Appendix D

STAR Center Ship Simulation 2011

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Gulfport Restoration Program 2010

Overview

The port of Gulfport, Mississippi is in the process of port expansion. These plans include the expansion of container handling facilities at the port that will accommodate the ever increasing size of container vessels currently servicing the industry now and in the future. Expansion of the Panama Canal, now ongoing, will allow passage of even larger vessels that will require port facilities to provide increased support for these vessels. Construction is presently underway to increase and expand the container pier at Gulfport to provide adequate berthing facilities in support of these vessels. Of equal importance to a shore facility expansion, is the ability of vessels to transit into and out of these facilities via an entrance channel of sufficient width and depth to ensure safe passage.

Vessels accessing the port of Gulfport transit a dredged channel approximately 22 nautical miles in length, and requiring approximately two hours to transit. In order to determine/evaluate vessel access via this channel, STAR Center (STAR), located in Dania Beach, Florida was commissioned to conduct a simulator-based study of this channel and maneuvering area at the new pier on its 360 degree full-mission simulator. Because vessels vary widely in size (length, width and draft) and handling characteristics, normal practice in the evaluation of a navigation channel is to do so using a "design vessel". A "design vessel" is usually selected that represents the type of vessel, in this case a Container vessel, with dimensions equal to the largest vessel expected to routinely transit this channel. The port of Gulfport selected a Panamax[1] Container vessel as "design vessel" for this study. The study was conducted during the period 6 thru 11 March, and 14 thru 18 March 2011 at STAR Center. This report summarizes the results and conclusions of that study.

Participants

Two experienced pilots from the port of Gulfport participated in the simulations during separate sessions necessitated by their operational work schedules. They not only provided their expertise and local area knowledge of channel configurations, but also advised as to area winds, tides and local currents. The pilots' active participation included operating the test vessels during all simulation runs. During this report, these participating pilots will be referred to as the "shiphandlers". Our schedule provided 5

[1] Panamax. A vessel with a maximum beam of 32.2 meters. The maximum width allowable to transit the Panama Canal.

daily sessions for each pilot and the first day of the study, 6 March, was a day to validate the accuracy of the geographic database and for fine-tuning of local currents to ensure environmental conditions replicated actual conditions to the pilot's satisfaction.
STAR provided a Senior Researcher, simulator operator, simulator technician, a mate / helmsman, and a project facilitator to coordinate simulations, note results and conduct debriefings of participants at the end of each exercise.

Simulator Models

Geographic database
Database developers constructed the geographic database for the port of Gulfport, Mississippi containing the entrance channel and inner harbor. This database was constructed based on information gathered from NOAA Charts 11372 and 11373, Navigational publications, Tide and Current Tables and photographs obtained by internet sources such as Google Earth and Bing Maps. While channel depths were compiled from the NOAA charts, CH2M Hill, an engineering firm managing construction of the new pier, provided depth survey information for the inner channel from Ship Island northward to the harbor proper.

Hydrodynamic Vessel Models
The ship response model of the Container vessel "Jutlandia" was provided to be used in simulations as the "design vessel". Container vessel "Jutlandia" was available in STAR's extensive library of vessel models, and was selected because it most closely replicated the type of vessel and dimensions requested by the client. Those requirements were a large Panamax container vessel (3,000 to 6,000 TEU) with a draft of approximately 10 meters. "Jutlandia" whose vessel particulars are outlined below had a draft of 10.5 meters. The agreed upon strategy was to add a +0.5 meter tidal offset to ensure the under-keel-clearance was accurate for a vessel with a 10 meter draft. Other vessels ultimately required for the study included the container vessels "Dania Exporter", and "White Bay". Tidal offset of +1.0 meter was used when operating "White Bay" to compensate for its 11 meter loaded draft, and charted depth (no tidal offset) was used for "Dania Exporter". Additionally, although not officially part of the study, the "Bellatrix" a small general cargo vessel was used on 6 March as part of the pilot validation of tidal currents in the area. Vessel particulars are listed in **Table 1 – Vessel Particulars** below.

Table 1 – Vessel Particulars

Vessel Name	Bellatrix	Jutlandia	Dania Exporter	White Bay
Condition	Loaded	Partly Loaded	Loaded	Loaded
Displacement	27,520	60,640	34,390	59,100
Wind Profile	N/A	7085 m^2	4816 m^2	6544 m^2
LOA	159.6	294.1	198	254
Beam	24.9	32.2	32.2	32.2
Draft	9.1	10.5	9.5	11
Propulsion	Diesel Elec.	Slow Speed Diesel	Diesel Elec.	Diesel Elec.
Shaft HP	9,870	49,349	15,690	36,371
Propeller	1 (F) (CW)	1 (F) (CW)	1 (F) (CW)	1 (F) (CW)
Max Rudder	35	35	35	35

(F) Fixed Pitch Propeller, (CW) Clockwise direction, LOA, Beam, Draft in Meters.

Environmental Conditions

Wind Direction and Velocity

Winds in the area are normally from the eastern quadrant. Winds used in simulations were from the SE (southeast) and NE (northeast) at speeds ranging from calm to 20 knots and above. These winds, because of the general north/south direction of the entrance channel, act perpendicular, or slightly perpendicular to channel transit, and therefore, affect vessel steering and handling. Wind velocities of 25 knots were used in a small number of simulations.

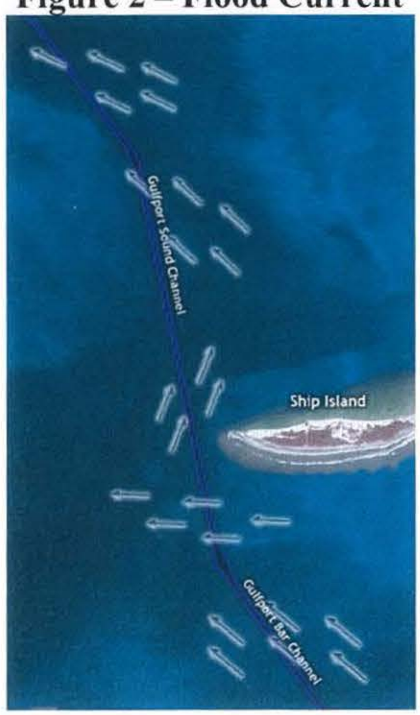
Tidal Currents

The range of tide in the Gulfport area is minimal, about 1.5 feet. Tidal currents therefore, are normally about 1. knot. Currents during simulations were described as Flood generally from an easterly direction and Ebb generally from a westerly direction. Current information supplied by the participating pilots during geographic database validation at the start of the project, identified an area east of Ship Island where currents often abruptly varied in direction and sometimes velocity. Modifications to the general current plan were incorporated in this area when both a Flood and Ebb current were used in the runs. Currents used in simulations were considered average velocities, and although currents, especially wind driven currents, may exceed the 1 knot limit used in simulations increased velocities were not considered. As with wind direction and velocity, currents, especially when perpendicular or nearly so, affect handling and steering of a transiting vessel.

The general directions of these currents are depicted in **Figure 1 – Ebb Current** and **Figure 2 – Flood Current** below.

Figure 1 – Ebb Current

Figure 2 – Flood Current



Channel Depths and Configuration

The Gulfport harbor is entered via an approximately 22 nautical miles long, well marked, buoyed channel. This channel is divided into two segments. This report will refer to these channels as the outer channel (Gulfport Bar Channel) and the inner channel (Gulfport Sound Channel). Channel details are as follows:

The outer southern most channel is the Gulfport Bar channel. It is 122 meters (400 ft.) wide and 10 miles in length. Its depth is 11.6 meters (38 ft.).

The inner or northern most channel identified as the Gulfport Sound channel is 91.5 meters (300 ft.) wide, 11 meters (36 ft.) deep, and 10.6 miles in length. These channel widths and depths were incorporated in the geographic database for all simulation exercises. Tidal offsets, of none, 0.5 meters and 1.0 meters, addressed earlier in this report, were used to correct for vessel draft.

The only exception to this rule was in run numbers 8 thru 13 when a depth of 12.8 meters (42 ft.) in both channels was used briefly, to identify a depth in which it was surmised that "Jutlandia" could safely operate in all environmental conditions tested.

Tugboats

The port of Gulfport has four (4) tugboats at its disposal to assist in docking and undocking vessels. These tugs are rated at 3,000 horsepower with single propeller propulsion. Two tugs are expected to assist arriving and departing container vessels during normal environmental conditions. These tugboats were controlled by the shiphandlers via VHF radio in simulations as they would in actual practice. Tugboat response was controlled by the simulator operator.

Testing Procedures

The focus of our study was to determine whether a large container vessel could safely access the port of Gulfport via the existing channel during "normal" environmental conditions of wind and current. Additionally, because plans are moving ahead to modify the existing pier in the harbor proper, examine the effects of this pier expansion on vessel maneuver room, and evaluate the inclusion of a breakwater on the eastern side of the pier area. As a related item, examine the ability of the assist tugboats currently employed at the port, to provide adequate maneuver assistance to the arriving or departing vessel.

Preplanning of simulation runs for this project was completed prior to commencement of on-line simulations. The resulting Run Matrix would challenge the participating shiphandlers to operate the "Jutlandia" in the existing entrance channel both inbound / arriving and outbound / departing. Docking and undocking with tugboat assistance would be included in these exercises.

In simulations, as in actual practice, vessel transit from "sea buoy" to the berth at the pier requires at least 2 hours, the number of complete inbound and outbound runs were limited in number to conserve time on the simulator. Transits were then divided into shorter "legs" to save time, identify problem areas if any, and better use simulator time. Both shiphandlers would complete these simulations independently, under the same environmental conditions in order to garner their opinions and comments concerning each run and its practicality.

Our usual practice is to brief the shiphandler on the environmental conditions of wind and current for the upcoming run, identify the starting and end point, set the vessel on a course and starting speed agreeable to the shiphandler. At the conclusion of each run, the shiphandler is asked to fill out a Pilot's Run Evaluation form that solicits his opinions concerning the satisfaction with vessel handling, safety, difficulty etc. The forms are designed to solicit opinions while details of the just completed run are fresh in the minds of the shiphandler. A STAR Center facilitator notes simulator results and also notes important shiphandler verbal comments and reactions.
Problems and difficulties with the use of "Jutlandia" were encountered early in the project and an alternate Matrix and project strategy was devised in an attempt to provide a usable and practical solution to this challenge. A revised run matrix was implemented and many of the scheduled simulator runs from the previous Run Matrix were incorporated into the new Matrix.

Simulation run information and environmental conditions during each run are identified in **Figure 3 – Run Matrix** below.

Figure 3 – Run Matrix

Run #	Vessel	Transit Direction	Tidal Offset +	Wind Dir/Spd	Current Dir	Tugs	Start Point	End Point	Remarks
1	Jutlandia	Inbound	0.5	None	Slack	N/A	SB	11	
2	Jutlandia	Outbound	0.5	None	Slack	N/A	11	SB	
3	Jutlandia	Inbound	0.5	SE/15	Ebb	N/A	SB	11	
4	Jutlandia	Inbound	0.5	SE/15	Flood	N/A	22	35	Grounded
5	Jutlandia	Outbound	0.5	SE/15	Ebb	N/A	35	22	
6	Jutlandia	Inbound	0.5	None	Slack	N/A	22	35	
7	Jutlandia	Inbound	0.5	SE/15	Ebb	2	57	Berth	
8	Jutlandia	Inbound	*	SE/15	Flood	2	SB	Berth	
9	Jutlandia	Outbound	*	NE/20	Flood	N/A	11	SB	
10	Jutlandia	Outbound	*	NE/20	Ebb	N/A	35	22	
11	Jutlandia	Outbound	*	NE/20	Ebb	2	Berth	57	
12	Jutlandia	Inbound	*	None	Slack	2	57	Berth	
13	Jutlandia	Outbound	*	SE/15	Ebb	2	Berth	57	
14	Dania Exporter	Outbound	none	SE/20	Ebb	2	Berth	SB	
15	Dania Exporter	Inbound	none	None	Slack	2	57	Berth	
16	Dania Exporter	Outbound	none	None	Slack	N/A	35	22	
17	Dania Exporter	Outbound	none	NE/25	Flood	N/A	35	22	
18	Dania Exporter	Outbound	none	E/20	Flood	2	Berth	57	
19	Dania Exporter	Inbound	none	NE/25	Flood	N/A	22	35	
20	Dania Exporter	Outbound	none	NW/20	Slack	2	Berth	57	
21	Dania Exporter	Inbound	none	NE/25	Flood	2	57	Berth	
22	Dania Exporter	Inbound	none	SE/25	Ebb	N/A	22	35	
23	Dania Exporter	Outbound	none	NE/15	Slack	0	Berth	61	
24	Dania Exporter	Inbound	none	NE/10	Flood	2	SB	Berth	
25	Dania Exporter	Inbound	none	NE/20	Flood	2	57	Berth	
26	Dania Exporter	Inbound	none	NW/20	Slack	2	57	Berth	
27	Dania Exporter	Inbound	none	NW/30	Ebb	N/A	17	40	
28	Jutlandia	Inbound	0.5	SE/15	Ebb	N/A	SB	Berth	Grounded
29	Jutlandia	Inbound	0.5	SE/15	Ebb	N/A	30	Berth	Grounded
30	Jutlandia	Inbound	0.5	SE/15	Ebb	N/A	SB	Berth	
31	Jutlandia	Outbound	0.5	SE/15	Ebb	2	SB	Berth	Grounded
32	Jutlandia	Outbound	0.5	SE/15	Ebb	2	34	Berth	Grounded
33	Jutlandia	Outbound	0.5	SE/15	Ebb	N/A	31	SB	Grounded
34	White Bay	Inbound	1.0	SE/15	Ebb	N/A	24	35	Grounded
35	White Bay	Inbound	1.0	SE/15	Slack	N/A	29	57	
36	White Bay	Outbound	1.0	None	Slack	N/A	35	22	
37	White Bay	Outbound	1.0	SE/15	Ebb	N/A	11	SB	
38	Blank	Blank							
39	White Bay	Inbound	1.0	NE/20	Flood	N/A	22	35	Grounded
40	White Bay	Outbound	1.0	SE/15	Ebb	N/A	35	22	
41	White Bay	Outbound	1.0	SE/15	Slack	N/A	35	22	Redo #40
42	White Bay	Outbound	1.0	None	Slack	2	Berth	57	
43	White Bay	Outbound	1.0	None	Slack	N/A	11	SB	
44	White Bay	Inbound	1.0	None	Slack	2	57	Berth	
45	White Bay	Outbound	1.0	SE/15	Ebb	2	Berth	57	
46	White Bay	Inbound	1.0	SE/15	Ebb	2	57	Berth	
47	White Bay	Inbound	1.0	NE/20	Flood	2	57	Berth	
48	White Bay	Outbound	1.0	NE/15	Ebb	2	Berth	SB	Grounded
49	White Bay	Outbound	1.0	NE/15	Ebb	N/A	39	SB	cont. run #48
50	White Bay	Inbound	1.0	SE/15	Flood	N/A	22	35	
51	White Bay	Outbound	1.0	NE/25	Flood	1	Berth	57	
52	White Bay	Outbound	1.0	NE/25	Ebb	N/A	41	20	
53	Jutlandia	Inbound	0.5	SE/20	Ebb	N/A	SB	11	Grounded
54	Jutlandia	Inbound	0.5	NE/25	Slack	2	57	Berth	
55	Jutlandia	Outbound	0.5	NE/25	Flood	N/A	35	22	Grounded
56	Jutlandia	Outbound	0.5	NE/25	Flood	N/A	35	22	Grounded

Start and End Points - Numbers = buoy numbers. SB = Sea buoy.

Simulation Results

"Jutlandia"

The original Run Matrix (not included in this report) called for the exclusive use of "Jutlandia" as the "design vessel" with which to evaluate the channel and inner harbor new pier configuration. Although the shiphandler was comfortable with run results, when operating "Jutlandia" during the first seven runs, some difficulties were immediately apparent. With the exception of run #7, these exercises were conducted in the wider and deeper "outer channel" and even then steering control challenges were apparent. Even when a run was completed successfully, under-keel-clearance (UKC) of less than 0.8 meters at times, made vessel heading control difficult. The shiphandler elected to increase vessel speed in an attempt to mitigate these steering problems, only to lessen UKC to approximately 0.4 meters or less due to squat[2] effects. See **Figure 4 – Computed Squat "Jutlandia"** below. Wind and tidal current effects during these runs were kept to a minimum to non-existent in an effort to establish a baseline for vessel performance. Run number 4 resulted in a grounding exacerbated by the combination of squat and bank effects[3]. The vessel's speed thru the water could be slowed to increase UKC, but this strategy would make the vessel more susceptible to wind and current effects and therefore, harder to maintain steerage. "Jutlandia" draft was effectively 10 meters plus 0.8 meters (computed squat @ 12 knots speed) totaling 10.8 meters, and operating in channels dredged to 11.6 and 11 meters respectively.
The above factors would provide no margin of safety during transits by "Jutlandia".

Figure 4 - Computed Squat "Jutlandia"

Speed Knots	Open Water Squat m	Confined Squat m
2	0.02	0.04
3	0.05	0.10
4	0.09	0.17
5	0.13	0.27
6	0.19	0.39
7	0.26	0.53
8	0.34	0.69
9	0.44	0.87
10	0.54	1.08
11	0.65	1.30
12	0.77	1.55
13	0.91	1.82

To continue testing of this vessel when insufficient channel depth was the major cause of concern seemed fruitless. The effects of mild to brisk winds, and tidal currents on the

[2] Squat – Increase in a vessels draft when speeds thru the water are increased.
[3] Bank Effects – Cushion and suction influences on a vessel caused by proximity of steep sides of a channel.

vessel to determine if channel width is adequate were cancelled because of this insufficient depth clearance. Communications with the client indicated that some idea of depth required to operate this vessel in the existing channel might be useful.

A one-day, very brief examination of access by "Jutlandia" with an arbitrary channel depth of 12.8 meters (42 feet) was conducted. Run numbers 8 thru 13 were conducted. Each of these runs was conducted without incident, and transits were successfully completed. Runs conducted at this 12.8 meter depth were meant to highlight the importance of channel depth. It has been our experience that in a narrow channel, when channel depth or UKC is more generous, narrow channels are less problematic. This fact is attributed to better steering/handling of a vessel in deeper water. In the case of our channel, especially the inner 91.5 meter wide channel, the combination of narrow channel and inadequate UKC make transits generally unsafe.

In order to solicit the opinions of the second participating shiphandler, during the second week of the project, "Jutlandia" was again examined. Run numbers 28 thru 33 and 53 thru 56 were conducted. Most runs ended in groundings and control problems due mainly to insufficient depths.

"Dania Exporter"

"Dania Exporter" was examined extensively during the first week of the project after "Jutlandia" runs indicated handling problems. Operation of "Dania Exporter" in the existing channel required no tidal offset as the vessel draft is 9.5 meters. Although it is also a panamax container vessel its length and therefore, its container carrying capacity are significantly reduced. A 9.5 meter draft will enable channel transits with little problems with UKC. This allowed us to observe its ability to maintain center channel during wind and current conditions normally experienced at the port.

As with all container vessels "Dania Exporter" presents a somewhat high wind profile due to the presence of containers stacked above deck. Although this vessel is smaller in length as well as less draft, and was not as large as the agreed upon "design vessel", testing it would yield useful information about channel capacity to support container vessel access. Simulation runs 14 thru 27 were conducted during various conditions of wind and current. Simulator exercises and participating shiphandler comments indicated that vessel performance during ebb or flood currents as well as winds from NE, SE, and E were not problematic. UKC during most runs were not less than 0.7 meters and when vessel speed was limited to approximately 10 knots, UKC was 1.0 meters or slightly more. The computed squat calculation for the vessel is +0.59 meters at a vessel speed of 10 knots.

Maneuvers inside the harbor proper presented few difficulties. Docking and undocking at the pier proved to have few difficulties as well. Two tugboats provided ample assistance, and in one instance, undocking from the new pier was accomplished without the use of tugs. The vessel docked both port side and starboard side to the berth.

"White Bay"

Because a combination of both vessel length and draft are major factors in determining the proper depth and width of the Gulfport channel, STAR Center made available "White Bay" a container vessel already in its library of vessel models. Its length of 254 meters, 40 meters shorter than "Jutlandia", could be used to determine/quantify safe transit limitations in the existing channel. The only drawback was its loaded draft of 11 meters. As with the "Jutlandia", a tidal offset was used to ensure UKC measurements and vessel handling characteristics were accurate. A tidal offset of +1.0 meters was used in all "White Bay" simulations, essentially giving it a draft of 10 meters. Run numbers 34 thru 52 were conducted using "White Bay".

The participating shiphandler made every effort to keep vessel transit speeds to a minimum (about 10 knots) in an effort to maximize UKC, having already experienced the steering/grounding difficulties with the larger "Jutlandia", also at 10 meter draft. See **Figure 5 – Computed squat "White Bay"** below.

Figure 5 – Computed Squat "White Bay"

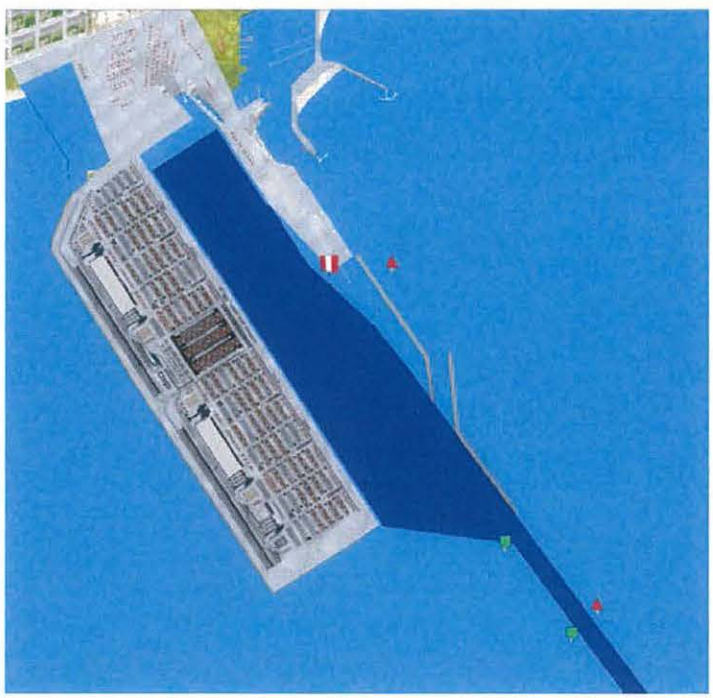
Speed Knots	Open Water Squat m	Confined Squat m
2	0.03	0.05
3	0.06	0.12
4	0.11	0.21
5	0.17	0.34
6	0.24	0.48
7	0.33	0.66
8	0.43	0.86
9	0.54	1.09
10	0.67	1.34
11	0.81	1.62
12	0.96	1.93
13	1.13	2.26

It was decided to examine short "legs" of the channel to determine trouble spots or particularly challenging segments of the channel for the shiphandler. Some exercises were defined as repeat of the runs completed by "Jutlandia", and some runs were at the request of the shiphandler. Docking and undocking at the existing pier as well as the new pier were successful, and tugboats were adequate in the opinion of the shiphandler. Vessel performance in the channel was about the same as with "Jutlandia". The shorter in length "White Bay" handled only slightly better in the channel, shiphandler comments indicated that even if the exercise was completed successfully, there was no "margin for error". The vessel performed better in the wider and deeper outer channel (Bar Channel) than the inner channel as expected. In the inner channel, vessel adherence to the center channel was important at all times. Should the vessel stray from the center of the channel, even if this strategy was deliberate, to combat the effects of wind or current, proximity to the bank of the channel taxed steering capabilities. Although not extensively repeated, no run from the sea buoy to the pier, or pier to sea buoy was completed without incident.

Extended Pier and Vicinity

The on-going construction of the container pier is extending the pier southward, providing additional berths for visiting vessels. Additionally, the 36 foot depth in the harbor will be extended northward along this pier providing added maneuver room for vessels. Lastly, a breakwater will be installed and extended on the eastern side of the harbor to shelter this pier and maneuver area from possible waves and swell. Each of the vessels examined in this simulation project transited into and out of this "plan of the future" configuration of completed harbor design. Maneuver room provided by the extended northward dredging provided more than ample room to turn a vessel when arriving or departing. When however, an inbound / arriving vessel passes green marker number 61 at the channel end, the proximity of the extended breakwater, because of its proximity to that channel marker, restricts vessel clearance. This juncture is particularly important to the shiphandler as transitioning from channel transit speeds to maneuver minimums in this area requires slowing with ships engines and / or the assistance of tugboats alongside. Not only must the shiphandler clear this narrow area, but must concern himself with ensuring that the alongside tugboats have ample passing distances from the breakwater, and adequate maneuver room to assist the vessel as necessary. Both participating shiphandlers remarked negatively about this constriction, no mater which vessel was being operated. See **Figure 6 – Harbor Breakwater** below.

Figure 6 – Harbor Breakwater



CONCLUSIONS AND REMARKS

The obvious challenge for the shiphandler was the transits in the entrance channel. The approximately 22 nautical mile long entrance channel, consisting of two parts, the Bar channel and Sound channel, is designed at 122 and 91.5 meters in width, and 11.6 and 11 meters in depth respectively, and was expected to present the biggest challenge to access by the larger (length and draft) modern container vessels. The "design vessel" selected to examine this channel and harbor / new pier was from STAR's library of vessel models. That vessel was the "Jutlandia", selected because its relatively long length and minimum draft (partially loaded) might be able to successfully and safely access the harbor via the existing channel. If successful, it would be used to establish the normal and upper limits of conditions of wind and current which could be expected during transits.

"Jutlandia" and "White Bay"

The "Jutlandia", the focus of the study, was of necessity the first vessel tested.
Problems with vessel control were noted with both the "Jutlandia" and "White Bay" early in the simulations. These steering control difficulties were the result of the lack of minimal to sufficient under-keel-clearance (UKC), and were compounded by the fact of transiting the narrow channels. Insufficient UKC can and does cause a vessel to "wander" across its intended course. Wind and tidal currents, especially when perpendicular, or nearly so, to the channel course, also may cause this effect. Container vessels with their large wind profile area are especially susceptible to wind influences, and all vessels are vulnerable to currents.

A brief description of the challenges facing the shiphandler trying to balance vessel speed vs. vessel control is presented here. Vessel squat, explained earlier, increases exponentially with vessel speed and is minimal to non-existent at speeds below 4-5 knots for most vessels. Vessel speed thru the water can provide increased steering control to combat the effects of wind and current when it is increased. When the effects of wind and current tend to set a vessel out of a channel for instance, the shiphandler might use course changes and increased speed to counter those effects. "Jutlandia" and "White Bay" were operated with a vessel draft for the purpose of simulation, at 10 meters. The effects of squat when vessels were operated at a 10 knot speed during transits increased this draft to 10.6 meters for "Jutlandia" and 10.7 meters for "White Bay". In channels whose available depth is 11 and 11.6, UKC for safe vessel control is problematic. A vessel operated to slowly may be overly susceptible to wind and current, too fast and grounding in the channel is an increased possibility.

Channel widths are also an integral factor in vessel handling. During simulations vessel leeway[4], at times, was about 3 degrees. This 3 degree leeway increased the "swept path" of "Jutlandia" and "White Bay" to 48 and 46 meters respectively. For "Jutlandia" this was 40% of the outer channel and 52% of the inner channel. "White Bay" used 38% of

[4] Leeway, crab angle, or drift angle – can be defined as the angular difference between the course steered and the course made good thru the water.

the outer channel and 50% of the inner. This increase essentially narrowed the available maneuver room in the channel, and proximity to the banks when course correcting.

The participating pilots, experienced and competent shiphandlers, used any and all of the strategies above to successfully complete the exercises. The Run Matrix presented in Figure 2 above, reported groundings during simulations involving both "Jutlandia" and "White Bay". These groundings would cause the simulator to stop or "trip" forcing a reset and rerun. Groundings reported in the Matrix were those of sufficient magnitude to cause this "trip". However, groundings that may have resulted in the vessel "bumping the bottom" during a run did not stop the simulation, but were none the less important groundings. Cases when "bumping the bottom" occurred were not infrequent. Even when the exercise was completed successfully, there was no "margin for error" demonstrated in simulation.

The "White Bay", the shorter vessel, performed only slightly better in simulations than did the "Jutlandia", however, it still had grounding and steering complications relating mainly to channel depth. Pilot Run Evaluations, which accompany this report, sometimes reflected an optimistic view of each exercise by the shiphandlers. In the case of the "Jutlandia" however, this opinion, when considered in hindsight, after completion of the entire project, Final Evaluations (also included) reported that both shiphandlers consider "Jutlandia" unsafe in the present channel. "White Bay" in the opinion of the shiphandler and expressed in the Final Evaluation, could be operated only during optimal environmental conditions. Since the ability of a container vessel to transit into and out of the port of Gulfport, during most conditions of tide, current, and wind, is important, the rating of "only during optimal conditions" is considered less than satisfactory.

"Dania Exporter"

"Dania Exporter" was included in our testing of the port and entrance channel to provide some example of vessel size that is facilitated by the existing channel. The "Dania Exporter" is considerably shorter in length and more importantly, less draft (9.5 meters) than the "design vessel" or the "White Bay". Its computed squat at a speed of 10 knots is 0.6 meters, giving it a 10.1 meter draft when transiting. Vessel performance during simulations was not problematic in either the outer or inner channels. Simulations included normal tidal currents and winds from different directions and velocities up to 30 knots. Shiphandler opinions both orally during debriefings and in writing in the Final Evaluation state that access by "Dania Exporter" is possible and safe. No problems were experienced when docking or undocking.

Recommendations

Simulation has shown that the larger container vessels "Jutlandia" and "White Bay" cannot consistently and safely access the port of Gulfport via the channel as currently designed in conditions tested.

"Dania Exporter" can safely access the port of Gulfport via the channel as currently designed in conditions tested.

The 3,000 horsepower, single propeller tugboats used at the port and in simulations are ample to provide maneuver and docking/undocking assistance to all vessels tested.

The breakwater scheduled for inclusion at the harbor entrance north of marker number 61 can restrict vessel maneuvers at that critical juncture. Repositioning or removal of this breakwater is recommended.