U.S. Department of Homeland Security

United States Coast Guard

Commanding Officer
United States Coast Guard
Marine Safety Center

2100 2ND ST SW
WASHINGTON, DC 20593
Staff Symbol: MSC-1
Phone: (202) 475-3401
Fax: (202) 475-3920

16732/P017842
Serial: H1-1300370
10 May 2013

MEMORANDUM

From: J. P. NADEAU [redacted]
CG MSC

Reply to Attn of: LT Czarniak
(202) 475-3362

To: CGD FIVE (dpi)

Subj: POST SINKING STABILITY ANALYSIS OF BOUNTY, O. N. 960956

Ref: (a) Your memo 16732, dated 14 Nov 2012
(b) David B. Wyman, Dwg. No. 181-5, "Lines Drawing," dated October 11, 2001
(c) Beckley Engineering Co. Inc., Dwg. No. Unknown, "Lines Drawing," dated February 14, 1990
(d) Beckley Engineering Co. Inc., Dwg. 8932_100, "Outboard Profile," dated February 20, 1990
(e) Undated HMS BOUNTY Sail Plan, Approved June 15, 2011

1. As requested in reference (a), we performed a stability analysis of the BOUNTY in its 2011 pre-drydock and 2012 post dry-dock conditions. Additionally, as requested, we performed a stability analysis of BOUNTY in intermediate stages of flooding, as experienced during the casualty.

2. The modifications to the BOUNTY undertaken during the 2012 drydocking invalidated the vessel's stability letter. However, our analysis of the weight changes indicated that stability was virtually unchanged as a result of the modifications.

3. Although not applicable to the BOUNTY at the time of the casualty, we found that she would have met the intact stability criteria in 46 CFR 170.170, 46 CFR 171.050, and 46 CFR 170.173, but would not have met the sailing vessel stability criteria in 46 CFR 171.055. This finding is inconsistent with the results of stability analyses performed in 2009 and 2011, which did not correctly account for the wind profile area of the vessel's topsides and rigging.

4. We do not know the source of BOUNTY's flooding. Regardless of the source, the bulkheads on BOUNTY's lower deck were apparently not watertight and, once water entered the hull, it would eventually progressively flood throughout the ship. We found that, even had the bulkheads been watertight, BOUNTY would not have met the subdivision or damaged stability standards applicable to comparable inspected passenger vessels.

5. Our analysis of BOUNTY's stability as she flooded indicates that the first several feet of floodwater eroded the vessel's capacity to weather seas by reducing the freeboard and downflooding angle. Despite this, BOUNTY still retained significant stability even with extensive multi-compartment flooding on the lower deck. As floodwater approached the level of the 'tween deck, water would spill through openings and onto the 'tween deck from spaces below. There, it would pocket, further reducing stability, and making it much more difficult for the vessel to remain upright in heavy winds and seas.

6. With respect to dewatering capacity, we estimate that if all pumps capable of dewatering below deck spaces were employed simultaneously, they could potentially discharge as much as 975 gpm. Use of the installed bilge system alone would likely discharge at a maximum rate of 265 gpm.

7. Enclosure (1) is a detailed explanation of our assumptions and analysis. If you have questions or need additional information, please contact LT Andrew Czarniak of our staff.

#

Encl: (1) Explanation of Analysis & Assumptions

USCG MARINE SAFETY CENTER (MSC) POST SINKING STABILITY ANALYSIS OF BOUNTY, O. N. 960956

EXPLANATION OF ANALYSIS & ASSUMPTIONS

1. General Comments Regarding Our Analysis

- All references in this analysis are as listed on Marine Safety Center Memo, Serial No. H1-1300370, dated May 10, 2013.

- Creative Systems' General HydroStatics (GHS) software version 13.00 was used for our analysis.

- All weights were reported in long tons (LT). One long ton is equivalent to 2240 pounds.

- Downflooding occurs when water enters the hull or superstructure of a vessel through an opening that is not watertight. Downflooding points were assumed to be located at the stern great windows and quarter windows, as well as the hatches on the main deck leading to the 'tween deck. These points were used to assess the vessel's compliance with stability standards applicable to similar commercial vessels.

- BOUNTY's general arrangements drawings show two levels below the weather deck. The lower deck was comprised of 7 compartments, separated by bulkheads. From witness testimony, these bulkheads had limber holes for the drainage of water and, as such, were not watertight. The 'tween deck, located above the lower deck, was open fore to aft. Additionally, the 'tween deck itself was not watertight, and there were non-tight openings to the lower deck compartments from the 'tween deck.

- All longitudinal references in this report were measured from a forward perpendicular as specified in reference (b). Vertical references were measured from a baseline 3 inches above the bottom of the keel, with the exception of the draft marks, which we assumed to reference the bottom of the keel.

- Permeability is a measurement of the floodable volume of a compartment. Since no more accurate information was available, our calculations used a machinery space permeability of 85%, as is assumed in Coast Guard stability regulations. All other spaces were assumed to have a permeability of 95%.

- The owners of the BOUNTY were reportedly seeking to have a load line assigned for the vessel. The Marine Safety Manual, Vol. IV - Technical, provides guidance on issuing load lines for these vessels when they are not Coast Guard inspected. Uninspected vessels requiring a load line are subject to the same intact stability criteria as inspected vessels of the same type in the same service. Due to her gross tonnage, in order to receive a load line, BOUNTY would need to comply with the same intact stability criteria applicable to a passenger vessel inspected under 46 CFR Subchapter H; namely: 46 CFR

170.170, 170.173, 171.050, and 171.055. BOUNTY was not load lined at the time of the casualty due to deficiencies identified in a 2010 load line examination, but had a stability letter issued by the Marine Safety Center in 2011. Because BOUNTY did not have a load line assigned at the time of the casualty, the stability letter was not in force.

- For a detailed assessment of stability, naval architects examine a vessel's righting arm curve. The righting arm curve is a plot of a vessel's righting arm vs. angle of heel. A righting arm is a measure of a vessel's ability to right itself when disturbed from its upright position. In general, the greater the righting arm, the better the vessel's stability characteristics. The area under the righting arm curve (measured in foot-degrees) , also called righting energy, is often used as a measure of the vessel's ability to absorb energy imparted by wind, waves, or other forces. A vessel with very little righting energy could roll past its range of positive stability and capsize as a result of even a relatively small disturbance.

2. Lines Plan & Model Development

Two different computer models were used by the MSC for analyses of the BOUNTY. Reference (b) is the lines plan that the MSC had on file for the BOUNTY. It was provided as part of the required documentation for stability reviews in 2009 and 2011. Model 1 was digitized from this lines plan and used in the MSC's stability analyses for the issuance of stability letters in 2009 and 2011. Reference (b) has a note indicating that it was "based on" a Beckley Engineering drawing dated February 14, 1990. Reference (c) is a photocopy of the 1990 Beckley Engineering drawing found in tonnage documentation provided by the American Bureau of Shipping. We digitized reference (c) to create Model 2.

The hydrostatic properties of Model 1 and Model 2 differed significantly. Statements by Mr. Wyman indicate that he took no hull measurements and incorporated no additional information when redrawing the 1990 Beckley Engineering lines plan to create reference (b). As such, we assumed that differences between the two models are the result of errors in Mr. Wyman's preparation of reference (b) and, therefore, have more confidence in the accuracy of the original Beckley drawing. For this reason, Model 2 has been used throughout this analysis, unless otherwise noted.

After review of all available information, we believe that the most detailed and accurate sail plan is provided in reference (d), which was reviewed prior to issuance of the stability letter in 2009. We therefore used reference (d) as the basis for modeling the masts and sails in computer Model 2. Reference (e) is the approved sail plan from the 2011 stability review; it lists the area of each sail, but is not to scale. Additionally, reference (e) does not show royal sails, nor a mizzen topgallant sail, reflecting restrictions on sail carriage from the 2011 stability letter. We compared the sail area of Model 2, discounting the area of the royals and the mizzen topgallant, to that of reference (e). While the individual sail areas in Model 2 and reference (e) match within 2%, the resultant area moment in that configuration (total windage area multiplied by the height of the center of effort), calculated using Model 2 was 45% greater than that calculated using reference (e). Reference (e) does not contain enough information to identify the source of this discrepancy, however it appears that details of the BOUNTY's topsides and rigging that were detailed in reference (d) were erroneously omitted from reference (e).

Figure 1 shows Model 2 and includes the sail plan digitized from reference (d).

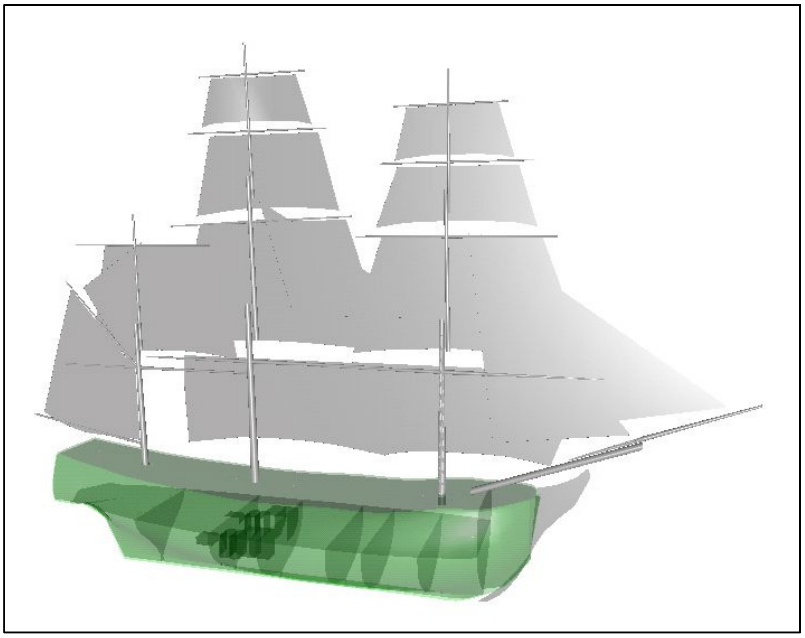

Figure 1 - Graphical representation of BOUNTY Model 2

3. Lightship Value Estimation

To conduct a stability analysis, it is necessary to know the vessel's hull shape as well as its displacement and centers of gravity. A stability test is conducted to accurately determine the vessel's lightship displacement and centers of gravity. The vessel's operating conditions are calculated by incorporating the effect of any weights that are not a part of lightship; e.g., crew weight, supplies, liquid loads, etc. Because the lightship values form the basis of these load calculations, accurate values are of the utmost importance.

Following a stability test conducted on April 15, 2009, stability calculations were submitted to the Marine Safety Center and a stability letter was issued on August 7, 2009, with the following lightship values:

Displacement	277.20	Long Tons
VCG	12.05	Feet Above the Baseline
LCG	54.39	Feet Aft of Station 0 (FP)

Table 1 - Lightship Values from Stability Letter dated August 7, 2009

In 2011, a Coast Guard inspector at Activities Europe noticed a large discrepancy between the lightship displacement in the 2009 stability letter and one issued many years before. The MSC determined that the discrepancy stemmed from a previously undetected error in the hydrostatic properties submitted for review in 2009. Because of this, the stability test was re-evaluated using Model 1, and the following lightship values were issued with the stability letter dated June 15, 2011.

Displacement	430.22	Long Tons
VCG	13.34	Feet Above the Baseline
LCG	54.49	Feet Aft of Station 0 (FP)

Table 2 - Lightship values from Stability letter dated June 15, 2011, Model 1

Because of concerns with the accuracy of Model 1, we have subsequently re-calculated the stability test results from 2009 using Model 2. Using Model 2, our best estimate of the lightship values from the inclining experiment in 2009 are presented in Table 3:

Displacement	430.88	Long Tons
VCG	13.56	Feet Above the Baseline
LCG	52.85	Feet Aft of Station 0 (FP)

Table 3 - Lightship values using Model 2

4. Modifications to Lightship Values

During the 2012 drydock period, several modifications were made to the vessel. The freshwater and fuel tanks were removed from the compartment between frames 23 and 29 and re-installed in the compartment between frames 29 and 35. Additionally, four new 500 gallon freshwater tanks were installed in this compartment. The berths that had originally been installed in the compartment between frames 29 and 35 were rebuilt in the compartment between frames 23 and 29.

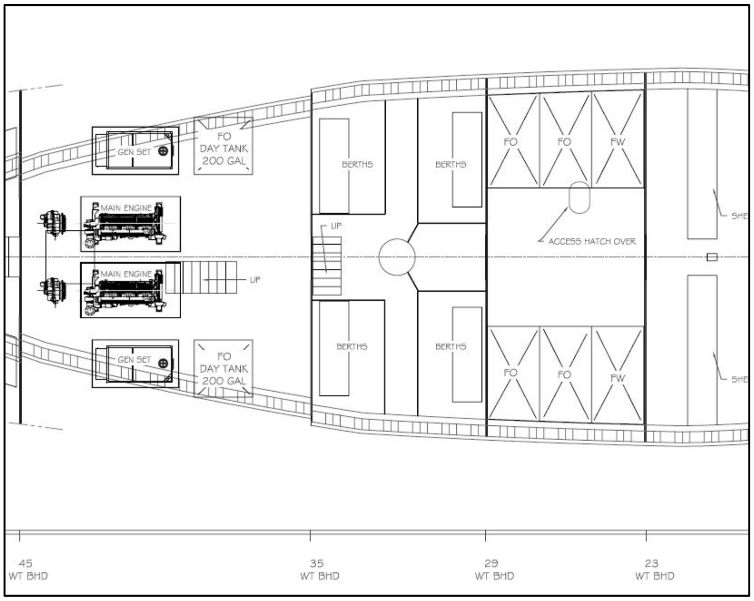

Figure 2 - Plan view of BOUNTY's arrangements prior to the 2012 modifications

The fore topmast was removed, and replaced with the topmast from the mizzen. The main hatch grating and tonnage opening house were altered to restore tonnage "grandfathering". In addition, after the BOUNTY was put back into the water, approximately 200 lead ingots, each weighing approximately 28 pound 10 ounces, were shifted from frame 25 to frames 41 and 48. Although, for the reasons mentioned above, BOUNTY's stability letter was never in force, these weight changes rendered it invalid.

Item	Weight (pounds)	LCG	VCG
Fore topmast removed	-640	18.96	100.70
Mizzen topmast removed	-640	95.43	94.50
Mizzen topmast installed on Fore	640	18.96	100.70
Old freshwater tanks	-7460	47.70	8.50
New freshwater tanks	460	60.00	8.50
Old fuel tanks	-14920	54.20	8.50
New fuel tanks	14920	66.20	8.50
Forward House Removed	-690	32.00	27.50
Main Hatch Grating	-810	44.00	24.00
Main Hatch House	965	44.00	25.60
Ballast removed	-5670	50.00	3.00
Bunkroom Removal	-3160	64.00	10.00
Bunkroom reinstallation	3160	50.00	10.00
Ballast added Frame 41	2835	82.00	3.00
Ballast added Frame 48	2835	96.00	3.00
Total	-8175		

Table 4 - Outline of weights affected from modifications

To account for these changes, we calculated the BOUNTY's drafts prior to drydocking based on the most recent stability letter. We then estimated the weight for the topmasts, tanks, tonnage changes, and other weight changes as shown in Table 4. After incorporating the estimated weight changes and shift in ballast, we estimated that the drafts would have been 9' 3" forward and 12' 8" aft. According to emails from Captain Walbridge, the drafts were actually 10' 6" forward and 11' 10" aft. This discrepancy in drafts represents a 16 long ton difference in displacement. As a result, we suspect that other, undocumented, weight changes have occurred since the BOUNTY's last stability test in 2009.

The drafts observed by Captain Walbridge offer the most reliable information regarding the displacement and LCG of the BOUNTY after the 2012 drydocking. As such, we added a 16 long ton correction to our estimated lightship displacement and assumed that it was located at the BOUNTY's lightship VCG. This "corrected" lightship displacement was used as the basis for our analysis of the BOUNTY.

5. Loading Conditions

Three loading conditions were chosen to analyze the BOUNTY's stability.

Loading Condition 1:

Item	**Weight (Long Tons)**	**LCG**	**VCG**
Lightship	430.88	52.78	13.56
36 persons (185 pounds)	2.97	55.00	19.93
Gangways (2)	0.30	65.00	22.90
Small Boat	0.32	56.00	24.17
Miscellaneous Stores	16.00	54.46	17.46
95% liquid loads	19.56	51.80	8.33
TOTAL	**470.03**	**52.82**	**13.53**

Table 5 - Full load departure prior to lightship modifications completed in 2012

Loading Condition 2:

Item	**Weight (Long Tons)**	**LCG**	**VCG**
Lightship (See Note 1)	443.44	50.94	13.54
36 persons (185 pounds)	2.97	55.00	19.93
Gangways (2)	0.30	65.00	22.90
Small Boat	0.32	56.00	24.17
Miscellaneous Stores	16.00	54.46	17.46
Yards stowed on deck	1.58	55.50	23.25
Fore Topmast stowed below	0.28	55.00	21.00
95% liquid loads	20.27	64.15	9.80
TOTAL	**485.16**	**51.66**	**13.60**

Note 1: Includes all reported 2012 drydock modifications and a 16 LT correction for unreported modifications.

Table 6 - Full load departure, with changes to lightship from 2012 yard period

Loading Condition 3:

Item	**Weight (Long Tons)**	**LCG**	**VCG**
Lightship (See Note 1)	443.44	50.94	13.54
14 persons (185 pounds)	1.16	55.00	19.93
Gangways (2)	0.30	65.00	22.90
Small Boat	0.32	56.00	24.17
Miscellaneous Stores	16.00	54.46	17.46
Yards stowed on deck	1.58	55.50	23.25
Fore Topmast stowed below	0.28	55.00	21.00
Liquid Loads (See Note 2)	15.55	64.30	8.48
TOTAL	**478.60**	**51.51**	**13.60**

Note 1: Includes all reported 2012 drydock modifications and a 16 LT correction for unreported modifications.
Note 2: No. 1 FO tanks at 60%, No. 2 FO tanks at 95%, No. 1 FW tanks at 100%, No. 2 FW tanks at 50%

Table 7 - Loading condition prior to flooding

6. Intact Stability Assessment

The righting arm curves in Figure 3 indicate that the reported modifications and unreported 16 ton weight change had minimal effect on the BOUNTY's stability. The righting arm at each angle of heel and the range of positive stability were virtually unchanged.

Our analysis showed BOUNTY met the intact stability standards in 46 CFR 170.170, 46 CFR 170.173, and 46 CFR 171.050 in all three load conditions. In contrast to the results of the 2011 stability analysis, we found that BOUNTY did not meet the sail stability criteria of 46 CFR 171.055. This inconsistency is due to the discrepancies between the wind profile calculated values from reference (d), and the sail area listed in reference (e). The significantly greater wind heeling moment that we calculated caused the vessel to fail the criteria in 46 CFR 171.055.

The stability letter, dated June 15, 2011, placed a limitation on the sail plan that the royals and mizzen topgallant sail were never to be set. Our analysis indicates that even with this limitation, BOUNTY probably did not meet the sailing vessel stability requirements in 46 CFR 171.055.

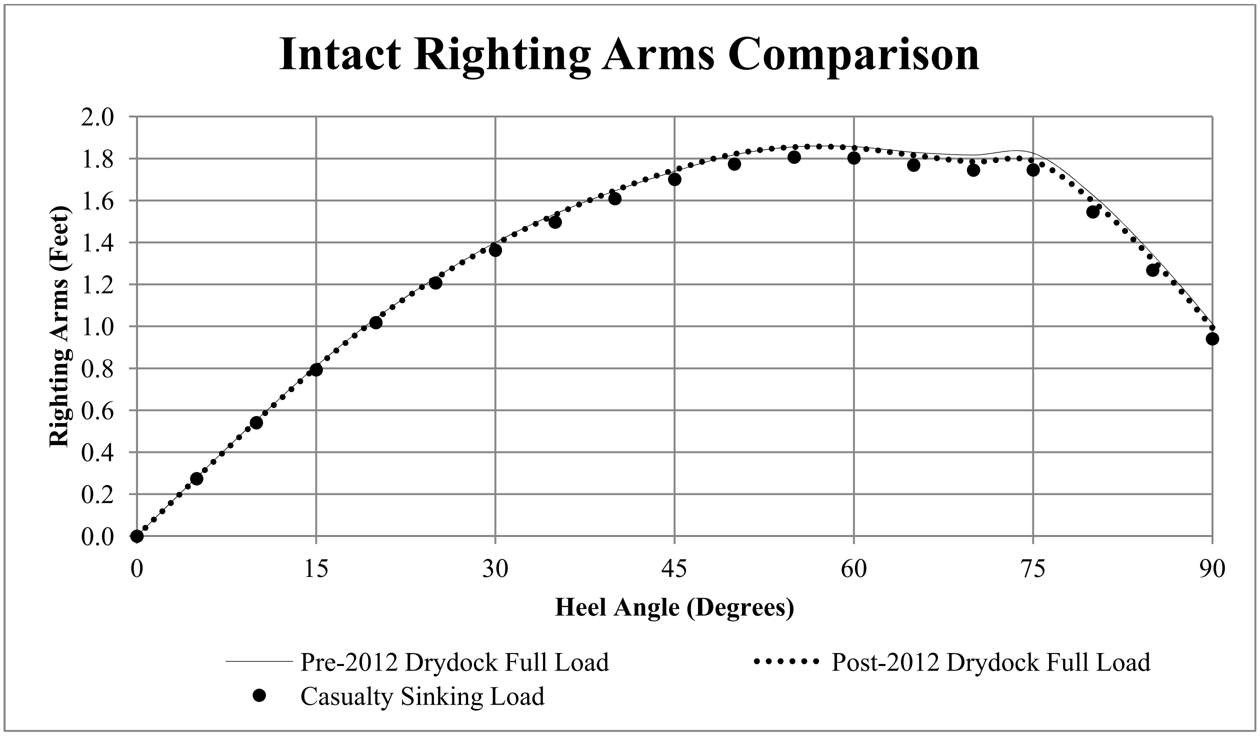

Figure 3 - Comparison of Intact Righting Arms

7. Damage Stability Assessment

The Type 2 subdivision criteria in 46 CFR 171.070 and the damage stability criteria in 46 CFR 171.080, although not required for the BOUNTY, provide an objective reference standard for vessels in similar service. As noted above, BOUNTY's transverse bulkheads apparently were not watertight. Our damaged stability analysis, which assumes these bulkheads are watertight, is hypothetical.

Subdivision standards assume that the entire volume between appropriately spaced adjacent main transverse watertight bulkheads is open to the sea. Damage stability standards assume a longitudinal and transverse extent of damage. For a vessel required to meet Type 2 subdivision, it is assumed there is no damage to any main transverse watertight bulkhead. The transverse penetration of damage is 1/5th of the beam inboard from the side shell.

BOUNTY would not meet these subdivision or damage stability criteria because damage to either the engine room or lazarette would result in submergence of the margin line.

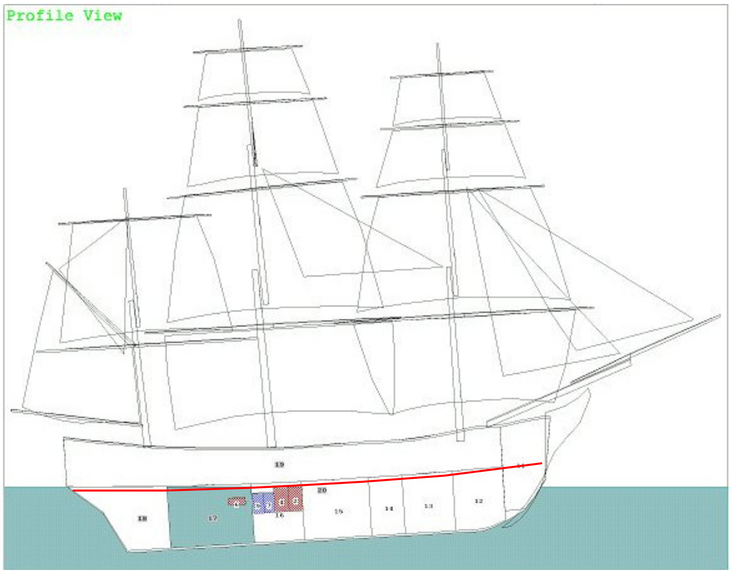

Figure 4 - Profile of BOUNTY with engine room flooded. Margin line, shown in red, is partially submerged.

8. Flooding Rate

As requested by the Investigating Officer, we estimated the volumetric rate of flooding that would cause the level of water in the lower deck compartments to rise two feet per hour. At lower water levels, less water is required to raise the water level 2 feet, as the hull is much narrower in the vicinity of the keel. Our estimates for flooding rates at various levels of floodwater are shown in Table 8.

Level of Floodwater	Flow rate required to raise flood level by 2 ft/hr	
	gal/hr	gpm
8	28,321	472
10	33,198	553
12	36,766	612
14	39,115	651
16	40,319	671

Table 8 - Flooding rates at various floodwater levels

9. Bilge System

The bilge system on the BOUNTY was analyzed to estimate the best case dewatering rates. Based on drawings and photographs of the system, we know that there were three different permanently installed pumps; two electric pumps and one hydraulic pump. The two electric pumps were driven by 7.5 HP motors and rated to deliver up to 140 gallons per minute (gpm). The hydraulically driven pump was rated to deliver up to 800 gpm. As a bilge dewatering system, it was designed to take suction via a bilge manifold from any of the compartments on the lower deck and discharge through overboard discharges located in the engine room. The system could also be used to provide firefighting water by taking suction through a sea suction in the engine room and discharging through the vessel's firemain. The bilge system was reportedly piped with 2 inch piping, while the firemain was piped with 1-1/2 inch piping.

In general, the total capacity of a piping system is governed by the flowrate of the pumps, the frictional losses in the piping, and the difference in height between the suction and discharge. The pump's actual flow rate decreases with increasing frictional losses in the piping system. The frictional losses are a function of the length of piping, diameter of piping, and the number of fittings (valves, elbows, tees, etc.) in the system. For a given system configuration, frictional losses increase with increasing flow rate.

BOUNTY's two electric pumps were rated to pump at relatively high pressure when compared to the hydraulic pump. The hydraulic pump could theoretically discharge water at a much higher flow rate, but at much lower pressure.

In the absence of detailed information about the piping system, we have assumed that the length of the suction piping ranged from 10 to 70 feet (this number depends greatly on the compartment being dewatered), at least 15 feet of discharge piping, at least 5 elbows in the system, and a single overboard discharge. This represents a best case estimate of the parameters affecting the frictional losses, meaning that it is likely that the total frictional losses were higher and we are likely over predicting the capability of the system.

We analyzed four different fixed pumping configurations: a single electric pump only, the hydraulic pump only, both electric pumps only, and all three pumps dewatering simultaneously. Table 9 contains the results of this analysis. In the single electric pump configuration, we estimate that the high pressure pump would have been able to deliver its peak flowrate regardless of the length of suction piping. In contrast, the lower pressure hydraulic pump's performance would have decreased significantly with increasing pipe length. Note also that even when dewatering the closest compartment (the engine room), the hydraulic pump would likely be discharging at no more than approximately 150 gpm, far below its 800 gpm rating. This is an indication that the pump was poorly matched with the piping system. [Note: The hydraulic pump was configured with 4 inch suction and discharge openings which were reduced down to 2 inch when installed aboard the BOUNTY. The reduction in pipe diameter would have significantly degraded the performance of the pump. For instance, had the entire system been piped with 4 inch pipe instead of 2 inch pipe, we estimate that the hydraulic pump may have been capable of discharging over 500 gpm with 10 feet of suction piping.] When operating the two electric pumps in parallel we estimate that the system would have the best possible flow rate, possibly dewatering at a rate of up to 265 gpm. If the hydraulic pump were to be operated along with the two electric pumps, the overall flowrate would not increase due to the high pressure in the system.

Total Bilge System Flowrate Estimates (gpm)			
	Suction Length (ft)		
Pump Configuration	10	30	70
1 Electric	140	140	140
1 Hydraulic	150	135	115
2 Electric	265	250	220
2 Electric & 1 Hydraulic	265	250	220

Table 9 - Bilge System Flowrate

There was also an identical portable hydraulic pump aboard that could be rigged to take suction in the engine room. It reportedly discharged through 3 inch flexible hose that was independent of the main bilge system. With no suction piping and 15 feet of 3 inch discharge piping, we estimate that it could, at best, discharge 360 gpm. Because the discharge piping for this portable hydraulic pump was reportedly independent of the bilge system, if both electric bilge pumps were energized and used in combination with the portable hydraulic pump, the total dewatering rate could have been as much as 625 gpm.

Finally, we examined the information provided regarding the gasoline powered “trash pump”, which was also independent of the installed bilge system. This pump was rated for 350 gpm but had a maximum suction lift of 16.4 feet. We were unable to find pump performance curves for the gasoline pump, and are therefore unable to make detailed estimates of its performance. However, with a 16.4 foot maximum suction lift, it is unlikely that the pump would have been effective at dewatering the lower deck compartments when operating on the main deck. If the pump were operated on the ‘tween deck in the latter stages of flooding, it is possible that it could have dewatered at a rate approaching its maximum rated capacity of 350 gpm.

In summary, if all pumps capable of dewatering below deck spaces were employed simultaneously, they could have potentially discharged as much as 975 gpm (265 from the installed system, 360 from the portable hydraulic pump, and 350 from the “trash pump”).

9. Assessment of the Casualty

We performed static stability analyses of multiple stages of flooding, assuming that water from the lower deck compartments could spill into the ‘tween deck as the vessel heeled, as shown in Figure 5.

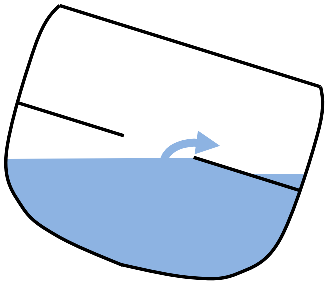

Figure 5 - Example of flood water spilling to the 'tween deck

As our model of the BOUNTY initially floods, the negative impact from free surface effects are offset by the weight of the floodwater, which acts as ballast, lowering the center of gravity. As the vessel heels, most of the water remains entrapped in the lower decks. The plot of righting arms versus heel angle in Figure 6 shows a distinct reduction in stability when the flooding reaches a depth of 12 feet. We attribute this reduction in righting arms to a significant amount of water spilling from the lower deck to the 'tween deck as the model heels.

Table 10 displays the reduction in several key stability parameters as the floodwater increases from 4 feet to 14 feet.

Floodwater		**Stability**		
Depth (Feet)	**Weight (Long Tons)**	**Minimum Freeboard (Feet)**	**Downflooding Angle (Degrees)**	**Maximum Righting Arm (Feet)**
0	0	10.55	47	1.8
4	55	9.90	44	1.6
8	230	7.80	34	1.9
12	470	4.80	23	1.3
14	615	2.75	19	0.4

Table 10 - Summary of Flooding with watertight bulkheads

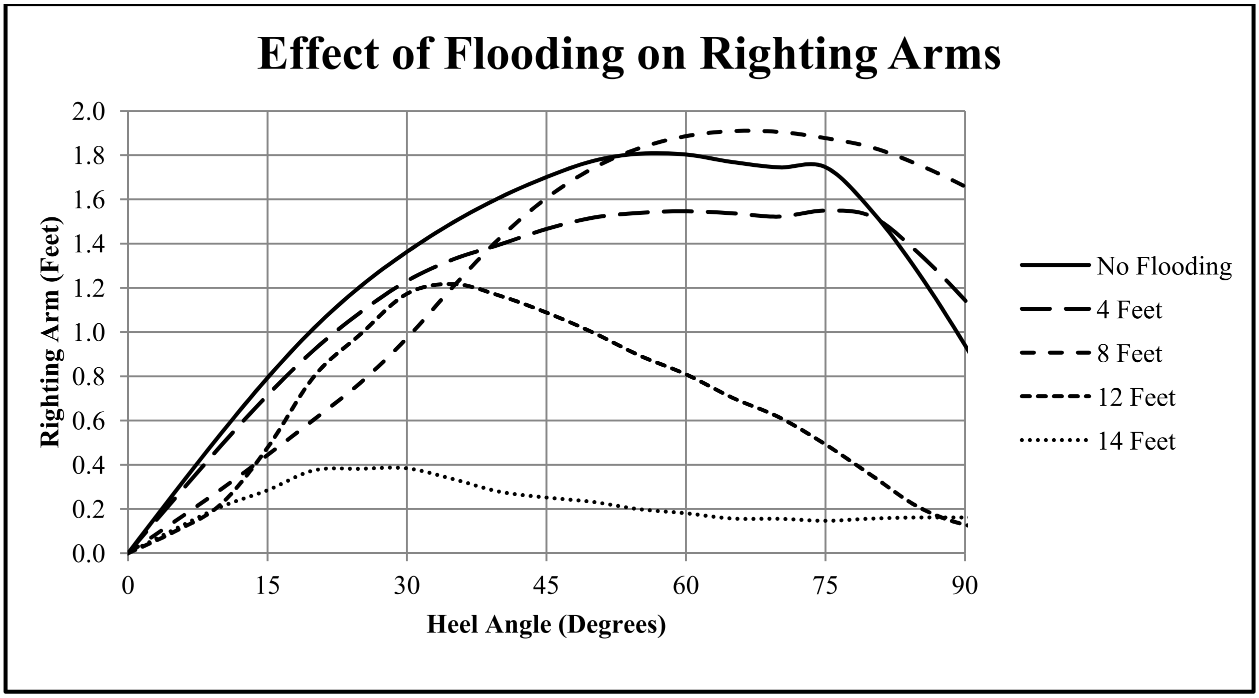

Figure 6 - Righting arms at various stages of flooding, assuming bulkheads are watertight

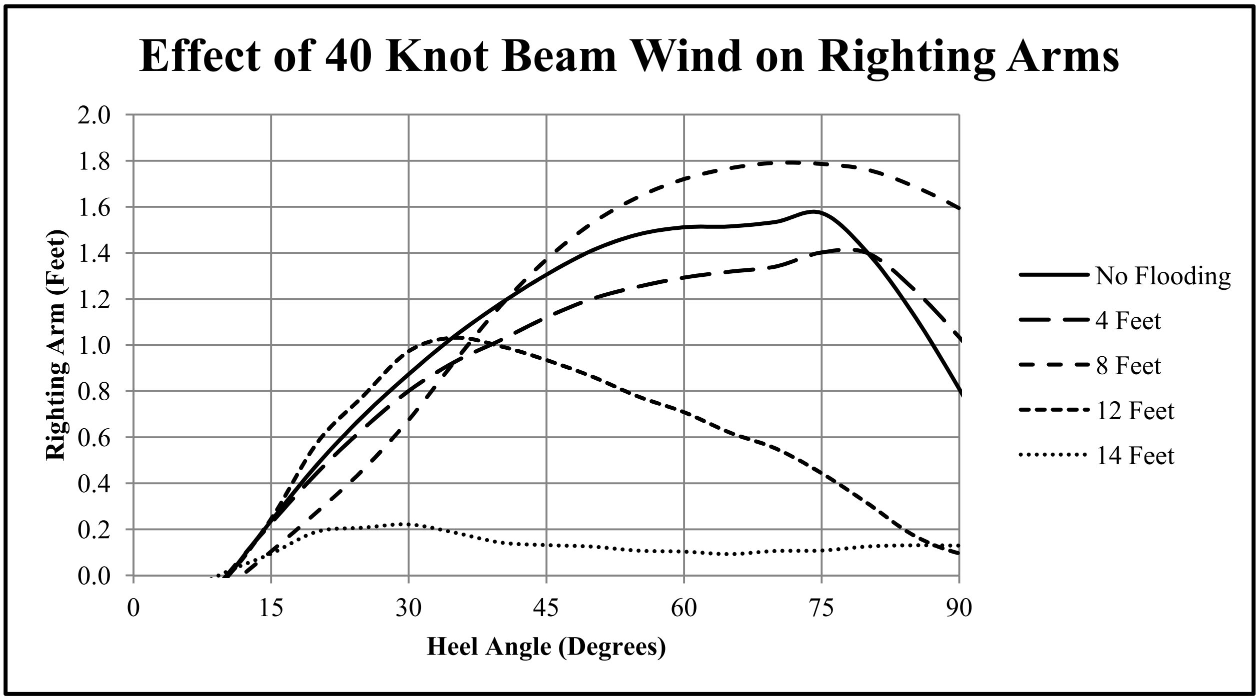

Figure 7 - Righting Arms at various stages of flooding, assuming bulkheads are watertight, with a 40 knot beam wind

Figure 7 shows that, at any level of flooding below the ‘tween deck, a steady 40 knot beam wind acting on the model flying only the main staysail would result in an equilibrium heel angle of approximately 9° to 12°. Further, with an assumed 40 knot beam wind, righting energy would have been significantly reduced, particularly at the later stages of lower deck flooding.

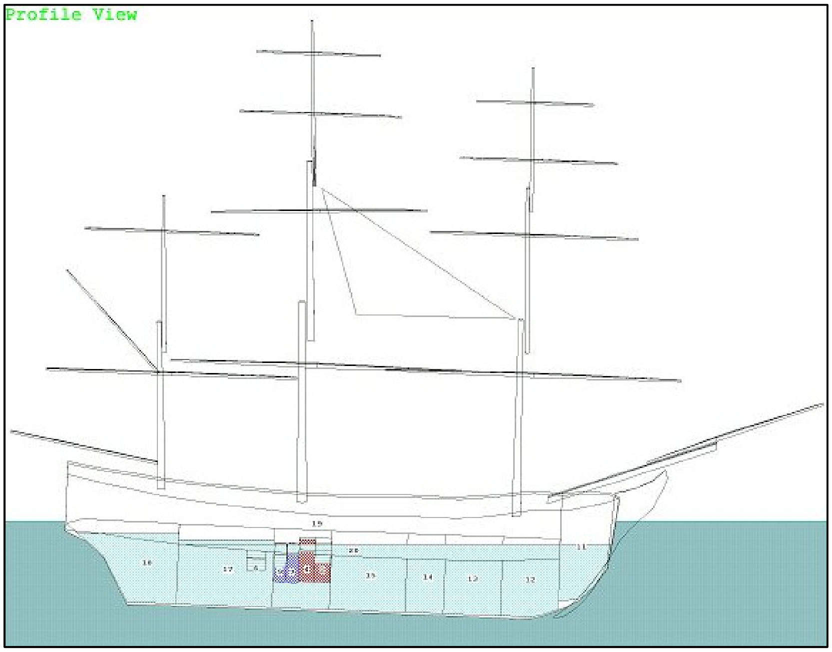

Figure 8 - BOUNTY with lower deck compartments flooded, 'tween deck flooded to 5%, and a 40 knot beam wind

10. Conclusion

The modifications to the BOUNTY undertaken during the 2012 drydocking invalidated the vessel's stability letter. However, our analysis of the weight changes indicated that stability was virtually unchanged as a result of the modifications.

Although not applicable to the BOUNTY at the time of the casualty, we found that she would have met the intact stability criteria in 46 CFR 170.170, 46 CFR 171.050, and 46 CFR 170.173, but would not have met the sailing vessel stability criteria in 46 CFR 171.055. This finding is inconsistent with the results of stability analyses performed in 2009 and 2011, which did not correctly account for the wind profile area of the vessel's topsides and rigging.

We do not know the source of BOUNTY's flooding. Regardless of the source, the bulkheads on BOUNTY's lower deck were apparently not watertight and, once water entered the hull, it would eventually progressively flood throughout the ship. We found that, even had the bulkheads been watertight, BOUNTY would not have met the subdivision or damaged stability standards applicable to comparable inspected passenger vessels.

Our analysis of BOUNTY's stability as she flooded indicates that the first several feet of floodwater eroded the vessel's capacity to weather seas by reducing the freeboard and downflooding angle. Despite this, BOUNTY still retained significant stability even with extensive multi-compartment flooding on the lower deck. As floodwater approached the level of the 'tween deck, water would spill through openings and onto the 'tween deck from spaces below. There, it would pocket, further reducing stability, and making it much more difficult for the vessel to remain upright in heavy winds and seas.

With respect to dewatering capacity, we estimate that if all pumps capable of dewatering below deck spaces were employed simultaneously, they could potentially discharge as much as 975 gpm. Use of the installed bilge system alone would likely discharge at a maximum rate of 265 gpm.