October 1978

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Feasibility Study On Development Of An Economical System For Cleaning Dry Docks Prior To Flooding

U.S. Department of Commerce
Maritime Administration

in cooperation with
Avondale Shipyards Inc.
New Orleans, Louisiana

Report Documentation Page

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FOREWORD

This is a report of the research project "Feasibility Study on Development of an Economical System for Cleaning Drydocks Prior to Flooding".

Our technical approach to this project fulfilled the stated objectives of the National Shipbuilding Research Program as established under the Merchant Marine Act of 1970. The project is one of a number of such projects being managed and cost shared by Avondale Shipyards, Inc. as part of the National Shipbuilding Research Program. The program is a cooperative effort between the Maritime Administrations's Office of Advanced Ship Development and the United States Shipbuilding Industry. The objectives described by the Ship Production Committee of the Society of Naval Architects and Marine Engineers places emphasis of cost effective producibility.

EXECUTIVE SUMMARY

The primary objective of this project was to determine effective and economical means of cleaning drydocks, prior to flooding, to satisfy EPA criteria.

The environmental protection agency has been considering enforcing regulations requiring broom cleaning of drydock floors and had considered imposing vacuum cleaning by 1983.

Utilizing broom clean as EPA's criteria, two crucial factors of dry docking operations would be effected; time and manhours.

The time required to obtain broom clean conditions prior to flooding the dock would impact scheduled dockings, emergency docking and contract negotiations. Dry docks operating in areas effected by tidal action could experience delayed docking operation from twelve (12) to fifteen (15) hours.

The manhours required to obtain broom clean conditions prior to flooding the dock would impact the cost of docking operation which would be a negative influence during contract negotiations.

The combined impact of time and manhours required to comply with EPA's proposed broom clean criteria determined two objectives of this project:

- EPA's enforcement of the proposed broom clean regulation would jeopardize the industry's ability to be competitive!

- The equipment design criteria was determined utilizing the proposed broom clean regulation as the requirement. A machine or combination of machines should be developed to reduce the cost of removal of residue material from drydock floors. The equipment should be of a design to reduce manhours per ton of media removed, also increase tons per hour removed.

EPA was preparing to issue final regulations in March 1977. By July 1, 1977 EPA would be enforcing the broom clean criteria.

Considering EPA's time table and the potential economical impact to the shipbuilding and repair industry, this project was re-scoped early in 1977. Our efforts were directed toward obtaining effluent guideline regulations for the shipbuilding and repair industry. The criteria being best management practices in lieu of numerical limitation and broom clean. This would allow the industry to comply to the regulation in a competitive posture.

Our efforts during the past fifteen (15) months produced the following results:

- The U. S. Environmental Protection Agency was provided with the technical data (Industry Consensus) to issue a more reasonable draft development document for the Shipbuilding and Repair Industry: Drydocks Point Source Category, dated December 1977.

- The U. S. Environmental Protection Agency was provided with the technical data to establish best management practices rather than broom clean and amended Sec. 50 and 51, Section 304 of the Federal Water Control Act.

- Established a continuing working relationship for industries input for the finalization and issuance of final guideline regulations and the development of economic impact statements.

The shipbuilding and repair industry is in business for the purpose of making a profit. EPA has been charged with the responsibility of promulgating regulation and enforcement of those regulations to assure pollution abatement. EPA and the shipbuilding and repair industry must work together to assure economic impact will not jeopardize the industries ability to be competitive in the world market.

I N D E X

SECTION I

BACKGROUND

I. BACKGROUND

A. ACTIVITIES CARRIED OUT AT SHIPYARD FACILITIES

The shipbuilding and repair industry is engaged in the construction of new ships and barges, and the conversion, alteration and repair of foreign and domestic ships. These activities encompass a broad range of functions, such as: Erection of Structural Steel Frameworks; Installation of Steel Plates to the Framework and/or Erection of Prefabricated hull sections; Surface preparation and the application of paint systems to the hull; Installation of a variety of mechanical, electrical and hydraulic equipment within the structure; Repair of damaged vessels; Replacement of paint coatings; Converting vessels; Restoration of malfunctioning equipment and systems to operational condition.

Typical of the trade skills involved in this industry are: Shipfitters; Welders and burners; Machinists, Electricians and electronic technicians; Pipefitters; Carpenters; Pattern makers; Painters; Riggers; Laborers; Blacksmiths and foundry men.

Not all of the listed activities, functions or trade skills are utilized at every facility. Some of the functions require placing the ship into drydock, replacing underwater paint coatings. Only those facilities providing drydock capabilities are covered in this report.

B. GRAVING DOCK DESCRIPTION

Graving docks are constructed with sides and a bottom and with a gate at the water end. The bottom is located below the adjacent water surface level with sufficient depth to allow floating of a vessel into the dock. Operations consist of positioning keel blocks on the bottom of the dock to match the keel surface of the ship, flooding the dock by opening valves, opening the gates, positioning the vessel over the keel blocks, closing the gates) and pumping the water out of the graving dock. During maintenance operations, the graving dock is kept dry by sump or stripping pumps which remove fluids and water by providing suction through drains located at low points in the dock. After completing operations on the vessel, the dock is flooded, the gates are opened, and the vessel is floated out of the dock. The gates to the graving dock are closed and the water is pumped out to make preparations for receiving another vessel, or if identical vessels are being maintained, the next vessel is moved into the dock prior to removing the water.

Graving docks are usually constructed of concrete although they may occasionally be of timber or steel sheetpile cell construction. Figure I-1 illustrates typical cross section and plan views of a concrete graving dock and includes the designations of drydock features.

Graving docks have two dewatering systems. The collector channel, a wide deep grating covered open culvert leading to the pump suction chamber, handles the greater portion of water pumped out of the flooded graving dock. Abrasive materials harmful to pumps and pump fittings are moved off a graving dock floor in sufficient quantities to prevent damage.

The main dewatering system of a drydock usually includes: (1) The suction inlet located within the dock chambers (2) The suction passage and/or culvert; (3) Pump suction chamber; (4) Pump suction bells; (5) Pumps; (6) Discharge; check and gate valves; (7) discharge culvert, including backwash trash rack, and (8) Hinged stop gate. Where pumping plants are designed to remove water from more than one dock, additional sluice gates are required to permit independent pumping of the docks. At least two main dewatering pumps are usually required to achieve reasonable dewatering times.

A secondary system collects the last few inches **of** water blanketing the graving dock floor. This system has sloping longitudinal floor drain culverts near the side walls which lead to collector channels at pump wells. The culverts may have rectangular cross sectional areas of several square feet.

They are covered, securely anchored, strong gratings. Drainage and/or sump pumps of lesser capacity than the main dewatering pumps are provided to remove seepage, precipitation, caisson and valve leakage) and wash water, and to clear the dewatering pump suction chamber and drainage system.

Ships ***in*** graving docks **do** not ordinarily fill all their own requirements for mechanical services essential for work, habitation, comfort and protection.

Some services, particularly those required for repairs and cleaning associated with the docking operations, must be supplied from dockside facilities. Such services include steam) compressed air, water systems for tank cleaning, and oxygen and acetylene for welding. Utility services are provided to ships in drydocks by lines from service galleries located around the upper perimeters of the dock.

Means must be provided to keep a docked vessel far enough above the floor to permit work on its keel, giving proper allowance for removal ***or*** installation of sonar domes, rudders, propellers, and similar parts. Blocking arrangements are laid out in the dock in accordance with the docking plan for each individual vessel. Keel blocks are placed under the longitudinal centerline keel of the vessel. Bilge or slide blocks are located according to dimensions indicated in the table of offsets on the vessel's docking plan, which indicate the location of bulkheads and frames or stiffeners.

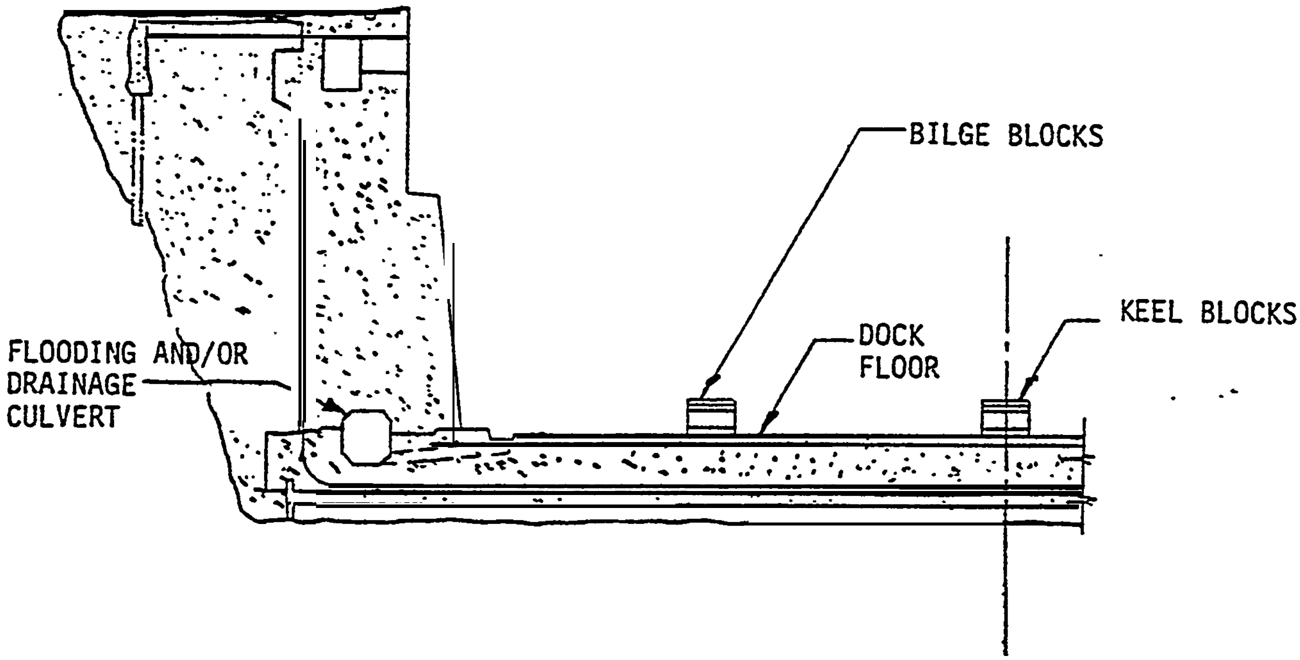
The following fittings are part of most graving dock installations: Capstans; bollards; cleats; ring bolts; eye bolts; stairways; ladders; manhole access; railings; marking plates; fenders and chafing strips. In addition, such supporting facilities as industrial shops, transportation facilities, weight and material handling equipment, personnel and storage facilities are normally located in close proximity in drydocks.

C. FLOATING DRYDOCK DESCRIPTION

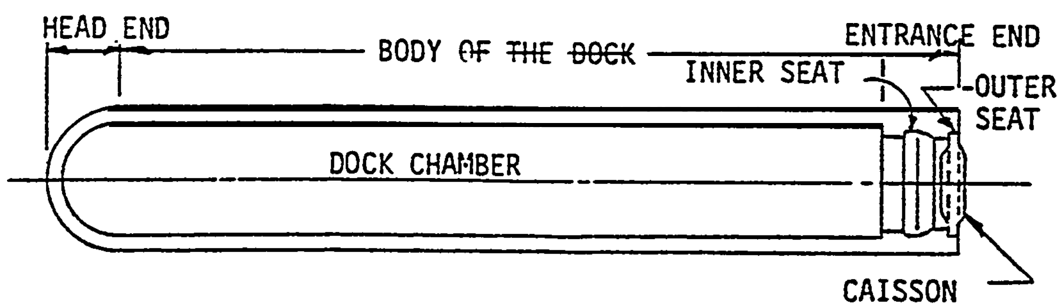
As implied by its name, a floating drydock floats on the water with the bottom of the drydocked vessel above the water surface. The floating drydock is a non-self-propelled mobile structure which can be relocated. The floating drydock consists of a plafform and associated ballast tanks used to raise ships above the water level for work which requires exposure of the entire hull. Ballast tanks are flooded and the dock platform is submerged to a predetermined level beneath the water's surface. A ship is then moved over the dock and positioned over keel blocks on the floor of the dock platform. This position is maintained as the ballast tanks are dewatered. Dewatering the ballast tanks lift the ship and drydock platform floor above the surface of the water.

Many different types of floating drydocks have been developed. The specific characteristic of the various types differ considerably as a result of the different requirements dictated from considerations of technical, operational or strategic nature. However, the basic general features and the related terminology are, more or less, the seine for all types of docks .

Figure I-2 illustrates the various parts of a typical floating drydock.
Figure I-3 shows a typical floating dock with and without a ship.



CROSS SECTION



PLAN

Figure I-1 Typical Graving Dock

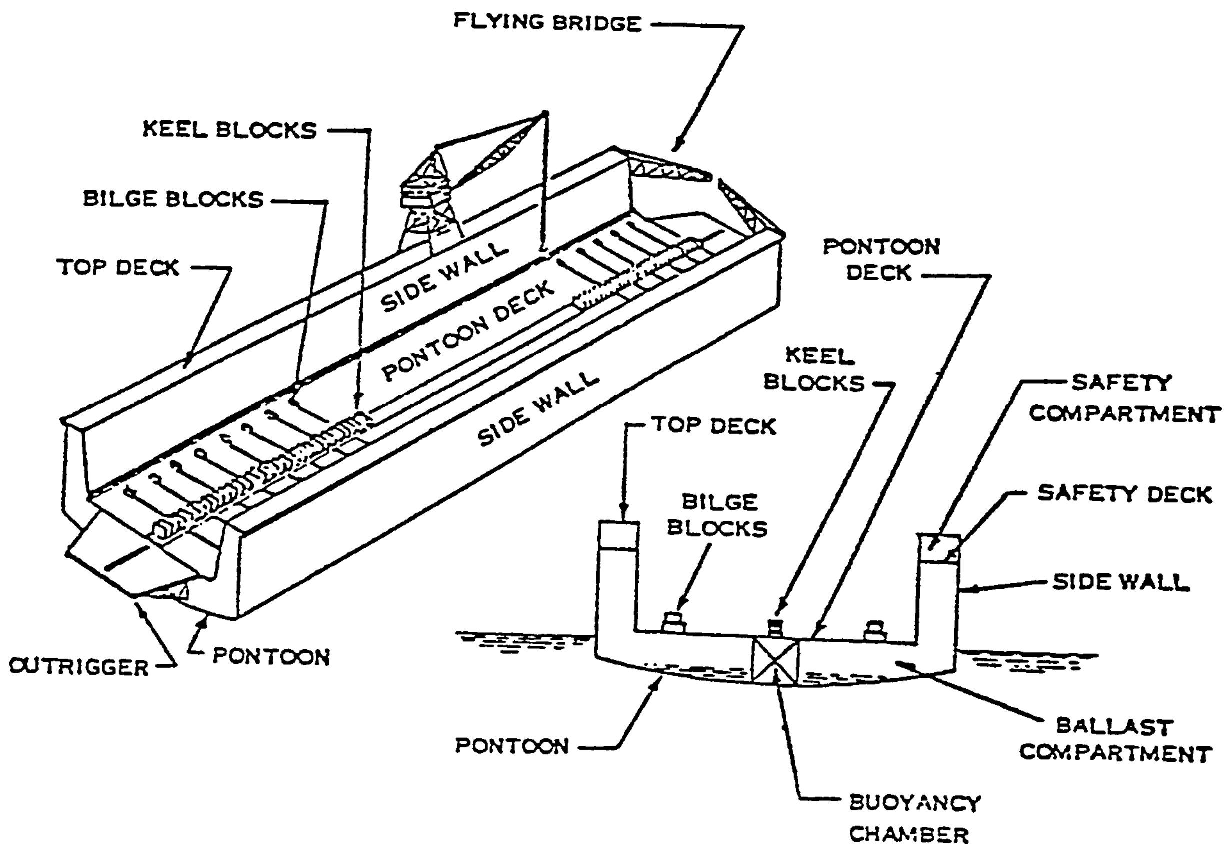


Figure I-2 Typical Floating Drydock

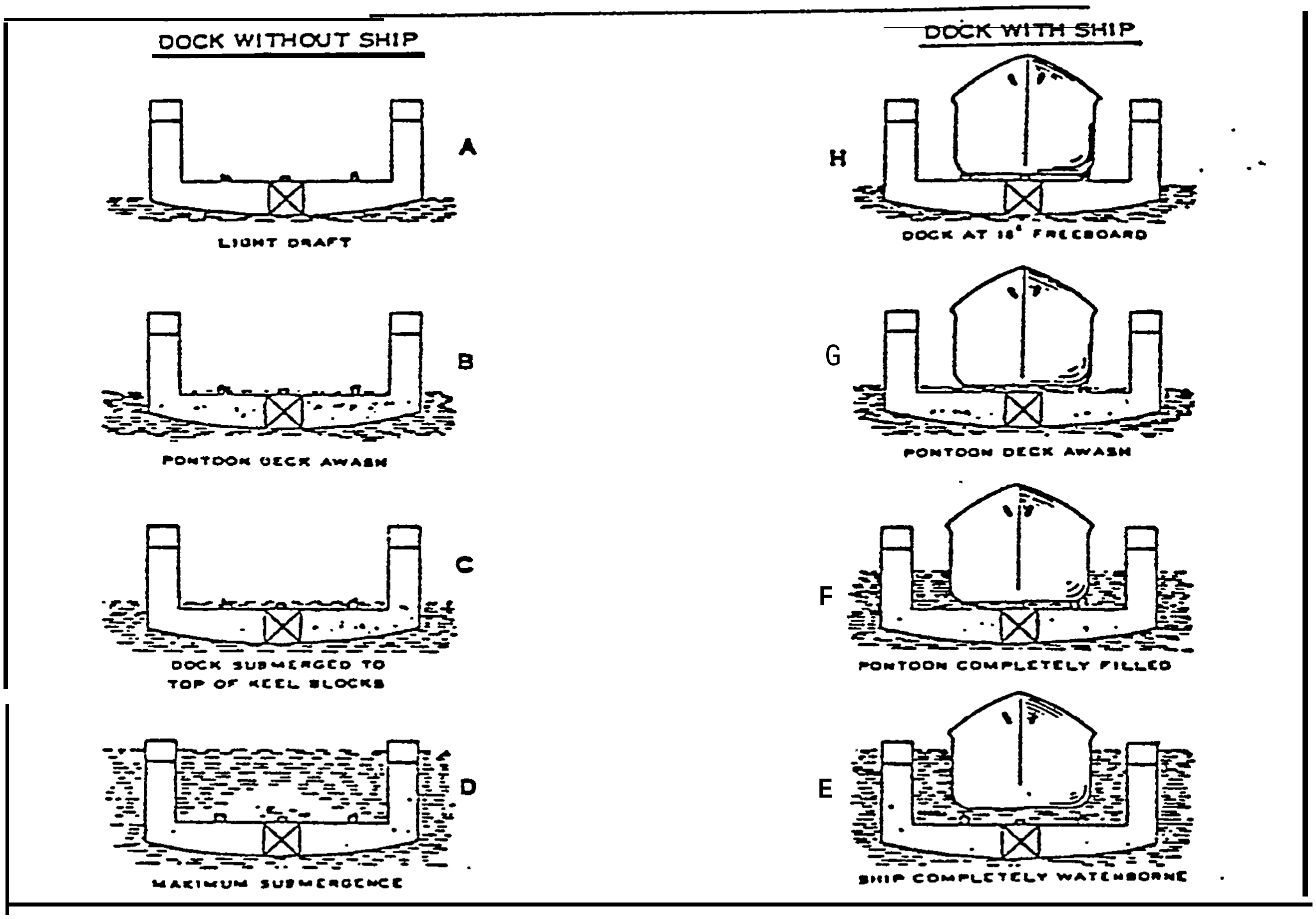


Figure I-3 Typical Floating Drydock With and Without a Ship

SECTION II

SOURCE OF RESIDUE MATERIAL

II. SOURCE OF RESIDUE MATERIAL

A. SHIPYARD PRACTICES

This section is limited to discussion of those operations normally or most frequently performed in drydocks which produce the residue material that must be removed at some point in time in order to continue efficient utilization of the drydock.

The basic functions of a drydock are the repair and installation, cleaning and painting of ship's bottoms, propellers, rudders and the external parts below the water line.

Drydocks provide access to the ship's bottom and utility service for shipyard personnel use. Service such as gas, electrician, steam, compressed air, fresh water, and fire water is supplied to the ship in drydocks from lines attached to or embedded in the drydock. Processes involved in drydocking include: docking, undocking, tank cleaning, abrasive and chemical paint removal, painting and mechanical repair of various ship parts. Mechanical repairs of machinery, welding, cutting of plates and alterations of a ship's structure are other functions performed in drydocks.

Tank cleaning operations remove dirt and sludge from fuel tanks, cargo tanks and bilges on the ship. Workmen spray detergents or hot water into the empty tanks by injecting cleaners into the steam supply hoses. Spent wash water in the tanks is pumped by machines, which are combination pump and storage tank units, into tank trucks or barges for subsequent disposal.

The almost universally perferred method of preparing steel surface for application of a fresh paint system for salt water immersion is dry abrasive blasting. Dry abrasive blasting is a process by which the blasting abrasive is conveyed in a medium of high pressure air through a hand held nozzle. This type of blasting produces the highest relative amount of dust and resulting residues are dry. Dry blasting is used for virtually all tank interior work and extensively on exterior hull work.

With the exception of closed cycle blast machines, which are being evaluated by the industry, all blasting presently carried out within drydocks is done manually. Three manual blasting methods are used within drydocks and the characteristics of debris produced by each method are different.

There are two techniques in use for dry abrasive blasting. The first generally known as “sand sweep” is frequently used on commercial vessels to remove marine growth, fouling and delaminating coatings only in preparation for refurbishment or renewal of paint systems. The second removes marine growth, fouling and all paint down to “white metal” and abrades the metal substrate to provide a suitable surface for application of a complete fresh coating system.

Two other manual blasting methods are water blasting and water blasting with abrasive injection.

Light water blasting (a water sweep) is used to remove loose, flaking or failed paint and marine growth in preparation for refurbishing paint systems.

Table II-1 describes the type of abrasives used and constituents of those abrasives.

Table II-2 describes the composition of formula paints.

B. During the surface preparation operation spent abrasive, paint particles, marine growth and other debris fall to the dock floor. The debris from the sandblast operation is picked up by scoop tractors, hand shovels, and/or vacuum systems for transfer to hoppers. In some yards, spent abrasive is reclaimed and reused, but abrasive contaminated with antifouling paint is discarded in designated landfill areas.

C. Scrap metal, wood and plastic, miscellaneous trash, such as paper and glass, industrial scrap and waste, such as insulation, welding rods, packing, etc. are another type of residue material produced during the operation on vessels in drydock.

TABLE II-1 CONSTITUENTS OF ABRASIVE BLAST MATERIAL

ABRASIVES	CONSTITUENTS % BY WEIGHT (See Note)														
	Iron Oxide	Calcium Oxide	Potassium Oxide	Aluminum Oxide	Magnesium Oxide	Sodium Oxide	Combined Silicon Dioxide	Copper	Chromic Oxide	Titanium	Manganese	Zinc Oxide	Free Silica	Sulfur	Other
BLACK DIAMOND	28	6.14		21	1.1		43			.95	.04			.15	.17
BLACK BEAUTY	35	4	2	23	1	1	34								
KLEEN BLAST	19	19		9	2.9		48	.1			.22				
GREEN DIAMOND	23	.6		1	23	.05	52		.04				.3	.01	
ROCK-WOOL SLAG	16	26	2	9	3	1	39	.2	.5			4			

NOTE: TOTALS MAY NOT EQUAL 100 DUE TO ROUNDING OFF. SINCE PERCENTAGES VARY BETWEEN LOTS, THESE VALUES ARE APPROXIMATIONS.

Table II-2 COMPOSITIONS OF FORMULA PAINTS

Formula No.	Mil. Spec. No.	Composition	lb/100 gal	gal/100 gal
117 Anti-corrosion	Mil.P-15328	Polyvinyl-butyral resin	56	6.10
		Zinc Chromate	54	1.59
		Magnesium silicate	8	0.35
		Lampblack	0.6	0.04
		Butyl Alcohol	125	18.40
		Ethyl Alcohol	482	70.70
		Phosphoric Acid		2.0
		Water	25	3.0
119 Anti-corrosion	Mil.P-15929	Re Lead	220	
		Vinyl Resin	145	12.8
		vinyl chloride		
		vinyl alcohol		
		vinyl acetate		
		Tricresyl Phosphate		
		Methyl Isobutyl Ketone	295	43.8
		Toluene	295	40.0
121 Anti-fouling	Mil.P-15931	Cuprous Oxide	1440	27.40
		Rosin	215	23.07
		Vinyl resin	55	4.69
		Tricresyl phosphate		4.92
		Methyl Isobutyl Ketone	165	23.88
		Xylene	115	15.42
		Anti-settling agent	5 to 9	0.62
129 Anti-fouling	Mil. P-16169	Cuprous Oxide	1120	21.62
		Lampblack		4.50
		Rosin	185	19.83
		Vinyl resin	45	3.84
		Tricresyl phosphate		3.93
		Methyl Isobutyl ketone	200	28.92
		Xylene	130	17.42
		Antisettling agency	5 to 9	0.64
1830	Mil.P-24441	Thixatrope	l0 to 20	
1029		Polyanide		
1827		Polyamide adduct	280 to 320	
150		Magnesium silicate	250 to 600	
151		Titanium dioxide	5 to 600	
152		Butyl alcohol	253 to 304	
153		Copper phthalocyanine blue	0 to l	
154		Yellow Iron oxide	0 to 500	

Table II-2 (cont.)

Formula No.	Mil. Spec. No.	COMPOSITION	lb/100 gal	gal/100 gal
155		Red iron oxide	0 to 300	
		Epoxy resin	500to 586	
		Haptha	215 to 258	
Anti-corrosive		Oiatomaceous silica	0 to 150	
		Lampblack	0 to 18	
102OA		Vinyl resin	1 b	16.1
Anti-fouling		bis (Tributyltin) oxide	38.3	
		Tributyltin Fluoride	167	16.1
		Carbon black	19.4	1.3
		Titanium Dioxide	7.2	0.2
		Ethylene glycol meno thyl other acetate		
		Normal prepanol	102	15.1
		Normal butyl acetate	400	54.8

DATA SHEET

A. GENERAL DATA

Paint Formula	
Trade Name	Bitoxy Aluminum
U. S. Reference	4456/4459 Aluminum
World Wide Reference	F.5Base/F.10
Type	Coal tar Epoxy
Manufacturer's Name	International Red Hand
Address	3915 Louisa Street New Orleans, La. 70126
Telephone for Emergency	
a. % solids by volume	68%
b. Net weight per U.S. gallon	10.48 Lbs.
c. Coverage theor. sq. ft./gal.	156

B. SOLVENT COMPOSITION

Solvent Component	e Spec. Gr. lbs./gal.	f % Solvent by Weight	g=e x f / 100 Contribution to Spec. Gr.	l=f x b / 100 Content lbs./gal.	n=l x 100 / e % Solvent by Volume
Cellosolve	7.24	15.04	1.088	1.576	21.17
M-butyl					
Xylene					
Phenyl					
Ethyl - enodiamine					
Ketamine Curing Agent					
Mineral Spirits					
Benzene					
Pentoxour	7.59	5.0	.37	.795	6.90
Solvent Calculations	j=H x 100 / i 7.27	i= Σ f 20.04	h= Σ g 1.458	m= Σ l 2.371	o= Σ n 28.07

DATA SHEET

A. GENERAL DATA

Paint Formula	
Trade Name	Bitoxy Black
U. S. Reference	4454
World Wide Reference	F.6/F.10
Type	Coal Tar Epoxy
Manufacturer's Name	International Red Hand
Address	3915 Louisa Street New Orleans, La. 70126
Telephone for Emergency	
a. % solids by volume	68%
b. Net weight per U.S. gallon	10.48 lbs.
c. Coverage theor. sq. ft./gal.	156

B. SOLVENT COMPOSITION

Sol vent Component	e Spec. Gr. lbs./gal.	% Solvent by Weight	g=e x f / 100 Contribu-tion to Spec. Gr.	l=f x b / 100 Content lbs./gal.	n=lx100 / e % Solvent by Volume
Cellosolve	11.6	7.79	.903	.816	15.61
M-butyl					
Xylene	28.8	7.24	2.085	.758	41.68
Phenyl					
Ethyl -. enodiamine					
Ketamine Curing Agent					
Mineral Spirits					
Benzene					
Sol vent Calculations	j=H x 100 / i 40.4	i= Σ f 15.03	h= Σ g 2.988	m= Σ l 1.574	o= Σn 57.29

DATA SHEET

A. GENERAL DATA

Paint Formula	
Trade Name	Bitoxy Red
U. S. Reference	4455-
World Wide Reference	F.6/F.l0
Type	Coal Tar Epoxy
Manufacturer's Name	International Red Hand
Address	3915 Louisa Street New Orleans, La. 70126
Telephone for Emergency	
a. %solids by volume	68%
b. Net weight per U.S. gallon	10.48 lbs
c. Coverage theor. sq. ft./gal.	156

B. SOLVENT COMPOSITION

Solvent Component	e Spec. Gr. lbs./gal.	f % Solvent by Weight	g=e x f / 100 Contribution to Spec. Gr.	l=f x b / 100 Content lbs./gal.	n=lx100 / e % Solvent by Volume
Cellosolve	7.79	3.75	.292	.816	5.42
M-butyl	6.75	4.45	.300	.707	6.91
Xylene	7.24	6.87	.497	.719	9.94
Phenyl					
Ethyl-enodiamine					
Ketamine Curing Agent					
Mineral Spirits					
Benzene					
Methyl Izobutyl ueton	6.68	3.62	.241	.379	5.67
Solvent Calculations	j=H x 100 / i 7.11	i= Σ f 18.69	h= Σ g 1.33	m= Σ l 2.621	o= Σ n 27.94

DATA SHEET

A. GENERAL DATA

Paint Formula	
Trade Name	Intergand Tank Coating
U. S. Reference	4400/4423 Series
World Wide Reference	ARH Series
Type	Epoxy
Manufacturer's Name	International Paint Co. Red Hand
Address	3915 Louisa Street. New Orleans, La. 70126
Telephone for Emergency	
a. % solids by volume	92.5
b. Net weight per U.S. gallon	11.6 lbs
c. Coverage theor. sq. ft./gal.	371

B. SOLVENT COMPOSITION

Solvent Component	e Spec. Gr. lbs./gal.	f % Solvent by Weight	g=e x f / 100 Contribution to Spec. Gr.	l=f x b / 100 Content lbs./gal.	n=l x 100 / e % Solvent by Volume
Cellosolve	7.79	.88	.00686	.102	1.31
M-butyl	6.75	.44	.0297	.051	.56
Xylene	7.24	.32	.0253	.037	.76
Phenyl	8.90	2.20	.1958	.255	2.90
Ethyl-enodiamine	8.80	.35	.0308	.041	.46
Ketamine Curing Agent	7.1	11.41	.9128	1.323	18.63
Mineral Spirits-	6.5	.55	.0358	.4182	.89
Benzene					
Solvent Calculations	j=H x 100 / i 7.65	i= Σ f 16.15	h= Σ g 1.237	m= Σ l 2.23	o= Σ n 25.51

DATA SHEET

A. GENERAL DATA

Paint Formula	
Trade Name	Catalyzed Epoxy
U. S. Reference	165 - 150 Butyl Alhshel
World Wide Reference	
Type	
Manufacturer's Name	
Address	
Telephone for Emergency	

a. %solids by volume
b. Net weightier U.S. gallon
c. Coverage theor. sq. ft./gal.

B. SOLVENT COMPOSITION

Solvent Component	Spec. Gr. lbs./gal.	% Solvent by Weight	$g = \frac{e \times f}{100}$ Contribution to Spec. Gr.	$l = \frac{f \times b}{100}$ Content lbs./gal.	$n = \frac{l \times 100}{}$ % Solvent by Volume
Cellosolve	7.79	.88			
M-butyl	6.75	.44			
Xylene	7.24	.35			
Phenyl	8.9	2.20			
Ethyl-enodiamine	8.8				
Ketamine Curing Agent		11.41			
Mineral Spirits					
Benzene					
Sol vent Calculations	$j = \frac{H \times 100}{i}$	$i = \Sigma f$	$h = \Sigma g$	$m = \Sigma l$	$o = \Sigma n$

DATA SHEET

A. GENERAL DATA

Paint Formula	
Trade Name	Intergand Aluminum
U. S. Reference	4435/4414
World Wide Reference	
Type	
Manufacturer's Name	International Red Hand
Address	3915 Louisa Street New Orleans, La. 70126
Telephone for Emergency	

a. % solids by volume — 50%
b. Net weight per U.S. gallon — 9.4 lbs.
c. Coverage theor. sq. ft./gal.

B. SOLVENT COMPOSITION

Solvent Component	e Spec. Gr. lbs./gal.	f % Solvent by Weight	g=e x f / 100 Contribution to Spec. Gr.	l=f x b / 100 Content lbs./gal.	n=l x 100 / e % Solvent by Volume
Cetlosolve	7.79	6.50	.506	.611	7.84
M-butyl					
Xylene	7.24	31.1	2.251	2.923	40.37
Phenyl					
Ethyl-enodiamine					
Ketamine Curing Agent					
Mineral Spirits					
Benzene					
dethyl izobutyl Jeton	6.68	14.8	.988	1.397	20.82
Solvent calculations	j=H x 100 / i 2.15	i= Σ f 52.4	h= Σ g 3.745	m= Σ l 4.931	)= Σ n 69.03

DATA SHEET

A. GENERAL DATA

Paint Formula	
Trade Name	Bitoxy Aluminum
U. S. Reference	**4456/4459** Aluminum
World Wide Reference	F.5 Base/F.10
Type	Coal Tar Epoxy
Manufacturer's Name	International Red Hand
Address	3915 Louisa Street New Orleans, La. 70126
Telephone for Emergency	
a. %solids by volume	68%
b. Net weight per U.S. gallon	10.48 lbs.
c. Coverage theor. sq. ft.kgal.	156

B. SOLVENT COMPOSITION

Solvent Component	e Spec. Gr. lbs./gal.	f % Solvent by Weight	g=e x f / 100 Contribution to Spec. Gr.	l=f x b / 100 Content lbs./gal.	n=lx100 / e % Solvent by Volume
Cellosolve					
M-butyl					
Xylene	7.24	21.35	1.546	2.237	30.90
Phenyl					
Ethyl-anodiamine					
Ketamine Curing Agent					
Mineral Spirits					
Benzene					
Methyl izobutyl ueton	6.68	5.0	.334	.700	7.84
Solvent calculations	j=H x 100 / i 7.13	i= Σ f 26.35	h= Σ g 1.88	m= Σ l 2.937	o= Σ n 38.74

SECTION III

REMOVAL OF RESIDUE MATERIAL FROM A DRYDOCK FLOOR

III. REMOVAL OF RESIDUE MATERIAL FROM A DRYDOCK FLOOR

A. THE REQUIREMENT TO REMOVE RESIDUE MATERIAL FROM DRYDOCKS

Residue material is removed from drydock floors as a matter of routine. Most managers in the industry practice good housekeeping, which is a must to comply with O.S.H.A. and maintain access to the docked vessel. The degree that the dock floor is clean varies from shipyard to shipyard. The amount of spent abrasive on the floor effects the pumping time required to raise the dock, so in effect, it is to the shipyard's benefit to remove as much spent abrasive as practicable to assure efficient operation of the dock.

EPA has been in the process of developing guidelines and impact statements relative to the degree of broom clean and possible vacuum clean prior to flooding. The EPA impact will be discussed later on in this document.

B. TIME CONSTRAINTS AFFECTING THE REMOVAL OF RESIDUE MATERIAL FROM DRYDOCKS

Scrap metal, wood and plastic, miscellaneous trash, such as paper and glass, industrial scrap and waste, such as, insulation, welding rods, packing, etc. are deposited into trash and scrap containers placed about the dock floor.

The containers are picked up from the dock by crane or fork lifts and removed periodically during the work day.

During surface preparation using dry blasting, light blasting would produce 200 tons of abrasive spread over the dock floor; heavy blasting would produce 1,350 tons of abrasive spread over the dock floor. The amount of abrasive will vary due to the size of the ship and the degree of surface preparation required. The weight of this material necessitates its removal to insure dock pumping times pertaining to floating docks. The abrasive is removed from accessible areas as practicable, using brooms, shovels and front end loaders to pick up the abrasive and put it into scrap containers which are removed from the dock by crane or fork lift. The time for removal of the spent abrasive is critical.

The spent abrasive, failed paint, scale and marine growth deposited under the ship bottom between the bilge blocks and keel block is removed less frequently. This is due to the frequency of docking schedules at each facility. Some docks turn ships in three (3) to five (5) days. The removal and degree of removal of spent abrasive vary due to ship docking contracts.

When water blasting is used, the amount of residue is reduced to the paint, scale and marine growth removed from the docked vessel.

C. METHODOLOGIES EMPLOYED FOR THE REMOVAL OF RESIDUE MATERIALS FROM DRYDOCKS

There are two basic problems constraining the removal of residue material from dock floors: Access and Timing

Access depends on the design and size of the floating dock. Large docks of recent construction have good working dimensions between the inboard side of the wing walls and the outer shell of the docked vessel. Obstructions, such as: Keel blocks, bilge blocks and chain runs, used to set bilge blocks by remote control, the height of the keel block from the floor to the docked vessel's bottom and the distance between bilge blocks and floor construction etc., inhibit the methods, cost and degree that residue material is removed. Older floating docks, which are currently being used at major repair shipyards) vary in design substantially. Concrete floating docks and sectional wooden floating docks are still being used. Some of these have limited working dimensions between the wing wall and the outer shell of the docked vessel. The dock floors are not smooth, which limits vehicular traffic as well as the methodology employed for cleaning the dock floor.

There are numerous small individually owned docks around the country used for repair of small boats and barges. Many of these small docks have access problems that affect the repair work that must be done on the docked boat or barge.

The tools employed for cleaning the floors are very basic at this time; brooms, shovels and front end loaders, demonstrating the state of the art for removal of residue material from drydocks. The vacuum system has been tried but further development is required. The development of a machine or most probably a,combination of machines to perform this task is surely needed.

The constraining factor for acquisition of such equipment is Return on Investment. The acquision price must be of a value that gives return through manhour.savings. This equipment must reduce cost in manhour per ton of material removed, also, increase tons per hour removed.

Time is the next element to consider. In the repair of large vessels the amount of time the vessel is docked depends upon the type of repair, size of vessel and availability of the vessel. Then the facility management must determine dock availability, man power availability, and all support facility requirements. Once those factors are determined, the vessel is then docked.

At this point representatives of the shipyard, regulatory agencies, and the owners complete the ship survey. When the survey is completed, the repair job is scoped and the repair process begins. If the repair is minor, water sweep and apply new coating system to ship's hull beneath the water line, the total docking time could be as short as 72 hours.

If blasting to white metal is required, the time for surface preparation would be extended. The repair job could call for sand sweep which again affects the surface preparation time element. Sand sweep or white metal blasting requires the use of blasting media which brings us to the function of removal of residue material from dock floors. The degree of removal is currently constrained by the length of time the vessel is in the dock and time between docking the next vessel, as well as the previously mentioned factors.

SECTION IV

COST OF REMOVAL OF RESIDUE MATERIAL

FROM A DRYDOCK FLOOR

IV. COST OF REMOVAL OF RESIDUE MATERIAL FROM A DRYDOCK FLOOR

A. UNIT COST OF MANAGEMENT PRACTICES

The element of cost which combine to make up the costs associated with management practices include capital investment and depreciation, operating and maintenance costs for equipment, labor costs (with overhead), and contract costs where contractual arrangements are made. When equipment is used for multiple purposes, only one of which relates to the clean up operations, the cost attributed to management practices must be prorated on the basis of the fractional time so used.

The approach used in this section has been to define the costs associated with methodologies used for clean up. These costs have been normalized to one, eight-hour shift. For comparing various techniques which may be used in an existing facility, the use cost per shift will be multiplied by the number of shifts required for the clean-up cycle.

Clean-up techniques and methodologies included in this breakdown involve use of front end loaders, mechanical sweeper, vacuum equipment and backhoe operations. Labor costs for support of these operations, as opposed to the direct operation costs are separately identified and in most instances represent manual operations when considered alone.

Table IV-1 summarizes the clean-up methodologies which may be used in management practices. The applicability of each method is shown. When the cost of equipment or method varies due to the presence of raised bilge block slides, two entries have been made to allow for this effect.

Table IV-2 shows cost in manhours to pick up abrasive from the dock floor, put abrasive in containers, and remove filled containers from the dock.

Table IV-1 UNIT COST OF SELECTED OPERATIONS WHICH MAY BE USED IN BEST MANAGEMENT PRACTICES

(DOLLAR VALUES EXCLUDE ESCALATORS)

	Large Front Loader		Small Front Loader		Mechanical Sweepers				
	Smooth Dock Floor	Raised Bilge Block Slides	Smoth Dock Floor	Raised Bilge Block Slides	Large	Small	Backhoe	Suporting Crane Operations	
Capital Equipment Cost	$15,000	$15,000	$8,000	$8,000	$35,000	$3,000	$15,000	NA	
Depreciation Period, Years	8	3	8	3	8	8	8	NA	
Annual Depreciation	$1,875	$5,000	$1,000	$2,667	$4,375	$375	$1,875	NA	
Depreciation Chargeable to one 8 hour shift	$1.71	$4.57	$0.91	$2.44	$4.00	$0.34	$1.71	NA	
Operating Labor									
Skill Level	Operator	Operator	Operator	Operator	Operator	Operator	Operator	Operator	Rigger
Number of Operators	1	1	1	1	1	1	1	1	2
Hourly Rate with Overhead	$11.80	$11.80	$11.80	$11.80	$11.80	$11.80	$11.80	$17.00	$10.0
Cost per 8 hour shift	$94.40	$94.40	$94.40	$94.40	$94.40	$94.40	$94.40	$136.00	$160.00
Operating and Maintenance Cost									
Annual Maintenance	$1,500	$3,000	$800	$1,600	$5,250	$600	$2,250	NA	
Maintenance Chargeable to one 8 hour shift	$1.37	$2.74	$0.73	$1.46	$4.79	$0.55	$2.05	NA	
Fuel, Oil, etc. per 8 hour shift	$20.00	$20.00	$13.00	$13.00	$26.00	$13.00	$13.00	NA	
Cost of Operation	$117.48/ Shift	$121.71/ Shift	$109.04/ Shift	$111.30/ Shift	$129.19/ Shift	$103.29/ Shift		$37.00/hour	
Purpose Operation	Clean-up of Debris		Clean-up of Debris		Clean-up of Spent Paint and Abrasive		Clean-up of Debris from Drainage Trenches	Move Equipment and Containers	
Additional Support Services Required, Not included in Cost of Operation	Shovellers, Crane	Shovellers, Crane	Shovellers, Crane	Shovellers, Crane	Crane	Crane	Crane	NA	

Manual Support Operations

(Dollar Values Exclude Escalators)

	Shoveling	Sweeping	Hosing		Tunnel Cleanout: Preparation	Tunnel Cleanout: Cleanout
Operating Labor Cost						
Skill Level	Shovelers	Sweepers	Nozzle Men	Assistants	Electrical/Mechanical	Shovelers
Number of Operators	1	1	2	2	4	5
Hourly Rate with Overhead	$8.90	$8.90	$8.90	$8.90	$9.00	$8.90
Cost per 8 hour Shift	$71.20	$71.20	$142.40	$142.40	$288.00	$356.00
Cost of Operation	$71.20/ Shift	$71.20/ Shift	$284.80/Shift		$288.00/Shift	$356.00/ Shift
Purpose of Operation	Clean-up of Spent Paint and Abrasive from Dock Floor				Lighting and Ventilation in Tunnels	Cleanout of Accumulated Debris from Tunnel

NA- Not Applicable

TABLE IV-2

COST TO REMOVE RESIDUE MATERIAL FROM A DRYDOCK

	Tons of Debris per ship	*Cost @ 5.0 manhour/ton
Light Blasting:	200	1000 M/Hrs.
Heavy Blasting:	1,350	6750 M/Hrs.

*Note: The cost of 5.0 manhours/ton was obtained from a dock study using the following:

1.	(4) Men- Shovels & Brooms	314.28 M/Hrs.
2.	(2) Men - Operating Front End Loaders	151.14 M/Hrs.
3.	(1) Crane Operator	25.00 M/Hrs.
	TOTAL :	496.42 M/Hrs.

4. Remove 100 tons of abrasive from dock floor

5. $\frac{\text{496.42 M/Hrs.}}{\text{100 tons}}$ = 4.96 Manhours per ton*

*Rounded to 5.0 M/Hrs. per ton

SECTION V

ENVIRONMENTAL PROTECTION AGENCY'S IMPACT

V. ENVIRONMENTAL PROTECTION AGENCY'S IMPACT

A. THE REQUIREMENT

EPA's Time Table: In order to analyze the shipbuilding industry in preparation for the development of regulations restricting shipbuilder's effluent discharges under Section 301, 304 and 402 of the Federal Water Pollution Control Act, an Environmental Protection Agency (EPA) contractor completed a study of the industry approximately three (3) years ago. EPA was not satisfied with that study and subsequently conducted its own effluent sampling of a few shipbuilding facilities, including extensive sampling at Newport News and Long Beach. Effluent guideline regulations such as those being developed for the shipbuilding industry are prepared by EPA in three (3) stages.

First, the EPA contractor gathers data, analyzes the industry, and makes a report (called a "Draft Development Document") to EPA. EPA reviews that document and makes it available to interested persons for comment. This comment period usually lasts between 30 to 60 days. The "Draft Development Document" for the shipbuilding industry was prepared by Hittman Associates of Columbia, Maryland. EPA reviewed that draft and thereafter distributed it for comments to interested parties, including the Shipbuilder's Council and the shipyards involved in the study.

Second, proposed regulations (accompanied by an EPA Proposed Development Document) for the shipbuilding industry are issued. Based on the Development Document, an Economic Impact Report is made analyzing the ability of the shipbuilding industry to bear the expense which the proposed regulations would entail. The second stage has not been completed.

Third, final effluent guideline regulations are to be issued by EPA. Two sets of regulations were to be issued in March of 1977, one which must be met by July 1, 1977 and the other by July 1, 1983. At the present time Stage III has not been completed.

B. EPA'S IMPACT

EPA was preparing to issue final regulations in March 1977. By July 1, 1977 EPA would be enforcing the broom clean criteria.

Considering EPA's time table and the potential economic impact to the shipbuilding and repair industry, this project was re-scoped early in 1977. Our efforts were directed toward obtaining effluent guideline regulations for the shipbuilding and repair industry. The criteria being best management practices in lieu of numerical limitation and broom clean. This would allow the industry to comply to the regulation in a competitive posture.

In March 1977 we prepared an industry consensus standard through Panel SP-3 (Shipyard Environmental Effects SNAME) and the Shipbuilders Council of America. The consensus standard was intended to be industry's input to EPA for inclusion in the "Draft Development Document". The development document is EPA s interim steps in developing regulations.

July 27, 1977 members of Panel SP-3 and the Shipbuilders Council of America met with EPA in Washington, D.C. At this meeting EPA representatives reviewed the industry consensus standard, accepted it and indicated considerations for inclusion in the Development Document (Drydocks Poaint Source Category) for the Shipbuilding and Repair Industry.

The "Draft Development Document" was issued to Panel SP-3 and SCA in October, 1977. The eleventh meeting of Panel SP-3 was held October 27th and 28th, 1977 in the conference room at National Steel and Shipbuilding Company in San Diego, California. Mr. E. P. Hall and Mr. J. P. Whitescarver of the Effluent Guideline Division of E.P.A. presented the current status of the effluent guidelines to the panel and discussed its economic impact.

Through Panel discussion it was determined that additional comments were required. On January 26, 1978 we formed an advisory committee comprised of four (4) SP-3 Panel members and representatives from the Shipbuilders Council of America to coordinate the task of editing the comments received by the industry.

The twelfth meeting of Panel SP-3 was held Monday and Tuesday, April 3 & 4, 1978 in Washington, D.C. On April 3rd the panel reviewed and approved the edited industry comments for the Effluent Guideline Document. The EPA representatives accepted the industry comments with the revisions executed during the meeting. A copy of EPA's revised Sidelines will be made available for review and further comment in the near future.

our efforts during the past fifteen (15) months, produced the following results:

1. The U. S. Environmental Protection Agency was provided with the technical data (Industry Consensus) to issue a more reasonable draft development document for the shipbuilding and repair industry: Drydocks Point Source Category dated **December** 1977. (Exhibit V-1)

2. The U. S. Environmental Protection Agency was provided with the technical data to establish best management practices rather than broom clean, and amended Sec. 50 and 51, Section 304 of the Federal Water Control Act. (Exhibit V-2)

3. Establish a continuing working relationship for industries' input for the finalization and issuance of final guideline regulations and the development of economic impact statements.

The shipbuilding and repair industry is in business for the purpose of making a profit. EPA has been charged with the responsibility of promulgating regulation and enforcement of those regulations to assure pollution abatement. EPA and the shipbuilding and repair industry must work together to assure economic impact will not jeopardize the industry's ability to be competitive ***in the*** world market.

DEVELOPMENT DOCUMENT

for the

SHIPBUILDING AND REPAIR INDUSTRY: DRYDOCKS POINT SOURCE CATEGORY

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December 1977

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ABSTRACT

This document presents the findings of an extensive study of the shipbuilding and repair industry. Its purpose is to provide specific guidance for the development of discharge permits to be issued under the authority of Section 402 of the Federal water Pollution Control Act as amended. These permits are issued by state and federal authorities participating in the National Pollutant Discharge Elimination System(NPDES).

The studies conducted by the Environmental Protection Agency (EPA) determined that the imposition of national industry wide numerical limitations and standards is impractical at this time. This document, therefore, provides specific guidance which recommends specific best management practices. Such management practices should be tailored to specific facilities. This determination shall in no way restrict the use of numerical limitations in NPDES permits.

The best management practices identified in this document shall be guidance for the determination of best practicable control technology currently available, best available control technology economically achievable, and best available demonstrated control technology. Supporting data and rationale are contained in this document.

BEST MANAGEMENT PRACTICES FOR INDUSTRY

Sec. 50, Section 304 of the Federal Water Pollution Control Act is amended by inserting immediately after subsection (d) the following new subsection and by redesignating succeeding subsections, including references thereto, accordingly:

"(e) The Administrator, after consultation with appropriate Federal and State agencies and other interested persons, may publish regulations, supplemental to any effluent limitations specified under subsections (b) and (c) of this section for a class or category of point source, for any specific pollutant which the Administrator is charged with a duty to regulate as a toxic or hazardous pollutant under section 307(a)(l) or 311 of this Act, to control plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage which the Administrator determines are associated with or ancillary to the industrial manufacturing or treatment process within such class or category of point sources and may contribute significant amounts of such pollutants to navigable waters. Any applicable controls established under this subsection shall be included as a requirement for the purposes of section 301, 302, 306 307 **or** 403, as the case may be, in any permit issued to a point source pursuant to section 403 of this Act".

INTERAGENCY AGREEMENTS

Sec. 51, Section 304(k) of the Federal Water Pollution Control Act as redesignated by this Act is amended to read as follows:

"(k)(l) The Administrator shall enter into agreements with the Secretary of Agriculture, the Secretary of the Army, and the Secretary of the Interior, and the heads of such other departments, agencies and instrumentalities of the United States as the Administrator determines, to provide for the maximum utilization of other Federal laws and programs for the purpose of achieving and maintaining water quality through appropriate implementation of plans approved under section 208 of this Act.

"(2) The administrator is authorized to transfer to the Secretary of Agriculture, the Secretary of the Army, and the Secretary of the Interior and the heads of such other deparments, agencies, and instrumentalities of the Unites States as the Administrator determines,

REFERENCES

AND

SPECIAL ACKNOWLEDGEMENTS

Many people have made significant contribution to the development of the Shipbuilding Industry Consensus Standard which provided EPA with the technical data to revert back to Best Management Practices. While it is impossible to list every person who has-made a contribution to the project, an attempt is made to mention those who were most directly involved.

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