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ABC DECONTAMINATION EQUIPMENT FOR PERSONNEL IN THE ARCTIC

U. S. NAVAL CIVIL ENGINEERING LABORATORY

Port Hueneme, California

ABC DECONTAMINATION EQUIPMENT FOR PERSONNEL IN THE ARCTIC

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by

W. R. Nehlsen

U. S. NAVAL CIVIL ENGINEERING LABORATORY
Port Hueneme, California

OBJECT OF PROJECT

To develop equipment and methods for ABC passive defense of the naval shore establishment.

OBJECT OF TASK

To develop emergency equipment for ABC decontamination of large numbers of personnel at polar forward bases.

OBJECT OF REPORT

To present final results of the project.

ABSTRACT

A 60 man per hour portable shower unit was designed by NCEL to fulfill a BuDocks requirement for decontamination of large numbers of personnel in arctic climates. A shower waste water treatment and recirculation system was included to minimize the effects of critical water shortages expected under arctic conditions. Tests performed by NRDL, Fort Detrick, and the Army Chemical Warfare Labs on the shower waste recirculation system showed that satisfactory results could be obtained on atomic and biological agents, but the allowable time interval before starting chemical agent decontamination proved to be so brief that no mass decontamination method could be considered effective.

Because of the inherent dangers of the recirculating system, an individual washing kit was devised by NCEL as an alternative to the shower unit. The individual washing kit is safer and more economical for atomic and biological decontamination, but neither system is suitable for chemical agent decontamination.

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INTRODUCTION

Navy personnel constructing, operating, and maintaining advanced bases and shore establishments in extremely cold areas may be subject to atomic, biological, or chemical contamination. Removing such agents from the skin promptly will help prevent personal injury and casualties from such attacks. Ordinary field shower units can be used in temperate climates, but BuDocks activities include polar-operations, and NCEL was directed to develop a shower unit for cold climates. It was required that the unit be of a standby nature, stored near bases subject to possible attack. Simplicity, low cost, and high capacity of operation were desired. Suitability for being rapidly placed in operation from a storage condition was suggested. Because of potential water shortages in the areas under consideration, BuDocks included treatment and re-use of the shower waste water as project objectives.

In the event of ABC contamination, the prime requirement is the rapid removal of the contaminant from the skin. The time available for decontamination depends considerably on the type of contamination. A bacterial contaminant on the skin generally causes no direct harm but should be removed to avoid the possibility of the organisms being inhaled, penetrating a skin break, or being taken into the mouth accidentally. Chemical and radiological agents may cause immediate and continuing damage and must be removed as soon as possible. To be most effective, a shower unit must be capable of being activated in less than an hour. With some types of CW agents this provides only a secondary decontamination since immediate measures are necessary for survival.

The amount of contamination that actually reaches the skin of an individual depends on the amount and type of clothing worn. It is assumed, however, that many persons would be sufficiently contaminated to require a shower and fresh clothing. The amount of effort required to remove typical contaminants varies from washing with clear water to special medical treatment, but a decontamination shower or washing with soap and water is effective in most instances. In some cases, a second shower might be required to remove radiological contamination.

BuDocks initially indicated that a single unit with a 1000 man per hour capacity was desired, but, for experimental work, a 60 man per hour unit was designed and constructed.

EXPERIMENTAL 60 MAN PER HOUR SHOWER UNIT

The experimental shower unit consists of three major components: the shower shelter, the water heating and treatment section mounted on a pallet, and an engine generator set to supply electrical power. Figure 1 illustrates the three sections loaded on a flat bed trailer for transport.

The Shower Shelter

The shower shelter has a rigid center frame and a skid base 2-1/2 feet wide. Canvas is used for the walls and roof. To open the shelter from its collapsed position, the floor panels are lowered and the compartment separators unfolded to support the canvas in the shape shown in Figure 2.

Water Supply Section

The water supply section consists of a rectangular, 150 gallon water tank, a 3/4 hp pump, and an oil-fired water heater with a thermostatic control which maintains the water temperature at 90 to 100 F so that personnel will remain in the showers long enough to do a good job of scrubbing. The three shower heads each deliver approximately 3.5 gpm at 20 psi making a total flow of 10.5 gpm for the unit. Figure 3 is a diagram of the water circulation system.

Showering Procedure

The showering procedure for this unit was based on previous work at Fort Detrick and this Laboratory. Each individual goes through the following compartments (see Figure 4) in sequence to perform the indicated operation:

1. Undressing room
2. Rinse shower stall
3. Soaping stall
4. Rinse shower stall
5. Soaping stall
6. Final rinse stall
7. Toweling room

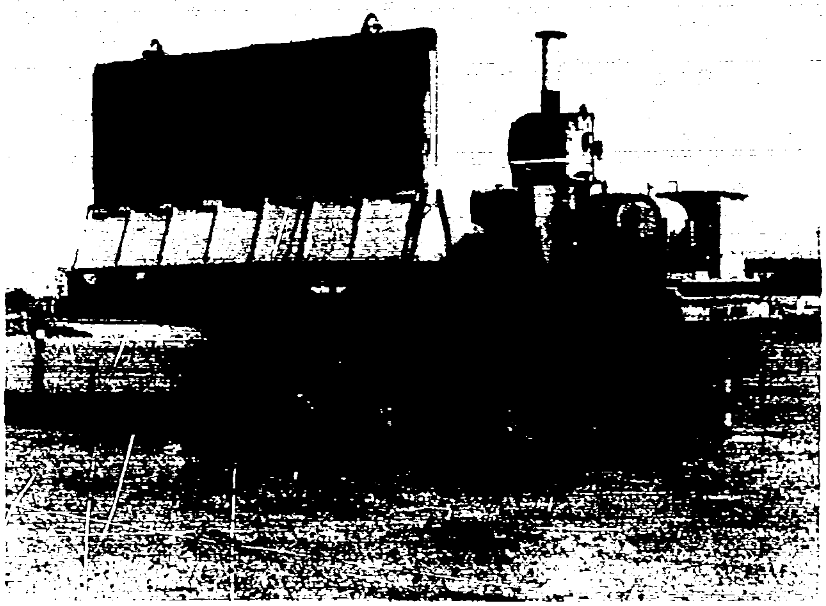

Figure 1. Shower unit loaded for transport.

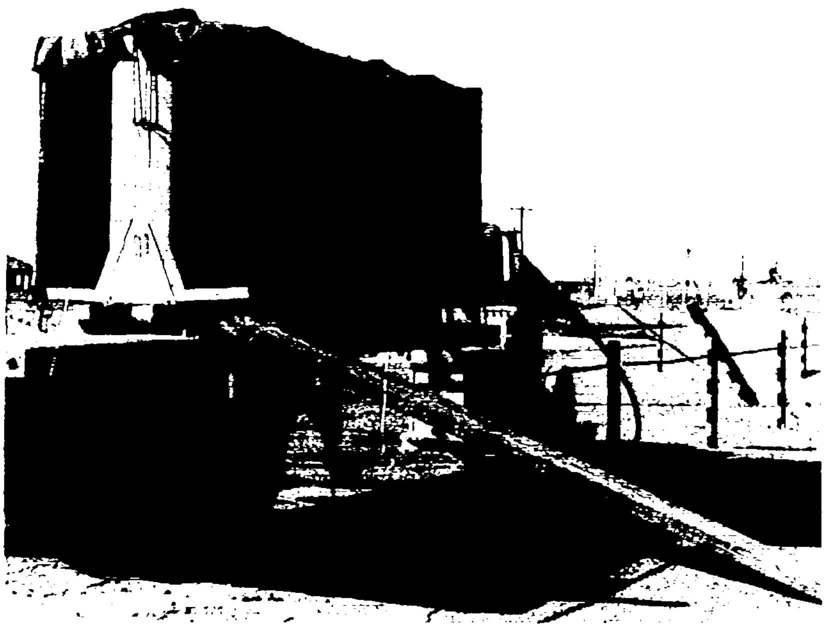

Figure 2. Shower shelter after erection.

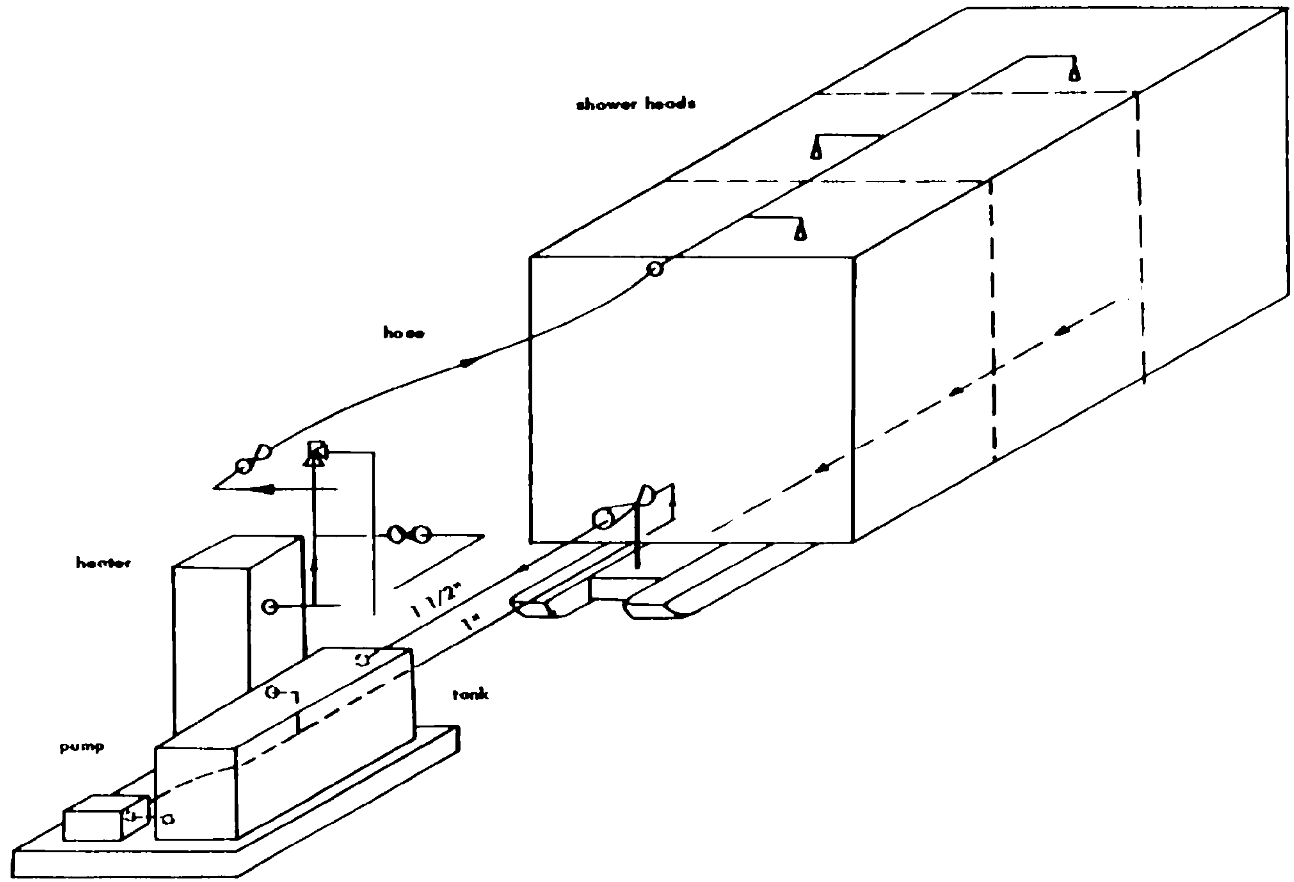

Figure 3. Water circulation diagram.

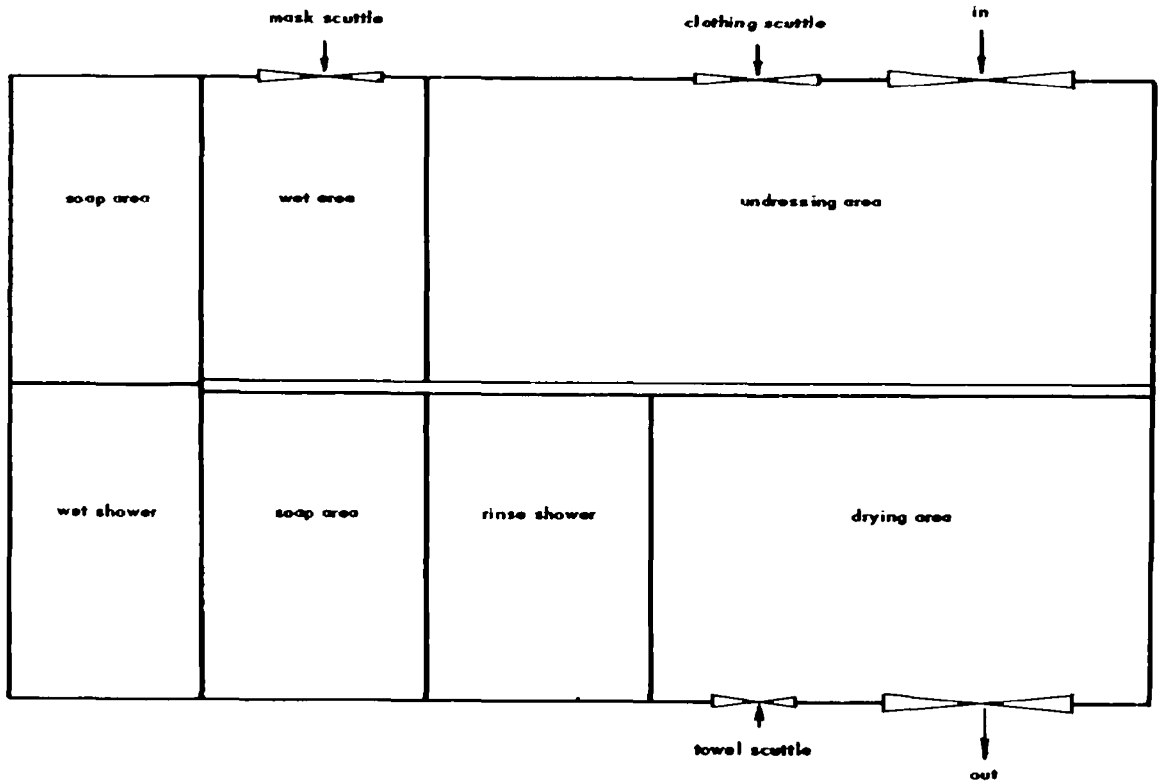

Figure 4. Shower functional diagram.

One minute is allowed for each person in each section except the undressing room where space allows each person to spend two minutes.

Water Treatment for Recirculation

The water treatment system was designed to provide about 10 minutes chlorination and sedimentation time. A chlorine residual of over 50 ppm at a pH of 8 to 9 was selected as being most likely to destroy both BW and CW agents. Provision was made in the water tank for a course filter to reduce scum recirculation. A 2" Fiberglas insulation mat was used as a scum filter, and sedimentation during the 10 minutes detention was the only provision for removing radioactive contaminants. No soap removal equipment was included. A color comparator and litmus paper provided for control tests on the detention tank. Since the STB bleach used as a chlorinating agent results in higher than desired pH's, and some CW agent reactions result in low pH's, an acid or alkali was used to keep the proper pH.

INDIVIDUAL WASHING KIT

The 60 man per hour shower unit appears to have certain difficulties which might prevent successful development[1]. One problem is that CW agents require an hour or more to detect. Since the shower operates on a 10 minute cycle, it would be impossible to check on water contamination before re-use. A second problem of the shower unit is the time required for set-up and for showering a number of men. Even with very large shower units it would require an hour or more to decontaminate any number of troops.

Results of earlier bacteriological tests[2] showed that a sponge and bucket cleaning method might be a satisfactory decontamination method. Consequently, NCEL proposed an individual washing kit for arctic decontamination use[1] which would consist of a 1 gallon can of cleansing solution, a 1 gallon can of rinse water, a brush and a towel all in one package. Emergency clothing items could be included if desired. Such individual kits could be provided in sufficient quantity for use by any number of men and exposure time to contaminants could be reduced considerably. The economy appeared superior to the mechanical water treatment of the portable shower unit, and cross-contamination between individuals is eliminated.

DECONTAMINATION EQUIPMENT TESTS

The 60 man per hour unit recirculation system was tested with atomic, biological and chemical simulants and agents. The individual washing kit was conceived too late to receive any except the chemical agent tests.

Bacteriological Recirculation Tests

The effectiveness of the chlorine as a biological disinfectant in recirculating water was tested by Fort Detrick personnel[3]. The test organisms were added to the system at the shower water gutter. When untreated and soap water were contaminated and circulated, large numbers of the test organisms, Bacillus globigii and Serratia marcescens, were contained in the shower water. However, when a chlorine concentration of greater than 10 ppm at a pH of 6.7 was maintained in circulating soapy water, none of the test organisms survived to reach the pump inlet end of the contact tank. Almost all were killed before they had reached the contact tank. The remaining few were killed in the tank. No concentration of organisms in the soap scum or the contact tank was noted.

Although the circulating water has a milky appearance from the liquid hexachlorophene soap, observation of the water delivered at the shower head indicated that it was impossible to visually detect the soap in the circulating water. A definite, but not strong, soap taste built up to fairly high levels in the water after gradual addition of soap, but there was very little difference in taste or appearance of the water regardless of the amount of soap added. Little interference between the soap and chlorine was noted; it was possible to use the colorimetric chlorine tester to determine the chlorine residual. Samples were diluted with distilled water to reduce the milkiness before testing and to bring the concentration within the range of the tester.

Radiological Recirculation Tests

The unit was set up for operation in an experimental area to simulate field service. It was operated without test subjects, but with soap added to the waste water in amounts approximating that which would actually be used by personnel. The thermostat was set to maintain a water temperature of 90 F and a chlorine residual in excess of 50 parts per million was maintained. Acid was used to keep the pH down.

It was calculated, from the showering rate of one man per minute and fallout information, that four grams per minute of synthetic fallout should be added to the system during the operation period. The material used has a specific tracer activity of 2.5×10^8 counts per minute per gram resulting in a total feed of 10^9 counts per minute. Five milliliter samples of the recirculated shower water were taken periodically and the gamma radiation activity measured in counts per minute.

Table I lists the total counts per minute added radioactivity per five milliliters of water during the test period and the counts per minute of accumulated radioactivity in the five milliliter portions of shower water over the same period of time. The removal percentage range is over 99 percent. At the end of the test period approximately one-thousandth of the tracer activity added was carried in the shower water indicating that the fallout simulant had been largely deposited in the water system. Inspection of Table 2 indicates the locations where the activity was deposited. Much of the contaminant never left the waste sump to which it was fed. Other points of concentration are the scum and scum filter.

Chemical Agent Tests

After receiving the favorable results for the atomic and biological recirculation tests, BuDocks arranged with the Directorate of Medical Research, of the CWL for a chemical agent test program for both the shower unit and individual wash kit. This program, more comprehensive than the AB tests, included bio-assay of wash kit and shower cleansing effectiveness, water treatment effectiveness, and toxic build-up in the water. Typical agents of different gas classifications were used.

Details of the test methods used are contained in reference 4. Results show that the critical decontamination factor is time. Only one or two minutes elapsed before the test animals received the full effect of some of the test agent applications. On other, slower acting agents, both systems were equally effective. The treatment and recirculation system generally prevented return of the agents to shower, but the system can allow passage of agents before failure of treatment is detected. The test report concluded that because of the immediate action of some CW agents neither method was suitable for CW decontamination. If skin contamination occurs, immediate cleaning with canteen water is suggested.

DISCUSSION

Rapid decontamination of large groups of personnel may result in considerable reduction of casualties from an ABC warfare attack. Although results of tests showed that re-use of shower waste water in a portable unit may be possible for

Table I. Shower Water Radioactivity Build-Up

Time from start of test (minutes)	Total Radioactivity added to shower sump per 5 ml water (cpm)	Radioactivity build-up in shower water (cpm/5 ml)
0	0	0
10	1×10^6	2.0×10^3
20	2×10^6	2.0×10^3
30	3×10^6	2.1×10^3
40	4×10^6	2.5×10^3
50	5×10^6	3.3×10^3
60	6×10^6	4.7×10^3
70	7×10^6	7.8×10^3
80	8×10^6	8.7×10^3
90	9×10^6	9.0×10^3
100	1.0×10^7	9.6×10^3
110	1.1×10^7	1.05×10^4
120	1.2×10^7	1.15×10^4
130	1.3×10^7	1.3×10^4
140	1.4×10^7	1.45×10^4
150	1.5×10^7	1.68×10^4

Table II. Radiation Survey of Shower Unit After Recirculation Test

Location	Radiation
Open water tank	2 to 10 mr/hr
Simulant feeder location	30 mr/hr
Outside tent north side	1 mr/hr
Floor by tank	.8 mr/hr
Outside tent west side	.1 mr/hr
Inside tent west side, over air intake screen	.1 mr/hr
Inside tent floor shower corridor	1 mr/hr
Inside tent roof shower corridor	.1 mr/hr
Inside above shower air intake	.2 mr/hr
Inside tent drain gutter shower	.7 mr/hr
Inside tent east side floor	.4 to 2.0 mr/hr
Inside tent air intake above shower (east side)	.4 mr/hr
Inside tent southeast side floor near curtain	.15 mr/hr
Inside tent southeast side rest of floor	less than .1 mr/hr
Inside tent air intake screen	.2 mr/hr
Outside tent east side (through canvas)	.1 to .3 mr/hr
Top of tent (center—wood wall)	.25 mr/hr
Stack inside	less than .1 mr/hr

atomic and biological attacks, the individual wash kit seems considerably more suitable for large groups. It may be stored indefinitely without maintenance; needs no operators or operator training program, and eliminates cross-contamination possibilities. The heavy clothing in cold weather areas should reduce the skin area exposure to a minimum and the kit can be used on exposed areas without complete undressing.

The kit components can be modified for the different decontamination requirements and situations in various climatic areas. None of the esthetic objections to re-use of shower water exist with the kit.

CONCLUSIONS

An individual washing kit is more practical than a portable shower unit for mass AB decontamination in the arctic.

CW decontamination is not feasible with the shower unit or wash kit in any climate.

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1. NCEL "Review of Decontamination Shower Unit Tests and Plans," Technical Note N-297, W. R. Nehlsen, Port Hueneme, California, 13 March 1957.

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3. NCEL "Development of a Portable Decontamination Shower Unit," Technical Note N-218, W. R. Nehlsen, S. Giles, and E. N Hellberg, Port Hueneme, California, 25 April 1955. AD-8127C

4. Chemical Warfare Laboratories "Evaluation of Safety and Adequacy of a Naval Portable Decontamination Shower," Special Publication 2-21, Army Chemical Center, Maryland (Confidential).