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COST EFFECTIVENESS STUDY OF WASTEWATER MANAGEMENT SYSTEMS FOR SELECTED U.S. COAST GUARD VESSELS

Volume III - Installation Analysis

Part 3 - FIREBUSH (180')

Sidney Orbach

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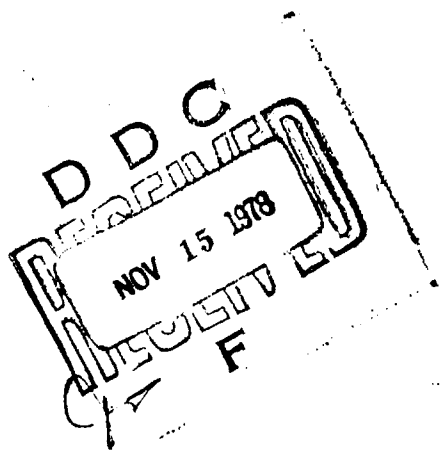

February 1977

FINAL REPORT

PREPARED FOR

U.S. DEPARTMENT OF TRANSPORTATION

UNITED STATES COAST GUARD
OFFICE OF RESEARCH AND DEVELOPMENT
WASHINGTON, D.C. 20590

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16. Abstract

Each of the 18 candidate Wastewater Management System (WMS) configurations developed in Volume IV was analyzed for installation aboard the FIREBUSH (WLB - 393). The following information was developed: vessel conditions including locations of black water (sewage and garbage grinder slurry) and gray water (galley and turbid) waste sources, vessel/resources capacities and estimated usage rates, determination of viable candidate systems based on installation guidelines and assumptions developed in Volume IV, black and gray wastewater (or sludge) holding tank capacities which can be fitted, installation cost estimates for each viable candidate system, arrangement drawings for WMS equipment and waste sources, installation related effectiveness attribute data.

The analysis was performed in three stages. A preliminary installation analysis was made on the basis of vessel plans available. This was followed by a shipcheck of the vessel to determine the viable candidate systems and obtain required vessel data. The final step consisted of a more detailed analysis of each viable candidate system to develop installation cost estimates and other required installation related information including arrangement drawings and effectiveness attribute data. Cost estimates were developed using a form which analyzes each viable candidate system in terms of standard installation cost elements, each of which has an assumed unit cost.

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WASTEWATER MANAGEMENT SYSTEMS FOR

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Volume III - Installation Analysis

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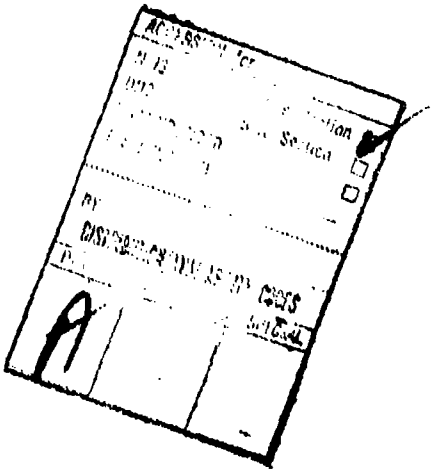
This study was conducted under the technical direction of Mr. Thomas S. Scarano of the Office of Research and Development, U.S. Coast Guard. Mr. Scarano and Lt. Ed Magsig of the Office of Engineering made available the vessel plans and provided valuable assistance in the formulation of the guidelines and assumptions governing this installation analysis.

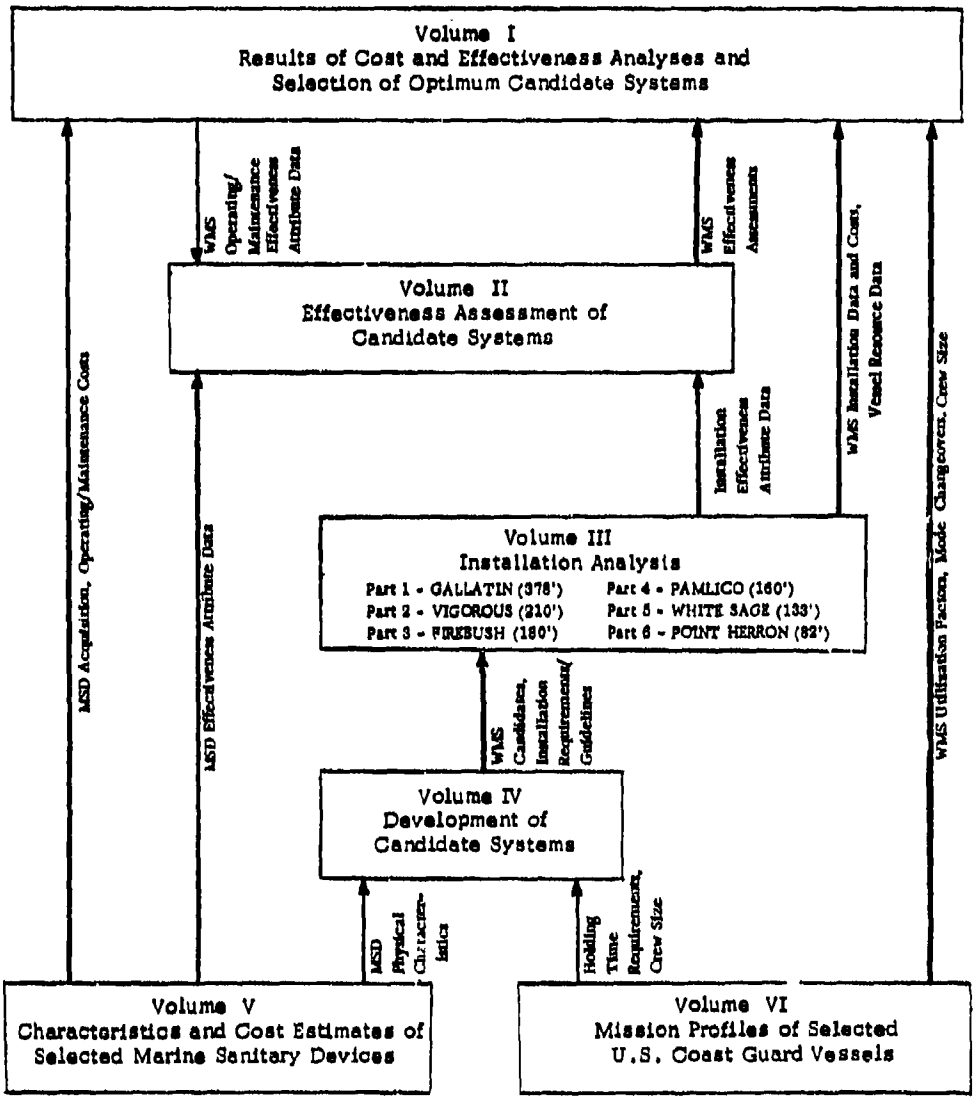
The installation analysis was performed in consultation with George G. Sharp, Inc., 100 Church Street, New York, N.Y. 10007.

The cooperation and assistance of the officers of U.S. Coast Guard Cutter FIREBUSH (WLB-393) in scheduling the shipcheck and providing the requested vessel data is greatly appreciated.



PREFACE

The relationship among the volumes of the report is depicted below. This relationship does not convey all the information contained within each volume.



SUMMARY OF WMS INSTALLATION COSTS

Vessel: FIREI JSH (180')

WMS No.	TYPE: Coll/Trans Subsys (Black)	TYPE: Treatment/Disposal Subsystem: Black	TYPE: Treatment/Disposal Subsystem: Gray	Holding Capacity: Black (%)	Holding Capacity: Gray (%)	INSTALLATION COST ($)
1	Gravity Collect.	Holding Tank	Holding Tank	100	0	16,850
2	Oil Recircul. (Chrysler)	Chrysler + Hld Tnk	Holding Tank	100	0	12,060
3		Chrysler + Incin.	Holding Tank	100	12	20,630
4	Gravity Collect. (Grumman)	Grum Flow Thru+HldTk	Holding Tank	100	22	18,760
5		Grumman Flow Thru + Holding Tank		100	100	16,070
6	Gravity Collect.	Holding Tank	Grum Flow Thru+HldTnk	100	100	21,590
7	Gravity Collect. (Grumman)	Grum Flow Thru+Incin.	Holding Tank	100	29	25,640
8		Grumman Flow Thru + Incinerator		100	100	19,250
9	Vacuum Collect. (Jered)	Holding Tank	Holding Tank	100	13	19,710
10		Incinerator	Holding Tank	100	35	33,740
11		GATX Evap.	Holding Tank	100	35	31,660
12		Holding Tank	Grum Flow Thru+ Hld Tnk	100	100	21,810
13		Incinerator	Grum Flow Thru + Incin.	100	100	29,320
14	M/T Pump Collect. (GATX)	Holding Tank	Holding Tank	100	13	19,420
15		Incinerator	Holding Tank	100	35	29,520
16		GATX Evap.	Holding Tank	100	35	23,060
17		Holding Tank	Grum Flow Thru+Hld Tnk	100	100	21,280
18		Incinerator	Grum Flow Thru + Incin.	100	100	29,590

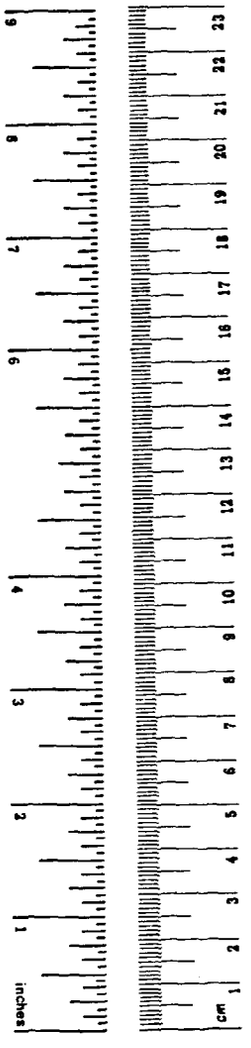
N/A - Not a viable candidate system for this vessel.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

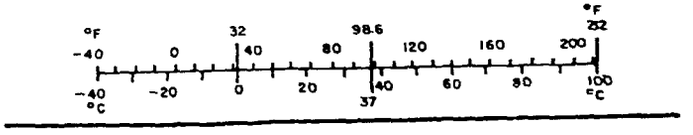
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	*square kilometers*	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	*tonnes*	t
		VOLUME		
tsp	teaspoons	5	*milliliters*	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	*fluid ounces*	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after *subtracting* 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	*kilometers*	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	*liters*	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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INTRODUCTION

OBJECTIVES

The objectives of the installation analysis are as follows:

- Development of pertinent vessel information necessary for the cost and effectiveness analyses, including the following:
  - .. Existing physical conditions aboard the vessel, especially in compartments where wastewater management system equipments may be installed.
  - .. Existing wastewater management equipments/systems aboard the vessel (holding tanks, garbage grinders, sewage treatment systems, etc.).
  - .. Location of black and gray wastewater sources aboard the vessel.
  - .. Vessel resource capacities and estimated usage rates (prior to system installation).
- Selection of the viable candidate systems as determined on the basis of the feasibility of installation, using the governing installation guidelines and assumptions.
- Determination of the black/gray wastewater (or sludge) holding tank capacities which can be fitted.
- Development of installation cost estimates for each viable candidate system.
- Development of drawings showing the proposed arrangement of the wastewater management system equipments for each viable candidate as well as the arrangement of the black and gray wastewater sources on board the vessel.
- Development of installation related effectiveness attribute data.

ASSUMPTIONS

The pertinent assumptions and guidelines governing the installation analysis are presented in Volume IV of this report, along with the details of each of the 18 candidate wastewater management system concepts in configurations suitable for each vessel included in this study.

APPROACH

The installation analysis was performed in three stages consisting of a preliminary installation analysis, a shipcheck to establish viable system/vessel combinations, and an installation cost analysis all of which are discussed below. Prior to this analysis, visits were made to a number of vessels to inspect installations of the wastewater management subsystems and equipments included in this study.

Preliminary Installation Analysis

The candidate ship's general arrangement drawings and piping diagrams as furnished by the U.S. Coast Guard were reviewed at length to determine existing conditions so that the WMS requirements delineated in Volume IV could be applied to the vessel and a preliminary installation analysis made prior to an actual visit to the ship. This approach was intended to maximize familiarity with the vessel and to determine any possible questionable areas of interest. Each system was investigated as to space requirements, possible equipment locations, relationship to ship's functions (operation, mission, fuel stowage, water capacity, support systems, etc.) and its relationship to the reportedly existing waste disposal system.

In order to obtain as accurate a picture as possible, arrangement drawings to scale were made from the ship's plans of the possible installation spaces and "dummy cut-outs" of WMS equipment (also to scale) were used to determine if a proposed arrangement was feasible and if any problems could be anticipated. The results of the preliminary installation analysis are presented in Appendix A.

Shipchecks To Determine Viable Candidate Systems

Upon completion of the preliminary installation analysis, a detailed shipcheck of the vessel was made. During this visit various factors bearing on the investigation were considered, e.g., support systems (compressed air, sanitary flushing medium, electrical power generation, salt water systems, fresh water systems, fuel oil systems, etc.), correlation between actual ship arrangement and that shown in ship's drawings furnished for the study, relationship of other ship's systems and equipment to the location

and installation of WMS components to determine interferences and relocations, access for shipping WMS equipment aboard, removals, relocations, etc. The drawings prepared during the preliminary installation study were checked out and modified to reflect actual shipboard conditions.

The discussion of the shipcheck results presents a verbal picture of what conditions actually exist aboard the vessel and how these conditions affect the viability determination of each wastewater management system. The installation acceptance or rejection rationale for each candidate WMS is presented, complete with estimated tank sizes, equipment locations, possible space modifications, relocations, limitations, exclusions, and any other such considerations as may be necessary to obtain a lucid understanding of the situation.

Vessel resource capacities (including the source of fresh water) and estimates of usage rates (prior to WMS installation) were obtained from interviews with cognizant officers. The locations of all black water (sewage and garbage grinder slurry) and gray water (galley and turbid) waste sources were determined.

The shipcheck also provided the necessary information to determine the capacities (in gallons) of required black and gray wastewater (or sludge) holding tanks (not part of manufacturer supplied wastewater treatment equipment) which can be accommodated, as well as their configurations (heights). This information was used to determine the black and gray wastewater holding capacities of each viable candidate system (expressed as a percentage of the required holding time). These results are presented on the WMS Equipment Requirements form together with the other equipment types and quantities required in order to synthesize each viable candidate system on the vessel. This WMS Equipment Requirements form served as the starting point for the cost and effectiveness assessments of each viable candidate system.

Installation Cost Analysis

The following were generated as part of the installation cost analysis:

- WMS equipment arrangement drawings for each viable candidate system and arrangement drawings for the black and gray wastewater sources aboard the vessel.
- Installation related effectiveness attribute data.
- Installation cost estimates for each viable candidate system.

The starting point for the installation cost estimates was the condition of the vessel at the time of the shipcheck inspection. Each viable candidate system installation was then analyzed in terms of a fixed set of installation cost elements. The Installation Cost Estimate Form shown in Figure 1 was used to record the estimated requirements for each cost element and the associated cost was computed. Each installation cost element in Figure 1 is discussed below.

(a) Piping - Wherever possible and applicable, existing piping runs were retained for reuse as installed. Pertinent information contained in the available ship's piping plans was used insofar as practicable. New piping runs were estimated from these drawings and the system equipment arrangement drawing prepared.

For estimating purposes of this nature, it is usual marine practice to use a dollars per pound of material to be installed. Therefore, an estimated present-day price, including material and labor to install, was placed at $4.50/lb.

For the sake of uniformity and simplification since the WMS evaluations are comparative, the piping material used is copper-nickel. It is recognized that most waste disposal piping systems under consideration in the U.S. Coast Guard vessels are of copper-nickel, although some PVC (plastic) piping and a small amount of steel is used. Since the established guidelines call for the principal piping (drainage) to be of copper-nickel it was considered that for the relatively small additional piping, such as vents, the use of copper-nickel for all piping components would not adversely influence the overall results. Accordingly, the amounts of each size piping were estimated and a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.

(b) Steel - For this part of the cost estimate only the steel involved in the various shipyard supplied tanks is considered. Foundations are a separately treated item. For these tanks it was considered that one-quarter inch plate would be a good average thickness. Since the tanks would have to be structurally stiffened for proper support, a factor of 30% was added to the plate weight. The weight estimate was derived from the system guideline size requirements translated into configurations as shown on the equipment location and arrangement drawings.

For cost estimating of this nature, it is usual to apply a cost per pound figure. It was considered that a good current price of $0.55/lb. would cover material and labor for fabrication and placing on board. This does not include the cost of fixing the tanks permanently in place by welding. This is a separate consideration.

WMS INSTALLATION COST ESTIMATES

Vessel_____

WMS No._____

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	[2]	
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	[4]	
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	[5]	
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)		
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)		
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)		
Welding		Feet	$ 6.00/Ft. (Materials and Labor)		
Removals	Cutting	Hours	$50.00/Hr. (Labor) [6]		
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)		
Total Installation Cost ($)					

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

Figure 1

INSTALLATION COST ESTIMATE FORM

(c) Foundations - Supporting steel structure for all components of each WMS (tanks, pumps, MSD, incinerators, etc.) was estimated as approximately 10% of the weight which has to be carried. This is a usual rule of thumb for this type of installation. Fabrication and installation costs for material and labor were taken as $0.92/lb. based on consideration of today's average costs. The weights were estimated from the tank configurations and contents as well as the component weights given in Volume IV.

(d) Electrical Power Cable - The amount of footage was estimated from the ship's arrangement plans and the WMS equipment arrangement drawings prepared, with allowances for the devious routings which could be encountered. Since ship alteration work is usually more complex than new construction, allowance as made for less installation per unit time. Therefore a cost of approximately $2.00/ft. of cable was used to cover material and labor.

(e) Miscellaneous Installations - To cover the installation of various items such as pumps, motors, skid-mounted components, etc. where the activity centers principally around alignments and bolting in place, an estimate was made of the amount of time it would take to perform the tasks for each system installation, since the number and type of components varies. An estimated shipyard labor cost of approximately $15 per man-hour (MH) was considered representative.

(f) Access Cuts - In order to get material and components into the compartments where they would be fitted it could become necessary to temporarily cut the ship's hull, or deck plating or a bulkhead to provide passageway. The number of feet of cutting was estimated for each system installation based on the approximate size of the largest component anticipated. Estimated shipyard cost for such cutting is approximately $1.00/ft.

(g) Welding - This consideration includes securing tanks and non-bolted items and welding back any plating temporarily cut to provide access. An estimate of the number of feet of welding was made for each item in each system and a cost factor of $6.00/ft was considered satisfactory to cover material and labor.

(h) Removals - In cases where some existing equipment would have to be cut and removed from the vessel as no longer required, an estimate was made as to the approximate length of time it would take a team of two men to accomplish certain tasks. Estimated factors of $50/hour for cutting (based on an estimated cutting note of 50 ft/hour) and $15/man-hour (MH) for miscellaneous handling labor were considered representative of such costs.

(i) Other Considerations - The installation cost estimates do not include some shipyard costs which yards to include as a matter of quotation to perform a certain ship modification. Such intangibles would include: cleaning and gas-freeing tanks, temporary removals or modifications to ducts, piping, electric cables, machinery, ship's outfit or furnishings, etc. and re-installation to existing state after the basic modification has been completed; cleaning, preparing and repainting the compartments and parts of the steel work distrubed, use of special rigging and shipyard lifting gear; and other work items which are part of a hipyard's everyday business and which are normal for them to price out.

If a complete ship alteration price is desired, it would involve drawing up a complete set of specification and drawings in sufficient detail for a shipyard's estimating department to analyze at length. If possible, yard personnel would prefer to visit the vessel for a more accurate cost estimate to eliminate or minimize costs which it could possibly have to absorb.

One of the most difficult factors to consider and which is not obvious but which is very much a determinant is the shipyard's workload or backlog. If there is a convenient "hole" in the yard's work schedule, the price could be made attractive since it would provide needed economic continuity for its work force and facilities. Certainly if there is little or no other work in the offing, the yard will be inclined to "buy" the job by bidding lower than it normally would.

Thus it can be seen that there will be additional costs to those detailed herein, if one is interested in a "finished product" price than a comparative estimate.

LIMITATIONS

The installation cost estimating procedures used are considered to be fairly general and applicable for study purposes of this type which places greater emphasis on relative cost among candidate systems rather than on the absolute cost for a given system. However, the installation cost estimates developed herein are based on specific vessel conditions, wastewater management system requirements and the governing installation guidelines and assumptions. Therefore, caution is advised in attempting to use these estimates directly for vessels and/or systems other than those specifically included in this study.

PERTINENT VESSEL INFORMATION

FIREBUSH (180')

Vessel Characteristic	Data
Class	WLB - 393 Basswood (180') C Class
Type	Buoy Tender (Seagoing)
Crew Size	50
Home Port	Governor's Island, New York

SHIPCHECK OBSERVATIONS OF EXISTING VESSEL CONDITIONS

FIREBUSH (180')

Crew 50 men

Waste Sources

Complete information on the sewage and gray water sources is contained in the tabulation sheets forming a part of these introductory remarks.

Existing Arrangement

(a) All Sanitary flushing is with sea water furnished by two (2) sanitary water pumps.

(b) The vessel's configuration and compartmentation require two zones for drainage - one forward of Frame 124 and one aft.

(c) A 25 gallon collecting tank with a pump operating on automatic level sensing is fitted on the Second Deck in the Hawser and Canvas Stowage Room aft.

A 278 gallon collecting tank and an 1875 gallon retention tank are fitted on the lower level of the Main Cargo Hold forward. Two pumps serve these tanks on automatic or manual control.

(d) The Officers' Toilet space watercloset aft is fitted with an integral pump which can discharge directly to either the collecting or the retention tank forward. All gray water aft of Fr. 124 gravitates to the 25 gallon collecting tank from which it is pumped through a separate main to either the 278 gallon collecting tank or the 1875 gallon retention tank. There is no provision for gravitating the aft gray water overboard.

(e) Black and gray water from spaces forward of Frame 124 can gravitate via separate mains selectively (depending on overboard restrictions) to the 278 gallon collecting tank or to the 1875 gallon retention tank. Either of two pumps located just forward of these tanks can discharge their contents directly overboard or to weather deck shoreside connection, port and starboard.

(f) The collection tank operates under automatic or manual control and is fitted with a high level alarm.

The retention tank operates only on automatic control and is fitted with a high level alarm.

The tanks can be cross connected, but the discharge pumps must be operated manually under this condition.

(g) At present the vessel does not use the 278 gallon collecting tank. All wastes are routed to the 1875 gallon retention tank for pumping overboard or to pierside.

Special Remarks

Due to the arrangement of the various spaces and the cargo handling gear installation and operation immediately forward of the vessel's house, the routing of incinerator stacks to the weather poses a problem. Although the internal runs offer some space alteration considerations, the weather side runs offer more of a consideration from the viewpoint of routing compatible with the vessel's open type house structure and the need to keep clear of navigational and cargo operational stations. The solutions are not immediately apparent and would require additional investigation and approval before the specific waste management systems involved would be considered viable unconditionally.

In order to realize the maximum attainable tank volumes, it has been proposed in the system discussions that some tanks be trapezoidal in plan view, with vertical wall sides and ends, instead of completely rectangular. This will enable the tanks to approximate the converging contour of the deck at side when approaching the bow.

Where it may be necessary to relocate the laundry presently located in the Main Cargo Hold, Second Deck, Port, Frs. 44 to 53, consideration could be given to converting the storage and small shop areas just aft of the hold, Frs. 65 to 74, on the same deck and side. Space availability is at a premium and the Second Deck in the Main Cargo Hold is utilized for storage and small shops, port and starboard. Only the center portion in way of the hatch is kept clear. This is the area just above the collection and retention tanks. Further, a large spare concrete block buoy sinker (anchor), 6'x6'x2'-6", is stored in the lower hold and can be lifted out only by way of the hatch.

Use of the hold as described under the various system considerations would require relocating the concrete sinker and deletion of the portable horizontal hatch beams which are now covered over to provide extra decking on the Second Deck level of the Main Cargo Hold. These beams could be removed since they are not structural support members.

In all cases where the lower hold is used for a system, the storage area along the periphery of the space may have to be modified. Fuel Transfer hoses on reels port and starboard in the forward part of the lower hold should be left undisturbed if possible.

VESSEL RESOURCES

Vessel: FIREBUSH (WLB - 393) - Basswood (180')C Class

1. Fresh Water*	
a. Source of supply (i.e., storage tank, evaporator)	Supplied from off-shore to 7 storage tanks
b. Capacity (# of gals, etc.)	Main storage Tank - 18,430 gals; forward peak tank -6,055 gals; forward tanks (2) each contains 10,460 gals; after tank - 1,920 gals; after tanks (2) each contains 2,635 gals.
c. Usage rate (# of gpd, etc.)	In Port - approximately 1,500 gpd. Underway - 2,300 gpd
2. Fuel Oil*	
a. Tank capacity (# of gals)	3 storage tanks: (1) 02F tank-11,685 gals; (2) 83F tank - 8,130 gals; (3) 84F tank - 8,060 gals;
b. Usage rate (gpd, etc.)	Underway - MINIMUM - 150 gals. MAXIMUM - 1,300 gals. IN PORT - 50 gals (when generator is in use)
3. Electric Power	
a. Capacity kw	(2) 62.5 kw diesel generators (1) 50 kw diesel generators
b. Usage rate (when)	Underway - constant - when boom is in use, all 3 generators required
c. Maximum kw used	Use (2) generators constantly 62.5 kw Use additional generator when total electronic equipment in use (radar, etc.)
d. Average kwh per day	3,120 kwh underway (without use of boom)
4. Compressed Air	
a. Capacity	2 compressors - 100 psi (each) one for ships service air; One for Pneudyne control (Bridge - Engine Room control)
b. Usage rate	Variable - Ships Service Air is for air horn; and ships maintenance Pneudyne Bridge Control used only while underway when Bridge is controlling the engines
c. No. of hours compressors run per day or percentage of time	10% of day in normal use
5. Capacity of Ventilation Air in CFM (CFM INFORMATION NOT AVAILABLE ON VESSEL) Number of Blowers & Exhaust Fans: (1) Main vent blower above engine room (FIDLEY); (2) Main engine exhausts on q'ter deck; (1) Reefer supply blowe reefer room; (2) Supply blowers for engine room (FIDLEY); (1) Reefer exhaust - located in reefer spaces; (1) Supply blower for main hold; (1) Exhaust for main hold; (1) Main motor cooling blower; Exhaust in engine generator space; (1) Supply blower for Crew's berthing located under Bridge; (1) Exhaust blower in Crew's head; (1) Exhaust blower in galley; (1) Supply blower on mess deck for ammunition spaces.	
Personnel Utilization of each drainage area -	Vessel sanitary wastes all drain to one area (1,875 gal.) Retention tank in lower Hold.

*Light towers supplied (1) Ambrose - Quarterly - 20,000 gals water; 10,000 gals fuel oil
(2) Execution Rock - approximately every 2 months - 1,500 gals water; no fuel oil.
(3) Throgs Neck - approximately every 2 months - 1,200 gals water; 1,200 gals fuel oil.

LOCATION OF BLACK WATER* WASTE SOURCES ABOARD A VESSEL

Vessel: FIREBUSH (WLB - 393) - Basswood (180') C Class

Bulkhead Identification Frame #/To #	Level Identification	Compartment Location	Compartment Name	Number of Water Closets	Number of Urinals	Estimate of Number of People Served	Comments
95-101	01	CL	C.O. Toilet	1	0	1	
70-82	1	P	Crew's Toilet	2	1	40	
82-89	1	P	C.P.O. Bathroom	1	0	4	
89-92	1	P	Hospital Toilet	1	0	1	
154-157	1	P	Officers' Toilet	1	0	6	

* Sewage (output from commodes and urinals) and garbage grinder slurry.

LOCATION OF GRAY WATER* WASTE SOURCES ABOARD A VESSEL

Vessel: FIREBUSH (WLB-393) - Basswood (180') C Class

Bulhead Identification Frame #/To #	Level Identification	Compartment Location	Compartment Name	Waste Source	Comments
44-65	3	P-S	Hold	Collection Tank (278 gal) Retention Tank. (1875 gal)	
147-161	2	P-S	Hawser & Canvas Storage Room	Collecting Tank (25 gal)	

* Galley and turbid wastewater.

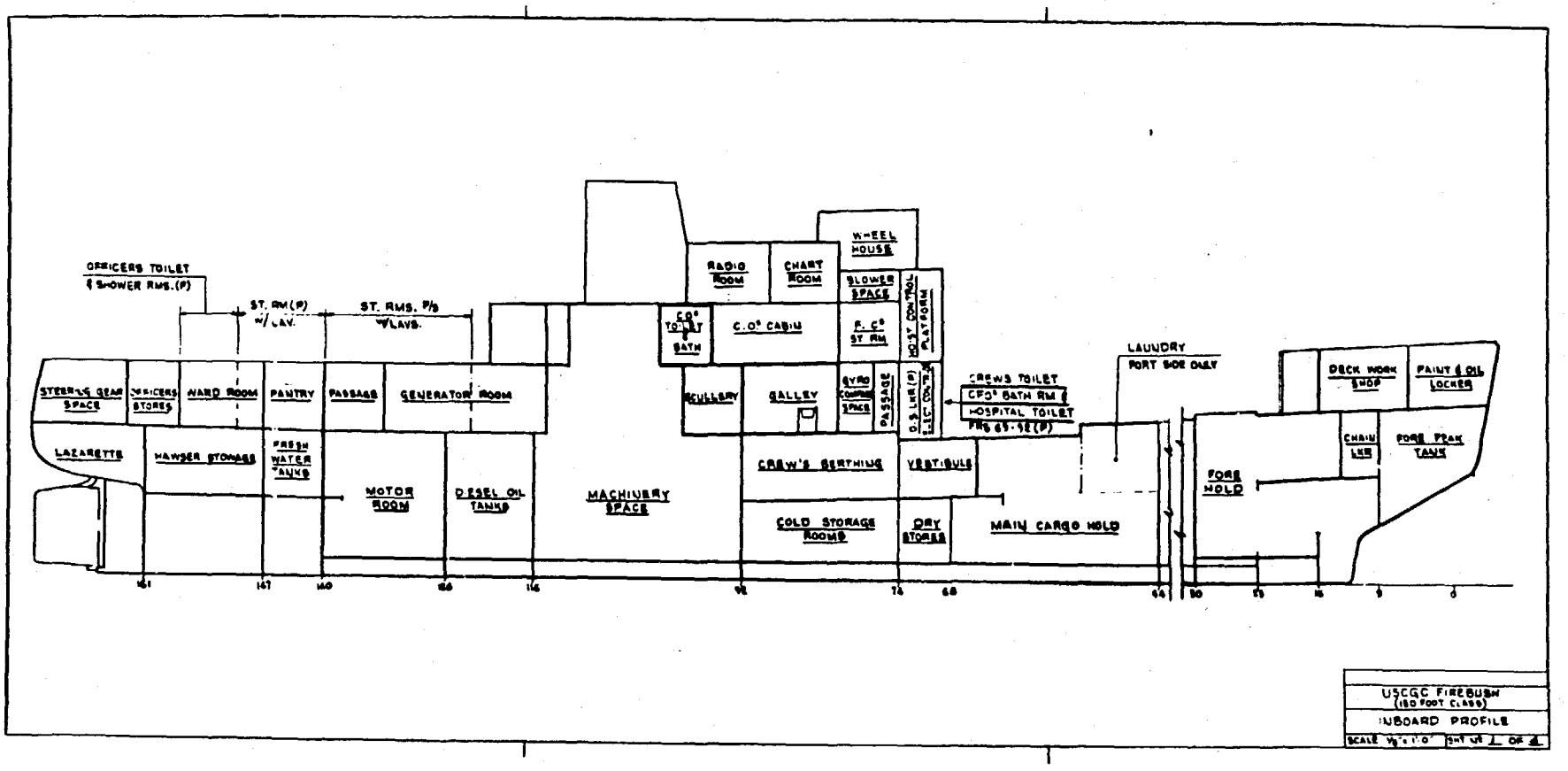
LOCATION OF GRAY WATER* WASTE SOURCES ABOARD A VESSEL

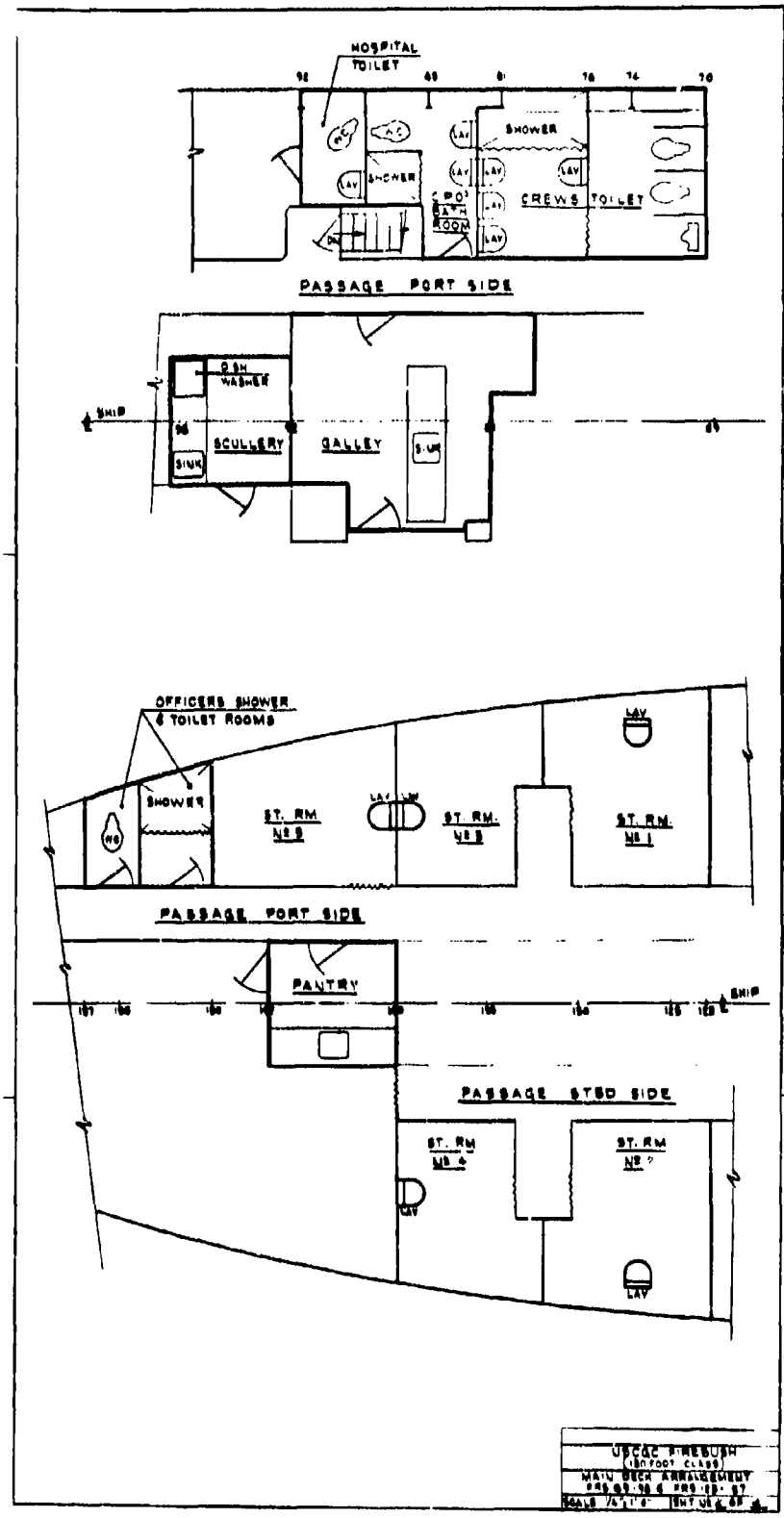
Vessel: FIREBUSH (WLB - 393) - Basswood (180') C Class

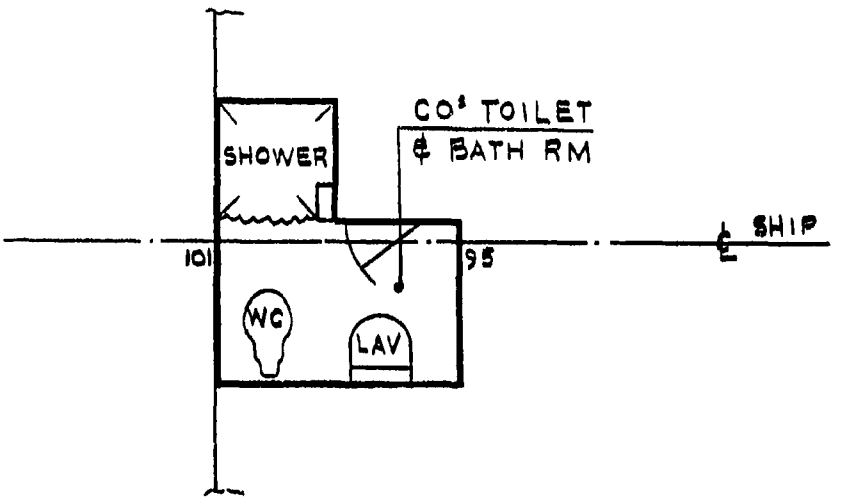
Bulhead Identification Frame #/To #	Level Identification	Compartment Location	Compartment Name	Waste Source	Comments
9[illegible]-101	01	CL	C.O. Bathroom	Shower (1)	
95-101	01	CL	C.O. Bathroom	Lavatory (1)	
7[illegible]-82	1	P	Crew's Toilet	Shower (1)	
78-82	1	P	Crew's Toilet	Lavatory (4)	
81-92	1	S	Galley	Sink (1)	
92-98	1	P	Scullery	Dishwasher (1)	
92-98	1	S	Scullery	Sink (1)	
82-89	1	P	C.P.O. Bathroom	Shower (1)	
82-89	1	P	C.P.O. Bathroom	Lavatory (2)	
89-92	1	P	Hospital Toilet	Lavatory (1)	
124-140	1	P	SR. A, B	Lavatory (2)	
140-149	1	P	SR. C	Lavatory (1)	
122-140	1	S	SR. D, E	Lavatory (2)	
140-14[illegible]	1	S	Pantry	Sink (1)	
140-154	1	P	Officers Shower	Shower (1)	
44-53	2	P	Main Cargo Hold	Washing Machines (2)	

* Galley and turbid wastewater.

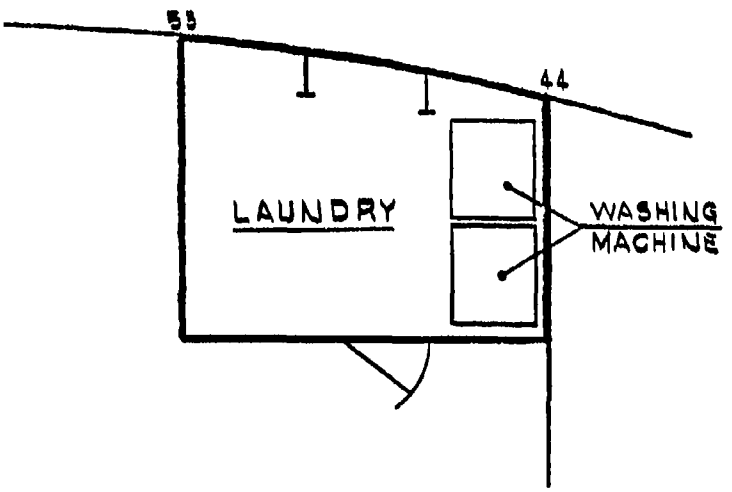
ARRANGEMENT OF BLACK AND GRAY WASTEWATER SOURCES




HOSPITAL TOILET
SHOWER
LAV
SHOWER
CREWS TOILET
PASSAGE PORT SIDE
D.W. WASHER
SCULLERY
GALLEY
SINK
S. UR
SHIP
OFFICERS SHOWER & TOILET ROOMS
SHOWER
ST. RM. NO 2
ST. RM. NO 3
ST. RM. NO 1
PASSAGE PORT SIDE
PANTRY
SHIP
PASSAGE STBD SIDE
ST. RM NO 4
ST. RM NO 5
USCGC FIREBUSH
MAIN DECK ARRANGEMENT

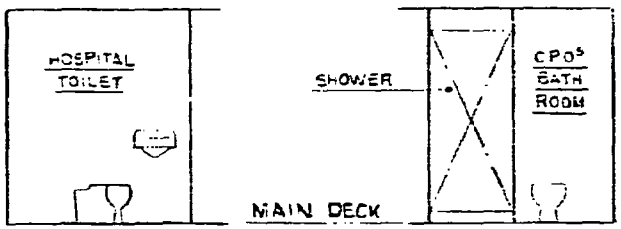


PLAN VIEW
UPPER DECK



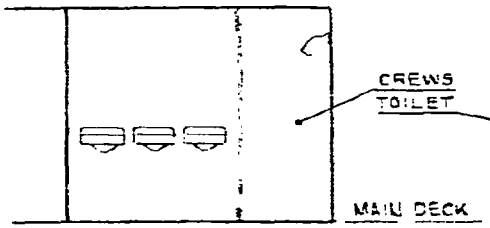
PLAN VIEW
SECOND DECK PORT SIDE

USCGC FIREBUSH (180 FOOT CLASS)
CO's TOILET & BATH RM-UPPER DECK & LAUUDRY-SECOND DECK
SCALE: 1/4"=1'-0" SHT NO 2 OF 4

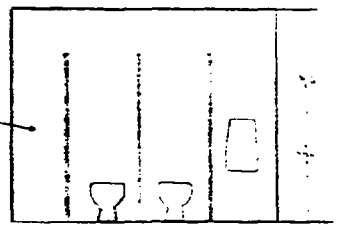


SECT AT FR 91
PORT SIDE-LKG FWD

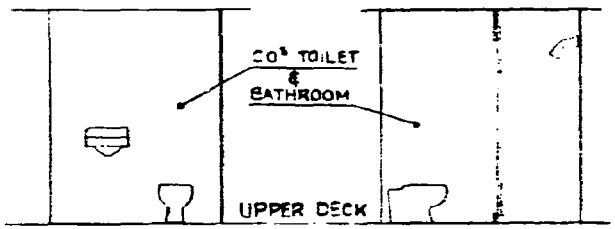
SECT AT FR 85
PORT SIDE-LKG AFT



SECT AT FR 78
PORT SIDE-LKG AFT

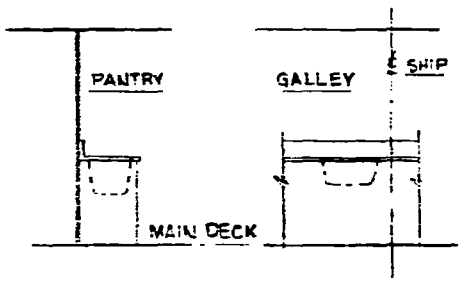


SECT AT FR 74
PORT SIDE-LKG FWD



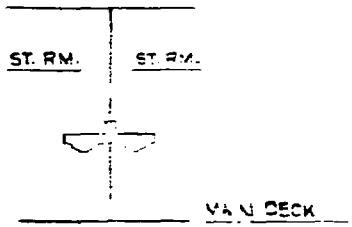
ELEV
LKG OUTB'D

SECT AT FR 100
LKG AFT

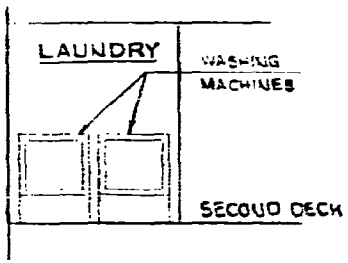


SECT AT FR 141
STBD-LKG AFT

SECT AT FR 81
LKG AFT



ELEV AT FR 140
PORT SIDE - LKG OUTB'D



SECT AT FR 44
PORT SIDE-LKG FWD

USCGC FIREBUSH (180 FOOT CLASS)
SECTIONS & ELEVATIONS THRU WAT SPACES
SCALE AS NOTED SHEET 4 OF 4

WMS EQUIPMENT REQUIREMENTS

Vessel FIREBUSH (180')

WMS NUMBER	WMS ACCEPTABILITY: For Installation (Yes/No)	Holding Time (%): Black	Holding Time (%): Gray	Safety (Yes/No) (1)	NUMBER OF FIXTURES: Commodes (2)	NUMBER OF FIXTURES: Urinals (3)	JERED: NUMBER OF VCT's (Sized By Gallons): Small Boat 30	Small Boat 60	Large Boat 120	Large Boat 200	Large Boat 250	JERED: NUMBER OF INCINERATORS: Jered	Thiokol	JERED: Number of M/F Pumps	GATX: NUMBER OF EVAPORATORS (Sized By Gallons): 20	40	60	80	GATX: Number of Vapor Treatment Sections	GATX: Number of Treatment Subsystems	GRUMMAN: Number of Thiokol Incinerators	CHRYSLER: COLLECTION AND RECIRCUL. SUBSYSTEM: Number of Separator Tanks: Model A	Model A/B	Model B	Number of P&FM Packages: Model A	Model B	CHRYSLER: INCINERATOR SUBSYSTEM: Number of Sludge Surge Tanks: Model B	Model C	Number of Incinerators: Model A	Model C	TANKS (4): BLACK (Gallons Each Tank)	GRAY (Gallons Each Tank)
1	Yes	100	0	Yes	6S	1S																											7295B	0
2	Yes	100	0	Yes	6S	1S																	1			1							1381C	0
3	Yes	100	12	Yes	6S	1S																	1			1		1				1		2395B
4	Yes	100	22	Yes	6S	1S														1													261A, 680C	4495B
5	Yes	100	100	Yes	6S	1S														2													1029A, 2345C	
6	Yes	100	100	Yes	6S	1S														2													9032B	768A
7	Yes	100	29	Yes	6S	1S														1	1												261A	6109B
8	Yes	100	100	Yes	6S	1S														2	2												1029A	
9	Yes	100	13	Yes	6J	1S/2J					1																						2145B	2737B
10	Yes	100	35	Yes	6J	1S/2J					1	1																						7295B
11	Yes	100	35	Yes	6J	1S/2J					1							2	2															7295B
12	Yes	100	100	Yes	6J	1S/2J					1									2													2145B	768A, 1737C
13	Yes	100	100	Yes	6J	1S/2J					1									1	3													768A
14	Yes	100	13	Yes	6G	1S/1G								4																			2345B	2693B
15	Yes	100	35	Yes	6G	1S/1G						1		4																				7295B
16	Yes	100	35	Yes	6G	1S/1G								4				2	2															7295B
17	Yes	100	100	Yes	6G	1S/1G								4						2													2345B	768A, 1737C
18	Yes	100	100	Yes	6G	1S/1G								4						1	3												101D	768A

WMS = Wastewater Management System
P&FM = Pressurization and Fluid Maintenance
(1) Does WMS meet all applicable safety standards?
(2) Letter following entered number means: S = Standard, J = JERED, G = GATX
(3) Letters following entered numbers mean: S = Standard urinal only, S/J = Standard urinals with indicated number of Jered urinal discharge valves, S/G = Standard urinals with indicated number of GATX flushometers.
(4) Letter following entered gallonage denotes tank usage: A = Influent Surge, B = Wastewater holding, C = Sludge holding, D = Intermediate tank not supplied with MSD.

WMS No.	1	2, 5	4	6	9, 12	14, 17
Tank Height	8'-3"	5'-0"	4'-0"	11'-1"	7'-6"	6'-9"

NOTES: (a) WMS No. 6 = Combined sewage/sludge holding tank.
(b) WMS No. 18 = Intermediate tank used as influent surge tank.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 1 Full Volume Flush Gravity Collection/Holding Tank for Black Water/Holding Tank for Gray Water

	Required
Sewage Holding Tank	7,295 gal. (975 cu. ft.)
Galley/Turbid Holding Tank	20,843 gal. (2786 cu. ft.)
Sewage Holding Tank Discharge Pump	Two (2)
Galley/Turbid Holding Tank Discharge Pump	Two (2)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

It is possible to provide the required holding tankage capability for the black water. There is insufficient space available to provide the required holding tankage capability for gravity drainage of gray water due to the design configuration of the vessel. Available space will be designated for black water holding, leaving no means to receive and hold the gray water. It will, however, be possible to gravitate the gray water directly overboard from all spaces except from the laundry and its nearby deck drains, both located on the Second Deck in the Main Cargo Hold, Port side.

The sewage holding tank would be located in the Main Cargo Hold (Bhds. 44 to 68). It would be approximately 14 feet long, 7 feet wide fwd., 10 feet wide aft and 8 feet 3 inches high. The tank would be fitted entirely within the dimensions of the hatchway such that the top of the tank would extend slightly above the Second Deck level.

The black water gravity drainage piping serving the spaces forward of Frame 124 could still gravitate forward with modification of the runs within the Main Cargo Hold. The overboard discharge pumps could be located in the lower part of the hold, just aft of the tank with piping runs overboard and to pierside using existing connections.

System No. 1 (cont'd.)

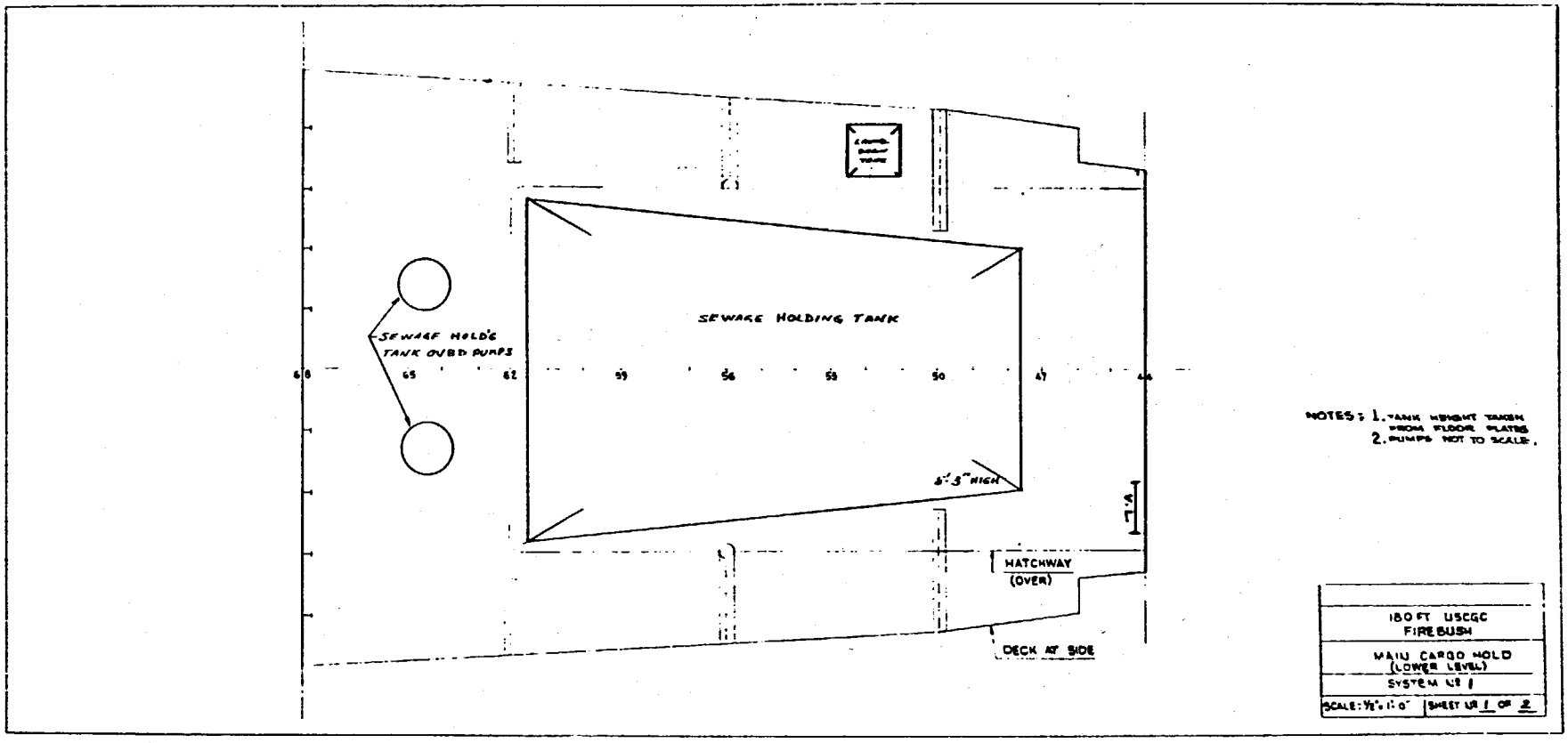
For the spaces aft of Frame 124, it would be necessary to fit a small collecting tank/pump arrangement in the Hawser Room aft similar to the existing 25 gallon tank fitted for gray water disposal. The tank would receive watercloset drains from the Officers' Toilet and garbage grinder drains from the Ward Room pantry (if fitted in the future). If the garbage grinder is not to be fitted, the existing watercloset/pump arrangement could be retained in lieu of adding the second 25 gallon collecting tank/pump arrangement which would be pumped on automatic tank level control, discharging forward to the Sewage Holding Tank.

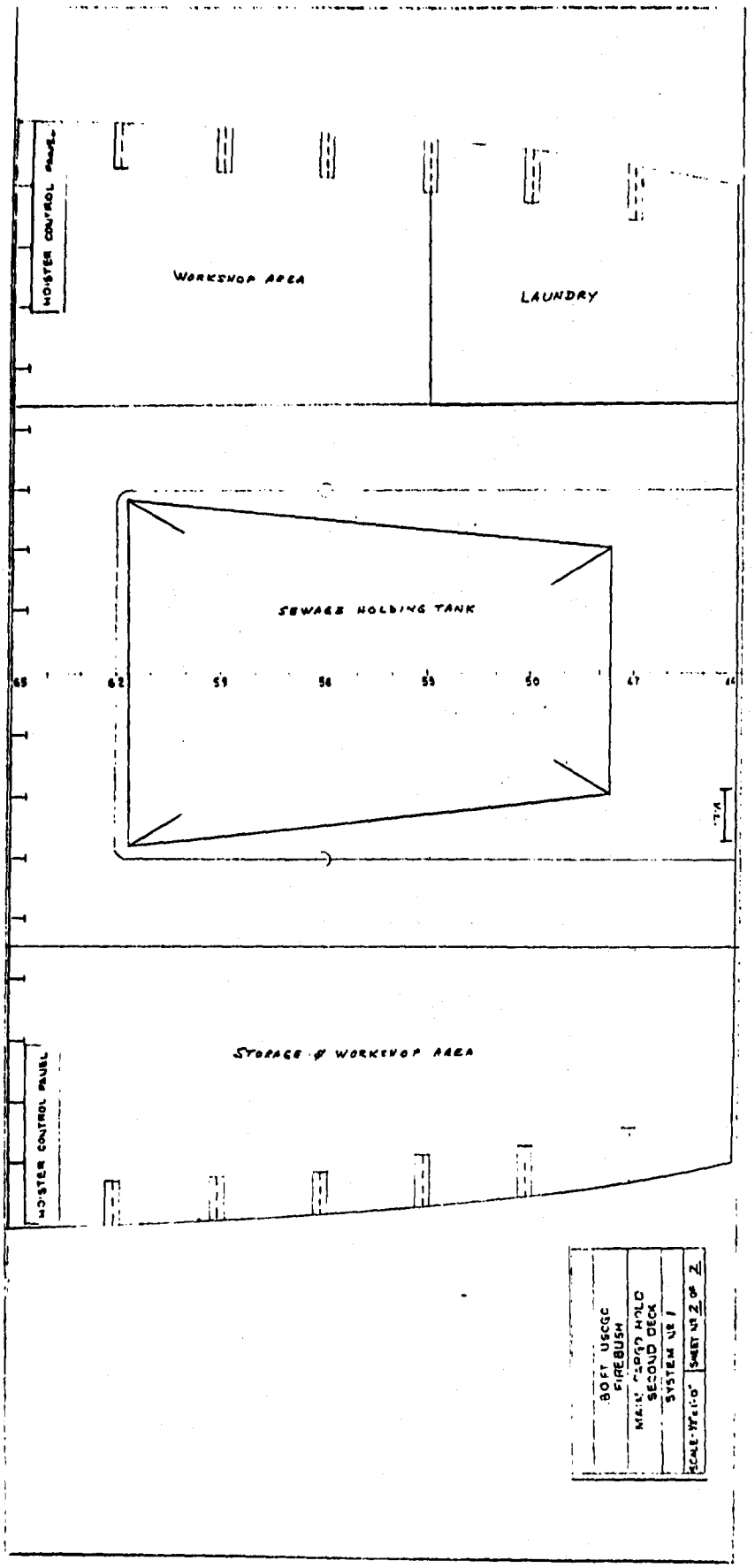
Gray water from spaces forward of Frame 124 would continue to drain forward by gravity as at present. However, instead of going to the present collecting tank or the retention tank, the drains would go directly overboard above the Second Deck level approximately where the present overboard discharge shell connection is fitted. When overboard discharge is not permitted, the gray water would have to be diverted to the Sewage Holding Tank for off-loading.

The gray water from the Laundry and deck drains on the Second Deck in the Main Cargo Hold cannot drain overboard by gravity since the vessel's design draft is just above the Second Deck level. The drains will not be able to gravitate to the Sewage Holding Tank since the tank will protrude above the Second Deck. Therefore, these drains would best go to a small collecting tank fitted with a liquid level actuated pump which would discharge overboard or to the Sewage Holding Tank when overboard discharge is not permitted.

The gray water drains from the spaces aft of Frame 124 would continue to drain to the existing 25 gallon collecting tank/pump arrangement in the Hawser Room for discharge forward to overboard and to the Sewage Holding Tank for off-loading when overboard discharge is not permitted.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
WORKSHOP AREA
LAUNDRY
SEWAGE HOLDING TANK
68
62
59
56
53
50
47
44
STORAGE & WORKSHOP AREA
HOISTER CONTROL PANEL
80 FT USCGC
FIREBUSH
MAIN CARGO HOLD
SECOND DECK
SYSTEM NO 1
SCALE-1/4"=1'-0"
SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 1

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	720[2]	3,240
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	8,150[4]	4,409
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	6,950[5]	6,394
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	230	460
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	20	300
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	45	270
Removals	Cutting	Hours	$50.00/Hr.[6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					16,848

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft. /hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 2 Full Volume Flush Oil Recirculation and Gravity Collection/ Chrysler System with Sludge Holding Tank for Sewage/Holding Tank for Gray Water

	Required
Sewage Holding Tank	1,362 gal. (182 cu. ft.)
Galley/Turbid Holding Tank	20,843 gal. (2786 cu. ft.)
Chrysler Model and Quantity	One (1) - A/B Separation Tank with One (1) Model A Pump & Fluid Maintenance Package or Two (2) Model A Separation Tanks with Two (2) Model A Pump & Fluid Maintenance Packages
Sewage Holding Tank Discharge Pumps	Two (2)
Galley/Turbid Holding Tank Discharge Pumps	Two (2)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

Equipment locations and drainages would be as follows:

(a) The required sewage holding tank capacity would be provided.

(b) No galley and turbid holding tankage is possible due to lack of space.

(c) Sewage from the Officers' Toilet aft of Frame 124 would continue to be pumped forward for disposition. In this system they would go to the Chrysler Separation Tank in the Main Cargo Hold.

Garbage grinder drains aft cannot gravitate forward and cannot be mixed with the flush fluid in the Chrysler system. Therefore they would have to be collection tank fitted with a sump pump similar to the existing 25 gallon Galley Collecting Tank in the Hawser Room. The drains would be pumped forward for disposition via the Sewage Holding Tank.

Sewage drains from spaces forward of Fr. 124 would gravitate to the Chrysler Separation Tank in the Main Cargo Hold.

System No. 2 (cont'd.)

(d) Gray water from spaces aft of Frame 124 would continue to use the existing 25 gallon collecting tank with internal sump pump. The discharge would be forward to overboard and when not permitted to go overboard, would go to the Sewage Holding Tank for off-loading in the Main Cargo Hold.

(e) Laundry and deck drains therefrom would have to be collected and pumped overboard when permissible, and pumped to the sewage holding tank for off-loading when overboard discharge is not permitted.

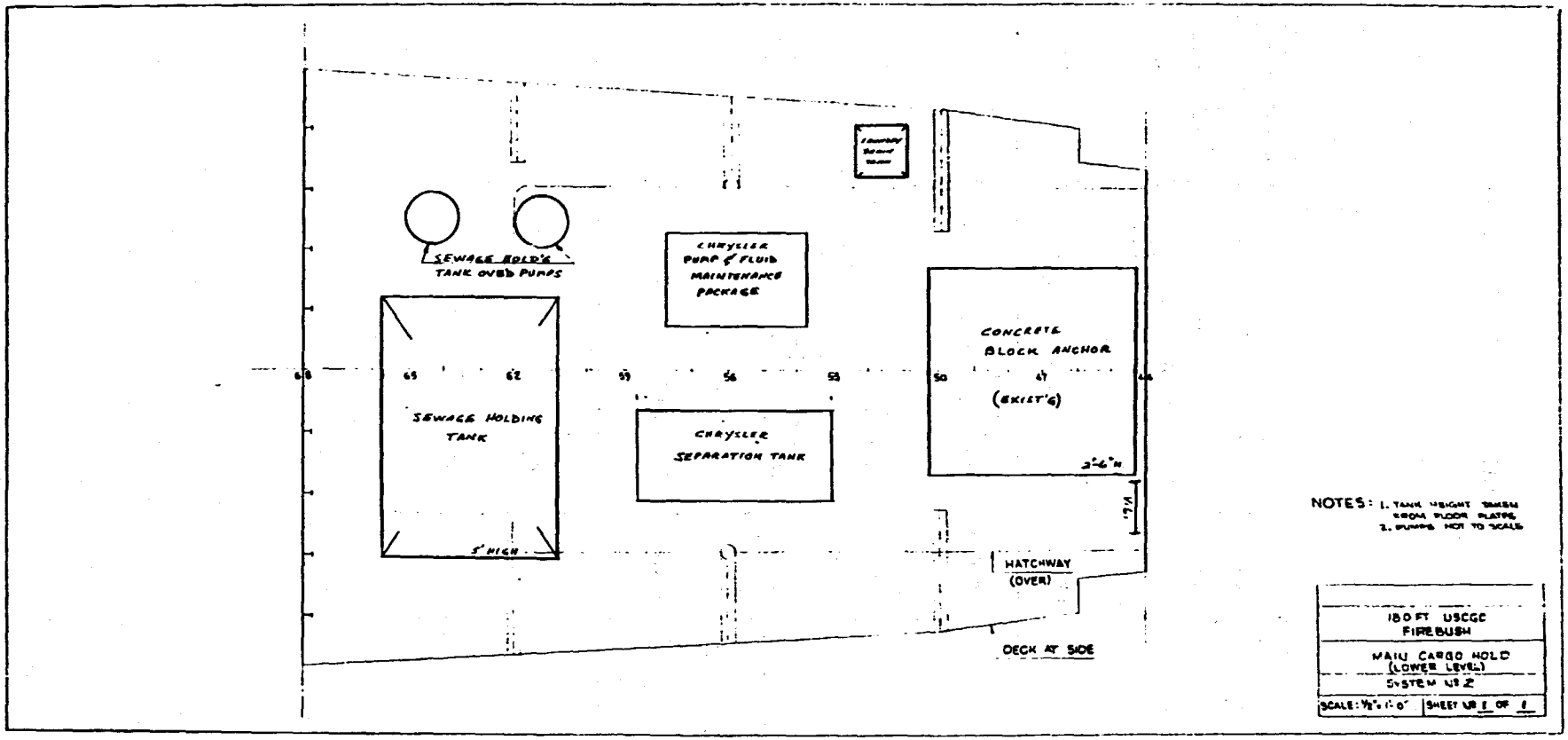
(f) Other gray water would be gravitated directly overboard, and for pierside off-loading would be diverted to the sewage holding tank.

The sewage holding tank (approximately 7'-6" long, 5'-0" wide and 5'-0" high) would be located on the lower level of the Main Cargo Hold, at its aft end. The tank would extend from the ship's centerline outboard to starboard.

The overboard discharge pumps would be located to port of the sewage holding tank.

The alternative arrangement having one Chrysler separation tank and one pump and fluid maintenance package is preferred since it requires a simpler piping arrangement and less space. The components would be arranged just forward of the sewage holding tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT



WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 2

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,395 [2]	6,278
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	2,260 [4]	1,243
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	1,760 [5]	1,620
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	345	690
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	20	300
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	25	150
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					12,056

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 3 Full Volume Flush Oil Recirculation and Gravity Collection/ Chrysler System with Incinerator for Sewage/Holding Tank for Gray Water

	Required
Galley/Turbid Holding Tank	20,843 gal. (2786 cu.ft.)
Sludge Holding Tank	One (1) Model B
Chrysler Model and Quantity	One (1) - A/B Separation Tank with One (1) Model A Pump & Fluid Maintenance Package, or Two (2) Model A Separation Tanks with Two (2) Model A Pump & Maintenance Packages
Incinerator Model and Quantity	One (1) - C
Sludge Surge Tank Transfer Pump	One (1)
Sludge Surge Tank Discharge Pump	One (1)
Galley/Turbid Holding Tank Discharge Pump	Two (2)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

The alternative arrangement having one Chrysler separation tank and one pump and fluid maintenance package is preferred since it requires a simpler piping arrangement and less space. The components would be fitted in the aft portions of lower level of the Main Cargo Hold, along the ship's centerline. The Model B sludge holding tank (3'-4" L x 3'-0" W x 4'-1" H) would be located nearby where the existing 278 gallon collecting tank is presently fitted on the port side.

The galley and turbid holding tank size would be restricted to approximately 320 cu.ft. (2395 gallons) due to space availability. The tank would be approximately 7'-0" long, 6'-9" wide at the forward end, 8'-6" wide at the aft end and 6'-0" high and would be fitted also in the lower level of the Main Cargo Hold, at its forward end and on the vessel's centerline.

System No. 3 (cont'd.)

The pumps associated with these components would be fitted on the port side aft and in the area forward of the sludge holding tank.

The incinerator, blower and fuel tank would be located on the 2nd Deck level of the Main Cargo Hold, Stbd. side.

The incinerator stack could possibly be led to the weather stores space on the port side, Frs. 65-74, Second Deck and up through the Crew's Toilet on the Main Deck. There appears to be no way to run the stack via the existing ship's stack enclosure. See the Special Remarks in the discussion at the beginning of this Section.

Sewage from the Officers' Toilet aft of Fr. 124 would continue to be pumped forward for disposition. It would go to the Chrysler Separation Tank in the Main Cargo Hold.

Garbage grinder drains aft cannot gravitate forward and cannot be mixed with the flush fluid in the Chrysler system. Therefore they would have to be collected in a small collection tank fitted with a sump pump similar to the existing 25 gallon Galley Collecting Tank in the Hawser Room. The drains would be pumped to the Sludge Holding Tank in the Main Cargo Hold for disposition in the incinerator.

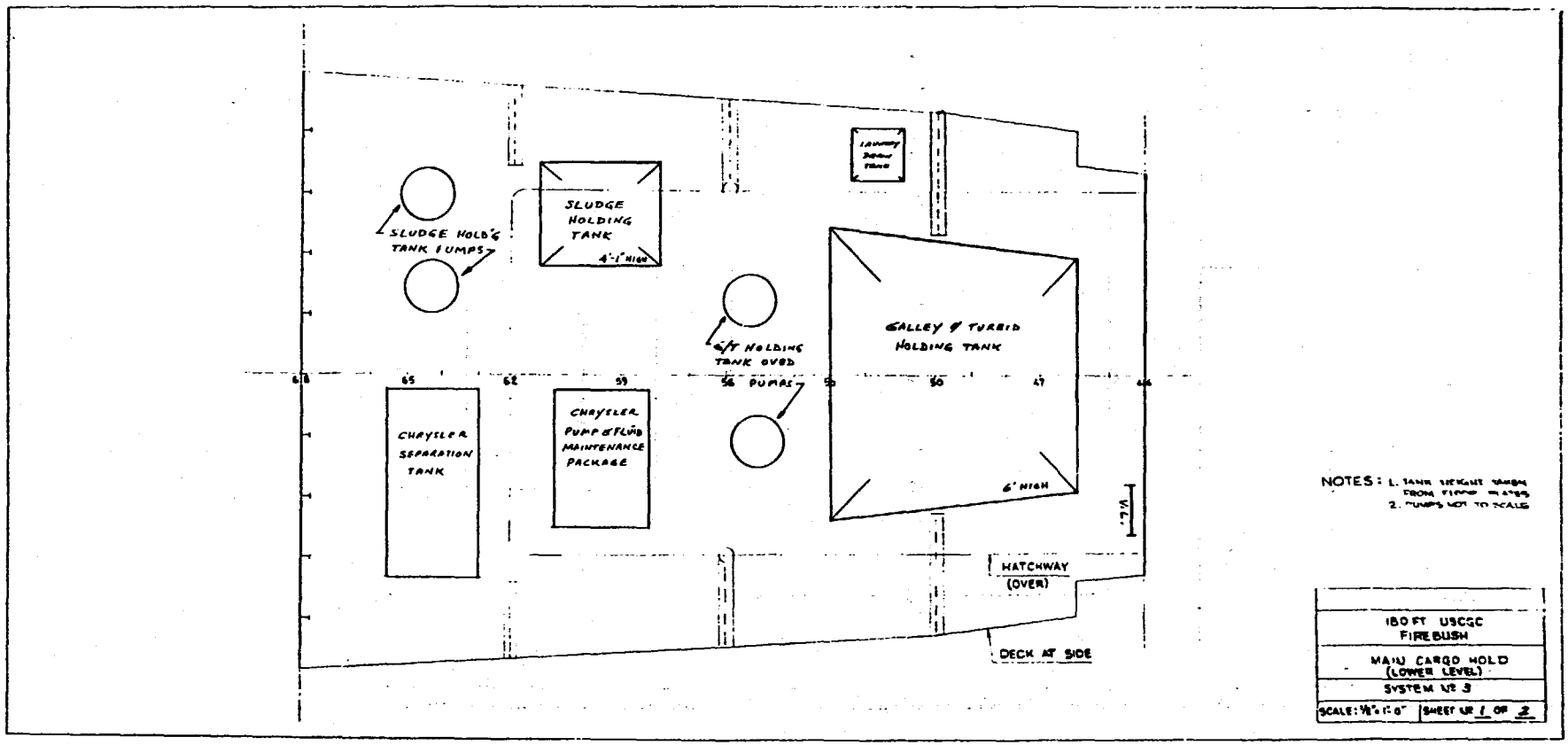
Gray water drains aft of Fr. 124 would gravitate to the existing 25 gallon collecting tank in the Hawser Room and then be pumped forward to overboard and to the Galley/Turbid Tank for pierside discharge.

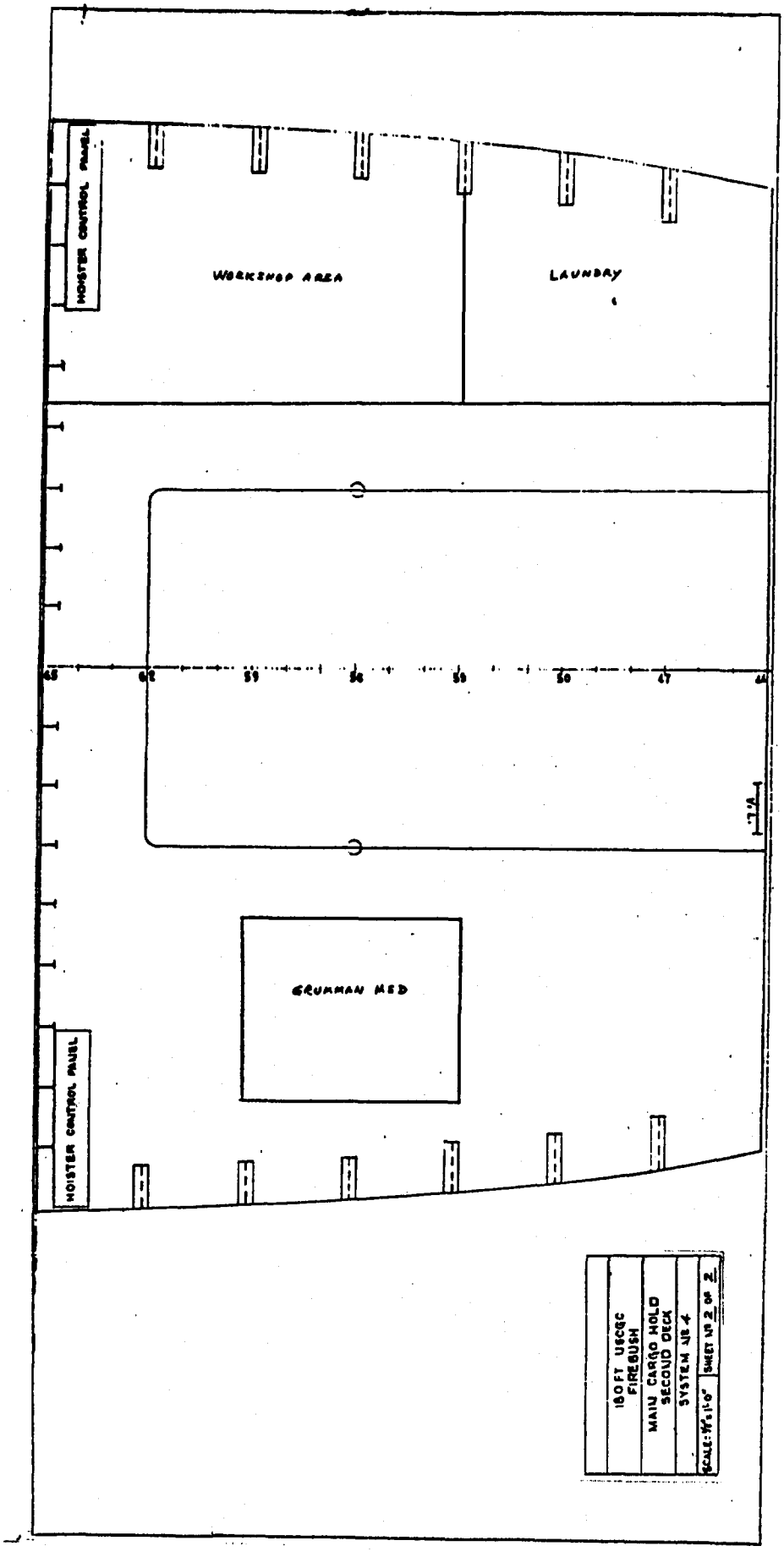
Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard via the Main Cargo Hold and for pierside off-loading would be diverted to the galley/turbid holding tank.

The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with a small (approximate 25 gallons) collecting tank with sump pump for overboard discharge. For pierside off-loading the drains would gravitate to the G/T holding tank.

Installation of the incinerator would require additional fire protection equipment and possibly a modification to the ventilation system for the Main Cargo Hold.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
WORKSHOP AREA
LAUNDRY
68
62
59
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47
44
GRUMMAN MED
HOISTER CONTROL PANEL
180 FT USCGC
FIREBUSH
MAIN CARGO HOLD
SECOND DECK
SYSTEM NO 4
SCALE: 1/8" = 1'-0"
SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 3

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	2,615 [2]	11,768
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	4,590 [4]	2,525
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	3,120 [5]	2,871
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	460	920
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	40	240
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					20,624

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft. /hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 4 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Holding Tank for Black Water/ Holding Tank for Gray Water

	Required
Sanitary Influent Surge Tank	261 gal. (35 cu. ft.)
Galley/Turbid Holding Tank	20,848 gal. (2786 cu. ft.)
Sludge Holding Tank	680 gal. (81 cu. ft.)
Grumman Unit	One (1)
Influent Surge Tank Pump	One (1)
Influent Surge Tank Overboard Pump	Two (2)
Sludge Tank Transfer Pump	One (1)
G/T Holding Tank Discharge Pump	Two (2)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

Equipment would be located in the Main Cargo Hold as follows:

On the Lower Level

(a) Sanitary influent surge tank (approx. 3' L x 3' W x 4' H), on port side where 278 gallon collecting tank exists.

(b) Sludge holding tank (approx. 4'-6" L x 4'-6" W x 4'-0" H) on starboard side where 1875 gallon retention tank exists.

(c) Galley/Turbid holding tank (approx. 9'-3" L x 6'-9" W fwd x 9'-0" W aft x 8'-3" H) on the ship's centerline, at forward end of the hold, within the hatchway, protruding slightly above the 2nd deck level. Tank is limited to approximately 600 cu. ft. (4495 gal.) due to lack of space.

(d) Various associated pumps aft of the G/T holding tank.

System No. 4 (cont'd.)

On the 2nd Deck Level

(e) The Grumman MSD on starboard side.

Drainages would be as follows:

(a) For the spaces aft of Frame 124, it would be necessary to fit a small collecting tank/pump arrangement in the Hawser Room aft similar to the existing 25 gal. tank fitted for gray water disposal. The tank would receive watercloset drains from the Officer's Toilet and garbage grinder drains from the Ward Room pantry (if fitted in the future) which would be pumped on automatic tank level control, discharging forward to the Sanitary Influent Surge Tank. If the garbage grinder is not to be fitted, the existing watercloset/pump arrangement could be retained in lieu of adding the second 25 gallon collecting tank/pump arrangement.

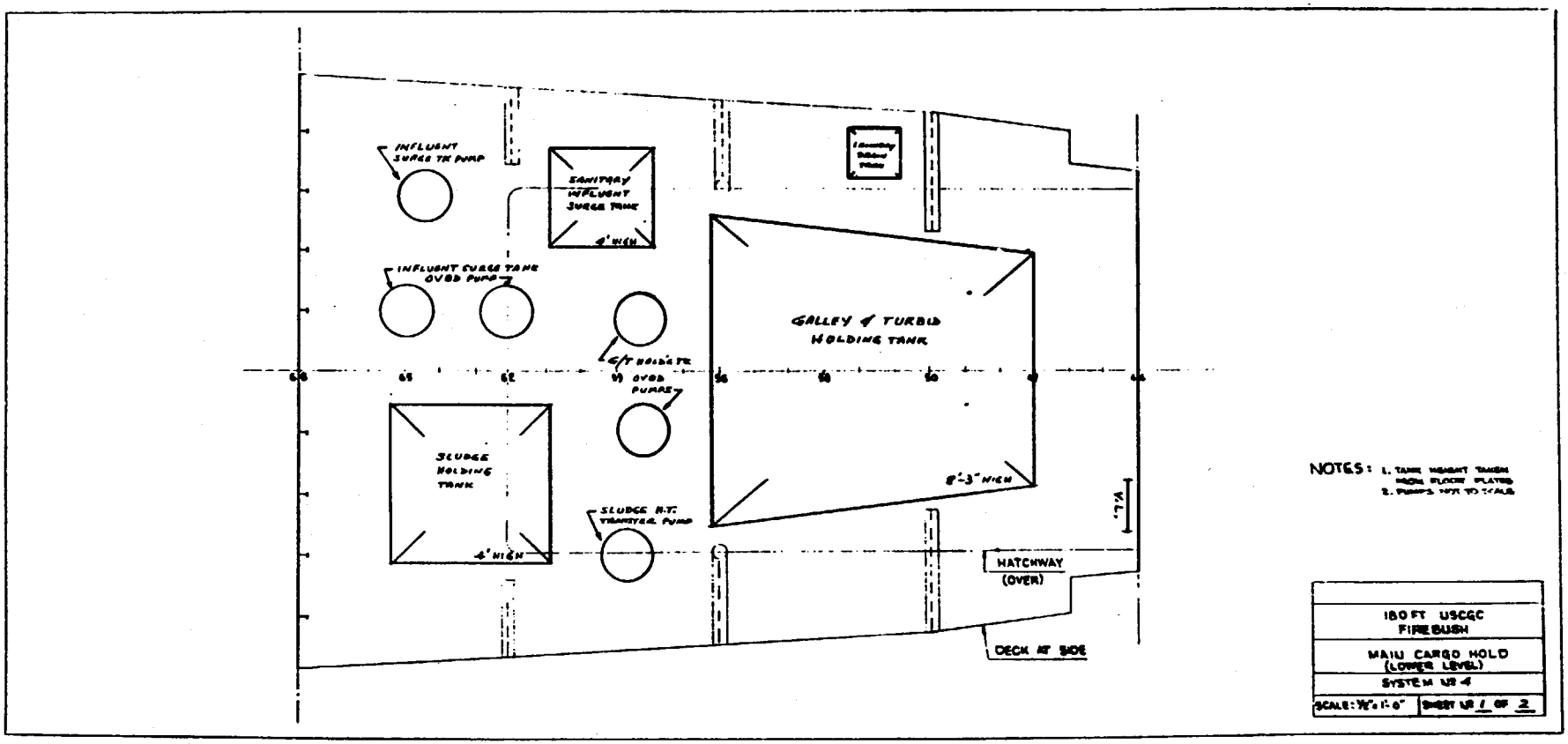
For spaces forward of Fr. 124, sewage drains would gravitate directly to the Influent Surge Tank.

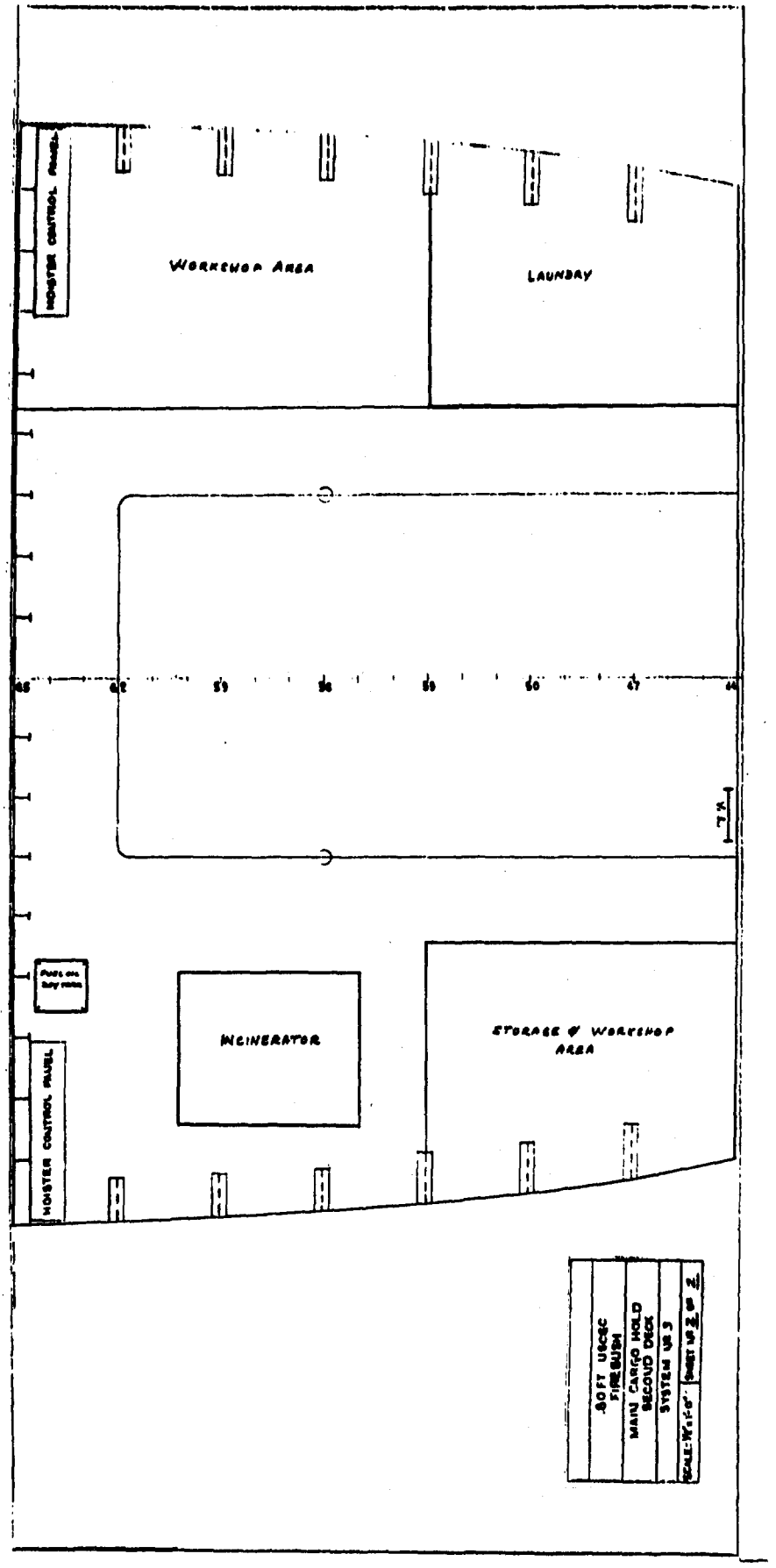
(b) The gray water drains from the spaces aft of Frame 124 would continue to drain to the existing 25 gallon collecting tank/pump arrangement in the Hawser Room for discharge forward to overboard and to the Galley/Turbid Holding Tank for off-loading when overboard discharge is not permitted.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G/T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with a small (approximately 25 gallon) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
WORKSHOP AREA
LAUNDAY
INCINERATOR
STORAGE & WORKSHOP AREA
HOISTER CONTROL PANEL
80FT USCGC
FIREBUSH
MAIN CARGO HOLD
SECOND DECK
SYSTEM NO 3

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 4

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,015[2]	4,568
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	7,930[4]	4,362
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	5,730[5]	5,272
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	805	1,610
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	50	750
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	70	420
Removals	Cutting	Hours	$50.00/Hr.[6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					18,757

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 5 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Holding Tank for Combined Black and Gray Waters

	Required
Influent Surge Tank	1,029 gal. (138 cu. ft.)
Sludge Holding Tank	2,345 gal. (313 cu. ft.)
Grumman Unit	Two (2)
Influent Surge Tank Pump	Two (2)
Influent Surge Tank Overboard Pump	Two (2)
Sludge Tank Transfer Pump	One (1)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

The system is very similar to System No. 4 except that the G/T holding tank has been eliminated. All wastes go to the influent surge tank.

The influent surge tank (approx. 5'-0" L x 5'-6" W x 5'-0" H) would be fitted at the forward end of the lower level of the Main Cargo Hold, on the ship's centerline.

The sludge holding tank (approx. 8' L x 8' W x 5' H) would be located where the 1875 gallon retention tank is presently located on the lower hold level.

The associated pumps would be located principally on the starboard side of the lower level of the hold.

The Grumman MSD's would be located on the 2nd Deck level of the Main Cargo Hold. They could be fitted one each port and starboard, or both on the starboard side. The former could require slight modification of the laundry and its ventilation ducting to permit better access room around the Grumman MSD. However, the arrangement affords better weight distribution. The latter arrangement, while satisfactory, would offer less access room between the units.

System No. 5 (cont'd.)

Drainages would be as follows:

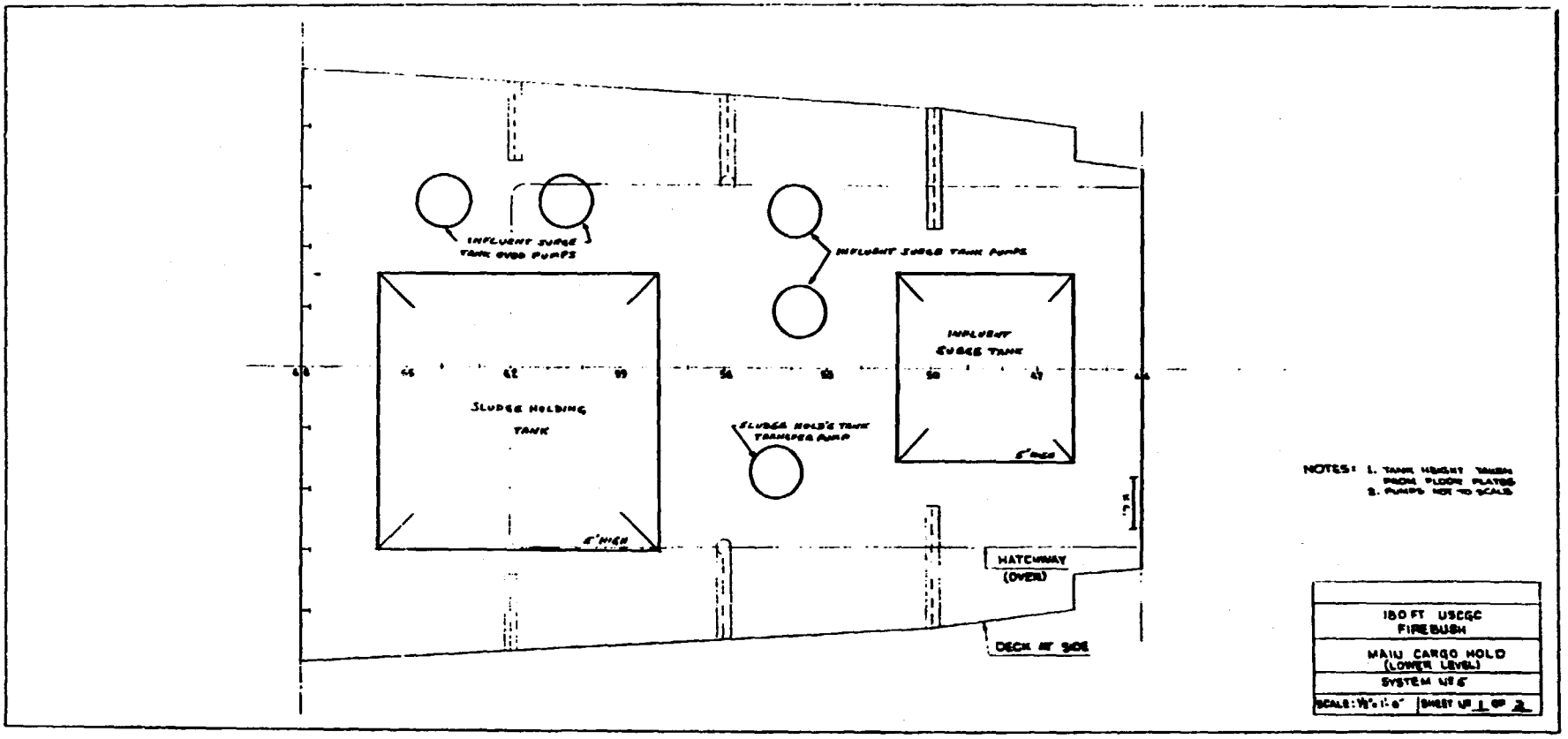
(a) For the spaces aft of Frame 124, it would be necessary to fit a small collecting tank/pump arrangement in the Hawser Room aft similar to the existing 25 gal. tank fitted for gray water disposal. The tank would receive watercloset drains from the Officer's Toilet and garbage grinder drains from the Ward Room pantry (if fitted in the future) which would be pumped on automatic tank level control, discharging forward to the Influent Surge Tank. If the garbage grinder is not to be fitted, the existing watercloset/pump arrangement could be retained in lieu of adding the second 25 gallon collecting tank/pump arrangement.

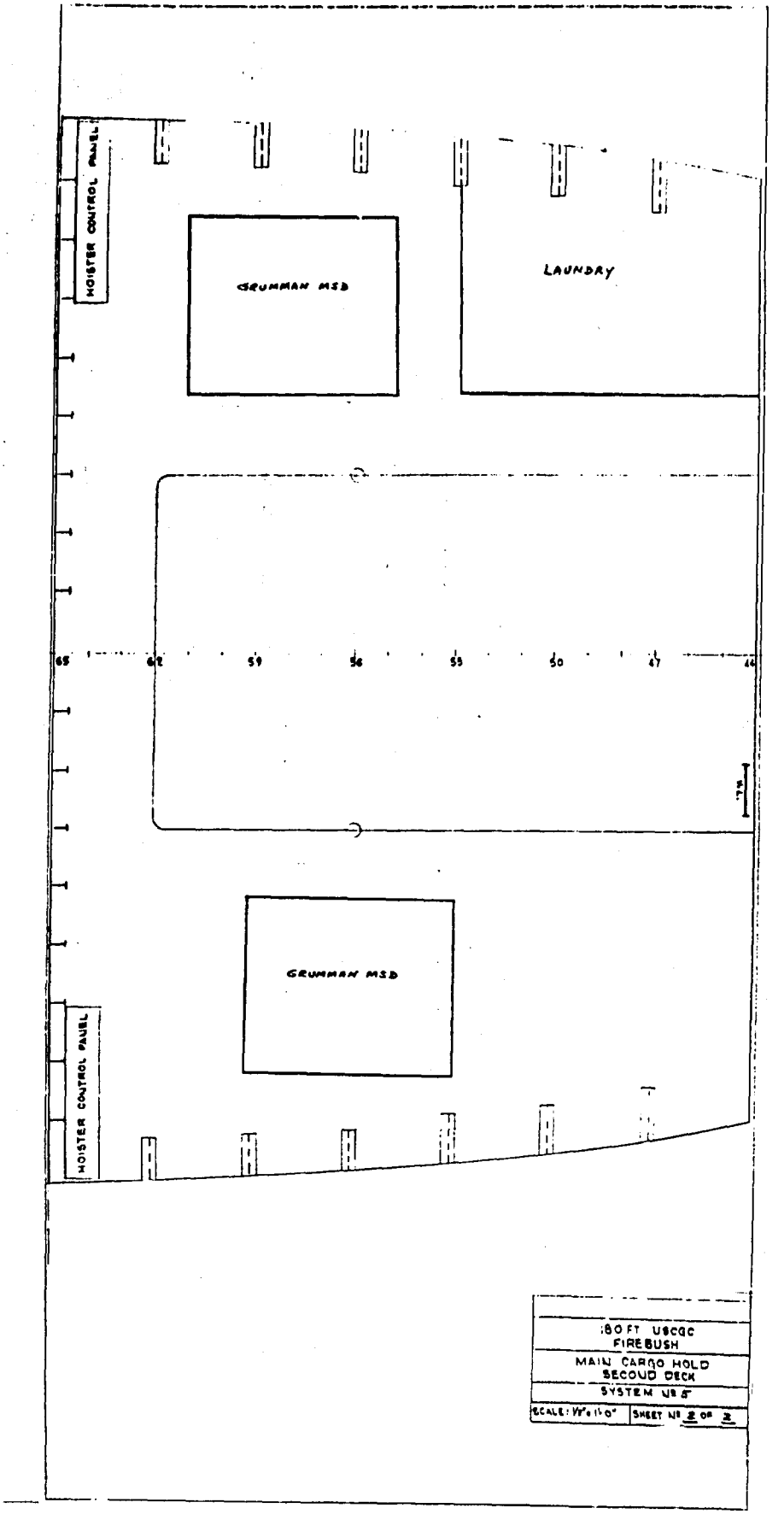
For spaces forward of Fr. 124, sewage drains would gravitate directly to the Influent Surge Tank.

(b) The gray water drains from the spaces aft of Frame 124 would continue to drain to the existing 25 gallon collecting tank/pump arrangement in the Hawser Room for discharge forward to the Influent Surge Tank for off-loading and feed to the Grumman Feed Tank.

(c) Including the laundry space, gray water from spaces forward of Frame 124 would gravitate to the influent surge tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
GRUMMAN M3D
LAUNDRY
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GRUMMAN M3D
HOISTER CONTROL PANEL
180 FT USCGC
FIREBUSH
MAIN CARGO HOLD
SECOND DECK
SYSTEM NO 5
SCALE: 1/8"=1'-0"
SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 5

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,095 [2]	4,928
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	5,960 [4]	3,278
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	4,100 [5]	3,772
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	690	1,380
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	40	600
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	55	330
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					16,063

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft. /hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 6 Full Volume Flush Gravity Collection/Holding Tank for Black Water/Grumman Flow Through System with Sludge Holding Tank for Gray Water

	Required
G/T Influent Surge Tank	768 gal. (103 cu. ft.)
Sewage Holding Tank	7,295 gal. (975 cu. ft.)
Sludge Holding Tank	1,737 gal. (232 cu. ft.)
Optional Combined Sewage/Sludge Holding Tank	9,032 gal. (1,207 cu. ft.)
Grumman Unit	Two (2)
Sewage Holding Tank Discharge Pump	Two (2)
G/T Influent Surge Tank Pumps	Two (2)
G/T Influent Surge Tank Transfer Pump	One (1)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

Equipment in and drainage systems to the Main Cargo Hold would be as follows:

On Lower Level

(a) The required sewage holding tank capacity would be provided via a tank the same configuration and location in the hatchway as in System No. 1.

Alternatively, an optional Combined Sewage/Sludge Holding Tank could be fitted in the same location.

(b) The required G/T influent surge tank could be incorporated as a separate compartment within the Combined Sewage/Sludge Holding Tank configuration due to lack of other space.

(c) Associated pumps would be located aft of the sewage holding tank or the optional combined tank.

System No. 6 (cont'd.)

On the 2nd Deck Level

(d) For the spaces aft of Frame 124, it would be necessary to fit a small collecting tank/pump arrangement in the Hawser Room aft similar to the existing 25 gal. tank fitted for gray water disposal. The tank would receive watercloset drains from the Officer's Toilet and garbage grinder drains from the Ward Room pantry (if fitted in the future) which would be pumped on automatic tank level control discharging forward to the Sewage Holding Tank in the Main Cargo Hold. If the garbage grinder is not to be fitted, the existing watercloset/pump arrangement could be retained in lieu of adding the second 25 gallon collecting tank/pump arrangement.

Sewage from spaces forward of Fr. 124 would gravitate directly to the Sewage Holding Tank.

(e) The gray water drains from the spaces aft of Frame 124 would continue to drain to the existing 25 gallon collecting tank/pump arrangement in the Hawser Room for discharge forward to overboard and to the Grumman feed tanks or to the Sewage Holding Tank for off-loading when overboard discharge is not permitted.

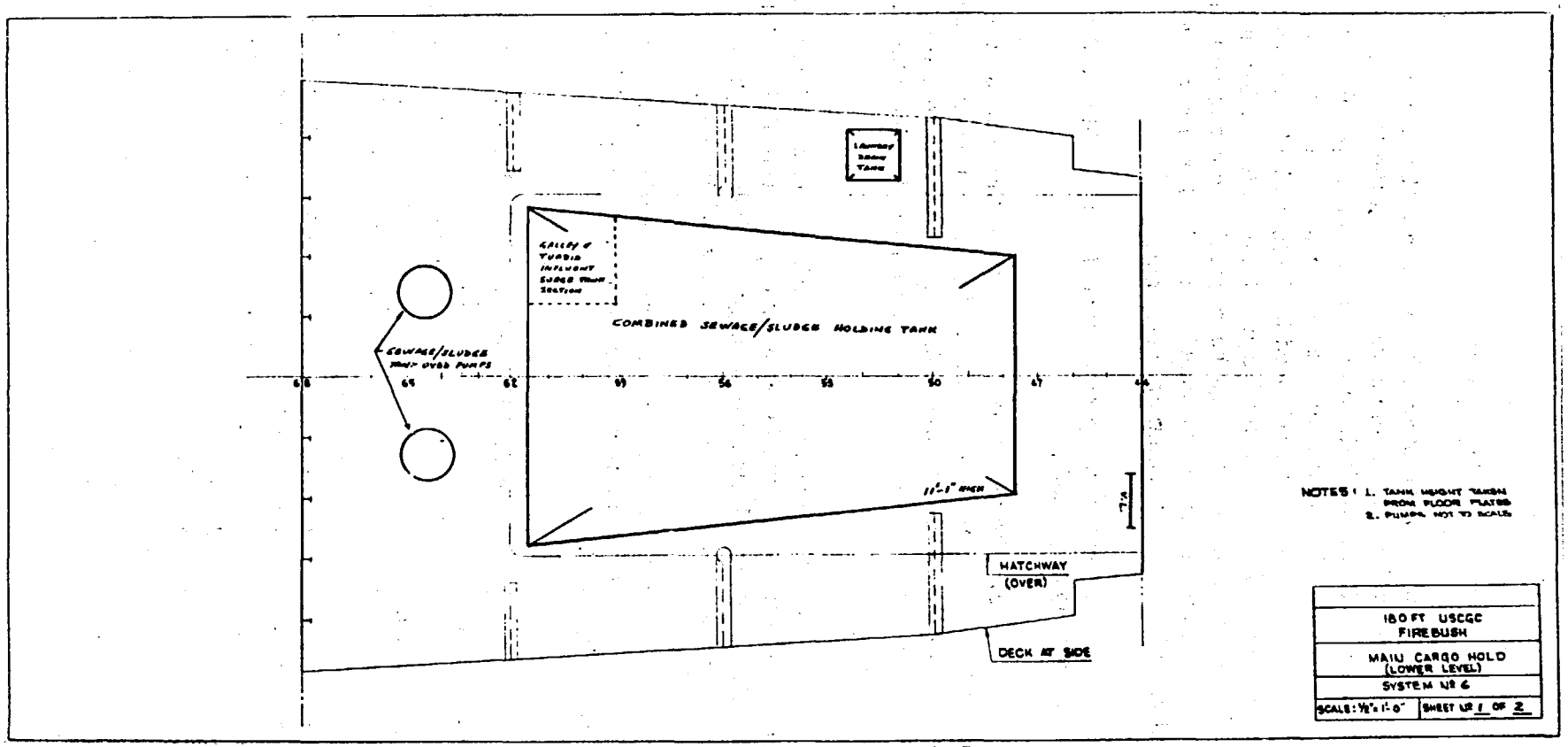
(f) Laundry and nearby deck drains would have to go to a small (25 gal.) collection tank fitted with a sump pump (similar to the one in the Hawser Room aft) which would discharge overboard, to the Grumman feed tanks and to the Sewage Holding Tank (for pierside off-loading).

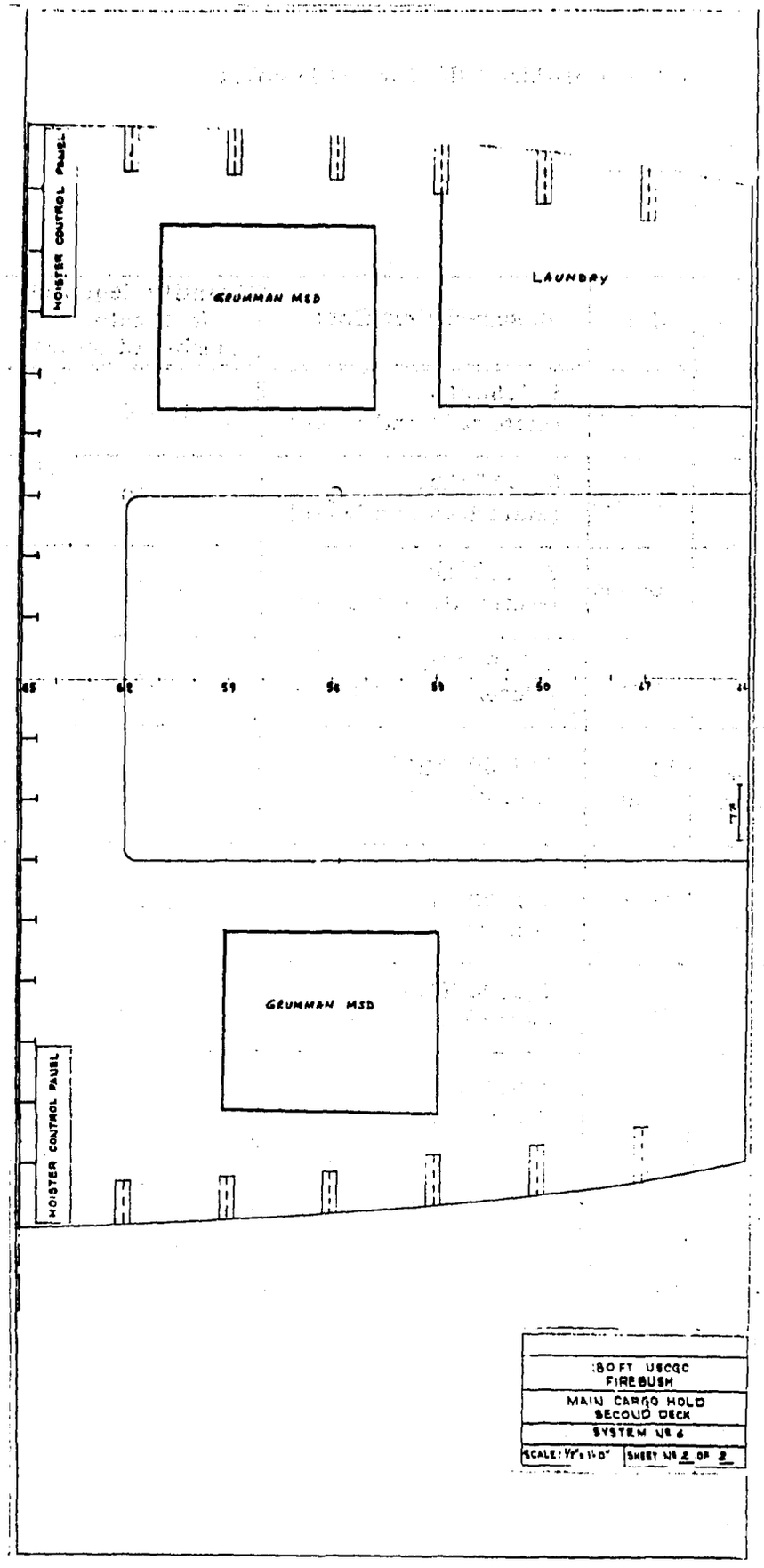
(g) Other gray water drains would gravitate directly overboard, gravitate to the Grumman feed tanks and to the Sewage Holding Tank (for pierside off-loading).

(h) The Grumman MSD s could be located 1 each port and starboard in the aft part of the space. Due to space requirements the full capacity of the Sludge Holding Tank could be met only by fitting two tanks each with one-half of the total required capacity. These tanks would be approximately 5'L x 5'W x 4'-9"H each, and would be located forward of each Grumman MSD. The one on the port side would require relocation of the Laundry. To reduce the amount of alteration work, it would be better to fit the optional Combined Sewage/Sludge Holding Tank in lieu of the separate tanks. This tank would include the aforementioned G/T Influent Surge Tank compartment and would be approximately 14'-0" long, 7'-0" wide forward, 10'-0" wide aft and 11'-1" high.

Optionally, also, both Grummans could be located on the starboard side, but would not afford the equal weight distribution afforded by a Port/Starboard arrangement.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
GRUMMAN M&D
LAUNDRY
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7'6"
GRUMMAN M&D
HOISTER CONTROL PANEL
180 FT USCGC
FIREBUSH
MAIN CARGO HOLD
SECOND DECK
SYSTEM NO 6
SCALE: 1/8" = 1'-0"
SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 6

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,090 [2]	4,905
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	9,500 [4]	5,225
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	9,155 [5]	8,423
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	345	690
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	20	300
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	45	270
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					21,588

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 7 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Incinerator for Black Water/Holding Tank for Gray Water

	Required
Gray Water Holding Tank	20,843 gal. (2786 cu. ft.)
Sewage Influent Surge Tank	261 gal. (35 cu. ft.)
Fuel Oil Day Tank	25 gal. (3.3 cu. ft.)
Grumman Unit with Incinerator	One (1) with One (1) Thiokol Incinerator
Influent Surge Tank Pump	One (1)
Influent Surge Tank Overboard Pump	Two (2)
G/T Holding Tank Overboard Pump	Two (2)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

Equipment would be located in the Main Cargo Hold as follows:

On the Lower Level

(a) Sewage influent surge tank (approx. 3'L x 3'W x 4'H) on starboard side near shell, Frame 63 - 66.

(b) Gray water holding tank (approx. 12'L x 7'W fwd x 9'-6" aft x 8'-3" H) on the ship's centerline, Frames 47 to 59 (forward end of hold) within the hatchway, protruding slightly above the 2nd Deck level. Tank is limited to about 816 cu. ft. (6109 gallons) due to lack of space.

(c) Various associated pumps functionally arranged to port of the influent surge tank.

On the 2nd Deck Level

(a) Grumman MSD and its incinerator fuel tank on starboard side.

System No. 7 (cont'd.)

The incinerator stack could possibly be led to the weather via the stores space on the port side, Frs. 65 to 74, Second Deck and up through the Crew's Toilet on the Main Deck. There appears to be no way to run the stack via the existing ship's stack enclosure. See the Special Remarks in the discussion at the beginning of this Section.

Installation of the incinerator would require additional fire protection equipment and possibly a modification to the ventilation system for the Main Cargo Hold.

(a) For the spaces aft of Frame 124, it would be necessary to fit a small collecting tank/pump arrangement in the Hawser Room aft similar to the existing 25 gal. tank fitted for gray water disposal. The tank would receive watercloset drains from the Officer's Toilet and garbage grinder drains from the Ward Room pantry (if fitted in the future) which would be pumped on automatic tank level control, discharging forward to the Influent Surge Tank. If the garbage grinder is not to be fitted, the existing watercloset/pump arrangement could be retained in lieu of adding the second 25 gallon collecting tank/pump arrangement.

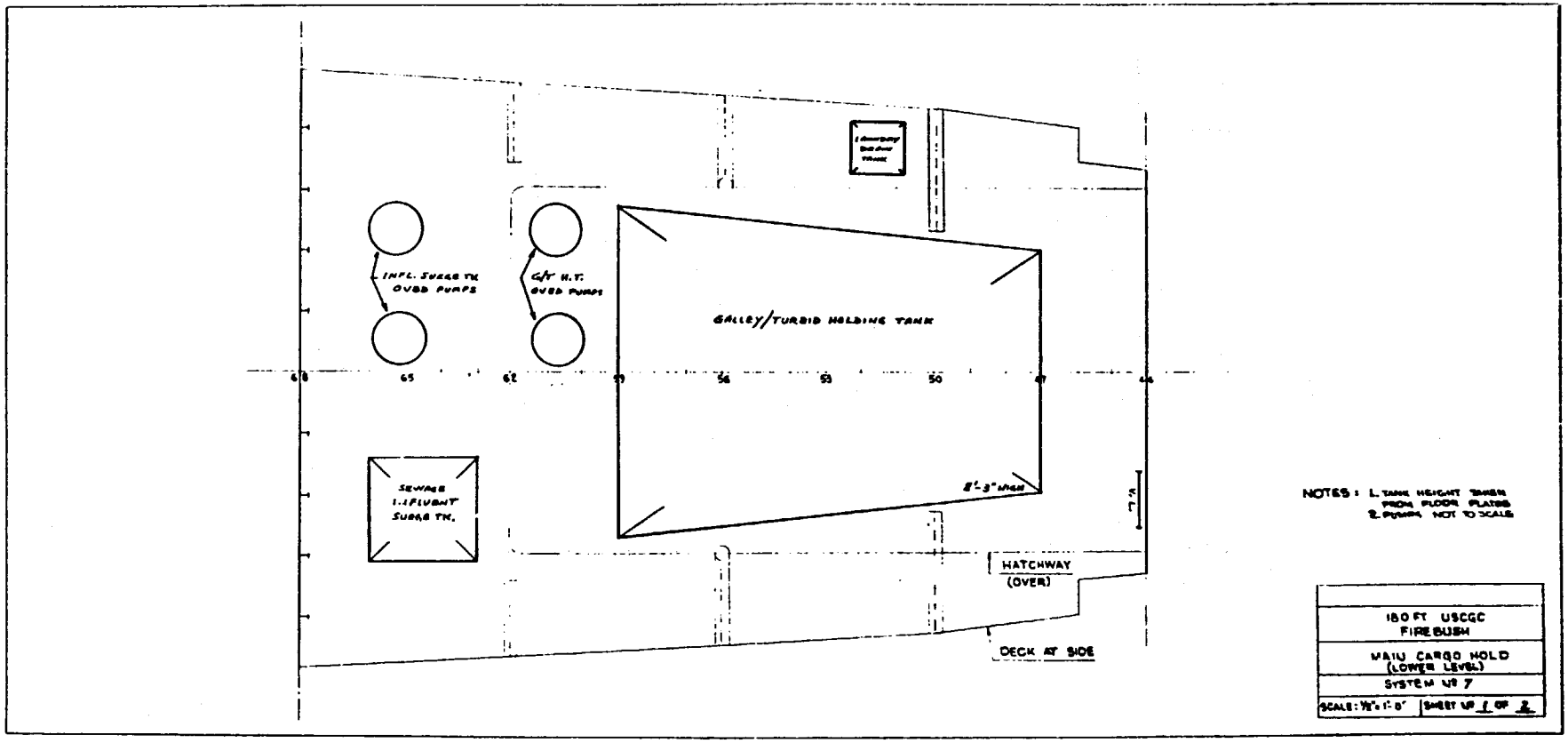
Sewage from spaces forward of Fr. 124 would gravitate directly to the Influent Surge Tank.

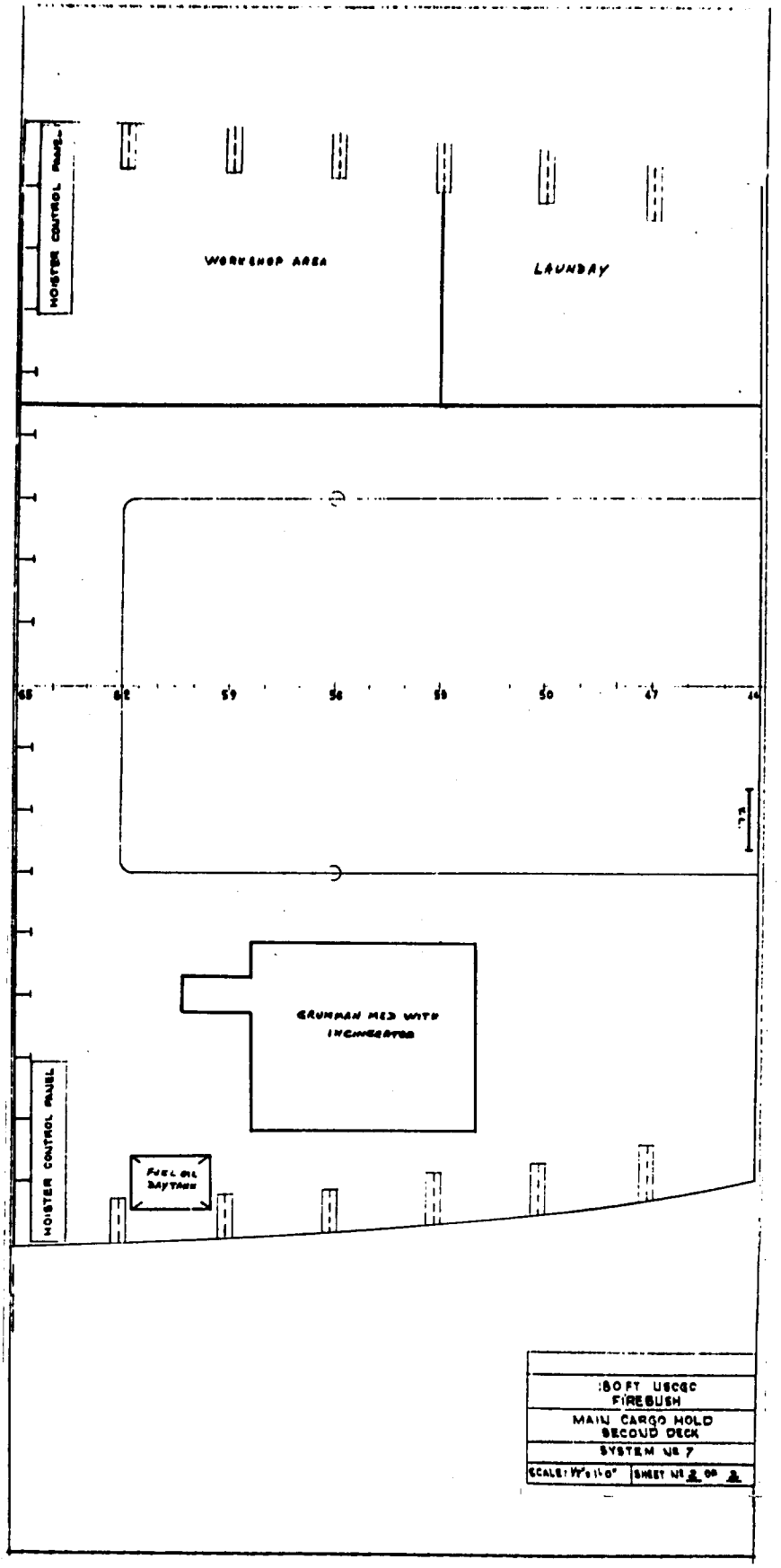
(b) The gray water drains from the spaces aft of Frame 124 would continue to drain to the existing 25 gallon collecting tank/pump arrangement in the Hawser Room for discharge forward to overboard and to the Gray Water Holding Tank for off-loading when overboard discharge is not permitted.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard, and for pierside off-loading would be diverted to the G/T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with a small (approx. 25 gallons) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
WORKSHOP AREA
LAUNDRY
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GRUMMAN MK3 WITH INCINERATOR
HOISTER CONTROL PANEL
FUEL OIL DAYTANK
180FT USCGC FIREBUSH
MAIN CARGO HOLD SECOND DECK
SYSTEM NO 7
SCALE: 1/4"=1'-0"
SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 7

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	2,490 [2]	11,205
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	8,190 [4]	4,505
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	6,675 [5]	6,141
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	575	1,150
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	55	330
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					25,631

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 8 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Incinerator for Combined Black and Gray Waters

	Required
Influent Surge Tank	1,029 gal. (138 cu. ft.)
Fuel Oil Day Tank	25 gal. (3.3 cu. ft.)
Grumman Units with Incinerators	Two (2) with Two (2) Thiokol Incinerators
Influent Surge Tank Pumps	Two (2)
Influent Surge Tank Overboard Pump	Two (2)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

The system is very similar to System No. 5 except that an incinerator replaces the sludge holding tank.

The influent surge tank (approx. 5'-0"L x 5'-6" W x 5'-0" H) would be fitted at the forward end of the lower level of the Main Cargo Hold, on the ship's centerline.

The associated pumps would be located aft of the influent surge tank.

The Grumman MSD's with their incinerators and fuel oil day tank would be located on the 2nd deck level of the Main Cargo Hold, one each port and starboard.

The Laundry space may require modification to provide adequate clearance on the Port side.

Incinerator stacks could possibly be run similar to System No. 3. It appears impossible to run them via the existing ship's stack enclosure. Since there are two stacks, this could pose more of a problem. See the Special Remarks in the discussion at the beginning of this Section.

System No. 8 (cont'd.)

Installation of the incinerator would require additional fire protection equipment and possibly a modification to the ventilation system for the Main Cargo Hold.

Drainage would be as follows:

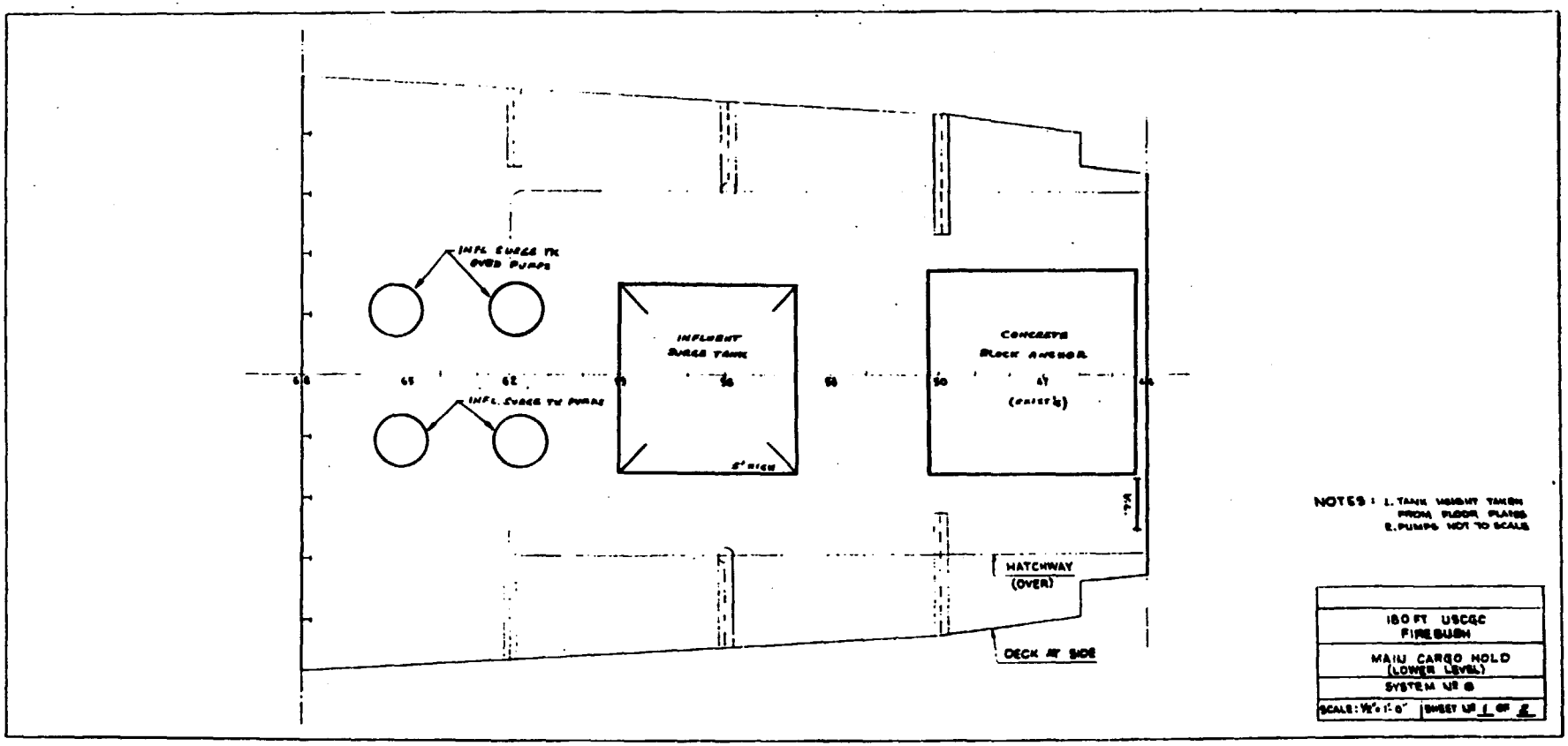
(a) For the spaces aft of Frame 124, it would be necessary to fit a small collecting tank/pump arrangement in the Hawser Room aft similar to the existing 25 gal. tank fitted for gray water disposal. The tank would receive watercloset drains from the Officer's Toilet and garbage grinder drains from the Ward Room pantry (if fitted in the future) which would be pumped on automatic tank level control, discharging forward to the Influent Surge Tank. If the garbage grinder is not to be fitted, the existing watercloset/pump arrangement could be retained in lieu of adding the second 25 gallon collecting tank/pump arrangement.

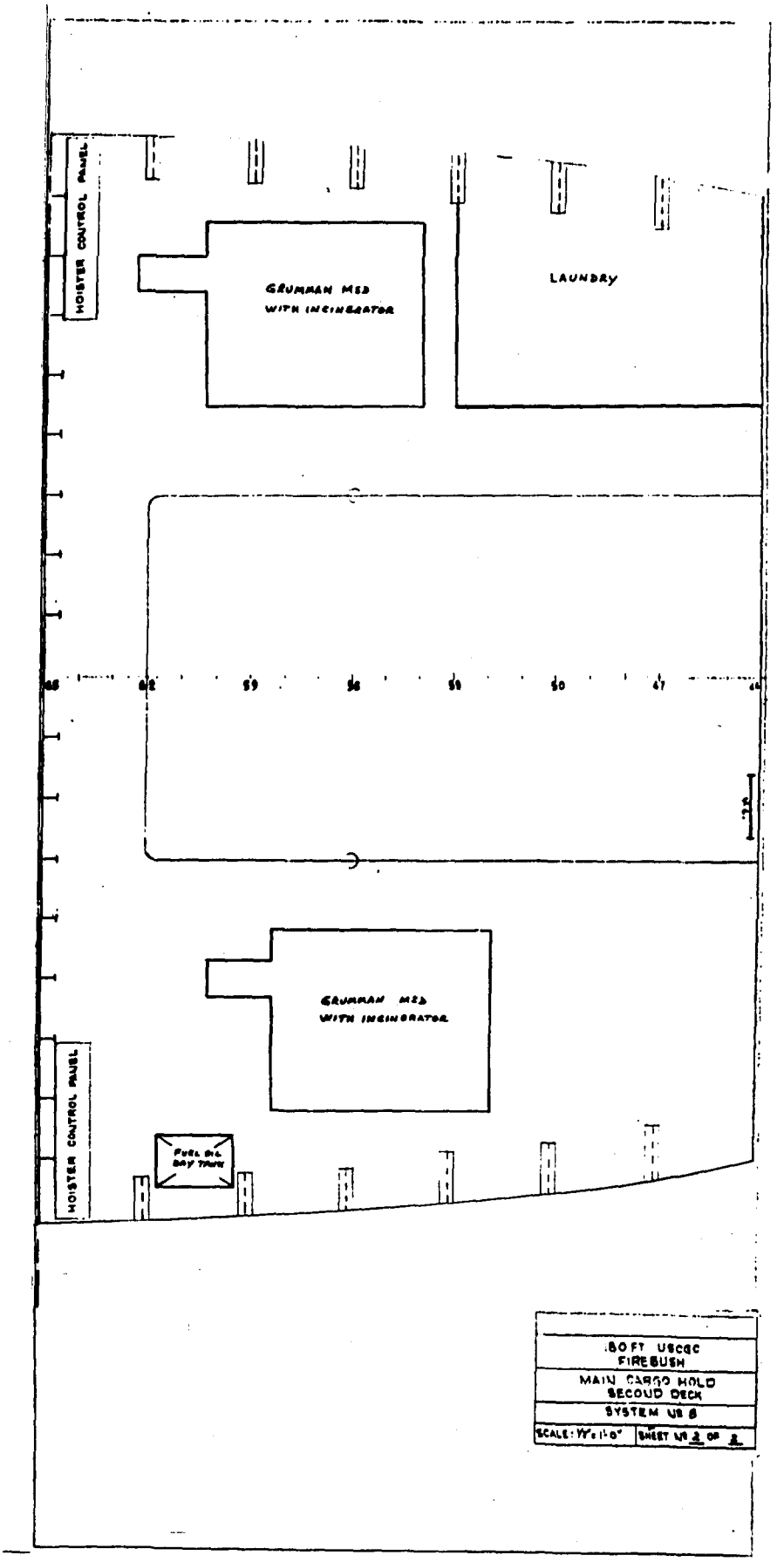
For spaces forward of Fr. 124, sewage drains would gravitate directly to the Influent Surge Tank.

(b) The gray water drains from the spaces aft of Frame 124 would continue to drain to the existing 25 gallon collecting tank/pump arrangement in the Hawser Room for discharge forward to the Influent Surge Tank for off-loading and feed to the Grumman Feed Tank.

(c) Including the laundry space, gray water from spaces forward of Frame 124 would gravitate to the influent surge tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
GRUMMAN MK3
WITH INCINERATOR
LAUNDRY
GRUMMAN MK3
WITH INCINERATOR
HOISTER CONTROL PANEL
FUEL OIL DAY TANK
180 FT USCGC
FIREBUSH
MAIN CARGO HOLD
SECOND DECK
SYSTEM NO 8
SCALE: 1/8"=1'-0"
SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 8

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	2,775 [2]	12,488
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	2,320 [4]	1,276
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	2,040 [5]	1,877
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	575	1,150
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	20	120
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
Removals	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					19,241

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 9 JERED Reduced Volume Flush Vacuum Collection/Holding Tank for Concentrated Black Water/Holding Tank for Gray Water

	Required	
Vacuum Collection Tank	250 gal.	
Vacuum Collection Assembly		(165 cu. ft.)
Sanitary Holding Tank	2,145 gal.	(287 cu. ft.)
Galley/Turbid Holding Tank	20,843 gal.	(2786 cu. ft.)
Sanitary Holding Tank Overboard Pump	Two (2)	
G/T Holding Tank Overboard Pump	Two (2)	

Discussion

The system is considered to be a viable candidate subject to certain limitations.

Reuse of existing piping arrangements would have to be considered. A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the Lower Level

(a) Sanitary holding tank (approx. 5' L x 8' W x 7'-6" H) in the hatchway, Frame 56-61 on ship's centerline.

(b) Galley/turbid holding tank (approx. 6' L x 7' W fwd x 8'-3" W aft x 8' H) in the hatchway, Frame 47-53 on ship's centerline. This tank is limited to 366 cu. ft. (2737 gal.) due to lack of more space.

(c) Pumps associated with tanks to be fitted aft of sanitary holding tank.

On the 2nd Deck Level

(a) Vacuum collection tank (approx. 6' L x 5' W x 5'-6" H) on either port or starboard side. The starboard side appears to be preferable since the Laundry on the Port side would limit the piping arrangement more than the storerooms on the starboard side.

System No. 9 (cont'd.)

Drainages would be as follows:

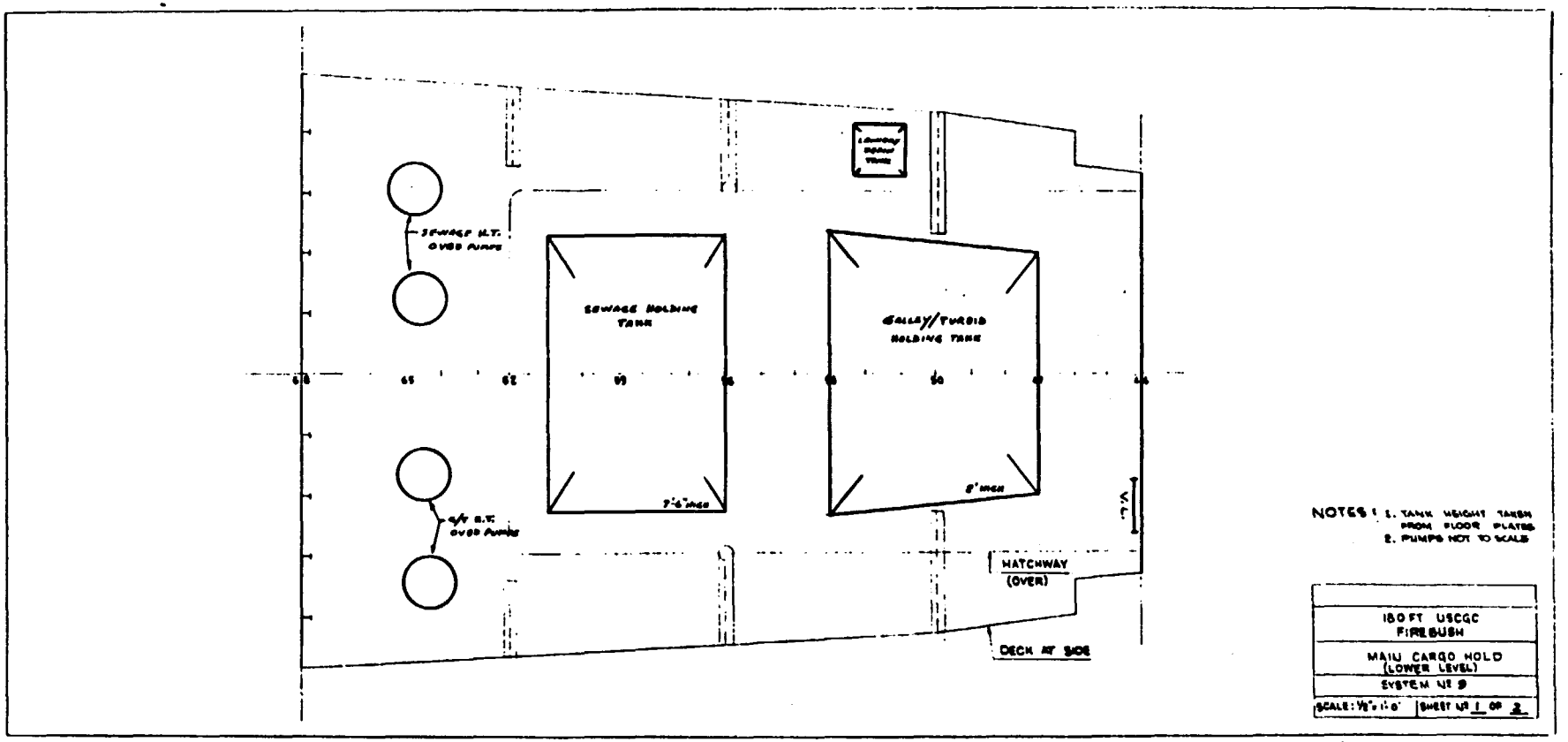
(a) Sewage from Officers' Toilet aft of Frame 124 as well as from spaces forward of Fr. 124 would discharge by vacuum forward to the vacuum collection tank. The garbage grinder aft (if fitted) would require a special vacuum type valve (similar to urinal discharge type) to permit collection and discharge to the vacuum collection tank forward.

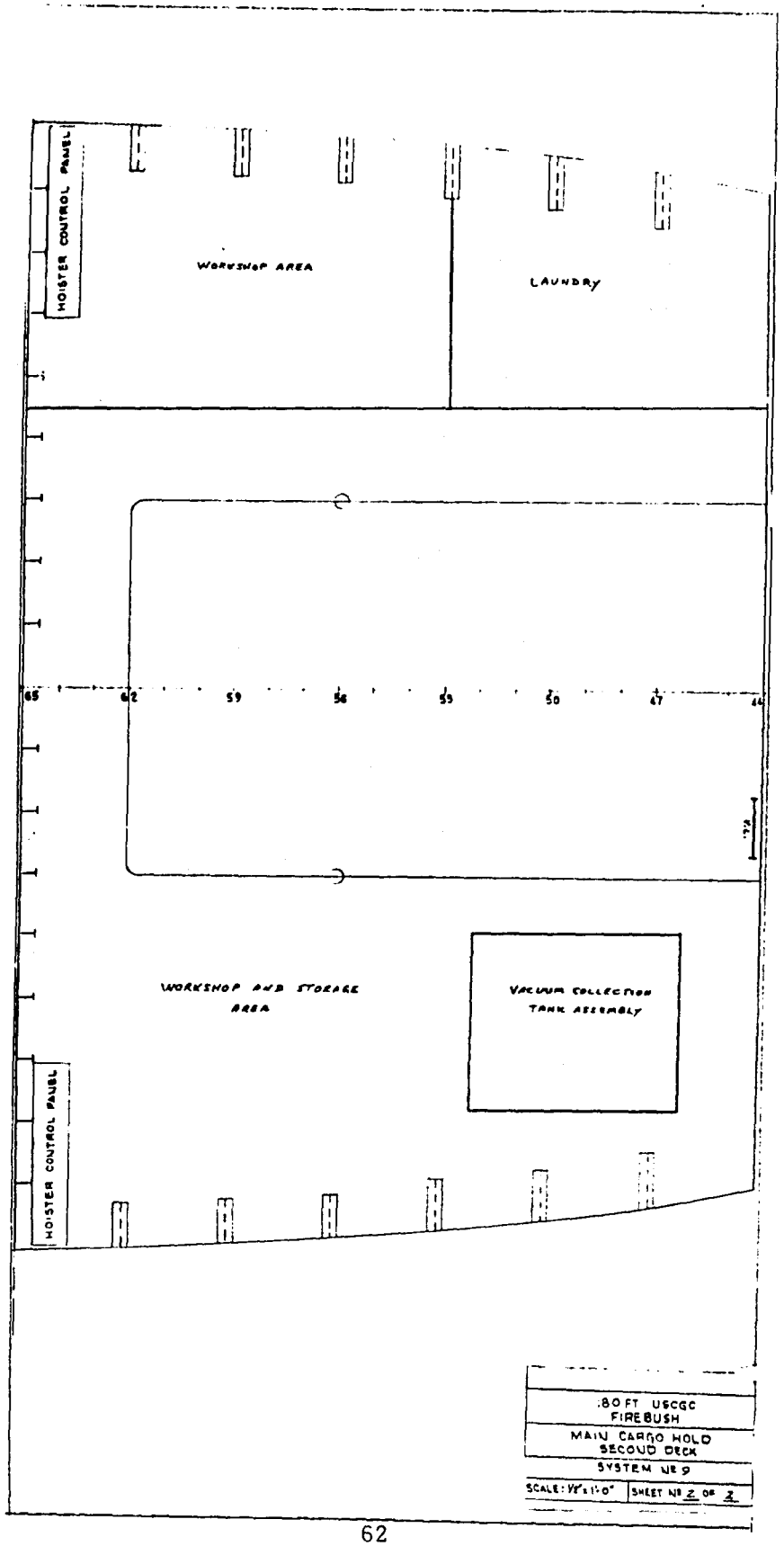
(b) Gray water from spaces aft of Frame 124 would continue to drain to the small holding tank (approx. 25 gallon) and sump pump in the Hawser Room from which it would discharge forward to overboard and to the G/T holding tank for off-loading.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G/T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with small (approx. 25 gallons) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
WORKSHOP AREA
LAUNDRY
65
62
59
56
53
50
47
44
WORKSHOP AND STORAGE AREA
VACUUM COLLECTION TANK ASSEMBLY
HOISTER CONTROL PANEL
180 FT USCGC FIREBUSH
MAIN CARGO HOLD SECOND DECK
SYSTEM NO 9
SCALE: 1/8"=1'-0"
SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 9

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,420 [2]	6,390
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	7,860 [4]	4,323
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	5,665 [5]	5,212
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	575	1,150
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	55	330
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					19,705

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 10 JERED Reduced Volume Flush Vacuum Collection/Incinerator for Concentrated Black Water/Holding Tank for Gray Water

	Required
Vacuum Collection Tank	250 gal.
Vacuum Collection Assembly	(165 cu. ft.)
Galley/Turbid Holding Tank	20,843 gal. (2786 cu. ft.)
Fuel Oil Day Tank	50 gal. (6.7 cu. ft.)
Incinerator	One (1) Jered
Vacuum Collection Tank Overboard Pump	One (1)
Galley/Turbid Holding Tank Overboard Pump	Two (2)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

Reuse of existing piping arrangements would have to be considered. The system is similar to System No. 9 except that an incinerator replaces the sewage holding tank.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the Lower Level

(a) Galley/Turbid holding tank (approx. 14' L x 7'W fwd x 10'W aft x 8'-3" H) in the hatchway, on ship's centerline. This tank is limited to 975 cu. ft. (7295 gallons) due to lack of more space.

(b) Pumps associated with tanks to be fitted aft of G/T holding tank.

System No. 10 (cont'd.)

On the 2nd Deck Level

(a) Vacuum collection assembly (approx. 6'L x 5' W x 5'-6" H), port or starboard side. The starboard side appears to be preferable since the Laundry on the Port side would limit the piping arrangement more than the storerooms on the starboard side.

(b) Incinerator (approx. 6'-5" L x 3' W x 5'-3" H) and fuel oil day tank, port or starboard side, just aft of the laundry.

The stack would be run to the weather similar to System No. 3 via the stores space on the Port side, Frs. 65-74, Second Deck. It does not appear to be possible to run it inside the ship's stack. See the Special Remarks in the discussion at the beginning of this Section.

Installation of the incinerator would require additional fire protection equipment and possibly a modification to the ventilation system for the Main Cargo Hold.

Drainages would be as follows:

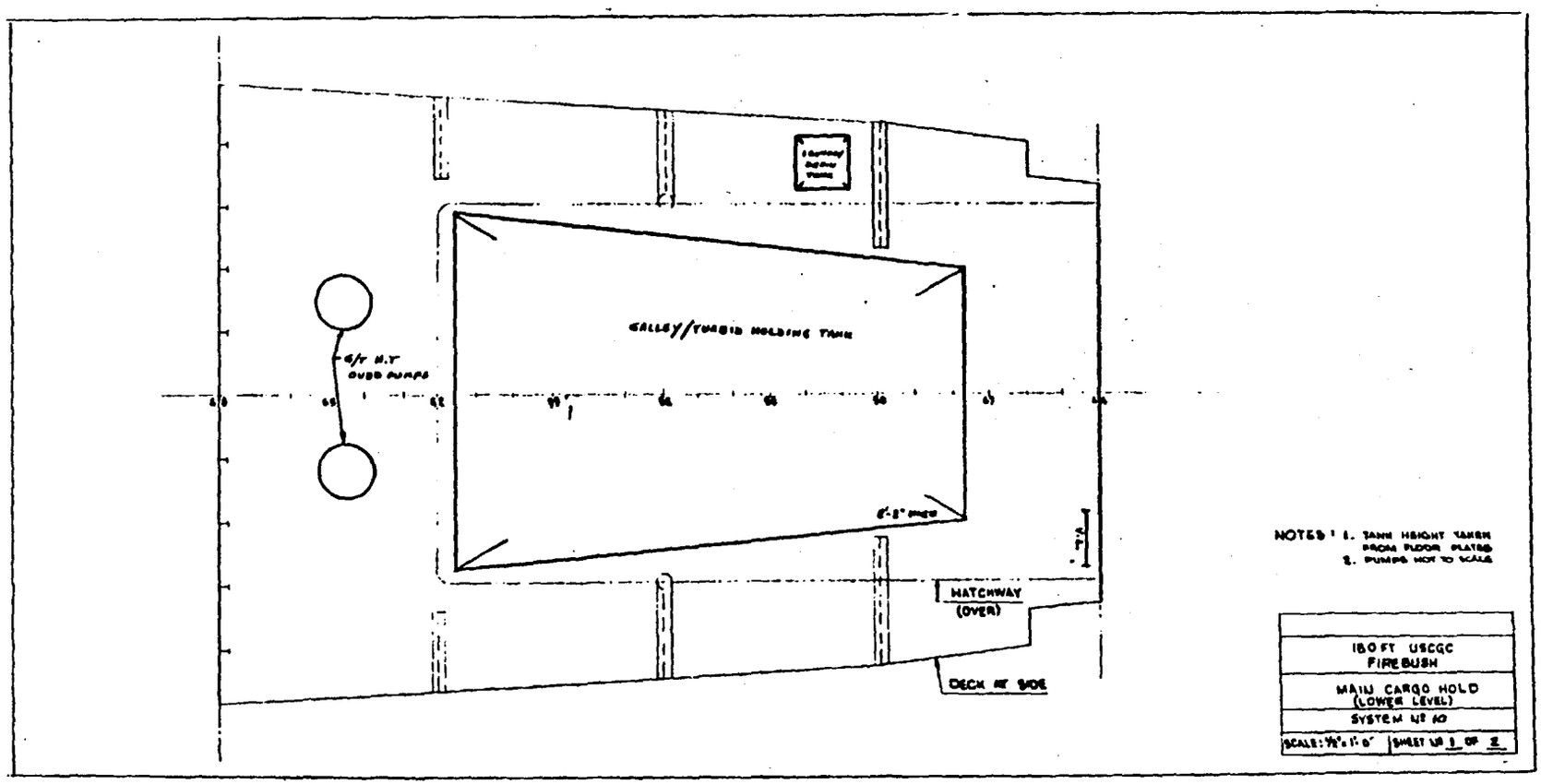
(a) Sewage from Officers' Toilet aft of Frame 124 as well as spaces forward of Fr. 124 would discharge by vacuum forward to the vacuum collection tank. The garbage grinder aft (if fitted) would require a special vacuum type valve (similar to urinal discharge type) to permit collection and discharge forward to the vacuum collection tank.

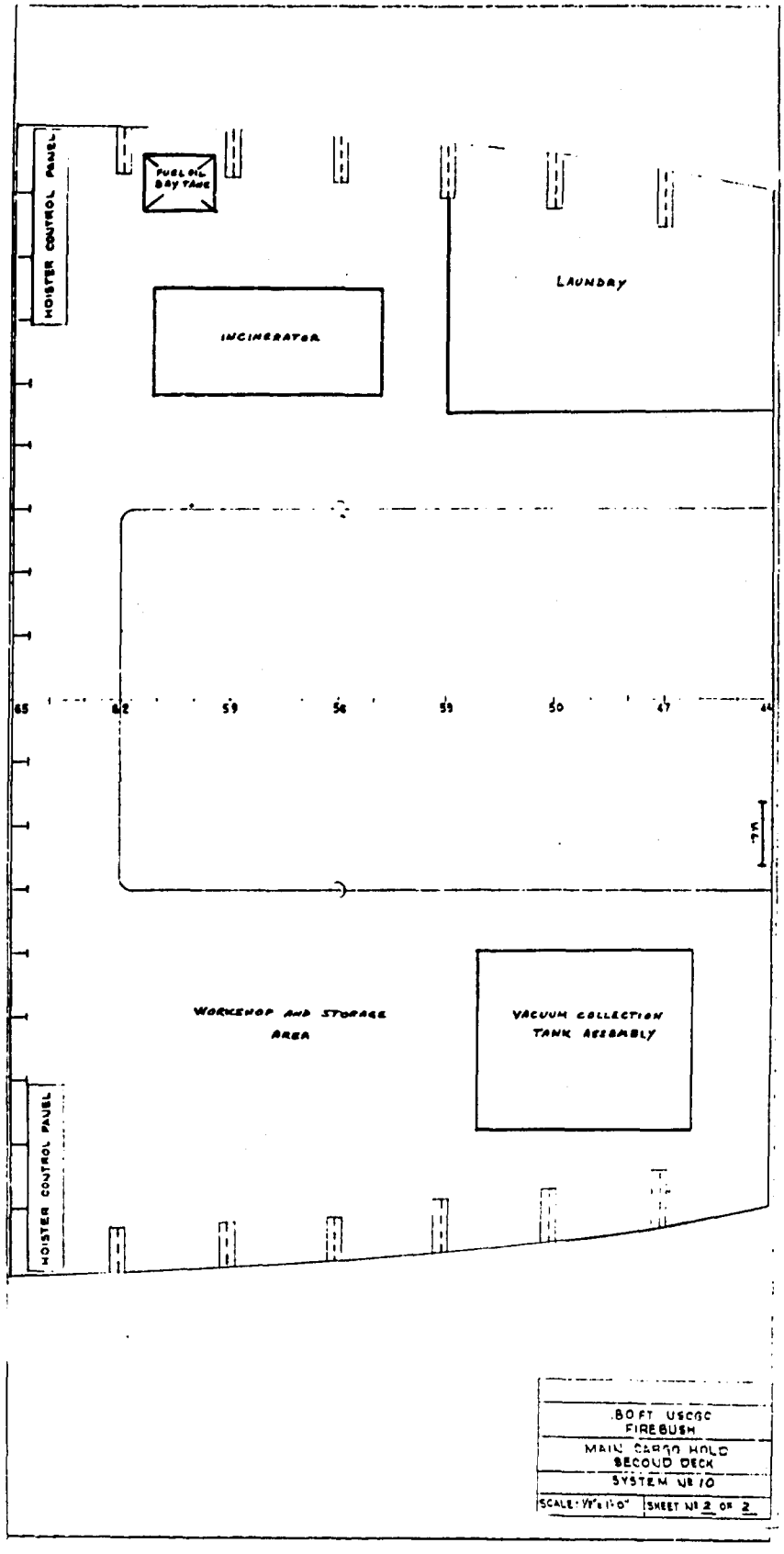
(b) Gray water from spaces aft of Frame 124 would continue to drain to the small holding tank (approx. 25 gallons) and sump pump in the Hawser Room from which it would discharge forward to overboard and to the G/T holding tank for off-loading.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G/T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with small (approx. 25 gallons) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
FUEL OIL DAY TANK
INCINERATOR
LAUNDRY
65
62
59
56
53
50
47
44
WORKSHOP AND STORAGE AREA
VACUUM COLLECTION TANK ASSEMBLY
HOISTER CONTROL PANEL
180 FT USCGC FIREBUSH
MAIN CARGO HOLD SECOND DECK
SYSTEM NR 10
SCALE: 1/8" = 1'-0"
SHEET NR 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 10

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	4,165 [2]	18,743
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	8,500 [4]	4,675
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	7,920 [5]	7,287
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	345	690
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	20	300
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	45	270
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					33,740

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 11 JERED Reduced Volume Flush Vacuum Collection/GATX Evaporator for Concentrated Black Water/Holding Tank for Gray Water

	Required
Vacuum Collection Tank	250 gal.
Vacuum Collection Assembly	(165 cu. ft.)
Galley/Turbid Holding Tank	20,843 gal. (2786 cu. ft.)
Evaporator (GATX)	Two (2) - 80 gal.
Catalytic Oxidizer	One (1) large or Two (2) regular
G/T Holding Tank Overboard Pump	Two (2)

Discussion

The system is considered to be a viable candidate subject to certain limitations. Reuse of existing piping arrangements would have to be considered. The system is similar to System Nos. 9 and 10 except that the vacuum collection tank discharges to an evaporator.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the Lower Level

(a) Galley/Turbid Holding Tank (approx. 14' L x 7' W fwd x 10' W aft x 8'-3" H) in the hatchway, on ship's centerline. This tank is limited to 975 cu. ft. (7295 gallons) due to lack of more space.

(b) Pumps associated with tanks to be fitted aft of G/T holding tank.

System No. 11 (cont'd.)

On the 2nd Deck Level

(a) Vacuum collection assembly (approx. 6' L x 5' W x 5'-6" H), port side aft of laundry.

(b) Evaporators (approx. 3'-2" dia. x 4'-2" high) and catalytic oxidizer(s) (6" dia. x 18" high), starboard side.

Drainages would be as follows:

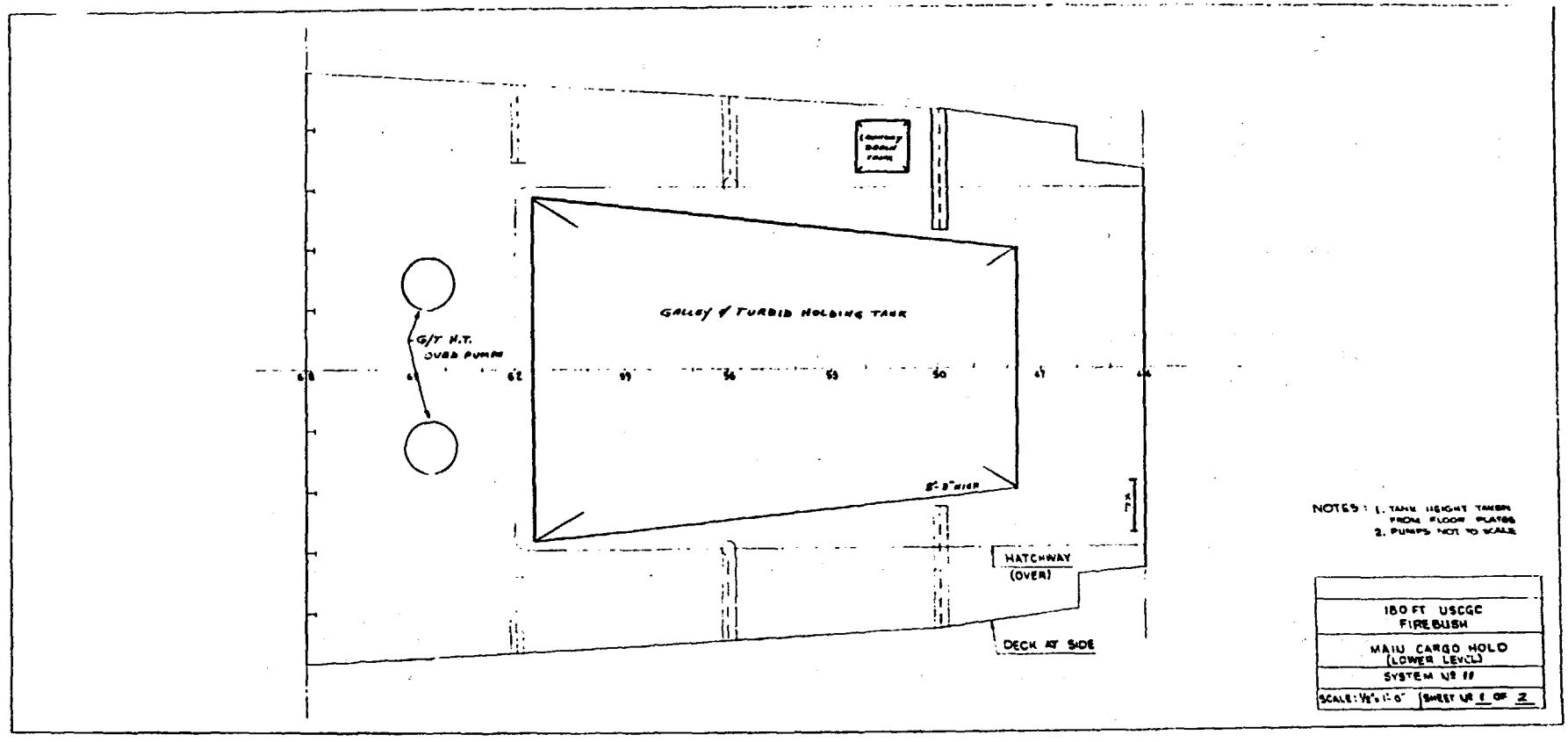
(a) Sewage from Officers' Toilet aft of Frame 124 as well as spaces forward of Fr. 124 would discharge by vacuum forward to the vacuum collection tank. The garbage grinder aft (if fitted) would require a special vacuum type valve (similar to urinal discharge type) to permit collection and discharge forward to the vacuum collection tank.

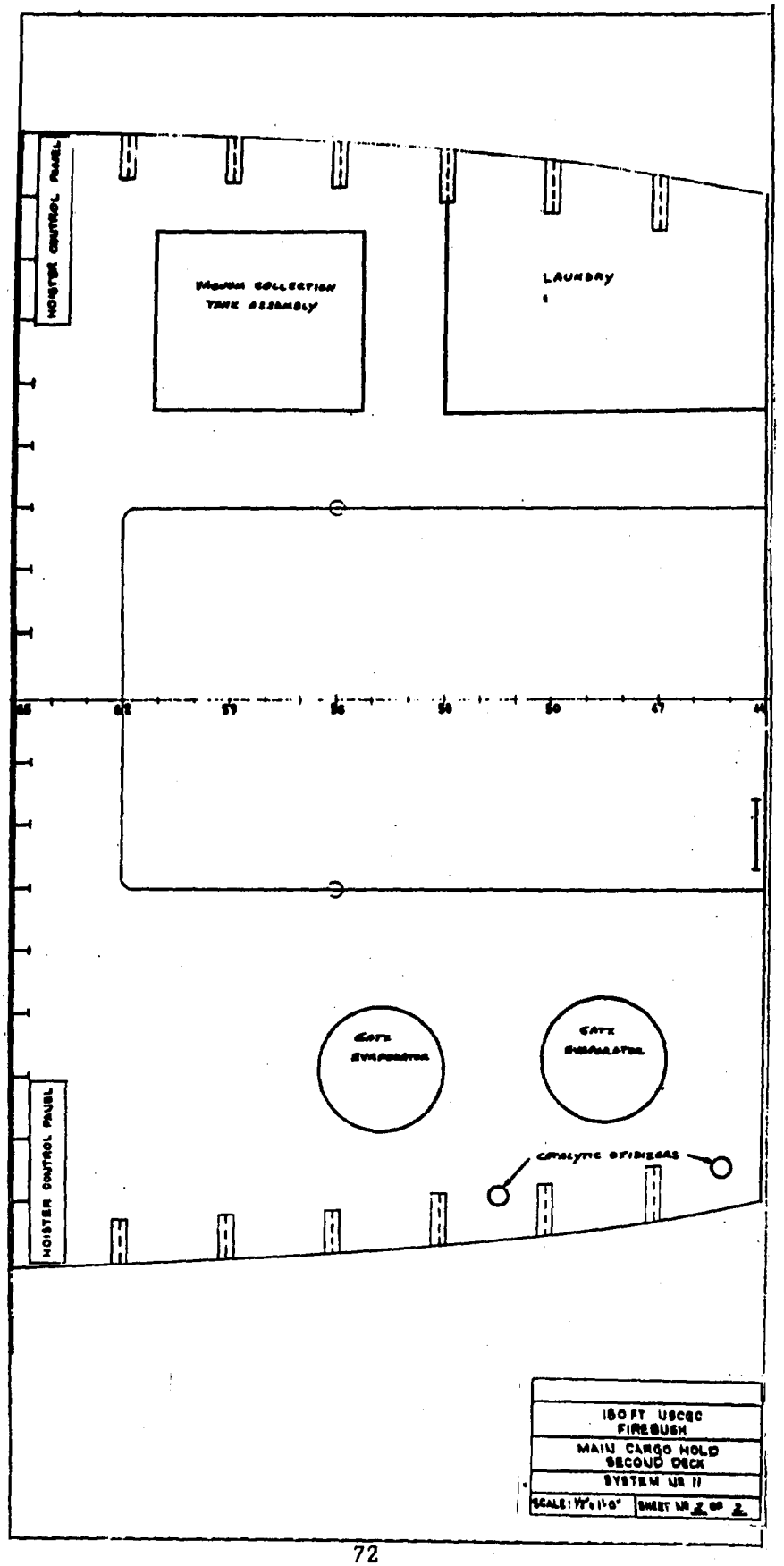
(b) Gray water from spaces aft of Frame 124 would continue to drain to the small holding tank (approx. 25 gallons) and sump pump in the Hawser Room from which it would discharge forward to overboard and to the G/T holding tank.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G/T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with small (approx. 25 gallons) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
LAUNDRY
HOISTER CONTROL PANEL
CATALYTIC OXIDIZERS
180 FT USCGC
FIREBUSH
MAIN CARGO HOLD
SECOND DECK
SYSTEM UR II
SCALE: 1/8"=1'-0"
SHEET NR 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 11

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	3,745 [2]	16,853
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	8,150 [4]	4,483
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	7,920 [5]	7,287
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	345	690
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	20	300
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	45	270
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					31,658

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 12 JERED Reduced Volume Flush Vacuum Collection/Holding Tank for Concentrated Black Water/Grumman Flow Through System with Sludge Holding Tank for Gray Water

	Required
G/T Influent Surge Tank	768 gal. (103 cu.ft.)
Sludge Holding Tank	1737 gal. (232 cu.ft.)
Sewage Vacuum Collection Tank	250 gal.
Vacuum Collection Tabk Assembly	(165 cu.ft.)
Sewage Holding Tank	2145 gal. (287 cu.ft.)
Grumman Unit	Two (2)
Sewage Holding Tank Overboard Pump	Two (2)
G/T Influent Surge Tank Transfer Pump	One (1)
G/T Influent Surge Tank Pump	Two (2)

Discussion

The system is considered to be a viable candidate subject to certain limitations. Reuse of existing piping arrangements would have to be considered. The system is similar to System No. 9 except that the galley/turbid drains will go to a Grumman MSD instead of a holding tank.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Vacuum collection tank assembly (approx. 6'L x 5'W x 5'-6"H) Frames 61-66, approximately where present retention tank is fitted.

(b) Sewage Holding Tank (approx. 5' L x 8' W x 7'-6" H) on ship's centerline, in hatchway, Frames 54-59.

(c) Galley/turbid influent surge tank (approx. 3'L x 6' W x 5'-9"H), in hatchway, on ship's centerline, Frames 47-50.

(d) Various associated pumps between tanks and to port of the vacuum collection assembly.

On the 2nd Deck level

(a) The two Grumman MSD's, one each port and starboard, each with its sludge holding tank (approx. 5' L x 5' W x 4'-9" H) fitted forward of the MSD. The total required tankage would be fitted in halves this way, otherwise it would not be possible to locate.

(b) The laundry will have to be relocated. See Special Remarks in the discussion at the beginning of this Section.

Drainages would be as follows:

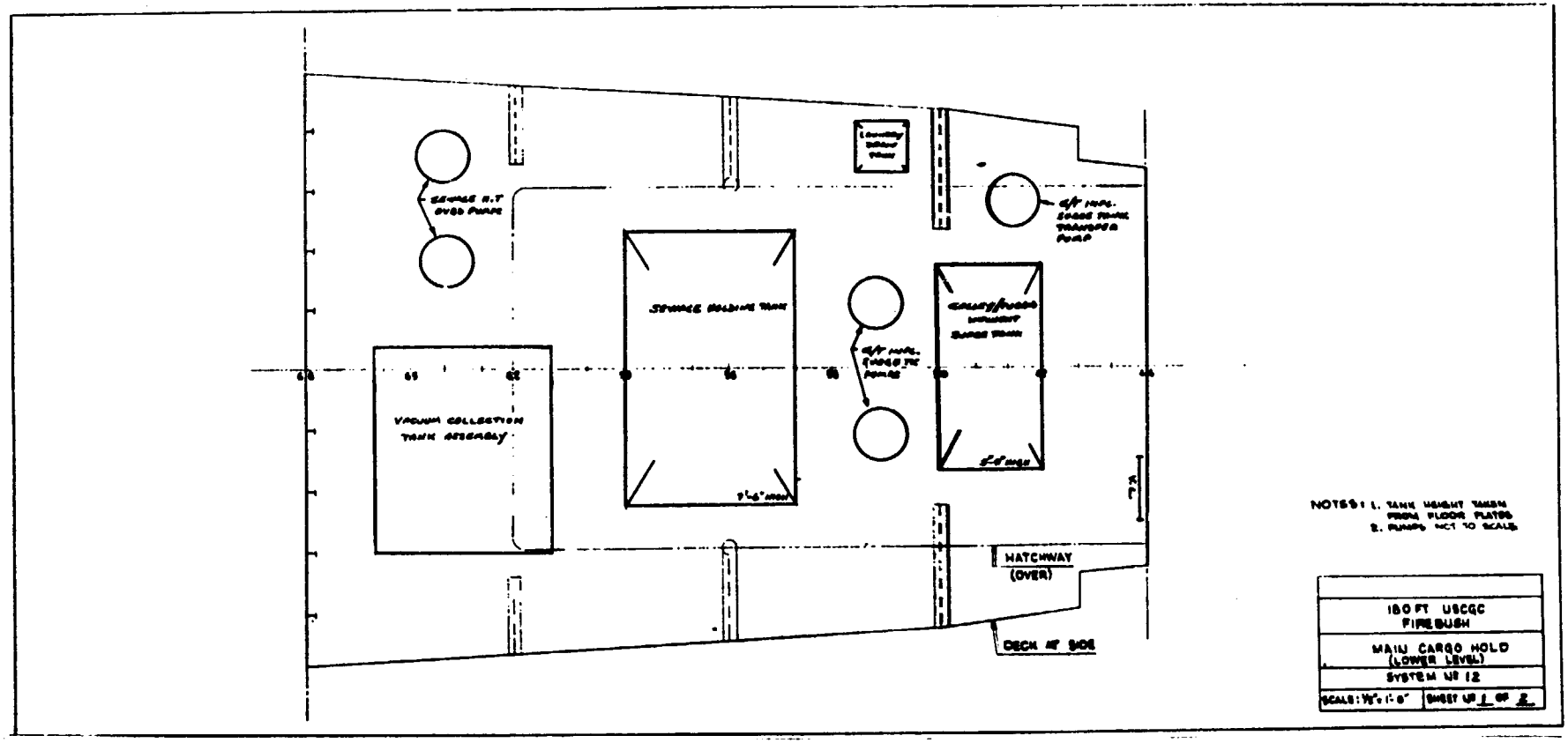
(a) Sewage from Officers' Toilet aft of Frame 124 as well as spaces forward of Fr. 124 would discharge by vacuum forward to the vacuum collection tank. The garbage grinder aft (if fitted) would require a special vacuum type valve (similar to urinal discharge type) to permit collection and discharge forward to the vacuum collection tank.

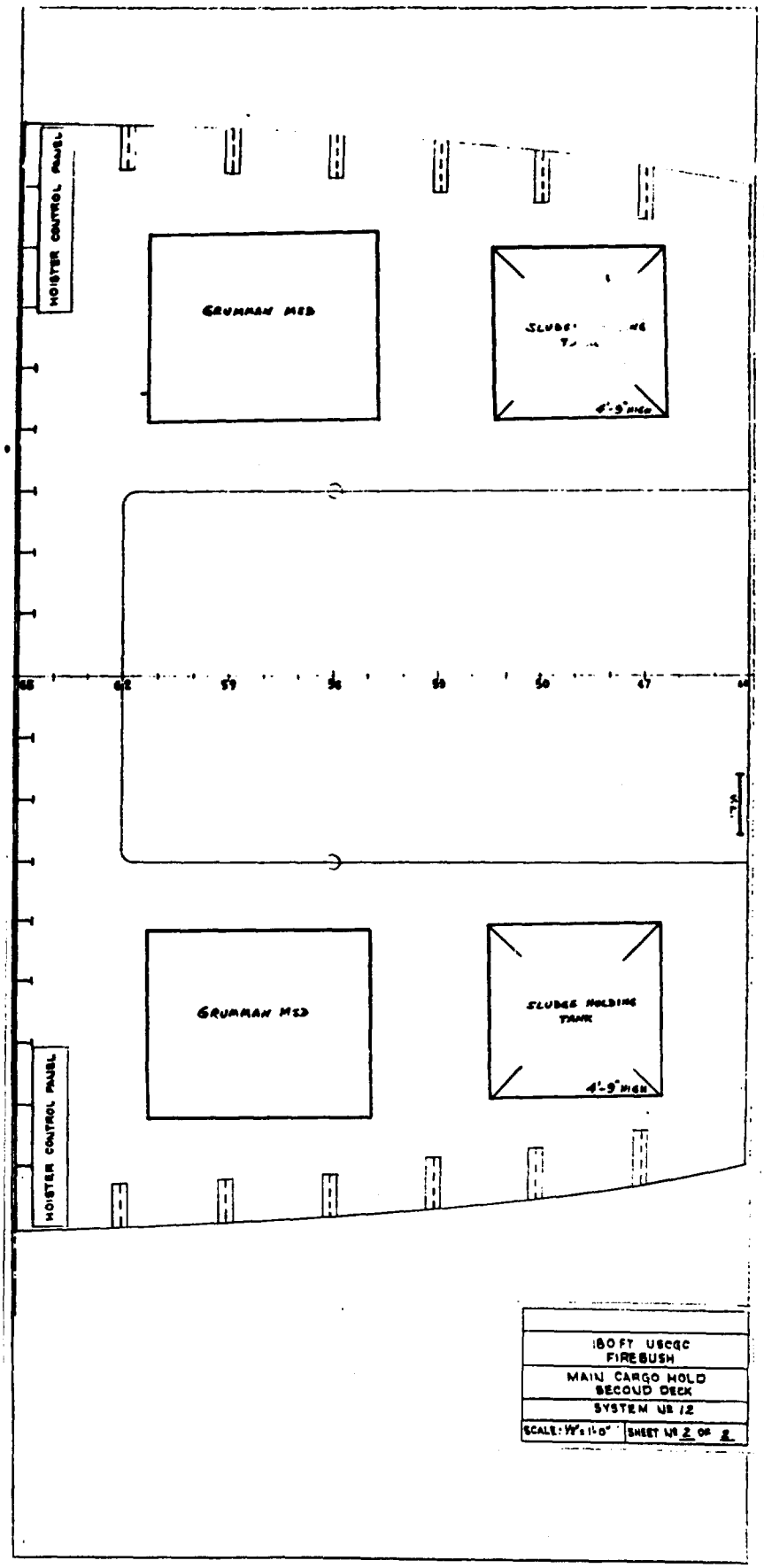
(b) Gray water from spaces aft of Frame 124 would continue to drain to the small holding tank (approximately 25 gals.) and sump pump in the Hawser Room from which it would discharge forward to overboard and to the G/T influent surge tank.

(c) Gray water from spaces forward of frame 124 would gravitate overboard and to the G/T influent surge tank for pierside off-loading.

(d) The laundry and its deck drains cannot gravitate overboard from the Second Deck. Therefore, they would have to drain to a small (approx. 25 gals.) collection tank with sump pump for discharge overboard and to the G/T influent surge tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
GRUMMAN MED
SLUDGE HOLDING TANK
4'-9" HIGH
68
62
59
56
53
50
47
44
7'-4"
GRUMMAN MED
SLUDGE HOLDING TANK
4'-9" HIGH
HOISTER CONTROL PANEL
180 FT USCGC FIREBUSH
MAIN CARGO HOLD SECOND DECK
SYSTEM NO 12
SCALE: 1/4"=1'-0"
SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 12

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,785 [2]	8,033
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	7,450 [4]	4,098
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	6,025 [5]	5,543
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	690	1,380
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	75	450
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					21,804

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 13 JERED Reduced Volume Flush Vacuum Collection/Grumman Flow Through System for Gray Water/Incinerator for both Concentrated Black Water and Gray Water Sludge

	Required
Gray Water Surge Tank	768 gal. (103 cu.ft.)
Vacuum Collection Tank	250 gal.
Vacuum Collection Tank Assembly	(165 cu.ft.)
Fuel Oil Day Tank	94 gal. (12.5 cu.ft.)
Grumman Unit with Incinerators	One (1) with Three (3) Thiokol Incin.
VCT Transfer Pump	Three (3)
VCT Overboard Pump	One (1)
G/T Surge Tank Pump	One (1)
G/T Surge Tank Overboard Pump	One (1)

Discussion

The system is considered to be a viable candidate subject to certain limitations. Reuse of the existing piping arrangements would have to be considered.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Vacuum collection assembly (approx. 6' L x 5' W x 5'-6" H) in hatchway, on ship's centerline, Frames 55-61.

(b) Galley/turbid influent surge tank (approx. 5' L x 5' W x 4'-3"H) in hatchway, on ship's centerline, Frames 47-52.

(c) Various pumps associated with the equipment, located where present overboard pumps are fitted.

On the 2nd Deck level

(a) Grumman MSD with incinerator, located just aft of laundry (port side). Laundry configuration will have to be modified to accommodate the installation.

(b) Two separate incinerators with sludge tanks, blowers, and fuel oil day tanks, located on starboard side.

Incinerator - - -	4'-1" L x 1'-0" W x 3'-4" H
Blower - - - - - -	3'-0" L x 1'-10" W x 2'-0" H
Sludge Tank - - -	2'-6" L x 1'-0" W x 2'-7" H

Three (3) stack runs offer a significant problem. It is impossible to run them via the existing ship's stack enclosure. A special study would have to be made to determine how they could be accommodated. The path outlined in System No. 3 has possibilities, but may also have limitations. See also the Special Remarks in the discussion at the beginning of this Section.

Installation of incinerators would require additional fire protection equipment and possibly a modification to the ventilation system for the Main Cargo Hold.

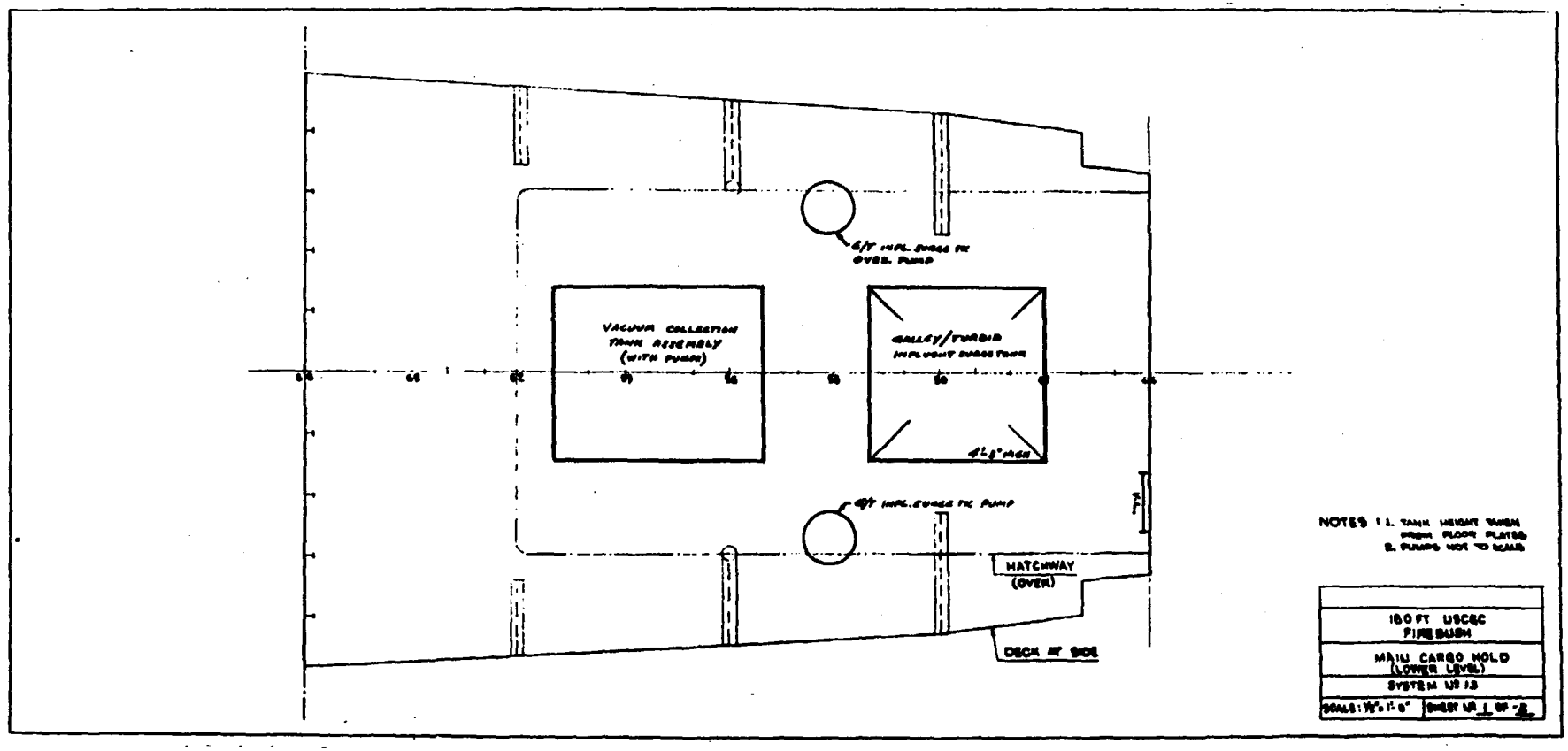
Drainages would be as follows:

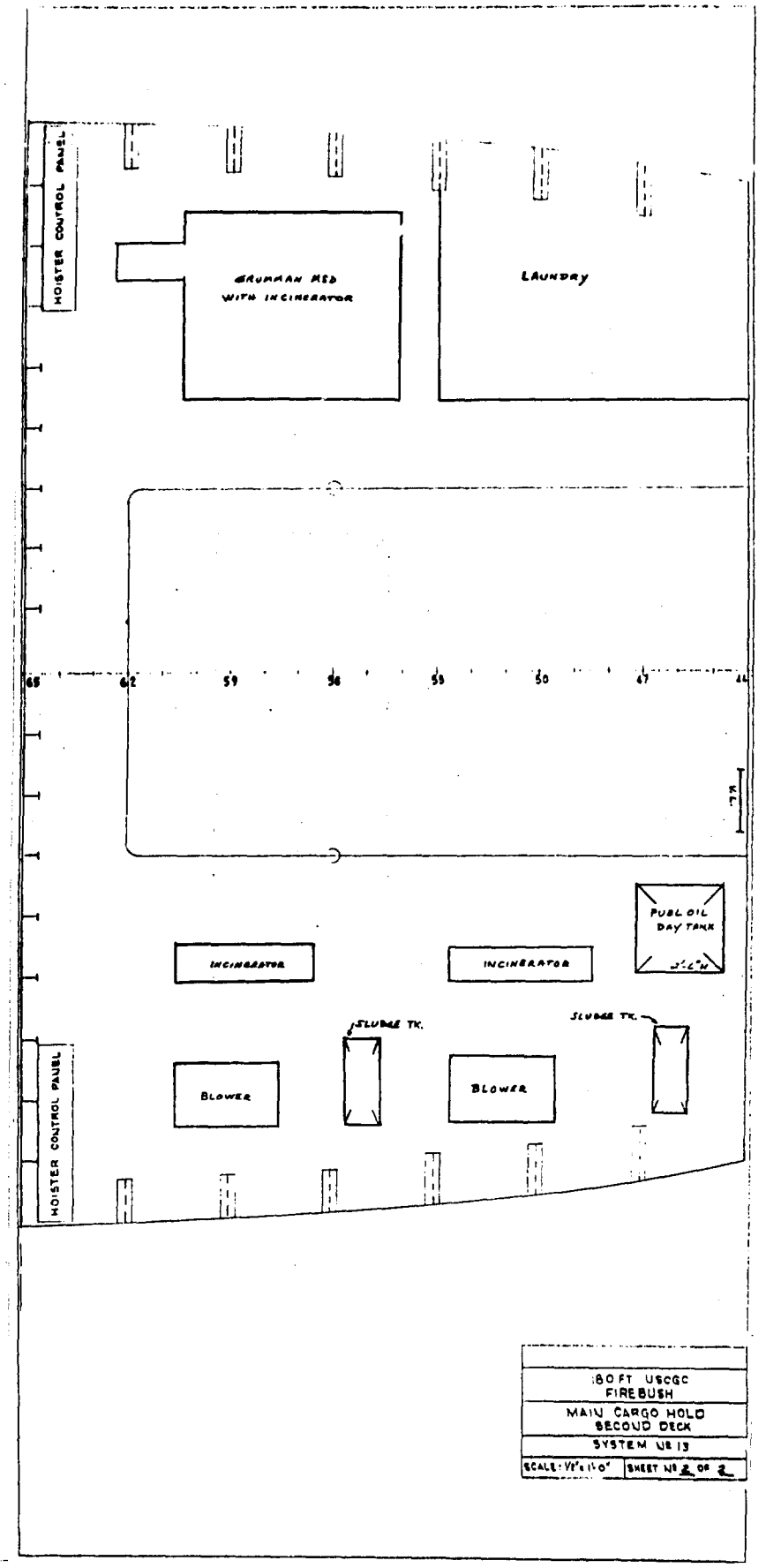
(a) Sewage from Officers' Toilet aft of Frame 124 as well as spaces forward of Fr. 124 would discharge by vacuum forward to the vacuum collection tank. The garbage grinder aft (if fitted) would require a special vacuum type valve (similar to urinal discharge type) to permit collection and discharge to the vacuum collection tank.

(b) Gray water from spaces aft of Frame 124 would continue to drain to the small holding tank (approximately 25 gals.) and sump pump in the Hawser Room from which it would discharge forward to overboard and to the Gray Water Surge Tank.

(c) Including the laundry space, gray water from spaces forward of Frame 124 would gravitate to the Gray Water Surge Tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
GRUMMAN MED WITH INCINERATOR
LAUNDRY
65
62
59
56
55
50
47
44
PUBL OIL DAY TANK
INCINERATOR
INCINERATOR
SLUDGE TK.
SLUDGE TK.
BLOWER
BLOWER
HOISTER CONTROL PANEL
80 FT USCGC FIREBUSH
MAIN CARGO HOLD SECOND DECK
SYSTEM UE 13
SCALE: 1/4"=1'-0"
SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 13

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	5,055 [2]	22,748
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	2,240 [4]	1,232
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	2,345 [5]	2,158
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	460	920
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	20	300
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	30	180
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					29,313

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 14 GATX Reduced Volume Flush M/T Pump Collection/Holding Tank for Concentrated Black Water/Holding Tank for Gray Water

	Required
Sewage Holding Tank	2,345 gal. (313 cu.ft.)
Galley/Turbid Holding Tank	20,843 gal. (2786 cu.ft.)
Sewage Holding Tank Discharge Pump	Two (2)
G/T Holding Tank Discharge Pump	Two (2)
Macerator/Transfer Pumps	Six (6)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

A fresh water sanitary flushing system would be required.

Equipment would be located on the lower level of the Main Cargo Hold as follows:

(a) Sewage holding tank (approx. 5' L x 9' W fwd. x 10' W aft x 6'-9" H) on ship's centerline, in hatchway, Frames 56-61.

(b) Galley/turbid holding tank (approx. 6' L x 7' W fwd. x 8' W aft x 7'-9" H) on ship's centerline, in hatchway.

This tank is limited to 360 cu.ft. (2693 gallons) due to lack of space.

(c) Various pumps associated with the tanks would be located aft of sewage holding tank, approximately Frames 62-68.

Deainages would be as follows:

(a) Sewage from all spaces and the garbage grinder aft (if fitted) would be collected in the sewage holding tank via macerator/transfer pumps.

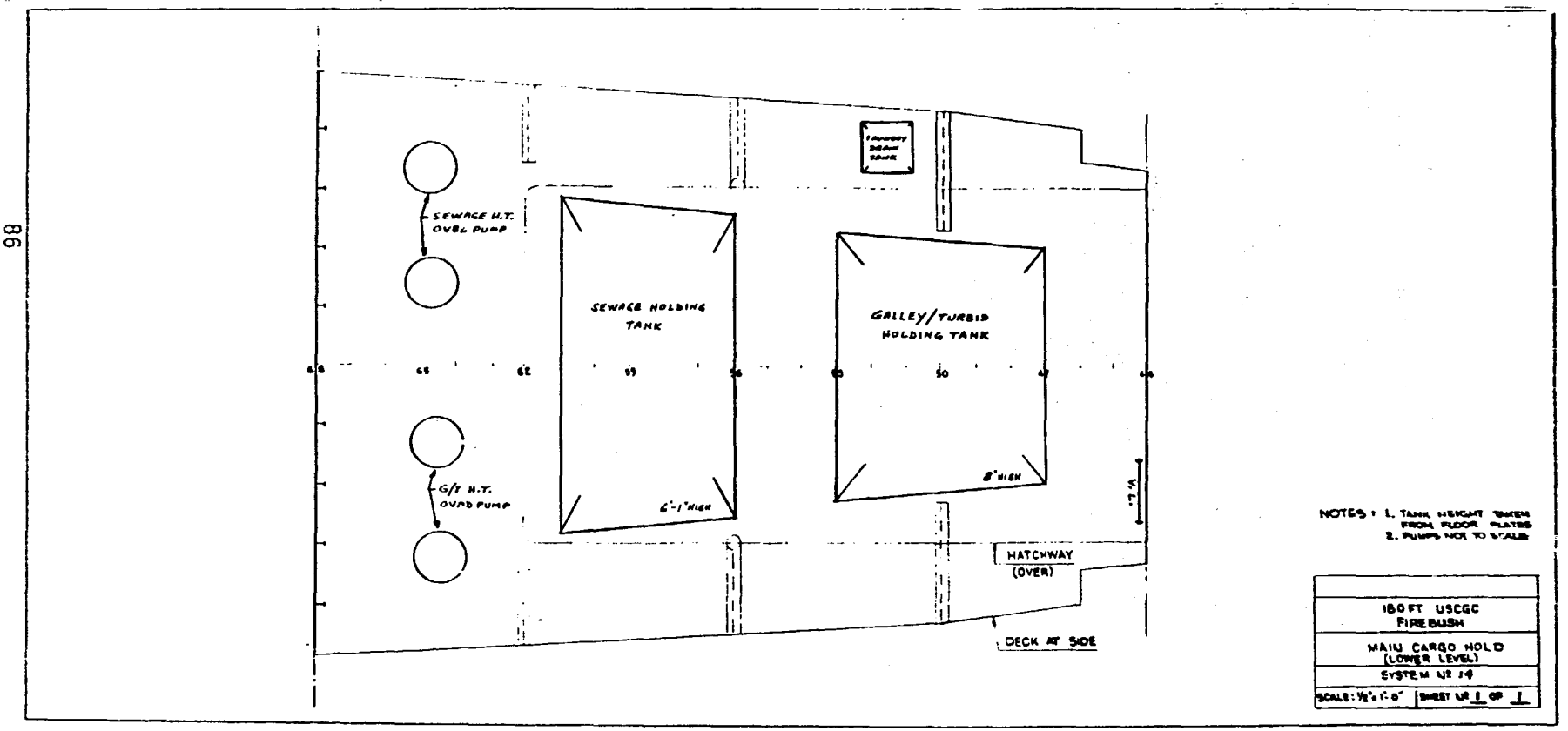
System No. 14 (Cont'd.)

(b) Gray water from spaces aft of Frame 124 would continue to drain to the small holding tank (approximately 25 gals.) and sump pump in the Hawser Room from which it would discharge forward to overboard and to the G/T Holding Tank for off-loading.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G/T holding tank.

(c) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with a small (approximately 25 gals.) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT



WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 14

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,515 [2]	6,818
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	7,870 [4]	4,329
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	5,100 [5]	4,692
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	460	920
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	60	360
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
Removals	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					19,419

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 15 GATX Reduced Volume Flush M/T Pump Collection/Incinerator for Concentrated Black Water/Holding Tank for Gray Water

	Required
Incinerator Feed Tank	100 gal. (13 cu.ft.)
Galley/Turbid Holding Tank	20, 843 gal. (2786 cu.ft.)
Fuel Oil Day Tank	50 gal. (6.7 cu.ft.)
Incinerator	One (1) Jered
Incinerator Feed Pump	One (1)
Incinerator Feed Tank Overboard Pump	One (1)
G/T Holding Tank Overboard Pump	Two (2)
Macerator/Transfer Pumps	Six (6)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Galley/turbid holding tank (approx. 14' L x 7' W fwd x 10' W aft x 8'-3" H), in hatchway, on ship's centerline, Frames 47-61. This tank is limited to 975 cu.ft. (7295 gal.) due to lack of space.

(b) G/T overboard discharge pump, aft of G/T holding tank.

On 2nd Deck Level

(a) Jered incinerator (approx. 6'-5" L x 3'-0" W x 5'-3" H), with feed pump (approx. 2'-6" L x 9" W x 1'-4" H), blower and fuel oil day tank (approx. 2' L x 2' W x 1'-9" H), starboard side.

(c) Incinerator feed tank overboard pump near feed tank.

(d) The incinerator stack would be run to the weather via the stores space on the port side, Frs. 65-74, Second Deck and up through the Crew's Toilet on the Main Deck. There is no apparent way to run it via the ship's stack. See Special Remarks in the discussion at the beginning of this Section.

System No. 15 (Cont'd.)

Installation of the incinerator would require additional fire protection equipment and possibly a modification to the ventilation system for the Main Cargo Hold.

Drainages would be as follows:

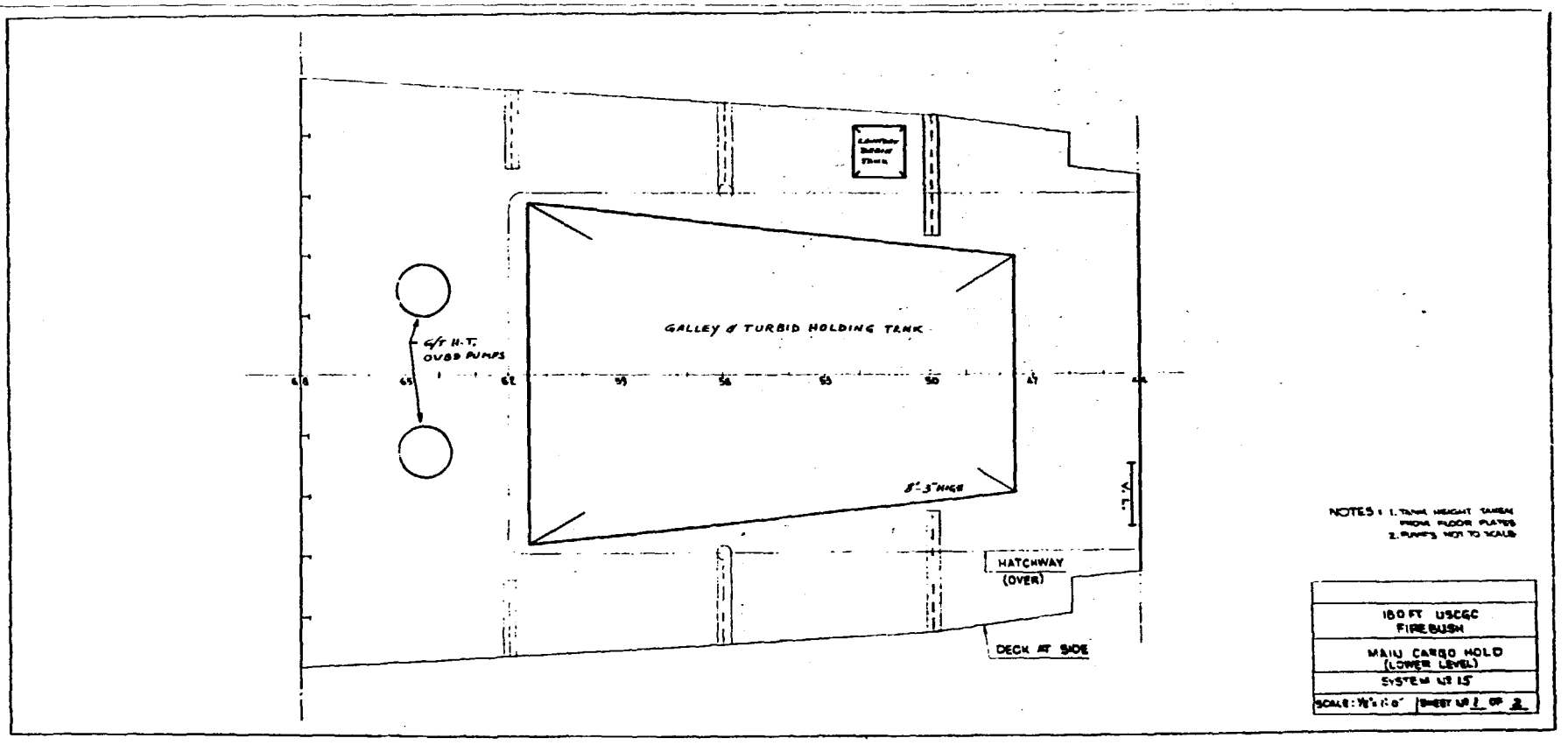
(a) Sewage from all spaces and the garbage grinder aft (if fitted) would be collected in the incinerator feed tank via incinerator transfer pumps.

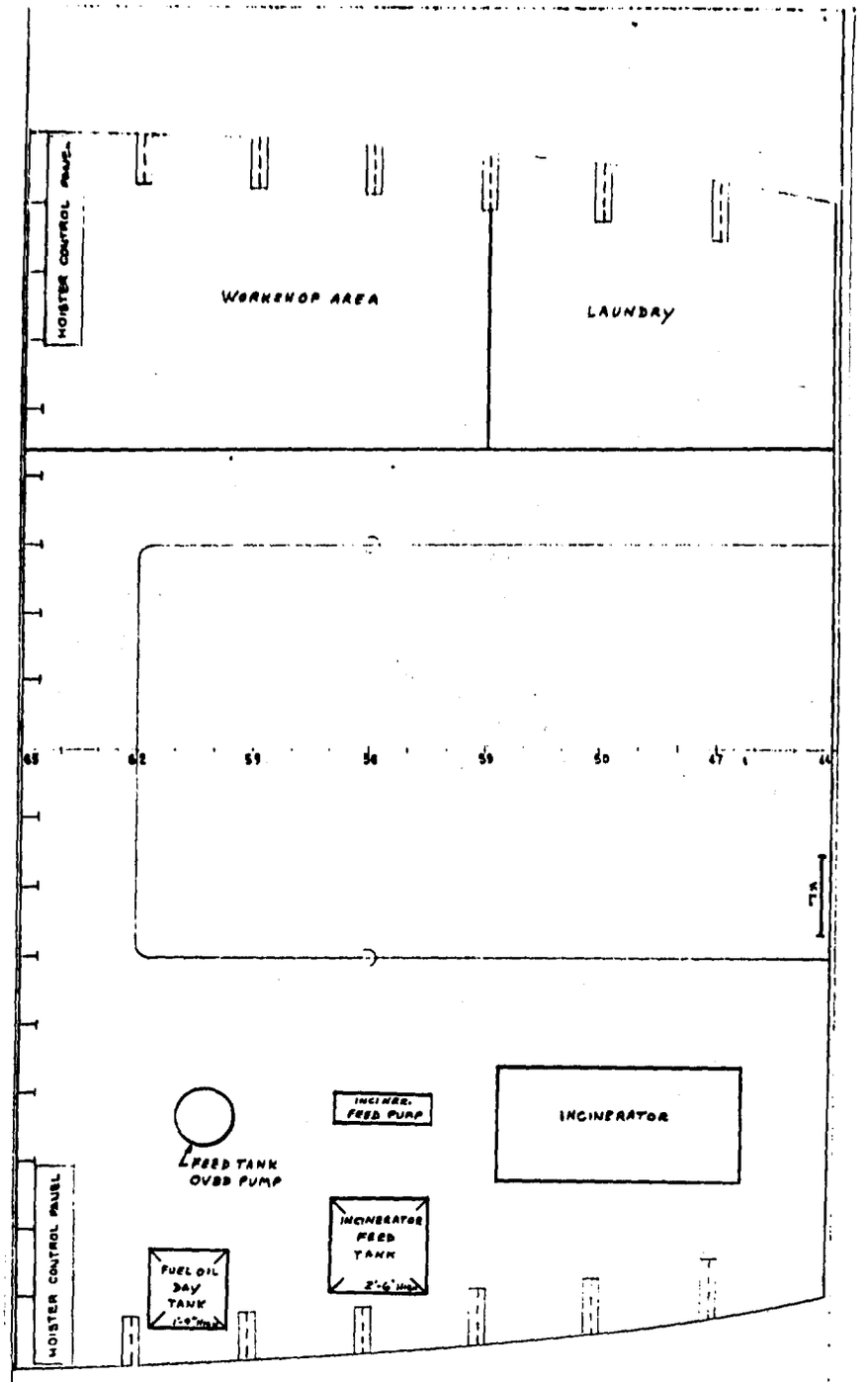
(b) Gray water from spaces aft of Frame 124 would continue to drain to the small holding tank (approximately 25 gals.) and sump pump in the Hawser Room from which it would be pumped forward to overboard and to the G/T Holding Tank for off-loading.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G/T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with a small (approximately 25 gals.) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT





NOTE: PUMP NOT TO SCALE

180 FT USCGC FIREBUSH
MAIN CARGO HOLD SECOND DECK
SYSTEM NO 1 F
SCALE: 1/8" = 1'-0" | SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 15

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	3,235 [2]	14,558
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	9,005 [4]	4,953
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	7,395 [5]	6,804
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	345	690
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	25	375
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	60	360
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
Removals	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					29,515

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 16 GATX Reduced Volume Flush M/T Pump Collection/GATX Evaporator for Concentrated Black Water/Holding Tank for Gray Water

	Required
Galley/Turbid Holding Tank	20, 843 gal. (2786 cu.ft.)
Evaporator Feed Tank	100 gal.
Evaporator (GATX)	Two (2) - 80 gal.
Catalytic Oxidizer	One (1) large or Two (2) regular
Evaporator Feed Pump	One (1)
Evaporator Feed Tank Overboard Pump	One (1)
G/T Holding Tank Overboard Pump	Two (2)
Macerator/Transfer Pumps	Six (6)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Galley/turbid holding tank (approx. 14' L x 7' W fwd x 10' W aft x 8'-3" H), in hatchway, on ship's centerline, Frames 47-61. This tank is limited to 975 cu.ft. (7295 gallons) due to lack of space.

(b) G/T overboard discharge pumps, aft of G/T holding tank.

On 2nd Deck level

(a) GATX Evaporators (2), (approx. 3'-2" dia x 4'-2" high) and catalytic oxidizer(s) (6" dia x 18" high), stbd side.

(b) Evaporator feed tank (approx. 2'-6" L x 2'-6" W x 2'-6" H) and feed pump(s) (2'-6" L x 0'-9" W x 1'-4" H) near evaporators.

(c) Evaporator feed tank overboard pump, near the tank.

System No. 16 (Cont'd.)

Drainages would be as follows:

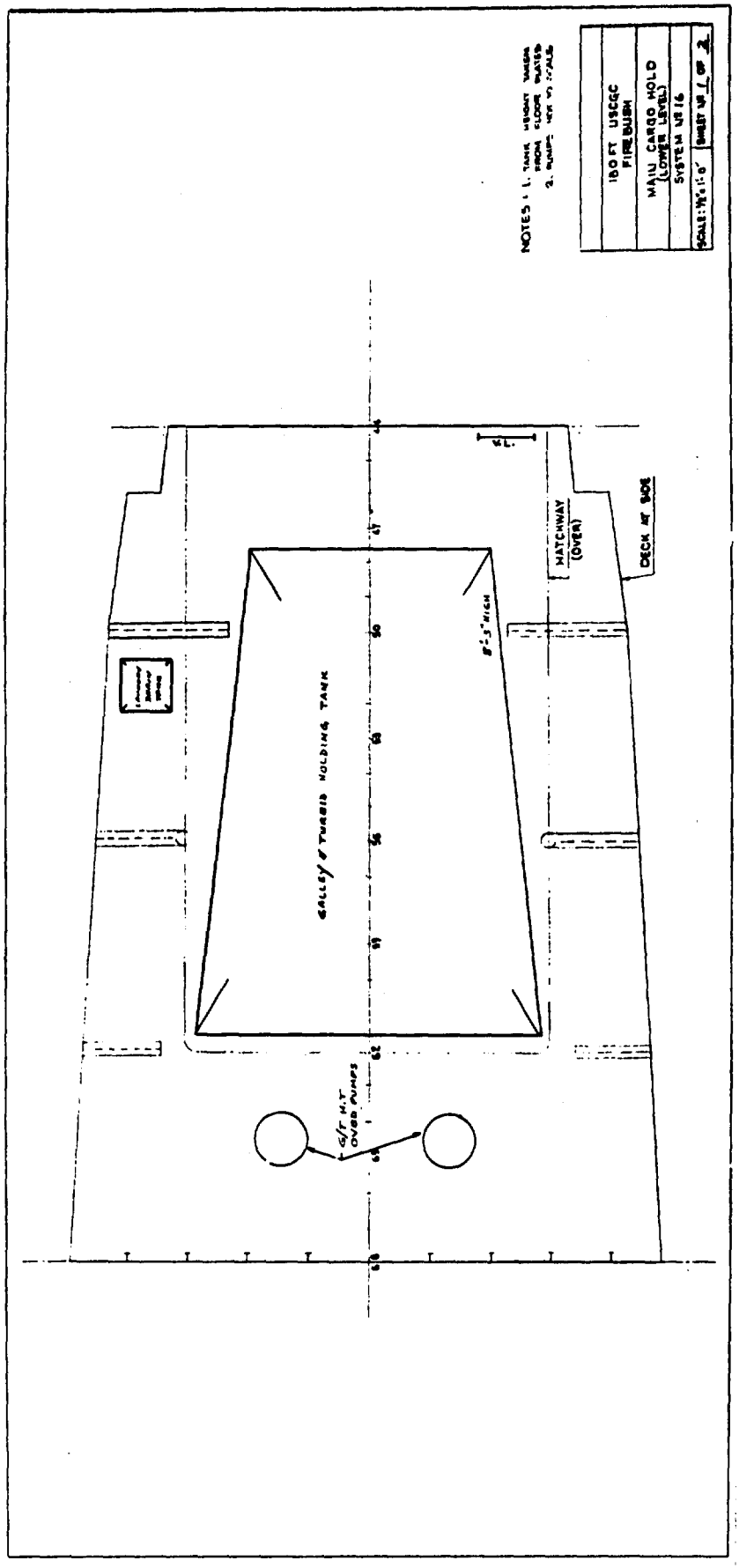
(a) Sewage from all spaces and the garbage grinder aft (if fitted) would be collected in the evaporator feed tank via macerator/transfer pumps.

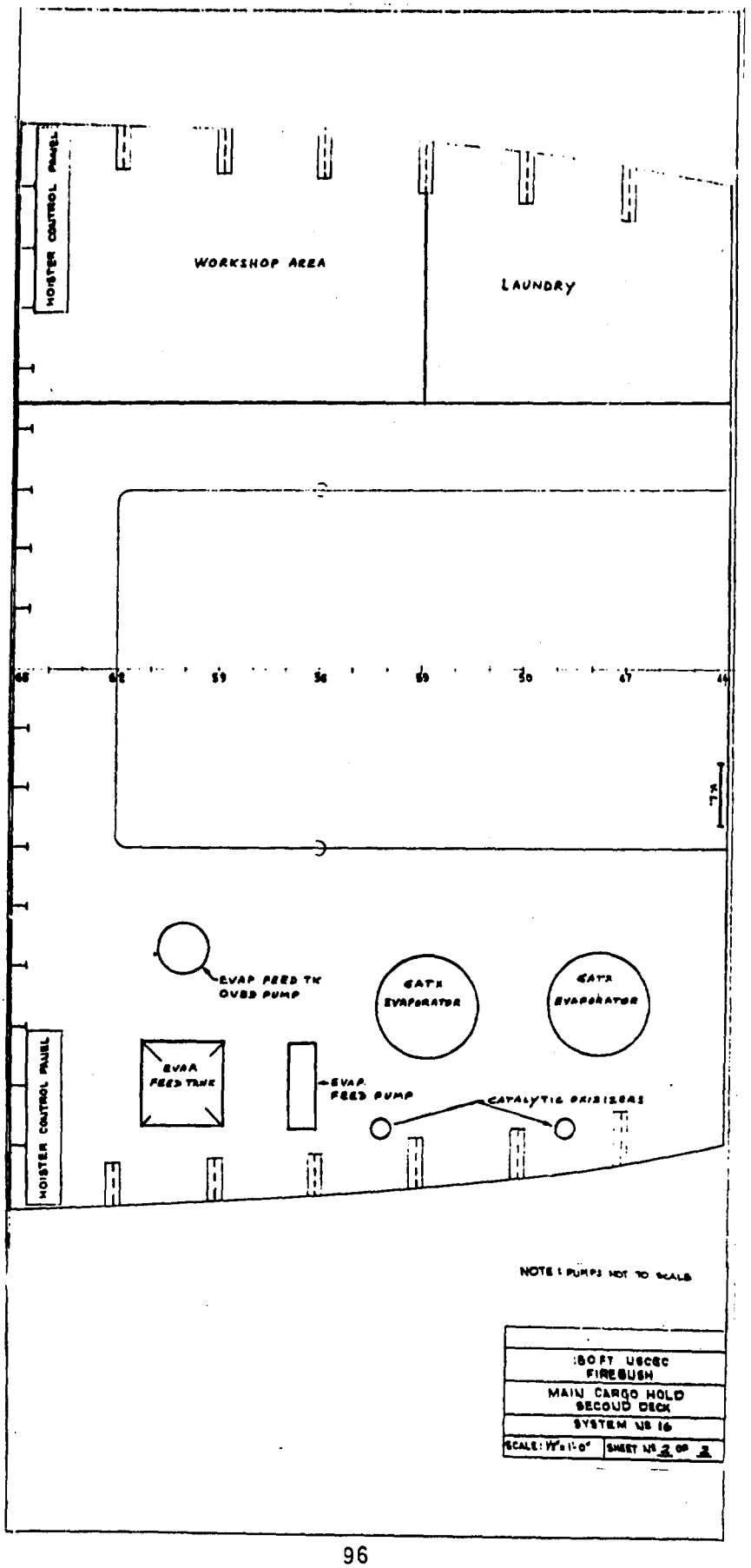
(b) Gray water from spaces aft of Frame 124 would continue to drain to the small holding tank (approximately 25 gals.) and sump pump in the Hawser Room from which it would be pumped forward to overboard and to the G/T Holding Tank for off-loading.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G/T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with a small approximately 25 gals.) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
WORKSHOP AREA
LAUNDRY
EVAP FEED TK OVBD PUMP
CATS EVAPORATOR
CATS EVAPORATOR
EVAP FEED TANK
EVAP. FEED PUMP
CATALYTIC OXIDIZERS
HOISTER CONTROL PANEL
NOTE : PUMPS NOT TO SCALE
180 FT USCGC FIREBUSH
MAIN CARGO HOLD SECOND DECK
SYSTEM NO 16
SCALE: 1/8" = 1'-0"
SHEET NO 2 OF 2

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 16

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,845[2]	8,303
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	8,150[4]	4,483
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	7,435[5]	6,841
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	460	920
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	25	375
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	60	360
Removals	Cutting	Hours	$50.00/Hr.[6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					23,057

(1) Copper-Nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 17 GATX Reduced Volume Flush M/T Pump Collection/Holding Tank for Concentrated Black Water/Grumman Flow Through System with Sludge Holding Tank for Gray Water

	Required
Sewage Holding Tank	2345 gal. (313 cu.ft.)
Galley/Turbid Influent Surge Tank	768 gal. (103 cu.ft.)
Sludge Holding Tank	1737 gal. (232 cu.ft.)
Grumman Unit	Two (2)
Sewage Holding Tank Overboard Pump	Two (2)
G/T Influent Surge Tank Transfer Pump	One (1)
Influent Surge Tank Pump	Two (2)
Macerator/Transfer Pumps	Six (6)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Sewage holding tank (approx. 5' L x 9' W fwd x 10' aft x 6'-9" H), on ship's centerline, in hatchway, Frames 56-61.

(b) Galley/Turbid influent surge tank (approx. 3' L x 6' W x 5'-9" H), just fwd of sewage holding tank, Frames 47-50.

(c) Various associated pumps - sewage overboard (2) Frame 63-65 port, G/T influent surge tank pump (to sewage holding tank) and surge tank pumps (2) (to Grumman feed tank), all located between tanks Frames 50-56.

On the 2nd Deck level

(a) Grumman MSD's 1 each port and starboard.

(b) Sludge holding tanks (2) each half of total required capacity for one tank (approx. 5'L x 5' W x 4'-9" H), located forward of each Grumman MSD.

Drainages would be as follows:

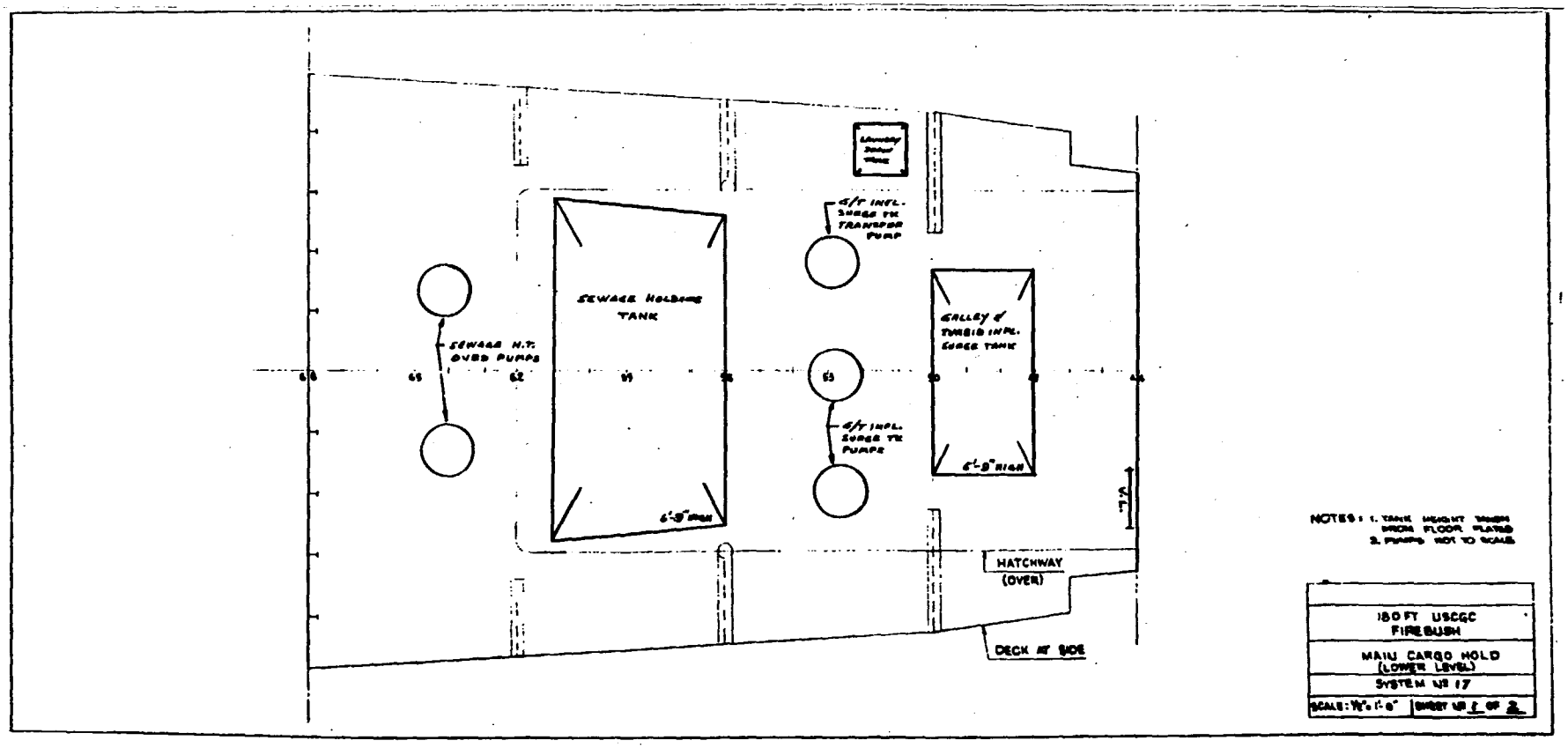
(a) Sewage from all spaces and the garbage grinder aft (if fitted) would be collected in the sewage holding tank via macerator/transfer pumps.

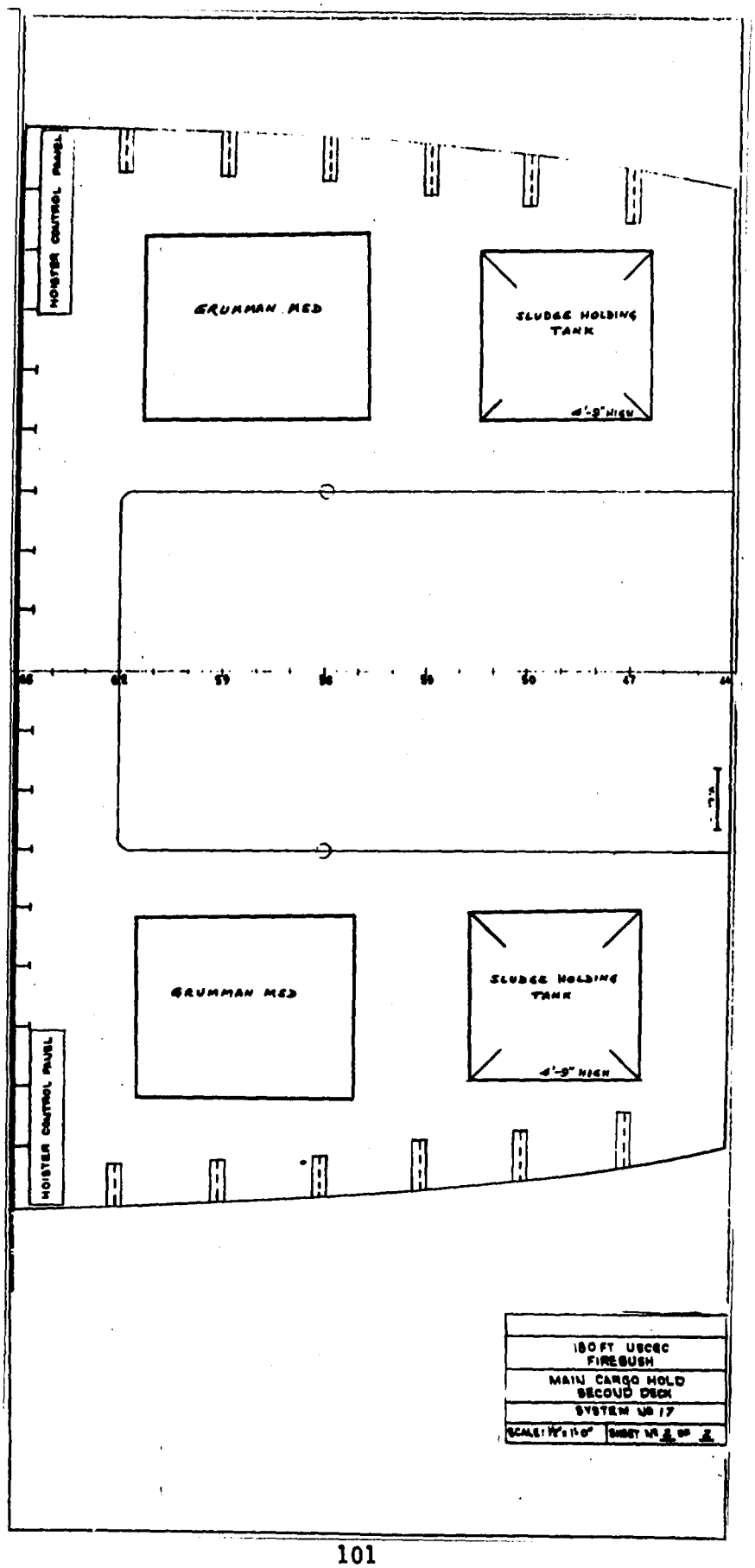
(b) Gray water from spaces aft of Frame 124 would continue to drain to the small holding tank (approximately 25 gals.) and sump pump in the Hawser Room from which it would be pumped forward to overboard and to the G/T influent surge tank.

(c) Gray water from spaces forward of Frame 124 would gravitate overboard and to the influent surge tank for off-loading.

(d) The laundry and its deck drains cannot gravitate overboard from the Second Deck. Therefore, they would have to drain to a small (approx. 25 gal.) collection tank with sump pump for discharge overboard and to the G/T influent surge tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
GRUMMAN MED
SLUDGE HOLDING TANK
4'-9" HIGH
GRUMMAN MED
SLUDGE HOLDING TANK
4'-9" HIGH
HOISTER CONTROL PANEL
180 FT USCGC FIREBUSH
MAIN CARGO HOLD SECOND DECK
SYSTEM NO 17

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 17

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	1,880[2]	8,460
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	7,590[4]	4,175
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	4,720[5]	4,343
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	690	1,380
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	40	600
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	90	540
Removals	Cutting	Hours	$50.00/Hr.[6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					21,273

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft./hr.

DISCUSSION OF INSTALLATION BASED ON SHIPCHECKS

Vessel: FIREBUSH (180')

WMS No. 18 GATX Reduced Volume Flush M/T Pump Collection/Grumman Flow Through System for Gray Water/Incinerator for both Concentrated Black Water and Gray Water Sludge

	Required
Black Water Surge Tank	101 gal. (13.5 cu.ft.)
Gray Water Surge Tank	768 gal. (103 cu.ft.)
Fuel Oil Day Tank	94 gal. (12.5 cu.ft.)
Grumman Unit with	One (1)
Incinerators	Three (3) Thiokol Incinerators
Sewage Surge Tank Overboard Pump	One (1)
Sewage Furge Tank Transfer Pump	One (1)
G/T Surge Tank Pump	One (1)
G/T Surge Tank Overboard Pump	One (1)
Macerator/Transfer Pumps	Six (6)

Discussion

The system is considered to be a viable candidate subject to certain limitations.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Black water surge tank (approx. 2'-6" L x 2'-6" W x 2'-3" H) on ship's centerline, Frames 48-50 1/2.

(b) Gray water surge tank (approx. 5' L x 5' W x 4'-3" H), on ship's centerline, Frames 56-61.

(c) Various associated pumps:

sewage overboard - Frames 63-65 port
solid handling (sewage to sludge feed tank) - Frames 51-56
G/T overboard - Frames 63-65
G/T surge tank to Grumman MSD - Frames 51-56

System No. 18 (Cont'd)

On the 2nd Deck level

(a) Grumman MSD with incinerator, port side aft of the Laundry. The Laundry will have to be modified slightly to provide more access room around the added equipment.

(b) Thiokol incinerators (2) with blowers, sludge tanks, sludge feed pumps, fuel oil day tank (2'-6" L x 2'-6" W x 2'-0" H) on the starboard side similar to System No. 13.

(c) Three (3) incinerator stacks would have to be run to the weather similar to System No. 13. This will offer a problem. See the discussion given in System No. 13.

Installation of incinerators would require additional fire protection equipment and possibly a modification to the ventilation system for the Main Cargo Hold.

Drainages would be as follows:

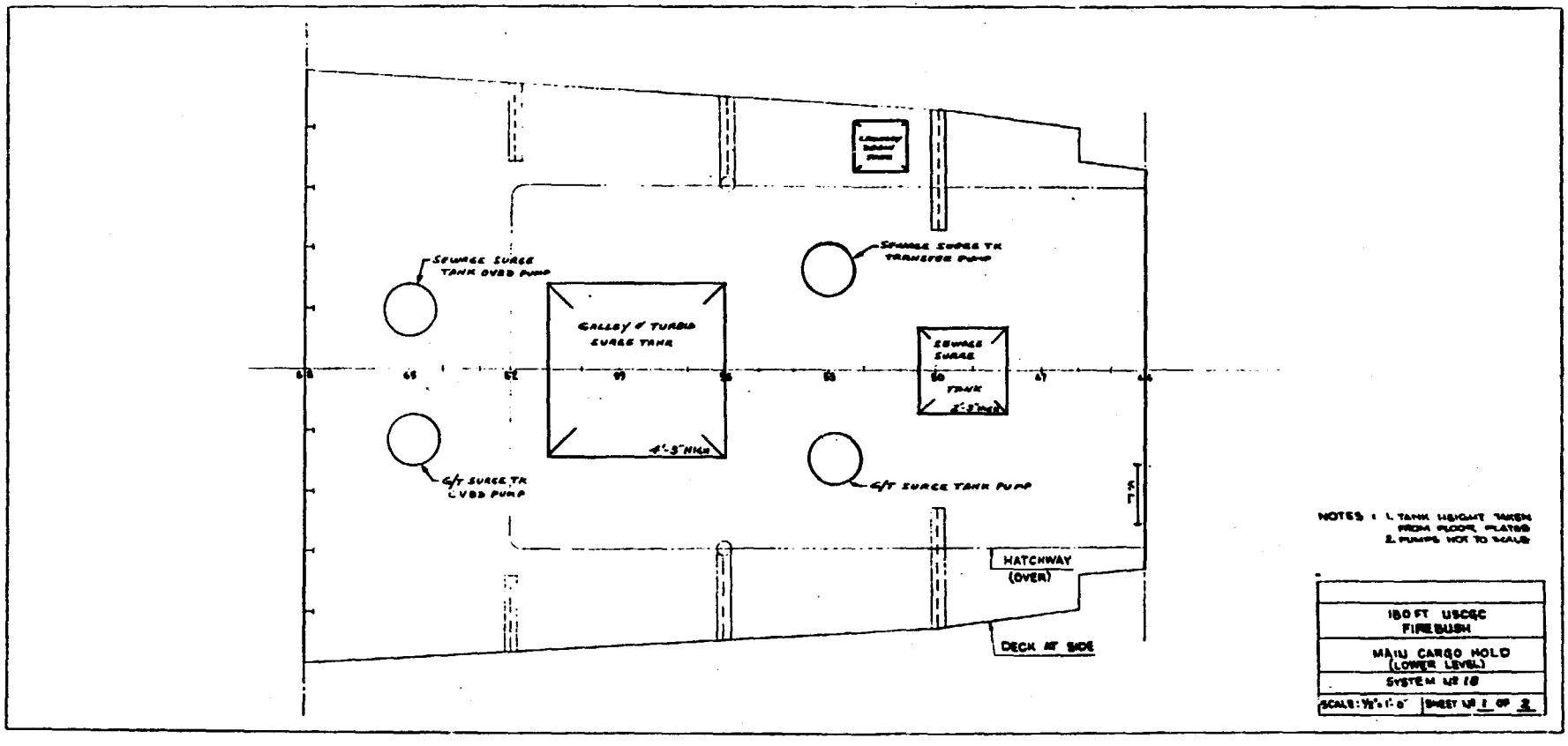
(a) Sewage from all spaces and the garbage grinder aft (if fitted) would be collected in the black water surge tank via macerator/transfer pumps.

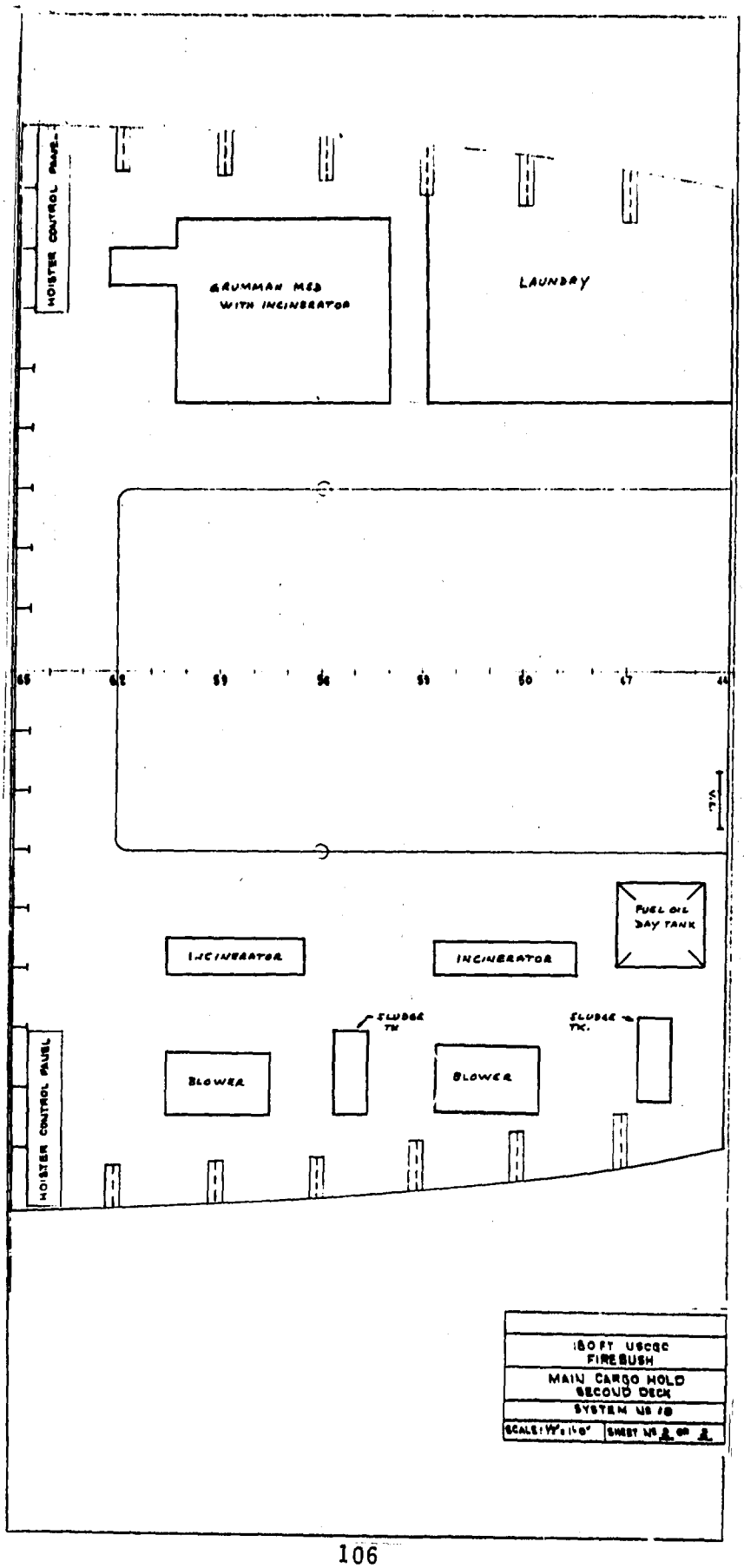
(b) Gray water from spaces aft of Frame 124 would continue to be drained to the small holding tank (approximately 25 gals.) and sump pump in the Hawser Room from which it would be pumped forward to overboard and to the Gray Water Surge Tank.

(c) Gray water from spaces forward of Frames 124 would gravitate overboard and to the gray water surge tank for off-loading.

(d) The laundry and its deck drains cannot gravitate overboard from the Second Deck. Therefore, they would have to drain to a small (approx. 25 gal.) collection tank with sump pump for discharge overboard and to the Gray Water Surge Tank.

PROPOSED WMS EQUIPMENT ARRANGEMENT




HOISTER CONTROL PANEL
GRUMMAN MES WITH INCINERATOR
LAUNDRY
65
62
59
56
53
50
47
44
V.T.
FUEL OIL DAY TANK
INCINERATOR
INCINERATOR
SLUDGE TK.
SLUDGE TK.
BLOWER
BLOWER
HOISTER CONTROL PANEL
180 FT USCGC FIREBUSH
MAIN CARGO HOLD SECOND DECK
SYSTEM MS 18
SCALE: 1/4"=1'-0"

WMS INSTALLATION COST ESTIMATES

Vessel FIREBUSH (180')

WMS No. 18

Installation Cost Element		Unit	Assumed Unit Cost	Quantity Required (estimated number of units)	Cost ($)
Piping[1]		Pounds	$ 4.50/Lb. (Materials and Labor)	5,055 [2]	22,748
Tank Steel[3]		Pounds	$ .55/Lb. (Materials and Labor)	2,740 [4]	1,507
Foundations		Pounds	$ .92/Lb. (Materials and Labor)	1,785 [5]	1,643
Electric Cables		Feet	$ 2.00/Ft. (Materials and Labor)	575	1,150
Miscellaneous Installations (pumps, motors, skid-mounted components, etc.)		Man-Hours	$15.00/MH (Labor)	35	525
Access Cuts (in hull, deck plating or bulkhead to provide passageway)		Feet	$ 1.00/Ft. (Labor)	N/A	-
Welding		Feet	$ 6.00/Ft. (Materials and Labor)	40	240
Removals	Cutting	Hours	$50.00/Hr. [6] (Labor)	25	1,250
	Other (miscellaneous handling)	Man-Hours	$15.00/MH (Labor)	35	525
Total Installation Cost ($)					29,588

(1) Copper-nickel assumed.
(2) Estimate includes a factor of 50% added to allow for valves, flanges, fittings, take-down joints, etc.
(3) One-quarter inch plate assumed.
(4) Estimate includes a factor of 30% added to allow for required structural stiffening for proper support.
(5) Estimated on the basis of 10% of the weight which has to be supported.
(6) Based on an assumed cutting rate of 50 ft. /hr.

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel FIREBUSH (180')

M/E I - ADAPTABILITY FOR SHIPBOARD INSTALLATION

Factor/Subfactor Ident. No.	INSTALLATION CHARACTERISTIC																	
111	Required black water handling capacity for vessel versus actual capacity of WMS (a) Actual capacity of WMS equals or exceeds required capacity for vessel. (b) WMS marginally suitable for vessel (has 95-99% of required capacity). (c) WMS capacity insufficient for vessel (less than 95% of required capacity).																	
WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
112	Required gray water handling capacity for vessel versus actual capacity of WMS (a) Actual capacity of WMS equals or exceeds required capacity for vessel. (b) WMS marginally suitable for vessel (has 95-99% of required capacity). (c) WMS capacity insufficient for vessel (less than 95% of required capacity).																	
WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	c	c	c	c	a	a	c	a	c	c	c	a	a	c	c	c	a	a
13	Extent of additional support systems or equipment required to accommodate WMS(1) (a) No additional support systems or equipments required. (b) Some additional support systems or equipments required.(2) (c) Many additional support systems or equipments required.(3) (1) Examples: . Firefighting system must be installed with incinerator. . Bilge alarm required if large tank is installed above bilge. . Compressor required on vessels that do not already have one. . Detectors of toxic or noxious gases should be installed with any system that, as an inherent design feature, uses such gases in processing wastes. (2) Need for support system/equipment does not significantly reduce WMS suitability for on-board installation. (3) Suitability of WMS for installation on vessel significantly reduced.																	
WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b
21	Extent of fixture modifications required for WMS installation (a) No fixtures need modification or replacement. (b) Some fixtures need modification or replacement. (c) All commodes need replacement and modification of urinal-associated equipment (e.g., urinal discharge valves) is required. (d) All fixtures need replacement or modification (e.g., replacement or commodes and urinal flushometers). (e) All fixutres need replacement or modification and each fixture has additional hookup requirements associated with it.																	
WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	c	c	c	c	c	e	e	e	e	e

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel FIREBUSH (180')

Factor/Subfactor Ident. No.

M/E I - ADAPTABILITY FOR SHIPBOARD INSTALLATION (Cont'd)

INSTALLATION CHARACTERISTIC

22 Extent of flush medium supply modifications required for WMS installation

(a) Existing flush medium is used.
(b) WMS requires conversion of flush medium to potable water.
(c) WMS requires conversion of flush medium to recirculating non-aqueous medium.
(d) WMS requires conversion of flush medium to salt water.(1)

(1) Conversion to salt water requires pump re-sizing, tapping into the sea-chest and provision for its corrosive properties. For PAMLICO, salt water would be used if the drain system were converted to a standard flush system (C.G. supplied information).

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	c	c	a	a	a	a	a	b	b	b	b	b	b	b	b	b	b

231 Hookup requirements(1) for WMS Collection/Transport subsystem installation

(a) No additional hookup requirements beyond existing ones.
(b) Requires piping for recirculation of flush medium (in existing gravity drain system).
(c) Special and centralized Collection/Transport subsystem required.
(d) Special and non-centralized Collection/Transport subsystem required (includes conversion from reduced flush vacuum collection to a standard gravity drain system, with or without recirculation).

(1) Drain piping; electric cables connecting commode, M/T pump and control panel in GATX, but not in JERED, etc.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	b	b	a	a	a	a	a	c	c	c	c	c	d	d	d	d	d

232 Routing flexibility for drain piping modifications(1) associated with WMS Collection/Transport subsystem installation(2)

(a) Routing is highly flexible.(3)
(b) Routing is moderately flexible, with some restrictions.
(c) Routing is highly inflexible.

(1) Of the three relevant categories of routing of lines (piping, ventilation, electrical), piping is the most important for assessing use of WMS installation.

(2) Notes: . With gravity drainage, lines must always slope downward and require venting.
. Smaller size lines are inherently more flexible.
. With the pump or vacuum Collection/Transport subsystem, sharp bends, rises and long runs can be accommodated in piping.

(3) In all cases, WMS installation is to be considered from the point of view of modifications required to existing conditions.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel FIREBUSH (180')

M/E I - ADAPTABILITY FOR SHIPBOARD INSTALLATION (Cont'd)

Factor/Subfactor Ident. No.	INSTALLATION CHARACTERISTIC
233	Space requirements for WMS Collection/Transport subsystem installation. (a) No additional space required.(1) (b) Some additional space required.(2) (c) Large amount of additional space required. (1) E.g., M/T pumps in GATX; or small influent surge tank. (2) E.g., large VCT in JERED; or large influent surge tank, if not already installed.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	b	b	a	a	a	a	b	b	b	b	b	b	a	a	a	b	a

Factor/Subfactor Ident. No.	INSTALLATION CHARACTERISTIC
234	Modularity of WMS Collection/Transport subsystem (as it affects installation)(1) (a) Degree of modularity of subsystem aids in installation of C/T subsystem. (b) Degree of modularity of subsystem results in some (minimal) difficulty in installation of C/T subsystem. (c) Degree of modularity of subsystem results in moderate difficulty in installation of C/T subsystem. (1) On vessels that do not currently have a WMS, a high degree of modularity aids in installation, and a high degree of subsystem centralization (as in the JERED) results in difficulties for installation.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	c	a	a	a	a	a	a	a	a	a	a	a	a

Factor/Subfactor Ident. No.	INSTALLATION CHARACTERISTIC
235	Vent requirements for WMS Collection/Transport subsystem installation (a) No vents are required other than the existing vents. (b) Few vents are required in addition to the existing vents. (c) Many vents are required in addition to existing vents.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	b	b	b	b	b	b	b	b	b	b	b	b	a	a	a	a	a

Factor/Subfactor Ident. No.	INSTALLATION CHARACTERISTIC
241	Space requirements for WMS waste Treatment/Disposal subsystem installation (a) Volume required is minimal and dimensions(1) of equipment present no problems in fitting equipment into available compartment space. (b) Volume required is moderate and dimensions(1) of equipment present no problems in fitting equipment into available compartment space. (c) Volume and dimension(1) of equipment do present problem in fitting equipment into available compartment space. (d) Large volume required and dimension(1) of equipment do present problem in fitting equipment into available compartment space. (1) The two main factors are (i) deck area required and (ii) height required.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	d	b	b	b	b	b	b	b	b	b	b	b	b	d	b	b	b	b

Factor/Subfactor Ident. No.

M/E I - ADAPTABILITY FOR SHIPBOARD INSTALLATION (Cont'd)

INSTALLATION CHARACTERISTIC

242 Hookup requirements[1] for WMS waste Treatment/Disposal subsystem installation

(a) Pipes, ducts and/or cable requirements are minimal.
(b) Pipes, ducts and/or cable requirements are moderate.
(c) Pipes, ducts and/or cable requirements are extensive.

[1] Piping for fuel oil, fresh water, cooling water, compressed air, interconnecting remotely located equipment, overboard discharge line, etc.; electric cables for power supply, remote control panels, etc.; ducting for ventilation, etc.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b

243 Degree of modularity of WMS waste Treatment/Disposal (as it affects installation)[1]

(a) Degree of modularity of subsystem aids in installation of T/D subsystem.
(b) Degree of modularity of subsystem results in some (minimal) difficulty in installation of T/D subsystem.
(c) Degree of modularity of subsystem results in moderate difficulty in installation of T/D subsystem.

[1] Decentralization of components may require additional hookups and piping runs.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	a	a	a	a	a		a	a	a	a

244 Vent requirements for WMS waste Treatment/Disposal subsystem installation[1]

(a) No vents are required.
(b) Vents are required.

[1] Vents that are only internal to the compartment in which subsystem is located are not considered here.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	b	b	b	b	b	b	b	b	b	b	b	b	a	b	b	b	b

245 Exhaust stack requirements for WMS waste Treatment/Disposal subsystem installation[1]

(a) Exhaust not required.
(b) Exhaust required, size of stack relatively small and stack can be run via existing ship's stack enclosure (fiddley).
(c) Exhaust required, size of stack relatively large and stack can be run via existing ship's stack enclosure.
(d) Exhaust required, size of stack relatively small and stack cannot be run via existing ship's stack enclosure.
(e) Exhaust required, size of stack relatively large and stack cannot be run via existing ship's stack enclosure.

[1] Notes: . Electric incinerator requires small (2") exhaust.
. Fuel incinerator requires large (10") exhaust.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	c	a	a	a	c	e	a	e	a	a	e	a	e	a	a	e

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel FIREBUSH (180')

M/E I - ADAPTABILITY FOR SHIPBOARD INSTALLATION (Cont'd)

Factor/Subfactor Ident. No. | INSTALLATION CHARACTERISTIC

25 Ease of installing WMS support equipment[1]

(a) No support equipment required.
(b) Some support equipment required but easy to install.
(c) Much support equipment required and difficult to install.

[1] Examples:
- Firefighting system must be installed with incinerator.
- Bilge alarm required if large tank is installed above bilge.
- Compressor required on vessels that do not already have one.
- Detectors of toxic or noxious gases should be installed with any system that, as an inherent design feature, uses such gases in processing wastes.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b

26 Ease of compensating for added weight of WMS

(a) No or minimal compensation for added weight required.
(b) Moderate compensation for added weight required.
(c) Extensive compensation for added weight required.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	c	b	b	b	b	b	b	b	b	c	c	c	c	c	c	c	b	b

271 Extent of SHIPALTS (permanent modifications) required for WMS installation[1]

(a) No SHIPALTS required.
(b) Minor SHIPALTS required.
(c) Extent of SHIPALTS required is moderate.
(d) Extensive SHIPALTS required.

[1] Foundations, enlarged doors/hatches, increased capacity requirements for air compressor, etc.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c

272 Extent of temporary modification[1] required for WMS installation

(a) No temporary modifications required.
(b) Temporary modifications required are minor.
(c) Extent of temporary modifications required are moderate.
(d) Temporary modifications required are extensive.

[1] Cutting access openings, etc.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	c	c	c		c	c	c	c	c	c	c	c	c	c	c	c	c	c

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel FIREBUSH (180')

M/E I - ADAPTABILITY FOR SHIPBOARD INSTALLATION (Cont'd)

INSTALLATION CHARACTERISTIC

31 Effect of WMS on vessel stability

(a) No effect on existing stability characteristics of vessel.
(b) Some effect on existing stability characteristics of vessel, easily compensated for.
(c) Severe effect on existing stability characteristics of vessel, compensation required extensive modifications to vessel (e.g., no tankage in Point Herron).

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

32 Effect of WMS on vessel trim and list

(a) No effect on trim or on list.
(b) Some easily compensated for effect on trim or list.
(c) Compensation for effect on trim or list requires extensive modification to vessel.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

33 Effect of WMS on normal range of vessel

Vessel resource capacity and usage rates.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	- Presented on Vessel Respurce Data Sheets -																	

34 Degree of space trade-off/reallocation required for WMS installation

(a) No space trade-off/reallocation required.
(b) Minimal degree of space trade-off/reallocation required.
(c) Moderate degree of space trade-off/reallocation required.
(d) High degree of space trade-off/reallocation required.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	b	b	b	b	b	b	c	c	c	c	a	b	c	d	d

M/E II - PERFORMANCE

PERFORMANCE CHARACTERISTIC

12 WMS per capita wet weight (lb)[1] - W_1

[1] Drain piping material is assumed to be copper-nickel (Cu-Ni).

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	1626	496	826	1353	996	2108	1691	593	1333	1891	1873	1417	703	1231	1785	1751	1152	601

M/E II - PERFORMANCE (Cont'd)

Factor/Subfactor Ident. No.

PERFORMANCE CHARACTERISTIC

13 WMS per capita volume (ft^3)(1) - V_1

(1) Volumes are calculated as follows:
- Fixture volumes are calculated using smallest space envelopes.
- Pipe volume is the volume of a square tube with side = outside diameter of pipe.
- Other equipment: Deck area: smallest rectangle enclosing all equipment in a single package plus extra dimension area required for operation and maintenance.
  Height: either maximum height of equipment, or full compartment height, if space above package is not usable for any other purposes.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	35.9	30.2	60.7	62.4	64.8	52.7	55.3	40.9	58.7	52.9	55.9	90.8	71.9	45.1	60.8	60.1	87.5	65.7

21 Adequacy of WMS black water holding times

HT_b - % of required black water holding time met by WMS(1)

(1) A WMS which employs an incinerator is considered to meet 100% of the required holding time. The holding time of a WMS which employs a holding tank (for wastewater or sludge) is determined by the ratio of available tank capacity to required capacity.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

22 Adequacy of WMS gray water holding times

HT_g - % of required gray water holding time met by WMS(1)

(1) A WMS which employs an incinerator is considered to meet 100% of the required holding time. The holding time of a WMS which employs a holding tank (for wastewater or sludge) is determined by the ratio of available tank capacity to required capacity.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	0	0	12	22	100	100	29	100	13	35	35	100	100	15	35	35	100	100

311 Effect of peak hydraulic loads in black water stream on WMS performance

$GIST_b$ - % of required Grumman (or other) influent surge tank capacity in black water stream met by installation.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	--	--	--	100	100	--	100	100	--	--	--	---	--	--	--	--	--	100

312 Effect of peak hydraulic loads in gray water stream on WMS performance

$GIST_g$ - % of required Grumman influent surge tank capacity in gray water stream met by installation.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	--	--	--	--	100	100	--	100	--	--	--	100	100	--	--	--	100	100

331 Ability of black water portion of WMS to handle additional personnel (on a long-term basis)

HTC_b - % of required black water (or sludge) holding tank capacity met by installation.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	100	100	--	100	100	100	--	--	100	--	--	100	--	100	--	--	100	--

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel FIREBUSH (180')

Factor/Subfactor Ident. No.

M/E II - PERFORMANCE (Cont'd)

PERFORMANCE CHARACTERISTIC

332	Ability of gray water portion of WMS to handle additional personnel (on a long term basis) HTC_g - % of required gray water (or sludge) hodling tank capacity met by installation.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	0	0	12	22	100	100	29	--	13	35	35	100	--	13	35	35	100	--

M/E IV - PERSONNEL SAFETY

SAFETY CHARACTERISTIC

21	Hazard of explosive potential for operator/maintainer due to inherent WMS design. I - Installation index (for personnel safety) (a) Likelihood of hazardous situation is not increased due to location of any portion of WMS. (b) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to working or berthing area. (c) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to fuel storage area.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	b	a	a	a	b	b	a	b	a	a	b	a	b	a	a	b

22	Hazard of explosive potential for operator/maintainer due to procedural error/equipment failures of WMS. I - Installation index (for personnel safety) (a) Likelihood of hazardous situation is not increased due to location of any portion of WMS. (b) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to working or berthing area. (c) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to fuel storage area.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	b	a	a	a	b	b	a	b	a	a	b	a	b	a	a	b

31	Hazard of fire ignition potential due to inherent WMS design I - Installation index (for personnel safety) (a) Likelihood of hazardous situation is not increased due to location of any portion of WMS. (b) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to working or berthing area. (c) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to fuel storage area.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	b	a	a	a	b	b	a	b	a	a	b	a	b	a	a	b

32	Hazard of fire ignition potential due to procedural errors/equipment failures of WMS. I - Installation index (for personnel safety) (a) Likelihood of hazardous situation is not increased due to location of any portion of WMS. (b) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to working or berthing area. (c) Likelihood of hazardous situation is increased due to proximity of any portion of WMS to fuel storage area.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	b	a	a	a	b	b	a	b	a	a	b	a	b	a	a	b

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel FIREBUSH (180')

M/E V - HABITABILITY

HABITABILITY CHARACTERISTIC

Factor/Subfactor Ident. No.

41 Heat generation for nearby personnel[1] due to inherent WMS design

I - Installation index (for heat)

(a) Location of WMS is not likely to raise h- .evel due to proximity to working and berthing areas.
(b) Location of WMS is likely to raise heat level due to proximity to working and berthing areas.

[1] For operator/maintainer/adjacent berthing and working areas.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

42 Heat generation for nearby personnel[1] due to procedural errors/equipment failures of WMS

I - Installation index (for heat)

(a) Location of WMS is not likely to raise heat level due to proximity to working and berthing areas.
(b) Location of WMS is likely to raise heat level due to proximity to working and berthing areas.

[1] For operator/maintainer/adjacent berthing and working areas.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

5 Noise level for personnel in vicinity of WMS[1]

I - Installation index (for noise)

(a) Location of WMS is not likely to raise noise level due to proximity to working and berthing areas.
(b) Location of WMS is likely to raise noise level due to proximity to working and berthing areas.

[1] For operator/maintainer/adjacent berthing and working areas.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

6 Vibration levels for nearby personnel[1] produced by WMS machinery

I - Installation index (for vibration)

(a) Location of WMS is not likely to raise vibration level due to proximity to working and berthing areas.
(b) Location of WMS is likely to raise vibration level due to proximity to working and berthing areas.

[1] For operator/maintainer/adjacent berthing and working areas.

WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

WMS INSTALLATION EFFECTIVENESS ATTRIBUTE DATA

Vessel FIREBUSH (180')

Factor/Subfactor Ident. No.	M/E VI - RELIABILITY RELIABILITY CHARACTERISTIC																	
22	Extent of WMS configuration redundancy WMS equipment requirements.																	
WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data						- Presented on WMS Equipment Requirement Data Form -												

M/E VII - MAINTAINABILITY MAINTAINABILITY CHARACTERISTIC																		
131	Accessibility of replaceable WMS components I - Installation Index (for accessibility) (a) High degree of physical clearance around WMS equipment. (b) Moderate degree of clearance around WMS equipment. (c) Very tight, i.e., very little clearance around WMS equipment.																	
WMS #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Data	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b

CONCLUDING REMARKS

The following are points of consideration and observation relevant to this vessel, some of which have been included in the shipcheck observations and are reiterated for emphasis and convenience.

(a) The vessel is fitted with a two-zone waste collection system due to its configuration and compartmentation. For most of the candidate wastewater management systems considered, this would have to be retained. However, the piping runs and space for equipment location are convenient and satisfactorily arranged, with separate runs of black and gray water mains to the collecting and holding tanks fitted in the Main Cargo Hold lower level. It is intended that this arrangement be reused to the maximum extend possible, including piping connections, where candidate WMS configurations permit. Where this is not possible, new piping will have to replace the existing.

(b) The vessel in fitted with all support systems with the exception of the fresh water flushing system. In addition, the fire protection and ventilation systems would probably require modification to suit the systems employing incinerating and other heat producing equipment.

(c) There is no ballast system per se. Therefore any weight compensation required would have to be by means of adjusting on-board weights.

(d) Since the proposed location of the WMS equipment is in the Main Cargo Hold as is presently the case, and since the hold is fitted with a large removable hatch cover, there does not appear to be any need for cuts in the hull to provide access for WMS components or removals of existing materials.

(e) Attention is directed to the "Special Remarks" in the shipcheck observations, where the following considerations are discussed:

- Inconclusive solution as to running incinerator stacks.
- Possibility of having to modify or relocate the laundry in the Main Cargo Hold.

- Lack of additional space for relocating stores shops and storerooms affected by some WMS configurations.

- Retention and handling or relocation of the 6' x 6' x 2'-6" concrete block buoy sinker presently stowed in the forward end of the lower level of the Main Cargo Hold.

- Need to retain fuel handling hoses and reels in their present locations port and starboard in the lower forward part of the Main Cargo Hold.

APPENDIX A

PRELIMINARY INSTALLATION ANALYSIS

FIREBUSH (180')

Vessel Characteristic	Data
Class	WLB - 393 Basswood (180') C Class
Type	Buoy Tender (Seagoing)
Crew Size	50
Home Port	Governor's Island, New York

SUMMARY OF PRELIMINARY INSTALLATION ANALYSIS RESULTS

FIREBUSH (180')

WMS No.	TYPE: Coll/Trans Subsys (Black)	TYPE: Treatment/Disposal Subsystem — Black	TYPE: Treatment/Disposal Subsystem — Gray	SYSTEM ACCEPTABILITY FOR INSTALLATION(1)
1	Gravity Collect.	Holding Tank	Holding Tank	Yes
2	Oil Recircul. (Chrysler)	Chrysler + Hld Tnk	Holding Tank	Yes
3		Chrysler + Incin.	Holding Tank	Yes
4	Gravity Collect. (Grumman)	Grum Flow Thru+HldTk	Holding Tank	Yes
5		Grumman Flow Thru + Holding Tank		Yes
6	Gravity Collect.	Holding Tank	Grum Flow Thru+HldTnk	Yes
7	Gravity Collect. (Grumman)	Grum Flow Thru+Incin.	Holding Tank	Yes
8		Grumman Flow Thru + Incinerator		Yes
9	Vacuum Collect. (Jared)	Holding Tank(2)	Holding Tank	Yes
10		Incinerator	Holding Tank	Yes
11		GATX Evap.	Holding Tank	Yes
12		Holding Tank(3)	Grum Flow Thru+ Hld Tnk	Yes
13		Incinerator	Grum Flow Thru + Incin.	Yes
14	M/T Pump Collect. (GATX)	Holding Tank	Holding Tank	Yes
15		Incinerator	Holding Tank	Yes
16		GATX Evap.	Holding Tank	Yes
17		Holding Tank	Grum Flow Thru+Hld Tnk	Yes
18		Incinerator	Grum Flow Thru + Incin.	Yes

(1) Based on:
- Information contained in available vessel plans.
- WMS installation requirements.
- WMS installation criteria and guidelines.

(2) Two subchoices available for WMS No. 9 as follows:
- 9a - Concentrated black water transferred from VCT to holding tank (acceptable for all vessels).
- 9b - Concentrated black water held in VCT (acceptable for Point Herron only).

(3) Two subchoices available for WMS No. 12 as follows:
- 12a - Concentrated black water transferred from VCT to holding tank (acceptable for all vessels).
- 12b - Concentrated black water held in VCT (acceptable for Point Herron only).

PERTINENT VESSEL INFORMATION

FIREBUSH (180')

Crew: 50 men

Sanitary Fixtures:
7 Waterclosets
1 Urinal
4 Showers
13 Lavatories

Existing Arrangement:

(a) All sanitary flushing is with sea water furnished by two (2) sanitary water pumps.

(b) The vessel's configuration and compartmentation apparently require two zones for drainage - one forward of Frame 124 and one aft.

(c) A 25 gallon collecting tank with a pump operating on automatic level sensing is fitted on the Second Deck in the Hawser and Canvas Stowage Room aft.

A 278 gallon collecting tank and an 1875 gallon retention tank are fitted on the lower level of the Main Cargo Hold forward. Two pumps serve these tanks on automatic or manual control.

(d) Available ship's piping drawings indicate two alternative arrangements exist aft for this class vessel. The piping arrangement is dependent upon the type of watercloset fitted in the Officers' Toilet.

If the watercloset is a standard unit, all black and gray water from spaces aft of Frame 124 gravitate to the 25 gallon collecting tank via separate mains. The contents of the collecting tank are pumped forward to either the 278 gallon collecting tank or the 1875 gallon retention tank from which they are pumped overboard or to a shoreside connection on deck. Alternatively, the gray water can be gravitated directly overboard aft.

If the watercloset is a pressurized type unit ("Brotco" type), its effluent is ejected directly to the collecting or retention tanks forward. The gray water gravitates to the 25 gallon collecting tank from which it is pumped through a separate main to the 278 gallon collecting tank or the 1875 gallon retention tank. There is no provision for gravitating the aft gray water overboard in this case.

(e) Black and gray water from spaces forward of Frame 124 gravitate via separate mains selectively (depending on overboard restrictions) to the 278 gallon collecting tank or to the 1875 gallon retention tank. Either of two pumps located nearby serve these tanks and can discharge overboard or to a weather deck shoreside connection.

The collection tank operates under automatic or manual control and is fitted with a high level alarm.

The retention tank operates only on manual control and is fitted with a high level alarm.

The tanks can be cross connected, but the discharge pumps must be operated manually under this condition.

PRELIMINARY INSTALLATION ANALYSIS OF INDIVIDUAL CANDIDATE SYSTEMS

Vessel: FIREBUSH (180')

WMS No. 1 Full Volume Flush Gravity Collection/Holding Tank for Black Water/Holding Tank for Gray Water

	Required
Sewage Holding Tank	7,295 gal. (975 cu. ft.)
.Galley/Turbid Holding Tank	20,843 gal. (2786 cu. ft.)

Discussion

The system installation in acceptable subject to certain limitations.

It is possible to provide the required holding tankage capability for the black water. There is insufficient space available to provide the required holding tankage capability for gravity drainage of gray water due to the design configuration of the vessel. Available space will be designated for black water holding, leaving no room for a gray water tank. It will however, be possible to gravitate the gray water directly overboard from all spaces except from the laundry and its nearby deck drains, both located on the Second Deck in the Main Cargo Hold.

The sewage holding tank would be located in the Main Cargo Hold (Bhds 44 to 68). It would be approximately 14 feet long, 7 feet wide fwd, 10 feet wide aft and 8 feet 3 inches high. The tank would be fitted entirely within the dimensions of the hatchway such that the top of the tank would extend slightly above the Second Deck level. The black water gravity drainage piping serving the spaces forward of Frame 124 could still gravitate forward with minor modification of the runs within the Main Cargo Hold. The overboard discharge pumps could be located in the lower part of the hold, just aft of the tank with piping runs overboard and to pierside similar to existing. For the spaces aft of Frame 124, it would be necessary to retain the small collecting tank/pump arrangement presently fitted in the Hawser Room aft. The tank would receive black water which would be pumped on automatic tank level control, discharging forward to the large Sewage Holding Tank. Vessel configuration does not permit gravitation of the black water drains from the single Officers' Toilet at the stern end to the holding tankage forward.

Gray water from spaces forward of Frame 124 would continue to drain forward by gravity as at present. However, instead of going to the present collecting tank or the retention tank, the drains would go directly overboard above the Second Deck level approximately where the present overboard discharge shell connection is fitted. When overboard discharge is not permitted, the gray water would have to be diverted to the Sewage Holding Tank for off-loading.

The gray water from the Laundry and deck drains on the Second Deck in the Main Cargo Hold cannot drain overboard by gravity since the vessel's design draft is just above the Second Deck level. The drains will not be able to gravitate to the Sewage Holding Tank since the tank will protrude above the Second Deck. Therefore, these drains would best go to a small collecting tank fitted with a liquid level actuated pump which would discharge overboard or to the Sewage Holding Tank when overboard discharge is not permitted.

The gray water drains from the spaces aft of Frame 124 could continue to drain by gravity overboard at the stern of the vessel as at present since they cannot gravitate forward. A small collecting tank/pump arrangement operating on automatic tank level control would have to be fitted to permit discharge of the gray water to the Sewage Holding Tank for off-loading when overboard discharge is not permitted.

Vessel: FIREBUSH (160')

WMS No. 2 Full Volume Flush Oil Recirculation and Gravity Collection/ Chrysler System with Sludge Holding Tank for Sewage/Holding Tank for Gray Water

	Required
Sewage Holding Tank	1362 gal. (182 cu. ft.)
Galley/Turbid Holding Tank	20843 gal. (2786 cu. ft.)
Chrysler Model and Quantity	One (1) - A/B Separation Tank with One (1) Model A Pump & Fluid Maintenance Package or Two (2) Model A Separation Tanks with Two (2) Model A Pump & Fluid Maintenance Packages

Discussion

The system installation in acceptable subject to certain limitations.

This system is similar to System No. 1 in regard to the following:

(a) The required sewage holding tank capacity would be provided.

(b) No galley and turbid holding tankage is possible due to lack of space.

(c) Sewage from the Officers' Toilet aft of Frame 124 would continue to be pumped forward for disposition via the sewage holding tank.

(d) Gray water from spaces aft of Frame 124 would gravitate overboard, and when not allowed to go overboard would be pumped via a new small holding tank (say approximately 25 gallons) and sump pump to the sewage holding tank forward for off-loading.

(e) Laundry and deck drains therefrom would have to be collected and pumped overboard when permissible and pumped to the sewage holding tank for off-loading when overboard discharge is not permitted.

(f) Other gray water would be gravitated directly overboard, and for pierside off-loading would be diverted to the sewage holding tank.

The sewage holding tank (approximate 7'-6" long, 5'-0" wide and 5'-0" high) would be located on the lower level of the Main Cargo Hold forward. The tank would extend from the ship's centerline outboard to starboard.

The overboard discharge pumps would be located to port of the sewage holding tank, approximately where the presently installed pumps are located.

Regardless of which Chrysler models are contemplated, the components would be arranged just forward of the sewage holding tank.

Vessel: FIREBUSH (180')

WMS No. 3 Full Volume Flush Oil Recirculation and Gravity Collection/ Chrysler System with Incinerator for **Sewage/Holding Tank for Gray Water**

	Required
Galley/Turbid Holding Tank	20,843 gal. (2786 cu. ft.)
Sludge Holding Tank	One (1) Model B
Chrysler Model and Quantity	One (1) - A/B Separation Tank with One (1) Model A Pump & Fluid Maintenance Package, or Two (2) Model A Separation Tanks with Two (2) Model A Pump & Maintenance Packages
Incinerator Model and Quantity	One (1) - C

Discussion

The system installation appears to be acceptable subject to certain limitations.

Regardless of the options for the Chrysler MSD components listed above, these would be fitted in the aft portions of lower level of the Main Cargo Hold, along the ship's centerline. The Model B sludge holding tank (3'-4" L x 3'-0" W x 4'-1" H) would be located nearby where the existing 278 gallon collecting tank is presently fitted on the port side.

The galley and turbid holding tank size would be restricted to approximately 320 cu. ft. (2395 gallons) due to space availability. The tank would be approximate 7'-0" long, 6'-9" wide at the forward end, 8'-6" wide at the aft end and 6'-0" high and would be fitted also in the lower level of the Main Cargo Hold, at its forward end and on the vessel's centerline.

The pumps associated with these components would be fitted on the port side where the existing pumps are located and in the space forward of the sludge holding tank.

The incinerator, blower and fuel tank would be located on the 2nd Deck level of the Main Cargo Hold, preferably on the side not fitted with the laundry equipment.

The incinerator stack could possibly be led to the weather in front of the house via the dry stores space on the port side. There appears to be no way to run the stack via the existing ship's stack enclosure.

Sewage from the Officers' Toilet aft of Frame 124 would continue to use the 25 gallon collecting tank aft with its sump pump discharging forward to the Chrysler MSD.

Gray water from spaces aft of Frame 124 would gravitate overboard, and when not allowed to go overboard would be pumped via a new small holding tank (approximate 25 gallon) and sump pump to the galley and turbid holding tank for off-loading.

Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the galley/turbid holding tank.

The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with a small (approximate 25 gallons) collecting tank with sump pump for overboard discharge. For pierside off-loading the drains would gravitate to the G/T holding tank.

Vessel: FIREBUSH (180')

WMS No. 4 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Holding Tank for Black Water/ Holding Tank for Gray Water

	Required
Sanitary Influent Surge Tank	261 gal. (35 cu. ft.)
Galley/Turbid Holding Tank	20843 gal. (2786 cu. ft.)
Sludge Holding Tank	680 gal. (81 cu. ft.)
Grumman Unit	One (1)

Discussion

The system installation appears to be acceptable subject to certain limitations.

Equipment would be located in the Main Cargo Hold as follows:

On the Lower Level

(a) sanitary influent surge tank (approximate 3' L x 3' W x 4' H), on port side where 278 gallon collecting tank exists.

(b) Sludge holding tank (approximate 4'-6" L x 4'-6" W x 4'-0" H) on starboard side where 1875 gallon retention tank exists.

(c) Galley/Turbid holding tank (approximate 9'-3" L x 6'-9" W fwd x 9'-0" W aft x 8'-3" H) on the ship's centerline, at forward end of the hold, within the hatchway, protruding slightly above the 2nd deck level. Tank is limited to approximately 600 cu. ft. (4495 gal.) due to lack of space.

(d) Various associated pumps aft of the G/T holding tank.

On the 2nd Deck Level

(e) The Grumman MSD on either the port or starboard side depending on the location of the laundry. The free side is preferred.

Drainages would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use the 25 gallon collecting tank aft with its sump pump discharging forward to the sanitary influent surge tank.

(b) Gray water from spaces aft of Frame 124 would gravitate overboard and when not allowed to go overboard would be pumped via a new small holding tank (approximate 25 gallons) and sump pump to the G/T holding tank for off-loading.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G/T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with a small (approximately 25 gallon) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

Vessel: FIREBUSH (180')

WMS No. 5 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Holding Tank for Combined Black and Gray Waters

	Required
Influent Surge Tank	1029 gal. (138 cu. ft.)
Sludge Holding Tank	2345 gal. (313 cu. ft.)
Grumman Unit	Two (2)

Discussion

The system installation appears to be acceptable subject to certain limitations.

The system is very similar to System No. 4 except that the G/T holding tank has been eliminated. All wastes go to the influent surge tank.

The influent surge tank (approximate 5'-0" L x 5'-6" W x 5'-0" H) would be fitted at the forward end of the lower level of the Main Cargo Hold, on the ship's centerline.

The sludge holding tank (approximate 8' L x 8' W x 5' H) would be located where the 1875 gallon retention tank is presently located on the lower hold level.

The associated pumps would be located principally on the starboard side of the lower level of the hold.

The Grumman MSDs would be located on the 2nd Deck level of the Main Cargo Hold. Depending on the location of the Laundry, they would be fitted one each port and starboard, or both on the side not containing the Laundry.

Drainages would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use the 25 gallon collecting tank aft with its sump pump discharging forward to the influent surge tank.

(b) Gray water from spaces aft of Frame 124 would be pumped via a new small holding tank (approximate 25 gallons) and sump pump to the influent surge tank for off-loading.

(c) Gray water from spaces forward of Frame 124, including the laundry space, would gravitate to the influent surge tank.

Vessel: FIREBUSH (180')

WMS No. 6 Full Volume Flush Gravity Collection/Holding Tank for Black Water/Grumman Flow Through System with Sludge Holding Tank for Gray Water

	Required
G.T Influent Surge Tank	768 gal. (103 cu. ft.)
Sewage Holding Tank	7295 gal. (975 cu. ft.)
Sludge Holding Tank	1737 gal. (232 cu. ft.)
Optional Combined Sewage/ Sludge Holding Tank	9032 gal. (1207 cu. ft.)
Grumman Unit	Two (2)

Discussion

The system installation appears to be acceptable subject to certain limitations.

Equipment in and drainage systems to the Main Cargo Hold would be as follows:

On Lower Level

(a) The required sewage holding tank capacity would be provided via a tank the same configuration and location in the hatchway as in System No. 1.

(b) No G/T influent surge tank is possible to fit due to lack of space. Grumman MSD would have to function without it.

(c) Sewage from Officers' Toilet aft of Frame 124 would continue to be pumped forward for disposition via the sewage holding tank.

(d) Associated pumps would be located aft of the sewage holding tank.

On the 2nd Deck Level

(e) Gray water from spaces aft of Frame 124 and from the Laundry and nearby deck drains would have to be pumped to the Grumman MSD's via individual 25 gallon collecting tanks fitted with sump pumps.

(f) Other gray water would have to gravitate to the Grumman MSD feed tanks.

(g) All gray water would have to be off-loaded pierside via the sewage holding tank directly since no influent surge tank can be fitted.

(h) The Grumman MSD's would be located 1 each port and starboard in the aft part of the space, each with a sludge holding tank forward of it. Each sludge holding tank would be approximately 5' L x 5' W x 4'-9" H, representing one-half of the total tankage required.

The Laundry equipment may have to be moved to accommodate these tanks.

Vessel: FIREBUSH (180')

WMS No. 7 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Incinerator for Black Water/Holding Tank for Gray Water

	Required
Gray Water Holding Tank	20,843 gal. (2786 cu. ft.)
Sewage Influent Surge Tank	261 gal. (35 cu. ft.)
Fuel Oil Day Tank	25 gal. (3.3 cu. ft.)
Grumman Units	One (1)
Incinerator	One (1) Thiokol

Discussion

The system appears to be acceptable subject to certain limitations.

Equipment would be located in the Main Cargo Hold as follows:

On the Lower Level

(a) Sewage influent surge tank (approximate 3' L x 3' W x 4' H) on starboard side near shell, Frame 63-66.

(b) Gray water holding tank (approximate 12' L x 7' W fwd x 9'-6" aft x 8'-3" H) on the ship's centerline, Frames 47 to 59 (forward end of hold) within the hatchway, protruding slightly above the 2nd Deck level. Tank is limited to about 816 cu. ft. (6109 gallons) due to lack of space.

(c) Various associated pumps functionally arranged to port of the influent surge tank.

On the 2nd Deck Level

(a) Grumman MSD and its incinerator fuel tank on either port or starboard side whichever does not have the laundry located on it.

The incinerator stack could possibly be led to the weather in front of the house via the dry stores space on the port side. There appears to be no way to run the stack via the existing ship's stack enclosure.

Drainage would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use the 25 gallon collecting tank aft with its sump pump discharging forward to the sanitary influent surge tank.

(b) Gray water from spaces aft of Frame 124 would gravitate overboard and when not allowed to go overboard would be pumped via a new small holding tank (approximate 25 gallons) and sump pump to the G/T holding tank for off-loading.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard, and for pierside off-loading would be diverted to the G/T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with a small (approximate 25 gallons) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

Vessel: FIREBUSH (180')

WMS No. 8 Full Volume Flush Gravity Collection/Grumman Flow Through System with Sludge Incinerator for Combined Black and Gray Waters

	Required
Influent Surge Tank	1029 gal. (138 cu. ft.)
Fuel Oil Day Tank	25 gal. (3.3 cu. ft.)
Grumman Units	Two (2)
Incinerators	Two (2) Thiokol

Discussion

The system installation appears to be acceptable subject to certain limitations.

The system is very similar to System No. 5 except that an incinerator replaces the sludge holding tank.

The influent surge tank (approximate 5'-0" L x 5'-6" W x 5'-0" H) would be fitted at the forward end of the lower level of the Main Cargo Hold, on the ship's centerline.

The associated pumps would be located aft of the influent surge tank.

The Grumman MSD's with their incinerators and fuel oil day tank would be located on the 2nd deck level of the Main Cargo Hold, one each port and starboard. Possible interference with the Laundry will have to be checked.

Incinerator stacks could possibly be run similar to System No. 3. It appears impossible to run them via the existing ship's stack enclosure.

Drainage would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use the 25 gallon collecting tank aft with its sump pump discharging forward to the influent surge tank.

(b) Gray water from spaces aft of Frame 124 would be pumped via a new small holding tank (approximate 25 gallons) and sump pump to the influent surge tank for off-loading.

(c) Gray water from the spaces forward of Frame 124, including the laundry space, would gravitate to the influent surge tank.

Vessel: FIREBUSH (180')

WMS No. 9 JERED Reduced Volume Flush Vacuum Collection/Holding Tank for Concentrated Black Water/Holding Tank for Gray Water

	Required	
Vacuum Collection Tank	250 gal.	
Vacuum Collection Assembly		(165 cu. ft.)
Sanitary Holding Tank	2145 gal.	(287 cu. ft.)
Galley/Turbid Holding Tank	20843 gal.	(2786 cu. ft.)

Discussion

The system installation appears to be acceptable subject to certain limitations.

Reuse of existing piping arrangements would have to be considered. A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the Lower Level

(a) Sanitary holding tank (approximate 5' L x 8' W x 7'-6" H) in the hatchway, Frame 56-61 on ship's centerline.

(b) Galley/turbid holding tank (approximate 6' L x 7' W fwd x 8'-3" W aft x 8' H) in the hatchway, Frame 47-53 on ship's centerline. This tank is limited to 366 cu. ft. (2737 gal.) due to lack of more space.

(c) Pumps associated with tanks to be fitted aft of sanitary holding tank.

On the 2nd Deck Level

(a) Vacuum collection tank (approximate 6' L x 5' W x 5'-6" H) on either port or starboard side, wherever laundry is not located.

Drainages would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use a 25 gallon collecting tank aft, but it would discharge by vacuum forward to the vacuum collection tank.

Sewage from other spaces would be collected by vacuum in the vacuum collection tank.

(b) Gray water from spaces aft of Frame 124 would gravitate overboard and when not allowed to go overboard would be pumped via a new small holding tank (approximate 25 gallon) and sump pump to the G/T holding tank for off-loading.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G.T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with small (approximate 25 gallons) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

Vessel: FIREBUSH (180')

WMS No. 10 JERED Reduced Volume Flush Vacuum Collection/Incinerator for Concentrated Black Water/Holding Tank for Gray Water

	Required
Vacuum Collection Tank	250 gal.
Vacuum Collection Assembly	(165 cu. ft.)
Galley/Turbid Holding Tank	20843 gal. (2786 cu. ft.)
Fuel Oil Day Tank	50 gal. (6.7 cu. ft.)
Incinerator	One (1) Jered

Discussion

The system installation appears to be acceptable subject to certain limitations.

Reuse of existing piping arrangements would have to be considered. The system is similar to System No. 9 except that an incinerator replaces the sewage holding tank.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Galley/Turbid holding tank (approximate 14' L x 7' W fwd x 10' W aft x 8'-3" H) in the hatchway, on ship's centerline. This tank is limited to 975 cu. ft. (7295 gallons) due to lack of more space.

(b) Pumps associated with tanks to be fitted aft of G/T holding tank.

On the 2nd deck level

(a) Vacuum collection assembly (approximate 6' L x 5' W x 5'-6" H), port or starboard side, depending on where the laundry is not fitted.

(b) Incinerator (approximate 6'-5" L x 3' W x 5'-3" H) and fuel oil day tank, port or starboard side, just aft of the laundry, depending on where it is fitted.

The stack would be run to the weather similar to System No. 3 via the dry stores area and up the front of the house. It does not appear to be possible to run it inside the ship's stack.

Drainages would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use a 25 gallon collecting tank aft, but it would discharge by vacuum forward to the vacuum collection tank.

Sewage from other spaces would be collected by vacuum in the vacuum tank.

(b) Gray water from spaces aft of Frame 124 would gravitate overboard and when not allowed to go overboard would be pumped via a new small holding tank (approximate 25 gallons) and sump pump to the G/T holding tank for off-loading

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G/T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with small (approximate 25 gallons) collecting tank with sump pump for discharge overboard and to the G/T Holding tank.

Vessel: FIREBUSH (180')

WMS No. 11 JERED Reduced Volume Flush Vacuum Collection/GATX Evaporator for Concentrated Black Water/Holding Tank for Gray Water

	Required
Vacuum Collection Tank	250 gal.
Vacuum Collection Assembly	(165 cu. ft.)
Galley/Turbid Holding Tank	20,843 gal. (2786 cu. ft.)
Evaporator (GATX)	Two (2) - 80 gal.
Catalytic Oxidizer	One (1) large or Two (2) regular

Discussion

The system installation appears to be acceptable subject to certain limitations. Reuse of existing piping arrangements would have to be considered. The system is similar to System Nos. 9 and 10 except that the vacuum collection tank discharges to an evaporator.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Galley/Turbid Holding Tank (approximate 14' L x 7' W fwd x 10' W aft x 8'-3" H) in the hatchway, on ship's centerline. This tank is limited to 975 cu. ft. (7295 gallons) due to lack of more space.

(b) Pumps associated with tanks to be fitted aft of G/T holding tank.

On the 2nd Deck level

(a) Vacuum collection assembly (approximate 6' L x 5' W x 5'-6" H), port side aft of laundry (if fitted).

(b) Evaporators (approximate 3'-2" dia x 4'-2" high) and catalytic oxidizer(s) (6" dia x 18" high), starboard side.

Drainages would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use a 25 gallon collecting tank aft, but it would discharge by vacuum forward to the vacuum collection tank.

Sewage from other spaces would be collected by vacuum in the vacuum collection tank.

(b) Gray water from spaces aft of Frame 124 would gravitate overboard and when not allowed to go overboard would be pumped via a new small holding tank (Approximate 25 gallons) and sump pump to the G/T holding tank for off-loading.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G/T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with small (approximate 25 gallons) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

Vessel: FIREBUSH (180')

WMS No. 12 JERED Reduced Volume Flush Vacuum Collection/Holding Tank for Concentrated Black Water/Grumman Flow Through System with Sludge Holding Tank for Gray Water

	Required
G/T Influent Surge Tank	768 gal. (103 cu. ft.)
Sludge Holding Tank	1737 gal. (232 cu. ft.)
Sewage Vacuum Collection Tank	250 gal.
Vacuum Collection Tank Assembly	(165 cu. ft.)
Sewage Holding Tank	2145 gal. (287 cu. ft.)
Grumman Unit	Two (2)

Discussion

The system installation appears to be acceptable subject to certain limitations. Reuse of existing piping arrangements would have to be considered. The system is similar to System No. 9 except that the galley/turbid drains will go to a Grumman MSD instead of a holding tank.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Vacuum collection tank assembly (approximate 6' L x 5' W x 5'-6" H) Frames 61-66, approximately where present retention tank is fitted.

(b) Sewage Holding Tank (approximate 5' L x 8' W x 7'-6" H) on ship's centerline, in hatchway, Frames 54-59.

(c) Galley/turbid influent surge tank (approximate 3' L x 6' W x 5'-9" H), in hatchway, on ship's centerline, Frames 47-50.

(d) Various associated pumps between tanks and to port of the vacuum collection assembly.

On the 2nd Deck level

(a) The two Grumman MSD's, one each port and starboard, each with its sludge holding tank (approximate 5' L x 5' W x 4'-9" H) fitted forward of the MSD. The total required tankage would be fitted in halves this way, otherwise it would not be possible to locate.

(b) The laundry may have to be relocated.

Drainages would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use a 25 gallon collecting tank aft, but it would discharge by vacuum forward to the vacuum collection tank.

Sewage from other spaces would be collected by vacuum in the vacuum collection tank.

(b) Gray water from spaces aft of Frame 124 would be pumped via a new small holding tank (approximate 25 gallons) and sump pump to the G/T influent surge tank.

(c) Gray water from spaces forward of Frame 124, including the laundry space, would gravitate to the G/T influent surge tank.

Vessel: FIREBUSH (180')

WMS No. 13 JERED Reduced Volume Flush Vacuum Collection/Grumman Flow Through System for Gray Water/Incinerator for both Concentrated Black Water and Gray Water Sludge

	Required
Gray Water Surge Tank	768 gal. (103 cu. ft.)
Vacuum Collection Tank	250 gal.
Vacuum Collection Tank Assembly	(165 cu. ft.)
Fuel Oil Day Tank	94 gal. (12.5 cu. ft.)
Grumman Unit	One (1)
Incinerator	Three (3) Thiokol

Discussion

The system installation appears to be acceptable subject to certain limitations. Reuse of the existing piping arrangements would have to be considered.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Vacuum collection assembly (approximate 6' L x 5' W x 5'-6" H) in hatchway, on ships centerline, Frames 55-61.

(b) Galley/turbid influent surge tank (approximate 5' L x 5' W x 4'-3" H) in hatchway, on ship's centerline, Frames 47-52.

(c) Various pumps associated with the equipment, located where present overboard pumps are fitted.

On the 2nd Deck level

(a) Grumman MSD with incinerator, located just aft of laundry (port or starboard as applicable). Laundry location may have to be modified.

(b) Two separate incinerators with sludge tanks, blowers, and fuel oil day tanks, located on side opposite grumman MSD.

Incinerator ------	4'-1" L x 1'-9" W x 3'-4" H
Blower ----------	3'-0" L x 1'-10" W x 2'-0" H
Sludge Tank - - --	2'-6" L x 1'-0" W x 2'-7" H

Stack runs (3) would offer a problem but would be checked for run similar to System No. 3. It appears inpossible to run them via the existing ship's stack enclosure.

Drainages would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use a 25 gallon collecting tank aft, but it would discharge by vacuum forward to the vacuum collection tank.

Sewage from other spaces would be collected by vacuum in the vacuum collection tank.

(b) Gray water from spaces aft of Frame 124 would be pumped via a new small holding tank (approximate 25 gallons) and sump pump to the G/T influent surge tank.

(c) Gray water from spaces forward of Frame 124, including the laundry space, would gravitate to the G/T influent surge tank.

Vessel: FIREBUSH (180')

WMS No. 14 GATX Reduced Volume Flush M/T Pump Collection/Holding Tank for Concentrated Black Water/Holding Tank for Gray Water

	Required
Sewage Holding Tank	2345 gal. (313 cu. ft.)
Galley/Turbid Holding Tank	20,843 gal. (2786 cu. ft.)

Discussion

The sytem installation appears to be acceptable subject to certain limitations.

A fresh water sanitary flushing system would be required.

Equipment would be located on the lower level of the Main Cargo Hold as follows:

(a) Sewage holding tank (approximate 5' L x 9' W fwd x 10' W aft x 6'-9" H) on ship's centerline, in hatchway, Frames 56-61.

(b) Galley/turbid holding tank (approximate 6' L x 7' W fwd x 8' W aft x 7'-9" H) on ship's centerline, in hatchway.

This tank is limited to 360 cu. ft. (2693 gallons) due to lack of space.

(c) Various pumps associated with the tanks would be located aft of sewage holding tank, approximate Frames 62-68.

Drainages would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use the 25 gallon collecting tank aft with its sump pump discharging forward to the sewage holding tank.

Sewage from other spaces would be collected in the sewage holding tank via macerator/transfer pumps.

(b) Gray water from spaces aft of Frame 124 would gravitate overboard and when not allowed to go overboard would be pumped via a new small holding tank (approximate 25 gallons) and sump pump to the G/T holding tank for off-loading.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G/T holding tank.

(c) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with a small (approximate 25 gallons) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

Vessel: FIREBUSH (180')

WMS No. 15 GATX Reduced Volume Flush M/T Pump Collection/Incinerator for Concentrated Black Water/Holding Tank for Gray Water

	Required
Incinerator Feed Tank	100 gal. (13 cu. ft.)
Galley/Turbid Holding Tank	20,843 gal. (2786 cu. ft.)
Fuel Oil Day Tank	50 gal. (6.7 cu. ft.)
Incinerator	One (1) Jered

Discussion

The system installation appears to be acceptable subject to certain limitations.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Galley/turbid holding tank (approximate 14' L x 7' W fwd x 10' W aft x 8'-3" H), in hatchway, on ship's centerline, Frames 47-61. This tank is limited to 975 cu. ft. (7295 gal.) due to lack of space.

(b) G/T overboard discharge pump, aft of G/T holding tank

On 2nd Deck Level

(a) Jered incinerator (approximate 6'-5" L x 3'-0" W x 5'-3" H), with feed pump (approximate 2'-6" L x 9" W x 1'-4" H), blower and fuel oil day tank (approximate 2' L x 2' W x 1'-9" H).

(b) Incinerator feed tank (approximate 2'-6" L x 2'-6" W x 2'-6" H) in vicinity of incinerator.

(c) Incinerator feed tank overboard pump near feed tank.

(d) The incinerator stack would be run to the weather via the dry stores area and up the house front. There is no apparent way to run it via the ship's stack.

Drainages would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use the 25 gallon collecting tank aft with its sump pump discharging forward to the incinerator feed tank.

Sewage from other spaces would be collected in the incinerator feed tank via incinerator transfer pumps.

(b) Gray water from spaces aft of Frame 124 would gravitate overboard and when not allowed to go overboard would be pumped via a new small holding tank (approximate 25 gallons) and sump pump to the G/T holding tank for off-loading.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G/T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with a small (approximate 25 gallons) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

Vessel: FIREBUSH (180')

WMS No. 16 GATX Reduced Volume Flush M/T Pump Collection/GATX Evaporator for Concentrated Black Water/Holding Tank for Gray Water

	Required
Galley/Turbid Holding Tank	20,843 gal. (2786 cu. ft.)
Evaporator Feed Tank	100 gal.
Evaporator (GATX)	Two (2) - 80 gal.
Catalytic Oxidizer	One (1) large or Two (2) regular

Discussion

The system installation appears to be acceptable subject to certain limitations.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Galley/turbid holding tank (approximate 14' L x 7' W fwd x 10' W aft x 8'-3" H), in hatchway, on ship's centerline, Frames 47-61. This tank is limited to 975 cu. ft. (7295 gallons) due to lack of space.

(b) G/T overboard discharge pumps, aft of G/T holding tank

On 2nd Deck level

(a) GATX Evaporators (2), (approximate 3'-2" dia x 4'-2" high) and catalytic oxidizer(s) (6" dia x 18" high), stbd side.

(b) Evaporator feed tank (approximate 2'-6" L x 2'-6" W x 2'-6" H) and feed pump(s) (2'-6" L x 0'-9" W x 1'4" H) near evaporators.

(c) Evaporator feed tank overboard pump, near the tank

Drainages would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use the 25 gallon collecting tank aft with its sump pump discharging forward to the evaporator feed tank.

Sewage from other spaces would be collected in the evaporator feed tank via macerator/transfer pumps.

(b) Gray water from spaces aft of Frame 124 would gravitate overboard and when not allowed to go overboard would be pumped via a new small holding tank (approximate 25 gallons) and sump pump to the G/T holding tank for off-loading.

(c) Except for the laundry space, gray water from spaces forward of Frame 124 would gravitate overboard and for pierside off-loading would be diverted to the G/T holding tank.

(d) The laundry and nearby deck drains cannot gravitate overboard (being below the waterline) and would have to be fitted with a small (approximate 25 gallons) collecting tank with sump pump for discharge overboard and to the G/T holding tank.

Vessel: FIREBUSH (180')

WMS No. 17 GATX Reduced Volume Flush M/T Pump Collection/Holding Tank for Concentrated Black Water/Grumman Flow Through System with Sludge Holding Tank for Gray Water

	Required
Sewage Holding Tank	2345 gal. (313 cu. ft.)
Galley/Turbid Influent Surge Tank	768 gal. (103 cu. ft.)
Sludge Holding Tank	1737 gal. (232 cu. ft.)
Grumman Unit	Two (2)

Discussion

The system installation appears to be acceptable subject to certain limitations.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Sewage holding tank (approximate 5' L x 9' W fwd x 10' W aft x 6'-9" H), on ship's centerline, in hatchway, Frames 56-61.

(b) Galley/Turbid influent surge tank (approximate 3' L x 6' W x 5'-9" H) just fwd of sewage holding tank, Frames 47-50.

(c) Various associated pumps - sewage overboard (2) Frame 63-65 port, G/T influent surge tank pump (to sewage holding tank) and surge tank pumps (2) (to Grumman feed tank), all located between tanks Frames 50-56.

On the 2nd Deck level

(a) Grumman MSDs 1 each port and starboard. Laundry location should be checked for interference.

(b) Sludge holding tanks (2) each half capacity (approximate 5' L x 5' W x 4'-9" H), are located forward of each Grumman MSD.

Drainages would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use the 25 gallon collecting tank aft with its sump pump discharging forward to the sewage holding tank.

Sewage from other spaces would be collected in the sewage holding tank via macerator/transfer pumps.

(b) Gray water from spaces aft of Frame 124 would be pumped via a new small holding tank (approximate 25 gallons) and sump pump to the influent surge tank.

(c) Gray water from spaces forward of Frame 124, including the laundry space, would gravitate to the influent surge tank.

Vessel: FIREBUSH (180')

WMS No. 18 GATX Reduced Volume Flush M/T Pump Collection/Grumman Flow Through System for Gray Water/Incinerator for both Concentrated Black Water and Gray Water Sludge

	Required
Black Water Surge Tank	101 gal. (13.5 cu. ft.)
Gray Water Surge Tank	768 gal. (103 cu. ft.)
Fuel Oil Day Tank	94 gal. (12.5 cu. ft.)
Grumman Unit	One (1)
Incinerator	Three (3) Thiokol

Discussion

The system installation appears to be acceptable subject to certain limitations.

A fresh water sanitary flushing system would be required.

Equipment would be located in the Main Cargo Hold as follows:

On the lower level

(a) Black water surge tank (approximate 2'-6" L x 2'-6" W x 2'-3" H) on ship's centerline, Frames 48-50 1/2.

(b) Gray water surge tank (approximate 5' L x 5' W x 4'-3" H), on ship's centerline, Frames 56-61.

(c) Various associated pumps:

sewage overboard - Frames 63-65 port
solids handling (sewage to sludge feed tank)- Frames 51-56
G/T overboard - Frames 63-65
G/T surge tank to Grumman MSD-Frames 51-56

On the 2nd Deck level

(a) Grumman MSD with incinerator, port side aft of the laundry, similar to System No. 12.

(b) Thiokol incinerators (2) with blowers, sludge tanks, sludge feed pumps, fuel oil day tank (2'-6" L x 2'-6" W x 2'-0" H) on the starboard side similar to System No. 13.

(c) Three (3) incinerator stacks would have to be run to the weather similar to System No. 13. This may offer a problem.

Drainages would be as follows:

(a) Sewage from Officers' Toilet aft of Frame 124 would continue to use the 25 gallon collecting tank aft with its sump pump discharging forward to the black water surge tank.

Sewage from other spaces would be collected in the black water surge tank via macerator /transfer pumps.

(b) Gray water from spaces aft of Frame 124 would be pumped via a new small holding tank (approximate 25 gallons) and sump pump to the gray water surge tank.

(c) Gray water from spaces forward of Frame 124, including the laundry space, would gravitate to the gray water surge tank.

* U.S.G.P.O. 727-099/1302-1665