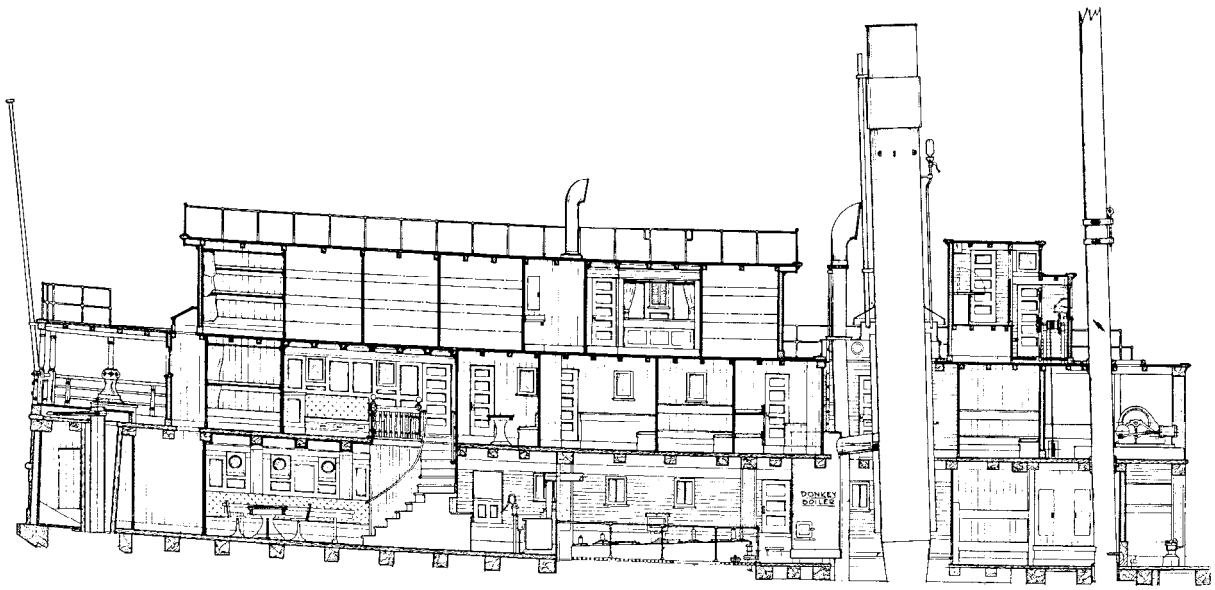
National Historic Landmark
Steam Schooner *Wapama*

Salvage and Disassembly Feasibility Study

December 21, 2009



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1.0 BACKGROUND

The rigors of the marine environment have caused extensive deterioration to the National Historic Landmark (NHL) Steam Schooner *Wapama*. Currently *Wapama* is supported and resting atop a Park Service owned barge located at the Point Potrero Marine Terminal, in Richmond, CA. The primary characteristics of *Wapama* are summarized as follows:

Constructed: 1915 in St Helens, Oregon; towed to San Francisco to install engine

Material: Douglas Fir

LBP (length between perpendiculars): 212.5'

LWL (length waterline): 212.5'

LOA (length overall): 216' 11"

Beam: moulded - 40' 4" extreme - 42' 4"

Depth (base line to top of deck on center line): 19'

Draft to present ABS plimsoll: 17'

Tonnage: gross – 945; net - 524

Displacement: light ship estimated at 1360 Long Tons (L.T.)

Cargo Capacity: 1,100,000 board feet, about 1600 L.T.

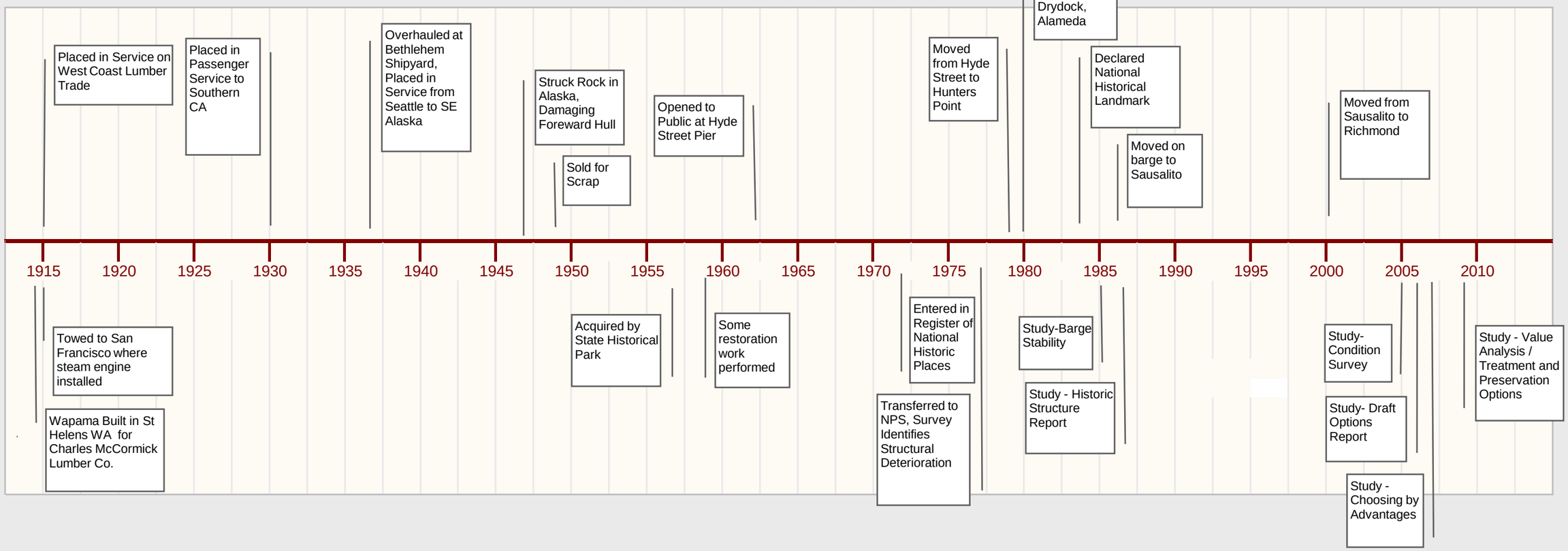
Passenger Capacity: cabin (1st Class): 44; steerage: 12 - 22

Propulsion System: single screw, steam triple expansion, 800 IHP

Boilers: 2 oil fired water tube

Wapama was taken out of service in 1947 and has largely been in a deteriorating condition since. A summary of *Wapama*'s history is presented on a timeline On Exhibit 1. Numerous studies, naval and architectural, have been performed and have indicated that portions of the ship have deteriorated well beyond restoration and have become unsafe. These studies are referenced in this report and summaries of their findings are presented in Appendix A.

WAPAMA Timeline



2.0 SCOPE

The purpose of this study is to propose a methodology for the salvage, transportation and set-up of the salvaged portions of the *Wapama* onto government owned property, including budget costs for each major work element, to review the previous reports and make specific written recommendations on the following elements:

1) Sequencing and phasing of major demolition and salvage operations.
2) Ballasting of vessel components and barge.
3) Pier loading and crane requirements.
4) Barge and salvaged vessel stability following removals.
5) Securing salvaged components to the barge.
6) Lifting of house, hull and engine components.
7) Permit or other requirements from Port of Richmond.
8) Hazardous Materials remediation with costs.
9) Space requirements of salvaged items.
10) Barge disposal at end of Project

3.0 PRESERVATION / SALVAGE WORKPLAN

3.1 SEQUENCING AND PHASING OF MAJOR DEMOLITION AND SALVAGE OPERATIONS

From the scope of work and on site meetings with San Francisco Maritime National Historical Park (SAFR) personnel (September 2009) the primary focus of this study is to validate the feasibility and costs of the conceptual salvage/preservation plan of the *Wapama*. This plan is based upon alternative 5 which was considered during the "Choosing By Advantages" (CBA) workshop (see refs 6 & 7). This alternative 5 was based on option 3 in the draft options report (see ref 4) which was prepared prior to the CBA Workshop. The present plan will salvage the After House from the main deck up, and the engine, where the previous alternative 5 and option 3 called for salvaging varying amounts of the hull below the main deck. This plan has the following major objectives:

- Salvage superstructure (After House – aft of frame 48) of vessel
- Dismantle and selective salvage of cargo section and bow
- Transport to landside location
- Place in new open air "enclosure" for public access and viewing and preservation

In determining the feasibility of performing the work to accomplish these project objectives and developing an effective methodology, we met with National Park Service (NPS) personnel and contractors who were involved with the restoration work on the vessel C.A. Thayer, or who have experience in the salvage, demolition and moving of large structures. From this we have developed the following overall methodology for accomplishing the work:

- Perform as much work on the barge as practical with *Wapama* in existing position
- Portions of vessel not salvaged will be removed with the most cost-effective means available
- Limit salvaged items forward of frame 48 to those pieces that are singularly expressive of unique construction or specific history.
- Remove forward section first to facilitate installation of steel support beam grid beneath salvaged After House section
- Transport to ultimate site onboard barge 214

Figures 1 and 2 show the major items to be salvaged and Figures 3.1 to 3.3 show the phasing of the work on barge 214. From this, a work plan with sequencing of the major

work elements was developed and is presented in Appendix C and summarized as follows:

- Document—Develop drawings of ships lines (may use laser scan in process) as called for in Historic Report (ref 2, III-B-3)
- Brace section aft of frame 48 and sever from forward section
- Dismantle and selective salvage cargo section
- Control bow section so no portion is directly over the water during salvage/demolition operations (move back onto barge deck or provide catchment below).
- Underpin After House below main deck, install steel beams through hull
- Remove Steam Engine and associated equipment
- Move After House forward on barge with straddle carriers / wheeled jacks and secure to barge
- Transport on barge to final location (to be determined)
- Slide After House off barge onto land with straddle carrier / wheeled jacks
- Set After House with steel beam supports onto permanent foundation on shore

Details of these work elements will be further detailed during the design and preparation of the contract documents and drawings. Some type of foundation support will be required at the final site. Beams would distribute the load most efficiently and will take up load as the timber beams continue to age. Utilizing the beams that will be required to transport the *Wapama* After House would be a very efficient reuse of material and is the method planned at present. The specific type of foundation will be determined during the design phase and for this reason costs for additional foundation work are included in the cost estimate.

3.2 BALLASTING OF BARGE WITH VESSEL COMPONENTS

An analysis of Barge 214's stability was performed as part of the study and is presented in Appendix D. The barge stability was analyzed for various load cases:

1. *Wapama* on the barge in its present configuration
2. *Wapama* on the barge after removal of the forward section

In addition, these load cases were considered for the intact condition (compartments tight) and damaged condition (some compartments flooded). The estimated weights of the major work components that were used in the stability analysis are as follows:

After House (Main, Cabin, Boat decks aft of frame 48):	400-500 Short Tons (S.T.). (1 S.T. = 2,000 lbs.)
Salvaged timbers (total estimate)	10-20 S.T.
Demolition removal	800-900 S.T.
Steam Engine (w/o steam chest)	25-35 S.T.
Hawse Pipes	0.5 S.T.
Knees	800 lb ea

The analysis showed that Barge 214 could be ballasted to trim her out. However, considering the hull bending stress that would likely result and the condition of the barge after all of these years of little or no maintenance, it is recommended that the aft portion of the *Wapama* be moved forward to a more central location on the barge. Other recommendations were developed from the analysis and are presented in section 3.4.

3.3 PIER LOADING AND CRANE REQUIREMENTS

The loading on the adjacent piers at Pt Potrero graving docks will be limited since most of the work will be performed on the barge. However the steel beam grid loads on the barge deck will be as high as 70 tons at the support bogie trucks. This will require matting on the barge deck to safely support these loads on the deck.

The option of lifting the superstructure with a crane and setting the superstructure on the existing barge, or another barge, was examined. In order to perform this, a crane with a minimum capacity of 400 tons would be required. There are 3 barge mounted cranes of this capacity on the West Coast:

- DB General (General) – 700 tons
- Derrick 24 (Manson) – 400 tons
- Haakon (Mason) – 400 tons

The cost to mobilize these cranes would be high and availability limited because of long term commitments. A land based crane is available but has a high mobilization cost of at least $100,000. Further, in a lifting operation there is greater risk of total collapse of the structure if a progressive yielding occurs when the vessel is being hoisted. For these reasons the use of a steel beam grid supported on barge mounted jacks from below is recommended.

3.4 BARGE AND SALVAGED VESSEL STABILITY FOLLOWING REMOVALS

Based upon the onsite observations of Barge 214 and the analysis of the barge stability (see Appendix D) the following measures are recommended:

Summary of Recommendations

1. Patch and seal centerline bulkhead penetrations

2. Move After House portion forward during demolition to maintain trim.

3. Perform updated survey and structural analysis of Barge 214 prior to performing substantial work. To include:

    - Compartments evacuated and inspected
    - Metal thickness measured
    - Leakage and Pressure test
    - Longitudinal strength, analyzed in present condition
    - Inclination/ Stability Test Performed.

3.5 SECURING SALVAGED COMPONENTS TO THE BARGE

Most of the salvaged components will be stored in standard steel shipping containers while on site at the Pt. Potrero Facility. These would be the timbers and metal artifacts but not the steam engine due to its size and weight. This will allow them protection from the elements and vandalism and will allow easy transport to a warehouse or other storage facility until they are finally reused.

The cabin portion that will be transported on the barge will be moved to the center of the barge, lowered onto support blocks on the deck and secured with tension wires tied to fittings which will be welded onto the barge deck.

3.6 LIFTING OF AFTER HOUSE, HULL AND ENGINE COMPONENTS

As noted above, the option of lifting the superstructure with a heavy lift crane or dismantling the superstructure for lifting in sections using a more conventional crane were studied but found wanting compared to installing a steel beam grid on the barge and jacking from below. Once the cabin section is supported, the boilers and piping can be removed from below by pulling them forward onto the, then, clear barge deck. Once this is accomplished, the cabin structure can be lowered and moved forward onto the center of the barge, and readied for transport to its final location.

The offloading would be accomplished by either driving the straddle carriers or pulling wheeled jacks off onto a structure (pier or ramp) that is at the same elevation as the barge deck—depending on the final destination once that is known. Transfer of the after house section over land by means of the supporting steel beam grid and wheeled carriers is relatively straightforward. The *Wapama* will roll to its final location and set on foundation piers, utilizing the steel beam grid.

3.7 PERMITS/ OTHER REQUIREMENTS FROM PORT OF RICHMOND

The Port of Richmond does not require any permit applications for the work that will be performed on the barge or at the Pt Potrero facility. Any welding or cutting that is performed would require a "hot work" permit from the City of Richmond.

Barge 214 is owned by the National Park Service and is not a vessel for hire but rather a private vessel. Further, it will not be carrying hazardous material as bulk cargo. For these reasons, inspection of the barge or any other permitting from the Coast Guard is not required to use Barge 214 to transport *Wapama* in San Francisco Bay (ref 46 CFR I-2.01). The NPS could notify the Coast Guard and request an inspection, but this would be voluntary.

Wapama is located at the Point Potrero graving docks in Richmond, CA. Rosie the Riveter/World War II Home Front National Historical Park has interpretive responsibilities for these graving docks and notification of project activities should be made in advance of the work, although the Park does not issue permits for such.

3.8 HAZARDOUS MATERIALS REMEDIATION

Asbestos and lead (as well as other metal) based paint are present on *Wapama* as identified in the Reference 3. Asbestos is primarily located in the engine compartment, and lead based paint (LBP) is found throughout *Wapama*. The removal of asbestos and treatment (likely encapsulation) of the LBP's in the cabin section would best be performed at the present location and over the barge deck where it can be contained. Cost for this work is included in the estimate presented in Appendix B.

3.9 SPACE REQUIREMENTS FOR SALVAGED ITEMS

As noted above most of the salvaged components can be accommodated in shipping containers on the barge deck or within a storage area nearby. Most of the timber forward of frame 48 is badly deteriorated and as such will be loaded into trucks and disposed of soon after removal.

3.10 BARGE DISPOSAL AT THE END OF THE PROJECT

The barge can be either sold or scraped at a metal recycling facility once *Wapama* has been offloaded at the final destination. One such facility is Sims Metal in Redwood City

who indicated they could readily accept and recycle the barge at their facility, accessible by water.

3.11 EVALUATE THE IMPACTED AREA AT RICHMOND SHIPYARD

Utilizing the barge as the primary area of work will minimize the impacts to the Pt. Potrero Shipyard. Access to the piers on each side of *Wapama*'s present berth will be required to offload the salvaged items, and to load the steel beam grid, and straddle carriers/wheeled jacks onto the barge. Additional landside storage area will be needed for temporary use; this is estimated at about 10,000 sf.

3.12 FUTURE SITE ADEQUACY AND PLAN

The specific location for the final display of the *Wapama* salvage is not known now. To accommodate the salvaged After House and engine of *Wapama*, a minimum area footprint of 80 ft by 140 ft (1/4 of an acre) will be required. The After House that is salvaged is approximately 100 ft long x 50 ft wide x 30 ft tall. This section would be moved to the final site. Utilities will need to be available in the immediate vicinity. The NPS provided the following criteria for the final display location:

1. At a NPS controlled location.
2. Within ½ mile of the waterfront.
3. On San Francisco Bay.

In evaluating potential sites that meet the above criteria, additional factors must be considered. These factors are dependent on the specific site and were identified during the CBA (refs 6, 7) process:

- Property's Integrity: Location and association (ref 7, Appendix 4)
- Visitor's Services/ Ease of Accessibility (ref 7, factors 3, 4)
- Operational Efficiency (ref 7, factor 6)

The National Register recognizes a property's integrity through seven qualities: location, design, setting, materials, workmanship, feeling, and association. The properties most relevant to a specific site for *Wapama* are location and association. These excerpts from the NPS standards provide guidance:

> Location….consideration of "integrity of location" should be construed to mean that a vessel is located in a port or other location with which the vessel historically had some association, such as a port of construction, or a port of call.
>
> Association: A period or accurate waterfront setting for a historic vessel is desirable and adds to the integrity of setting for the vessel. A vessel loses her integrity of association if she is removed from the water and displayed out of sight of the water.

To maximize visitor's services and ease of accessibility, the site should be located at a site that currently has easy access and a large volume of visitors. This would ideally be a location served by public transit as provided in NPS policy guidance (see 2006 Management Policies, Section 9.2). The current location of the historic vessel Hornet in Alameda at the former Naval Air Station provides an example of location that does not have these qualities, as evidenced by the low visitor volume at that location.

Operational efficiency will be realized at a location that is close to existing facilities and staff that will have to maintain and operate the facility.

4.0 SUMMARY

4.1 PROJECT SCHEDULE

The work schedule for the project is presented in Appendix C. A Summary of the major work elements of which there is some overlap is as follows:

Environmental Review, Engineering, Permits	12 Months
Preparatory Work (documentation, HAZMAT)	3 Months
Hull Section Salvage/Removal (Forward of Frame 48)	5 Months
Bow Section Salvage/Removal	3 Months
Cabin Section Salvage/Steel Beam Support	6 months
Preparation for, and Transport	1 month
Final Site Preparation and Offload	11 months
After House Preservation and Rehabilitation (at final site)	12 months
Total Duration (overlap between work items)	25 Months

4.2 SAFETY

During the preparatory work, the selected contractor will be required to prepare a safety plan for submittal and approval prior to commencing work. The final design specifications and contract documents will describe the requirements and standards that the safety plan will need to address such as worker safety, temporary support of the deteriorated members during removal, compliance with occupational safety standards and hazardous material removals.

Due to the deteriorated condition of *Wapama* access onto the vessel presents safety hazard risks at present. Any access onto *Wapama* prior to work being performed by the selected contractor should be performed with appropriate safeguards in place. Personnel performing any observations or measurements should have appropriate protective equipment on and access should continue to be restricted in areas that have been identified as having lost significant structural support.

4.3 CONSTRUCTION AND CONTRACT DOCUMENTS

The disassembly and salvage work to be performed on *Wapama* is highly specialized and will depend heavily on the selected contractor's work means and methods. In order to obtain the best end result for the preservation of *Wapama* and to do so in an efficient and cost effective way, the contract documents should not be overly restrictive, but should allow the contractor to utilize the most appropriate means and methods to achieve the desired result. This requires a performance based contracting method. It also strongly favors a "best value" contractor selection method, to help insure that the contractor's qualifications and proposed approach to the work are considered as well as cost. For example, requiring that the engine be removed undamaged and delivered onshore onto a truck for transport, rather than specifying that a certain type of jack be utilized and that it must be removed from the front. On the other hand, for items where a more defined product is required, the contract should be prescriptive. For example, the foundation and enclosure for display of the *Wapama* should be specific as to the exact material, finish, dimension, load capacity, color, etc. that are to be provided.

For these reason's the contract documents should be prepared by a qualified engineer who is specialized in maritime and shipyard related work, particularly with the NPS and historical parks. As described above, the documents should provide the appropriate level of performance and prescriptive requirements for the contractor to prepare submittals of work elements that best utilize the individual contractor's means and methods, but are subject to review and approval by the engineer, who is experienced and familiar with such work.

4.4 PROJECT COST ESTIMATE

The detailed estimated cost for the project is presented in Appendix B. As was decided by the NPS during this study, these costs reflect salvaging the After House from the main deck up from the stern to frame 48, the engine and singular timbers are representative of the construction forward of frame 48. A summary of the detailed costs are as follows:

TABLE 1 COST ESTIMATE SUMMARY

Description	Cost
Preparatory Work	$1,405,000
Disassemble Bow	$245,000
Disassemble Hull Section to Front of House	$521,000
Cabin Salvage/Disassemble Lower Hull Section under House	$2,535,000
Towing and Barge	$10,000
Final Display Location	$1,690,000
Subtotal	$6,406,000
Contingency @ 20%	$1,281,200
Total Estimated Cost	$7,687,200
Permits	$230,616
Engineering	$614,976
Post Project Catalogue & Document	$230,616
Bonds, Insurance	$192,180
	$8,960,000

A preliminary life cycle calculation was performed for an assumed 25 year life cycle and is presented in Appendix B. The life cycle calculation was performed using the format and procedures from the NPS CBA workflows and modified for this project. It is noted that this procedure is primarily used for choosing between alternatives; however the approach yields the present cost and annual costs of the entire project in present dollars which may be used for future planning and budgeting of the selected alternative.

Based upon the staffing at the Hyde Street Pier of a total of 6 personal devoted full time to the preservation and maintenance of the 6 ships berthed there, it is anticipated that an additional full time equivalent (FTE) position will be required to preserve the *Wapama* at the final location. This position is in fact a composite of the various specialties and grades of personnel that will be involved with the preservation work. In addition, 2 hours per day for 1 person (0.25 FTE) of maintenance time is allocated for general clean up of the *Wapama* at the final display location.

4.5 NPS INFORMATION REQUIREMENTS

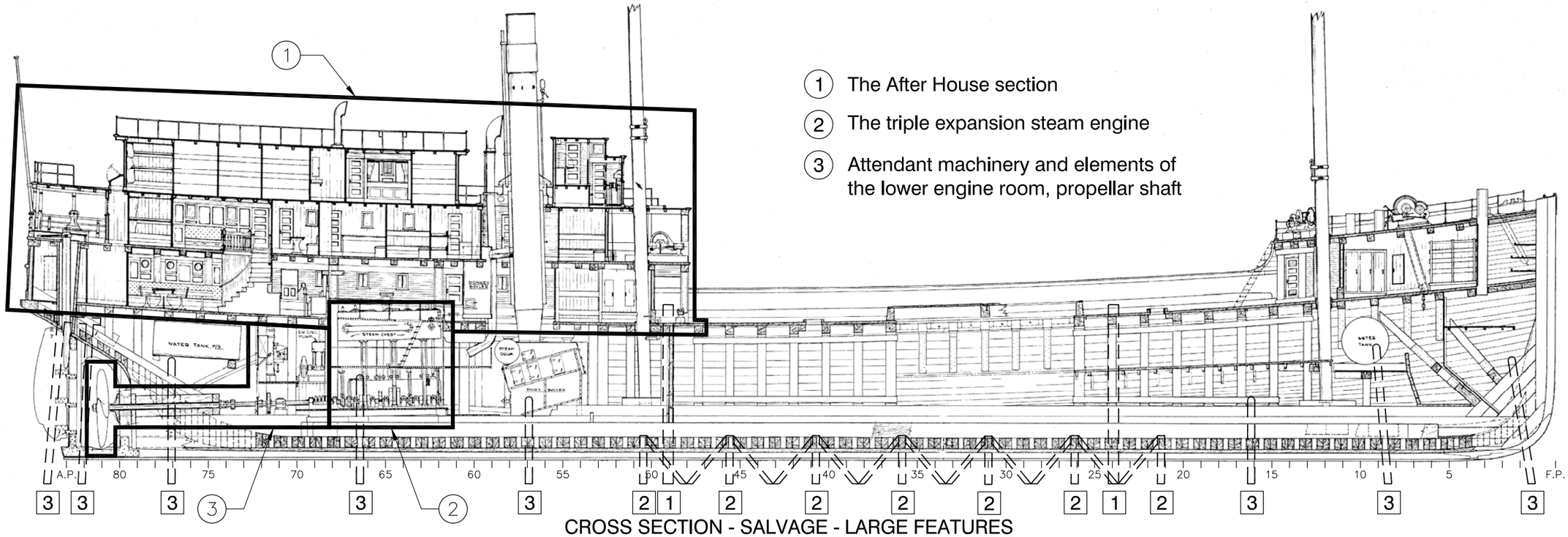
We understand that the following items will be provided by the NPS to include in the final report submitted in their PMIS package:

1. Confirmation of the costs based upon NPS input (see Notes in Appendix B), work descriptions and work elements to be performed by the NPS, including:

- Final location site improvements, enclosure type, foundation pad and utilities
- Preservation and rehabilitation of house and salvaged pieces bow/engine
- Life cycle costs in Appendix B
- Personnel required (FTE) during the life cycle to maintain, preserve and interpret *Wapama* at the final location.

2. Identification of final location, NPS controlled site

Figures

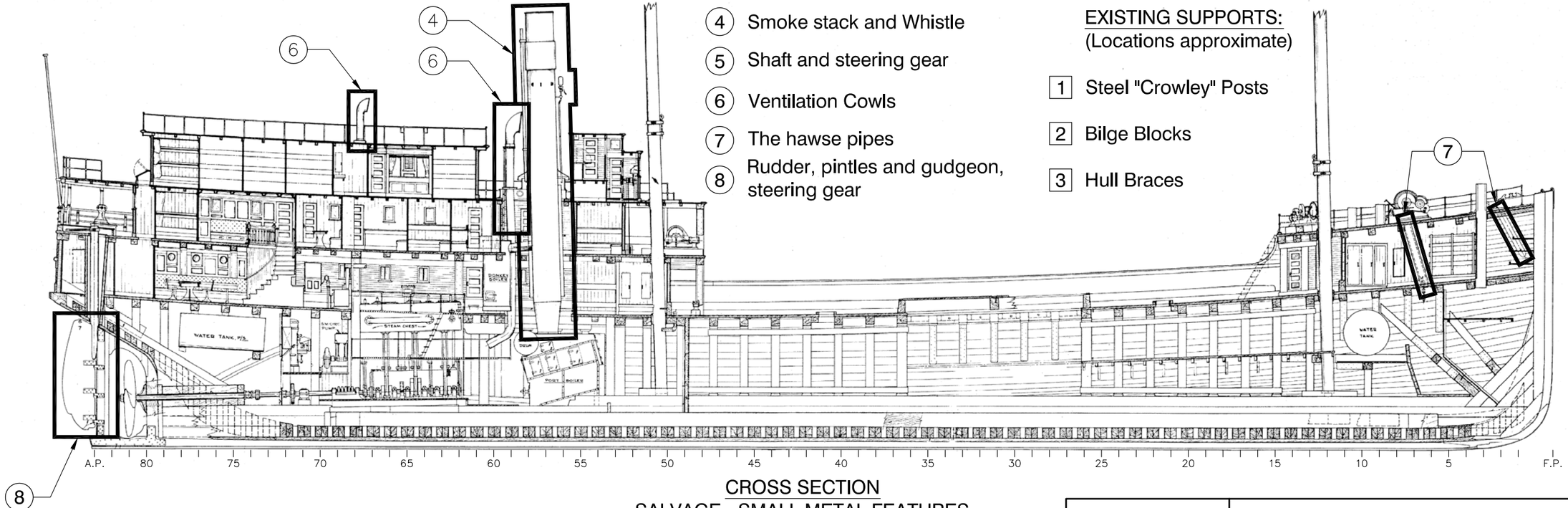


1 The After House section

2 The triple expansion steam engine

3 Attendant machinery and elements of the lower engine room, propellar shaft

CROSS SECTION - SALVAGE - LARGE FEATURES



4 Smoke stack and Whistle

5 Shaft and steering gear

6 Ventilation Cowls

7 The hawse pipes

8 Rudder, pintles and gudgeon, steering gear

EXISTING SUPPORTS:
(Locations approximate)

1 Steel "Crowley" Posts

2 Bilge Blocks

3 Hull Braces

CROSS SECTION
SALVAGE - SMALL METAL FEATURES

0 10' 20' 30' 40' 50'

1/16"=1'-0"

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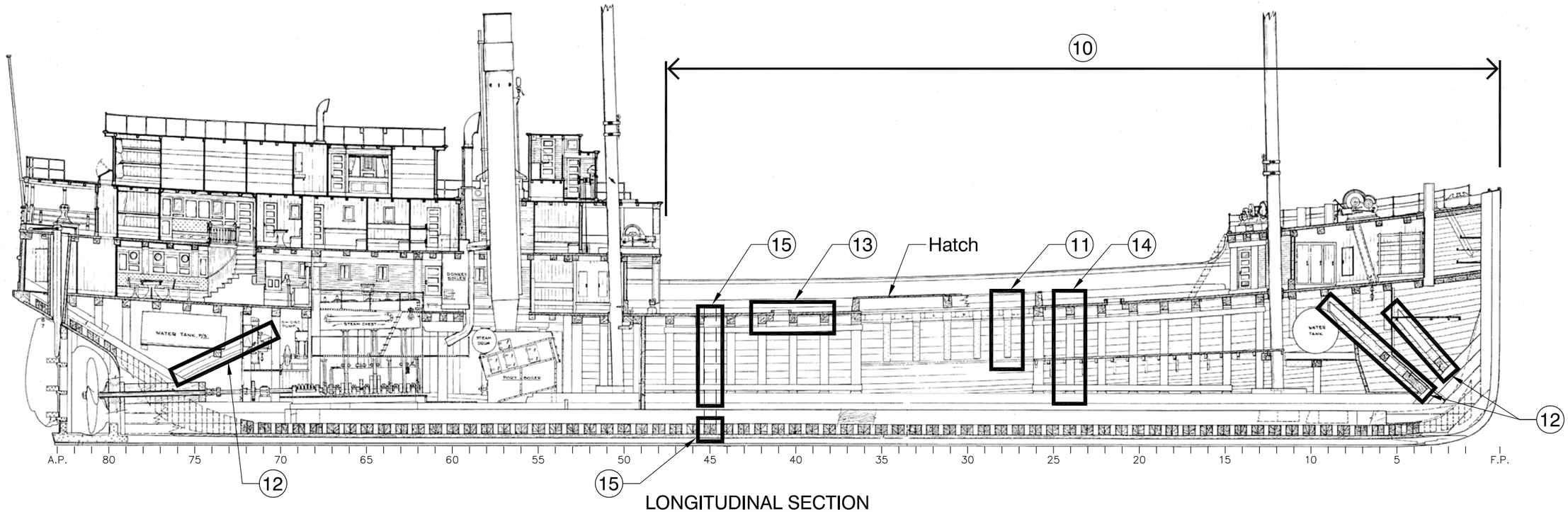
S.F. MARITIME NATIONAL HISTORICAL PARK

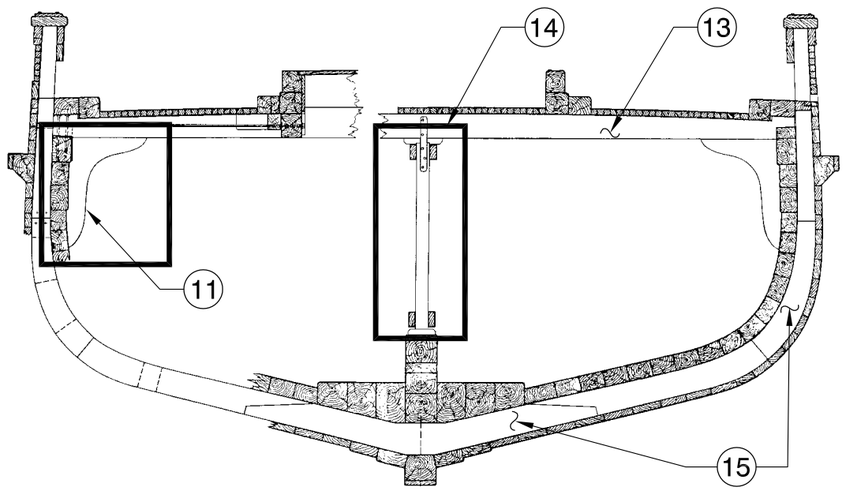
NHL STEAM SCHOONER WAPAMA
SALVAGE FEASIBILITY

CROSS SECTION
SALVAGE - METAL FEATURES

FIG. 1



LONGITUDINAL SECTION



MIDSHIP SECTION

(10) Salvage selected great timbers forward of frame 48:

- (11) Wooden knees - adaptive reuse
- (12) Pointers
- (13) Beams
- (14) Stanchions
- (15) Frames

0 10' 20' 30' 40' 50'

1/16"=1'-0"

0 5' 10' 15' 20' 25'

1/8"=1'-0"

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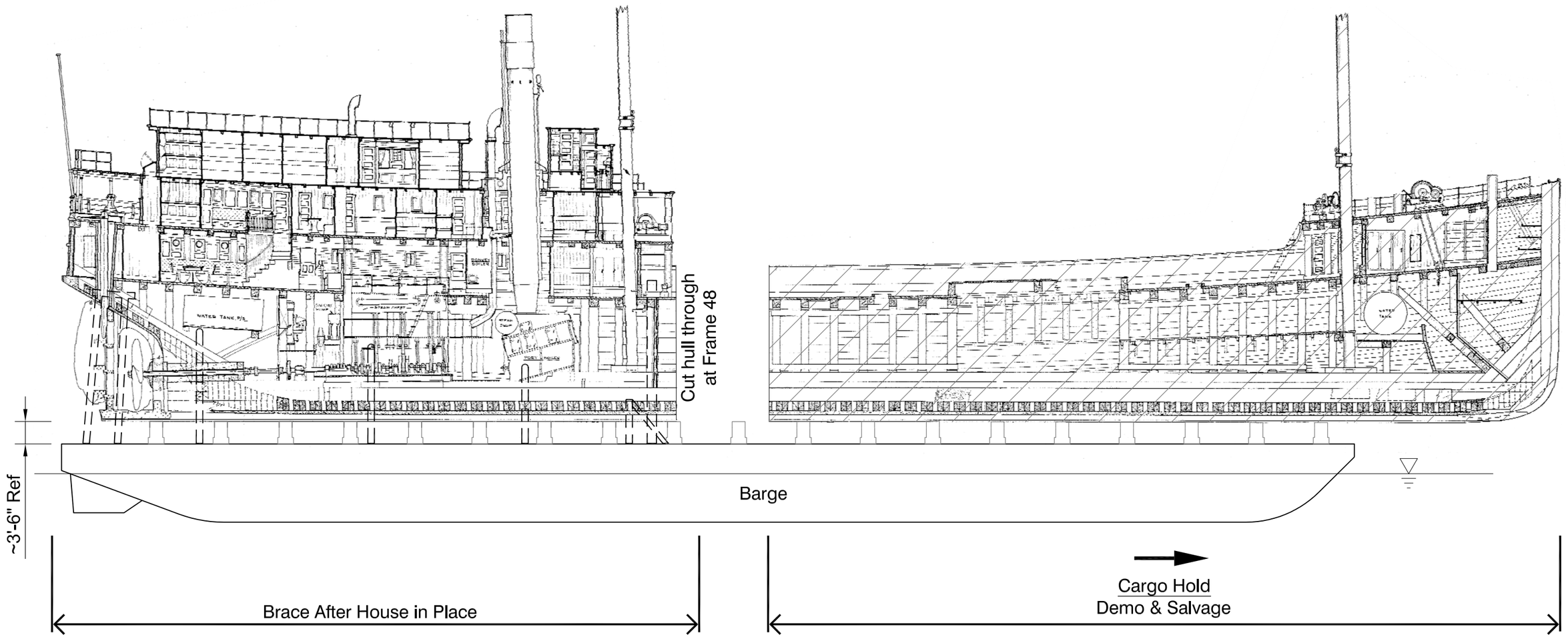
NHL STEAM SCHOONER WAPAMA
SALVAGE FEASIBILITY

CROSS SECTION
SALVAGE - WOODEN FEATURES

FIG. 2



CROSS SECTION PHASE 1

0 10' 20' 30' 40' 50'

1/16"=1'-0"

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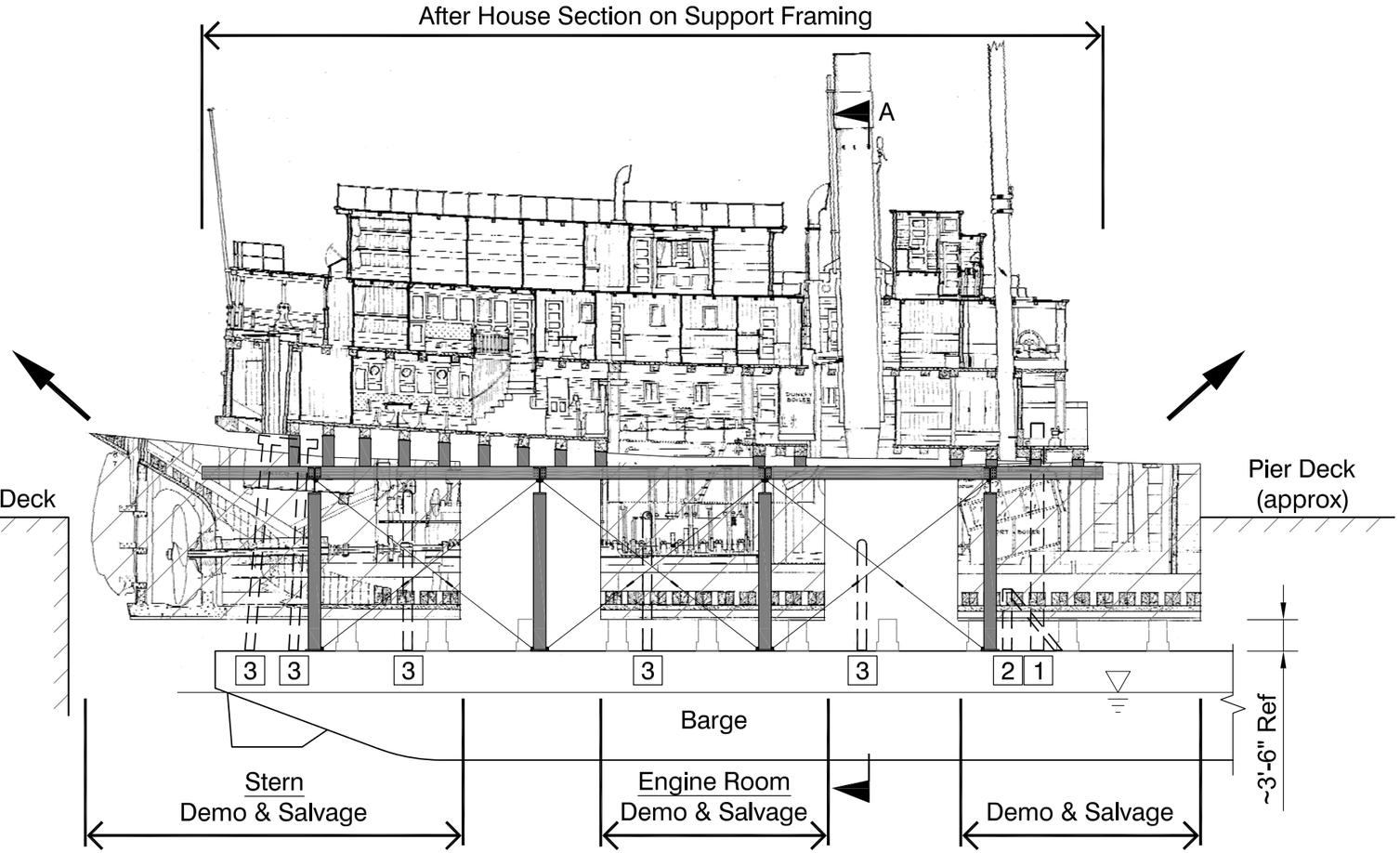
NHL STEAM SCHOONER WAPAMA
SALVAGE FEASIBILITY

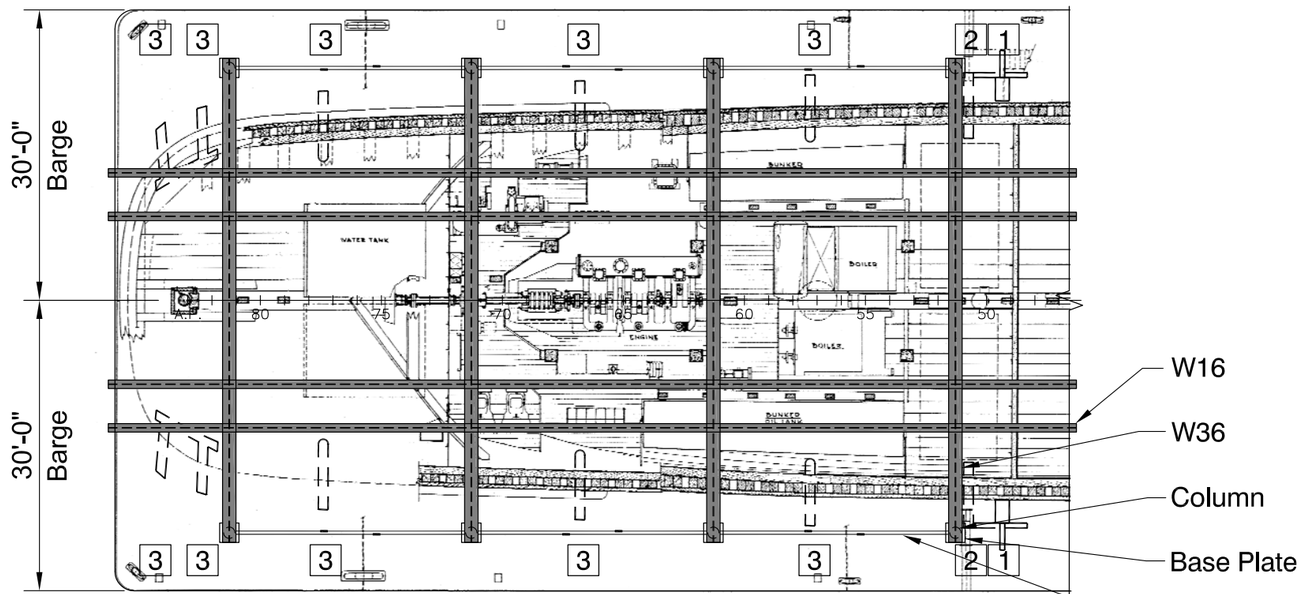
AFTER HOUSE SECTION LIFT
PHASE 1

FIG. 3.1

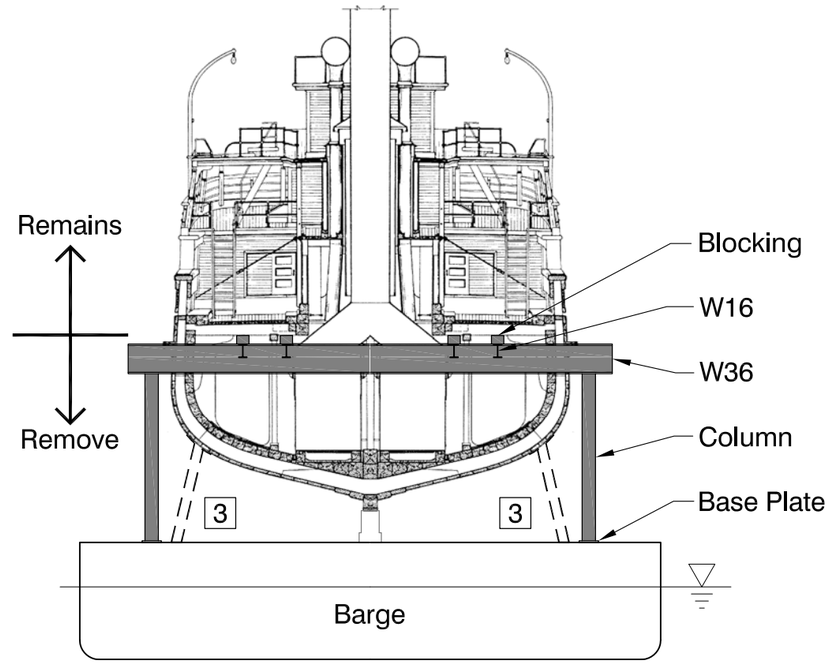
After House Section on Support Framing



CROSS SECTION PHASE 2



AFTER HOUSE SECTION - PLAN



SECTION A-A

EXISTING SUPPORTS:
(Locations approximate)

1 Steel "Crowley" Posts

2 Bilge Blocks

3 Hull Braces

NOTE:

1. Weight of Cabin is greater than 400 tons (estimated).

0 10' 20' 30' 40' 50'

1/16"=1'-0"

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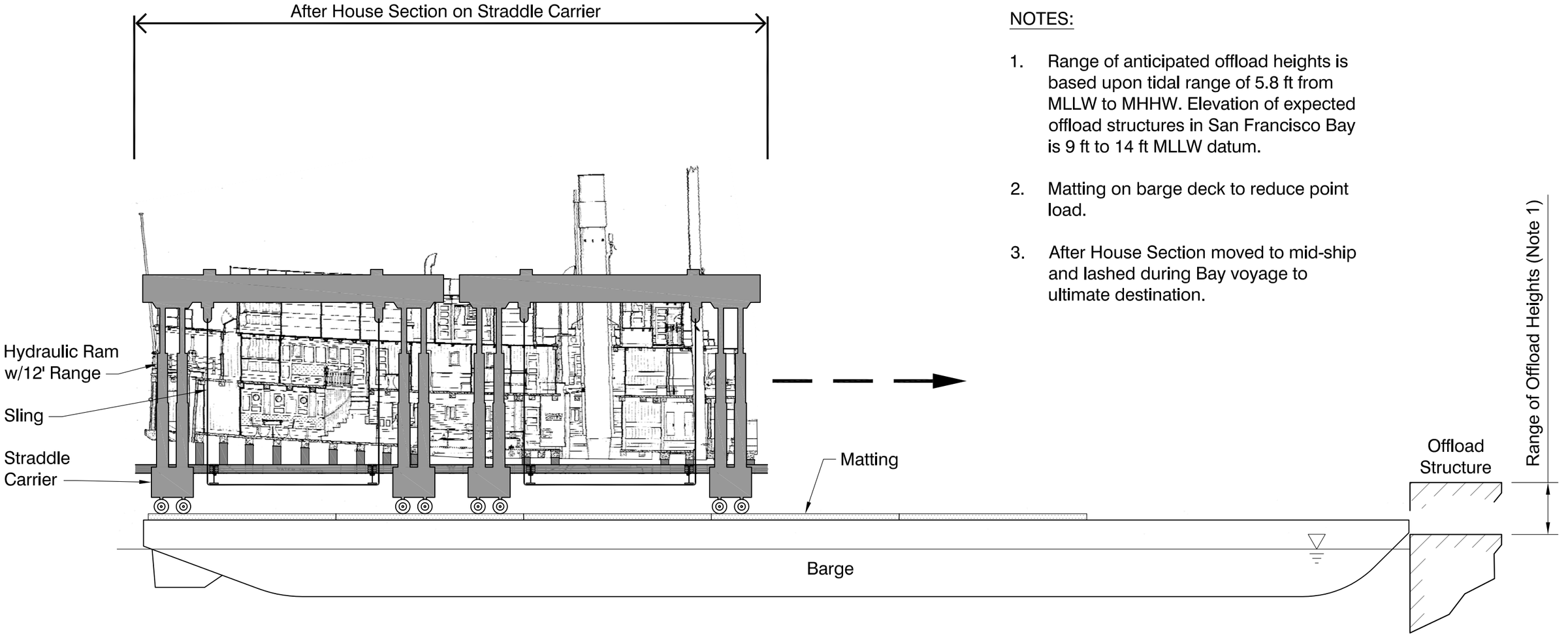
NHL STEAM SCHOONER WAPAMA
SALVAGE FEASIBILITY

AFTER HOUSE SECTION LIFT
PHASE 2

FIG. 3.2



NOTES:

1. Range of anticipated offload heights is based upon tidal range of 5.8 ft from MLLW to MHHW. Elevation of expected offload structures in San Francisco Bay is 9 ft to 14 ft MLLW datum.
2. Matting on barge deck to reduce point load.
3. After House Section moved to mid-ship and lashed during Bay voyage to ultimate destination.

CROSS SECTION PHASE 3

0 10' 20' 30' 40' 50'

1/16"=1'-0"

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S.F. MARITIME NATIONAL HISTORICAL PARK

NHL STEAM SCHOONER WAPAMA
SALVAGE FEASIBILITY

AFTER HOUSE SECTION LIFT
PHASE 3

FIG. 3.3

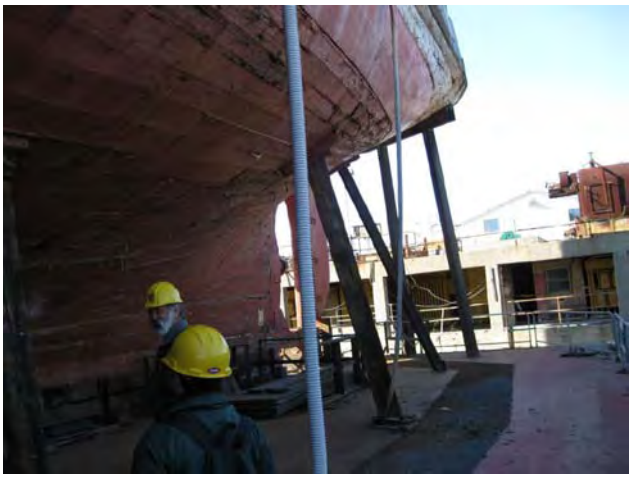
Photographs

PHOTOS	LOCATION
1-8	HULL EXTERIOR
9-23	CABIN DECK
24-35	MAIN DECK
36-45	ENGINE ROOM
47-49	CARGO HOLD

1- WAPAMA Hull

2- Hull at Stern

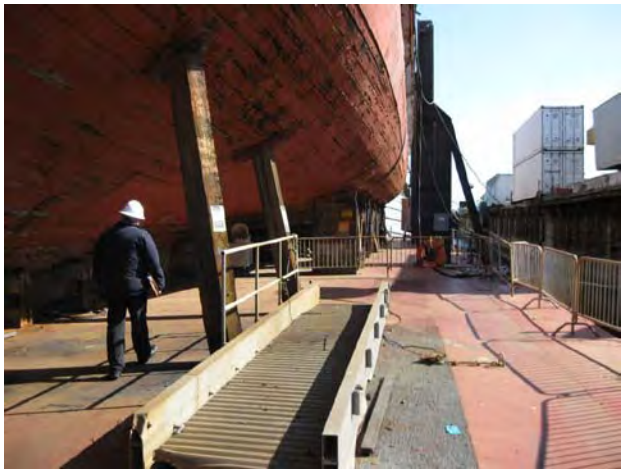
3-Hull Blocking Port Side



4-Hull Blocking Port Side

5-Hull Blocking Port Side

6-Hull Blocking Starboard Side



7- Hull Starboard

8-Blocking

9-Boat Deck Port

10-Boat Deck at Stack

11- Stack at Boat Deck

12-Stack at Fidley

13-Cabin Deck at Stack

14-Cabin Deck at Stern-Capstan removed

15-Cabin Deck Port looking Forward

16-Cabin Deck Port-Aft

17-Cabin Deck Port

18-Cabin Deck Social Hall Aft

19- Cabin Deck Social Hall Forward

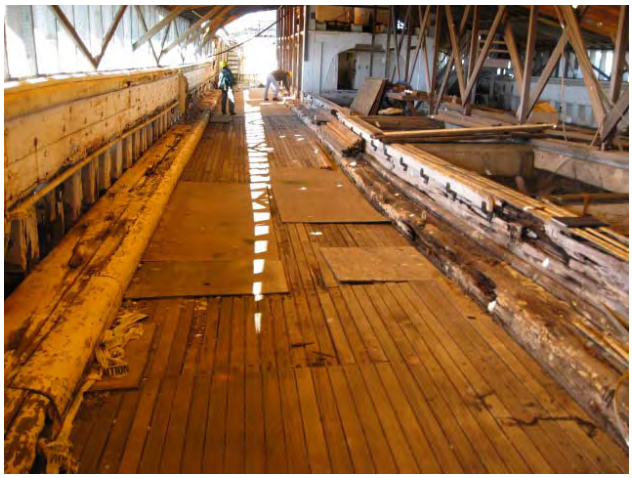
20-Cabin Deck Berth

21-Cabin Deck Quarters

22-Cabin Deck Overhead

23-Cabin Deck Quarters

24-Forecastle-Windlass and Winch Removed



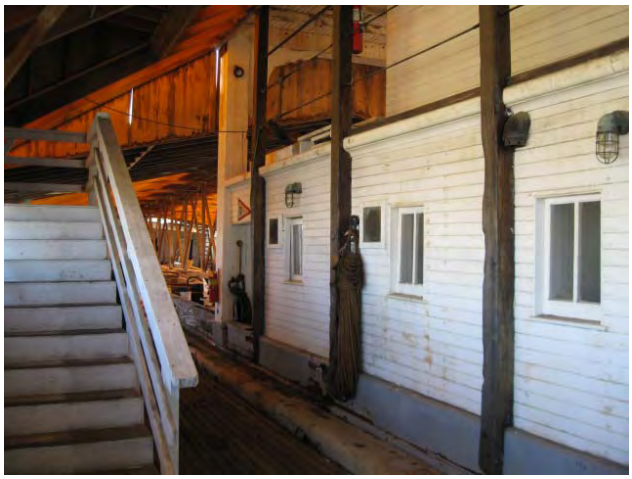
25-Main Deck Starboard looking aft

26-Main Deck Starboard looking Forward

27-Main Deck Port looking Forward

28-Main deck at Steam Chest

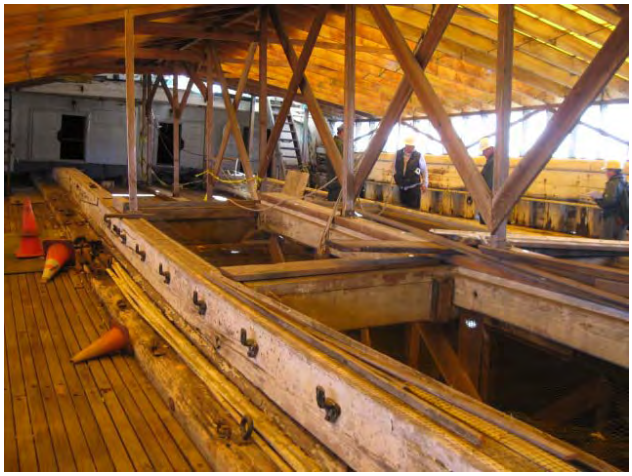
29-Main Deck-Winchmen Compartment



30-Main Deck Port, Looking Forward

31-Main Deck Port Looking Aft

32-Main Deck Port Looking Aft



33-Main Deck Port Looking Forward

34-Main Deck Stringers

35-Main Deck Starboard at Forecastle

36-Steam Chest Looking Aft

37-Steam Chest Looking Forward

38-Donkey Boiler

39-Elect Panel in Engine Room

40-Steam Engine- Engine Room

41-Steam Engine at Chest-Main Deck

42-Engine Room

43-Boiler Doors Engine Room

44-Between Port/Starboard Boilers

45-Manifold/Fuel Tank-Engine Room

46-Cargo Hold at Hatch-Ships Beam

47-Cargo Hold Knees

48-Cargo Hold Fuel Tank

49-Cargo Hold

Appendix A

References and Summary of Reports

Ref	Title	Date	By	Summary of Report
1	Stability analysis SS *WAPAMA*, Barge 214	Jul, 1985	Hull and Cargo Surveyors, Inc, Richmond CA	• Barge has adequate stability for moored state. • Loss of one compartment yields instability. Further examination required for towing in open water
2	Historic Structure Report	1986	Tri Coastal Marine,Galveston TX	• Performed a comprehensive condition survey by section and found *WAPAMA* in advanced state of deterioration. • Prepared measured drawings of *WAPAMA*; not able to, but recommended ships lines be prepared. • Concluded that: 1. Complete rebuild required to refloat *WAPAMA*--but not viable 2. *Wapama* "married' to Barge 3. Not presently suitable for Public Access 4. Long term, comprehensive preservation program is required. • Recommended preservation as a shore based exhibit.
3	Condition Survey Ph 1A	Nov, 2005	Architectural Resources Group (ARG), San Francisco	• Performed rapid structural survey to update the 1985 Stability and 1986 Structure reports. • Found condition of superstructure (cabin accommodations aft of frame 48 in main/cabin/boat decks) relatively good, portion foreward of frame 48 (cargo hold and forecastle) in extremely deteriorated condition
4	Draft Options/Condition Survey Ph 1B	Oct, 2006	ARG	• Identified 4 options for preservation (and rough costs): 1. Full Rehabilitation and Restoration ($35mil) 2. Full Stabilization ($11 mil) 3. Partial Salvage ($12 mil) 4. Dismantling and Selective Salvage ($8 mil)
5	Condition Assessment	Feb, 2006	Univ of Minnesota, Duluth	• Performed Non destructive testing and sampling of *Wapama*'s structure at 3 frames, and along the deck stringers and keelsons forward of frame 48, performed visual inspection of structure aft of frame 48 of the cabin superstructure (main/cabin and boat decks). • Found extensive deterioration in those areas and elements exposed to wetting and drying: hull above waterline, deck stringers, keelsons and frames near the cargo hatch.

				• Found less deterioration in remaining areas: keelsons outside of hatch area, superstructure and below, hull below waterline. • Recommended repair or replacement of roof shelter and more extensive analysis of key structural components
6	Choosing By Advantages (CBA) Mtg	Nov, 2006	NPS-SAFR/DSC, ARG	• A value analysis (VA) was performed on the options in the 2006 report--including additional options--to evaluate historic preservation effectiveness. • The analysis was performed during a 2 day workshop in San Francisco. The options considered are summarized: 1. Full Rehabilitation / Restoration to Floating Exhibit ($36 mil) 2. Preservation (Stabilization) of Vessel on Barge ($17 mil) 3. Preservation (bow) / Rehabilitation (stern) in Building ($25 mil) 4. Preserve Structure / Rehabilitate Exterior for Outdoor Exhibit ($22 mil) 5. Rehabilitate stern in Building / Dismantle and Salvage Remainder ($12 mil) 6. Partial Salvage / Disposal ($10 mil) • Alternatives were ranked by the choosing by advantages (CBA) process and alternative 5 stood out as having twice the advantage of the preferred alternative 6, with only marginally higher costs
7	Value Engineering Study	March 2008	ARG	• Results from the VA study and updated costs were presented : 1. Full Rehabilitation / Restoration to Floating Exhibit ($38.2 mil) 2. Preservation (Stabilization) of Vessel on Barge ($13.2 mil) 3. Preservation (bow) / Rehabilitation (stern) in Building ($19.5 mil) 4. Preserve Structure / Rehabilitate Exterior for Outdoor Exhibit ($19.0 mil)

				5. Rehabilitate stern in Building / Dismantle and Salvage Remainder ($15.9 mil) 6. Partial Salvage / Disposal ($8.5 mil) • Alternatives were ranked again with these updated costs and the advantage scores from the CBA process. Alternative 5 stood out as having twice the advantage of the preferred alternative 6, with only marginally higher costs

Appendix B

Cost Estimate

Wapama Rehabilitation - Cost Estimate Breakdown

(2009 Costs)

No.	Description	Cost
1	**Preparatory Work**	**$1,405,000**
1.1	Documentation (Historic Ship Consultant on Contractor Staff)	$50,000
1.2	Barge Stability and Structural Assessment	$50,000
1.3	Barge Ballasting Setup	$100,000
1.4	Install Additional Shoring/Bracing in Barge	$200,000
1.5	Remove Rudder & Shaft (note 5)	$10,000
1.6	Remove/Salvage Items from House	$35,000
1.7	Treat/Store Salvage Items	$50,000
1.8	Brace/Frame Internal Elements in House	$70,000
1.9	Furnish/Install/Maintain Support System & Jacks	$500,000
1.10	Hazardous Materials Remediation	$300,000
1.11	Remove Existing Temporary Coverings	$40,000
2	**Disassemble Bow**	**$245,000**
2.1	Disassemble Machinery, Forgings, etc. from Bow Section	$35,000
2.2	Salvage Timbers - Bow (Reduced Crew-note 6)	$30,000
2.3	Treat Timbers as Required for Storage	$50,000
2.4	Salvage additional items - Bow (Reduced Crew)	$20,000
2.5	Demo/Remove Remaining Bow from Barge	$40,000
2.6	Scrap Timbers, etc. - Bow (Reduced Crew)	$20,000
2.7	Disposal Fees - Allowance	$50,000
3	**Disassemble Hull Section to Front of House**	**$521,000**
3.1	Not Used	
3.2	Not Used	
3.3	Allow Crane Lift Rig (Include Mob/Demob)	$75,000
3.4	Not Used	
3.5	Disassemble Remaining 60 ft. of Hull Section (note 3)	$144,000
3.6	Salvage Timbers - Hull Section (note 3)	$70,000
3.7	Treat Timbers as Required for Storage	$35,000
3.8	Demo/Remove Remaining Hull Section from Barge	$72,000
3.9	Scrap Timbers, etc. - Hull Section	$50,000
3.10	Disposal Fees - Allowance	$75,000
4	**Cabin Salvage/Disassemble Lower Hull Section under House**	**$2,535,000**
4.1	Disassemble Engine and other associated piping	$70,000
4.2	Remove/Salvage Stack & Other Associated Piping	$60,000
4.3	Remove Boiler & Other non-Salvagable Items (Reduced Crew)	$80,000
4.4	Dispose of Boiler & Other non-Salvagable Items	$80,000
4.5	Remove/Salvage Engine and Other Associated Piping	$140,000
4.6	Transport/Store Engine & Piping Until re-Assembled	$60,000
4.7	Demo/Remove Remaining Hull Section from Under House	$80,000
4.8	Scrap Remaining Hull Section (Reduced Crew)	$50,000
4.9	Disposal Fees - Allowance	$100,000
4.10	Lower House Section on Barge & Block	$15,000
4.11	Allowance Preserve House (note 2)	$1,800,000

Wapama Rehabilitation - Cost Estimate Breakdown

(2009 Costs)

No.	Description		Cost
5	**Towing and Barge**		**$10,000**
5.1	Prepare Barge for Transportation		$10,000
5.2	Towing to Display Location		$25,000
5.3	Offload/Travel to Final Location (note 7)		$80,000
5.4	Towing Barge to Scrap Yard		$25,000
5.5	Scrap Barge - Allow Salvage Value		-$130,000
6	**Final Display Location**		**$1,690,000**
6.1	Site Improvements - Foundation (note 4)		$420,000
6.2	Site Improvements - Utilities		$250,000
6.3	Site Improvements - Open Air enclosure		$400,000
6.4	Final Placement/Remove Jacks		$360,000
6.5	Signage Display Costs (Note 2)		$60,000
6.6	Fire Protection System		$125,000
6.7	Security System		$75,000
	Subtotal		$6,406,000
	Contingency @ 20%		$1,281,200
	Total Estimated Cost		$7,687,200
	Environmental Review, Permits	3.00%	$230,616
	Engineering and Construction Support	8.00%	$614,976
	Documentation and Catelogue at Close Out	3.00%	$230,616
	Bonds, Insurance	2.50%	$192,180
		Total Cost	**$8,960,000**

Notes:

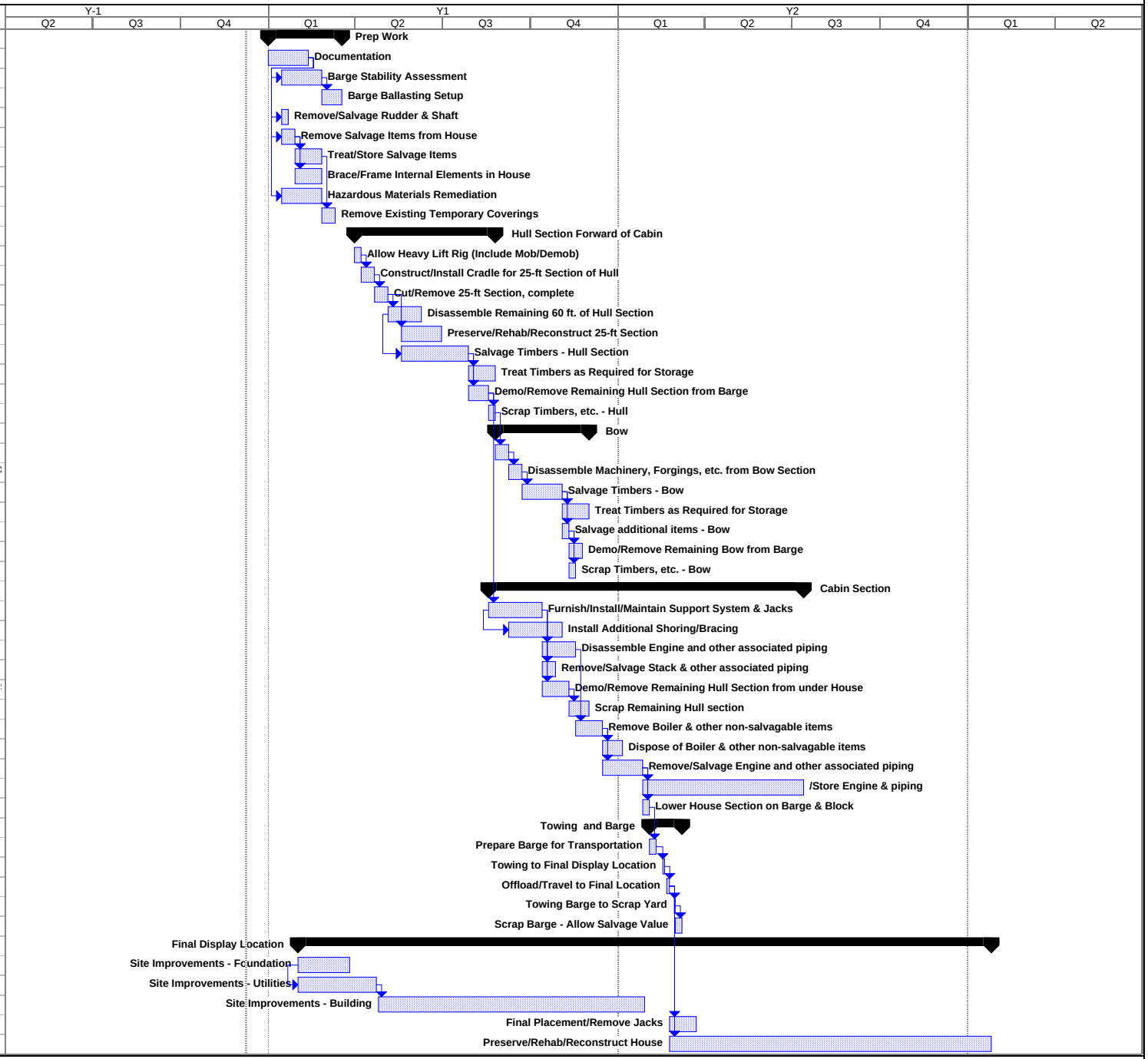
1) Cost of NPS staff onsite during construction not included.
2) Preservation and display costs are based upon input from NPS
3) Allows 5 shifts of standby time for each task
4) Specific foundation type will be determined in design, additional costs added to to allow for more than just using beams from item 1.9
5) Full crew is 11 workers 4 ea Laborers, Carpenter, 1 ea operator, oiler, crane used for most tasks unless reduced crew noted
6) Reduced crew is 4 to 9 workers appropriate to work task
7) Allow for overland transportation located within 2000 ft of shore at offloadable facility--ramp or skids, and unobstructed path to display location, no traffic control required.

Appendix C

Work Sequence

WAPAMA Work Sequence and Schedule

ID	Task Name
1	**Prep Work**
2	Documentation
3	Barge Stability Assessment
4	Barge Ballasting Setup
5	Remove/Salvage Rudder & Shaft
6	Remove Salvage Items from House
7	Treat/Store Salvage Items
8	Brace/Frame Internal Elements in House
9	Hazardous Materials Remediation
10	Remove Existing Temporary Coverings
11	**Hull Section Forward of Cabin**
12	Allow Heavy Lift Rig (Include Mob/Demob)
13	Construct/Install Cradle for 25-ft Section of Hull
14	Cut/Remove 25-ft Section, complete
15	Disassemble Remaining 60 ft. of Hull Section
16	Preserve/Rehab/Reconstruct 25-ft Section
17	Salvage Timbers - Hull Section
18	Treat Timbers as Required for Storage
19	Demo/Remove Remaining Hull Section from Barge
20	Scrap Timbers, etc. - Hull
21	**Bow**
22	Move bow section aft onto barge deck
23	Disassemble Machinery, Forgings, etc. from Bow Sectio
24	Salvage Timbers - Bow
25	Treat Timbers as Required for Storage
26	Salvage additional items - Bow
27	Demo/Remove Remaining Bow from Barge
28	Scrap Timbers, etc. - Bow
29	**Cabin Section**
30	Furnish/Install/Maintain Support System & Jacks
31	Install Additional Shoring/Bracing
32	Disassemble Engine and other associated piping
33	Remove/Salvage Stack & other associated piping
34	Demo/Remove Remaining Hull Section from under Hou
35	Scrap Remaining Hull section
36	Remove Boiler & other non-salvagable items
37	Dispose of Boiler & other non-salvagable items
38	Remove/Salvage Engine and other associated piping
39	/Store Engine & piping
40	Lower House Section on Barge & Block
41	**Towing and Barge**
42	Prepare Barge for Transportation
43	Towing to Final Display Location
44	Offload/Travel to Final Location
45	Towing Barge to Scrap Yard
46	Scrap Barge - Allow Salvage Value
47	**Final Display Location**
48	Site Improvements - Foundation
49	Site Improvements - Utilities
50	Site Improvements - Building
51	Final Placement/Remove Jacks
52	Preserve/Rehab/Reconstruct House



Appendix D

Barge Stability Calculation

INTACT AND DAMAGED STABILITY REVIEW OF THE BARGE 214 WITH SS WAPAMA ABOARD

Hull and Cargo Surveyors, Inc. (H&CS) issued a Stability Analysis of the Barge 214 with the SS Wapama aboard on July 19, 1985. David J. Seymour, Ltd. (DJS) performed a stability check partially based on the H&CS report on March 1, 1986. The estimated light ship weight for the Barge 214 was 460 ST (short tons) from H&CS and 448 ST from DJS. The weight of the Wapama was 1,400 ST from the H&CS report and 1,523 ST from DJS. The Wapama weight estimates were derived by observing the drafts of the Barge 214 and estimating the displacement of the barge, plus cargo, and then subtracting the estimated barge lightship weight.

On September 29, 2009 prior to the kick-off meeting aboard the Wapama the Barge 214 was observed to be floating at a mean draft of 5.58 ft. Subsequently, an approximate hull model was developed to represent the Barge 214. Note: There is no indication that the barge lines plan has ever been available for a precise hydrostatics and stability analyses. From the approximate model the barge would displace 1,879 ST.

A quick check weight estimate was performed for the Barge 214 that resulted in a lightship weight of 457 ST. Using the two previous barge lightship weights (460 ST and 448 ST) and the quick check weight, the weight of the Barge 214 is estimated to be 454 ST. The weight of the Wapama is then 1,400 ST plus about 25 ST of shoring, access tower, etc. It was noted that there may be water in the barge and that the barge is pumped dry from time to time. Considering that the approximate model gives results between the two previous estimates and in light of the varying amount of water in the barge, the approximate model is adequate to evaluate the trim and stability effects of removal of portions of the Wapama.

The previous studies had estimated a total vertical center of gravity (VCG) of the Barge 214 with the Wapama aboard. H&CS estimated the VCG to be 25.57 ft. DJS estimated the VCG to be 26.00 ft. A spreadsheet was prepared of the component weights of the Barge 214, plus Wapama as observed on September 29, 2009. The VCG of the barge was assumed to be half the barge depth, plus half-a-foot, or 6.50 ft – this is common practice. The VCG of the Wapama (referenced to the keel of the barge) was based upon a visual observation of 32.50 ft. The VCG of the shoring and tower taken together was estimated at 16.00 ft. This produces a total VCG of 26.00 ft compared to the 25.57 and 26.00 in previous reports.

BARGE 214	w/ WAPAMA as Cargo							
Loading Condition:	As Observed September 29, 2009							
	Weight	LCG	TCG	VCG	Lmoment	Tmoment	Vmoment	VMFS
Item Description	(ST)	(ft)	(ft)	(ft)	(ST-ft)	(ST-ft)	(ST-ft)	(ST-ft)
Lightship	454.00	-5.00	0.00	6.50	-2270.00	0.00	2951.00	
Wapama	1,400.00	-3.00	0.00	32.50	-4200.00	0.00	45500.00	
Shoring & Tower	25.00	2.00	0.00	16.00	50.00	0.00	400.00	
Total	1,879.00	-3.42	0.00	26.00	-6420.00	0.00	48851.00	0.00

Note: Wapama weight may include water in barge hull and associated free surface.

In the intact or undamaged condition, the Barge 214 has a maximum righting arm of 7.616 ft at a heel angle of 15.25 deg. The forward corner of the deck will submerge at an angle of 12.24 deg. At the angle of deck edge submergence the righting arm is 7.048 ft.

The Barge 214 is internally subdivided into eight compartments. There are full width (60 ft) compartments at the bow and the stern that are 25 ft long – these compartments have been numbered C1.c and C5.c for this report. There are three compartments Port and three compartments Starboard along the midlength, all of which are 50 ft long by 30 ft wide – these compartments have been numbered C2.p, C2.s, C3.p, C3.s, C4.p and C4.s for this report. The H&CS report indicated that the longitudinal bulkhead had been perforated between C2.p and C2.s compartments. The H&CS report stated that the free surface effect can be considered as two separate tanks due to the longitudinal bulkhead acting as a swash bulkhead. This is partially true only in the dynamic sense; however, in the static case, the holes allow water to flow from side to side, and this quadruples the free surface effect for these compartments.

For the Barge 214 with the Wapama in its present condition three damaged cases were studied. The first case assumed flooding of the foremost compartment (C1.c). This flooding resulted in a mean draft of 6.309 ft with a draft forward of 8.596 ft and a draft aft of 4.022 ft. The barge has zero list, but the forward corner of the deck will submerge at an angle of 6.39 deg, and at the angle of deck edge submergence the righting arm is 3.105 ft.

The second case was flooding of one of the second compartments (C2.s). This flooding resulted in a mean draft of 6.685 ft with a bow down trim angle of 1.21 deg and a heel angle of 6.05 deg. The forward corner of the deck only has 0.023 ft of freeboard.

The third case was flooding of both of the second compartments (C2.p & C2.s). This flooding resulted in a mean draft of 8.230 ft with a draft forward of 12.998 ft and a draft aft of 3.462 ft. The barge has zero list, but the bow is a foot underwater. If there is no downflooding, then the maximum righting arm is 2.034 ft, and the maximum occurs at 10.69 deg.

The H&CS report concluded that this third damage case produced “a very serious situation.” The H&CS report also noted that if there was any wind, then any open or leaking hatches would immediately sink the barge.

The DJS report on this third damage case underestimated the free surface effect, because the vertical moment of free surface was divided by the total displacement instead of the net displacement – this is a common mistake when using the added weight method. The DJS report did recommend an inclining experiment (stability test) to verify the estimated vertical center of gravity.

The holes in the centerline longitudinal bulkhead must be patched and the water tightness of all of the original barge compartments must be verified. In light of the fact that the use of the barge is being changed from unmanned deck cargo barge to manned work barge, consideration of the safety of the workers onboard demands restoring the water tightness of the hull and bulkheads. Also, the structural integrity of the hull and bulkheads with respect to their ability to survive flooding heads and the resulting hull bending moments must be verified.

Additionally, the intact case and a damage case were analyzed for the Barge 214 with just the salvaged after portion of the Wapama aboard. This represents the condition near the end of the deconstruction / salvage of the Wapama.

Using the recreated drawings of inboard profile, outboard profile and the deck plans the portion of the Wapama aft of Frame 48 and above the Load Waterline (LWL) has been estimated at 400 ST. The support beam grid and support frames with an eight bogie-truck transport system will add another 110 ST to the weight remaining on the barge. Leaving the aft portion of the Wapama where it is resulted in a barge mean draft of 2.989 ft, with a draft aft of 6.027 ft and a draft forward of -0.049 ft. This amount of trim is unacceptable (that produces about 3% G aft horizontal load/there are damaged stability issues that will be discussed later).

BARGE 214	w/ WAPAMA as Cargo							
Loading Condition:	Only Aft Section above Load Waterline							
	Weight	LCG	TCG	VCG	Lmoment	Tmoment	Vmoment	VMFS
Item Description	(ST)	(ft)	(ft)	(ft)	(ST-ft)	(ST-ft)	(ST-ft)	(ST-ft)
Lightship	454.00	-5.00	0.00	6.50	-2270.00	0.00	2951.00	
Wapama	400.00	50.00	0.00	42.75	20000.00	0.00	17100.00	
Longitudinals W 16	20.00	50.00	0.00	32.00	1000.00	0.00	640.00	
Transv. Beams W 36	30.00	50.00	0.00	29.83	1500.00	0.00	895.00	
Side Frames	20.00	50.00	0.00	16.50	1000.00	0.00	330.00	
Bogies (8)	40.00	50.00	0.00	14.50	2000.00	0.00	580.00	
Total	964.00	24.10	0.00	23.34	23230.00	0.00	22496.00	0.00

Therefore, the Barge 214 can be ballasted to trim her out, one must be mindful of the hull bending stress that will result and the condition of the barge after all of these years of little or no maintenance. Adding ballast to the forward compartment would be helpful. However, this would generate a hogging load condition on the barge hull structure. Alternately, the aft portion of the Wapama can be moved forward to a more central location on the barge.

This loading condition was also checked with damaged flooding of the aft most compartment (C5.c). The resulting mean draft was 3.369 ft with a draft aft of 7.823 ft and a draft forward of -1.085 ft. This would produce 4½% G of aft lateral acceleration.

Therefore, it appears that the best solution is to move the aft portion of the Wapama forward as the vessel deconstruction and salvage progresses, i.e. the aft portion should be movable and the deconstruction should start just forward of Wapama Frame 48.

The previous condition survey of the Barge 214 was performed in 1985 and is part of the H&CS report. At that time the barge had been in service about 15 years and had suffered a recent grounding. The barge has had an additional 24 years of little or no maintenance in which deterioration has continued.

Prior to allowing large numbers of workers on the Barge 214, and particularly, prior to towing the Barge 214 about San Francisco Bay, the condition of the Barge 214 should be surveyed and assessed. The hull compartments should be opened, gas freed, pumped out and dried out, so that a marine surveyor is able to enter each compartment to check for leaks, severe corrosion, damaged or buckled frames, etc. Leaks and severe corrosion should be repaired, or at least patched. Damaged or buckled frames should

be replaced, or at least braced. The repairs could range from slight to extensive (expensive). Repair of the Barge 214 is necessary to minimize the risk of structural failure, flooding and possible capsize or even sinking of the barge while a large number of workers are aboard.

The longitudinal strength of the Barge 214 should be calculated taking into account the amount of corrosion and any existing buckling or structural damage. This calculation is necessary to determine whether there will be restrictions on counter ballasting during deconstruction / salvage or restrictions on weather conditions for towing.

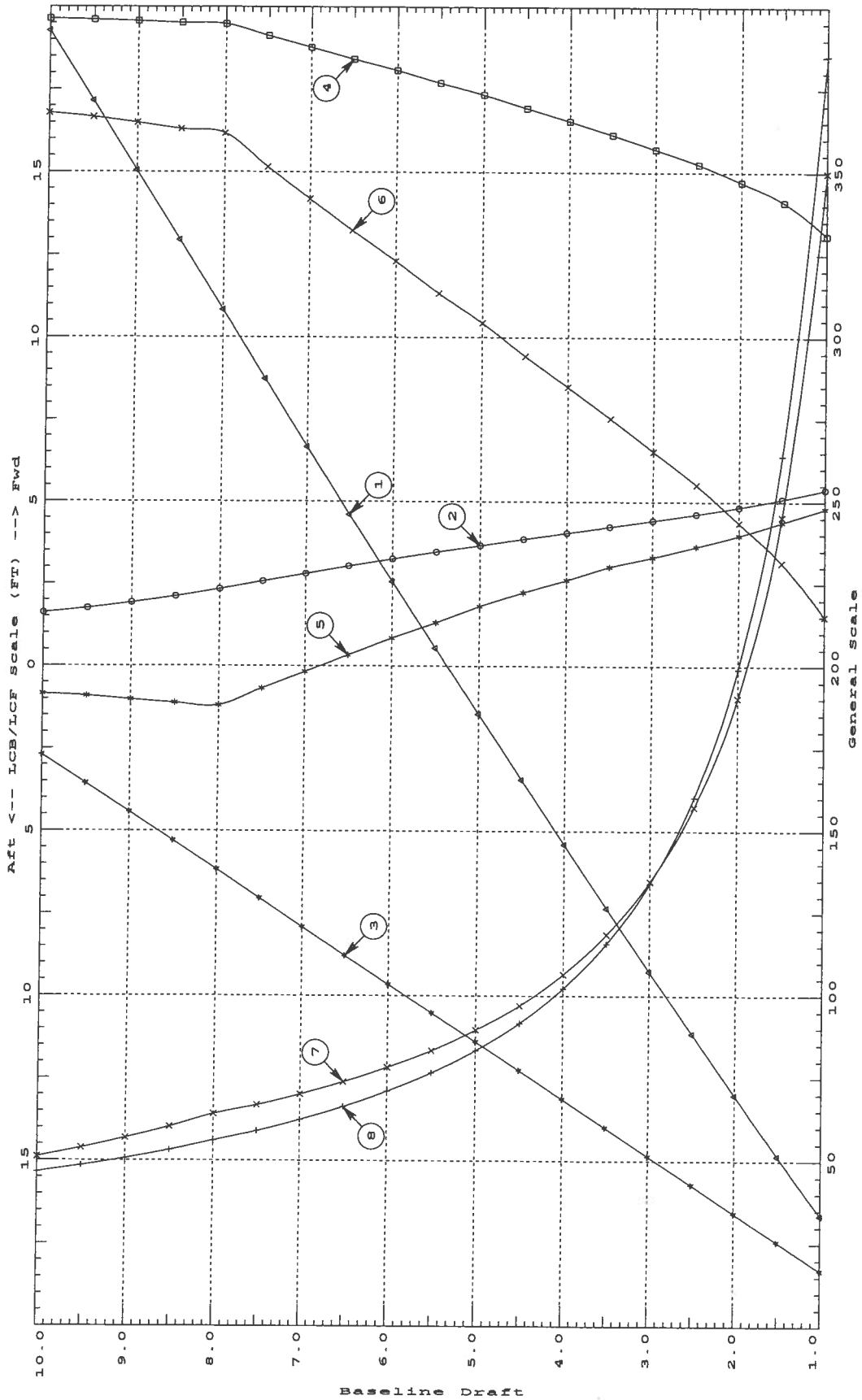
With the compartments dried out, the Barge 214 with Wapama aboard should be inclined, i.e. a stability test should be performed to determine the total weight and center of gravity. This data will be used during the deconstruction / salvage of the Wapama for the daily calculation of the trim and stability of the barge, and it will be necessary for evaluating the seaworthiness of the barge for transporting the Wapama about San Francisco Bay.

HYDROSTATIC PROPERTIES
No Trim, No Heel, VCG = 0.00

LCF Draft	Displacement Weight(ST)	Buoyancy-Ctr. LCB	VCB	Weight/ Inch	Moment/ LCF	Deg trim	KML	KMT
1.000	301.98	5.37f	0.51	26.46	4.80f	12905	2448.3	308.19
1.500	463.38	5.09f	0.77	27.28	4.38f	13889	1717.1	211.10
2.000	628.54	4.84f	1.03	27.77	3.98f	14618	1332.4	159.27
2.500	796.43	4.63f	1.28	28.20	3.64f	15311	1101.4	128.18
3.000	966.76	4.43f	1.54	28.56	3.31f	15921	943.5	107.34
3.500	1,139.18	4.24f	1.80	28.91	3.01f	16520	830.8	92.69
4.000	1,313.63	4.05f	2.06	29.24	2.61f	17098	745.7	81.78
4.500	1,490.01	3.86f	2.32	29.55	2.23f	17661	679.1	73.31
5.000	1,668.29	3.66f	2.58	29.87	1.81f	18262	627.1	66.69
5.500	1,848.37	3.46f	2.84	30.16	1.31f	18803	582.8	61.20
6.000	2,030.21	3.24f	3.10	30.46	0.84f	19385	547.0	56.76
6.500	2,213.76	3.02f	3.36	30.73	0.33f	19934	515.9	52.98
7.000	2,399.00	2.80f	3.62	31.01	0.18a	20510	489.8	49.83
7.500	2,585.94	2.56f	3.89	31.30	0.69a	21093	467.3	47.12
8.000	2,774.61	2.33f	4.15	31.58	1.20a	21700	448.1	44.81
8.500	2,964.07	2.10f	4.41	31.61	1.13a	21783	421.0	42.49
9.000	3,153.87	1.91f	4.67	31.65	1.02a	21892	397.7	40.51
9.500	3,343.90	1.75f	4.93	31.69	0.91a	21997	376.9	38.76
10.000	3,534.17	1.61f	5.19	31.71	0.85a	22073	357.8	37.22

Distances in FEET.-------Specific Gravity = 1.025.-----------Moment in Ft-ST.
Draft is from Baseline.

HYDROSTATIC PROPERTIES at LEVEL TRIM



(1) Displacement 1=9 ST
(2) LCB (use top scale)
(3) VCB (KB) 1=.03 FT
(4) Immersion 1=.08 ST/IN
(4) WPA 1=30 Sq.FT
(5) LCF (use top scale)
(6) Moment/Trim 1=60 FT-ST/Deg
(7) KML 1=7 FT
(8) KMT 1=.8 FT

Specific Gravity = 1.025 Assumed KG = 0.00 FT
"K" = BPL

BARGE 214 w/ WAPAMA as Cargo
Loading Condition: As Observed September 29, 2009

Item Description	Weight (ST)	LCG (ft)	TCG (ft)	VCG (ft)	Lmoment (ST-ft)	Tmoment (ST-ft)	Vmoment (ST-ft)	VMFS (ST-ft)
Lightship	454.00	-5.00	0.00	6.50	-2270.00	0.00	2951.00	
Wapama	1,400.00	-3.00	0.00	32.50	-4200.00	0.00	45500.00	
Shoring & Tower	25.00	2.00	0.00	16.00	50.00	0.00	400.00	
Total	1,879.00	-3.42	0.00	26.00	-6420.00	0.00	48851.00	0.00

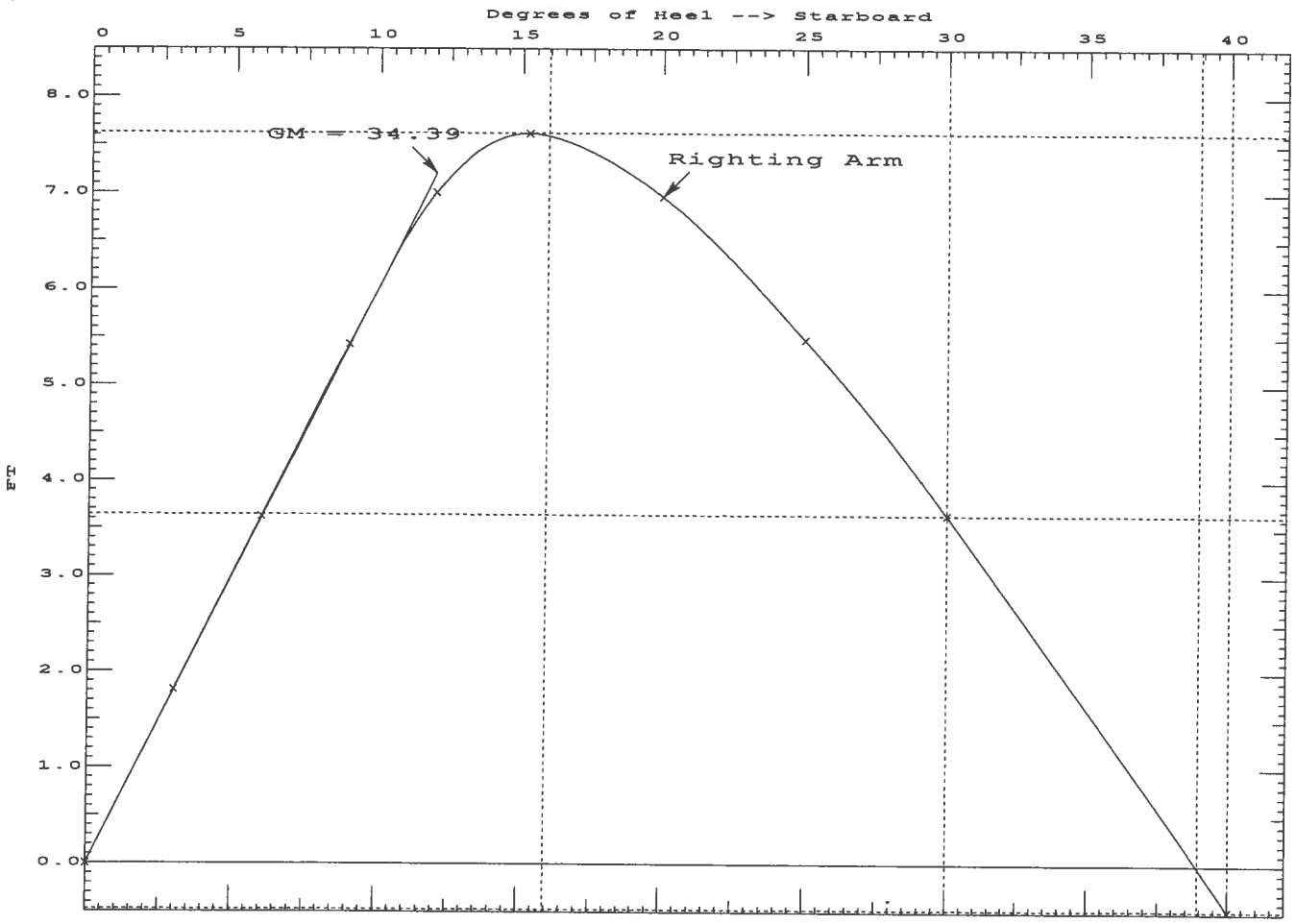
Note: Wapama weight may include water in barge hull and associated free surface.

RIGHTING ARMS vs HEEL ANGLE

LCG = 3.42f TCG = 0.00 VCG = 26.00

Origin Depth	Degrees of Trim	Heel	Displacement Weight(ST)	Righting Arms in Trim	in Heel
5.585	0.00	0.00	1,879.32	0.00	0.000
5.568	0.01f	3.00s	1,879.07	0.00	1.811
5.522	0.03f	6.00s	1,879.19	0.00	3.621
5.442	0.07f	9.00s	1,879.00	0.00	5.424
5.293	0.12f	12.00s	1,879.00	0.00	6.999
5.030	0.18f	15.00s	1,879.12	0.00	7.611
5.007	0.19f	15.25s	1,879.04	0.00	7.616
4.555	0.30f	20.00s	1,879.00	0.00	6.963
4.046	0.41f	25.00s	1,879.13	0.00	5.478
3.504	0.53f	30.00s	1,879.00	0.00	3.642
2.479	0.73f	38.88s	1,879.05	0.00	0.000
2.345	0.76f	40.00s	1,879.00	0.00	-0.475

Distances in FEET.---Specific Gravity = 1.025.---------


Degrees of Heel --> Starboard
0
5
10
15
20
25
30
35
40
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
FT
GM = 34.39
Righting Arm

SUMMARY OF LOADING

0.0 Cu.Ft (0%) unknown

TANK LIST

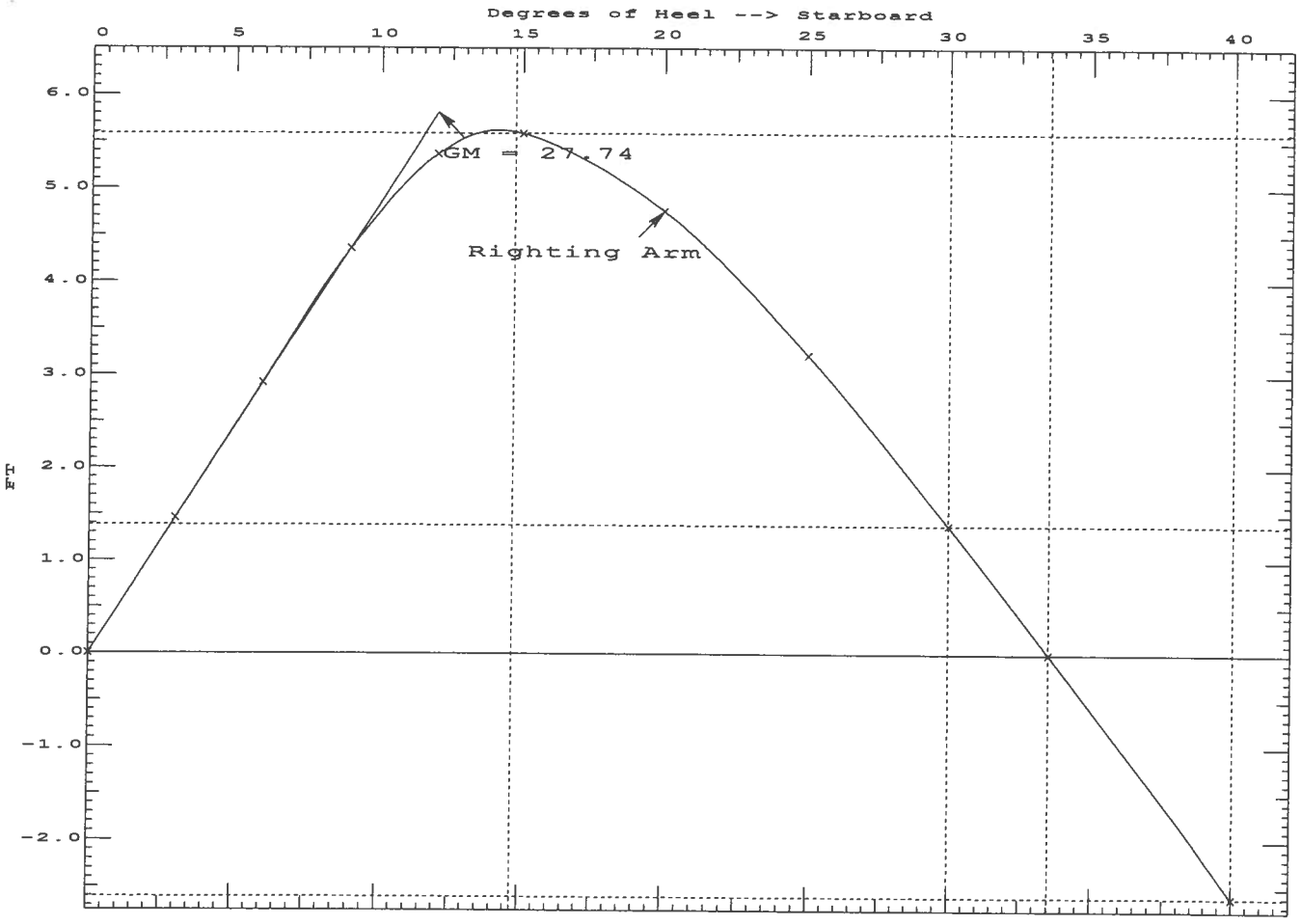
Part	Type	Reference Point Long	Trans	Vert
C1.C	FLOODED TANK	0.00	0.00	0.00
C2.P	INTACT TANK	0.00	0.00	0.00
C2.S	INTACT TANK	0.00	0.00	0.00
C3.P	INTACT TANK	0.00	0.00	0.00
C3.S	INTACT TANK	0.00	0.00	0.00
C4.P	INTACT TANK	0.00	0.00	0.00
C4.S	INTACT TANK	0.00	0.00	0.00
C5.C	INTACT TANK	0.00	0.00	0.00

Distances in FEET.

RIGHTING ARMS vs HEEL ANGLE with FLOODING
LCG = 3.42f TCG = 0.00 VCG = 26.00

Origin Depth	Degrees of Trim	Heel	Displacement Weight(ST)	Righting Arms in Trim	in Heel
6.309	1.31f	0.00	1,878.89	0.00	0.000
6.295	1.32f	3.00s	1,879.00	0.00	1.457
6.255	1.36f	6.00s	1,879.00	0.00	2.917
6.187	1.44f	9.00s	1,878.99	0.00	4.355
6.127	1.67f	12.00s	1,879.06	0.00	5.363
6.087	1.98f	14.41s	1,879.00	0.00	5.597
6.077	2.07f	15.00s	1,878.99	0.00	5.585
5.979	2.90f	20.00s	1,879.00	0.00	4.757
5.846	3.78f	25.00s	1,879.10	0.00	3.218
5.672	4.67f	30.00s	1,879.08	0.00	1.382
5.526	5.30f	33.53s	1,879.00	0.00	-0.001
5.211	6.44f	40.00s	1,879.09	0.00	-2.608

Distances in FEET.---Specific Gravity = 1.025.---


Degrees of Heel --> Starboard
0
5
10
15
20
25
30
35
40
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
FT
GM = 27.74
Righting Arm

TANK LIST

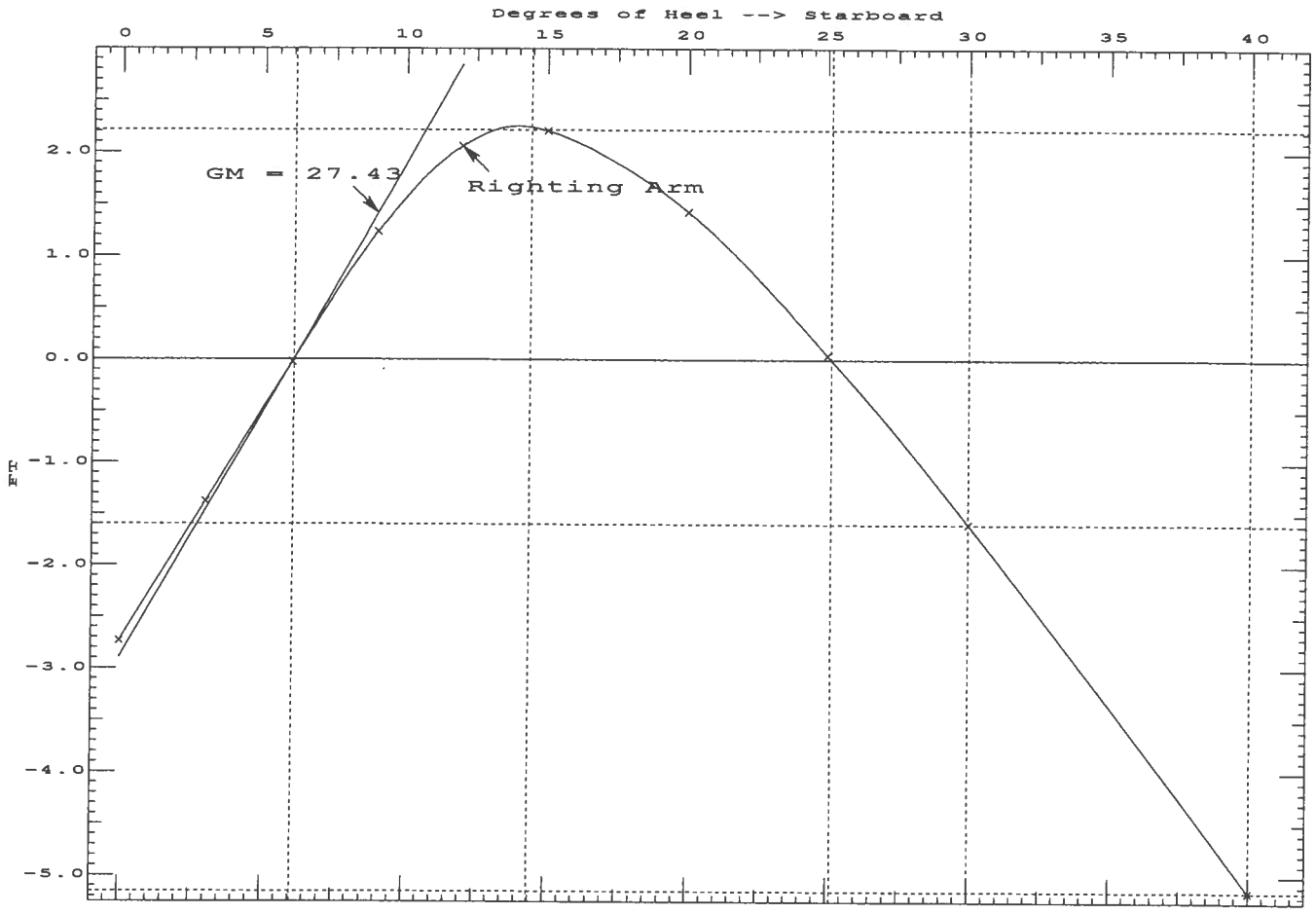
Part	Type	Reference Point Long	Trans	Vert
C1.C	INTACT TANK	0.00	0.00	0.00
C2.P	INTACT TANK	0.00	0.00	0.00
C2.S	FLOODED TANK	0.00	0.00	0.00
C3.P	INTACT TANK	0.00	0.00	0.00
C3.S	INTACT TANK	0.00	0.00	0.00
C4.P	INTACT TANK	0.00	0.00	0.00
C4.S	INTACT TANK	0.00	0.00	0.00
C5.C	INTACT TANK	0.00	0.00	0.00

Distances in FEET.

RIGHTING ARMS vs HEEL ANGLE with FLOODING
LCG = 3.42f TCG = 0.00 VCG = 26.00

Origin Depth	Degrees of Trim	Heel	Displacement Weight(ST)	Righting Arms in Trim	in Heel
6.498	0.92f	0.00	1,879.36	0.00	-2.731
6.606	1.05f	3.00s	1,878.99	0.00	-1.379
6.684	1.20f	6.00s	1,878.99	0.00	-0.022
6.685	1.21f	6.05s	1,879.00	0.00	0.002
6.751	1.41f	9.00s	1,879.08	0.00	1.230
6.844	1.73f	12.00s	1,879.06	0.00	2.057
6.930	2.05f	14.25s	1,878.97	0.00	2.225
6.959	2.17f	15.00s	1,878.99	0.00	2.205
7.135	2.97f	20.00s	1,879.00	0.00	1.423
7.249	3.78f	25.00s	1,879.00	0.00	0.043
7.251	3.80f	25.14s	1,879.00	0.00	0.000
7.297	4.58f	30.00s	1,879.07	0.00	-1.598
7.208	6.10f	40.00s	1,879.01	0.00	-5.150

Distances in FEET.---Specific Gravity = 1.025.


Degrees of Heel --> Starboard
0
5
10
15
20
25
30
35
40
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
FT
GM = 27.43
Righting Arm

TANK LIST

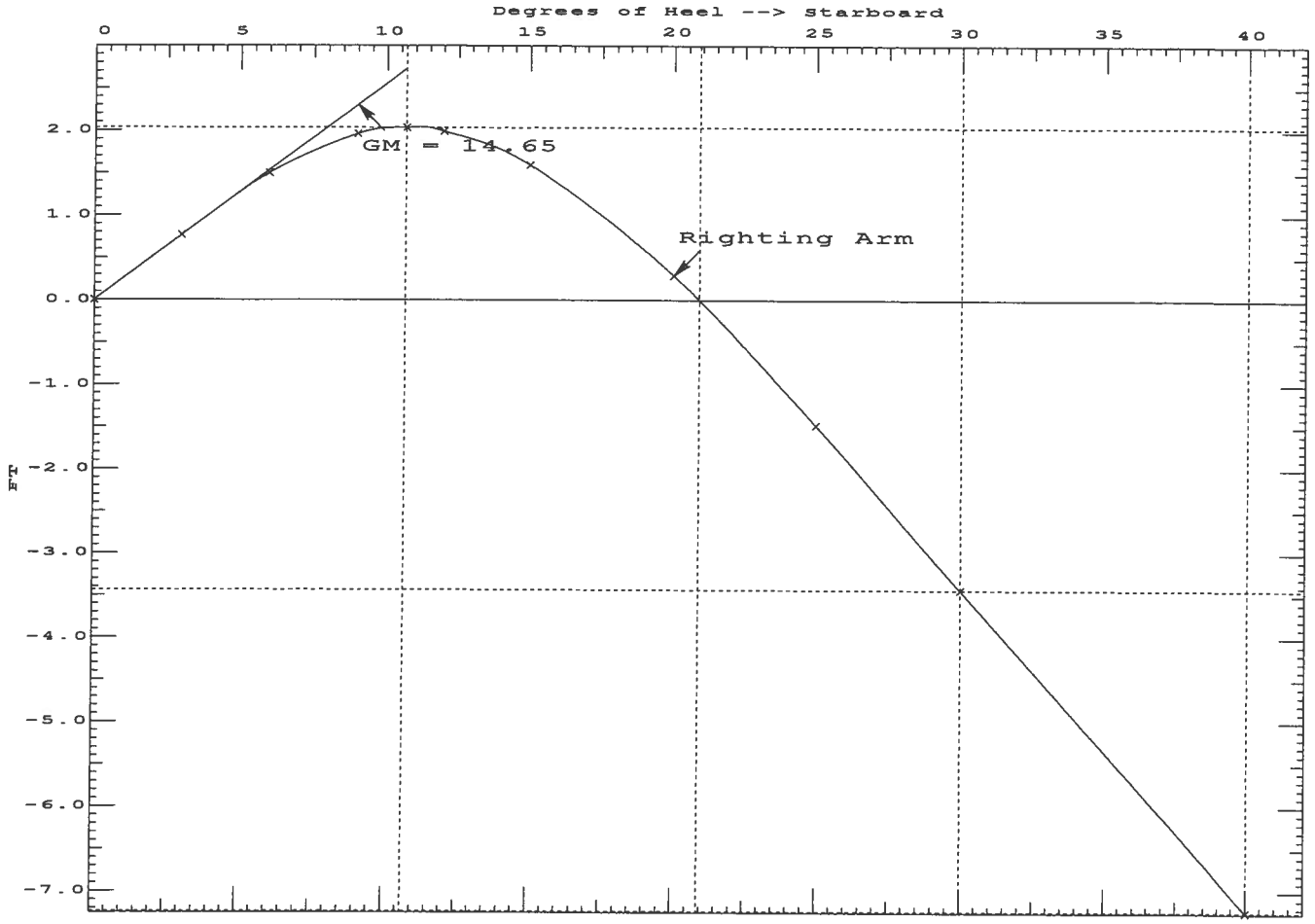
Part	Type	Reference Point Long	Trans	Vert
C1.C	INTACT TANK	0.00	0.00	0.00
C2.P	FLOODED TANK	0.00	0.00	0.00
C2.S	FLOODED TANK	0.00	0.00	0.00
C3.P	INTACT TANK	0.00	0.00	0.00
C3.S	INTACT TANK	0.00	0.00	0.00
C4.P	INTACT TANK	0.00	0.00	0.00
C4.S	INTACT TANK	0.00	0.00	0.00
C5.C	INTACT TANK	0.00	0.00	0.00

Distances in FEET.

RIGHTING ARMS vs HEEL ANGLE with FLOODING
LCG = 3.42f TCG = 0.00 VCG = 26.00

Origin Depth	Degrees of Trim	Heel	Displacement Weight(ST)	Righting Arms in Trim	in Heel
8.230	2.73f	0.00	1,879.00	0.00	0.000
8.332	2.91f	3.00s	1,879.08	0.00	0.768
8.465	3.21f	6.00s	1,878.91	0.00	1.497
8.677	3.64f	9.00s	1,878.88	0.00	1.961
8.852	3.97f	10.69s	1,878.99	0.00	2.034
9.008	4.26f	12.00s	1,878.97	0.00	1.989
9.434	5.08f	15.00s	1,878.83	0.00	1.591
10.332	6.81f	20.00s	1,878.92	0.00	0.288
10.523	7.18f	20.88s	1,879.03	0.00	0.000
11.536	9.13f	25.00s	1,878.84	0.00	-1.480
12.931	11.87f	30.00s	1,879.00	0.00	-3.436
15.776	17.87f	40.00s	1,879.00	0.00	-7.235

Distances in FEET.---Specific Gravity = 1.025.


Degrees of Heel --> Starboard
0
5
10
15
20
25
30
35
40
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
-7.0
FT
GM = 14.65
Righting Arm

BARGE 214 w/ WAPAMA as Cargo

Loading Condition: Only Aft Section above Load Waterline

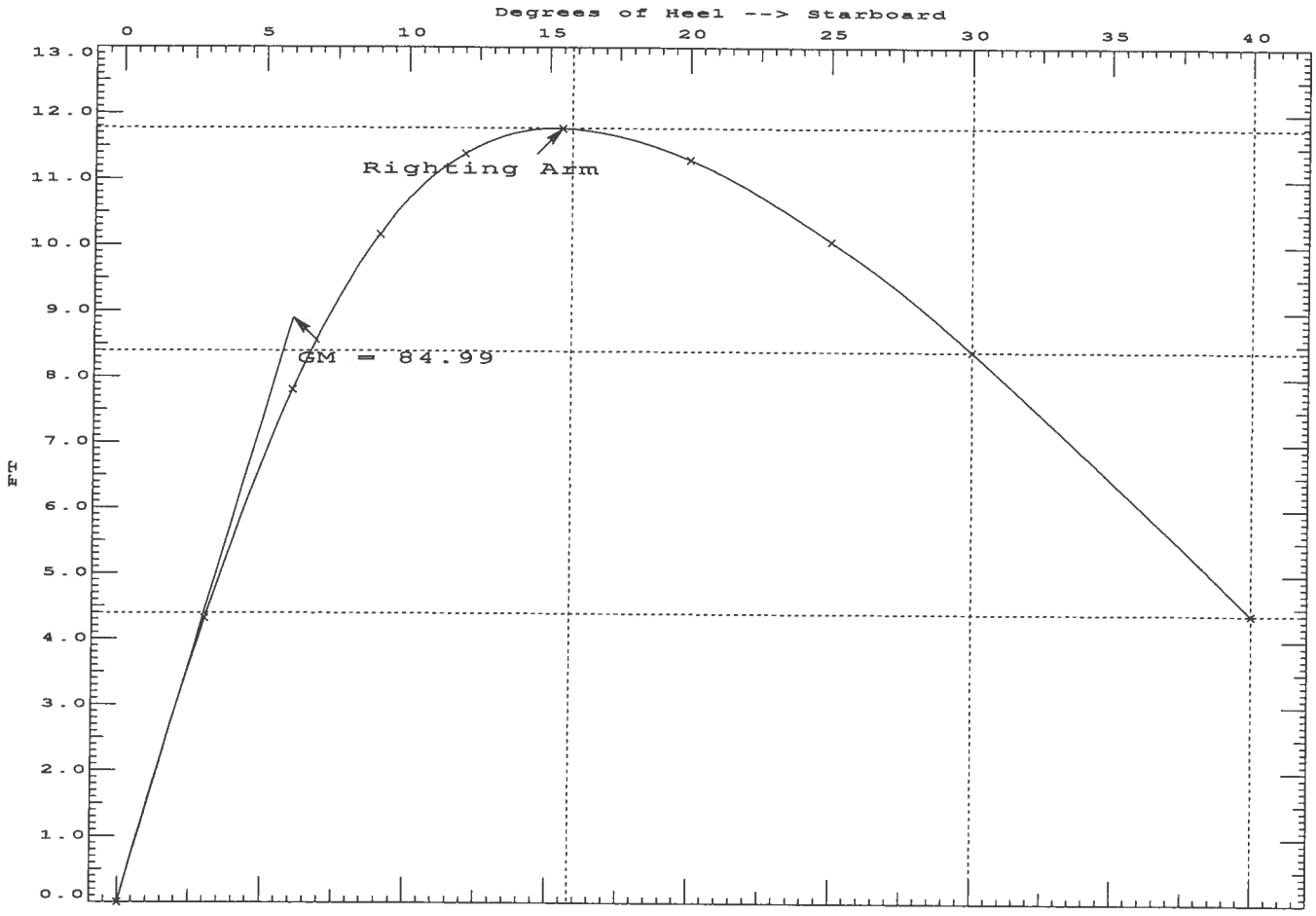
Item Description	Weight (ST)	LCG (ft)	TCG (ft)	VCG (ft)	Lmoment (ST-ft)	Tmoment (ST-ft)	Vmoment (ST-ft)	VMFS (ST-ft)
Lightship	454.00	-5.00	0.00	6.50	-2270.00	0.00	2951.00	
Wapama	400.00	50.00	0.00	42.75	20000.00	0.00	17100.00	
Longitudinals W 16 x 100	20.00	50.00	0.00	32.00	1000.00	0.00	640.00	
Transv. Beams W 36 x 300	30.00	50.00	0.00	29.83	1500.00	0.00	895.00	
Side Frames	20.00	50.00	0.00	16.50	1000.00	0.00	330.00	
Bogies (8)	40.00	50.00	0.00	14.50	2000.00	0.00	580.00	
Total	964.00	24.10	0.00	23.34	23230.00	0.00	22496.00	0.00

RIGHTING ARMS vs HEEL ANGLE

LCG = 24.10a TCG = 0.00 VCG = 23.34

Origin Depth	Degrees of Trim	Heel	Displacement Weight(ST)	Righting Arms in Trim	in Heel
2.989	1.74a	0.00	964.03	0.00	0.000
2.947	1.77a	3.00s	964.00	0.00	4.314
2.764	1.91a	6.00s	963.96	0.00	7.806
2.399	2.14a	9.00s	963.94	0.00	10.163
1.858	2.36a	12.00s	964.00	0.00	11.385
1.184	2.57a	15.00s	964.01	0.00	11.766
1.073	2.60a	15.45s	963.68	0.00	11.773
-0.104	2.96a	20.00s	963.98	0.00	11.299
-1.497	3.39a	25.00s	964.01	0.00	10.062
-2.930	3.86a	30.00s	964.02	0.00	8.397
-5.786	4.82a	40.00s	964.07	0.00	4.395

Distances in FEET.---Specific Gravity = 1.025.---------


Degrees of Heel --> Starboard
0
5
10
15
20
25
30
35
40
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
FT
Righting Arm
GM = 84.99

TANK LIST

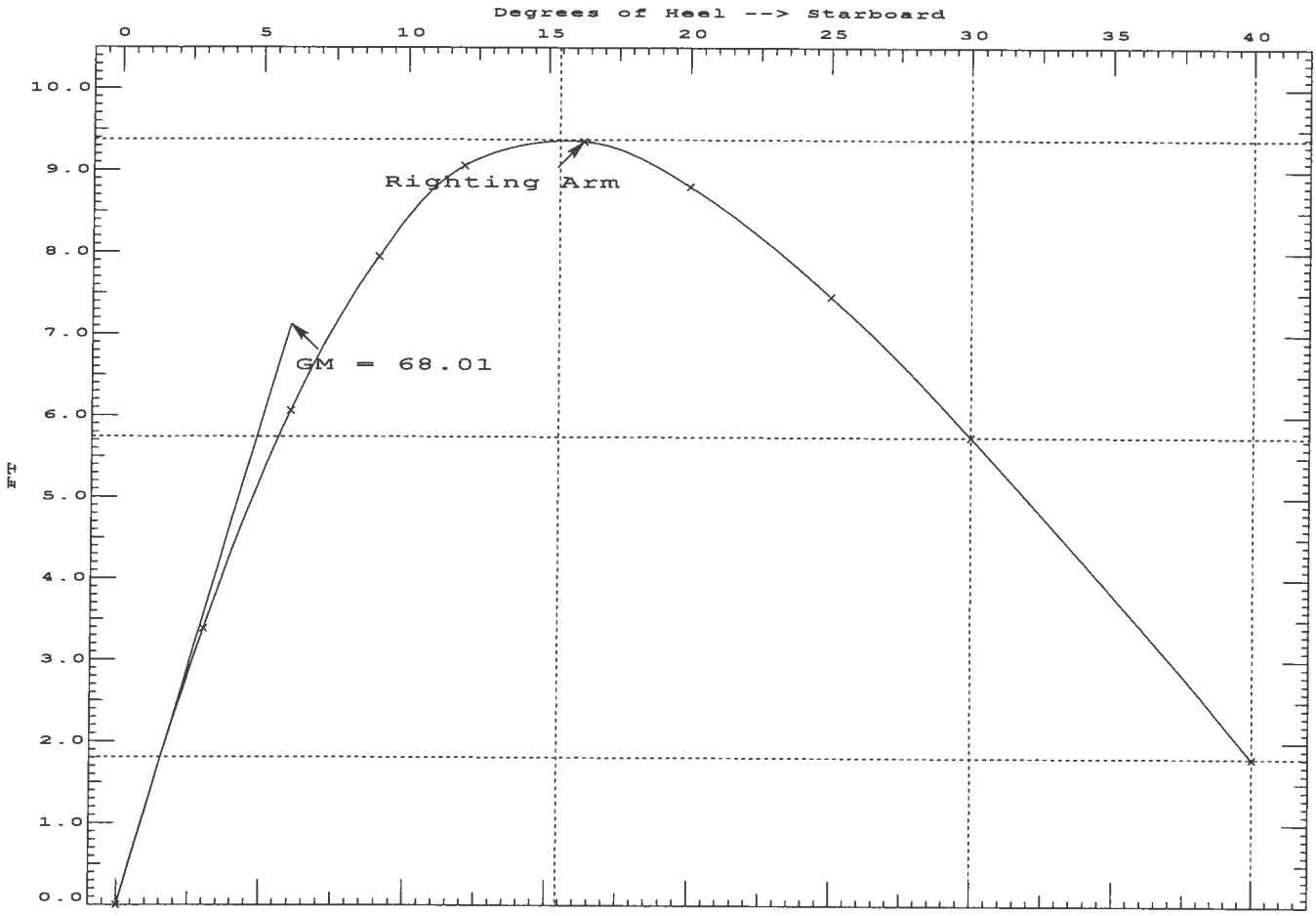
Part	Type	Reference Point Long	Trans	Vert
C1.C	INTACT TANK	0.00	0.00	0.00
C2.P	INTACT TANK	0.00	0.00	0.00
C2.S	INTACT TANK	0.00	0.00	0.00
C3.P	INTACT TANK	0.00	0.00	0.00
C3.S	INTACT TANK	0.00	0.00	0.00
C4.P	INTACT TANK	0.00	0.00	0.00
C4.S	INTACT TANK	0.00	0.00	0.00
C5.C	FLOODED TANK	0.00	0.00	0.00

Distances in FEET.

RIGHTING ARMS vs HEEL ANGLE with FLOODING
LCG = 24.10a TCG = 0.00 VCG = 23.34

Origin Depth	Degrees of Trim	Heel	Displacement Weight(ST)	Righting Arms in Trim	in Heel
3.369	2.55a	0.00p	963.99	0.00	0.000
3.306	2.67a	3.00s	964.03	0.00	3.380
3.114	2.97a	6.00s	964.03	0.00	6.063
2.776	3.37a	9.00s	964.17	0.00	7.947
2.300	3.85a	12.00s	963.92	0.00	9.057
1.731	4.39a	15.00s	963.96	0.00	9.393
1.473	4.62a	16.25s	963.97	0.00	9.353
0.654	5.36a	20.00s	964.19	0.00	8.802
-0.506	6.39a	25.00s	964.05	0.00	7.463
-1.694	7.46a	30.00s	964.40	0.00	5.744
-4.076	9.61a	40.00s	964.09	0.00	1.806

Distances in FEET.---Specific Gravity = 1.025.


Degrees of Heel --> Starboard
0
5
10
15
20
25
30
35
40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
FT
Righting Arm
GM = 68.01