0.00	0.00	12321.94	3483.6	2.53	27.69	307.67
5.30	0.00	0.00	12574.93	3507.3	2.53	27.69	307.67
5.40	0.00	0.00	12827.93	3531.1	2.53	27.69	307.67
5.50	0.00	0.00	13080.93	3554.9	2.53	27.69	307.67
5.60	0.00	0.00	13333.92	3578.7	2.53	27.69	307.67
5.70	0.00	0.00	13586.92	3602.4	2.53	27.69	307.67
5.80	0.00	0.00	13839.91	3626.2	2.53	27.69	307.67
5.90	0.00	0.00	14092.91	3650.0	2.53	27.69	307.67
6.00	0.00	0.00	14345.91	3673.8	2.53	27.69	307.67

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The modelled compartment codes are shown in the following figure



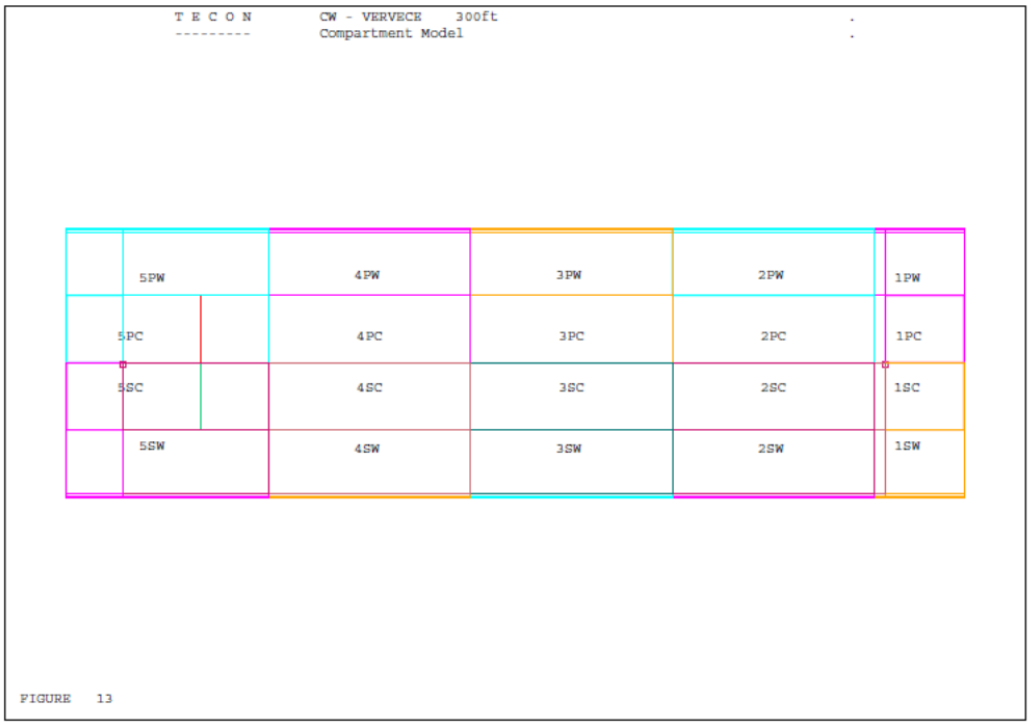


Figure 7.2 – Barge Compartments

The capacity plan for ballast compartments is presented in the Moses output.

The density used for ballast water is 1.025 t/m3 (same of sea water).

```
*****************************************************************************************************************
*                                          ***  MOSES   ***                                                     *
*          T E C O N       CW - VERVECE    300ft                                  .                             *
*          ---------       Capacity Plan                                          .                             *
*****************************************************************************************************************

                    +++ B U O Y A N C Y   A N D   W E I G H T   F O R   V E R V E C E +++
                    ======================================================================
                Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

                                  Results Are Reported In Body System

                       Draft =     0.00 Roll Angle =     0.00 Pitch Angle =     0.00

                                     Wet Radii Of Gyration About CG

                              K-X =     7.95 K-Y =    24.53 K-Z =    25.56

                                          /-- Center of Gravity ---/  Sounding   % Full
                       Name      Weight    ---X---  ---Y---  ---Z---  -------- --------

                       ----------------  Part VERVECE    ------------
                       LOAD_GRO   1832.80    47.02     0.00     3.52
                       --- Contents ---
                       1PC         234.61     5.60    -3.43     3.81     6.10   100.00
                       1PW         234.98     5.60   -10.28     3.82     6.10   100.00
                       1SC         235.12     5.60     3.43     3.81     6.10   100.00
                       1SW         234.98     5.60    10.28     3.82     6.10   100.00
                       2PC         873.69    19.43    -3.43     3.05     6.10   100.00
                       2PW         873.63    19.43   -10.28     3.05     6.10   100.00
                       2SC         873.69    19.43     3.43     3.05     6.10   100.00
                       2SW         873.63    19.43    10.28     3.05     6.10   100.00
                       3PC         873.69    40.01    -3.43     3.05     6.10   100.00
                       3PW         873.63    40.00   -10.28     3.05     6.10   100.00
                       3SC         873.69    40.01     3.43     3.05     6.10   100.00
                       3SW         873.63    40.01    10.28     3.05     6.10   100.00
                       4PC         873.69    60.58    -3.43     3.05     6.10   100.00
                       4PW         873.63    60.58   -10.28     3.05     6.10   100.00
                       4SC         873.69    60.58     3.43     3.05     6.10   100.00
                       4SW         873.63    60.58    10.28     3.05     6.10   100.00
                       5PC         492.02    83.89    -3.43     3.31     6.10   100.00
                       5PW         793.58    80.40   -10.28     3.22     6.10   100.00
                       5SC         484.29    83.89     3.43     3.31     6.10   100.00
                       5SW         793.58    80.40    10.28     3.22     6.10   100.00
                       ========  ========  =======  =======  =======
                       Total     15819.89    45.53    -0.00     3.18
                       Buoyancy      0.00     0.00     0.00     0.00

                            +++ C O M P A R T M E N T   P R O P E R T I E S +++
                            ===================================================
                                      Results Are Reported In Body System

                        Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

                                  Fill   Specific /--- Ballast ---/ /------ % Full --------/ Sounding
                          Name    Type    Gravity  Maximum  Current   Max.    Min.    Curr.  --------

                        1PC     CORRECT     1.0250    234.6    234.6  100.00    0.00  100.00     6.096
                        1PW     CORRECT     1.0250    235.0    235.0  100.00    0.00  100.00     6.096
                        1SC     CORRECT     1.0250    235.1    235.1  100.00    0.00  100.00     6.096
                        1SW     CORRECT     1.0250    235.0    235.0  100.00    0.00  100.00     6.096
                        2PC     CORRECT     1.0250    873.7    873.7  100.00    0.00  100.00     6.096
                        2PW     CORRECT     1.0250    873.6    873.6  100.00    0.00  100.00     6.096
                        2SC     CORRECT     1.0250    873.7    873.7  100.00    0.00  100.00     6.096
                        2SW     CORRECT     1.0250    873.6    873.6  100.00    0.00  100.00     6.096
                        3PC     CORRECT     1.0250    873.7    873.7  100.00    0.00  100.00     6.096
                        3PW     CORRECT     1.0250    873.6    873.6  100.00    0.00  100.00     6.096
                        3SC     CORRECT     1.0250    873.7    873.7  100.00    0.00  100.00     6.096
                        3SW     CORRECT     1.0250    873.6    873.6  100.00    0.00  100.00     6.096
                        4PC     CORRECT     1.0250    873.7    873.7  100.00    0.00  100.00     6.096
                        4PW     CORRECT     1.0250    873.6    873.6  100.00    0.00  100.00     6.096
                        4SC     CORRECT     1.0250    873.7    873.7  100.00    0.00  100.00     6.096
                        4SW     CORRECT     1.0250    873.6    873.6  100.00    0.00  100.00     6.096
                        5PC     CORRECT     1.0250    492.0    492.0  100.00    0.00  100.00     6.096
                        5PW     CORRECT     1.0250    793.6    793.6  100.00    0.00  100.00     6.096
                        5SC     CORRECT     1.0250    484.3    484.3  100.00    0.00  100.00     6.096
                        5SW     CORRECT     1.0250    793.6    793.6  100.00    0.00  100.00     6.096
```

7.2 LIGHTSHIP

As indicated in barge Stability booklet the barge has the following properties:

- Lightweight = 1833 t
- LCG = 44.42 m
- VCG = 3.524 m
- TCG = 0.0 m

7.3 DOWNFLOODING POINTS

Down flooding points have been modelled at barge edges and at deck elevation+600mm, Ref. /53/.

Following FloodingPoints are included in the calculations:

No.	Type	Fr.AP(M)	Fr.CL(M)	Ab/BASE(M)	Description
1	3	90.000	-13.000	6.700	Ventilator, Tk. 1 PW
2	3	90.000	13.000	6.700	Ventilator, Tk. 1 SW
3	3	1.000	-13.000	6.700	Ventilator, Tk. 5 PW
4	3	1.000	13.000	6.700	Ventilator, TK. 5 SW

7.4 ALLOWABLE LONG. BENDING MOMENT AND SHEAR IN STILL WATER

Section 13 of Ref. /53/, indicates the following values of bending moment and shear in still water:

	Max B.M.	W
Hogging	26700 tm	3.24 m3
Sagging	26130 tm	3.24 m3
Max shear midship	6150 ton	

7.5 LOADS

The cargoes are presented in the next Table in Moses ref. system.

cargo ID	cargo description	W (ton)	(CoG coordinates from: bow / CL / deck)		
			x (m)	y (m)	z (m) excluded barge height (6.10m)
BLPH	BLPH topside	1802	31.16	-1.24	9.67
TP	Transition Piece	290	65.41	-2.42	5.70

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GS1	Topside grillage and SF	75	30.86	-1.14	1.25
GS2	TP grillage and SF	45	65.20	-2.92	1.30
CF	Caisson Frame	26	69.38	11.22	1.45
GS3	Caisson Frame grillage and SF	0.5	67.44	11.22	1.00
		2238.5 t			

Table 7.1 -Transported loads

The cargo CoG positions on board are indicated by cubes in the following Moses figures and are listed in the next Moses table. Moses reference system is shown in section 7.

The loads include light ship, ballast water contents and cargo.

```
*****************************************************************************************************************
*                                                *** MOSES  ***                                                 *
*          T E C O N                                                                    .                       *
*          ---------     Weights and Wind Exposed Areas                                 .                       *
*                                                                                                               *
*****************************************************************************************************************

                    Process is DEFAULT: Units Are Degrees, Meters, and M-Tons Unless Specified

  LOAD              CONT.           /---------- FACTOR ----------/ /----------- AREA ----------/ /--------- LOCATION --------/
 GROUP     WEIGHT   NAME      DISPL     WIND   ADD. MASS    DRAG        X         Y         Z         X         Y         Z
-------- --------- -------- --------- --------- --------- --------- --------- --------- --------- --------- --------- ---------

CF           26.00                                                                                    69.38     11.22      7.55
                  #WEI|012 #Weight
                  #ARE|013      0.00      1.00      1.00      1.00      4.00      0.00      0.00     69.38     11.22      7.55
                  #ARE|014      0.00      1.00      1.00      1.00      0.00     25.00      0.00     69.38     11.22      7.55

TOPSIDE    1802.00                                                                                    31.16     -1.24     15.77
                  #WEI|004 #Weight
                  #ARE|005      0.00      1.00      1.00      1.00    500.00      0.00      0.00     31.16     -1.24     15.77
                  #ARE|006      0.00      1.00      1.00      1.00      0.00    800.00      0.00     31.16     -1.24     15.77

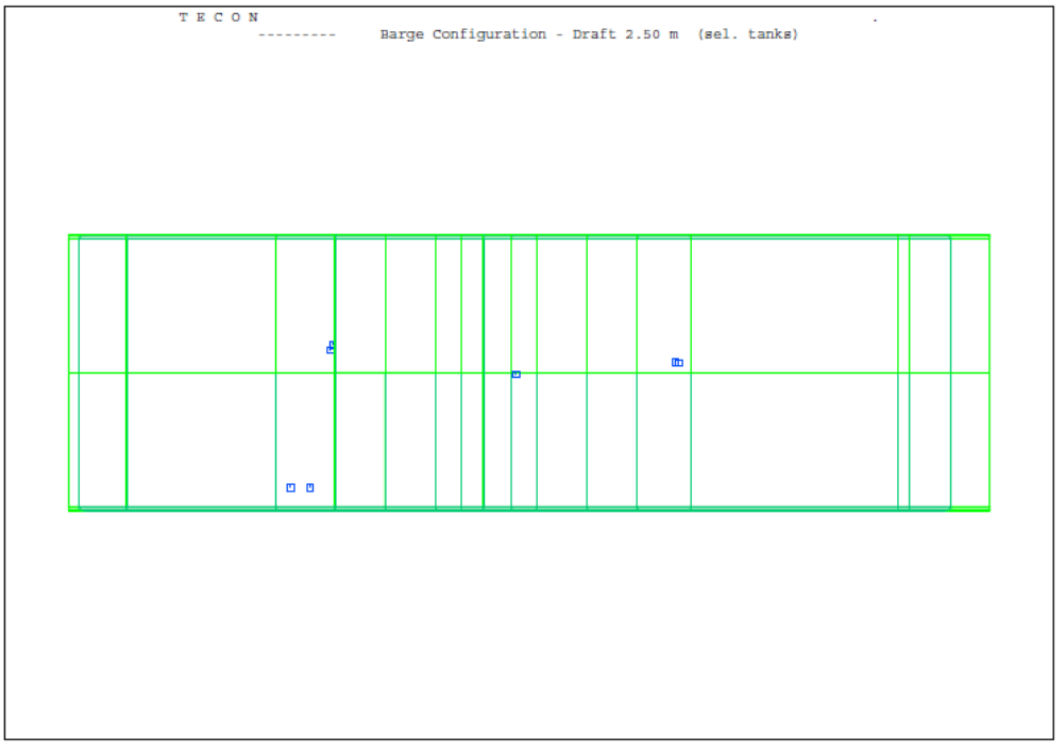
TP          290.00                                                                                    65.41     -2.42     11.80
                  #WEI|008 #Weight
                  #ARE|009      0.00      1.00      1.00      1.00    256.00      0.00      0.00     65.41     -2.42     11.80
                  #ARE|010      0.00      1.00      1.00      1.00      0.00    256.00      0.00     65.41     -2.42     11.80

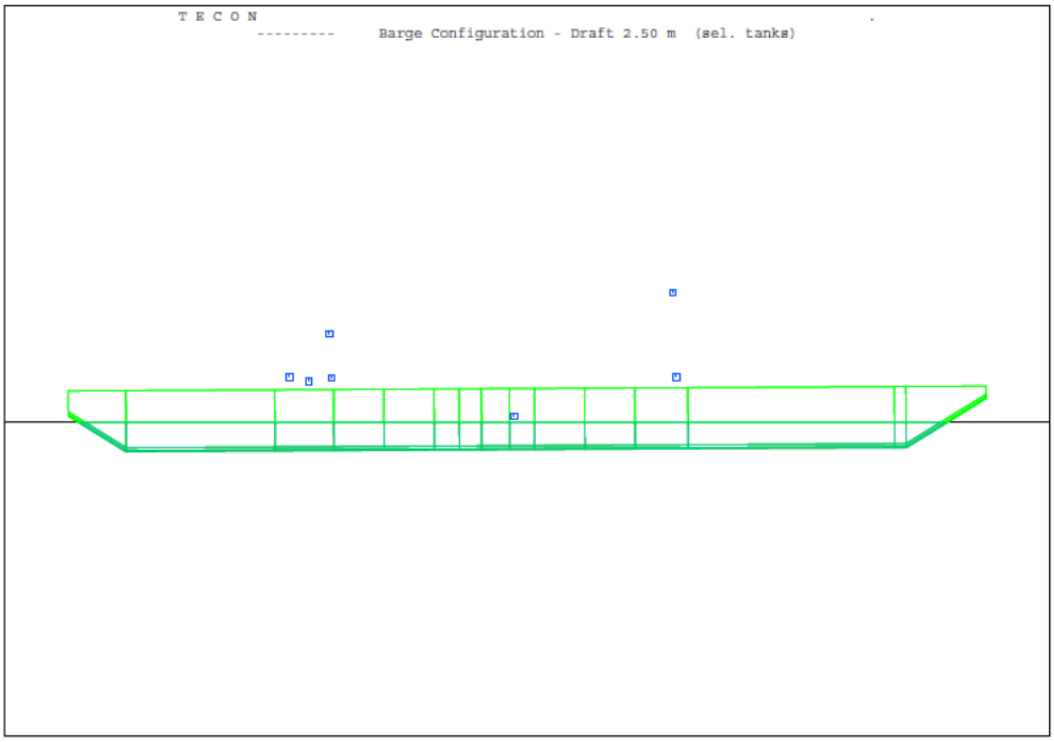
GRI&SF-B     75.00                                                                                    30.86     -1.14      7.35
                  #WEI|016 #Weight

GRI&SF-C      0.50                                                                                    67.44     11.22      7.10
                  #WEI|020 #Weight

GRI&SF-T     45.00                                                                                    65.20     -2.92      7.40
                  #WEI|018 #Weight

VERVECE    1832.80                                                                                    47.02      0.00      3.52
                  #WEI|002 #Weight
```


T E C O N
Barge Configuration - Draft 2.50 m (sel. tanks)


T E C O N
Barge Configuration - Draft 2.50 m (sel. tanks)

8 BALLAST PLAN SELECTION

The ballast plan was selected to have a barge draft of 2.75m mid, no roll and trim 0.30deg. by stern. The resulting draft at bow = 2.50m and at stern = 3.0m.

The density used for the sea water and ballast water is 1.025 t/m3.

The foreseen ballast plan is the following:

- Tank 1SC 83.5% ullage = 0.65m
- Tank 1SW 83.5% ullage = 0.65m
- Tank 5PW 87.5% ullage = 0.70m
- Tank 5SW 90.5% ullage = 0.50m
- All remaining tanks 3%

VERVECE - BALLAST PLAN for TOWING - Draft 2.50 bow - 3.00m stern - trim 0.30deg

STERN						BOW
87.5% **5PW** u=0.70m		**4PW**	**3PW**	**2PW**	**1PW**	
5PC		**4PC**	**3PC**	**2PC**	**1PC**	
5SC		**4SC**	**3SC**	**2SC**	83.5% **1SC** u=0.65m	
90.5% **5SW** u=0.50m		**4SW**	**3SW**	**2SW**	83.5% **1SW** u=0.65m	

Figure 8.1 - Barge Ballast Configuration

```
**********************************************************************************************************
*                                        ***  MOSES   ***                                                *
*          T E C O N                                                                .                    *
*          ---------     Barge Configuration                                        .                    *
*                                                                                                        *
**********************************************************************************************************

                    +++ B U O Y A N C Y   A N D   W E I G H T   F O R   V E R V E C E +++
                    ======================================================================

                 Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

                                  Results Are Reported In Body System

                       Draft =     2.50 Roll Angle =     0.00 Pitch Angle =     0.30

                                     Wet Radii Of Gyration About CG

                              K-X =     9.45 K-Y =    26.96 K-Z =    26.93

                                     GMT =    16.80 GML =   218.42

                                        /-- Center of Gravity ---/  Sounding   % Full
                       Name      Weight    ---X---  ---Y---  ---Z---  -------- --------

                       ----------------  Part CF         ------------
                       LOAD_GRO     26.00    69.38    11.22     7.55
                       ----------------  Part GRI&SF-B   ------------
                       LOAD_GRO     75.00    30.86    -1.14     7.35
```

```
---------------  Part GRI&SF-C   ------------
LOAD_GRO      0.50    67.44    11.22     7.10
---------------  Part GRI&SF-T   ------------
LOAD_GRO     45.00    65.20    -2.92     7.40
---------------  Part TOPSIDE    ------------
LOAD_GRO   1802.00    31.16    -1.24    15.77
---------------  Part TP         ------------
LOAD_GRO    290.00    65.41    -2.42    11.80
---------------  Part VERVECE    ------------
LOAD_GRO   1832.80    47.02     0.00     3.52
--- Contents ---
1PC           7.04     8.28    -3.43     0.36     0.63     3.00
1PW           7.05     8.28   -10.24     0.36     0.64     3.00
1SC         196.32     5.81     3.43     3.43     5.44    83.50
1SW         196.13     5.81    10.28     3.43     5.44    83.46
2PC          26.21    20.44    -3.43     0.09     0.18     3.00
2PW          26.21    20.43   -10.18     0.10     0.19     3.00
2SC          26.21    20.44     3.43     0.09     0.18     3.00
2SW          26.21    20.43    10.18     0.10     0.19     3.00
3PC          26.21    41.01    -3.43     0.09     0.18     3.00
3PW          26.21    41.00   -10.18     0.10     0.19     3.00
3SC          26.21    41.01     3.43     0.09     0.18     3.00
3SW          26.21    41.00    10.18     0.10     0.19     3.00
4PC          26.21    61.59    -3.43     0.09     0.18     3.00
4PW          26.21    61.58   -10.18     0.10     0.19     3.00
4SC          26.21    61.59     3.43     0.09     0.18     3.00
4SW          26.21    61.58    10.18     0.10     0.19     3.00
5PC          14.76    81.94    -3.43     0.14     0.28     3.00
5PW         692.78    80.33   -10.28     2.85     5.39    87.30
5SC          14.53    81.94     3.43     0.14     0.28     3.00
5SW         718.41    80.36    10.28     2.94     5.57    90.53
========  ========  =======  =======  =======
Total      6232.83    48.05    -0.00     7.19
Buoyancy   6232.81    48.08    -0.00     1.40

        +++ D R A F T   M A R K   R E A D I N G S +++
        ============================================

Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

  Name     Draft    Name     Draft    Name     Draft    Name     Draft    Name     Draft    Name     Draft
--------- -------- --------- -------- --------- -------- --------- -------- --------- -------- --------- --------

BOWPO      2.50 BOWST        2.50 MIDPO        2.74 MIDST        2.74 STEPO        2.98 STEST        2.98
```

The reductions in metacentric height (GM) due to the influence of free surface effect are included in the stability analysis.

9 BARGE INTACT STABILITY

All DNV intact stability criteria, ref. table 11-13 and sections 11.10.2 and 11.10.5 or Ref. /9/ are largely satisfied as follow

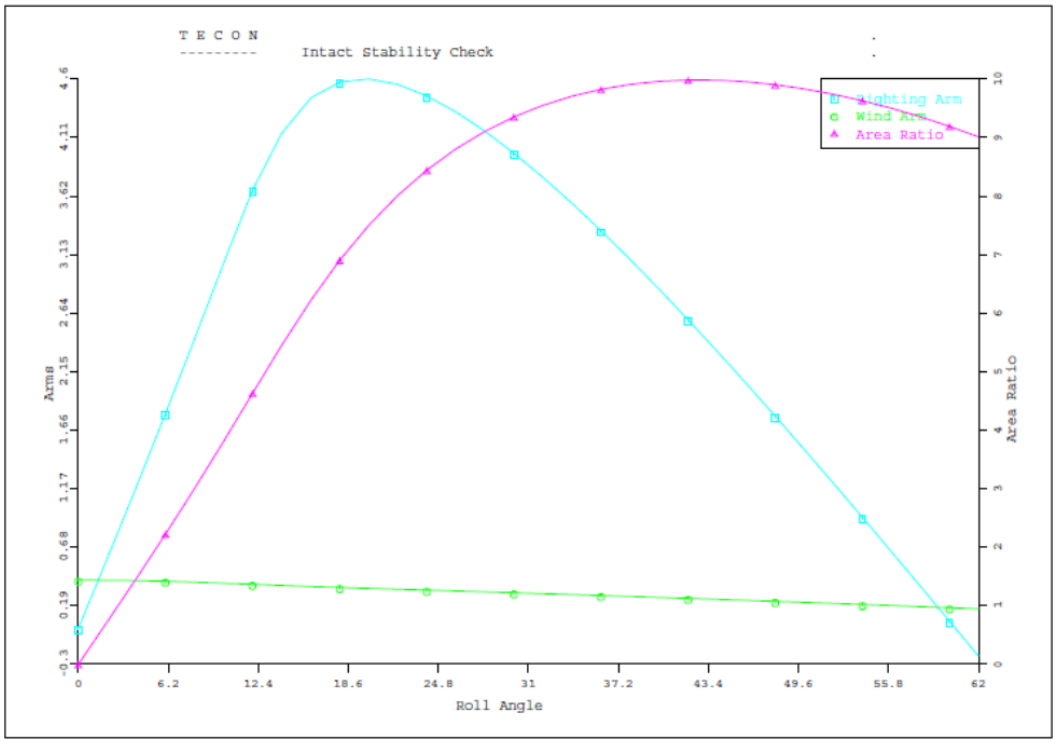
```
                    +++ S T A B I L I T Y   S U M M A R Y +++
                    =========================================

The Following Intact Condition
======================================
Draft                    =     2.50 M
Roll                     =     0.00 Deg
Pitch                    =     0.30 Deg
VCG                      =     7.19 M
Axis Angle               =     0.00 Deg
Wind Vel                 =   100.00 Knots
1st Intercept            =     1.37 Deg
2nd Intercept            =    58.99 Deg
NWT Down-Flooding        =    16.56 Deg
WT Down-Flooding         = Not App. Deg
MIN (1st Int. NWT Down) =    16.56 Deg

Passes All of The Stability Requirements:
=========================================

GM                          >=    1.00       M    16.80 Passes
Range                       >=   36.00     DEG    60.17 Passes
Area Ratio                  >=    1.40            6.42 Passes
```

The following figure and table show the stability check results.



```
**********************************************************************************************************
*                                          ***  MOSES   ***                                              *
*          T E C O N                                                                .                     *
*          ---------     Intact Stability Check                                     .                     *
*                                                                                                         *
**********************************************************************************************************
```

+++ R I G H T I N G A R M R E S U L T S +++

Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

Results are in the Body System

Moment Scaled By 6232.83, KG = 7.19, and Wind Speed = 100 Knots

Initial: Roll = 0.00, Trim = 0.30 Deg.

Critical NWT Down Flooding Point Is *STEPTWT

Arms About Axis Yawed 0.0 Deg From Vessel X

/----- Condition -----/			/-- Min. Height --/		/--- Righting ---/		/--- Heeling ---/		Area	Net
Draft	Roll	Trim	W Tight	NW Tight	Arm	Area	Arm	Area	Ratio	Arm
2.50	0.00	0.00	9999.00	3.72	-0.00	0.00	0.40	0.00	0.00	-0.405
2.50	2.00	0.00	9999.00	3.27	0.59	0.59	0.40	0.81	0.73	0.187
2.49	4.00	0.00	9999.00	2.81	1.19	2.37	0.40	1.61	1.47	0.786
2.47	6.00	0.00	9999.00	2.36	1.80	5.35	0.39	2.41	2.22	1.404
2.45	8.00	0.00	9999.00	1.90	2.42	9.57	0.39	3.19	3.00	2.036
2.43	10.00	0.00	9999.00	1.44	3.06	15.05	0.38	3.95	3.81	2.679
2.39	12.00	0.00	9999.00	0.99	3.67	21.78	0.37	4.70	4.63	3.299
2.32	14.00	0.00	9999.00	0.57	4.14	29.59	0.36	5.43	5.45	3.784
2.23	16.00	0.00	9999.00	0.17	4.44	38.18	0.35	6.14	6.21	4.089
2.14	18.00	0.00	9999.00	-0.23	4.57	47.19	0.34	6.84	6.90	4.230
2.04	20.00	0.00	9999.00	-0.64	4.60	56.36	0.34	7.52	7.50	4.264
1.94	22.00	0.00	9999.00	-1.04	4.55	65.52	0.33	8.18	8.01	4.226
1.83	24.00	0.00	9999.00	-1.44	4.46	74.53	0.32	8.83	8.44	4.138
1.73	26.00	0.00	9999.00	-1.83	4.32	83.31	0.31	9.46	8.80	4.011
1.62	28.00	0.00	9999.00	-2.23	4.16	91.80	0.31	10.08	9.10	3.857
1.51	30.00	0.00	9999.00	-2.62	3.98	99.94	0.30	10.69	9.35	3.680
1.40	32.00	0.00	9999.00	-3.01	3.78	107.70	0.29	11.28	9.55	3.485
1.28	34.00	0.00	9999.00	-3.39	3.56	115.03	0.28	11.85	9.71	3.275
1.17	36.00	0.00	9999.00	-3.78	3.33	121.92	0.28	12.41	9.82	3.054
1.05	38.00	0.00	9999.00	-4.15	3.09	128.34	0.27	12.96	9.91	2.822
0.93	40.00	0.00	9999.00	-4.52	2.84	134.27	0.26	13.48	9.96	2.581
0.82	42.00	0.00	9999.00	-4.89	2.58	139.69	0.25	13.99	9.98	2.332
0.70	44.00	0.00	9999.00	-5.25	2.32	144.60	0.24	14.49	9.98	2.077
0.57	46.00	0.00	9999.00	-5.60	2.05	148.97	0.24	14.97	9.95	1.816
0.45	48.00	0.00	9999.00	-5.95	1.78	152.80	0.23	15.43	9.90	1.550
0.33	50.00	0.00	9999.00	-6.29	1.50	156.07	0.22	15.88	9.83	1.280
0.21	52.00	0.00	9999.00	-6.62	1.22	158.79	0.21	16.30	9.74	1.007
0.09	54.00	0.00	9999.00	-6.95	0.93	160.94	0.20	16.71	9.63	0.730
-0.04	56.00	0.00	9999.00	-7.26	0.64	162.51	0.19	17.11	9.50	0.451
-0.16	58.00	0.00	9999.00	-7.57	0.35	163.51	0.18	17.48	9.35	0.171
-0.28	60.00	0.00	9999.00	-7.87	0.06	163.92	0.17	17.84	9.19	-0.112
-0.40	62.00	0.00	9999.00	-8.15	-0.23	163.75	0.16	18.17	9.01	-0.395

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10 BARGE DAMAGED STABILITY

This section presents the barge min. requirements request in damaged conditions considering the port side tanks 3PW and 4PW at port side and 3SW and 4SW at starboard as critical ones.

Only the final equilibrium condition is analyzed as found the more onerous compared to the intermediate ones. Ref to section 11.10.5.7 and 11.10.7 of Ref /9/.

10.1 DAMAGED TANK 3PW

```
*****************************************************************************************************************
*                                          ***  MOSES   ***                                                     *
*          T E C O N                                                                                             *
*          ---------     Damaged Stability Check - Tank 3PW                                                      *
*                                                                                                                *
*****************************************************************************************************************

                  +++ B U O Y A N C Y   A N D   W E I G H T   F O R   V E R V E C E +++
                  ======================================================================

               Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

                                Results Are Reported In Body System

                     Draft =     2.78 Roll Angle =     2.46 Pitch Angle =     0.18

                                    Wet Radii Of Gyration About CG

                              K-X =     9.59 K-Y =    26.44 K-Z =    25.78

                                    GMT =    13.64 GML =   208.20

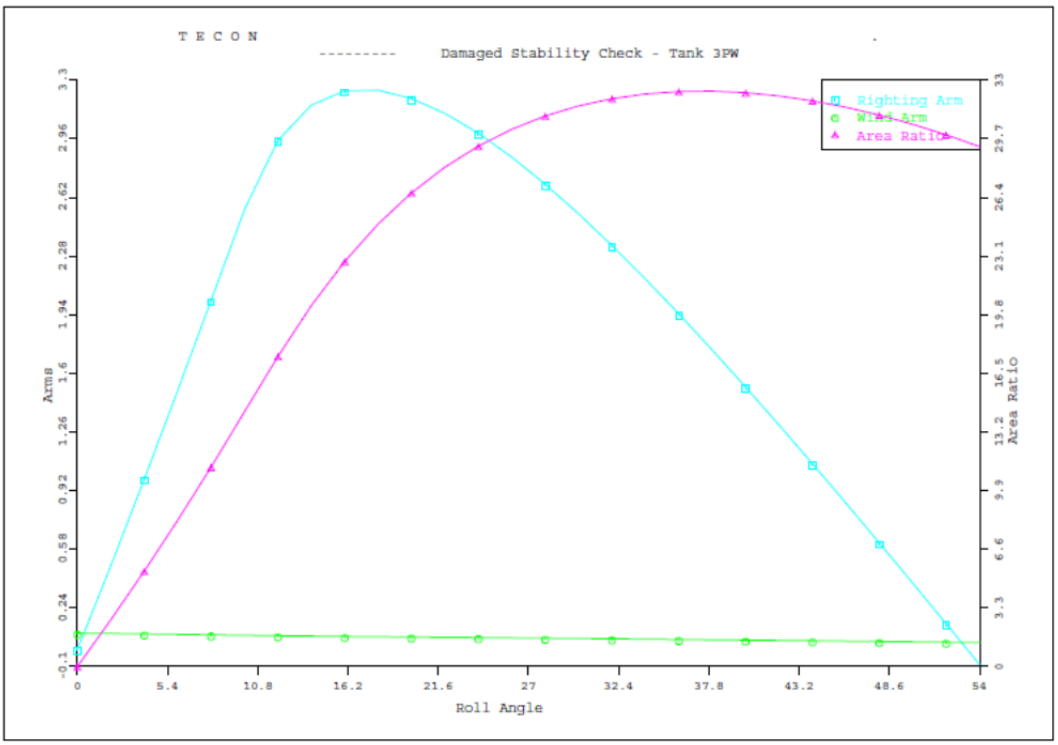
                                       /-- Center of Gravity ---/  Sounding   % Full
               Name      Weight     ---X---  ---Y---  ---Z---  -------- --------

               ----------------  Part CF          ------------
               LOAD_GRO     26.00    69.38    11.22     7.55
               ----------------  Part GRI&SF-B    ------------
               LOAD_GRO     75.00    30.86    -1.14     7.35
               ----------------  Part GRI&SF-C    ------------
               LOAD_GRO      0.50    67.44    11.22     7.10
               ----------------  Part GRI&SF-T    ------------
               LOAD_GRO     45.00    65.20    -2.92     7.40
               ----------------  Part TOPSIDE     ------------
               LOAD_GRO   1802.00    31.16    -1.24    15.77
               ----------------  Part TP          ------------
               LOAD_GRO    290.00    65.41    -2.42    11.80
               ----------------  Part VERVECE     ------------
               LOAD_GRO   1832.80    47.02     0.00     3.52
               --- Contents ---
               1PC           7.04     8.27    -3.77     0.37     0.63     3.00
               1SC         196.32     5.81     3.38     3.43     5.44    83.50
               1SW         196.13     5.81    10.23     3.43     5.59    83.46
               2PC          26.21    20.04    -4.35     0.11     0.18     3.00
               2PW          26.21    20.04   -11.09     0.12     0.04     3.00
               2SC          26.21    20.04     2.51     0.11     0.18     3.00
               2SW          26.21    20.01     9.32     0.11     0.33     3.00
               3PC          26.21    40.61    -4.35     0.11     0.18     3.00
               3PW         479.55    40.04   -10.33     1.68     3.20    54.89
               3SC          26.21    40.61     2.51     0.11     0.18     3.00
               3SW          26.21    40.59     9.32     0.11     0.33     3.00
               4PC          26.21    61.19    -4.35     0.11     0.18     3.00
               4PW          26.21    61.18   -11.09     0.12     0.04     3.00
               4SC          26.21    61.19     2.51     0.11     0.18     3.00
               4SW          26.21    61.16     9.32     0.11     0.33     3.00
               5PC          14.76    81.90    -4.07     0.15     0.28     3.00
               5PW         692.78    80.31   -10.32     2.85     5.24    87.30
               5SC          14.53    81.90     2.78     0.15     0.28     3.00
               5SW         718.41    80.34    10.25     2.94     5.71    90.53
               ========  ========  =======  =======  =======
               Total      6679.12    47.52    -0.74     6.83
               Buoyancy   6679.02    47.54    -0.97     1.52
```

+++ D R A F T M A R K R E A D I N G S +++

Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

Name	Draft	Name	Draft	Name	Draft	Name	Draft	Name	Draft	Name	Draft
BOWPO	3.37	BOWST	2.19	MIDPO	3.51	MIDST	2.34	STEPO	3.66	STEST	2.48



*** MOSES ***

T E C O N

Damaged Stability Check - Tank 3PW

+++ R I G H T I N G A R M R E S U L T S +++

Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

Results are in the Body System

Compartments Flooded Are: 3PW

Moment Scaled By 6679.12, KG = 6.83, and Wind Speed = 50 Knots

Initial: Roll = 2.46, Trim = 0.18 Deg.

Critical NWT Down Flooding Point Is *STEPTWT

Arms About Axis Yawed 0.0 Deg From Vessel X

/----- Condition -----/			/-- Min. Height --/		/--- Righting ---/		/--- Heeling ---/		Area	Net
Draft	Roll	Trim	W Tight	NW Tight	Arm	Area	Arm	Area	Ratio	Arm
2.78	0.00	0.00	9999.00	3.07	0.00	0.00	0.09	0.00	0.00	-0.093
2.79	2.00	0.00	9999.00	2.59	0.49	0.49	0.09	0.18	2.63	0.394
2.80	4.00	0.00	9999.00	2.11	0.99	1.96	0.09	0.36	5.37	0.898
2.80	6.00	0.00	9999.00	1.63	1.50	4.44	0.09	0.54	8.23	1.413
2.79	8.00	0.00	9999.00	1.15	2.02	7.97	0.08	0.71	11.22	1.940
2.78	10.00	0.00	9999.00	0.67	2.55	12.54	0.08	0.87	14.34	2.468

2.76	12.00	0.00	9999.00	0.20	2.95	18.04	0.08	1.03	17.45	2.872
2.73	14.00	0.00	9999.00	-0.26	3.16	24.15	0.08	1.19	20.31	3.079
2.69	16.00	0.00	9999.00	-0.73	3.24	30.54	0.07	1.34	22.80	3.163
2.65	18.00	0.00	9999.00	-1.19	3.24	37.02	0.07	1.49	24.90	3.169
2.60	20.00	0.00	9999.00	-1.65	3.19	43.45	0.07	1.63	26.66	3.122
2.55	22.00	0.00	9999.00	-2.10	3.11	49.75	0.07	1.77	28.11	3.038
2.49	24.00	0.00	9999.00	-2.55	2.99	55.85	0.07	1.91	29.29	2.924
2.43	26.00	0.00	9999.00	-2.99	2.85	61.70	0.07	2.04	30.24	2.788
2.36	28.00	0.00	9999.00	-3.43	2.70	67.25	0.06	2.17	30.98	2.632
2.30	30.00	0.00	9999.00	-3.87	2.52	72.47	0.06	2.30	31.55	2.462
2.23	32.00	0.00	9999.00	-4.30	2.34	77.33	0.06	2.42	31.95	2.280
2.15	34.00	0.00	9999.00	-4.73	2.15	81.82	0.06	2.54	32.22	2.088
2.08	36.00	0.00	9999.00	-5.15	1.94	85.91	0.06	2.66	32.36	1.887
2.00	38.00	0.00	9999.00	-5.57	1.73	89.59	0.06	2.77	32.38	1.680
1.92	40.00	0.00	9999.00	-5.97	1.52	92.84	0.05	2.88	32.29	1.467
1.84	42.00	0.00	9999.00	-6.38	1.30	95.66	0.05	2.98	32.11	1.249
1.75	44.00	0.00	9999.00	-6.77	1.08	98.04	0.05	3.08	31.83	1.026
1.67	46.00	0.00	9999.00	-7.15	0.85	99.96	0.05	3.18	31.47	0.800
1.58	48.00	0.00	9999.00	-7.53	0.62	101.42	0.05	3.27	31.03	0.571
1.49	50.00	0.00	9999.00	-7.90	0.38	102.42	0.04	3.36	30.51	0.340
1.40	52.00	0.00	9999.00	-8.26	0.15	102.95	0.04	3.44	29.92	0.107
1.30	54.00	0.00	9999.00	-8.60	-0.09	103.01	0.04	3.52	29.26	-0.128

+++ S T A B I L I T Y S U M M A R Y +++

The Following Damaged Condition

with 3PW Damaged

Draft	=	2.78 M
Roll	=	2.46 Deg
Pitch	=	0.18 Deg
VCG	=	6.83 M
Axis Angle	=	0.00 Deg
Wind Vel	=	50.00 Knots
1st Intercept	=	0.38 Deg
2nd Intercept	=	52.91 Deg
NWT Down-Flooding	=	12.83 Deg
WT Down-Flooding	=	Not App. Deg
MIN (1st Int. NWT Down)	=	12.83 Deg

Passes All of The Stability Requirements:

GM		>=	0.05	M	13.64 Passes
Range		>=	20.00	DEG	53.17 Passes
Area Ratio		>=	1.00		18.75 Passes
RA at roll	>= 30 deg	>=	0.10	M	2.52 Passes

10.2 DAMAGED TANK 4PW

```
*****************************************************************************************************************
*                                          ***  MOSES   ***                                                     *
*                                          ----------------                                                     *
*          T E C O N                                                                .                          *
*          ---------     Damaged Stability Check - Tank 4PW                          .                          *
*                                                                                                               *
*****************************************************************************************************************
```

+++ B U O Y A N C Y A N D W E I G H T F O R V E R V E C E +++

Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

Results Are Reported In Body System

Draft = 2.46 Roll Angle = 2.47 Pitch Angle = 0.56

Wet Radii Of Gyration About CG

K-X = 9.61 K-Y = 26.61 K-Z = 26.16

GMT = 13.56 GML = 204.28

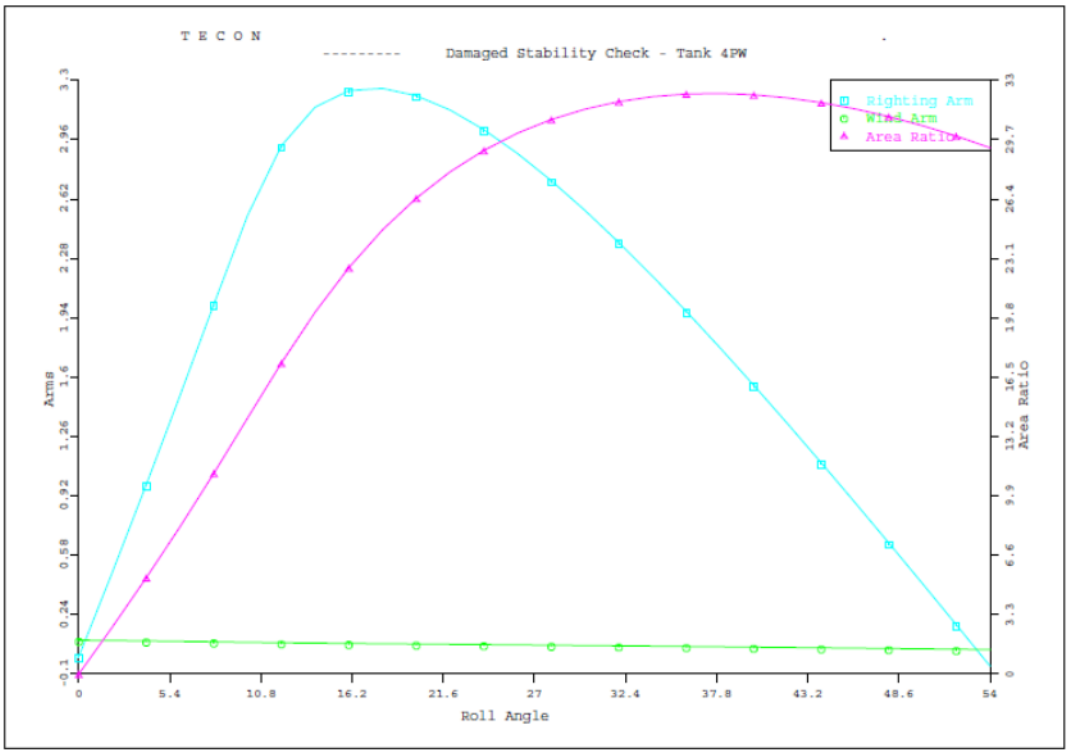
Name	Weight	/-- Center of Gravity ---/ ---X---	---Y---	---Z---	Sounding --------	% Full --------
---------- Part CF ----------						
LOAD_GRO	26.00	69.38	11.22	7.55		
---------- Part GRI&SF-B ----------						
LOAD_GRO	75.00	30.86	-1.14	7.35		
---------- Part GRI&SF-C ----------						
LOAD_GRO	0.50	67.44	11.22	7.10		

---------- Part GRI&SF-T ----------						
LOAD_GRO	45.00	65.20	-2.92	7.40		
---------- Part TOPSIDE ----------						
LOAD_GRO	1802.00	31.16	-1.24	15.77		
---------- Part TP ----------						
LOAD_GRO	290.00	65.41	-2.42	11.80		
---------- Part VERVECE ----------						
LOAD_GRO	1832.80	47.02	0.00	3.52		
--- Contents ---						
1PC	7.04	8.28	-3.77	0.37	0.61	3.00
1PW	7.05	8.28	-10.58	0.37	0.47	3.00
1SC	196.32	5.82	3.38	3.43	5.44	83.50
1SW	196.13	5.82	10.23	3.43	5.59	83.46
2PC	26.21	21.29	-4.34	0.12	0.18	3.00
2PW	26.21	21.30	-11.08	0.12	0.04	3.00
2SC	26.21	21.29	2.52	0.12	0.18	3.00
2SW	26.21	21.24	9.33	0.12	0.33	3.00
3PC	26.21	41.86	-4.34	0.12	0.18	3.00
3SC	26.21	41.86	2.52	0.12	0.18	3.00
3SW	26.21	41.81	9.33	0.12	0.33	3.00
4PC	26.21	62.44	-4.34	0.12	0.18	3.00
4PW	502.08	60.68	-10.33	1.76	3.36	57.47
4SC	26.21	62.44	2.52	0.12	0.18	3.00
4SW	26.21	62.39	9.33	0.12	0.33	3.00
5PC	14.76	82.06	-4.08	0.15	0.29	3.00
5PW	692.78	80.36	-10.32	2.85	5.24	87.30
5SC	14.53	82.06	2.78	0.15	0.29	3.00
5SW	718.41	80.39	10.25	2.94	5.71	90.53
Total	6682.49	49.01	-0.74	6.84		
Buoyancy	6682.25	49.07	-0.97	1.53		

+++ D R A F T M A R K R E A D I N G S +++

Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

Name	Draft	Name	Draft	Name	Draft	Name	Draft	Name	Draft	Name	Draft
BOWPO	3.06	BOWST	1.88	MIDPO	3.51	MIDST	2.33	STEPO	3.96	STEST	2.78



```
**********************************************************************************************************
*                                          ***  MOSES   ***                                              *
*          T E C O N                                                                .                     *
*          ---------     Damaged Stability Check - Tank 4PW                          .                     *
*                                                                                                         *
**********************************************************************************************************
```

+++ R I G H T I N G A R M R E S U L T S +++

Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

Results are in the Body System

Compartments Flooded Are: 4PW

Moment Scaled By 6682.49, KG = 6.84, and Wind Speed = 50 Knots

Initial: Roll = 2.47, Trim = 0.56 Deg.

Critical NWT Down Flooding Point Is *STEPTWT

Arms About Axis Yawed 0.0 Deg From Vessel X

/----- Condition -----/			/-- Min. Height --/		/--- Righting ---/		/--- Heeling ---/		Area	Net
Draft	Roll	Trim	W Tight	NW Tight	Arm	Area	Arm	Area	Ratio	Arm
2.46	0.00	0.00	9999.00	2.78	0.00	0.00	0.09	0.00	0.00	-0.093
2.48	2.00	0.00	9999.00	2.30	0.49	0.49	0.09	0.18	2.63	0.395
2.48	4.00	0.00	9999.00	1.82	0.99	1.96	0.09	0.37	5.35	0.896
2.49	6.00	0.00	9999.00	1.34	1.50	4.44	0.09	0.54	8.19	1.409
2.48	8.00	0.00	9999.00	0.86	2.02	7.95	0.08	0.71	11.15	1.933
2.47	10.00	0.00	9999.00	0.38	2.53	12.50	0.08	0.88	14.23	2.445
2.45	12.00	0.00	9999.00	-0.08	2.92	17.95	0.08	1.04	17.28	2.846
2.42	14.00	0.00	9999.00	-0.55	3.15	24.02	0.08	1.19	20.11	3.069
2.38	16.00	0.00	9999.00	-1.01	3.24	30.40	0.08	1.35	22.58	3.166
2.34	18.00	0.00	9999.00	-1.46	3.25	36.90	0.07	1.49	24.69	3.180
2.30	20.00	0.00	9999.00	-1.91	3.21	43.36	0.07	1.64	26.45	3.140
2.24	22.00	0.00	9999.00	-2.36	3.13	49.70	0.07	1.78	27.91	3.060
2.19	24.00	0.00	9999.00	-2.80	3.02	55.85	0.07	1.92	29.10	2.949
2.13	26.00	0.00	9999.00	-3.24	2.88	61.75	0.07	2.05	30.06	2.814
2.07	28.00	0.00	9999.00	-3.68	2.72	67.35	0.06	2.19	30.82	2.660
2.01	30.00	0.00	9999.00	-4.11	2.55	72.63	0.06	2.31	31.40	2.491
1.94	32.00	0.00	9999.00	-4.53	2.37	77.56	0.06	2.44	31.81	2.310
1.88	34.00	0.00	9999.00	-4.95	2.18	82.11	0.06	2.56	32.09	2.118
1.81	36.00	0.00	9999.00	-5.37	1.98	86.26	0.06	2.68	32.24	1.919
1.73	38.00	0.00	9999.00	-5.78	1.77	90.01	0.06	2.79	32.27	1.712
1.66	40.00	0.00	9999.00	-6.18	1.55	93.33	0.05	2.90	32.19	1.499
1.58	42.00	0.00	9999.00	-6.57	1.33	96.21	0.05	3.00	32.02	1.281
1.50	44.00	0.00	9999.00	-6.96	1.11	98.66	0.05	3.11	31.76	1.059
1.42	46.00	0.00	9999.00	-7.33	0.88	100.65	0.05	3.20	31.41	0.833
1.34	48.00	0.00	9999.00	-7.70	0.65	102.18	0.05	3.30	30.98	0.605
1.26	50.00	0.00	9999.00	-8.06	0.42	103.25	0.04	3.39	30.48	0.373
1.17	52.00	0.00	9999.00	-8.41	0.18	103.85	0.04	3.47	29.90	0.140
1.09	54.00	0.00	9999.00	-8.75	-0.05	103.97	0.04	3.55	29.25	-0.095

+++ S T A B I L I T Y S U M M A R Y +++

The Following Damaged Condition
==========
with 4PW Damaged

Draft	=	2.47 M
Roll	=	2.46 Deg
Pitch	=	0.56 Deg
VCG	=	6.84 M
Axis Angle	=	0.00 Deg
Wind Vel	=	50.00 Knots
1st Intercept	=	0.38 Deg
2nd Intercept	=	52.27 Deg
NWT Down-Flooding	=	10.81 Deg
WT Down-Flooding	=	Not App. Deg
MIN (1st Int. NWT Down)	=	10.81 Deg

Passes All of The Stability Requirements:
==========

GM	>=	0.05	M	13.56 Passes
Range	>=	20.00	DEG	52.60 Passes
Area Ratio	>=	1.00		15.53 Passes
RA at roll >= 30 deg	>=	0.10	M	2.46 Passes

10.3 DAMAGED TANK 3SW

```
*****************************************************************************************************************
*                                          ***  MOSES   ***                                                     *
*          T E C O N                                                                                            *
*          ---------     Damaged Stability Check - Tank 3SW                                                      *
*                                                                                                               *
*****************************************************************************************************************

                    +++ B U O Y A N C Y   A N D   W E I G H T   F O R   V E R V E C E +++
                    ====================================================================

                  Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

                                    Results Are Reported In Body System

                         Draft =     2.78 Roll Angle =    -2.80 Pitch Angle =     0.16

                                       Wet Radii Of Gyration About CG

                                 K-X =     9.56 K-Y =    26.54 K-Z =    25.85

                                       GMT =    14.21 GML =   210.51

                                         /-- Center of Gravity ---/  Sounding   % Full
                         Name      Weight    ---X---  ---Y---  ---Z---  -------- --------

                         ----------------  Part CF          ------------
                         LOAD_GRO     26.00    69.38    11.22     7.55
                         ----------------  Part GRI&SF-B    ------------
                         LOAD_GRO     75.00    30.86    -1.14     7.35
                         ----------------  Part GRI&SF-C    ------------
                         LOAD_GRO      0.50    67.44    11.22     7.10
                         ----------------  Part GRI&SF-T    ------------
                         LOAD_GRO     45.00    65.20    -2.92     7.40
                         ----------------  Part TOPSIDE     ------------
                         LOAD_GRO   1802.00    31.16    -1.24    15.77
                         ----------------  Part TP          ------------
                         LOAD_GRO    290.00    65.41    -2.42    11.80
                         ----------------  Part VERVECE     ------------
                         LOAD_GRO   1832.80    47.02     0.00     3.52
                         --- Contents ---
                         1PC           7.04     8.27    -3.04     0.37     0.64     3.00
                         1PW           7.05     8.27    -9.86     0.37     0.81     3.00
                         1SC         196.32     5.81     3.49     3.43     5.44    83.50
                         1SW         196.13     5.81    10.34     3.43     5.27    83.46
                         2PC          26.21    19.97    -2.38     0.12     0.18     3.00
                         2PW          26.21    19.94    -9.21     0.12     0.35     3.00
                         2SC          26.21    19.97     4.48     0.12     0.18     3.00
                         2SW          26.21    19.97    11.21     0.12     0.02     3.00
                         3PC          26.21    40.54    -2.38     0.12     0.18     3.00
                         3SC          26.21    40.54     4.48     0.12     0.18     3.00
                         3SW         486.34    40.03    10.34     1.70     3.23    55.67
                         4PC          26.21    61.11    -2.38     0.12     0.18     3.00
                         4SC          26.21    61.11     4.48     0.12     0.18     3.00
                         4SW          26.21    61.11    11.21     0.12     0.02     3.00
                         5PC          14.76    81.90    -2.70     0.15     0.27     3.00
                         5PW         692.78    80.31   -10.24     2.85     5.55    87.30
                         5SC          14.53    81.90     4.16     0.15     0.27     3.00
                         5SW         718.41    80.34    10.32     2.94     5.40    90.53
                         ========  ========  =======  =======  =======
                         Total      6640.54    47.44     0.85     6.88
                         Buoyancy   6640.99    47.45     1.11     1.52

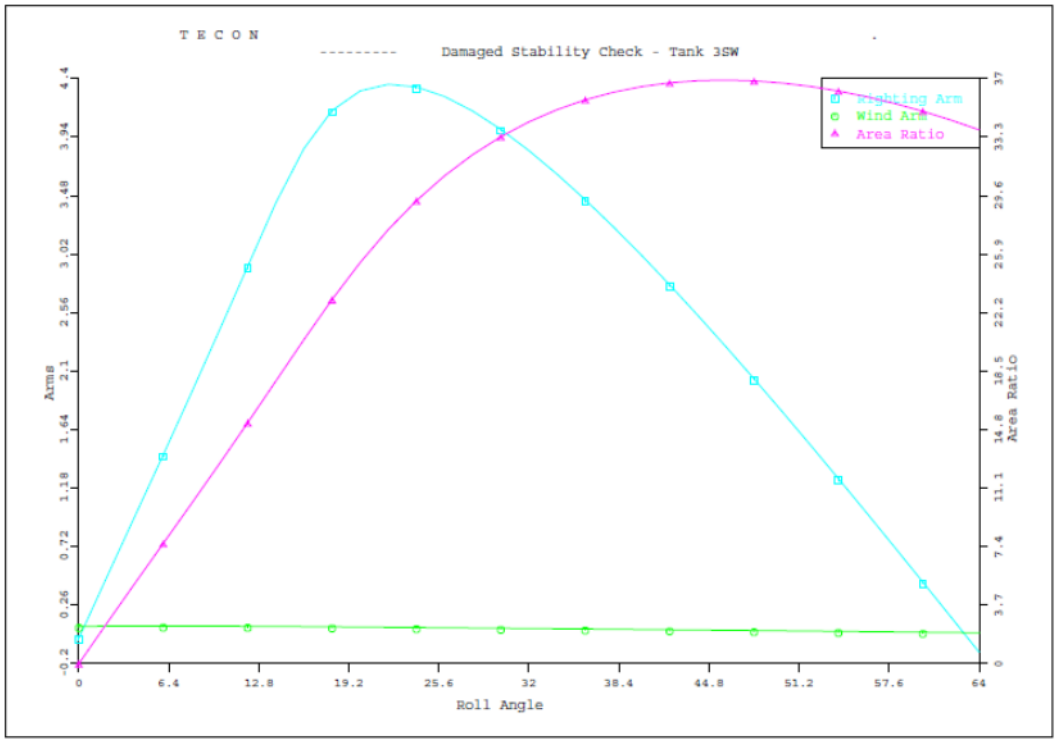
*****************************************************************************************************************
*                                          ***  MOSES   ***                                                     *
*          T E C O N                                                                                            *
*          ---------     Damaged Stability Check - Tank 3SW                                                      *
*                                                                                                               *
*****************************************************************************************************************

                                  +++ D R A F T   M A R K   R E A D I N G S +++
                                  ============================================

                              Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

    Name     Draft    Name     Draft    Name     Draft    Name     Draft    Name     Draft    Name     Draft
  -------- -------- -------- -------- -------- -------- -------- -------- -------- -------- -------- --------

  BOWPO        2.11 BOWST        3.45 MIDPO        2.24 MIDST        3.58 STEPO        2.37 STEST        3.71
```




```
*****************************************************************************************************************
*                                          ***  MOSES   ***                                                     *
*          T E C O N                                                                                           *
*          ---------     Damaged Stability Check - Tank 3SW                                                     *
*                                                                                                              *
*****************************************************************************************************************
```

+++ R I G H T I N G A R M R E S U L T S +++

Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

Results are in the Body System

Compartments Flooded Are: 3SW

Moment Scaled By 6640.54, KG = 6.88, and Wind Speed = 50 Knots

Initial: Roll = -2.80, Trim = 0.16 Deg.

Critical NWT Down Flooding Point Is *STEPTWT

Arms About Axis Yawed 0.0 Deg From Vessel X

Condition Draft	Roll	Trim	Min. Height W Tight	NW Tight	Righting Arm	Righting Area	Heeling Arm	Heeling Area	Area Ratio	Net Arm
2.78	0.00	0.00	9999.00	3.02	-0.00	0.00	0.09	0.00	0.00	-0.093
2.76	2.00	0.00	9999.00	3.50	0.48	0.48	0.09	0.19	2.57	0.389
2.74	4.00	0.00	9999.00	3.43	0.96	1.93	0.10	0.38	5.10	0.868
2.71	6.00	0.00	9999.00	3.00	1.44	4.34	0.10	0.57	7.60	1.346
2.67	8.00	0.00	9999.00	2.57	1.93	7.71	0.10	0.76	10.11	1.832
2.63	10.00	0.00	9999.00	2.13	2.42	12.06	0.10	0.95	12.65	2.327
2.59	12.00	0.00	9999.00	1.70	2.92	17.40	0.09	1.14	15.23	2.828
2.53	14.00	0.00	9999.00	1.27	3.42	23.75	0.09	1.33	17.86	3.329
2.46	16.00	0.00	9999.00	0.85	3.85	31.02	0.09	1.51	20.49	3.758
2.35	18.00	0.00	9999.00	0.46	4.15	39.01	0.09	1.69	23.02	4.059
2.24	20.00	0.00	9999.00	0.07	4.30	47.47	0.09	1.87	25.36	4.215
2.14	22.00	0.00	9999.00	-0.32	4.35	56.12	0.09	2.04	27.45	4.269
2.03	24.00	0.00	9999.00	-0.72	4.33	64.81	0.08	2.21	29.28	4.250
1.92	26.00	0.00	9999.00	-1.12	4.26	73.40	0.08	2.38	30.85	4.177
1.81	28.00	0.00	9999.00	-1.51	4.14	81.81	0.08	2.54	32.19	4.064
1.70	30.00	0.00	9999.00	-1.90	4.00	89.95	0.08	2.70	33.32	3.922
1.58	32.00	0.00	9999.00	-2.29	3.83	97.78	0.08	2.85	34.26	3.757

1.47	34.00	0.00	9999.00	-2.68	3.65	105.26	0.07	3.00	35.03	3.573
1.35	36.00	0.00	9999.00	-3.07	3.45	112.36	0.07	3.15	35.65	3.374
1.23	38.00	0.00	9999.00	-3.45	3.23	119.04	0.07	3.29	36.13	3.164
1.10	40.00	0.00	9999.00	-3.82	3.01	125.28	0.07	3.43	36.49	2.942
0.98	42.00	0.00	9999.00	-4.20	2.78	131.07	0.07	3.57	36.73	2.712
0.86	44.00	0.00	9999.00	-4.56	2.54	136.39	0.06	3.70	36.86	2.474
0.73	46.00	0.00	9999.00	-4.92	2.29	141.22	0.06	3.83	36.90	2.229
0.60	48.00	0.00	9999.00	-5.28	2.04	145.55	0.06	3.95	36.85	1.979
0.48	50.00	0.00	9999.00	-5.63	1.78	149.37	0.06	4.07	36.72	1.723
0.35	52.00	0.00	9999.00	-5.97	1.52	152.67	0.06	4.18	36.50	1.464
0.22	54.00	0.00	9999.00	-6.30	1.25	155.44	0.05	4.29	36.21	1.200
0.09	56.00	0.00	9999.00	-6.63	0.99	157.69	0.05	4.40	35.85	0.934
-0.04	58.00	0.00	9999.00	-6.95	0.71	159.39	0.05	4.50	35.42	0.665
-0.17	60.00	0.00	9999.00	-7.26	0.44	160.54	0.05	4.60	34.93	0.394
-0.30	62.00	0.00	9999.00	-7.56	0.17	161.15	0.04	4.69	34.37	0.122
-0.42	64.00	0.00	9999.00	-7.85	-0.11	161.21	0.04	4.78	33.76	-0.152

+++ S T A B I L I T Y S U M M A R Y +++

The Following Damaged Condition

with 3SW Damaged

Draft	=	2.78 M
Roll	=	-2.80 Deg
Pitch	=	0.16 Deg
VCG	=	6.88 M
Axis Angle	=	0.00 Deg
Wind Vel	=	50.00 Knots
1st Intercept	=	0.39 Deg
2nd Intercept	=	62.76 Deg
NWT Down-Flooding	=	19.66 Deg
WT Down-Flooding	=	Not App. Deg
MIN (1st Int. NWT Down)	=	19.66 Deg

Passes All of The Stability Requirements:

GM	>=	0.05	M	14.21	Passes
Range	>=	20.00	DEG	63.01	Passes
Area Ratio	>=	1.00		24.96	Passes
RA at roll >= 30 deg	>=	0.10	M	3.97	Passes

10.4 DAMAGED TANK 4SW

```
*****************************************************************************************************************
*                                          ***  MOSES   ***                                                     *
*          T E C O N                                                                                           *
*          ---------     Damaged Stability Check - Tank 4SW                                                     *
*                                                                                                              *
*****************************************************************************************************************

                  +++ B U O Y A N C Y   A N D   W E I G H T   F O R   V E R V E C E +++
                  ======================================================================

            Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

                                Results Are Reported In Body System

                     Draft =     2.45 Roll Angle =    -2.75 Pitch Angle =     0.56

                                    Wet Radii Of Gyration About CG

                              K-X =     9.56 K-Y =    26.60 K-Z =    26.20

                                    GMT =    14.08 GML =   206.71

                                       /-- Center of Gravity ---/  Sounding   % Full
                     Name      Weight    ---X---  ---Y---  ---Z---  -------- --------

                     ----------------  Part CF          ------------
                     LOAD_GRO     26.00    69.38    11.22     7.55
                     ----------------  Part GRI&SF-B    ------------
                     LOAD_GRO     75.00    30.86    -1.14     7.35
                     ----------------  Part GRI&SF-C    ------------
                     LOAD_GRO      0.50    67.44    11.22     7.10
                     ----------------  Part GRI&SF-T    ------------
                     LOAD_GRO     45.00    65.20    -2.92     7.40
                     ----------------  Part TOPSIDE     ------------
                     LOAD_GRO   1802.00    31.16    -1.24    15.77
                     ----------------  Part TP          ------------
                     LOAD_GRO    290.00    65.41    -2.42    11.80
```

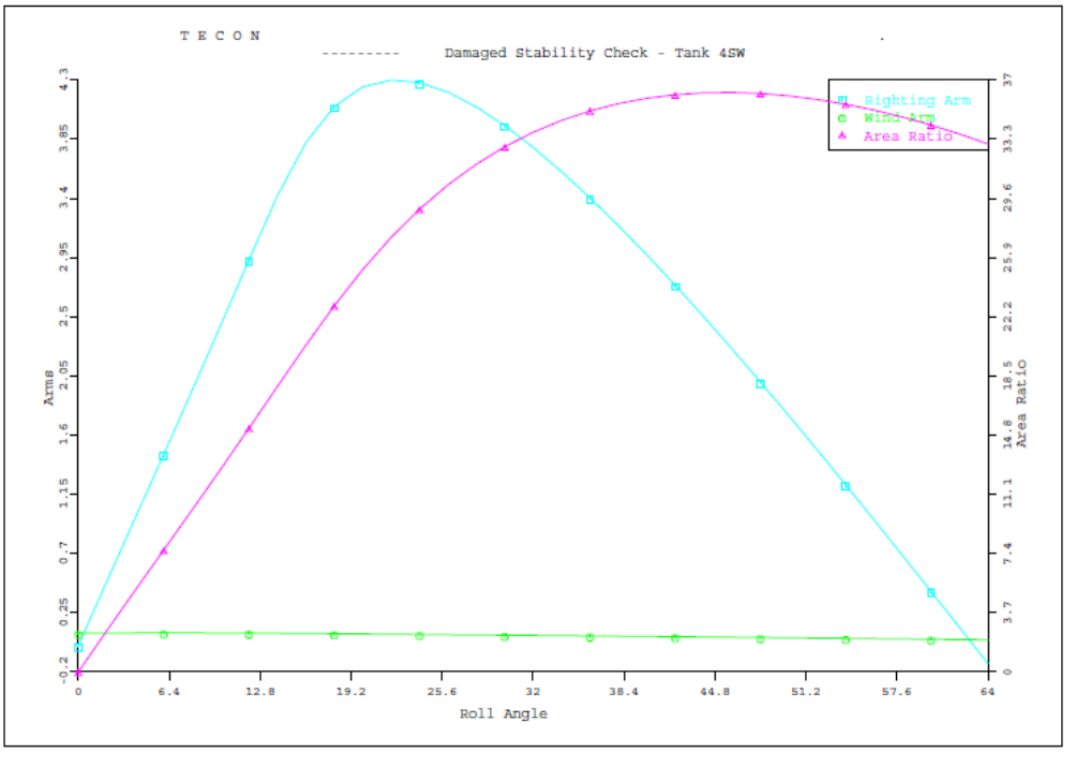
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---------------  Part VERVECE    ------------
LOAD_GRO   1832.80    47.02     0.00     3.52
--- Contents ---
1PC           7.04     8.28    -3.05     0.37     0.61     3.00
1PW           7.05     8.28    -9.86     0.37     0.78     3.00
1SC         196.32     5.82     3.49     3.43     5.44    83.50
1SW         196.13     5.82    10.34     3.43     5.28    83.46
2PC          26.21    21.24    -2.42     0.12     0.18     3.00
2PW          26.21    21.19    -9.24     0.12     0.35     3.00
2SC          26.21    21.24     4.43     0.12     0.18     3.00
2SW          26.21    21.25    11.18     0.13     0.02     3.00
3PC          26.21    41.81    -2.42     0.12     0.18     3.00
3SC          26.21    41.81     4.43     0.12     0.18     3.00
4PC          26.21    62.39    -2.42     0.12     0.18     3.00
4SC          26.21    62.39     4.43     0.12     0.18     3.00
4SW         506.24    60.68    10.33     1.77     3.37    57.95
5PC          14.76    82.06    -2.70     0.15     0.29     3.00
5PW         692.78    80.36   -10.24     2.85     5.55    87.30
5SC          14.53    82.06     4.15     0.15     0.29     3.00
5SW         718.41    80.39    10.32     2.94     5.40    90.53
========  ========  =======  =======  =======
Total      6634.23    48.99     0.84     6.89
Buoyancy   6634.10    49.04     1.09     1.52

        +++ D R A F T   M A R K   R E A D I N G S +++
        ============================================

Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

  Name     Draft    Name     Draft    Name     Draft    Name     Draft    Name     Draft    Name     Draft
-------- -------- -------- -------- -------- -------- -------- -------- -------- -------- -------- --------

BOWPO        1.79 BOWST        3.11 MIDPO        2.24 MIDST        3.56 STEPO        2.68 STEST        4.00
```




```
**********************************************************************************************************
*                                          *** MOSES ***                                                 *
*          T E C O N                                                                                     *
*          ---------     Damaged Stability Check - Tank 4SW                                               *
*                                                                                                        *
**********************************************************************************************************

                +++ R I G H T I N G   A R M   R E S U L T S +++
```

==========

Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

Results are in the Body System

Compartments Flooded Are: 4SW

Moment Scaled By 6634.23, KG = 6.89, and Wind Speed = 50 Knots

Initial: Roll = -2.75, Trim = 0.56 Deg.

Critical NWT Down Flooding Point Is *STEPTWT

Arms About Axis Yawed 0.0 Deg From Vessel X

/----- Condition -----/			/-- Min. Height --/		/--- Righting ---/		/--- Heeling ---/		Area	Net
Draft	Roll	Trim	W Tight	NW Tight	Arm	Area	Arm	Area	Ratio	Arm
2.45	0.00	0.00	9999.00	2.74	0.00	0.00	0.09	0.00	0.00	-0.094
2.43	2.00	0.00	9999.00	3.22	0.49	0.49	0.10	0.19	2.57	0.391
2.41	4.00	0.00	9999.00	3.13	0.97	1.94	0.10	0.38	5.10	0.873
2.38	6.00	0.00	9999.00	2.69	1.45	4.36	0.10	0.57	7.61	1.355
2.35	8.00	0.00	9999.00	2.26	1.94	7.75	0.10	0.77	10.12	1.842
2.31	10.00	0.00	9999.00	1.83	2.43	12.12	0.10	0.96	12.65	2.336
2.26	12.00	0.00	9999.00	1.40	2.93	17.49	0.09	1.15	15.22	2.835
2.21	14.00	0.00	9999.00	0.97	3.42	23.83	0.09	1.34	17.83	3.324
2.13	16.00	0.00	9999.00	0.56	3.82	31.07	0.09	1.52	20.41	3.730
2.03	18.00	0.00	9999.00	0.17	4.10	38.99	0.09	1.70	22.87	4.007
1.93	20.00	0.00	9999.00	-0.21	4.25	47.34	0.09	1.88	25.13	4.159
1.82	22.00	0.00	9999.00	-0.60	4.30	55.88	0.09	2.06	27.15	4.212
1.72	24.00	0.00	9999.00	-0.99	4.28	64.46	0.08	2.23	28.91	4.195
1.61	26.00	0.00	9999.00	-1.38	4.21	72.95	0.08	2.40	30.43	4.125
1.50	28.00	0.00	9999.00	-1.77	4.10	81.25	0.08	2.56	31.73	4.014
1.39	30.00	0.00	9999.00	-2.15	3.95	89.30	0.08	2.72	32.82	3.874
1.28	32.00	0.00	9999.00	-2.54	3.79	97.04	0.08	2.88	33.73	3.710
1.17	34.00	0.00	9999.00	-2.92	3.60	104.43	0.08	3.03	34.47	3.528
1.06	36.00	0.00	9999.00	-3.29	3.40	111.44	0.07	3.18	35.06	3.331
0.94	38.00	0.00	9999.00	-3.67	3.19	118.03	0.07	3.32	35.52	3.121
0.83	40.00	0.00	9999.00	-4.04	2.97	124.20	0.07	3.46	35.85	2.901
0.71	42.00	0.00	9999.00	-4.40	2.74	129.91	0.07	3.60	36.07	2.672
0.59	44.00	0.00	9999.00	-4.76	2.50	135.15	0.07	3.73	36.19	2.435
0.47	46.00	0.00	9999.00	-5.11	2.25	139.90	0.06	3.86	36.21	2.191
0.35	48.00	0.00	9999.00	-5.46	2.00	144.16	0.06	3.99	36.15	1.942
0.23	50.00	0.00	9999.00	-5.79	1.75	147.91	0.06	4.11	36.00	1.688
0.11	52.00	0.00	9999.00	-6.13	1.49	151.14	0.06	4.22	35.78	1.429
-0.01	54.00	0.00	9999.00	-6.45	1.22	153.85	0.05	4.34	35.48	1.167
-0.13	56.00	0.00	9999.00	-6.77	0.95	156.03	0.05	4.44	35.11	0.902
-0.25	58.00	0.00	9999.00	-7.08	0.68	157.66	0.05	4.55	34.68	0.634
-0.37	60.00	0.00	9999.00	-7.38	0.41	158.76	0.05	4.64	34.18	0.364
-0.49	62.00	0.00	9999.00	-7.67	0.14	159.31	0.05	4.74	33.62	0.093
-0.61	64.00	0.00	9999.00	-7.95	-0.14	159.31	0.04	4.83	33.00	-0.180

+++ S T A B I L I T Y S U M M A R Y +++

==========

The Following Damaged Condition

==========

with 4SW Damaged

Draft	=	2.45 M
Roll	=	-2.75 Deg
Pitch	=	0.55 Deg
VCG	=	6.89 M
Axis Angle	=	0.00 Deg
Wind Vel	=	50.00 Knots
1st Intercept	=	0.39 Deg
2nd Intercept	=	62.54 Deg
NWT Down-Flooding	=	19.73 Deg
WT Down-Flooding	=	Not App. Deg
MIN (1st Int. NWT Down)	=	19.73 Deg

Passes All of The Stability Requirements:

==========

GM	>=	0.05	M	14.08 Passes
Range	>=	20.00	DEG	62.80 Passes
Area Ratio	>=	1.00		24.88 Passes
RA at roll >= 30 deg	>=	0.10	M	3.95 Passes

11 BARGE LONGITUDINAL STRENGTH CHECK

The hull longitudinal strength check was carried out for the Still water condition. Being the barge classed, the longitudinal wave bending effect is not required (ref. 11.9.5.17 and 5.6.11.2 of Ref./9/).

The allowable stresses were assumed as follows: σ_{all} = 0.66*235 = 155 N/mm^2

τ_{all} = 0.40*235 = 94 N/mm^2

For normal stress, the maximum usage factor, i.e. the maximum bending / allowable stress ratio, is 0.46.

- UF = 11832/26130 = 0.46

For shear stress, the maximum usage factor is:

- UF_{shear} = 1000/6150 = 0.17

The maximum deflection results 3 cm.

Values of BM and Shear along the longitudinal section of the cargo barge were compared with the admissible values shown in section 7.4. All the values are within allowable ones.

Note: In the following tables, the allowable deflection is conventionally set equal to unity, therefore the values indicated under the columns with heading "Deflection/Allowable" are the computed deflections.

11.1 INTACT CONDITION

```
*****************************************************************************************************************
*                                          ***  MOSES   ***                                                     *
*          T E C O N                                                                .                           *
*          ---------     Longitudinal Strength Analysis - Still Water               .                           *
*                                                                                                               *
*****************************************************************************************************************

                    +++ L O N G I T U D I N A L   S T R E N G T H   R E S U L T S +++
                    ================================================================

               Process = DEFAULT: Units = Degrees, Meters, M-Tons, and MPa Unless Stated

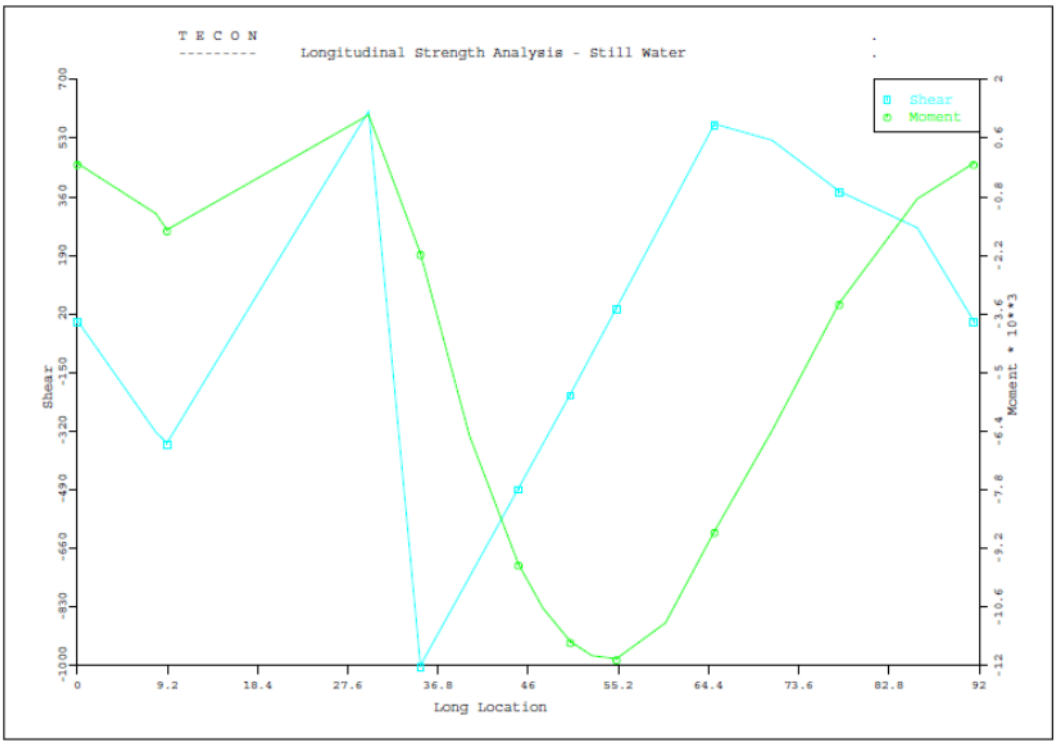
                                    Results are in the Body System

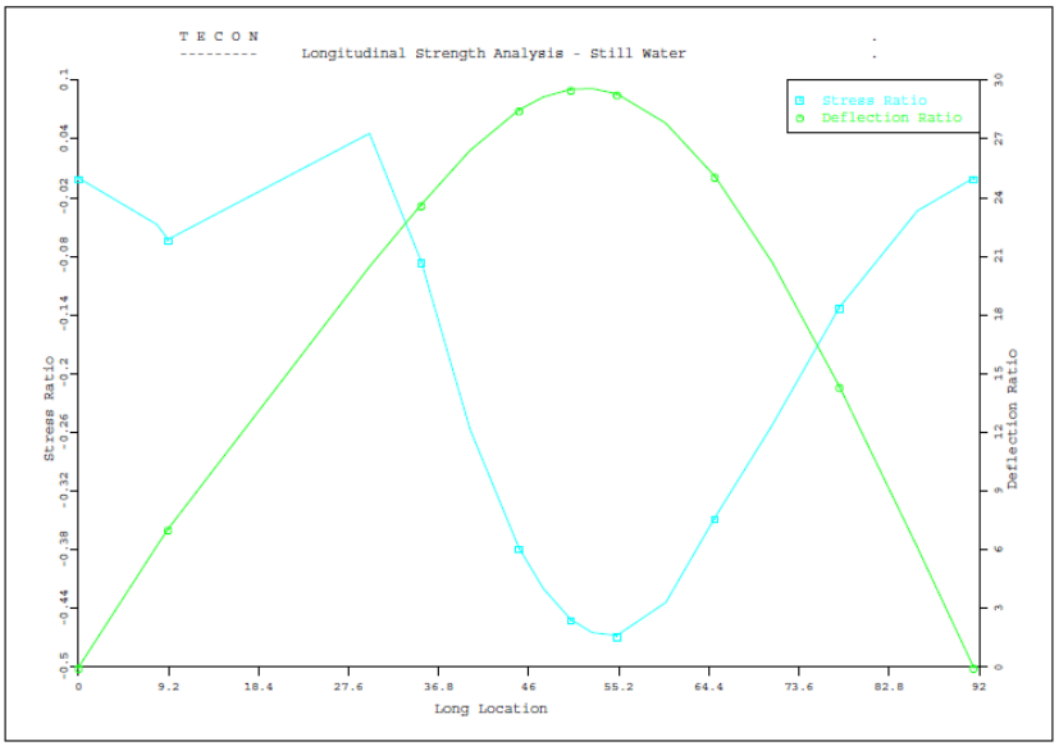
                                  Allowable Stress =     155.00 MPa

                                Allowable Deflection =       1.00 MM

     Longitudinal       Shear          Bending         B. Stress/     Deflection/
       Location         Force           Moment         Allowable      Allowable
    --------------  --------------  --------------  --------------  --------------

             0.00               1               0          0.0000          0.0000
             8.00            -322           -1201         -0.0475          6.1948
             9.14            -354           -1587         -0.0627          7.0651
            29.72             608            1153          0.0456         20.4690
            35.00            -999           -2151         -0.0850         23.6389
            40.00            -743           -6503         -0.2570         26.4152
            45.00            -486           -9573         -0.3783         28.4866
            47.50            -357          -10625         -0.4199         29.1466
            50.29            -213          -11420         -0.4513         29.5374
            52.50             -95          -11760         -0.4647         29.5702
            55.00              38          -11832         -0.4675         29.3027
            60.00             304          -10977         -0.4337         27.7991
            65.00             571           -8787         -0.3472         25.0976
            70.87             524           -6390         -0.2525         20.6949
            77.72             376           -3345         -0.1322         14.3532
            85.70             270            -848         -0.0335          6.1199
            91.44               1               0          0.0000          0.0001
```


T E C O N
Longitudinal Strength Analysis - Still Water
Shear
Moment
Shear
Moment * 10**3
Long Location


T E C O N
Longitudinal Strength Analysis - Still Water
Stress Ratio
Deflection Ratio
Stress Ratio
Deflection Ratio
Long Location

12 BOLLARD PULL CALCULATION

The min. bollard pull calculation has been performed considering the towing route, described in Section 7 of report /27/, and the meteorological criteria as per Table 11-17 of Ref./9/.

Table 11-17 Meteorological criteria for calculating TPR (towline pull required)

Section	*Condition*	*H_s(m)*	*Wind (m/sec)*	*Current (m/sec)*
[11.12.2.3]	Standard	5	20	0.5
[11.12.2.3]	Benign weather areas	As agreed with the MWS company but not less than:		
		2	15	0.5
[11.12.2.4]	Limited sea room	Design	Design (1 hour mean)	0.5 or predicted current if greater
[11.12.2.5]	Weather restricted towage	To document that the tow will maintain forward speed under all possible weather conditions and to render probable that the tow can be carried out within T_{POP}		
[11.12.2.6]	<24 hour staged tow or <24 hour jack-up move	3	15	0.5 or predicted current if greater
[11.12.2.7]	Sheltered from waves	As agreed with the MWS company.		

Table 12.1 - Criteria for TPR

- Significant wave height: Hs = 4 m
- Current speed: 0.5 m/s standard
- Wind speed: 20 m/s standard

The following excel spreadsheet details the min. bollard pull and the required bridles properties.

The full cargo surfaces have been considered in calculation, hence 30x20m of cargo windage area has been introduced in calculation with shape coefficient 1.30 to consider the exposed plate girders and beams.

Tug fort L = 45.6m tug length and 75 t bollard pull.

Calculation is performed according to DNV-ST-N001 at 0 knts FWD speed.

INPUT

GENERAL			
Parameter	**Notation**	**Value**	**Units**
Air Density	ρ_a	1.225	kg/m^3
Sea Water Density	ρ_w	1025	kg/m^3
Acc. Due to Gravity	g	9.81	m/s^2

TOWED BARGE			
VERVECE			
Parameter	**Notation**	**Value**	**Units**
Length	L	**91.20**	m
Breadth	B	**27.40**	m
Depth	D	**6.10**	m
Draft (Mid)	T	**2.50**	m
Freeboard	f	3.60	m
Hull Windage Area	$A_{WH} = B \times f$	98.64	m^2
Wind Coefficient (Hull)	C_W	**1.20**	
Hull Underwater Area	$A_{CH} = B \times T$	68.50	m^2
Current Drag Coefficient (Hull)	C_D	**1.00**	

CARGO			
BLPH			
Parameter	**Notation**	**Value**	**Units**
Breadth Overall	B_c	**30.00**	m
Height Overall	H_c	**20.00**	m
Height Coefficient	Ch	**1.10**	*RP-C205*
Shape Coefficient	Cs	**1.30**	*RP-C205*
Cargo Windage Area	$A_{WC} = B_C \times H_C$	600.00	m^2

SEA STATE			
Parameter	**Notation**	**Value**	**Units**
Wave Height	H_S	**4.0**	m
Current Speed	V_C	**0.5**	m/s
Wind Speed	V_W	**20.0**	m/s

TUG PROPERTY			
Parameter	**Notation**	**Value**	**Units**
Lenght	LOA	**45.7**	m
Actual Bollard Pull of Tug	BP	**75.0**	MT
Tug Efficiency	η	**0.68**	11.12.2.10
Towing Speed, Vt	Vt	**0.0**	knots
		0.0	*m/s*

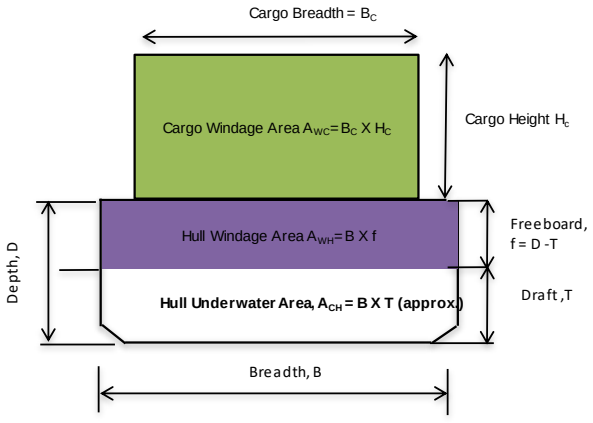
TUG	FORT	
BP	75	t
length	45.74	m

Table 12.2 - Input parameters

REQUIRED BOLLARD PULL CALCULATION FOR BARGES

Based on DNV Rules for Marine Operations DNV-OS-H202 (2-2) / DNV-ST-N001 / DNVGL-RP-N103 / DNV-RP-C205

REQUIRED BOLLARD PULL	74.53 MT



Sectional View of Barge with Cargo

TOW PULL CALCULATION

APPLICABILITY CHECK			
Ratio	Minimum Applicable	Actual	Check
L/B	3.0	3.3	OK
B/T	6.0	11.0	OK

Wind Resistance, $F_W = F_{WH} + F_{WC}$		
F_{WH} = Wind Resistance for Hull		
$F_{WH} = 1/2 \times \rho_a \times (V_W^2 + Vt^2) \times A_{WH} \times C_W$		
F_{WH}	2.96	MT
F_{WC} = Wind Resistance for Cargo		
$F_{WC} = 1/2 \times \rho_a \times (V_W^2 + Vt^2) \times A_{WC} \times C_h \times C_s$		
F_{WC}	21.43	MT
F_W = Total Wind Resistance		
$F_W = F_{WH} + F_{WC}$	24.38	MT

Current Resistance F_C		
$F_C = 1/2 \times \rho_s \times C_D \times (V_C^2 + Vt^2) \times A_{CH}$		
Fc	0.89	MT

Wave Drift Resistance F_D		
Fwd = 1/8 x ρw x g x R^2 x B x Hs^2		
R	0.67	reflection coeff
B11	-	drift damping
F_D	25.21	MT

Ref. DNVGL-RP-N103, sect 7.2.6.4 @ 0 fwd speed

TOTAL RESISTANCE, $F_T = F_W + F_C + F_D$		
Wind Resistance, F_W	24.38	MT
Current Resistance, F_C	0.89	MT
Wave Drift Resistance, $F_{D\ @0\ fwd\ speed}$	25.21	MT
Wave Drift Resistance, F_D + speed		
Total Resistance, F_T	50.49	MT

TUG EFFICIENCY		
Tug Efficiency, η	0.68	11.12.2.10

REQUIRED BOLLARD PULL (BP = F_T / η)		
BP	74.5	MT
Required Bollard Pull < Actual Bollard Pull => OK		

Table 12.3 - Bollard pull calculation

The requested min. bridle properties are:

Min. Req. TBL - RTBL (MT)			Table 11-19
Continuous Bollard Pull (BP)	Benign Areas	Other Ares	
BP < 40 MT	149.1	223.6	
40 <= BP <= 100 MT	149.1	180.7	
BP > 100 MT	149.1	149.1	

Selected **TBL** (MT)	181	
Tow line Connection Ultim. Capacity **UTC** =1.3*TBL	**235**	sect 11.13.8.1.

Min. Req. Towline Length (m)			sect 11.13.4.1.
L_{MIN} = BP/ MBL*1200m min 500 m	500	Benign Areas	
L_{MIN} = BP/ MBL*1800m min 650 m	725	Other Areas	
Selected Min. Req. Tow line L_{MIN} (m)	725		

BRIDLE PROPERTIES			
Toe Line L (>= L_{MIN})	800	m	CHECKED
Tow Line MBL (>= TBL)	185	MT	CHECKED
Apex MBL (>= UTC)	240	MT	CHECKED
Shackles MBL (>= UTC)	240	MT	CHECKED
Bridle Chain MBL (>= UTC)	240	MT	CHECKED

Table 12.4 - Towing Bridle check

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