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PESTICIDE PYROLYSIS DEVICE

by

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Final Report

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Aberdeen Proving Ground, Maryland 21005

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A system for destroying small stocks of DDT-kerosene solutions <u>in situ</u> has been developed. The system is designed to be fabricated by Post Engineers from commonly available materials, i.e., an oil burner, pipe fittings, sheet metal, a water pump and refractory material for lining the 55 gal drum used as a furnace. The system is capable of burning about 5 gallons of DDT solution per hour. Tests of the effluent from a prototype system by the Army Environmental Hygiene Agency showed that the emissions were below the pre-scribed safe limits.		

AD-784553

PREFACE

The concept for this system was originated by Dr. Clyde S. Barnhart who retired before the system was tested and completed. The cooperation of Mr. William Brangers and CPT R. Spann of AEHA is gratefully acknowledged.

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INTRODUCTION

The ban on the use of DDT left the Army with the problem of disposing of residual stocks. A great deal of the material was in relatively small quantities (less than 300 gallons) at Army installations throughout the world. The cost and burden of shipping small quantities to a central point for disposal suggested that in situ disposal would be more practical. However, the practicality of local disposal would depend on the use of inexpensive, simple, available materials and equipment for such disposal. In addition, the end products of disposal must meet environmental protection restraints. Since most of the accumulated stocks consist of kerosene solutions of DDT, they could provide their own medium for burning. It was known, however, that just setting fire to bulk quantities of kerosene-DDT solutions would produce unacceptable emissions of soot and unburned DDT, as well as harmful acid fumes.

The method described herein was conceived as a simple, relatively inexpensive way to provide local post engineer organizations with an acceptable means of disposing of small stocks of DDT. A prototype device was designed, assembled and tested. Sampling and analysis of stack gases and scrub water were performed by the US Army Environmental Hygiene Agency to determine the emission levels of residual DDT, unburned particulates and hydrochloric acid.

DESCRIPTION OF SYSTEM

Basically, the system combusts the kerosene-DDT mixture using a standard oil burner and then scrubs the resultant gases to remove the hydrochloric acid formed in the combustion process. This scrub water is neutralized by running it over limestone. The system consists of a furnace section and scrubtower section containing a scrubbing ring and a shower head.

Figure 1 shows the furnace section of the system. This consists of:

(1) Oil Burner. The one used here was of 3-5 gallon-per-hour capacity and was equipped with two 2-gal/hr-60° nozzles.

(2) Furnace. A 55 gal drum from which one end had been removed. To accommodate the burner a 5-inch hole was cut about 2 inches below the lower ring. The sides and bottom of the drum were lined with "Fiberfrax," a silica refractive blanket manufactured by Carborundum, Inc. It is possible to use other refractory materials, such as brick or cement. It is also possible to operate without a refractory lining, but the drum would burn through rather quickly. Even with a lining it was found necessary to replace the drum after several hours of burning. It is advisable, therefore, to have several drums available as furnace replacements.

(3) Scrubber-Section - Figures 2 and 3. Figure 2 shows the scrubbing ring in place over the furnace. Figure 3 shows the drum (both ends removed) with the shower head in place. Water from the shower head supplied by a 35 gal-per-minute pump (see Figure 3) falls on the ring and forms a curtain of water through which the gases from the furnace pass.

The scrub water is then conducted from the ring outlet to a drum filled with limestone gravel where it is neutralized (see Figure 4). The water passes out of this drum through holes punched low in the side. If necessary, in place of the holes, a fitting can be screwed into the end bung and connected to a drain. Modifications in the configuration of the various parts of the system can be made to accommodate the needs of individual users providing they do not affect the efficiency of the system. Appendix A is a sketch detailing the construction of the scrubber ring; Appendix B details the assembly of the shower head.



Figure 1. Furnace section.

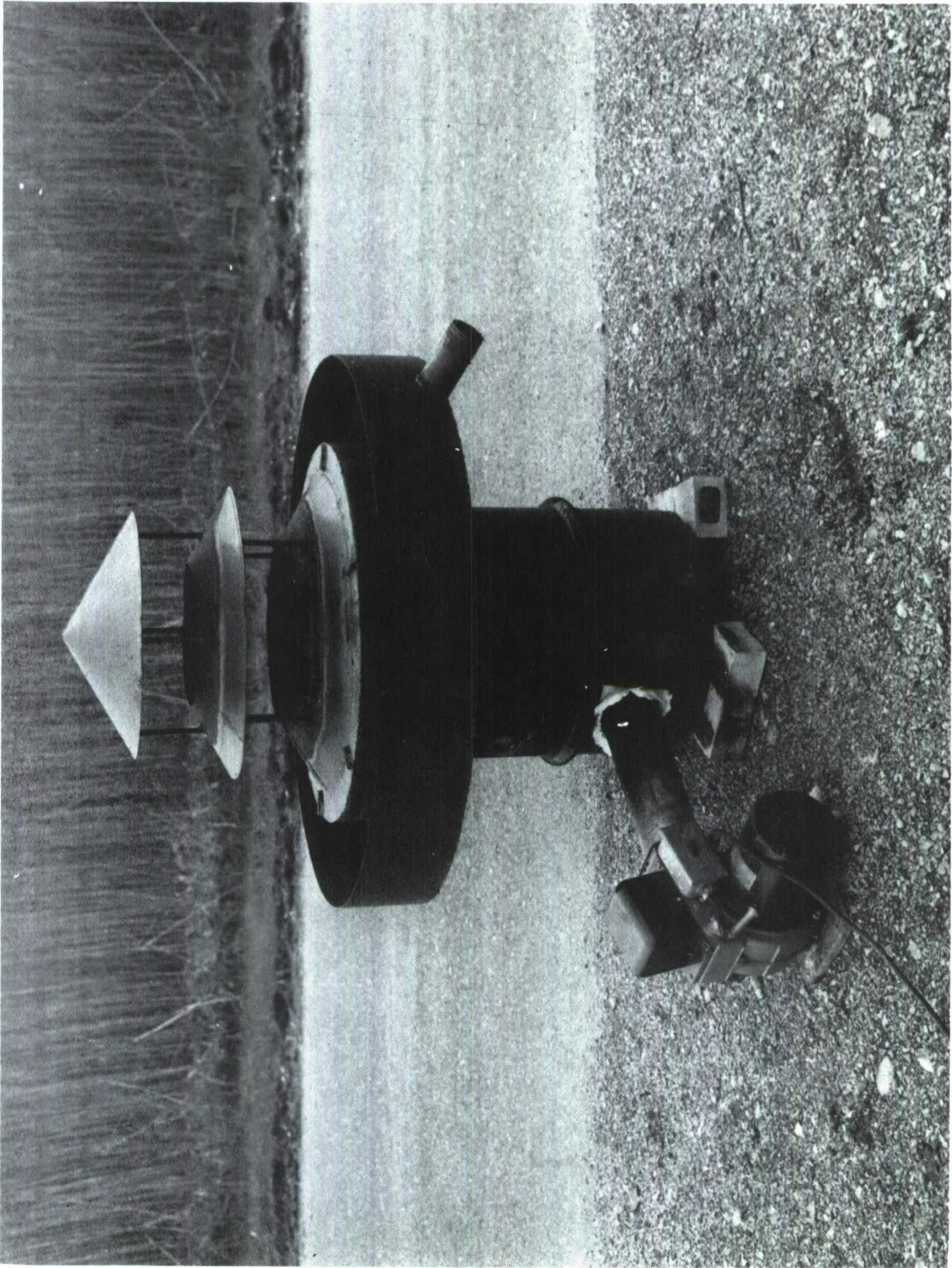


Figure 2. Scrubber section - scrubber ring.



Figure 3. Scrubber section - shower head and pump

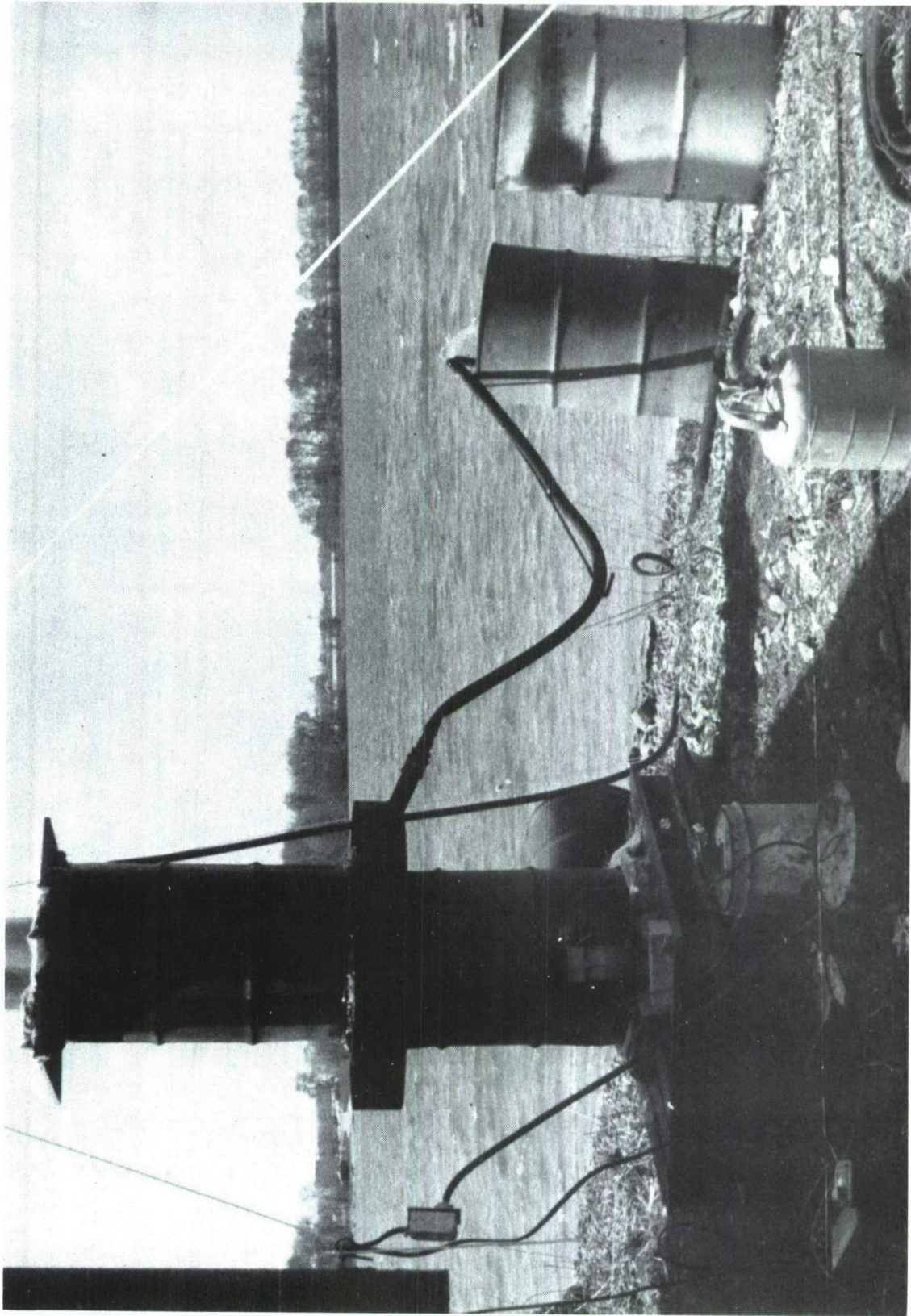


Figure 4. Limestone neutralizer.

PERFORMANCE TESTING

Performance tests were conducted by personnel of the Army Environmental Hygiene Agency in accordance with Federal standards. A sampling stack 10 ft. high and 1 ft. in diameter was utilized and is shown in Figure 5. The arrow indicates the sampling port. It should be noted that this stack was used only for sampling purposes and is not intended as part of the field system.

Testing was performed in two phases. In the first phase combustion was optimized and measurements were made of total hydrocarbons, opacity, CO₂, O₂, N₂ and CO. In the second phase of testing, residual DDT, particulates and total acid were measured to determine whether pollution standards were met. The scrub water as well as stack emissions was sampled for residual DDT. Stack gas and furnace temperatures were measured. In Phase 1, plain kerosene and kerosene solutions containing 1, 5, and 20 per cent DDT were used. In Phase 2 only 20 per cent DDT Solution was used since, it was reasoned, if that concentration were destroyed then lower concentrations would also be destroyed.

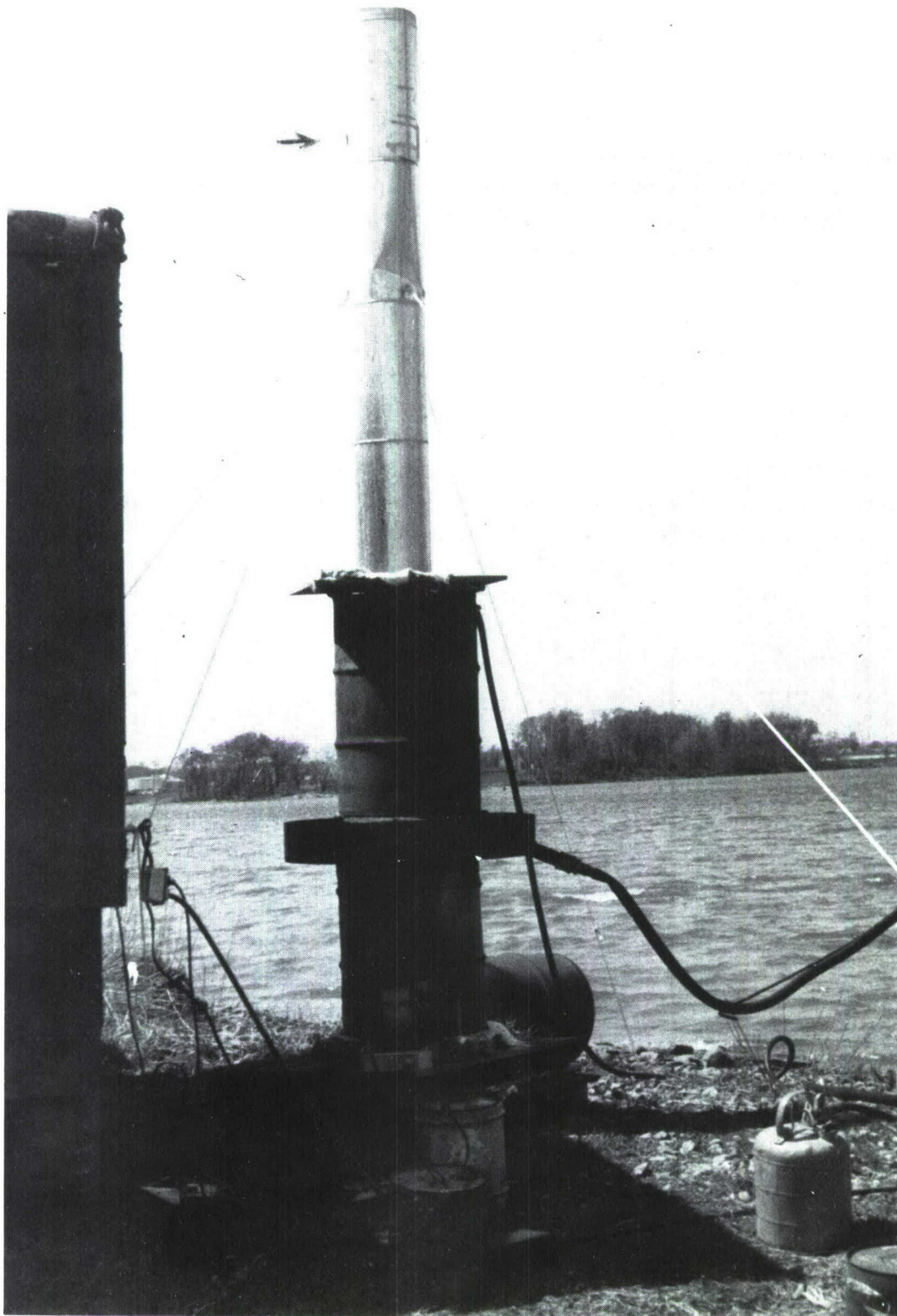


Figure 5. Sampling stack.

RESULTS

1. Air Pollution Standards

Various Army, State and Federal regulatory documents were examined by AEHA personnel to establish the following threshold limits for DDT, particulates and acid (HCl):

a. Particulates (AR 11-21, 3 Nov 67)

Visible emissions no greater than 20% opacity (No. 1 on the Ringelmann scale); no more than 0.3 grams per standard cubic foot (SCF) of dry flue gas, corrected to 12% CO₂.

The State of Colorado allows only 0.1 gram per SCF and the same opacity*.

b. DDT (Federal Register, vol. 39, no. 85, May 1, 1974)

Incineration at 1,000° C with 2 second dwell time is recommended, or such lower temperature and related dwell time that will cause complete destruction of the pesticide. Combustion chamber temperature of the LWL prototype was approximately 1400° C (2500° F) with a dwell time of 3 seconds. (The State of Colorado allows 0.068 grams (68 x 10³) micrograms) per second as the acceptable emission rate for DDT.)

c. Total acid (HCl)

The State of Colorado allows 0.238 grams per second as an acceptable emission rate.

2. Sampling Data

Data from Phase 1, in which combustion was optimized, are shown in Table I. Air pollution data from Phase 2 are presented in Table II.

*Colorado is one of the few states that has established standards for DDT combustion emissions (State of Colorado Air Pollution Control Commission Regulations No. 1 and No. 8).

Table 1

Results of Sampling Data - Phase One

Test Date: 19 April 1974

	<u>Percent DDT</u>			
	<u>0%</u>	<u>1%</u>	<u>5%</u>	<u>20%</u>
Total Hydrocarbons (ppm CH ₄)	8	4	2	10
Approximate Opacity (%)	40	40	20	80
Stack Gas Components (% _v)				
CO ₂	--	7.57	7.27	8.29
O ₂	--	10.60	11.34	9.87
N ₂	--	81.83	81.39	81.83
CO	--	0.01	--	0.01

Test Date: 22 April 1974

	<u>Percent DDT</u>			
	<u>0%</u>	<u>1%</u>	<u>5%</u>	<u>20%</u>
Total Hydrocarbons (ppm CH ₄)	5	35	12	4
Approximate Opacity (%)	10	10	10	40
Stack Gas Components (% _v)				
CO ₂	10.32	9.53	8.48	7.73
O ₂	7.23	8.00	9.28	10.82
N ₂	82.45	82.47	82.24	81.44
CO	--	--	--	.01

Table 2

Results of Sampling Data - Phase Two

	<u>Run 1</u>	<u>Run 2</u>	<u>Run 3</u>
A. Particulate (grains/DSCF@12%CO ₂)	0.397	0.0183	0.0591
Particulate (grams/sec)	0.0591	0.0013	0.0058
Opacity (%)	80	20	30
Av Stack Gas Temp (°F)	62.5	64.5	77
Av Stack Gas Velocity (mps)	1.364	1.225	1.232
Av Stack Gas Flow (SCM per sec)	0.102	0.091	0.0878
B. Total Acid (mg/SCM) HCl	138.4	93.0	0.5
Total Acid (ppm)	91.1	61.4	0.34
Total Acid (grams/sec)	0.0129	0.0085	0.00005
Av Stack Gas Temp (°F)	42	54	74
Av Stack Gas Velocity (mps)	1.185	1.206	1.22
Av Stack Gas Flow (SCM per sec)	0.0926	0.0912	0.0898
C. DDTR (mg/SCM)	0.00203	0.00517	
DDTR (µg/sec)	0.185	0.486	
Percent DDT conversion	99.9999+	99.9999+	
Av Stack Gas Temp (°F)	48	41	
Av Stack Gas Velocity (mps)	1.183	1.183	
Av Stack Gas Flow (SCM per sec)	0.0913	0.094	
D. <u>DDT IN SCRUBBER WATER</u>	<u>INTO LIMESTONE</u>	<u>FROM LIMESTONE</u>	
1% DDT (µg DDTR/gal H ₂ O)	0.250	0.718	
5% DDT (µg DDTR/gal H ₂ O)	0.442	--	
20% DDT (µg DDTR/gal H ₂ O)	0.643	0.416	

Note: (a) Standard Conditions are 25° C and 1 HTM.

(b) DDT is reported as DDTR and calculated as follows: DDTR = pp' DDT + op'' DDT + 1.117 (DDD's + DDE's).

DISCUSSION

There is no doubt from the AEHA quantitative measurements that this system is efficient and meets the environmental requirements. It was observed that a reliable indicator of how well the burner was working was the quantity of soot emitted. When the burner was working well, the stack emission was very clean. The appearance of black soot signalled the advent of a problem. Usually this meant some obstruction to the flame, such as some of the refractory falling and getting too close to the end of the gun. The system is uncomplicated and, with only a little experience, an operator should be able to maintain adequate efficiency. Table III compares the established limits to the values observed when the system worked efficiently.

Table III

Comparison of Observed Emissions to Established Limits

	<u>Observed</u>	<u>Established</u>
DDT	$5/10^{-7}$ gm/sec	6.8×10^{-2}
Acid (HCl)	$5/10^{-5}$ to 1×10^{-2} gm/sec	2.4×10^{-1} gm/sec
Particulates	.02 grams/SCF	1 gram/SCF

As noted previously, the oil burner was used with two-2gal/hr nozzles and the air supply was adjusted to full open. In this configuration the burning rate is 4.5 gal per hour. To prevent clogging of the filters and screen, it is recommended that straight kerosene be run through the burner prior to shutdown.

CONCLUSIONS

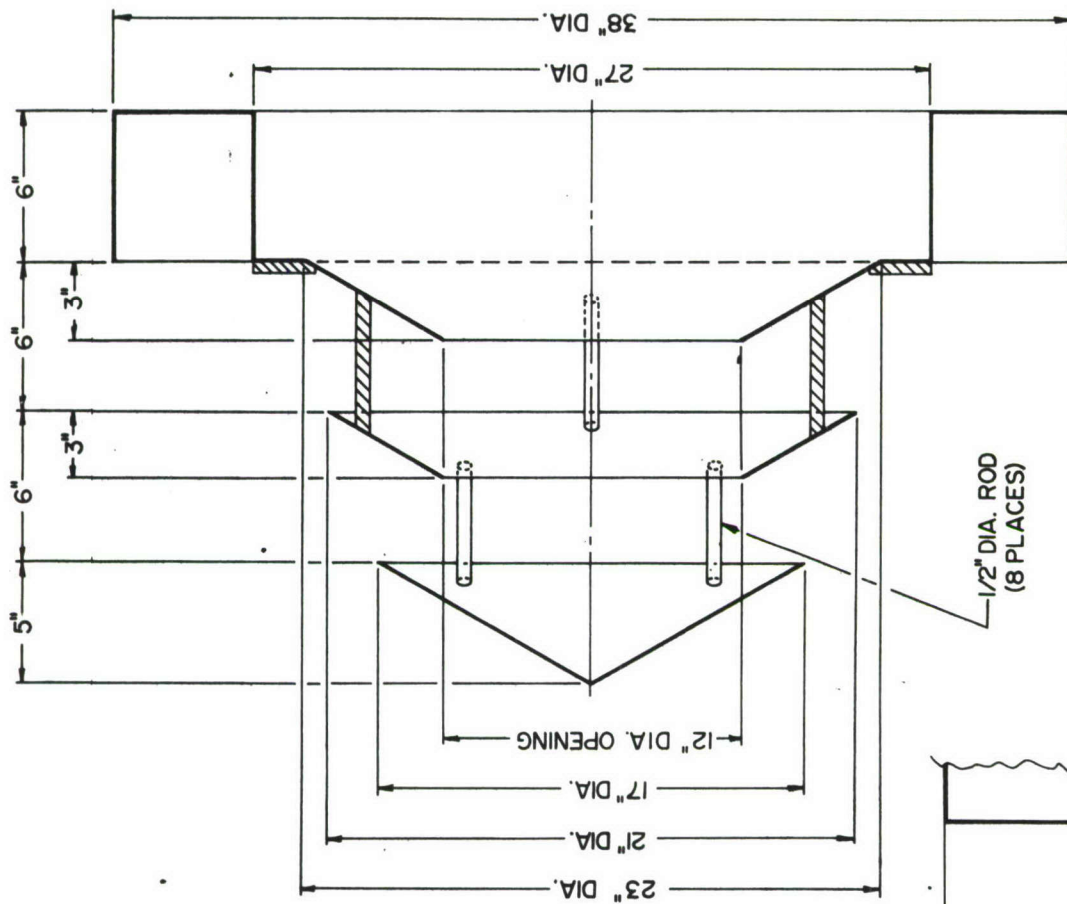
1. The system described should adequately serve the purpose of disposing of small quantities of accumulated DDT in an Army installation.
2. All of the material required to assemble and fabricate the system should be easily available in a typical Army installation, and personnel should also be available to operate the system at an acceptable level of efficiency.

RECOMMENDATION

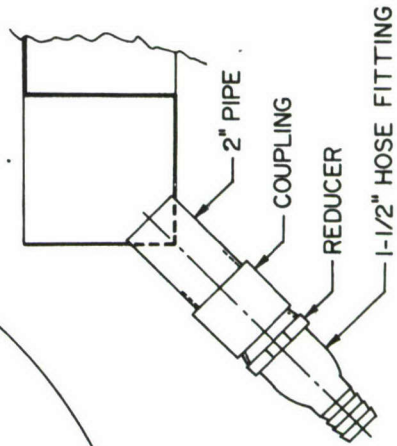
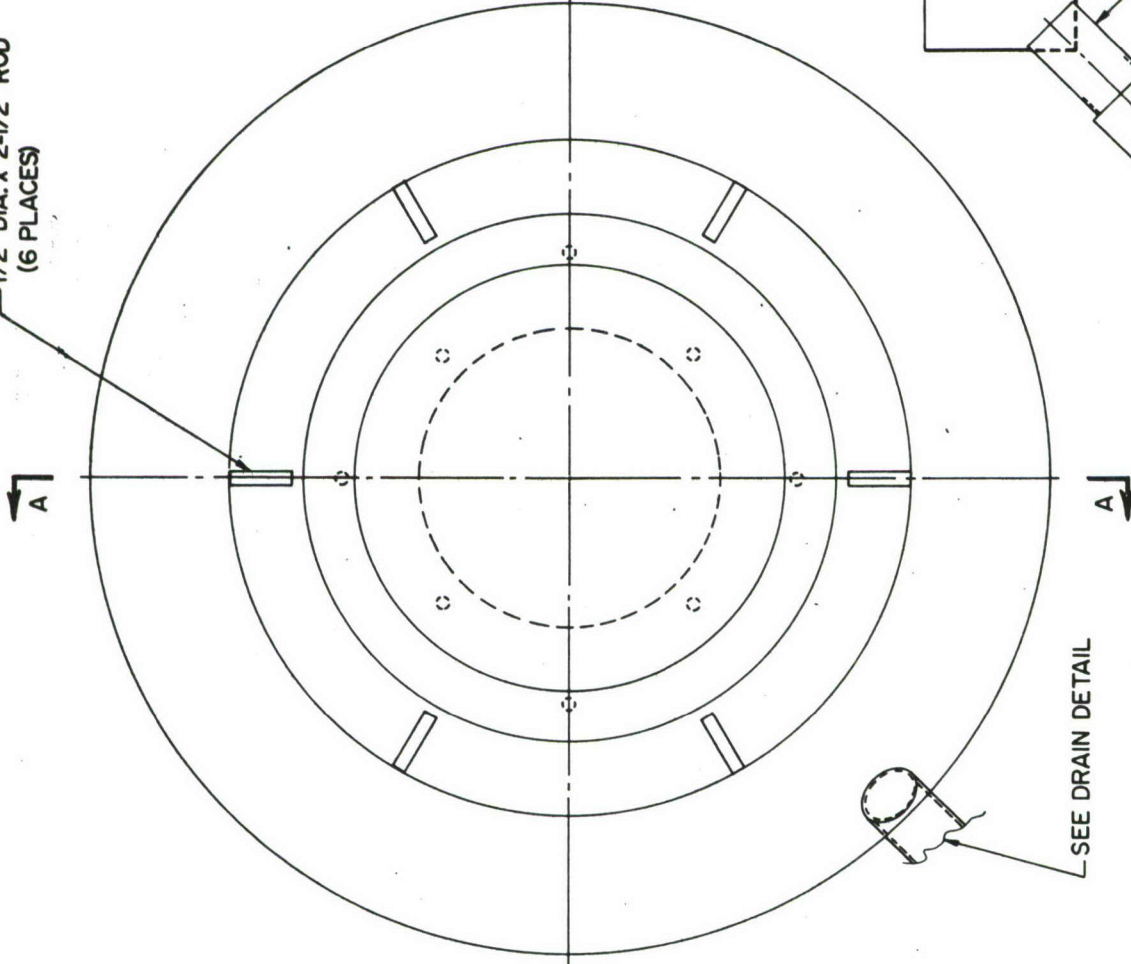
The information contained in this report should be widely disseminated to post engineer organizations in Army installations throughout the world.

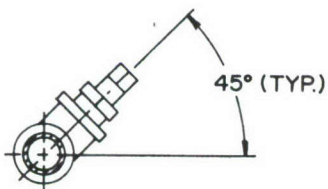
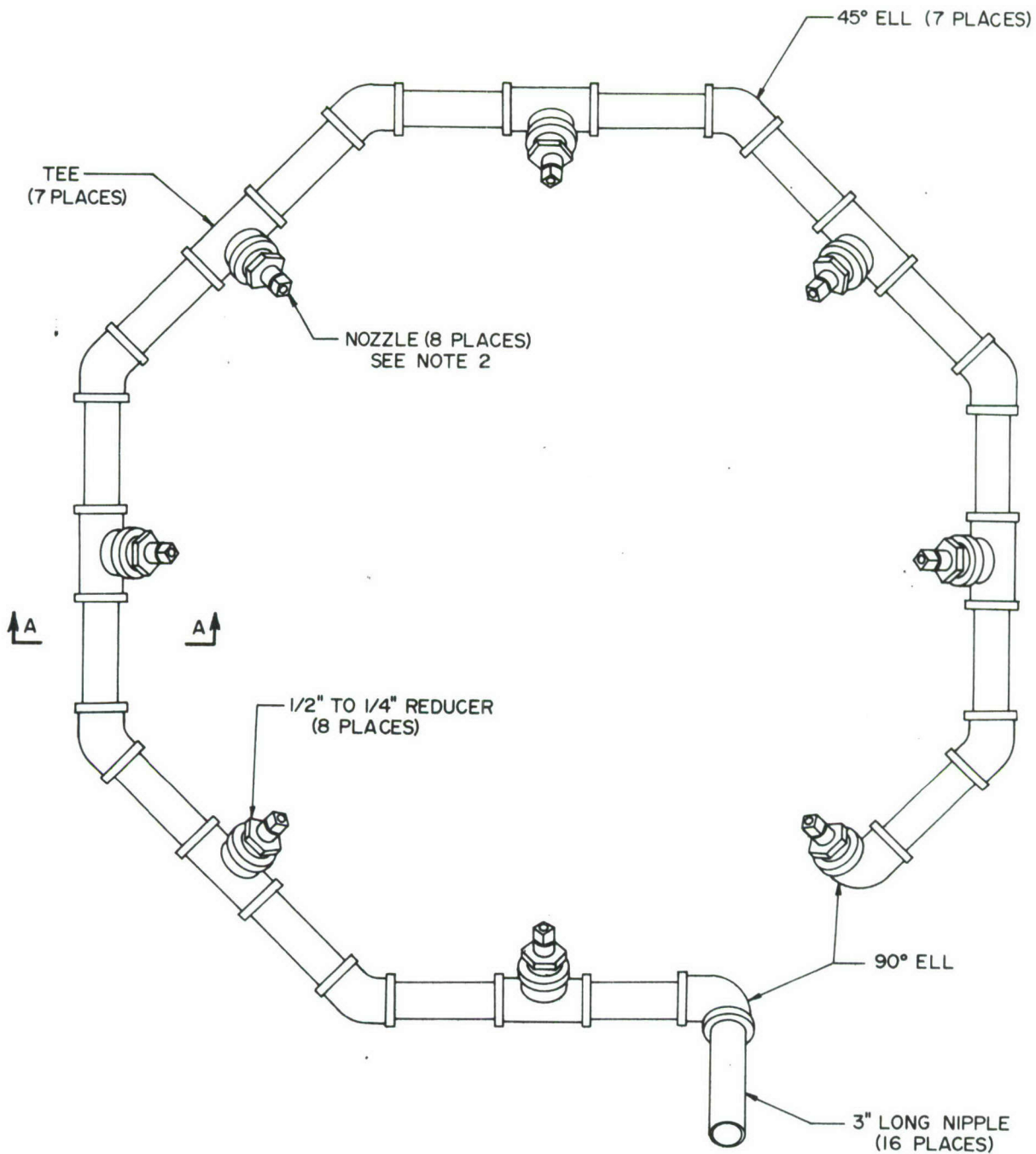
APPENDIX A

Construction of Scrubber Ring



1/2" DIA. x 2-1/2" ROD (6 PLACES)





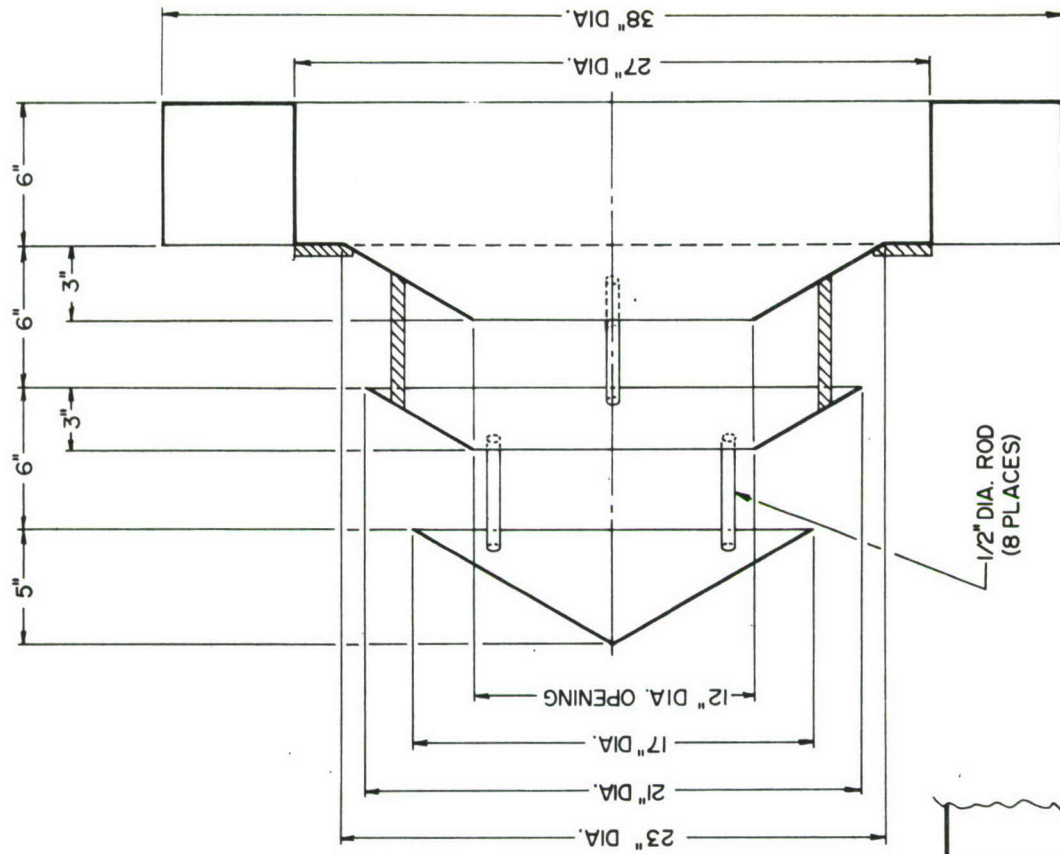
SECTION "A-A"

NOTES:

1. ALL FITTINGS ARE 1/2" N.P.T. UNLESS OTHERWISE SPECIFIED.
2. NOZZLE, FULL JET, WIDE ANGLE, SQUARE SPRAY, CAT. NO. 1/4HHI4W(SQUARE BRASS) SUPPLIER: SPRAYING SYSTEMS CO., ARDMORE, PA.

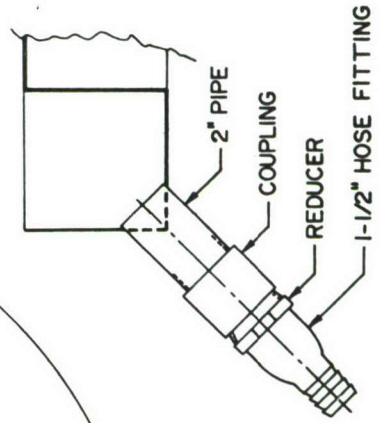
APPENDIX B

Assembly of Shower Head



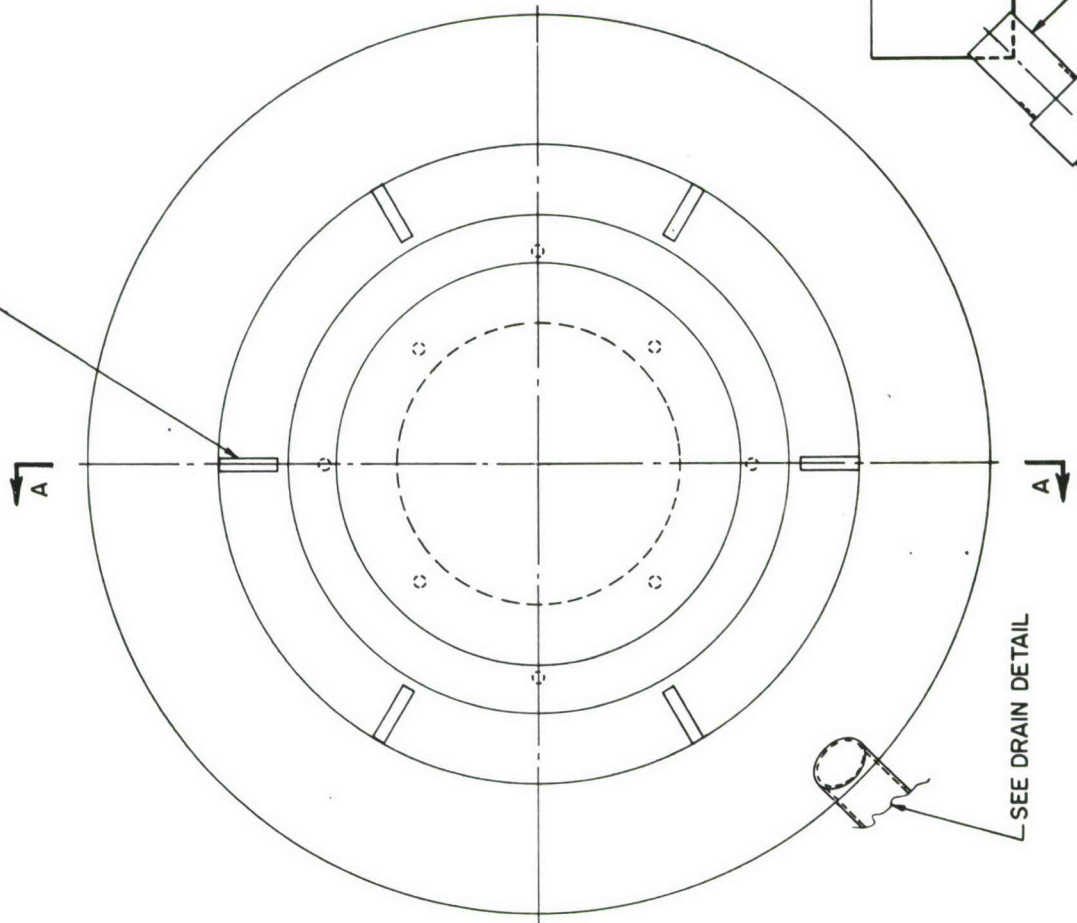
SECTION "A-A"

1/2" DIA. ROD
(8 PLACES)



DRAIN DETAIL

1/2" DIA. x 2-1/2" ROD
(6 PLACES)



SEE DRAIN DETAIL

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