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Technical Note N-968

DECONTAMINATION UNIT FOR BIOLOGICAL
AND CHEMICAL WARFARE

BY

Allan S. Hodgson, Ph.D. and R. S. Chapler

May 1968

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Internal Working Paper

NAVAL CIVIL ENGINEERING LABORATORY
Port Hueneme, California 93041

DECONTAMINATION UNIT FOR BIOLOGICAL

AND CHEMICAL WARFARE

Technical Note N-968

Y-F011-08-02-216

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Allan S. Hodgson, Ph.D. and R. S. Chapter

ABSTRACT

A study has been made of a new system developed to update and improve biological and chemical warfare decontamination equipment. An apparatus was required to meter, mix and disperse five specified solutions in water from separate storage tanks with the relative flow rates of the fluids to be maintained with considerable accuracy. The preliminary development of a unit is described. Fabrication of the unit was not pursued because its weight and cost were large enough to suggest that the five solution decontamination mixture must be further evaluated on a laboratory scale to completely justify the necessity of this equipment.

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INTRODUCTION

Existing decontamination units* consisting of a mixing and storage tank with associated pump and engine have several operational disadvantages. The decontaminating solution, in slurry form, requires a considerable mixing time, tends to clog pumps, hoses and dispensing nozzles and the unit needs extensive cleaning after each period of operation.

To overcome these problems a new nonslurry decontamination mixture was developed at the Naval Research Laboratory. This mixture consists of five different additives which must be introduced into a water stream before dispersal. Additional advantages of the new mixture are a greater wetting ability to assist decontamination, a less corrosive mixture and improved operation at low temperatures. Due to the incompatibility of the additive solutions, it was required that each have a separate storage tank and that mixing of predetermined amount be achieved with considerable accuracy just prior to discharge.

The objective was to develop an experimental unit for testing the metering and mixing devices, determining the chemical concentrations required in field use and feasibility of this type of unit.

DECONTAMINATION UNIT DEVELOPMENT

The equipment was to be designed to mix solutions for controlling pH, detergency, freezing point and corrosiveness of the decontaminating solution. The mixture to be dispersed from the equipment was anticipated to consist of the following typical compositions and proportions.

Water	10 gpm at 50 psi
Calcium hypochlorite solution, 5%	1 gpm
Detergent solution, 5%	1 gpm
Sodium dihydrogen phosphate solution (NaH_2PO_4), 10%	1 gpm
Deicing liquid	5 gpm
Organic acid	1 gpm

Although the unit was to be experimental in nature, it was desirable that the design should be as close as possible to the field

*U. S. Marine Corps Technical Manual, TM-04195A-12, Decontaminating Apparatus M12 Type II, Oct. 1965, FSN 4230-902-3224.

unit. The experimental unit would be used in a series of different field tests and depending on the results, minor design changes might be necessary for the production unit. The experimental unit was to have a considerable range of absolute and relative flow rates and the initial study produced four design concepts which were examined. The four concepts differed in the method of metering the solutions as follows:

1. Pneumatic pumping and manual control valves
2. Eductor pumping and manual control valves
3. Centrifugal pumping and manual control valves
4. Metered pumping

On further investigation, it was found that eductors were unsuitable due to their low efficiency and this concept was discarded. The concepts using compressed air or centrifugal pumps with manual control valves and flow meters were not considered suitable for the experimental unit due to the problem of accurately controlling flow rate with this type of system and the necessity of a more complex arrangement. The components of the three concepts considered practical have comparable weight and volume requirements and since metering pumps met the demand for accurate, variable solution flow rates, this concept was used for investigation of the prototype unit. The concept is illustrated schematically in Figure 1.

The apparatus was required to operate continuously for ten minutes with the capability for separate storage of the additive solutions for extended periods of time. The water supply was assumed available from external sources. All the pumps were to be driven by a single gasoline engine. The equipment had to be capable of starting and operating at ambient temperatures from 20°F to 130°F with discharge of the decontamination agent through a retractable hose and an adjustable spray nozzle. The whole unit was to be as compact as possible, assembled as a single unit and suitable for transportation by truck or trailer.

PROTOTYPE DECONTAMINATION UNIT DESIGN

A contract was awarded to The Ben Holt Company of Pasadena, California to complete a detailed design of the unit and produce drawings and specifications together with a detailed cost estimate for the construction. Design specifications and operation and maintenance manuals were received with a breakdown of the costs of individual items required for fabrication.

The unit is illustrated in Figures 2 to 8 and specific items are listed below.

1. Pumps. The water supply pump is of the vane type designed to deliver 10 gpm at 70 psi with adjustment of the flow rate accomplished by throttling of the discharge. The pump may be operated using water from streams, ponds, fire hydrants or other sources; a retractable suction hose is provided. The deicing fluid pump is of a similar type with means of accurately metering the discharge rates and provisions for water flushing and draining.

The remaining pumps (four) for the decontamination solutions are piston type metering pumps capable of fluid delivery rates from zero to the full specified flow. A scale is provided for accurate, reproducible settings of pump output. The pumps are of corrosion resistant materials and means of flushing and draining are provided.

The range of flow rates for the specified solutions are:

Calcium hypochlorite solution	0-2 gpm
Detergent solution	0-2 gpm
Sodium dihydrogen phosphate solution	0-2 gpm
Organic acid	0-2 gpm
Deicing fluid (ethylene glycol)	2-8 gpm

Since the deicing fluid required a rather high pump capacity and less accurate metering, it was pumped by an adjustable flow vane-type pump in conjunction with a rotameter. Flow rate accuracy for the other four solutions using metering pumps was ± 1 percent.

2. Storage tanks. Fiberglass reinforced polyester resin or polyethylene tanks are suitable for storage of the solutions and are of such a size as to provide ten minutes operation time at the specified maximum flow rates.

3. Drive. Power is provided by a gasoline engine with the required accessories and auxiliaries for efficient and dependable operation. The pumps are on a common base and driven from a single shaft through a clutch and speed reducer. The metering pumps or the deicing pump may be taken out of service by setting the appropriate pump control to zero flow.

4. Miscellaneous. Steel pipe and cast iron fittings are used in water and deicing service with polyvinyl chloride pipe, valves and fittings for the decontaminating chemicals. Mixing of the solutions is achieved by a polyvinyl chloride eductor type device designed for minimum pressure drop. Flow meters are provided on water and deicing fluid lines for the experimental unit. The hose is of Hypalon core

with neoprene cover and nylon braid, and is supplied with an adjustable brass spray nozzle at the downstream end.

The total cost of the complete unit is shown in Table 1. The amount is a conservative estimate for a single experimental unit, while considerable decrease would be likely if fabrication was undertaken for a production unit.

Table 1. Decontamination unit cost breakdown.*

Material	\$10,000
Fabrication	4,840
Shop drawings	1,200
Inspection and testing	<u>4,210</u>
TOTAL	\$20,250

The weight of the pumps, engine and tanks (when full) is considerable and thus the unit required a substantial base and framework. The dimensions and weight of the unit are shown in Table 2.

Table 2. Decontamination unit weight and dimensions.*

Length	10 ft
Width	5 ft 6 in
Height	6 ft
Weight (tanks empty)	3,425 lbs
Weight (tanks full)	4,610 lbs

* Figure based on quotation by The Bon Holt Company.

CONCLUSIONS AND RECOMMENDATIONS

A relatively heavy and expensive piece of field equipment is required to comply with the specifications for dispersal of the five solution decontamination mixture. The mixture is still under development and further tests by the Naval Research Laboratory may show that one or more of the solutions can be eliminated or that stronger concentrations are suitable, thereby reducing the tank storage requirements.

Consequently, fabrication of the unit is not recommended until further laboratory scale evaluations of the mixture can fully justify the development.

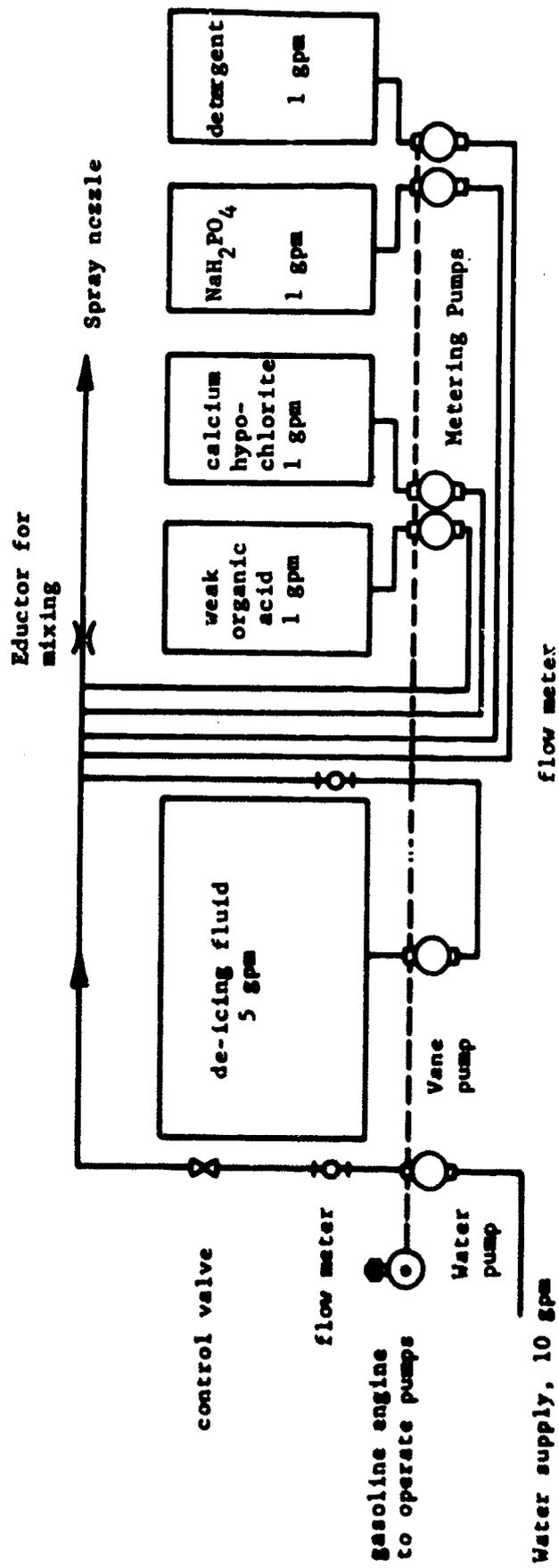


Figure 1. Decontamination unit using metering pumps.

J-1
MIXING
EDUCTOR

K-5
RETRACTABLE HOSE
ELBOW ASSEMBLY

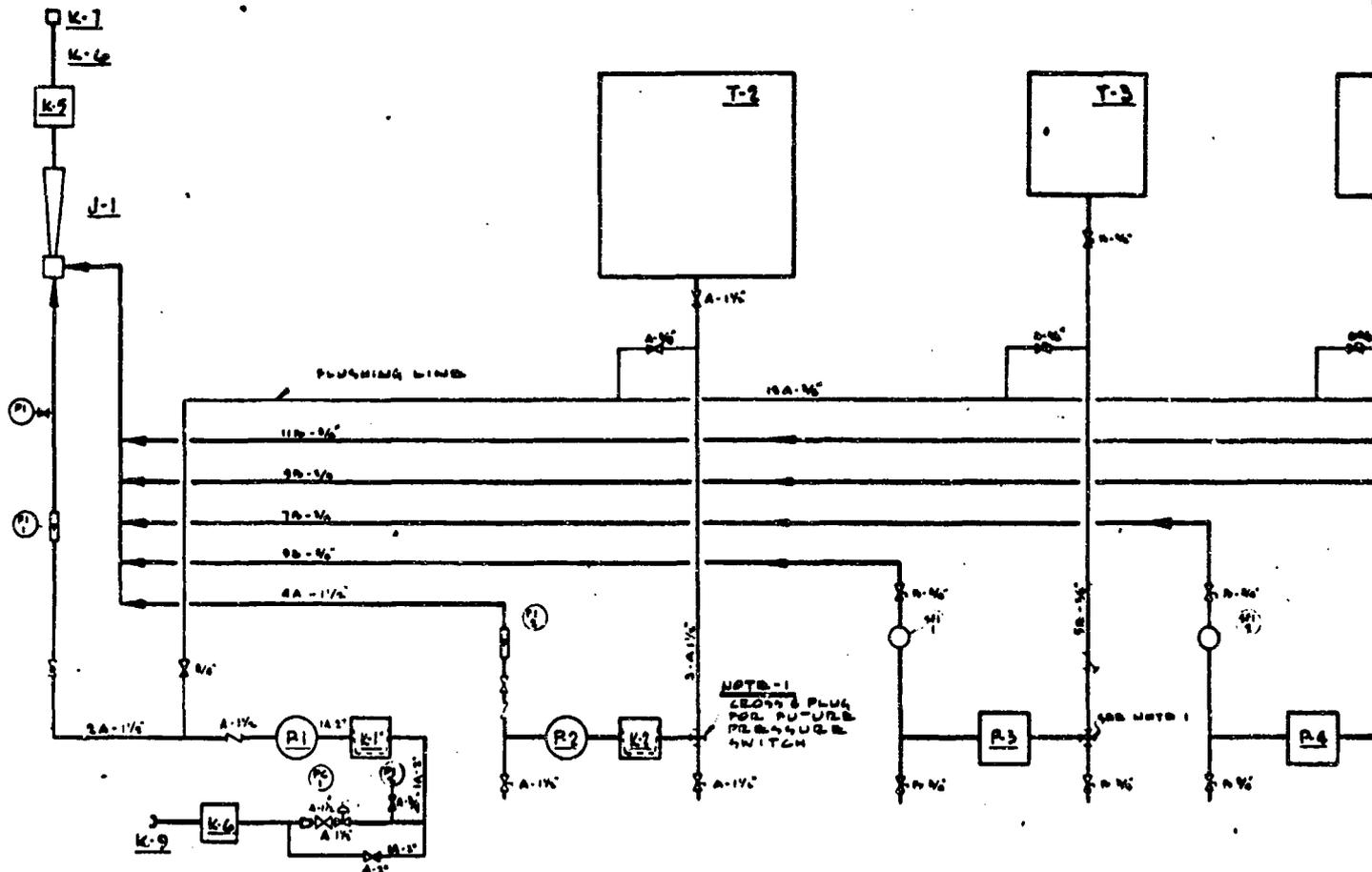
K-6
DISCHARGE
CHEMICAL HOSE

T-2
DRIVING FLUID
TANK - 80 GALS

T-3
WEAK ORGANIC ACID
TANK - 30 GALS

5%
HYPOCHLORITE
TANK

K-7
DISCHARGE
SPRAY NOZZLE



K-9
FIRE HYDRANT
FITTING

P-1
WATER PUMP
10 GPM
DISCH. PRESS = 70 PSI
VIKING MODEL
HL 125 HORIZ
PITTS
600 RPM

P-2
DRIVING FLUID PUMP
8 GPM MAX.
DISCH. PRESS = 70 PSI
WALWORTH VARI-FLO
VFD1 - 80
600 RPM

P-3
WEAK ORGANIC ACID PUMP
? GPM MAX.
DISCH. PRESS 70 PSI

P-4
5% CALCIUM HYP
PUMP
? GPM MAX
DISCH. PRESS

K-6
RETRACTABLE
HOSE ASSEMBLY

K-1
BASKET STRAINER

K-2
BASKET STRAINER

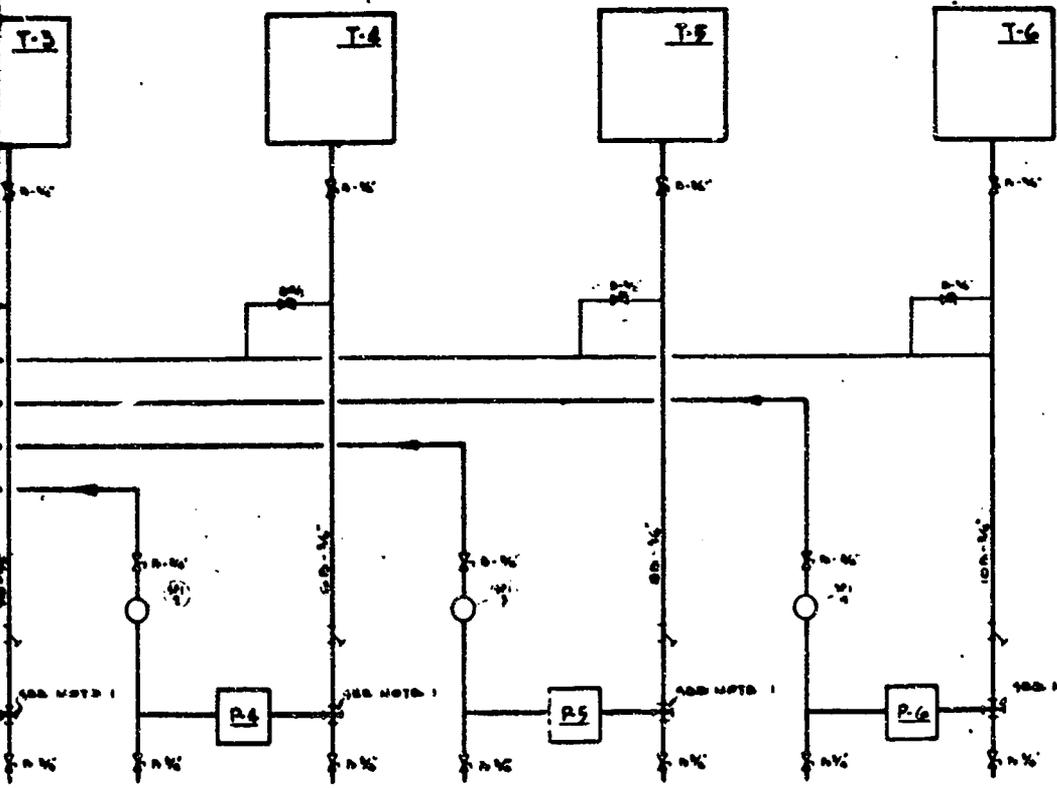
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I-3
ORGANIC ACID
20 GALS

I-4
5% CALCIUM
HYPOCHLORITE SOLN
CAP. 20 GALS

I-5
10% NaH_2PO_4 SOLN
CAP. 20 GALS

I-6
5% DETERGENT SOLN



LEGEND

- ☐ GLOBE VALVE
- ☐ GATE VALVE
- ✱ PLUG VALVE
- ∇ CHECK VALVE
- ⊥ Y STRAINER
- ⊙ ROTAMETER
- ⊙ NIGHT FLOW INDICATOR
- ⊙ PRESSURE GAUGE
- ⊙ DIRECT ACTING PRESSURE CONTROLLER

LINE NUMBERS

- LINE NUMBER
 - LINE SPECIFICATION
 - LINE SIZE
- 10 A 4
- A- CARBON STEEL
 - P- UNPLASTICIZED POLYVINYL CHLORIDE

P-4
PUMP 5% CALCIUM HYPOCHLORITE
PUMP
2 GPM MAX.
DISCH. PRESS = 70 PSI

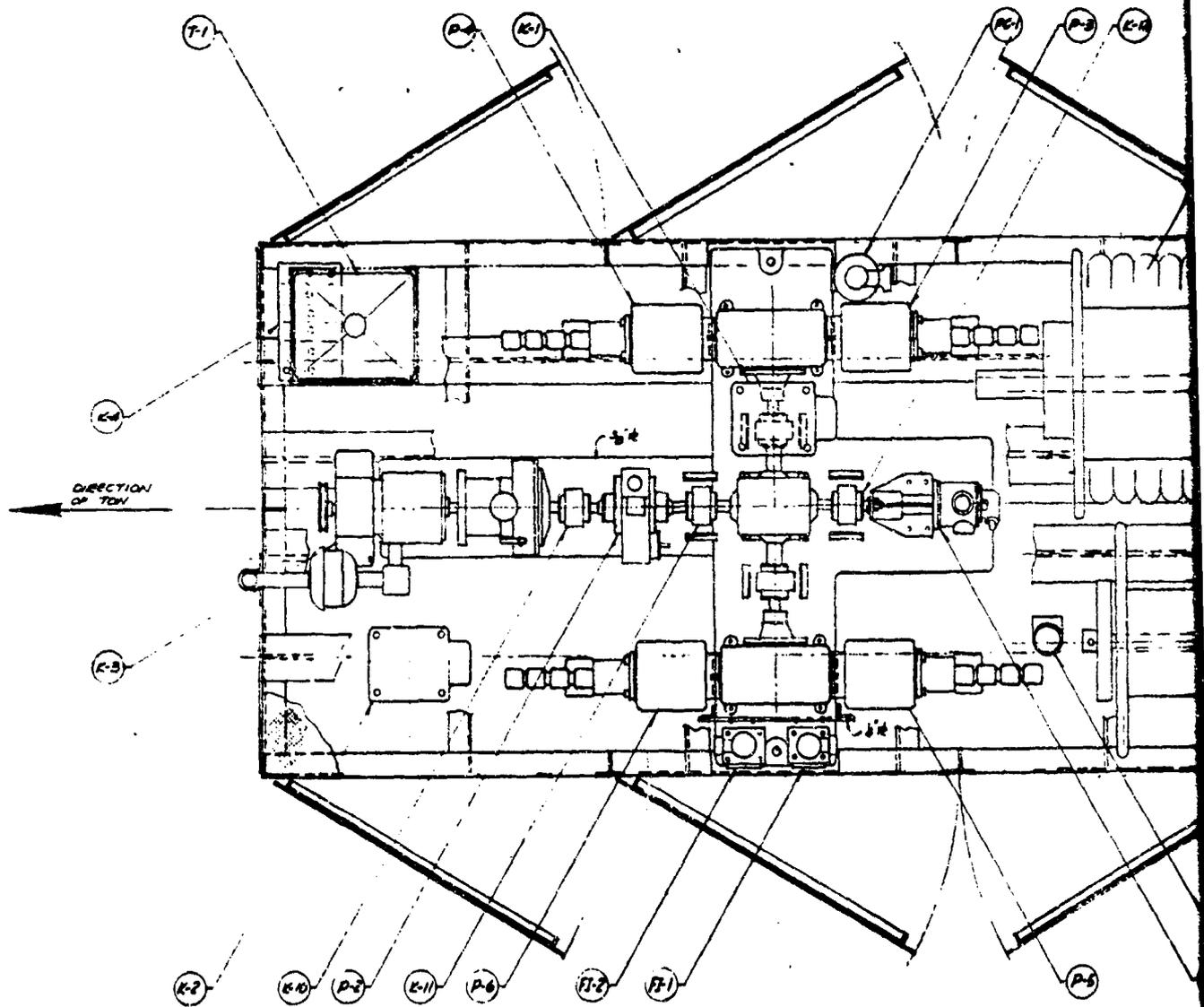
P-5
10% NaH_2PO_4 PUMP
2 GPM MAX.
DISCH. PRESS = 70 PSI

P-6
DETERGENT SOLN PUMP
2 GPM MAX.
DISCH. PRESS = 70 PSI

FLOW DIAGRAM

NO.	REVISION	BY	CHK	DATE
THE BEN HOLT CO.				
TITLE EXPERIMENTAL DECONTAMINATION APPARATUS				
CUSTOMER U.S. CIVIL ENGINEERING LABORATORY				
DESIGN BY D.D.	SCALE N.D.	STANDARD NO. 6710-1	REV. 0	
APPROVED H.W.H.	DATE 12 15 57			

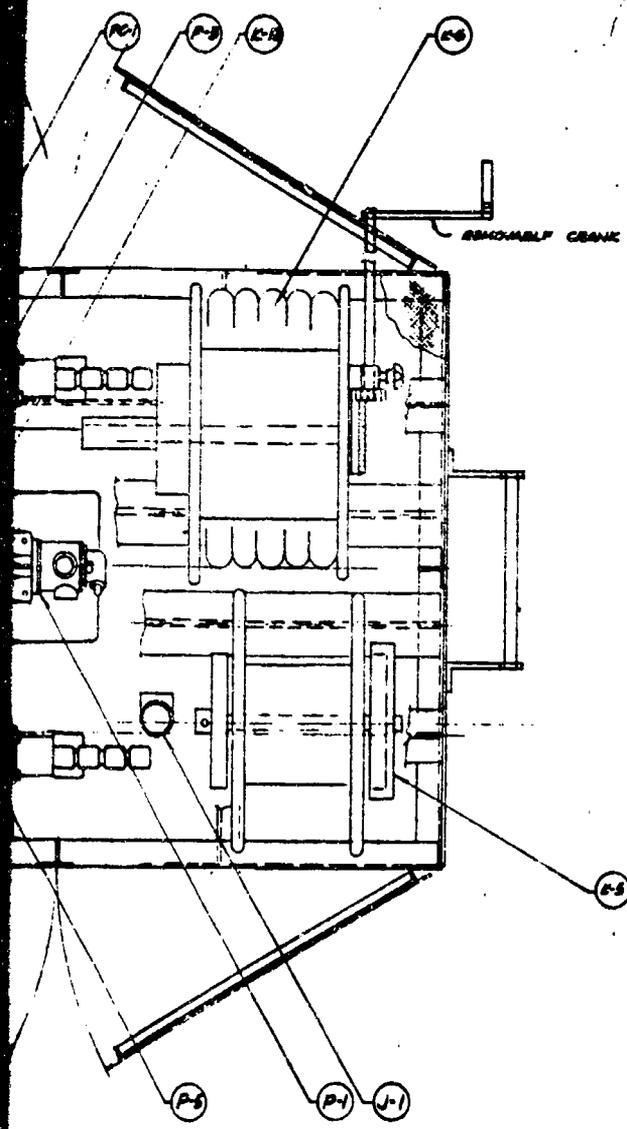
B



NOTES

- 1) FABRICATOR SHALL SHIP ALL THE BIRING IN-LINE UNDER NOT TO TRANSFER VIBRATION TO MECHANICAL
- 2) ALL STRUCTURAL STEEL SHOD COAT OF ZINC CHROMATE
- 3) ALL CONNECTIONS OF STEEL TO BE CONTINUOUS-FILLET

A



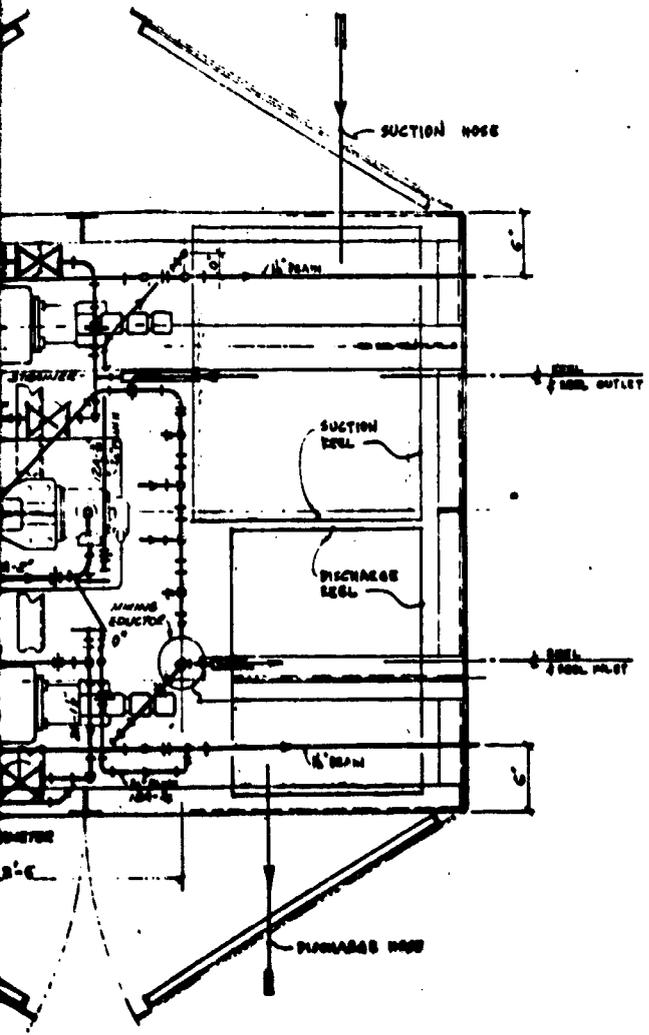
T - 6	5% DETERGENT SOLUTION TANK - 20 GAL.	REINFORCED PLASTIC	26
T - 5	10% AMALG. PHOSPHATE SOLUTION TANK - 20 GAL.	REINFORCED PLASTIC	26
T - 4	5% CALCIUM HYDROCHLORITE SOLUTION TANK - 20 GAL.	REINFORCED PLASTIC	26
T - 3	WEEK ORGANIC ACID TANK - 20 GAL.	REINFORCED PLASTIC	26
T - 2	DEICING FLUID TANK - 20 GAL.	REINFORCED PLASTIC	26
T - 1	FUEL TANK	METAL	15
P - 6	DETERGENT SOLUTION PISTON PUMP		
P - 5	PHOSPHATE SOLUTION PISTON PUMP		
P - 4	CALCIUM HYDROCHLORITE SOLUTION PISTON PUMP		1200
P - 3	ORGANIC ACID PISTON PUMP		
P - 2	ROTARY DEICING FLUID PUMP	(BLACKMER)	60
P - 1	ROTARY WATER PUMP	(WEHNS)	40
PC - 1	PRESSURE REGULATOR		10
PI - 2	PRESSURE GAUGE - DOWNSTREAM WATER PRESSURE REGULATOR		2
PI - 1	PRESSURE GAUGE - UPSTREAM MIXER		2
SFI - 4	SIGHT FLOW INDICATOR - DETERGENT		8
SFI - 3	SIGHT FLOW INDICATOR - PHOSPHATE		2
SFI - 2	SIGHT FLOW INDICATOR - CALCIUM HYDROCHLORITE		2
SFI - 1	SIGHT FLOW INDICATOR - ORGANIC ACID		2
FI - 2	DEICING FLUID ROTAMETER - 1"		5
FI - 1	WATER ROTAMETER - 1"		5
J - 1	MIXING EDUCTOR		2
K - 12	SHAFT COUPLING, SPEED REDUCER TO WEHNS PUMP		5
K - 11	SHAFT COUPLING, BLACKMER PUMP TO SPEED REDUCER		5
K - 10	SHAFT COUPLING, ENGINE TO BLACKMER PUMP		5
K - 9	DISCHARGE CHEMICAL HOSE		
K - 8	HOSE CONNECTION - SUCTION		5
K - 7	ADJUSTABLE SPRAY NOZZLE		5
K - 6	RETRACTABLE HOSE ASSEMBLY - SUCTION W/ HOSE		200
K - 5	RETRACTABLE HOSE ASSEMBLY - DISCHARGE W/ HOSE		150
K - 4	12-VOLT BATTERY		27
K - 3	GAS ENGINE DRIVE & SPEED REDUCER		170
K - 2	BASKET STRAINER - DEICING FLUID		40
K - 1	BASKET STRAINER - WATER		40

NOTES

- 1) FABRICATOR SHALL SUITABLY SUPPORT ALL THE PIPING IN-LINE EQUIPMENT IN ORDER NOT TO TRANSFER LOADS AND VIBRATION TO MECHANICAL EQUIPMENT.
- 2) ALL STRUCTURAL STEEL TO HAVE ONE SHOP COAT OF ZINC CARBONATE PRIMER.
- 3) ALL CONNECTIONS OF STRUCTURAL STEEL TO BE CONTINUOUS FILLET WELDED.

ITEM	DESCRIPTION	MATERIAL	WGT LB	
NAME	REVISION	DR.	CH.	DATE
THE BEN HOLT CO.				
TITLE GENERAL ARRANGEMENT - PLAN EXPERIMENTAL DECONTAMINATION APPARATUS				
CUSTOMER U. S. NAVY CIVIL ENGINEERING LABORATORY				
DESIGNED BY	OC	SCALE	1/4" = 1'-0"	DRAWN BY
APPROVED BY	BMH	DATE	30 OCT 67	NO. 6710-2

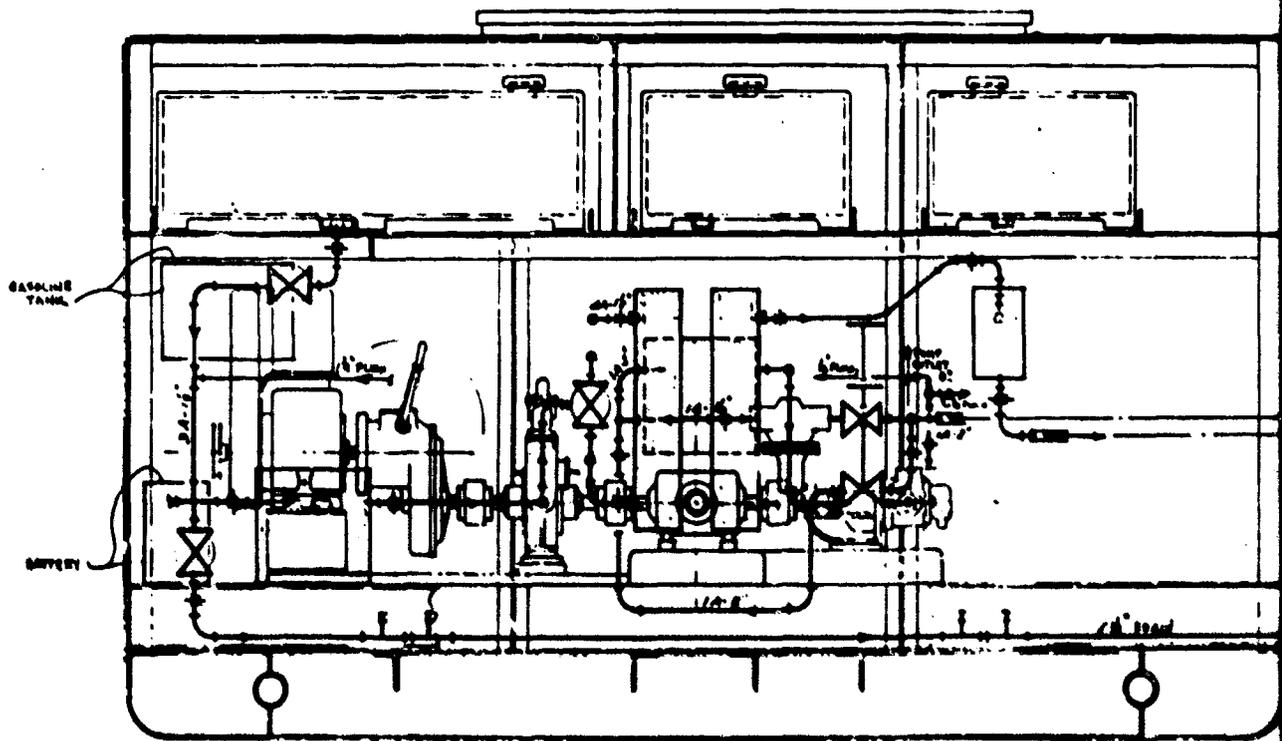
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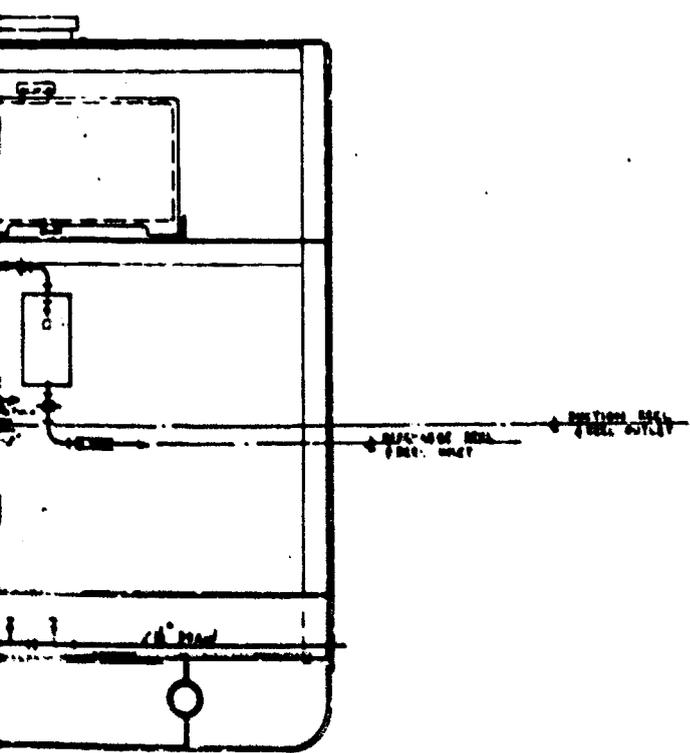
T - 6	500 DETERGENT SOLUTION TANK - 80 GAL.	REINFORCED PLASTIC	26
T - 6	1000 18M, PO ₄ PHOSPHATE SOLUTION TANK - 20 GAL.	REINFORCED PLASTIC	26
T - 4	800 CALCIUM HYDROXIDE SOLUTION TANK - 20 GAL.	REINFORCED PLASTIC	26
T - 3	WEAK ORGANIC ACID TANK - 10 GAL.	REINFORCED PLASTIC	26
T - 2	DECKING FLUID TANK - 80 GAL.	REINFORCED PLASTIC	26
T - 1	FUEL TANK	METAL	
P - 6	DETERGENT SOLUTION PISTON PUMP		
P - 6	PHOSPHATE SOLUTION PISTON PUMP		
P - 6	CALCIUM HYDROXIDE SOLUTION PISTON PUMP		1200
P - 3	ORGANIC ACID PISTON PUMP		
P - 2	ROTARY DECKING FLUID PUMP	(BLANKET)	65
P - 1	ROTARY WATER PUMP	(WATER)	65
PC - 1	PRESSURE REGULATOR		
PI - 2	PRESSURE GAGE - DOWNSTREAM WATER PRESSURE REGULATOR		
PI - 1	PRESSURE GAGE - UPSTREAM MIXER		
SPI - 6	SLIGHT FLOW INDICATOR - DETERGENT		2
SPI - 3	SLIGHT FLOW INDICATOR - PHOSPHATE		2
SPI - 2	SLIGHT FLOW INDICATOR - CALCIUM HYDROXIDE		2
SPI - 1	SLIGHT FLOW INDICATOR - ORGANIC ACID		2
FI - 2	DECKING FLUID ESTIMETER		
FI - 1	WATER ESTIMETER		
J - 1	MIXING EDUCTOR		2
E - 12	SHORT COUPLING, 1/2" REDUCER TO 1/4" WRENCH END		2
E - 11	SHORT COUPLING, BLANKET PUMP TO 1/2" WRENCH		2
E - 10	SHORT COUPLING, ENGINE TO BLANKET PUMP		2
E - 9	DISCHARGE CHEMICAL HOSE		
E - 8	HOSE CONNECTION - SUCTION		
E - 7	ADJUSTABLE SPRAY NOZZLE		
E - 6	ADJUSTABLE HOSE ASSEMBLY - SUCTION W/ HOSE		
E - 5	DETACHABLE HOSE ASSEMBLY - DISCHARGE		
E - 4	12-VOLT BATTERY		27
E - 3	GAS BURNING ENGINE & SAFETY ENVELOPE		170
E - 2	BLANKET STEAMER - DECKING FLUID		20
E - 1	BLANKET STEAMER - WATER		20

ITEM	DESCRIPTION	MATERIAL	NO. 14
THE BEN HOLT CO.			
WELL			
PIPING PLAN - WATER AND DECKING FLUID			
EXPERIMENTAL DECONTAMINATION APPARATUS			
ADDRESS			
U. S. NAVY			
CIVIL ENGINEERING LABORATORY			
DATE OF JOB	APPROVED BY	PROJECT NO.	26
DATE OF EST.	DATE OF ORDER	6710-4	0

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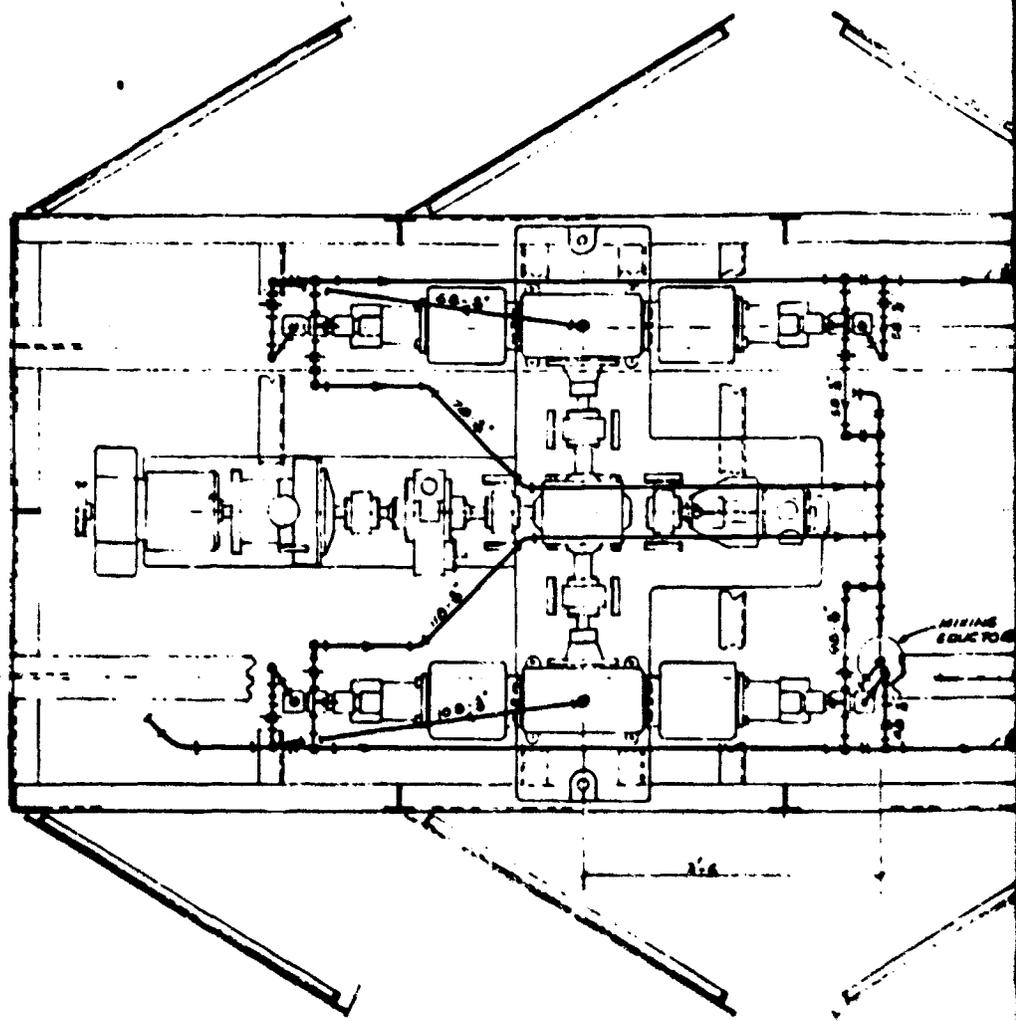


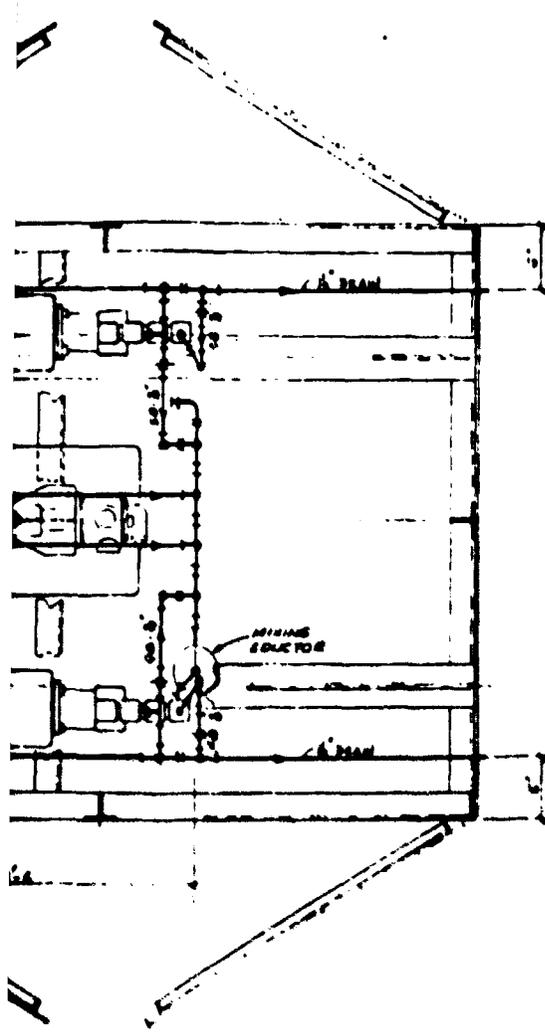
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NO.	REVISION	BY	DATE	THE BEN HOLT CO.	
				TITLE PIPING ELEVATION - WATER & DRAINING FLUID EXPERIMENTAL DECONTAMINATION APPARATUS	
				DESIGNED BY J. S. HARTY CIVIL ENGINEERING DEPT. HATCOY	
				DATE OF THIS DRAWING FEB 19 1954	BY J. S. HARTY
				APPROVED BY P. W. H.	DATE FEB 19 1954

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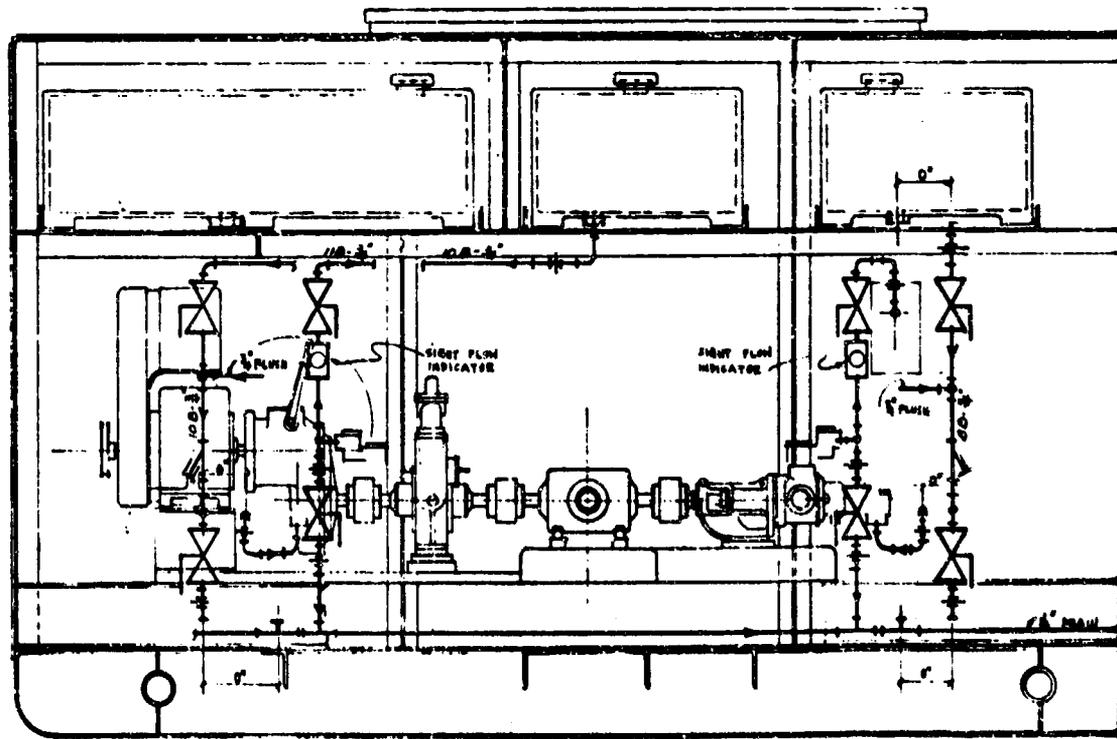




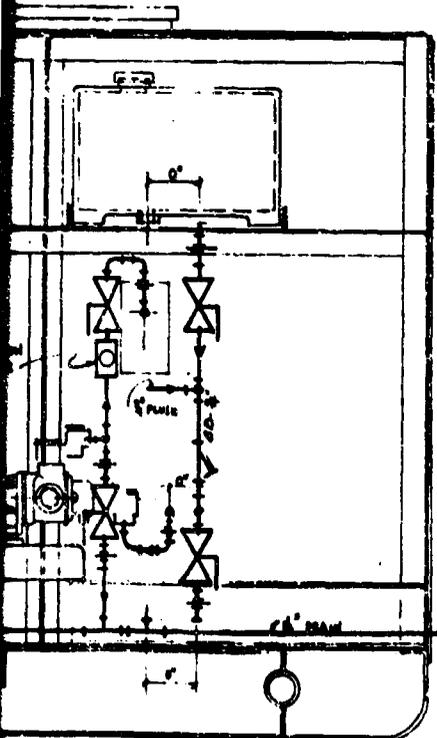
Y	- 6	500 DETEGENT SOLUTION TANK - 50 GAL.	REINFORCED PLASTIC	26
Y	- 6	1000 AMMONIUM PERMANGANATE SOLUTION TANK - 20 GAL.	REINFORCED PLASTIC	26
Y	- 6	500 CALCIUM HYDROXIDE SOLUTION TANK - 20 GAL.	REINFORCED PLASTIC	26
Y	- 6	NEAR ORGANIC ACID TANK - 10 GAL.	REINFORCED PLASTIC	26
Y	- 6	WASHING FLUID TANK - 50 GAL.	REINFORCED PLASTIC	26
Y	- 1	FUEL TANK	METAL	
P	- 6	DETERGENT SOLUTION PISTON PUMP		
P	- 6	PERSMATE SOLUTION PISTON PUMP		
P	- 6	CALCIUM HYDROXIDE SOLUTION PISTON PUMP		1200
P	- 6	ORGANIC ACID PISTON PUMP		
P	- 2	ROTARY WASHING FLUID PUMPS	(BLANKET)	20
P	- 1	ROTARY WATER PUMP	(PENAL)	20
PC	- 1	PRESSURE REGULATOR		
PI	- 2	PRESSURE GAUGE - DISTILLATION WATER PRESSURE REGULATOR		
PI	- 1	PRESSURE GAUGE - WASTE WATER MIXER		
SP1	- 6	SLIGHT FLOW INDICATOR - DETERGENT		2
SP1	- 6	SLIGHT FLOW INDICATOR - AMMONIATE		2
SP2	- 6	SLIGHT FLOW INDICATOR - CALCIUM HYDROXIDE		2
SP2	- 1	SLIGHT FLOW INDICATOR - ORGANIC ACID		2
P1	- 2	WASHING FLUID ROTAMETER		
P1	- 1	WATER ROTAMETER		
J	- 1	MIXING SUCTOR		2
E	- 12	SHORT COUPLERS - SEE SPECIFIC TO THESE PUMPS		2
E	- 11	SHORT COUPLERS - BLANKET PUMPS TO WASH SUCTOR		2
E	- 10	SHORT COUPLERS - ENGINE TO BLANKET PUMP		2
E	- 8	DISTILLATION WASHING HOSE		2
E	- 6	WASH SUCTOR HOSE - 1/2 INCH		2
E	- 7	ADJUSTABLE WASH NOZZLE		2
E	- 6	RETRACTABLE HOSE ASSEMBLY - SECTION OF HOSE		2
E	- 6	RETRACTABLE HOSE ASSEMBLY - DISTILLATION		2
E	- 6	12-CELL BATTERY		20
E	- 2	GAS ENGINE DRIVE & WASH SUCTOR		120
E	- 2	WASH SUCTOR - WASHING FLUID		20
E	- 1	WASH SUCTOR - WATER		20

ITEM	DESCRIPTION	MATERIAL	NO.
THE BEN HOLT CO.			
WORKING PLAN - CHEMICAL SOLUTIONS EXPERIMENTAL DECONTAMINATION APPARATUS			
U.S. NAVY CIVIL ENGINEER'S LABORATORY			
DATE	NO.	REV.	BY
1953	1003	1	
1953	1003	1	

B



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NO.	REVISION	BY	CHK.	DATE	THE BEN HOLT CO.			
					TITLE: PIPING ELEVATION - CHEMICAL SOLUTIONS EXPERIMENTAL DECONTAMINATION APPARATUS			
					CUSTOMER: U.S. NAVY CIVIL ENGINEERING LABORATORY			
					DESIGN BY: JMS	SCALE: 1/2" = 1'-0"	DRAWING NO: 6710-7	REV: 0
					APPROVED: B.m.d.	DATE: 007 67		

B

Unclas

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		2b. GROUP
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4. DESCRIPTIVE NOTES (Type of report and inclusive dates)		
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6. REPORT DATE May 1968	7a. TOTAL NO. OF PAGES 9	7b. NO. OF REFS
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13. ABSTRACT A study has been made of a new system developed to update and improve biological and chemical warfare decontamination equipment. An apparatus was required to meter, mix and disperse five specified solutions in water from separate storage tanks with the relative flow rates of the fluids to be maintained with considerable accuracy. The preliminary development of a unit is described. Fabrication of the unit was not pursued because its weight and cost were large enough to suggest that the five solution decontamination mixture must be further evaluated on a laboratory scale to completely justify the necessity of this equipment.		

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1 NOV 55

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	ROLE	WT	ROLE	WT	ROLE	WT
Decontamination Equipment CBR Warfare Development						