Yacht Salvage Stability

M/Y Baden Stability Evaluation

PREPARED FOR:			BY:	
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References

1. Northern Marine Drawing 8501 Elevations (REV-A)

Introduction

The *M/Y Baden* capsized during launch on 19 May 2014. Glosten was asked to be on-site to evaluate the stability of the vessel after it was righted and raised with a marine crane. Before Glosten arrived on-site and after the dewatering of the vessel was complete, the salvage team attempted to release load from the crane. The Global team reported that the vessel rolled to 20 degrees to port with load still on the crane, indicating a lack of stability in the salvaged condition.

The lack of static stability made performance of a standard stability test impractical. Glosten performed a deadweight survey of the vessel and calculated the righting moment provided by the crane. Glosten reviewed options for supporting the vessel during transport to a haul out facility.

Initial Survey

Glosten performed an initial survey of the vessel condition. The vessel was pumped dry of standing water. Saturated material, such as insulation, was still draining from the upper decks.

A small amount of outfit material was aboard, including some mattresses, seating, and galley appliances. Material that had shifted during the capsize had been moved to the sides of each space to create walkway access.

Fixed ballast, in the form of lead shot, had been added to voids under the tank top. Access panels were available under four (4) locations: the Guest Suites, VIP Suite, and Crew stateroom berths. Some lead shot had shifted during the capsize, but at the time of inspection the majority of the lead shot appeared to be in the compartments. There did appear to be some resin infused into the lead shot, but not a significant amount.

Three (3) LT of lead shot was reported as being present in open containers in the lazarette. The lead shot had shifted during the capsize event. The salvage team was collecting and returning the lead shot to the open containers.

The tanks were in the following condition:

[redacted]

Table 1: Tank Condition

Tank	Condition
Portable Water Tank, Port	Empty (visual inspection)
Portable Water Tank, Starboard	Empty (low point drain open and dry)
Forward Fuel Tank	Empty (visual inspection)
Gray Water Tank	Pressed (sea water)
Black Water Tank	Pressed (sea water)
Belly Fuel Tank	Pressed (sea water)
Saddle Fuel Tank, Port	Empty (low point drain open and dry)
Saddle Fuel Tank, Starboard	Empty (low point drain open and dry)
Lube Oil	Negligible (55 USG capacity)

Freeboard Measurement

Detailed freeboard measurements were taken to establish the current weight and longitudinal and transverse centers of gravity. A survey of weights aboard was not included. The crane was providing stability during the freeboard measurements.

Global and Glosten worked with Northern Marine to obtain information on design deck heights above baseline to support the freeboard measurements. Four (4) locations were measured each port and starboard. The hull geometry was based on the best information available (Reference 1).

Table 2: Freeboard Readings

Freeboard Location			Survey Fbd "f"	Survey Bwk Ht "b"	Molded Dk Ht "D" to BL	Molded Draft (D + t + b - f)	Average Draft to BL	Molded Beam	Heel Angle
Station	ft aft FR 0	Side	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(deg. + stbd)
Fr 1	4.000	P	14.9583	2.771	19.698	7.510	7.635	17.88	0.801
	4.000	S	14.7500	2.813	19.698	7.760			
Fr 5	20.000	P	15.5000	3.698	19.224	7.422	7.505	21.10	0.452
	20.000	S	15.3125	3.677	19.224	7.589			
Fr 12	48.000	P	7.6979	2.885	12.000	7.188	7.057	20.85	-0.715
	48.000	S	7.9583	2.885	12.000	6.927			
Fr 16 + 2' Aft	66.000	P	7.8438	2.896	12.000	7.052	7.151	19.13	0.593
	66.000	S	7.6458	2.896	12.000	7.250			
								Average Heel =	**0.283**

The specific gravity of the water was measured at multiple depths and found to be 1.025.

[redacted]

The freeboard measurements and the load cell readings form the crane, 15.4 kips port and 2.4 kips starboard, were used to calculate the current displacementusing GHS. The displacement information is as follows.

Displacement	167.5 LT
Longitudinal Center of Gravity (LCG)	40.5 ft aft of Frame 0
Transverse Center of Gravity (TCG)	0.38 ft port of centerline

Virtual TCG Shift

Since the crane was required to maintain the vessel upright, it is unclear if the source of the instability is from a TCG offset, a high vertical center of gravity (VCG), or a combination of both. To estimate the moment the crane was imparting on the vessel, the vessel was leveled with the port sling only and the load cell was recorded. An inclinometer was set on the foredeck of the vessel to determine the heel of the vessel. The crane slacked off the sling on the starboard pick point. This pick point was verified to have no load throughout the test. The port sling was adjusted to achieve an even heel. The resulting reading of the crane load cell was used to estimate the imparted moment. Accounting for the TCG above, a righting moment of 20.75 LT-ft was calculated using this method.

To be conservative, this moment was added to the TCG moment above. If the source of the instability is from a high VCG, this moment could be applied in either direction.

Transport Stability

Two main options were considered to establish stability for transport.

- Install fixed ballast low in the hull to achieve static stability. Perform an incline to determine VCG. Add additional fixed ballast if needed for transport.
- Provide additional stability through external means (buoyancy bags, barges, etc.)

Given the lack of verifiable VCG data and the inability to obtain it through physical testing and the limited options for effectively locating large amounts of fixed ballast, it was decided that providing external stability was the more reliable method to pursue.

A couple of possible options to provide external stability for this situation included buoyancy bags and small barges with support straps. However, given the space constraints of the marina, bringing in new equipment would be not be a practical option so a solution utilizing the crane barge was developed.

The proposed, and current, configuration of a crane barge hooked to a port and starboard sling and secondary lines on both the port and starboard side of the yacht attached to the barge deck fittings provides necessary stability. The secondary lines control the heel of the vessel with a port line connected down to the crane barge deck (preventing a roll to starboard) and a starboard line fed under the hull and up to the main deck (preventing a roll to port).

During transport, the crane will be unloaded but maintain the connections to the aft slings in case extra support is required. The forward slings (secondary lines) are intended to control the heel of the vessel.

A design load for the slings was based on the virtual TCG shift and wind moment from a 30 mph wind (for design only not for operational purposes). A safety factor on allowable of 1.5

was included. The design load for each sling is 36 kips in the global vertical direction. The geometry of the starboard sling is by default in the global vertical direction. The port sling shall be installed so that the line lead can be as vertical as possible. A vertical padeye on the side shell could be installed.

There shall be three sets of heel control lines, though the design load is based on one set. Breasting and spring lines shall be located forward and aft. See the figure below.

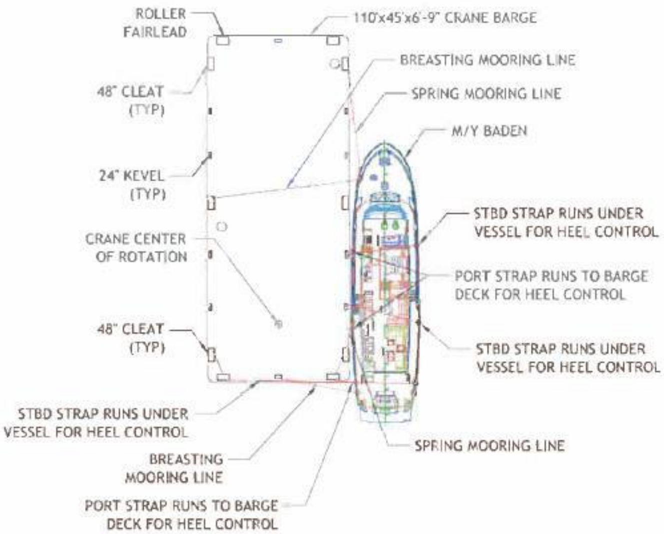

Figure 1: Transport Mooring Configuration

It is recommended that the tow be as short as possible and occur at a slow speed, in calm conditions, with minimal wind.

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