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RADIOLOGICAL TEST OF DECONTAMINATION SHOWER WASTE WATER RECIRCULATION

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SUMMARY

Project NY 300-010-4 requires the development of a portable arctic decontamination shower unit incorporating a waste water treatment and recirculation system. An experimental unit was devised using sedimentation and chlorination as a basis of waste treatment. This system was recently tested with a radioactive fallout simulant at the Naval Radiological Defense Laboratory. Results indicated that over 99 per cent of the simulant was removed from the waste water and was deposited in the shower sump and waste treatment tank. It is concluded that a waste water treatment and recirculation system should be included in the unit design.

INTRODUCTION

Navy personnel constructing, operating, and maintaining advanced bases and shore establishments may be contaminated by CBR agents during an enemy attack. To minimize personal injury from these agents, it is desirable to provide emergency decontamination shower facilities for all personnel. Project NY 300 010-4, "Portable Arctic Decontamination Shower Unit," directs the development of a lightweight, portable, shower assembly for decontamination of personnel exposed to chemical, biological, and radiological warfare agents. Development of an experimental unit embodying these features was undertaken by this Laboratory. Because of the probable scarcity of an adequate water supply under CBR warfare conditions, an investigation of the practicability of treating and reusing the shower water has been included. This report summarizes the results of testing and investigating the shower waste treatment for radiological decontamination.

DESCRIPTION OF UNIT

The 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 is based on a rigid center frame with a skid base. Canvas is used for the walls and roof. To open the shelter from its collapsed position, the floor panels are folded down and a metal frame is set up to support the canvas. The water supply section consists of a 150-gallon water tank, a pump, and an oil-fired instantaneous water heater with thermostatic control. The water tank provides chlorine reaction time. A glass wool scum filter is placed across the tank ahead of the pump inlet to minimize the amount of scum circulated. Three shower heads are located in the shower shelter.

DECONTAMINATION REQUIREMENTS

In the event of CBR contamination, the prime requirement is rapid removal of the contaminant from the skin to reduce the chance of injury. The time available for decontamination depends considerably on the type of contamination. A bacterial contaminant will generally cause no direct harm, but its removal is necessary to avoid the possibility of the organisms being inhaled, or of their 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 placed in service in less than an hour.

The amount of contamination that actually reaches the skin of an individual will depend on the amount and type of clothing worn. It is assumed, however, that many persons will be sufficiently contaminated to require a shower and fresh clothing. The amount of effort required to remove typical contaminants varies and ranges from washing with clear water to special medical treatment. A decontamination shower using soap and water is adequate in most instances. The design of the experimental unit is based on providing a four-minute shower.

WATER TREATMENT FOR RECIRCULATION

The waste water treatment scheme of the unit was kept as simple as possible to minimize cost and operation problems. Mainly, heavy chlorination is the treatment provided. The contact tank allows 10 to 15 minutes reaction time for the chlorine. Decontamination bleach is used for chlorination and a residual of 10 to 15 parts per million is considered the minimum for sanitation. Higher values may be used for biological decontamination. Since decontamination bleach normally raises the pH to a point at which the chlorine acts slowly, it is necessary to use acid to keep the value just below seven, the desired range. Litmus paper is used to test for pH and a color comparator type of device, for chlorine residuals by the drop dilution method.

ADDITIONAL TREATMENT

The 150-gallon chlorine contact water tank also allows for sedimentation of dirt particles. The glass wool filter across the tank ahead of the pump inlet serves to reduce the amount of scum circulating and will remove some particulate matter.

RECIRCULATION EXPERIMENT WITH RADIOACTIVE CONTAMINATION

Technical Note N-218, "Development of a Portable Decontamination Shower Unit," suggested that no recirculation be attemped on radioactive waste since the treatment scheme has no feature that will incure removal of soluble or colloidal material. However, since a radioactive contaminant might be a large particulate, it was decided to undertake a simple recirculation test at the Naval Radiological Defense Laboratory to explore the problems involved and to determine whether recirculation is possible.

NRDL EXPERIMENTAL DETAILS

The unit was set up for operation in an experimental area to simulate field service. Operation was without test subjects, but soap was added to the waste water in an amount to approximate that which would actually be used by personnel. The thermostat was set to maintain a water temperature of 90 degrees 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 had 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. Samples of the recirculated shower water were taken periodically and the gamma radiation activity was measured in counts per minute from five milliliter portions.

Table 1 lists the total counts per minute added radioactivity per five milliliters of water during the test period and the counts per minute of built up radioactivity in the five milliliter portions of shower water over the same period of time. The removal percentage range is over 99 per cent. 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 (see Figure 2). Other points of concentration are the scum and scum filter.

CONCLUSIONS

The effectiveness of the waste water treatment in removing fallout simulant was much greater than had been expected and indicates that the simulant settled out very readily. The concentration of radioactivity in the shower sump to form a 30 mr/hr radiation source indicates that special precautions may be necessary to minimize exposure of operating personnel when a more highly radioactive contaminant is involved.

The results of this test indicate that a waste water treatment and recirculation system can be usefully included in the portable arctic decontamination shower unit.

Table 1. 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 2. 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

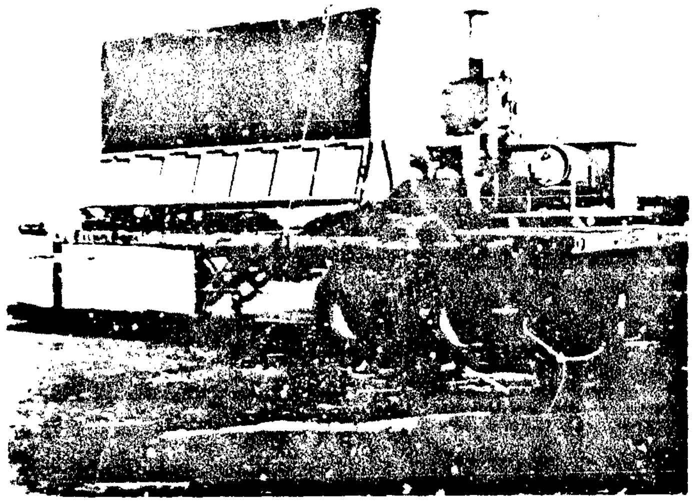

Figure 1. Shower unit loaded for transport.

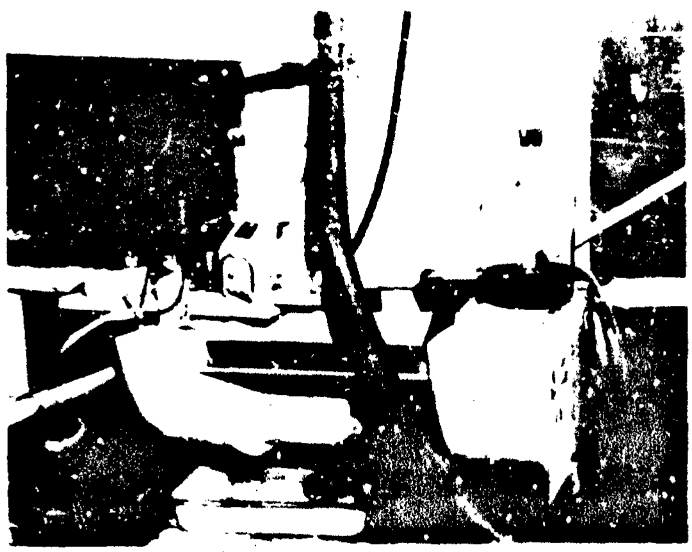

Figure 2. Fallout simulant and soap being fed to shower waste sump.