

# STA CRANEARGE

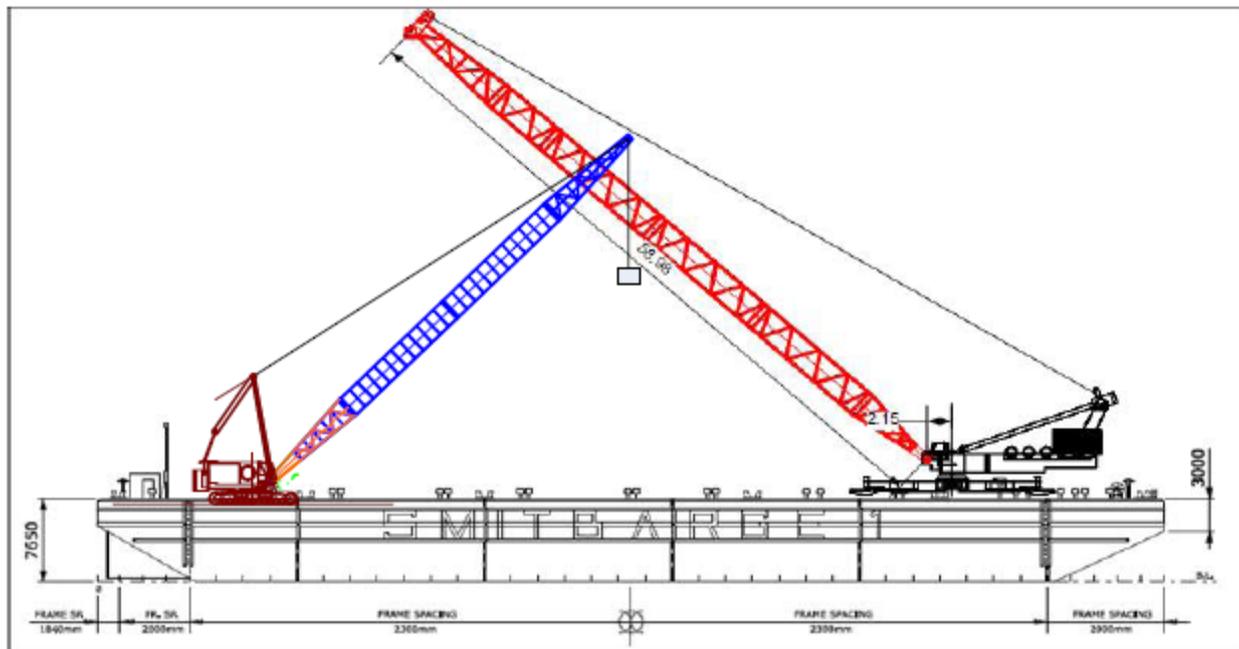
A Computer Program for the

## CAROLINA M

For Planning and Use During The Corocoro FSO Installation

### USER MANUAL

Revision 1  
November 20, 2006



This document describes the use of a bespoke Excel Workbook in its application to the planning and monitoring of lifting operations performed with a Gottwald AK 912 mobile crane mounted on the deck of the barge Carolina M.

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## 1.0 INTRODUCTION

The barge loaded condition is defined and stored. This includes ballast water in the ballast tanks, the barge lightship weight, the Gottwald AK 912 crane (which is welded in place on the forward end of the deck) and additional deck cargo.

The barge hydrostatics characteristics are pre-defined and re-computed every time any data item is edited. The program provides the immediate values for the vessel total displacement, draft (and freeboard) heel, and trim. Large angle properties are also available showing various stability margins.

The Gottwald crane characteristics are pre-defined. Crane limits are pre-calculated (within STA CRANE BARGE). Load charts are available and data for planned lifts are re-plotted plotted on the charts every time any data item is edited.

The program may simply be used for assessing and storing barge hydrostatics and stability for any load case. However, it is intended to do this while simultaneously investigating lift case scenarios where the crane limits are also determined.

In order to assist with deck load and ballast planning, the program allows the user to store 34 discrete items of deck cargo. These items are specified on the Deck Cargo Sheet. Two additional items may be specified on the Operations Planning Control Sheets.

Two lift scenarios are provided. In each case the user is informed of the barge hydrostatic characteristics before a load is lifted, when it is lifted and when it is set down in a new location. The conditions with the load on the hook just before set down and the conditions with the hook load released are reported.

In the first lift scenario, the crane is used to lift one of the cargo items from the Deck Cargo Sheet off the Carolina M and set it either onto another vessel, or onto the seabed or dock. Thus the lift conditions starts with a known load already on board at a known position and finishes with the load no longer on board.

In the second lift scenario a more general load sequence is analyzed that generally involves lifting a load from a location not on the Carolina and setting it onto another location that is not on the Carolina. However, results are also given for the final hydrostatic conditions of the barge for the condition of the lifted item being set on the deck of the Carolina when the hook load is released.

This document describes how to use the analysis tool simply and efficiently.

## 2.0 DEFINING UP DECK CARGO

Open the Deck Cargo Worksheet and edit the data. Figure 1, below shows an example case.

<b>Carolina M Deck Cargo for Corocoro</b>							
<b>Deck Loadout 1</b>		STA CRANE BARGE, Version 3.0 #####					
	<b>Cargo Item Name (Max. 34)</b>	<b>Weight</b>	<b>LCG from ap.</b>	<b>TCG</b>	<b>VCG</b>	<b>Length</b>	<b>Width</b>
1	Vryhof 1	39.0 t	36.0 m	9.0 m	10.9 m	7.0 m	8.0 m
1	Vryhof 2	39.0 t	29.0 m	9.0 m	10.9 m	7.0 m	8.0 m
1	Washrooms	5.0 t	20.0 m	-11.2 m	9.0 m	8.0 m	5.0 m
1	Tensioner	15.0 t	49.2 m	4.0 m	9.0 m	5.5 m	10.0 m
1	Vryhof 8	39.0 t	43.0 m	9.0 m	10.9 m	7.0 m	8.0 m
1	Tools	11.0 t	56.0 m	12.0 m	9.0 m	6.0 m	2.5 m
1	Tools	11.0 t	9.9 m	3.3 m	9.0 m	2.5 m	6.0 m
1	First Aid	5.0 t	9.9 m	-8.5 m	9.0 m	3.5 m	10.0 m
1	Vryhof 9	39.0 t	29.0 m	-10.5 m	10.9 m	8.0 m	7.0 m
1	Vryhof 10	39.0 t	56.0 m	-10.5 m	10.9 m	8.0 m	7.0 m
1	Wire Spool 8	117.9 t	65.3 m	-11.5 m	10.0 m	4.5 m	5.0 m
1	Wire Spool 3	117.9 t	49.0 m	-10.0 m	9.0 m	4.5 m	5.0 m
1	Wire Spool 5	42.9 t	41.2 m	0.0 m	10.0 m	4.5 m	5.0 m
1	Wire Spool 9	117.9 t	56.5 m	7.5 m	9.5 m	5.0 m	4.5 m
1	Wire Spool 10	117.9 t	81.5 m	-11.5 m	8.5 m	4.5 m	5.0 m
0	Wire Spool 6	0.0 t	40.0 m	-10.5 m	10.0 m	4.0 m	4.0 m
0	Wire Spool 7	0.0 t	42.0 m	-9.5 m	9.0 m	4.0 m	4.0 m
0	Wire Spool 8	0.0 t	44.0 m	-8.5 m	10.0 m	4.0 m	4.0 m
1	Generators	12.0 t	3.1 m	-8.5 m	9.5 m	5.0 m	9.0 m
1	Lima Crane	200.0 t	21.0 m	-0.5 m	15.0 m	9.0 m	7.0 m
1	Chain 1	54.3 t	66.0 m	11.0 m	10.0 m	12.0 m	3.0 m
1	Chain 2	62.0 t	35.5 m	-4.0 m	9.0 m	3.0 m	19.0 m
0	Chain 3	78.2 t	43.0 m	-10.5 m	10.0 m	2.0 m	2.0 m
0	Chain 4	78.2 t	45.0 m	-9.5 m	9.5 m	7.0 m	4.0 m
0	Chain 5	78.2 t	47.0 m	-8.5 m	8.5 m	7.0 m	4.0 m
0	Chain 6	54.3 t	49.0 m	-6.0 m	10.0 m	7.0 m	4.0 m
0	Chain 7	54.3 t	50.0 m	-10.0 m	9.0 m	7.0 m	4.0 m
1	Chain 8	87.0 t	77.0 m	11.0 m	10.0 m	12.0 m	3.0 m
1	Chain 9	87.0 t	41.5 m	-8.5 m	9.0 m	3.0 m	10.0 m
1	Chain 10	78.2 t	38.5 m	-8.5 m	10.0 m	3.0 m	10.0 m
1	Winch 1	12.0 t	6.8 m	9.0 m	9.0 m	3.0 m	5.0 m
1	Winch 2	12.0 t	85.0 m	9.8 m	9.0 m	3.0 m	5.0 m
1	Freezer	9.0 t	16.0 m	10.5 m	10.0 m	12.0 m	5.5 m
1	Offices	5.0 t	14.0 m	0.5 m	8.5 m	3.0 m	12.0 m
1	Wire Spool 10	117.9 t	81.5 m	-11.5 m	8.5 m	4.5 m	5.0 m

FIGURE 1 – Definition (by User) of deck cargo items.

In Figure 1, 34 items of deck cargo are defined. The user can edit their names, their weight values, and their LCG, TCG, and VCG locations in the barge coordinate system, as well as their plan view sizes. The barge has TCG = 0.0m on the longitudinal centerline. LCG and VCG = 0.0m at the stern and baseline (aft perpendicular, or ap). The barge deck is at 7.647m above the barge baseline. TCG to starboard is positive. An overall positive TCG will cause the starboard side of the barge to be lower than the port side.

The user may enter a description for the configuration of deck cargo defined on this sheet. In the example shown this is “**Deck Loadout 1**”.

In the column headed “**1 or 0**” the user types “**1**” if the defined cargo item in that row is to be included in the load case, or “**0**” if the item is to be ignored.

The sheet displays a summary of all the cargo items totaled up, as shown in Figure 2.

Deck Cargo Arrangement No.	Deck Loadout 1
<b>Deck Cargo Summary Properties For Stability Calcs.</b>	
<b>Total Cargo Weight</b>	<b>1375.0 t</b>
<b>Deck Cargo LCG</b>	<b>47.498 m</b>
<b>Deck Cargo TCG</b>	<b>-1.905 m</b>
<b>Deck Cargo VCG</b>	<b>10.428 m</b>

FIGURE 2 – Deck Cargo Summary

The Deck Cargo Sheet also shows a graphical view of the cargo items that are active. They are displayed in colors similar to the colors in the data entry table in Figure 1. An Autocad view of the deck plan is shown (in this example) that has been overlaid on the Excel chart, as illustrated in Figure 3,

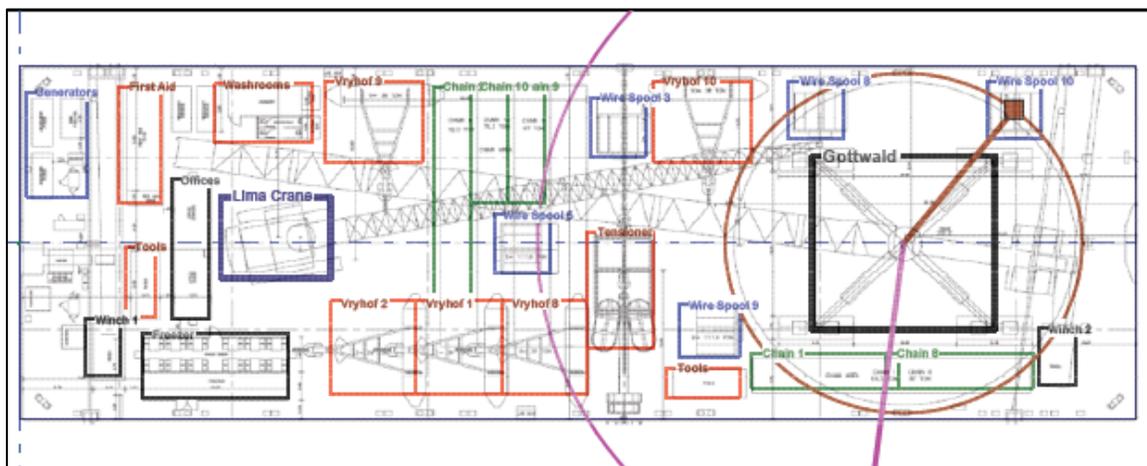


FIGURE 3 – Example of Deck Cargo Layout defined in Figure 1.

Note that the Gottwald crane is shown in Figure 3, but is not included in the user-defined cargo inventory. The location and weight of the crane is embedded within the workbook by the author.

Also note that on Figure 3 two circles are drawn around the Gottwald crane. These have radii which correspond to the radii of the load item selected by the user for the **Scenario 1** Lift Analysis (lifting a predefined item of deck cargo). It's pick up point is known (the brown circle) and the user has defined a set down location for analysis. This is described later.

In the example DATA SHOWN IN Figure 1, the last row indicates the cargo item the user has selected elsewhere for the **Scenario 1** Lift Analysis.

The layout of the deck cargo can be viewed at a larger scale (and printed) on another sheet, as illustrated in Figure 4.

Note that only active loads (that are set with a "1" in the first column in Figure 1) appear on Figures 3, 4, and 5.

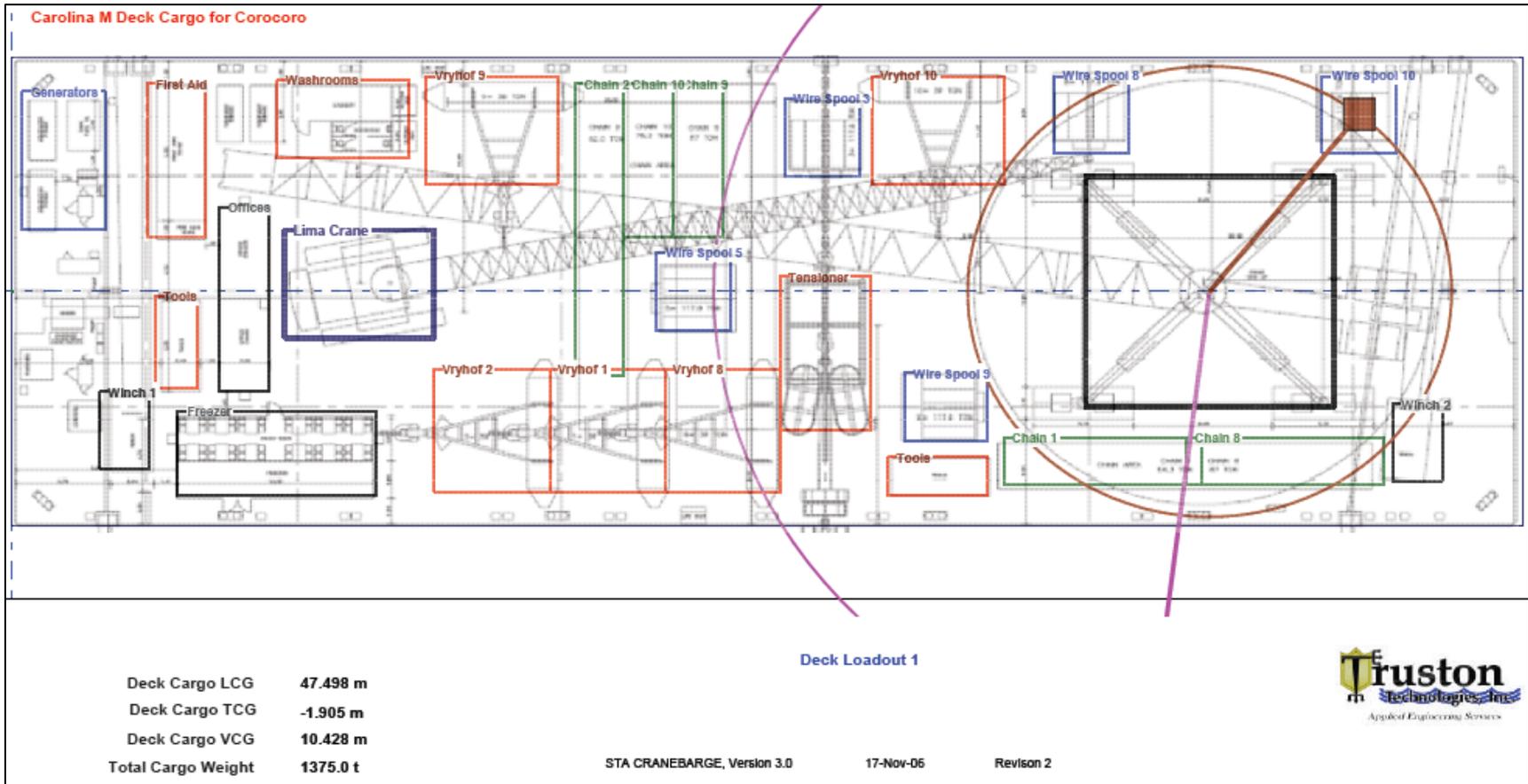


FIGURE 4 – Larger Schematic View of User-Defined Deck Cargo with an Autocad Deck Layout Plan Superimposed.

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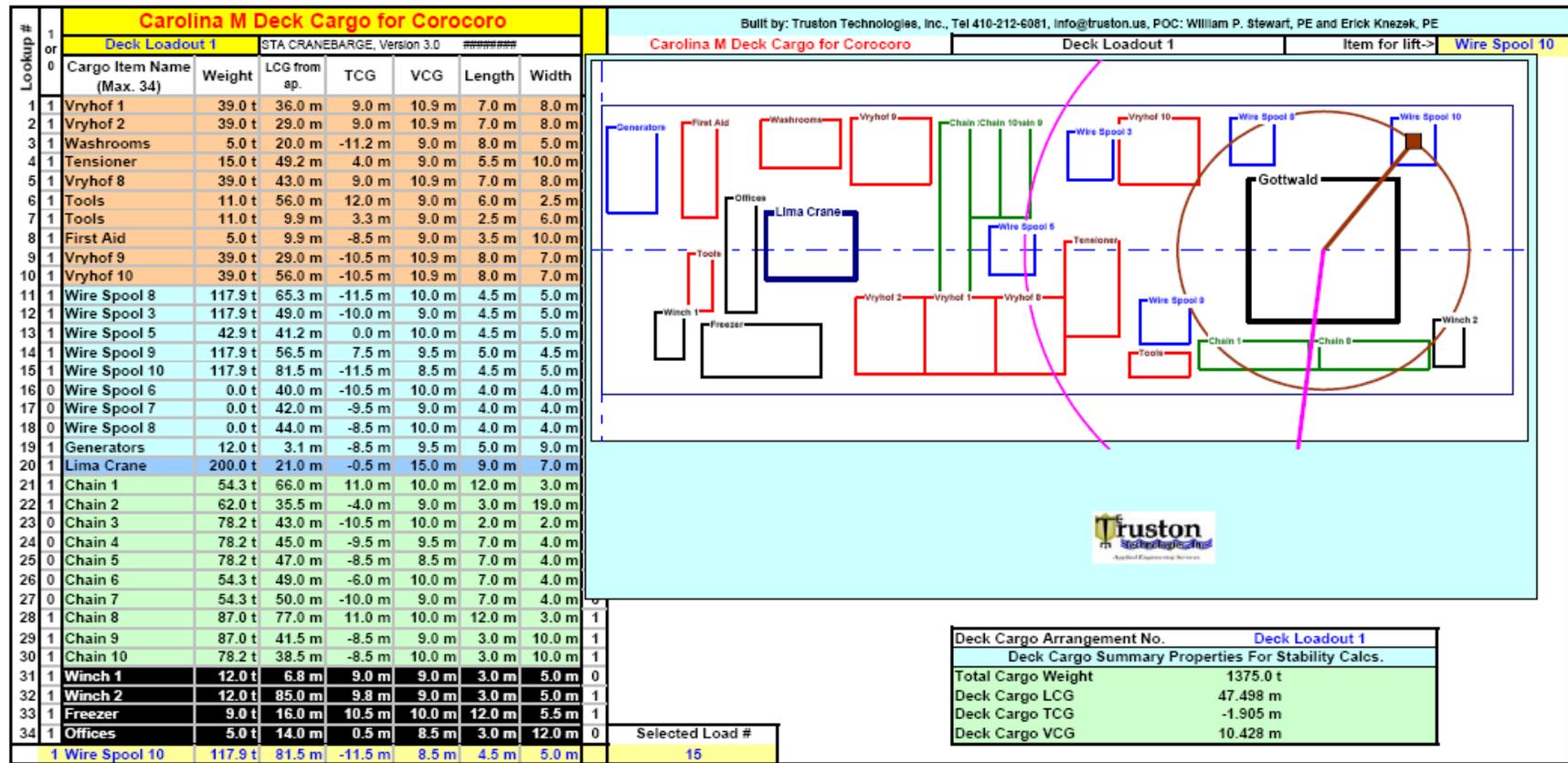


FIGURE 5 – Full Deck Cargo Input Data Worksheet Screen Shown to the User.

Figure 5 shows the full screen available to the user for the purposes of defining the deck cargo. The user may have to scroll around the screen on small notebook computers.

### 3.0 BALLAST TANK CONTENTS

Carolina M Hull Ballast Tanks													Info on Chart		
Built by: Truston Technologies, Inc., Tel 410-212-6081, info@truston.us, POC: William P. Stewart, PE and Eriok Knezek, PE STA CRANE BARGE, Version 3.0      17-Nov-06 Revision 2      CORO 061 - Adjust Ballast for Tow Name for Ballast Tank Arrangement: <b>Operations Corocoro 1</b>											Total Weight in Hull Tanks 6737 tonne VCG of Hull Tanks Liquide 3.831 m LCG of Hull Tanks Liquide 45.458 m TCG of Hull Tanks Liquids 0.425 m 11012.24				
Heel angle (stbd down +ve) 0.076° Trim angle (stern down +ve) -0.086°				Mean Draft 4.322 m Mean Freeboard 3.325 m		14.19 ft 10.91 ft									
Tank Name	P or S	Volume	Max Weight	% full	Weight in Tank	LCG from AP	Lmom	TCG	Tmom	VCG above base (full)	Est. VCG	Vmom	lxx water surface	lyy water surface	
<b>Fuel Oil</b>	<b>S</b>	26 m <sup>3</sup>	23 tonne	21.0%	4.8 tonne	8.840 m	33 t-m	6.00 m	24 t-m	4.845 m	3.759 m	18 t-m	15 m <sup>4</sup>	1 m <sup>4</sup>	
No. 1P Inn	Inn Tank	P	405 m <sup>3</sup>	415 tonne	0%	0 tonne	85.888 m	0 t-m	-3.81 m	0 t-m	4.730 m	0.000 m	0 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 1S Inn	Inn Tank	S	405 m <sup>3</sup>	415 tonne	0%	0 tonne	85.888 m	0 t-m	3.81 m	0 t-m	4.730 m	0.000 m	0 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 1P Out	Out Tank	P	403 m <sup>3</sup>	413 tonne	100%	413 tonne	85.875 m	35384 t-m	-11.43 m	-4721 t-m	4.729 m	4.729 m	1953 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 1S Out	Out Tank	S	403 m <sup>3</sup>	413 tonne	100%	413 tonne	85.875 m	35384 t-m	11.43 m	4721 t-m	4.729 m	4.729 m	1953 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 2P Inn	Inn Tank	P	921 m <sup>3</sup>	944 tonne	0%	0 tonne	73.390 m	0 t-m	-3.81 m	0 t-m	3.810 m	0.000 m	0 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 2S Inn	Inn Tank	S	921 m <sup>3</sup>	944 tonne	0%	0 tonne	73.390 m	0 t-m	3.81 m	0 t-m	3.810 m	0.000 m	0 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 2P Out	Out Tank	P	920 m <sup>3</sup>	943 tonne	0%	0 tonne	73.390 m	0 t-m	-11.43 m	0 t-m	3.812 m	0.000 m	0 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 2S Out	Out Tank	S	920 m <sup>3</sup>	943 tonne	0%	0 tonne	73.390 m	0 t-m	11.43 m	0 t-m	3.812 m	0.000 m	0 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 3P Inn	Inn Tank	P	921 m <sup>3</sup>	944 tonne	0%	0 tonne	57.290 m	0 t-m	-3.81 m	0 t-m	3.810 m	0.000 m	0 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 3S Inn	Inn Tank	S	921 m <sup>3</sup>	944 tonne	0%	0 tonne	57.290 m	0 t-m	3.81 m	0 t-m	3.810 m	0.000 m	0 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 3P Out	Out Tank	P	920 m <sup>3</sup>	943 tonne	100%	943 tonne	57.290 m	54024 t-m	-11.43 m	-10778 t-m	3.812 m	3.812 m	3595 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 3S Out	Out Tank	S	920 m <sup>3</sup>	943 tonne	100%	943 tonne	57.290 m	54024 t-m	11.43 m	10778 t-m	3.812 m	3.812 m	3595 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 4P Inn	Inn Tank	P	921 m <sup>3</sup>	944 tonne	0%	0 tonne	41.190 m	0 t-m	-3.81 m	0 t-m	3.810 m	0.000 m	0 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 4S Inn	Inn Tank	S	921 m <sup>3</sup>	944 tonne	0%	0 tonne	41.190 m	0 t-m	3.81 m	0 t-m	3.810 m	0.000 m	0 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 4P Out	Out Tank	P	920 m <sup>3</sup>	943 tonne	100%	943 tonne	41.190 m	38842 t-m	-11.43 m	-10778 t-m	3.812 m	3.812 m	3595 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 4S Out	Out Tank	S	920 m <sup>3</sup>	943 tonne	100%	943 tonne	41.190 m	38842 t-m	11.43 m	10778 t-m	3.812 m	3.812 m	3595 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 5P Inn	Inn Tank	P	921 m <sup>3</sup>	944 tonne	0%	0 tonne	25.090 m	0 t-m	-3.81 m	0 t-m	3.810 m	0.000 m	0 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 5S Inn	Inn Tank	S	921 m <sup>3</sup>	944 tonne	0%	0 tonne	25.090 m	0 t-m	3.81 m	0 t-m	3.810 m	0.000 m	0 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 5P Out	Out Tank	P	920 m <sup>3</sup>	943 tonne	100%	943 tonne	25.090 m	23660 t-m	-11.43 m	-10778 t-m	3.812 m	3.812 m	3595 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 5S Out	Out Tank	S	920 m <sup>3</sup>	943 tonne	100%	943 tonne	25.090 m	23660 t-m	11.43 m	10778 t-m	3.812 m	3.812 m	3595 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 6P Out	Out Tank	P	808 m <sup>3</sup>	828 tonne	0%	0 tonne	9.705 m	0 t-m	-11.43 m	0 t-m	4.220 m	0.000 m	0 t-m	0 m <sup>4</sup>	0 m <sup>4</sup>
No. 6S Out	Out Tank	S	808 m <sup>3</sup>	828 tonne	30%	248 tonne	9.705 m	2411 t-m	11.43 m	2839 t-m	4.220 m	1.266 m	314 t-m	0 m <sup>4</sup>	3142 m <sup>4</sup>
			17980 m <sup>3</sup>	18408 tonne		6737 tonne	45.458 m	306264 t-m	0.425 m	2863 t-m	3.831 m	25807 t-m	15 m <sup>4</sup>	3222 m <sup>4</sup>	

FIGURE 6 – Example of Ballast Tanks Contents Configuration

The Carolina M has 22 large ballast tanks for salt water and a fuel oil tank intended for the ballast pumps. Figure 6 shows how the user selects the desired %full in each tank and the program computes the weight distribution and free surface effects, if any. Only the yellow cells are to be edited by the user. Note that the overall barge displacement, draft, heel, and trim are shown. These values account for the deck cargo, the Gottwald crane, and the lightship weight in addition to the ballast water weight and its distribution.

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<b>STERN</b>	<b>6</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>BOW</b>
	No. 6P Outer <b>0%</b> 0 tonne		No. 5P Outer <b>100%</b> 943 tonne	No. 4P Outer <b>100%</b> 943 tonne	No. 3P Outer <b>100%</b> 943 tonne	No. 2P Outer <b>0%</b> 0 tonne	No. 1P <b>100%</b> 413 tonne
	<b>Fuel Oil</b> <b>21.0%</b> 4.8	<b>Store</b>  <b>Machinery Space</b>	No. 5P Inner <b>0%</b> 0 tonne	No. 4P Inner <b>0%</b> 0 tonne	No. 3P Inner <b>0%</b> 0 tonne	No. 2P Inner <b>0%</b> 0 tonne	No. 1P <b>0%</b> 0 tonne
			No. 5S Inner <b>0%</b> 0 tonne	No. 4S Inner <b>0%</b> 0 tonne	No. 3S Inner <b>0%</b> 0 tonne	No. 2S Inner <b>0%</b> 0 tonne	No. 1S <b>0%</b> 0 tonne
	No. 6S Outer <b>30%</b> 248 tonne		No. 5S Outer <b>100%</b> 943 tonne	No. 4S Outer <b>100%</b> 943 tonne	No. 3S Outer <b>100%</b> 943 tonne	No. 2S Outer <b>0%</b> 0 tonne	No. 1S <b>100%</b> 413 tonne

FIGURE 7 – Schematic View of Ballast Tank Contents Specified by The User.

A screen as illustrated in Figure 7, above, is provided to the user to assist in assessing optimal ballast water distribution strategies. Generally free surfaces should be kept to a minimum, with tanks either pressed full or kept empty (and stripped). Just one or two tanks should be used to obtain close to zero heel and trim angles for crane operations. Where possible outer tanks should be full in preference to inner tanks in order to minimize risks of flooding in damage situations. Bow tanks should be filled for the same reason, where the freeboard demands permit this. For motions minimization it is also preferable to fill tanks furthest from the barge center.

## 4.0 ANALYSIS CONTROL AND STABILITY SUMMARY

Having set deck cargo and ballast tank contents, the user checks the overall barge stability condition in preparation for lift analyses.

<b>CAROLINA M Trim and Stability</b>								
Deck Loads, Cranes and Hydrostatics - Lifting Cargo Off Carolina M								
Built by: Truston Technologies, Inc., Tel 410-212-6081, info@truston.us, POC: William P. Stewart, PE and Erick Knezak, PE								
STA CRANE BARGE, Version 3.0		17-Nov-06 Revision 2		A computer program (Excel Application) for Crane Barge Lift Planning				
Control Reference:		Loadout Plan November 15, 2006		Freeboard is Sufficient		Given a Draft	8.800 m	
Run Reference:		Truston 012		Lift Item->		Wire Spool 10	Calc. Disp. 15213 tonne	
LOADED CONDITION		LCG	TCG	VCG	Lmom	Tmom	Vmom	Condition Name
Lightweight Displacement	2300 tonne	43.770 m	0.000 m	4.250 m	100671 t-m	0 t-m	9775 t-m	
Weight of Hull Tank Liquids	6737 tonne	46.458 m	0.425 m	3.831 m	306264 t-m	2863 t-m	25907 t-m	Operations Corocoro 1
Deck Cargo	1375 tonne	47.498 m	-1.905 m	10.429 m	66311 t-m	-2820 t-m	14338 t-m	Deck Loadout 1
Gottwald Crane	400 tonne	72.440 m	0.000 m	14.300 m	28978 t-m	0 t-m	5720 t-m	Truston 012
Miscellaneous 1, including moorings	200 tonne	20.000 m	0.000 m	8.800 m	4000 t-m	0 t-m	1760 t-m	
Miscellaneous 2	0 tonne	0.000 m	0.000 m	7.900 m	0 t-m	0 t-m	0 t-m	
Total Deck Cargo Exc. Gottwald Crane	1575 tonne	59.864 m	-1.663 m	12.735 m	94287 t-m	-2820 t-m	20058 t-m	
Total Displacement	11012 tonne	45.878 m	0.022 m	5.212 m	599509 t-m	243 t-m	57400 t-m	
Total Deadweight	8712 tonne	46.435 m	0.028 m	5.486 m	498838 t-m	243 t-m	47825 t-m	
HYDROSTATIC PROPERTIES BEFORE LIFT OPERATION				Stability Criteria Checks With This Load Condition				
Mean Draft	4.322 m	14.18 ft	11267 t-m (1) CFR 173.005, (0.67)(W)(GM)/(F/B) Min Value for this load case.					
Mean Freeboard	3.325 m	10.91 ft	3537 t-m (2) Max Moment from Hook Load in this Lift.					
Heel angle (stbd down +ve)	0.076°		0 t-m (3) Max Manufacture's Moment from Hook Load					
Trim angle (stern down +ve)	-0.086°		The CFR Rules do not strictly apply because (1) is greater than (3)					
Mean Freeboard at Stern	3.393 m		53.43 m-deg (4) Area under righting arm curve up to max GZ					
Mean Freeboard at Bow	3.256 m		Area under righting arm curve is > 3.05 m-degrees					
Mean Freeboard at Port	3.304 m		20° (5) θ at max GZ				3.99 B/D in range 3.4 to 4.75	
Mean Freeboard at Stbd	3.345 m		4.86 m (6) Maximum value of GZ				3.00 L/B not within 3.2 to 4.5	
Deadweight Moment Margin	64.8%		135366 t-m Deadweight moment allowable				0.57 H/D not in range 0.6 to 0.85	
Deadweight VCG Margin	10.082 m		19° (7) Downflooding angle					

FIGURE 8 – Control Screen for Scenario 1 Lift Analysis

Figure 8 provides the user with a summary of the loaded condition of the barge before lift analysis is undertaken. This screen is intended for Scenario 1 lifts, where an item of cargo already defined in the deck cargo inventory is to be lifted from the Carolina M and placed on another vessel, the seabed or on the dock, or floated.

Two rows are available (yellow cells) for the user to input loads in addition to the deck cargo inventory.

If the barge afloat condition is not satisfactory (too much heel or trim for example) the user may elect to modify the ballast tank arrangements or to make adjustments to the cargo before going further.

The light yellow background cells provide stability check results that might limit operations. For the Corocoro installation these checks have not been found to be in any way limiting to the Carolina M in analyses with sensible displacement conditions and very small heel and trim angles before loads are lifted by the crane. Further details are provided elsewhere.

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Control Reference:		CORO 061 - Adjust Ballast for Tow		Freeboard is Sufficient			Given a Draft:	5.610 m
Run Reference:	Truston 019		Lift Item->	Powered Reel A		Calc. Disp.	14669 tonne	
<b>LOADED CONDITION</b>								
	LCG	TCG	VCG	Lmom	Tmom	Vmom	Condition Name	
Lightweight Displacement	2300 tonne	43.770 m	0.000 m	4.250 m	100671 t-m	0 t-m	9775 t-m	
Weight of Hull Tank Liquids	6737 tonne	45.458 m	0.425 m	3.831 m	306264 t-m	2863 t-m	25807 t-m Operations Corocoro 1	
Deck Cargo	1375 tonne	47.498 m	-1.905 m	10.428 m	65311 t-m	-2620 t-m	14338 t-m Deck Loadout 1	
Gottwald Crane	400 tonne	72.440 m	0.000 m	14.300 m	28976 t-m	0 t-m	5720 t-m Truston 019	
Gottwald Crane Hook Load	120 tonne	70.356 m	-11.818 m	69.332 m	8443 t-m	-1418 t-m	8320 t-m Powered Reel A	
Miscellaneous 1	200 tonne	20.000 m	0.000 m	8.800 m	4000 t-m	0 t-m	1760 t-m	
Miscellaneous 2	0 tonne	0.000 m	0.000 m	7.900 m	0 t-m	0 t-m	0 t-m	
Total Deck Cargo Exc. Gottwald Crane	1575 tonne	65.225 m	-2.564 m	18.018 m	102730 t-m	-4038 t-m	28378 t-m	
Total Displacement with Hook Load	11132 tonne	46.142 m	-0.106 m	5.904 m	513665 t-m	-1175 t-m	66720 t-m	
Total Deadweight	8832 tonne	46.760 m	-0.133 m	6.334 m	412994 t-m	-1175 t-m	56945 t-m	
<b>HYDROSTATIC PROPERTIES BEFORE LIFT &amp; at PICK UP</b>				<b>Stability Criteria Checks With This Load Condition</b>				
Mean Draft	4.322 m	4.365 m	11678 t-m (1) CFR 173.005, (0.67)(W)(GM)(F/B) Min value for this load case.					
Mean Freeboard	3.325 m	3.282 m	3240 t-m (2) Max Moment from Hook Load in this Lift.					
Heel angle (stbd down +ve)	0.076°	-0.381°	0 t-m (3) Max Manufacture's Moment from Hook Load					
Trim angle (stern down +ve)	-0.086°	-0.175°	The CFR Rules do not strictly apply because (1) is greater than (3)					
Mean Freeboard at Stern	3.393 m	3.421 m	53.43 m-deg (4) Area under righting arm curve up to max GZ					
Mean Freeboard at Bow	3.256 m	3.142 m	Area under righting arm curve is > 3.05 m-degrees					
Mean Freeboard at Port	3.304 m	3.383 m	20° (5) θ at max GZ			Geometric Checks		
Mean Freeboard at Stbd	3.345 m	3.180 m	4.86 m (6) Maximum value of GZ			3.99	B/D in range 3.4 to 4.75	
Deadweight Moment Margin	58.7%		135366 t-m Deadweight moment margin			3.00	L/B not within 3.2 to 4.5	
Deadweight VCG Margin	9.214 m		19° (7) Downflooding angle			0.57	H/D not in range 0.6 to 0.85	

FIGURE 9 – Control Screen for **Scenario 2** Lift Analysis

Figure 9 provides the user with a summary of the loaded condition of the barge before lift analysis is undertaken. This screen is intended for **Scenario 2** lifts, where a load is to be lifted by the Gottwald crane from a location not on the Carolina M. The load is to be set down either at another location off the barge, or on the barge.

The basic barge loaded condition is the same as for the **Scenario 1** lift analysis as shown in Figure 8 with the exception that the load to be lifted is included in the barge total deadweight. In this example the crane hook load is 120 tonnes and the total barge deadweight is 8,832 tonnes, compared to 8,712 tonnes for the **Scenario 1** lift analysis in Figure 8.

The two editable load items not included in the deck cargo inventory, but specified in the Control Screen for **Scenario 1**, are shown in this **Scenario 2** Control Screen and cannot be edited here. The crane hook load shown comes from the **Scenario 2** Crane Operations Screen.

The displacement heel and trim values shown in Figure 9 are the same as those in Figure 8 and reflect conditions before the crane lifts the load.

All data is now set for the user to proceed with crane lift analyses using either **Scenario 1** or **Scenario 2**.

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## 5.0 CRANE OPERATIONS – SCENARIO 1 ANALYSES

Having set up the barge loading conditions described in Sections 2, 3, and 4, the user may analyze numerous lift plans. Figure 10, below, shows the data for an example lift analysis.

CAROLINA M CRANE OPERATIONS SHEET - Cargo Lifted Off Carolina M						Select Cargo Item
Name for Lift Case -->		Truston 012		Freeboard is Sufficient		15
Deck Cargo Item is Active				Pick Radius Possible		
DEFINE Load, Radius, and Heading for Pick Up and Set Down				Set Down Radius Possible		
		Pick Up Point		Set Down Point		Block&Aux. wt. 5 t
Name of Item	Load	Radius	Heading	Radius	Heading	Max. Allowable Hook Load
Wire Spool 10	117.9 tonne	14.64 m	308°	30.00 m	97°	122.8 tonne
Position Vessels	Center X	Center Y			Hook Load is Allowable	
FEEDER Barge	52.00 m	28.00 m	BOA Heading			
BOA QUEEN	46.00 m	-25.00 m	-1	<-- 1 or -1	Max load at 40% derating = 85 tonne	

FIGURE 10 – Crane Operations 1 Analysis Control Screen for **Scenario 1** Lifts.

There are only eight editable cells for the user. The first is an optional name for the lift case. In this example the name “**Truston 012**” has been input. The next is the number of the cargo item specified in the deck cargo inventory (Figure 1). In this case item “**15**” is shown selected and the message “**Deck Cargo Item is Active**” is displayed.

The message “**Pick Radius is Possible**” indicates that the deck cargo item selected lies within the available radius of the Gottwald crane (not too close or too far away).

The name of the item (as specified on the Deck Cargo Sheet) is displayed in **brown font**, together with its location in terms of crane boom radius and heading in the crane azimuth axes (also computed from data given in the Deck Cargo Sheet).

The user specifies (**in the yellow cells**) the set down point in terms of crane radius and azimuth angle (0° is boom over bow; 90° is boom over the starboard side of the barge; 180° is boom towards the stern; 270° is boom over the port side).

A message in this example indicates “**Set Down Radius is Possible**” and other messages display:

“**Max Allowable Hook Load 122.8 tonne**”

“**Hook Load is Allowable**” and

“**Max load at 40% derating = 85 tonne**”.

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The user is informed that the weight of the Block and auxiliary weight, in addition to the weight of the load alone hanging on the hook is **5t**. This value can be edited on the second (**Scenario 2**) Crane Ops Sheet.

Hence, in this example, with the deck cargo and ballast arrangement selected, the crane operation is feasible and the crane will operate within its derated envelope.

The crane and load positions at the pick and set points are illustrated schematically on the screen as illustrated in Figure 11.

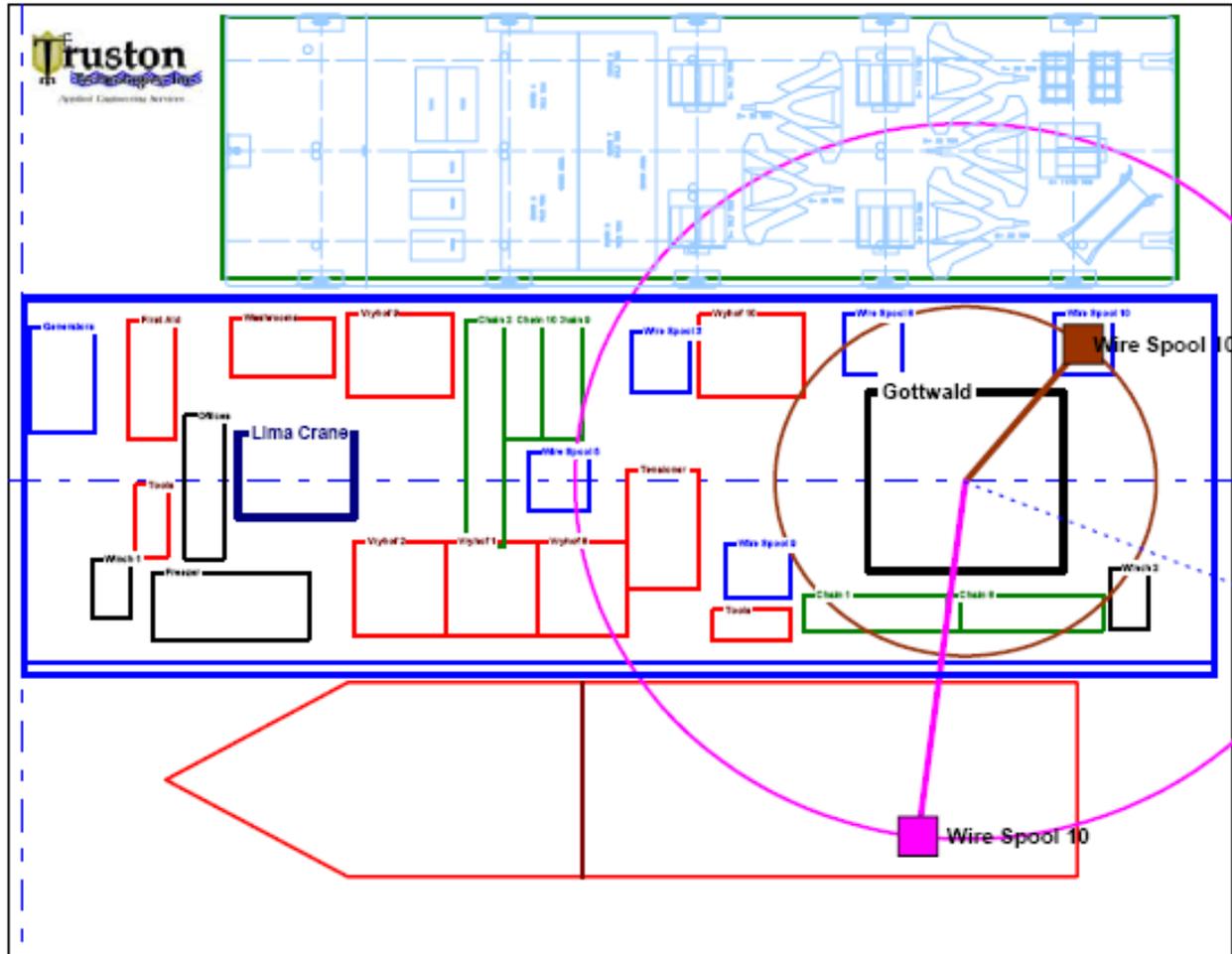


FIGURE 11 – Crane Ops1 Schematic View of Lift from Carolina M onto Boa Queen.

The last editable cells in Figure 10 allow the user to realistically position the Boa Queen and the Feeder Barge alongside the Carolina M for lift planning and analysis purposes.

Now knowing that the lift is feasible, the user can look closely at the angle and freeboard changes that will occur on the Carolina M during the key stages of the lift operation. This data is shown for this example in Figure 12.

<b>SUMMARY OF HYDROSTATIC RESULTS FOR THIS LIFT</b>				
	<b>Before Hook Load Picked Up</b>	<b>With Hook Load at Pick Up</b>	<b>With Hook Load at Set Down</b>	<b>After Hook Load Released</b>
<b>Mean Draft</b>	4.322 m	4.322 m	4.322 m	4.280 m
<b>Mean Freeboard</b>	3.325 m	3.325 m	3.325 m	3.367 m
<b>Heel angle (stbd down +ve)</b>	0.076°	0.079°	1.649°	0.497°
<b>Trim angle (stern down +ve)</b>	-0.086°	-0.086°	-0.040°	0.042°
<b>Min.freeboard any side/end</b>	3.256 m	3.256 m	2.886 m	3.234 m
<b>Max.angle for crane derating</b>	0.115°	0.117°	1.649°	0.499°
<b>GM transverse from this Lift</b>	16.719 m	16.072 m	16.128 m	16.918 m
<b>Max Crane Moment</b>	0 t-m	1726 t-m	3537 t-m	0 t-m
<b>(0.67)(W)(GM)(F/B)</b>	13176 t-m	12667 t-m	11267 t-m	13104 t-m

FIGURE 12 – Summary of Barge Conditions During Lift Operation

In this **Scenario 1** lift operation the load ends up on the Boa Queen and the mean draft of the Carolina M is reduced from 4.322m to 4.280m. The heel angle starts at 0.076° down to starboard, increases slightly as the load is raised off the deck, and its VCG is effectively at the height of the crane boom tip, and then increases to a maximum of 1.649° just before the load is set down, and finally comes to 0.497° when the load is released from the hook.

The minimum freeboard change at any side is from 3.256m to 2.866m, a freeboard variation of 390mm during the 120 tonne lift.

The maximum angles for crane derating are reported in Figure 12 for each stage of the lift and are further manipulated elsewhere.

Crane moment stability checks are also reported and described more fully elsewhere.

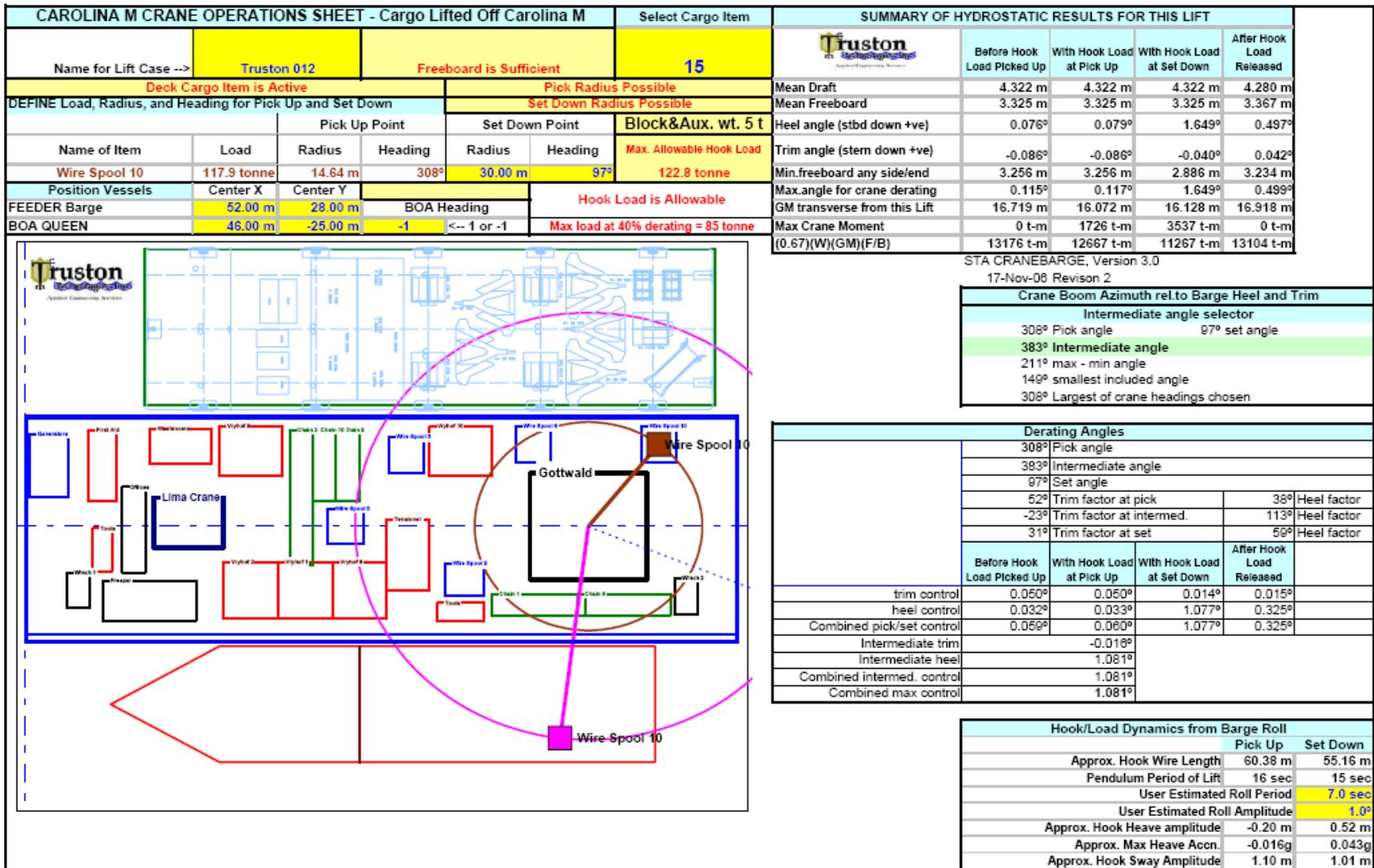


FIGURE 13 – Full Crane Ops1 Screen Available to the User.

It should be noted that a final angle selected for crane derating as a consequence of inclinations during this lift operation is found on the right hand side of Figure 13. It is 1.081° in this example. This is further explained elsewhere.

Initial crane hook dynamic calculations are shown in the lower right hand corner of Figure 13. Two cells for user input are provided. This is further explained elsewhere.

At this point the user can examine the crane load chart and note where the particular pick and set data points lay for this lift analysis.

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## 6.0 CRANE LOAD CHARTS – SCENARIO 1 DETAILED RESULTS

Having established the lift operation to be feasible (or even if it was shown to violate any limits) the user may examine the Gottwald crane load chart for the **Scenario 1** lift analysis just described. These results are given on the Gott1 worksheet.

CAROLINA M CRANE DERATING CALCULATIONS			STA CRANE BARGE, Version 3.0 17-Nov-06 Revision 2		
Built by: Truston Technologies, Inc., Tel 410-212-6081, info@truston.us, POC: William P. Stewart, PE and Erick Knezek, PE					
Interpolate Radius and Tilt Angle			Interpolate Radius and Tilt Angle		
Radius at Pick Up	14.64 m	Points on graph 14.64 m 171 tonne 14.64 m 122 tonne  122 tonne actual hook load + aux	Radius at Set Down	30.00 m	Points on graph 30.00 m 123 tonne 30.00 m 122 tonne  122 tonne actual hook load +aux
Barge Max Angle During Lift	1.081°		Barge Max Angle During Lift	1.081°	
Max Hook Load Limit for Tilt	197 tonne		Max Hook Load Limit for Tilt	141 tonne	
Add derating for being on barge	3%		Add derating for being on barge	3%	
Add derating for barge motion	10%		Add derating for barge motion	10%	
<b>Final Derating</b>	<b>47%</b>		<b>Final Derating</b>	<b>13%</b>	
<b>Max hook load before derating</b>	<b>320 tonne</b>		<b>Max hook load before derating</b>	<b>142 tonne</b>	
<b>Max hook load after derating</b>	<b>171 tonne</b>		<b>Max hook load after derating</b>	<b>123 tonne</b>	

FIGURE 14 – Crane Derating Data Specific to the Lift Case Just Analyzed.

The above figure shows that for the pick-up part of the lift analysis the maximum hook load could have been 171 tonnes. It was 122 tonnes (with the hook and auxiliary rigging weight). At the larger set-down radius of 30.0m, the limiting crane capacity is reported as 123 tonnes. Hence this condition is right at the crane limit. The derating at the set-down is just 13% below the manufacturer’s table. It is caused only by the barge dynamic deratings. While these values can be edited by the user (in the yellow cells) the author advises that no changes should be made at this point for lift planning purposes. If in the field barge motions exceed those anticipated, crane further dynamic derating may be recommended.

A larger derating was applied to the maximum permitted crane load at the pick point. This is 47% less than the manufacturer’s chart would indicate, 13% being due to dynamic issues and 30% being due to barge inclination during this lift operation.

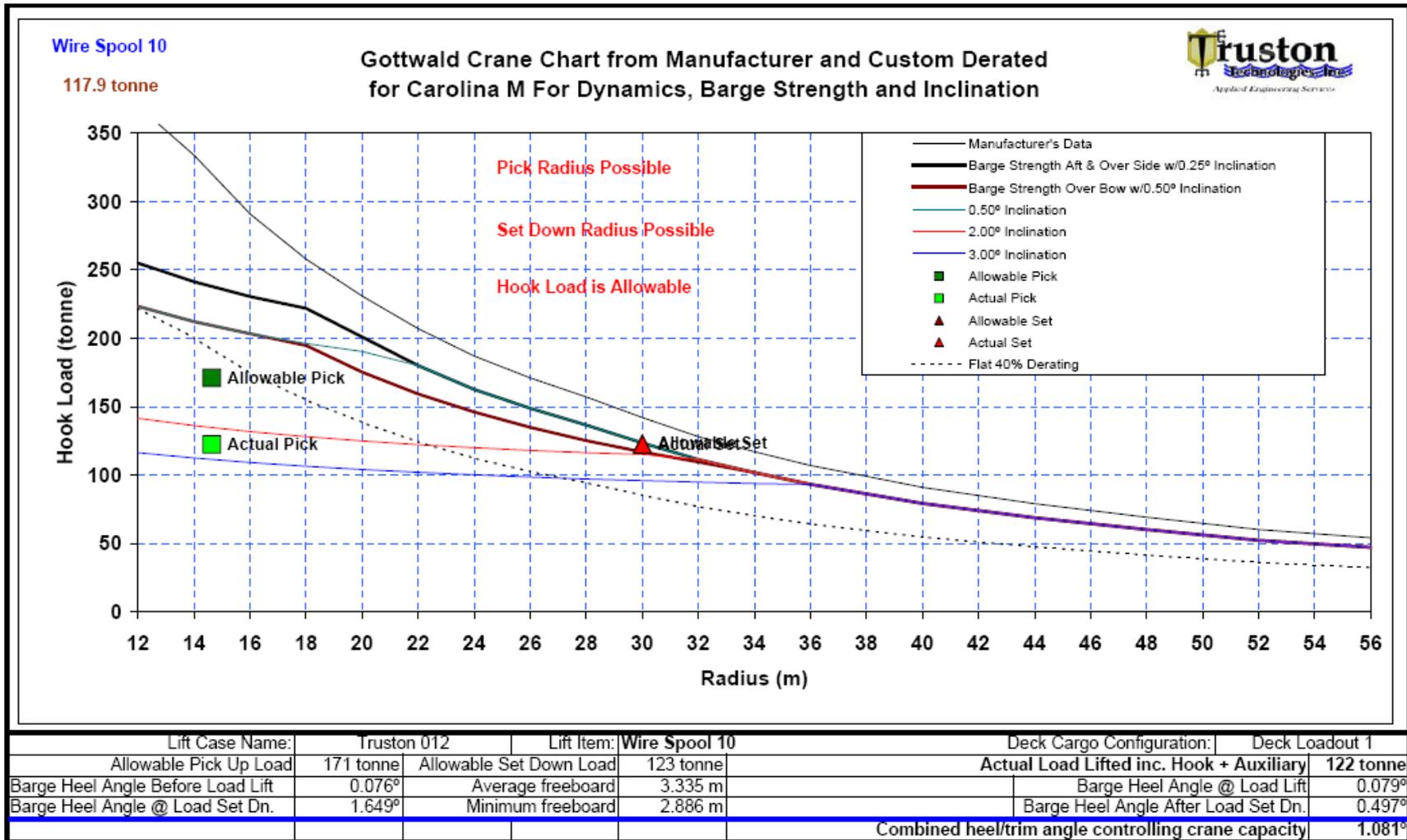


FIGURE 15 – Gottwald Crane Derated Load Chart Specific to Lift Operations on the Carolina M.  
(Previous **Scenario 1** Example Actual and Allowable Discrete Values Also Plotted).

Figure 15 contains much information about the limitations of the Gottwald AK 912 crane fitted with the 59m boom for use in the Corocoro installation in Venezuela on the Carolina M barge. The upper curve on the chart is the crane load chart as if in new condition and in full compliance with the Manufacturer's specifications. It is taken from Page 7 in the Gottwald Brochure (see elsewhere) for the crane's intended purpose to be used on land.

The four lower curves drawn with solid lines each offer derating values considering the lift conditions specific to the crane's use on the Carolina M.

The lower dotted curve indicates a flat 40% derating of lift capability from that provided by the Manufacturer. This curve and any data related to a 40% derating are shown for comparative purposes only. The flat 40% derating is dangerously non-conservative at short radii and high crane hook loads when inclination of the barge/boom angle exceeds 2.0°.

In the anticipated mild conditions in the Gulf of Paria, the 13% total effective dynamic derating applied to all inclination de-rating curves is considered conservative.

The method for crane derating linked to barge/boom inclination is explained more fully elsewhere.

The upper heavy black line "**Barge Strength Fwd and Over Side w/0.25° Inclination**" should be regarded as the upper limit of the load chart for operations at Corocoro. Very few conditions have been found where the barge/boom angle does not exceed 0.25°. This curve is a combination crane load curve, limited partly by the inclination angle and partly by the barge strength beneath the outriggers of the Gottwald AK 912.

The heavy brown line and the thin light green line merge into the heavy black "upper-limit" curve at a load radius of around 32m. The heavy brown curve "**Barge Strength Aft w/0.50° Inclination**" is a combination crane load curve, limited partly by the inclination angle and partly by the barge strength beneath the outriggers towards the bow. The 0.50° barge/boom angle is more typical of upper limiting conditions expected for the Corocoro installation.

The method for crane derating linked to barge strength is explained more fully elsewhere.

The thin solid red and blue lines indicate load limits at barge/boom angles of 2° and 3°. With careful lift planning and good ballast water management, the 3° angle should not be reached. The 2° angle has been found to be a likely lower limit of the Gottwald's capacity for the Corocoro installation.

BALLAST WATER SHOULD NEVER BE MOVED DURING A LIFT OPERATION.

The square and triangular markers on the load chart example in Figure 15 indicate the calculated maximum safe values for the hook load at the pick-up and set-down points, respectively. The actual values planned are also shown with different colors for the pick and set radii. These values are tabulated in Figure 14. Each time the user analyzes a lift case the barge angles are computed specific to the lift case and the load chart can be viewed and printed if required.

The tabular values beneath the load chart in Figure 15 provide further documentation of the lift analysis conditions. Messages and/or warnings are also given for the guidance of the user.

A useful planning tool is provided in Figure 16, below. It is not presently part of the CRANEARGE program.

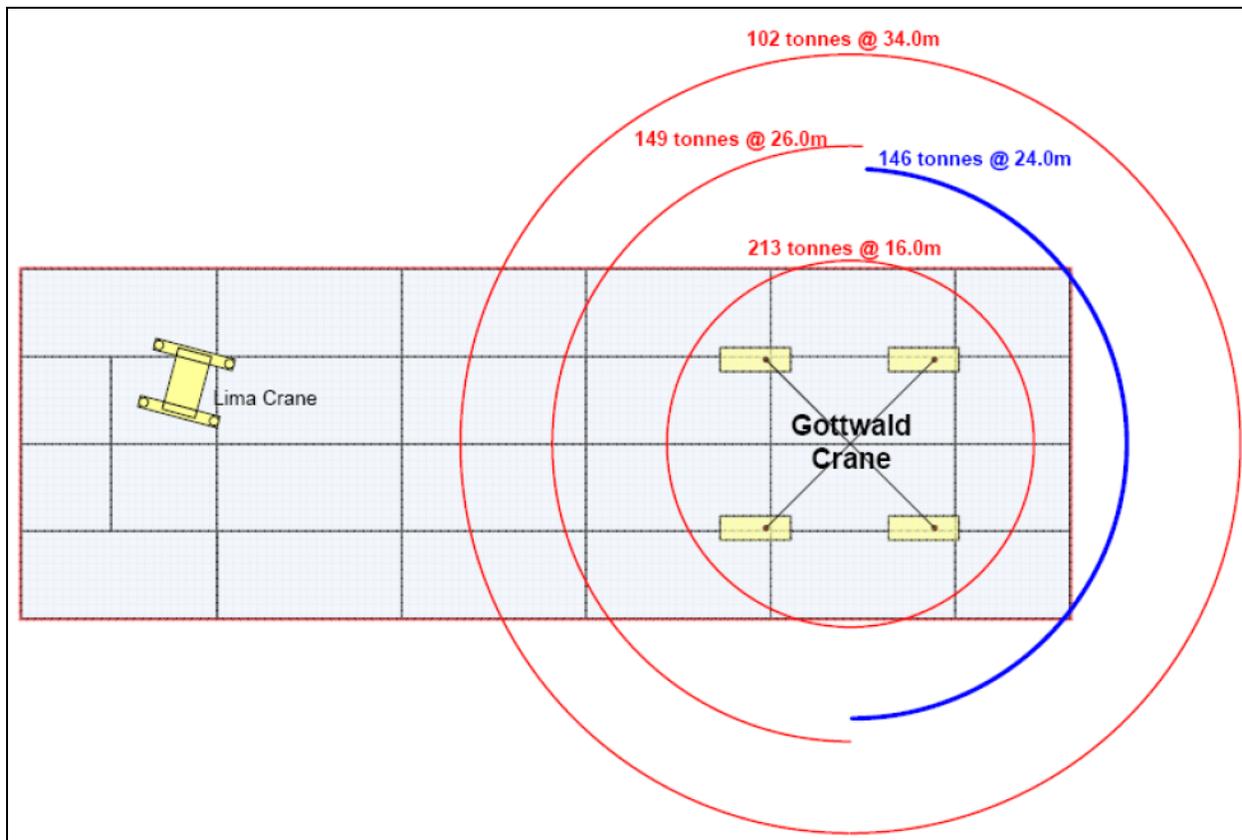


FIGURE 16 – Planning Guidance on Gottwald Lift and Radius Limitations with a Barge/Boom Inclination Angle of 0.50°.

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STA for Truston Technologies, Inc.	Revision 1	November 20, 2006

NOTE THAT LIMITATIONS ON SLEWING ARE NOT KNOWN. GREAT CARE SHOULD BE TAKEN TO CONTROL LOAD SWING WHEN SLEWING ANY LOAD.

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## 7.0 CRANE OPERATIONS – SCENARIO 2 ANALYSES

Having set up the barge loading conditions described in Sections 2, 3, and 4, the user may analyze numerous lift plans. Figure 17, below, shows the data for an example “miscellaneous”, or **Scenario 2**, lift analysis.

CAROLINA M CRANE OPERATIONS SHEET - MISCELLANEOUS OPERATIONS							
Name for Lift Case -->	Truston 019		Freeboard is Sufficient			Allowable Crane Radii from 14.7m to 56m	
Pick Radius Possible			Set Down Radius Possible				
DEFINE Load, Radius, and Heading for Pick Up and Set Down							Weight of block & Auxiliary
Name of Item	Load	Pick Up Point		Set Down Point		4.5 tonne	
Powered Reel A	60.0 tonne	Radius	Heading	Radius	Heading	Max. Allowable Hook Load	
VCG as if on Carolina M	10.00 m	36.00 m	260°	27.00 m	110°	93.1 tonne	
Position Vessels	Center X	Center Y	BOA Heading		Hook Load is Allowable		
FEEDER Barge	50.00 m	28.00 m	1		Max load at 40% derating = 64 tonne		
BOA QUEEN	80.00 m	-25.00 m	<- 1 or -1				
Target Areas 1&2 (X,Y,A)	X1 65 m	Y1 35 m	A1 10 m	X2 120 m	-Y2 30 m	A2 15 m	

FIGURE 17 – Crane Operations 2 Analysis Control Screen for **Scenario 2** Lifts.

The User-Screen shown above is similar to that in Figure 10, where a **Scenario 1** lift analysis example is provided. In Figure 17 the user specifies the load to be lifted and its location (not already on board the Carolina M) as opposed to picking a pre-defined cargo item as illustrated in Figure 10. There are twenty editable **yellow cells** for the user. The first is an optional name for the lift case. In this example the name “**Truston 019**” has been input. On this screen the user specifies the **Weight of Block and Auxiliary** items that will be associated with all lifts unless edited again. In this example the block and aux. wt. are shown input as **4.5 tonne**. The next five user-input items define the **Load** and its **Pick Up Point**:

- the **Name of the Item**, in this example “**Powered Reel A**”
- the **Load**, in this example “**60.0 tonne**”
- the load **VCG** in the Carolina coordinates, in this example “**10.00 m**”
- the **Radius** of the load pick point from the crane, in this example “**36.00 m**”
- the **Heading** of the load pick point from the crane, in this example “**260°**”

The user then defines the **Set Down Point**:

- the **Radius** of the load set point from the crane, in this example “**27.00 m**”
- the **Heading** of the load set point from the crane, in this example “**110°**”

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The last eleven user-input **yellow cells** in Figure 17 are for the user's convenience for lift planning and documentation purposes. They control the drawing of the schematic lift plan view shown in Figure 18.

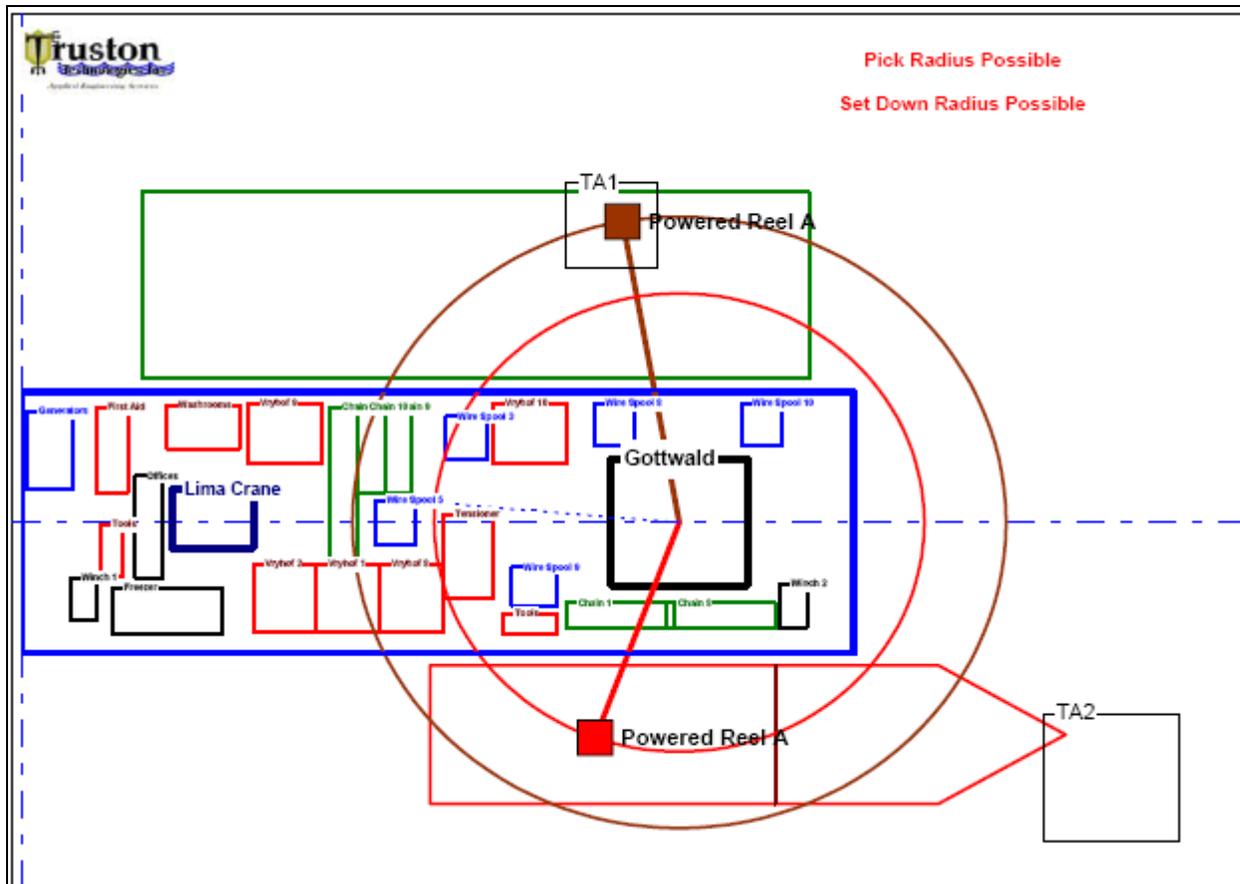


FIGURE 18 – Crane Ops2 Schematic View of Miscellaneous **Scenario 2** Lift.

The user is offered the opportunity to define the size and location of two target areas relative to the Carolina M, TA1, and TA2. These areas are shown but not needed for lift analysis. Similarly, the Feeder barge and the Boa Queen (heading in either direction parallel to the Carolina M) may be shown on the schematic plan, but are not needed for the lift analysis.

Hence, in this example, with the deck cargo and ballast arrangement selected, the crane operation is feasible and the crane will operate within its derated envelope. Messages are given in Figures 17 and 18.

Now knowing that the lift is feasible, the user can look closely at the angle and freeboard changes that will occur on the Carolina M during the key stages of the lift operation. This data is shown for this example in Figure 19.

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SUMMARY OF HYDROSTATIC RESULTS FOR THIS LIFT					
	Before Hook Load Picked Up	With Hook Load at Pick Up	With Hook Load at Set Down	After Set Down OFF Barge	After Set Down ON Barge
Mean Draft	4.322 m	4.344 m	4.344 m	4.322 m	4.344 m
Mean Freeboard	3.325 m	3.303 m	3.303 m	3.325 m	3.303 m
Heel angle (stbd down +ve)	0.076°	-0.597°	0.560°	0.076°	0.550°
Trim angle (stern down +ve)	-0.086°	-0.123°	-0.118°	-0.086°	-0.118°
Min.freeboard any side/end	3.256 m	3.144 m	3.154 m	3.256 m	3.157 m
Max.angle for crane derating	0.115°	0.609°	0.572°	0.115°	0.562°
GM transverse from this Lift	16.719 m	16.341 m	16.315 m	16.719 m	16.613 m
Max Crane Moment	0 t-m	2160 t-m	1620 t-m	0 t-m	0 t-m
(0.67)(W)(GM)(F/B)	13176 t-m	12506 t-m	12524 t-m	13176 t-m	12764 t-m

FIGURE 19 – Summary of Barge Conditions During Lift Operation

In this **Scenario 2** lift operation the load ends up on the Boa Queen and the mean draft of the Carolina M stays the same at 4.322m. If the load had been set onto the Carolina M, the mean barge draft would have become 4.344m. The heel angle starts and ends the same at 0.076° down to starboard. During the lift the Carolina M is heeled down to port -0.597° when the load is picked off the Feeder barge in this example. The Carolina M is heeled in the opposite direction, +0.560° down to starboard at load set down. The vertical range of the crane hook elevation relative to the water surface can be computed, but is not directly reported.

Detailed information on freeboard changes can be found on the Plan1 worksheet, but it is not normally expected that the user reviews this. For this example a selection of the information contained on the Plan2 worksheet is shown in Figure 20. The maximum range of freeboard at the barge side is found to be 308mm.

The maximum angles for crane derating are reported in Figure 19 for each stage of the lift and are further manipulated elsewhere.

Crane moment stability checks are also reported and described more fully elsewhere.

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<b>Carolina M Hydrostatics</b>					
	<b>Before Hook Load Picked Up</b>	<b>With Hook Load at Pick Up</b>	<b>With Hook Load at Set Down</b>	<b>After Hook Load Released Off Barge</b>	<b>After Hook Load Released On Barge</b>
Displacement	11012 tonne	11072 tonne	11072 tonne	11012 tonne	11072 tonne
LCG	45.878 m	45.988 m	45.972 m	45.878 m	45.972 m
TCG	0.022 m	-0.170 m	0.159 m	0.022 m	0.159 m
VCG	5.212 m	5.510 m	5.537 m	5.212 m	5.238 m
Mean Draft	<b>4.322 m</b>	<b>4.344 m</b>	<b>4.344 m</b>	<b>4.322 m</b>	<b>4.344 m</b>
Mean Freeboard	3.325 m	3.303 m	3.303 m	3.325 m	3.303 m
KM trans	21.933 m	21.853 m	21.853 m	21.933 m	21.853 m
KB	2.220 m	2.231 m	2.231 m	2.220 m	2.231 m
BM trans	19.713 m	19.622 m	19.622 m	19.713 m	19.622 m
GM Reduction for free surfaces	0.001 m	0.001 m	0.001 m	0.001 m	0.001 m
GM trans	16.719 m	16.341 m	16.315 m	16.719 m	16.613 m
Inclining Moment Transverse	243 t-m	-1884 t-m	1766 t-m	243 t-m	1766 t-m
Sin(theta)	0.0013	-0.0104	0.0098	0.0013	0.0096
<b>Angle of Heel, Theta</b>	<b>0.0758°</b>	<b>-0.597°</b>	<b>0.560°</b>	<b>0.076°</b>	<b>0.550°</b>
Freeboard reduction	0.020 m	-0.159 m	0.149 m	0.020 m	0.146 m
LCB	45.62370 m	45.62627 m	45.62627 m	45.62370 m	45.62627 m
LCF	46.13035 m	46.14880 m	46.14880 m	46.13035 m	46.14880 m
T/cm	27.9415 t/cm	27.9715 t/cm	27.9715 t/cm	27.9415 t/cm	27.9715 t/cm
MCT 1cm	203.7227 t-m	204.1925 t-m	204.1925 t-m	203.7227 t-m	204.1925 t-m
LCB-LCG, lever_l	-0.2545 m	-0.3620 m	-0.3459 m	-0.2545 m	-0.3459 m
Trim between perps	-0.1376 m	-0.1963 m	-0.1875 m	-0.1376 m	-0.1875 m
<b>Angle of trim</b>	<b>-0.086°</b>	<b>-0.123°</b>	<b>-0.118°</b>	<b>-0.086°</b>	<b>-0.118°</b>
<b>Mean Freeboard at Stern</b>	<b>3.393 m</b>	<b>3.401 m</b>	<b>3.397 m</b>	<b>3.393 m</b>	<b>3.397 m</b>
<b>Mean Freeboard at Bow</b>	<b>3.256 m</b>	<b>3.205 m</b>	<b>3.209 m</b>	<b>3.256 m</b>	<b>3.209 m</b>
<b>Mean Freeboard at Port</b>	<b>3.304 m</b>	<b>3.462 m</b>	<b>3.154 m</b>	<b>3.304 m</b>	<b>3.157 m</b>
<b>Mean Freeboard at Stbd</b>	<b>3.345 m</b>	<b>3.144 m</b>	<b>3.452 m</b>	<b>3.345 m</b>	<b>3.449 m</b>

FIGURE 20 – Detailed Hydrostatics for Lift Operation Specified by User in Figure 17 (Information Contained on Worksheet Plan2).

It should be noted that similar detailed hydrostatic barge results are also available for **Scenario 1** lift analyses on the Plan1 worksheet in the CRANE BARGE workbook.

## 8.0 CRANE LOAD CHARTS – SCENARIO 2 DETAILED RESULTS

Having established the lift operation to be feasible (or even if it was shown to violate any limits) the user may examine the Gottwald crane load chart for the **Scenario 2** lift analysis just described. These results are given on the Gott2 worksheet.

CAROLINA M CRANE DERATING CALCULATIONS			STA CRANE BARGE, Version 3.0 20-Nov-06 Revision 3		
Built by: Truston Technologies, Inc., Tel 410-212-6081, info@truston.us, POC: William P. Stewart, PE and Erick Knezek, PE					
Interpolate Radius and Tilt Angle			Interpolate Radius and Tilt Angle		
Radius at Pick Up	36.00 m	Points on graph 36.00 m 93 tonne 36.00 m 65 tonne  65 tonne actual hook load +aux	Radius at Set Down	27.00 m	Points on graph 27.00 m 143 tonne 27.00 m 65 tonne  65 tonne actual hook load +aux
Barge Trim Angle	0.375°		Barge Trim Angle	0.375°	
Max Hook Load Limit for Tilt	107 tonne		Max Hook Load Limit for Tilt	164 tonne	
Add derating for being on barge	3%		Add derating for being on barge	3%	
Add derating for barge motion	10%		Add derating for barge motion	10%	
<b>Final Derating</b>	<b>13%</b>		<b>Final Derating</b>	<b>13%</b>	
<b>Max hook load before derating</b>	<b>107 tonne</b>	<b>Max hook load before derating</b>	<b>164 tonne</b>		
<b>Max hook load after derating</b>	<b>93 tonne</b>	<b>Max hook load after derating</b>	<b>143 tonne</b>		

FIGURE 21 – Crane Derating Data Specific to the Lift Case Just Analyzed.

The above figure shows that for the pick-up part of the lift analysis the maximum hook load could have been 93 tonnes. It was 65 tonnes (with the hook and auxiliary rigging weight). At the smaller set-down radius of 27.0m, the limiting crane capacity is reported as 143 tonnes. The deratings at both pick-up and set-down are just 13% below the manufacturer's table. These are caused only by the barge dynamic deratings. While these values can be edited by the user (in the yellow cells) the author advises that no changes should be made at this point for lift planning purposes. If in the field barge motions exceed those anticipated, crane further dynamic derating may be recommended.

From the numbers tabulated in Figure 21 and the graphical and numerical data in the Gott2 worksheet, shown below in Figure 22, it can be concluded that this is a rather safe lift as far as the crane boom and barge strength limitations are concerned.

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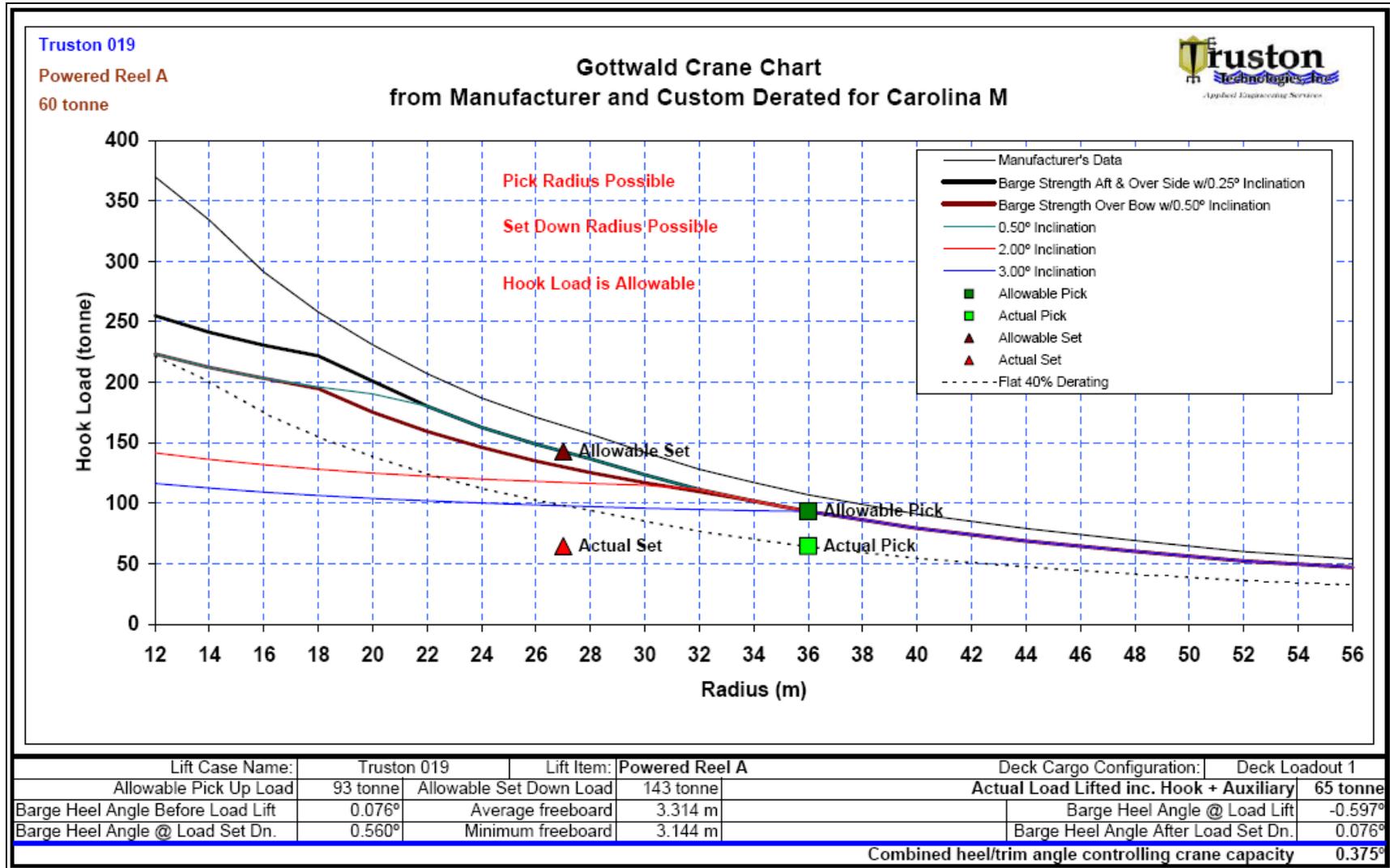


FIGURE 22 – Gottwald Crane Derated Load Chart Specific to Lift Operations on The Carolina M.  
(Previous **Scenario 2** Example Actual and Allowable Discrete Values Also Plotted).

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## 9.0 BARGE ALLOWABLE VCG AND MOMENTS

The Carolina M (originally Smit Barge 1) is a relatively strong and heavy ocean going barge intended for a wide range of cargoes. It has its own trim and stability booklet the full contents of which include allowable deadweight VCG and moment tables. These are incorporated into the CRANE BARGE program. The charts are shown in Figure 23, below, where both the previously analyzed lift load cases are shown plotted as discrete data points. The only difference between the data points for the **Scenario 1** and Scenario 2 conditions are the displacement (and deadweight) and VCG differences caused by the hook load in **Scenario 2** (reported in detail in Figures 8 and 9 from Control1 and Control2 worksheets).

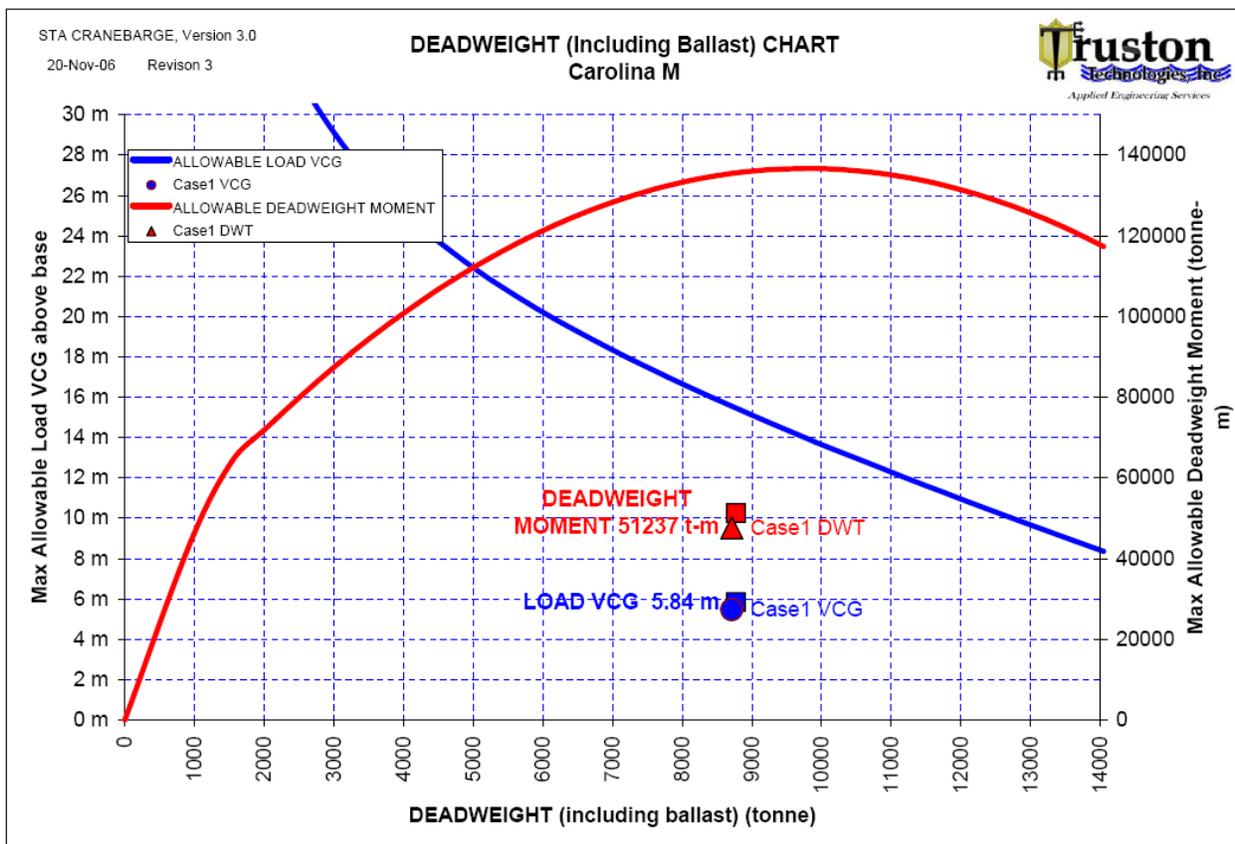


FIGURE 23 – Allowable Deadweight VCG and Moment Curves for Carolina M.

As in all load cases anticipated and analyzed to date for the Corocoro installation, very large margins on the allowable VCG and moment constraints are achieved for the examples shown in this document. This chart is on the DWT worksheet in the CRANE BARGE workbook.

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## 10.0 BARGE RIGHTING ARM CURVES

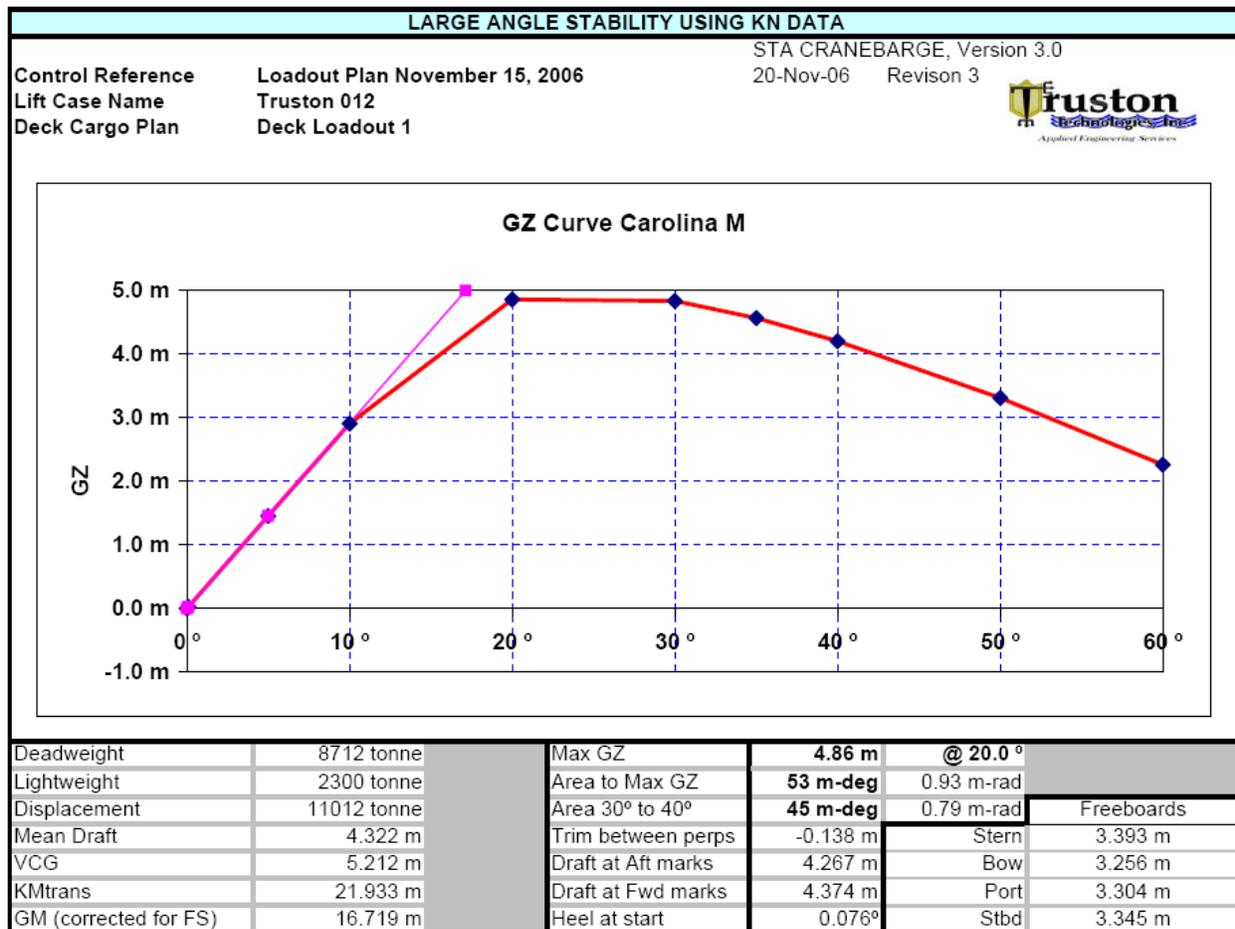


FIGURE 24 – Large Angle Stability Base Case Without Hook Load

For every loaded condition analyzed a large angle stability report with a righting arm curve is available on worksheet KN1, as shown in Figure 24. The stability (righting arm) curve is based on the KN values tabulated in the Smit Barge 1 T&S Booklet and used interactively in the CRANE BARGE software. Critical stability parameters are shown tabulated beneath the chart in Figure 24 and are also reported on the Analysis Control Sheets (Figures 8 and 9).

In all loaded conditions anticipated for the Corocoro installation the Carolina M is found to have adequate intact stability for its intended purpose.

In addition to the basic loaded condition with no hook load, a righting arm curve is also available for the **Scenario 2** lift case with the load suspended on the crane hook at its desired pick-up point. The stability report for the example in this document is shown in Figure 25.

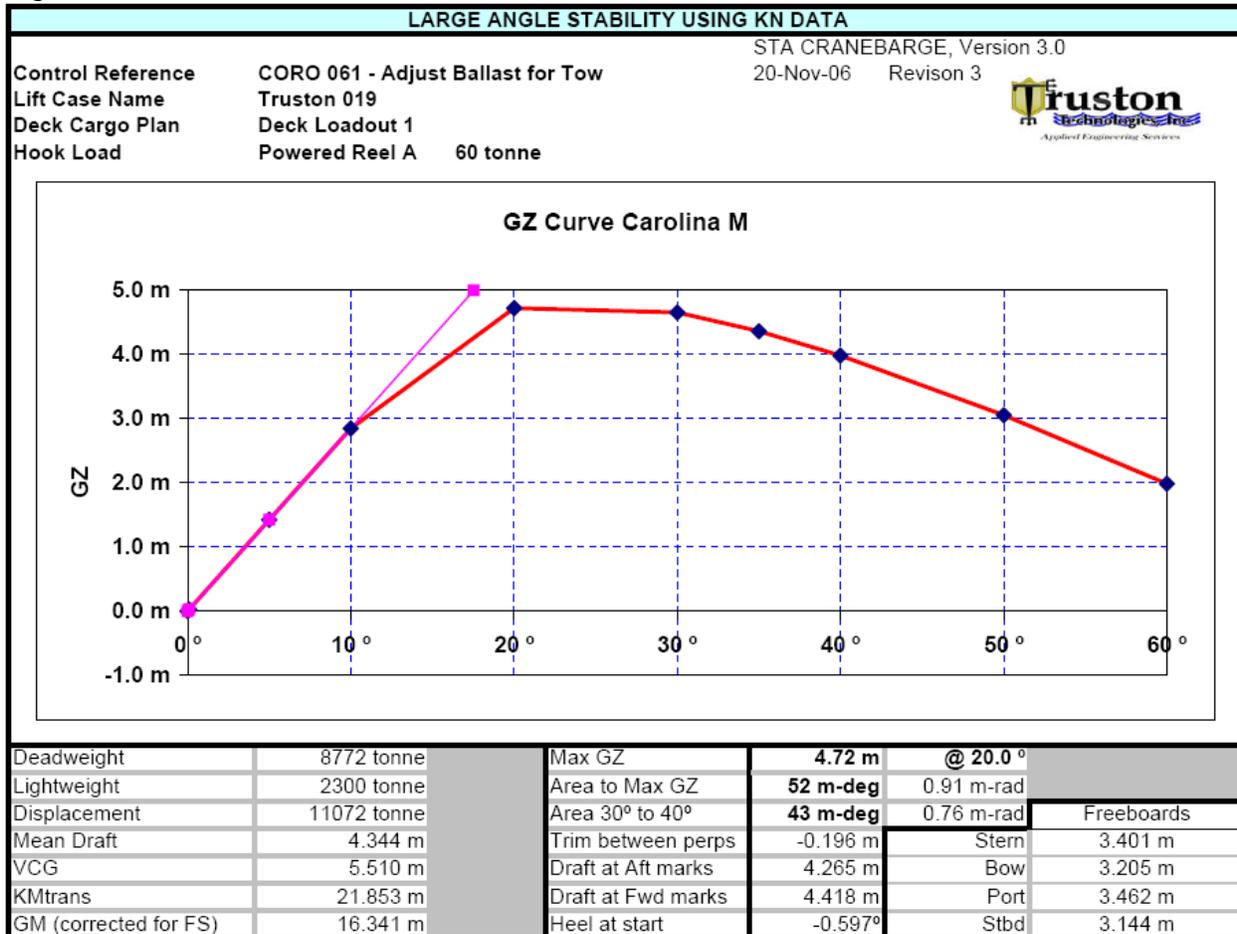


FIGURE 25 – GZ Curve for Scenario 2 Example With Hook Load Included.

The stability margins reported in Figure 25 are marginally smaller than those for the base case example in Figure 25 as a consequence of the 60 tonne hook load. However, the barge stability is easily adequate for the intended operations. For example, the area under the curve from zero to the maximum GZ value is reported as 52 meter-degrees, compared to a minimum required of 3.05 meter-degrees for these operations.

## 11.0 DOCUMENTING LOAD CASES & ARCHIVING RESULTS

The CRANEARGE worksheets may be individually printed, or saved to pdf format for subsequent report production. They may be re-formatted by the user but are presently configured to print much as shown in this document.

It is recommended that a new workbook is saved for each deck cargo and ballast tank configuration planned.

## 12.0 COROCORO CARGO VARIATIONS AND BALLASTING

As deck cargo is lifted from the Carolina M during the Corocoro installation there will be significant changes in the barge draft heel and trim. The changes in heel and trim may be compensated for by changing the ballast tank contents.

With the cargo distributed initially as shown in Figure 1, the heel and trim are shown in Figure 6 to be +0.076° and -0.086° respectively with ballast tank no. 6 starboard outer at 30% full.

If all mooring cargo (five sets of anchors, chains and wires, approximately 1,100 tonnes) were removed, the heel and trim angles would become +0.957° and +0.159° respectively.

If ballast tank no.6SO was emptied (approximately 250 tonnes) the heel and trim angles would be changed to +0.085° and -0.126°, making crane operations less restricted.

Clearly there is merit in considering staged ballast water changes to minimize barge angles and permit maximum crane lift versatility as demonstrated in the above simple example.

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## 13.0 CARGO DISTRIBUTION AND GHOST LOADS

As cargo is loaded onto the Carolina M, the draft marks will be carefully checked. The final draft marks are unlikely to be exactly as predicted by the software as the cargo item weights and weight distribution are unlikely to be perfectly known.

Adjustment of the level of ballast water in tank no.6SO (with other tanks filled as shown in Figures 6 and 7 of this document) may be sufficient to achieve the desired values of zero (or less than  $\pm 0.10^\circ$ ) for heel and trim angles. However other tanks may have to be used and ghost loads, positive or negative, may appear to be present. Every effort should be made to identify the source of such loads. Every ballast tank must be properly inspected.

If the predicted drafts do not agree with the measured drafts it must be concluded that more or less weight is present than can be identified. This ghost weight can be simulated with one of the two line items on the Control2 worksheet, presently named "Miscellaneous 2". This is not an ideal solution but may be expedient under the time constraints that exist.

## 14.0 INDEPENDENT DEDICATED INCLINOMETERS

Dedicated bubble gauge inclinometers are recommended with a range of  $\pm 5^\circ$  over a distance of about 200mm. One should be permanently attached to the Gottwald crane above the slewing ring and in the plane perpendicular to the boom. This will always measure the critical inclination angle. This inclinometer should be a supplement to the measuring devices anticipated to be on the present crane equipment.

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