NEW LIMITATION CHANGE

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DECONTAMINATION UNIT FOR BIOLOGICAL
AND CHEMICAL WARFARE

BY

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

May 1968

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Port Hueneme, California 93041
DECONTAMINATION UNIT FOR BIOLOGICAL
AND CHEMICAL WARFARE

Technical Note N-968
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by
Allan S. Hodgson, Ph.D. and R. S. Chapier

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 non-slurry 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 amounts 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 (NaH₂PO₄), 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

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 \(20^\circ\text{F}\) to \(130^\circ\text{F}\) 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.*

<table>
<thead>
<tr>
<th>Material</th>
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<tr>
<td>Fabrication</td>
<td>4,840</td>
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<td>Shop drawings</td>
<td>1,200</td>
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<tr>
<td>Inspection and testing</td>
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<td><strong>TOTAL</strong></td>
<td><strong>$20,250</strong></td>
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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.*

<table>
<thead>
<tr>
<th>Length</th>
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<tr>
<td>Width</td>
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<tr>
<td>Height</td>
<td>6 ft</td>
</tr>
<tr>
<td>Weight (tanks empty)</td>
<td>3,425 lbs</td>
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<tr>
<td>Weight (tanks full)</td>
<td>4,610 lbs</td>
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*Figure based on quotation by The Ben 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.
Decontamination Unit for Biological and Chemical Warfare

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.
**KEY WORDS**

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