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EVALUATION OF A DEWATERING SYSTEM FOR HASTY FUEL STORAGE RESERVOIRS

Joe Medrano

Army Mobility Equipment Research and
Development Center
Fort Belvoir, Virginia

October 1972

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13. ABSTRACT

This report covers the testing and evaluation of a dewatering system to determine its suitability to remove rainwater from the top surface of hasty fuel storage reservoirs.

The dewatering system was field tested with suitable pumping units employing a single- and a double-tube configuration under simulated heavy rainfall conditions. The test showed that with suitable pumping units, better dewatering results were obtained with a single-tube configuration than with a double-tube configuration. The test also showed that several factors in the dewatering system prevent successful dewatering operations on hasty fuel storage reservoirs under field conditions.

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EVALUATION OF A DEWATERING SYSTEM FOR HASTY FUEL STORAGE RESERVOIRS

Task 1J664717DL4111

Octobe: 1972

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The Commanding Officer
U. S. Army Mobility Equipment Research and Development Center

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SUMMARY

This report covers the test and evaluation of dewatering equipment to determine its suitability to remove rainwater from the top outside surface of hasty fuel storage reservoirs.

The dewatering system was field tested with suitable pumping units employing a single- and a double-tube configuration under simulated heavy rainfall conditions. The test showed that with suitable pumping units, better dewatering results were obtained with a single-tube configuration than with a double-tube configuration. The test also showed that several factors prevent successful dewatering operations on hasty fuel storage reservoirs under field conditions.

This is an interim report; work is continuing on techniques for elimination of rainwater from Hasty Fuel Storage Reservoirs.

FOREWORD

The test and evaluation covered by this report were conducted under the general authority of Project 1J664717DL41, "POL Distribution Systems." The work was accomplished in conformance with specific requirements of the Task 1J664717DL4111, "Bulk Fuel Storage."

The period covered is September 1970 through October 1970.

This project was under the general supervision of John D. Grabski, Chief, Fuels Handling Equipment Division, and under the direct supervision of N. A. Caspero, Chief, Onshore Fuel Systems Branch.

The following personnel participated in the test program: Joe Medrano, Project Engineer; James Christopher, Equipment Specialist; Warren Parrish, Test Leadman.

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FOR HASTY FUEL STORAGE RESERVOIRS

I. INTRODUCTION

1. **Background.** The hasty bulk fuel storage reservoir is a new item of equipment developed by the U. S. Army Mobility Equipment Research and Development Center (USAMERDC). The reservoir is intended to provide bulk storage facilities until permanent storage can be constructed. It has a capacity of 25,000 barrels and can be rapidly installed by engineer troops and other troops with construction equipment support. The reservoir is a revetment-supported envelope-type tank constructed of a lightweight elastomer-coated fabric which is positioned within a trapezoidal cross-sectional earthen pit prepared by excavation (Fig. 1). When filled to capacity, the top dimensions are 92 feet wide by 185 feet long, and it is 13 feet deep. The storage facility is designed to be suitable for operation under all environmental conditions except polar and arctic. Continuous reuse of the reservoir is planned during wartime to the extent of 1-year operational life.

Rainwater and melted snow which accumulate on the top outside surface of the reservoir must be removed to prevent operational problems. The water, having a greater density than fuel in storage, tends to migrate to a level beneath the fuel. To control the formation of water pools on the tank surface, a dewatering system consisting of tubes, hoses, and pumps is positioned longitudinally along the top surface of the tank. The weight of the tubes form a slight depression on the tank fabric where water can collect and can be pumped out from pools.

The concept of the dewatering system was first used on the 10,000-barrel hasty fuel storage reservoir, the top pit dimensions of which were 45 feet wide by 185 feet long. The dewatering performance was considered marginal. The same system was proposed for the 25,000-barrel reservoir.

The reservoir was subjected to integrated engineering/service tests under limited temperature climatic conditions (0° F to 90° F) at Fort Lee, Virginia during the period from June 1969 to June 1970. The reservoir was safely, durably, and efficiently utilized to receive, store, and transfer bulk fuel during a 12-month fuel cycling test period. The only difficulty experienced was in removing accumulated rainfall from the top surface of the tank. The dewatering system furnished with the reservoir was not acceptable. Two types of dewatering pumps furnished did not possess sufficient durability to allow completion of testing (Fig. 2). Failure of the pumping units prevented accomplishment of testing under simulated heavy rainfall conditions (4 inches per hour)

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Fig. 1. A 25,000-bbl hasty fuel storage reservoir installation with dewatering system.

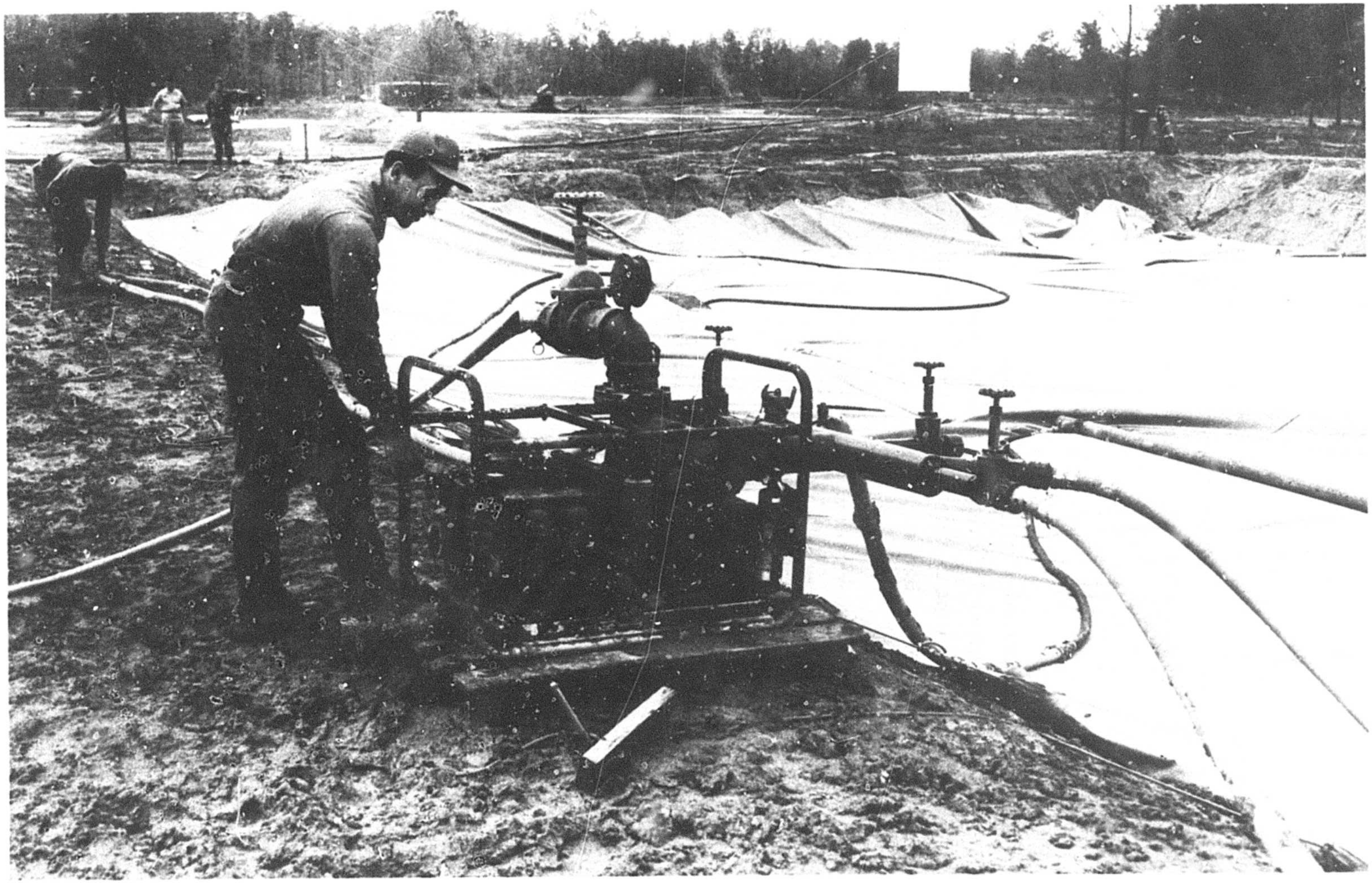

Fig. 2. Pump, manifold and hose arrangement for dewatering system during ET/ST.

designed to completely evaluate the system. To determine the suitability of the dewatering system, USAMERDC recommended that a complete evaluation of the system be conducted using suitable pumping units.

2. **Objective.** The objective was to evaluate the suitability of the dewatering system by using a single and a double dewatering tube to remove accumulations of simulated rainfall from the top surface of hasty fuel storage reservoirs (Fig. 3).

II. INVESTIGATION

3. **Description of Material.** The dewatering equipment for the test consisted of the same equipment used during the ET/ST with the exception of the pumping units. The pumps were commercial type 2-cycle "trash pumps." The dewatering equipment consisted of the following components:

a. Dewatering pumps – two each, 2-cycle, self-priming centrifugal, Homelite Model 9TP3-1A, "Trash Pumps," 385 gpm at 22 feet total head, with a lift of 15 feet, 3650 rpm.

b. Dewatering tubes – fourteen sections of 6-inch diameter, 20-foot length perforated steel tubing with 6-inch tees and coupling for attaching dewatering hoses.

c. Dewatering hose – seven hundred and fifty feet of various lengths (10-foot, 25-foot, 50-foot sections) of 2-inch suction hose.

d. Manifold for dewatering hose – two each 4-inch aluminum manifold with attachments and valving for five 2-inch dewatering hoses.

The dewatering equipment was positioned in two different configurations as shown on Fig. 4. Each pump was attached using a 4-inch manifold to either three or five 2-inch suction hoses, depending upon the tube configuration utilized. One of the suction hoses was designated as a "free" hose and was not attached to the dewatering tube. The "free" hose was positioned by use of ropes and was used to dewater pools which were not accessible to the dewatering tubes.

4. **Details of Test.** The dewatering equipment was tested under simulated heavy rainfall conditions. Single-tube and double-tube configurations were used to remove the accumulated water while the reservoir was filled to one-third and two-thirds capacity. Heavy rainfall conditions (4 inches per hour) were simulated by spraying water at

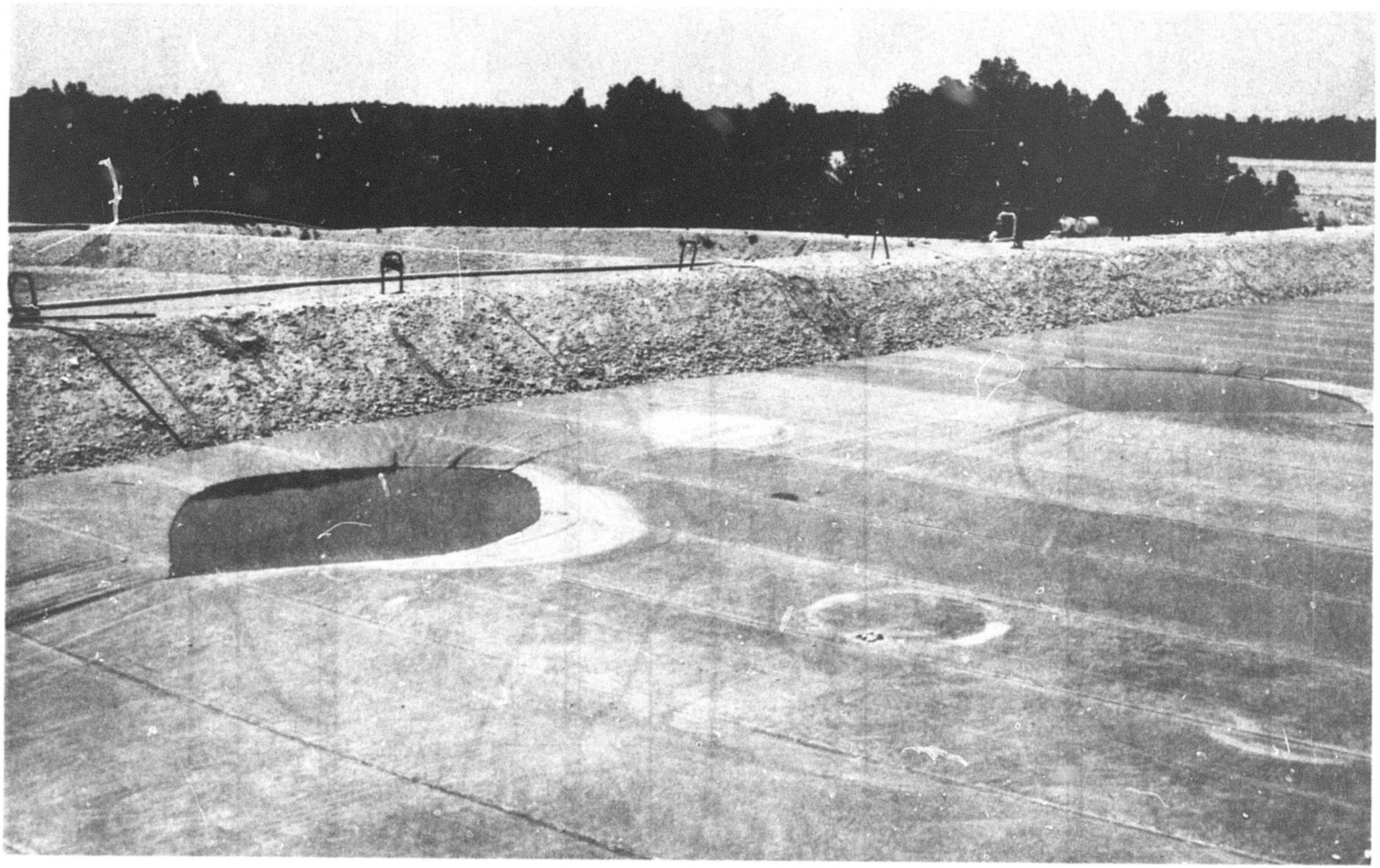

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Fig. 3. Typical rainwater pool formation on top of tank surface.

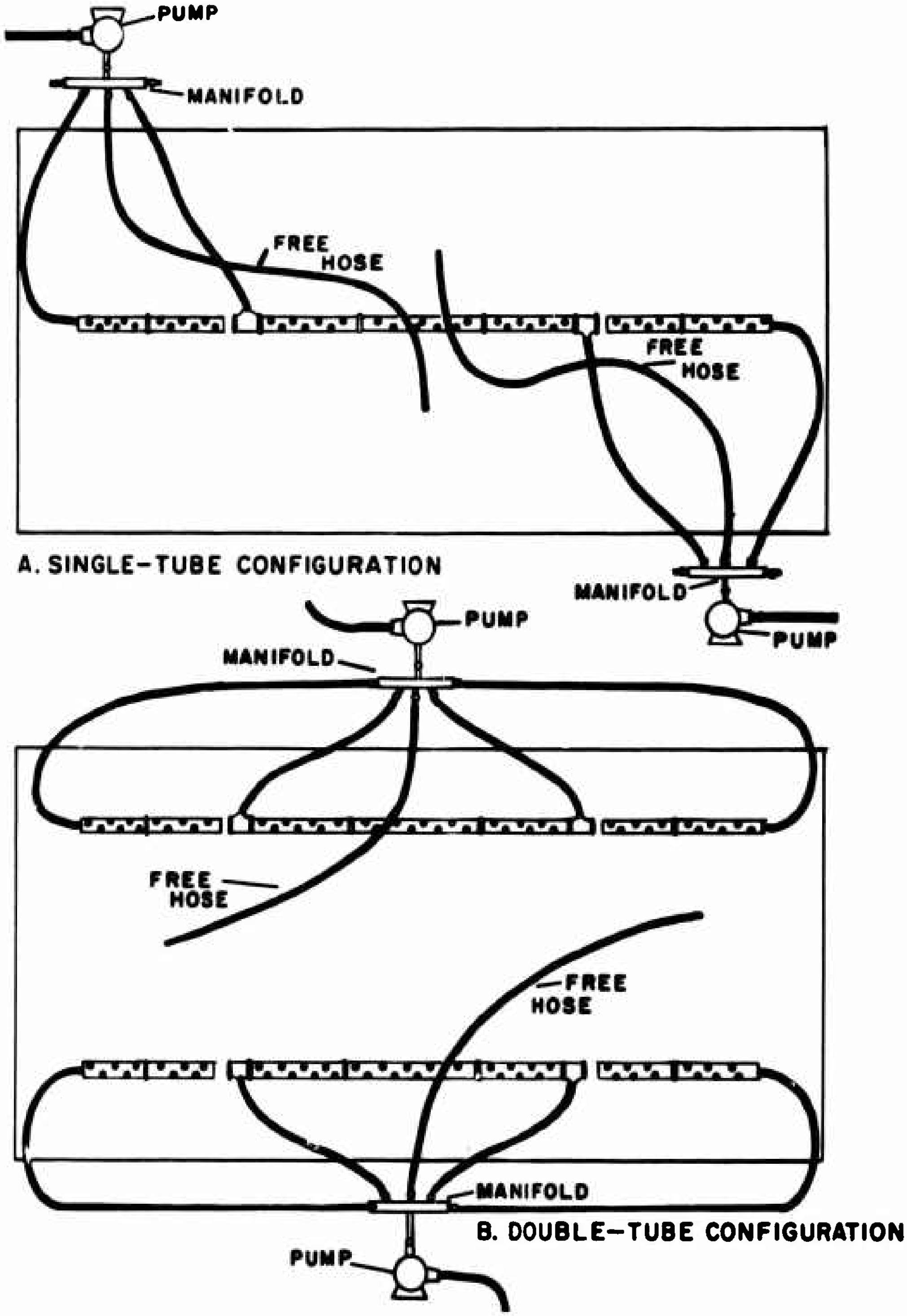

Fig. 4. Dewatering system test configurations.

a rate of 650 gpm over the entire surface of the reservoir using six 2-inch firefighting nozzles attached to high pressure water hoses.

a. Evaluation of Single Dewatering Tube with Reservoir at One-Third of Capacity. One dewatering tube and two pumps were positioned as shown on Fig. 4A, and the reservoir was filled with approximately 8000 barrels of fuel. The rainfall simulation system was operated for a period of 20 minutes.

The test showed that the major portion of the water accumulated in the crease made by the tube at the center of the tank. One man operated each pump and manifold while a second man handled the free hose to pump out small puddles. Both pumping units were started 3 minutes after the start of the simulated rainfall and obtained prime in less than 2 minutes. The established dewatering flow rate on each pump was 160 gpm with three hoses operational. No serious problems were experienced under the test conditions in dewatering at a rate of 440 gpm with both pumping units.

b. Evaluation of Single Dewatering Tube with Reservoir at Two-Thirds of Capacity. With the same dewatering tube positioning, the reservoir was filled with approximately 16,000 barrels of fuel. All loose tank fabric was pulled up against the berm slope. The rainfall simulation system was then operated for a period of 20 minutes.

The test showed that most of the water accumulated in pools where the tube was positioned with the largest pool located over the reservoir fill-draw fitting. There were small pools in areas away from the dewatering tubes. The pools were pumped out using one free hose.

Both pumping units again primed in less than 2 minutes and established a dewatering flow rate on each pump of 120 gpm with one hose operational and 200 gpm with three hoses operational. No serious problems were experienced under the test conditions in dewatering at a total rate for both pumping units of 440 gpm.

c. Evaluation of Double Dewatering Tubes with Reservoir at One-Third of Capacity. The reservoir was completely emptied of fuel and a second set of dewatering tubes was installed. Both sets of tubes were positioned as shown on Fig. 4B. The reservoir was then filled with approximately 8000 barrels of fuel (Fig. 5). The rainfall simulation system was operated for a period of 30 minutes.

The test showed that the major portion of rainfall accumulation occurred on the center of the reservoir instead of along the dewatering tubes. Water had to be pumped out using the free hose. At one point one set of tubes submerged when enough water had collected and caused the second set of tubes to come up to the top

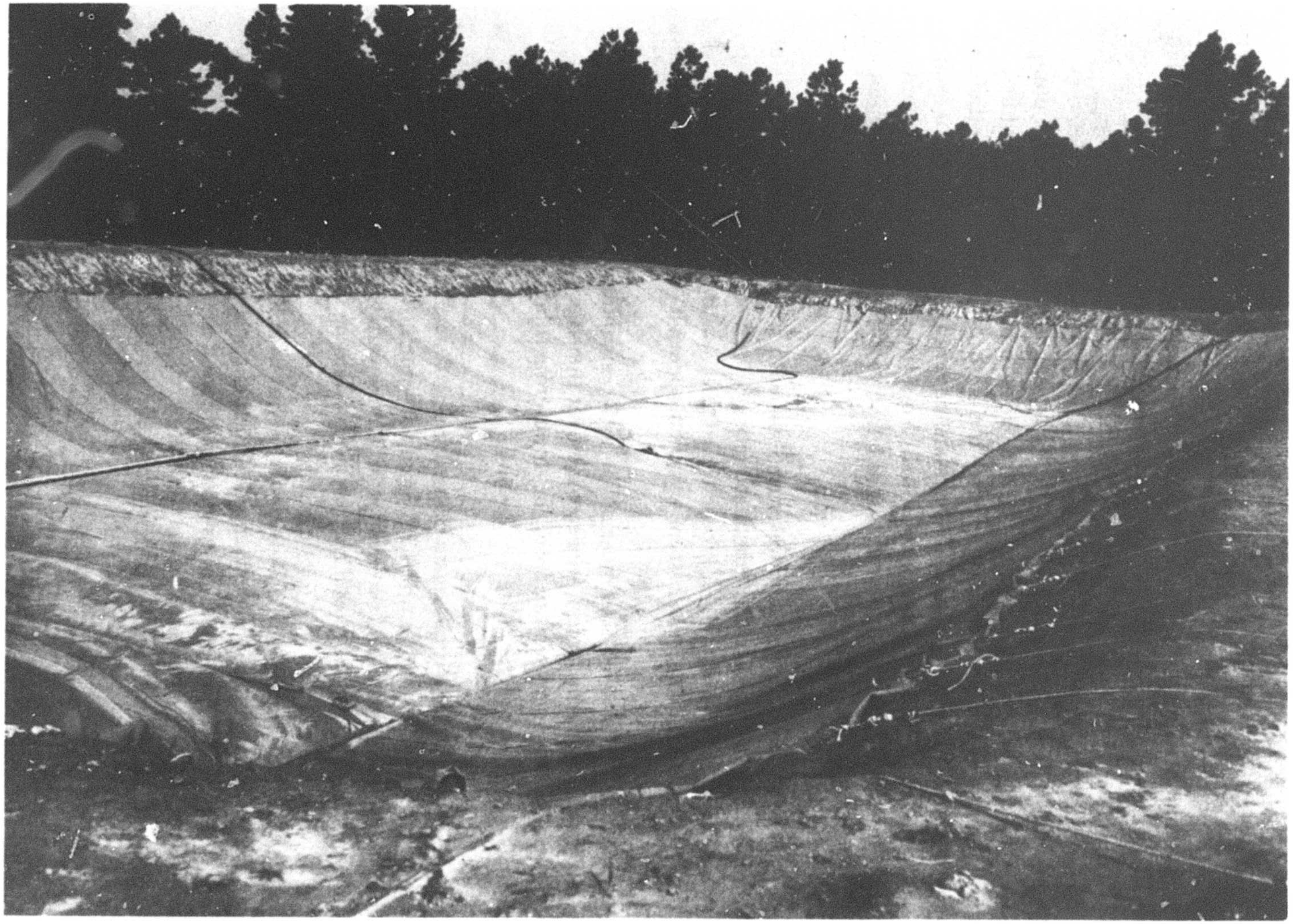

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Fig. 5. Double dewatering tubes on reservoir filled to approximately one-third capacity.

surface of the tank. Both dewatering tubes shifted position and became misaligned during dewatering operation as water from one pool emptied into a larger pool. One set of tubes bridged over pools of water could not be pumped using the dewatering tubes (Fig. 6). Some pools began to "tear drop" after a large volume of water had collected and could be pumped off only using the free hose. It was noted that the rate of rainfall simulation greatly exceeded the rate of removal.

d. **Evaluation of Double Dewatering Tubes with Reservoir at Two-Thirds of Capacity.** With the dewatering tubes positioned the same as in the previous test, the reservoir was filled with approximately 16,000 barrels of fuel (Fig. 7). The rainfall simulation system was operated for a period of 25 minutes.

The test showed that, as in the previous test, one set of tubes became completely submerged with large pools while the other set of tubes remained on the top surface of the tank, bridging over large water pools. The largest pools were noted directly over the fill-draw fitting of the reservoir. A section of tubes was misaligned during the operation and in another area the tank fabric slipped over the tube but no damage to the tank was noted. Pump prime could be obtained from one tube through only two hoses. A dewatering flow rate of 180 gpm was established during the dewatering operation. It was noted again that the rate of accumulation greatly exceeded the rate of water removal.

III. DISCUSSION

5. **Discussion.** Testing was conducted for a limited time period under controlled test conditions. Extended operation under adverse weather conditions of cold, mud, darkness and heavy rainfall would greatly complicate dewatering operations.

Dewatering operations were started immediately after simulated rainfall accumulations. In actual field conditions, the time to start dewatering could be expected to be longer. Pools of water will form "tear drops" and become entrapped between folds of fabric if dewatering is not started immediately when water begins to collect.

Operation of the dewatering system in each case required one NCO in charge with at least two men to operate each pumping unit, manifold, and free hose, for a total of five men. A 24-hour operational capability (8-hour shifts) during periods of heavy rainfall would require a total of 15 men to operate the dewatering system on each reservoir installation.

It was noted that hot climatic conditions presented a problem during dewatering operations. Gasoline vapor caused by the evaporation of fuel created pockets of

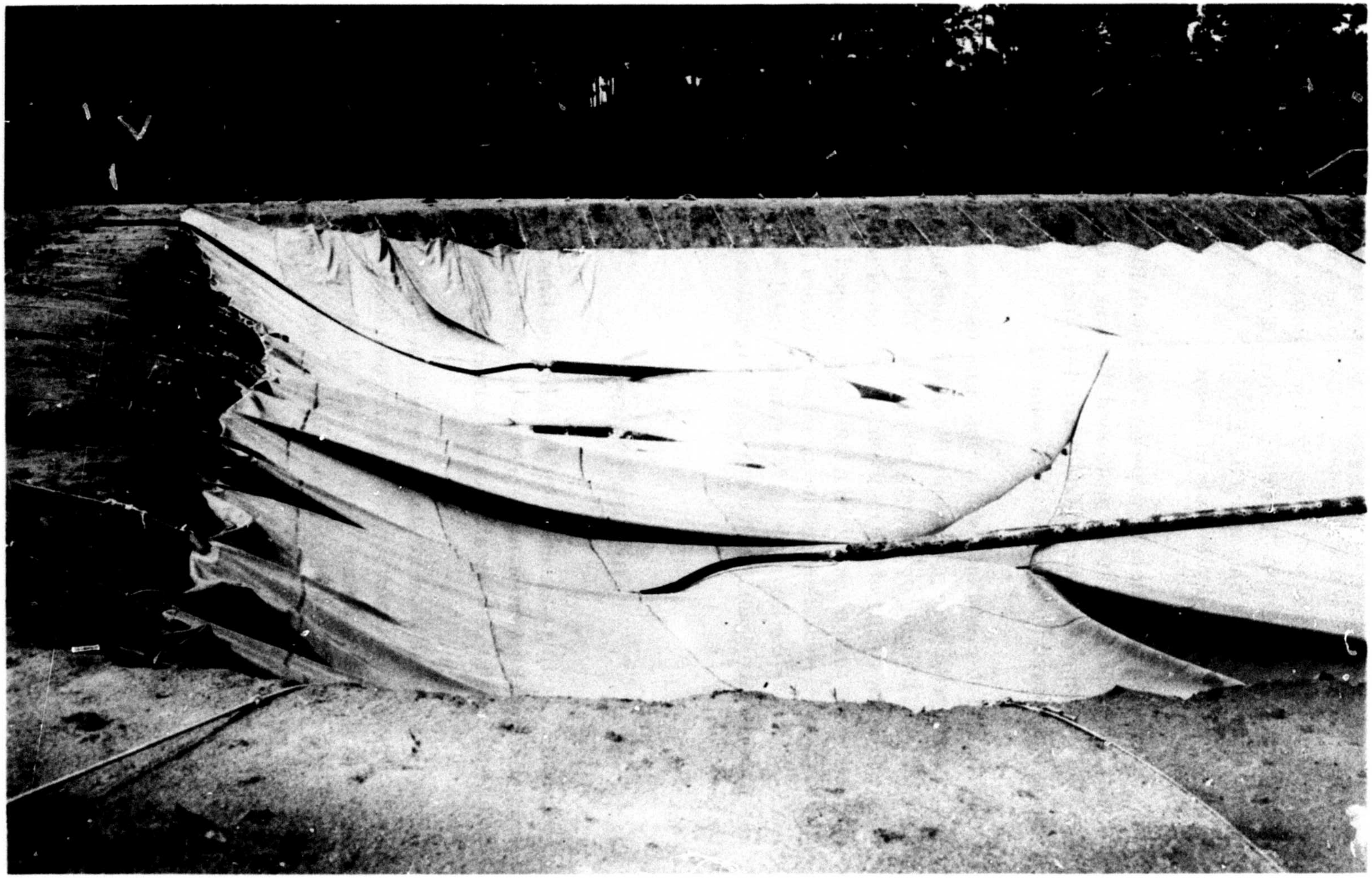

Fig. 6. Dewatering tube bridging over pool of water.

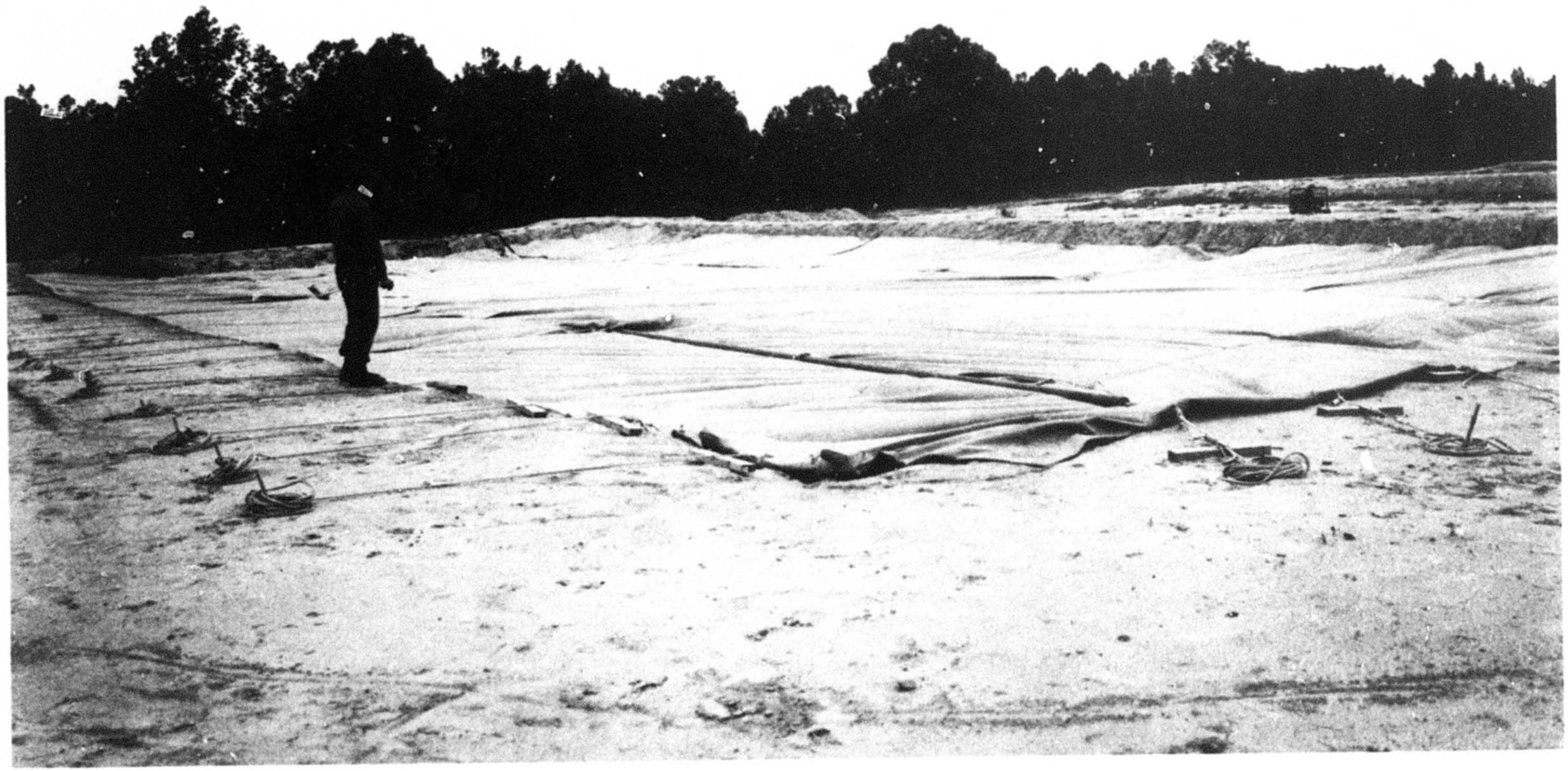

Fig. 7. Dewatering tubes on reservoir filled less than full capacity.

Fig. 8. Dewatering tubes on tank with gasoline vapor pockets.

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Fig. 9. Accumulations of snow on the top surface of a hasty fuel storage reservoir.

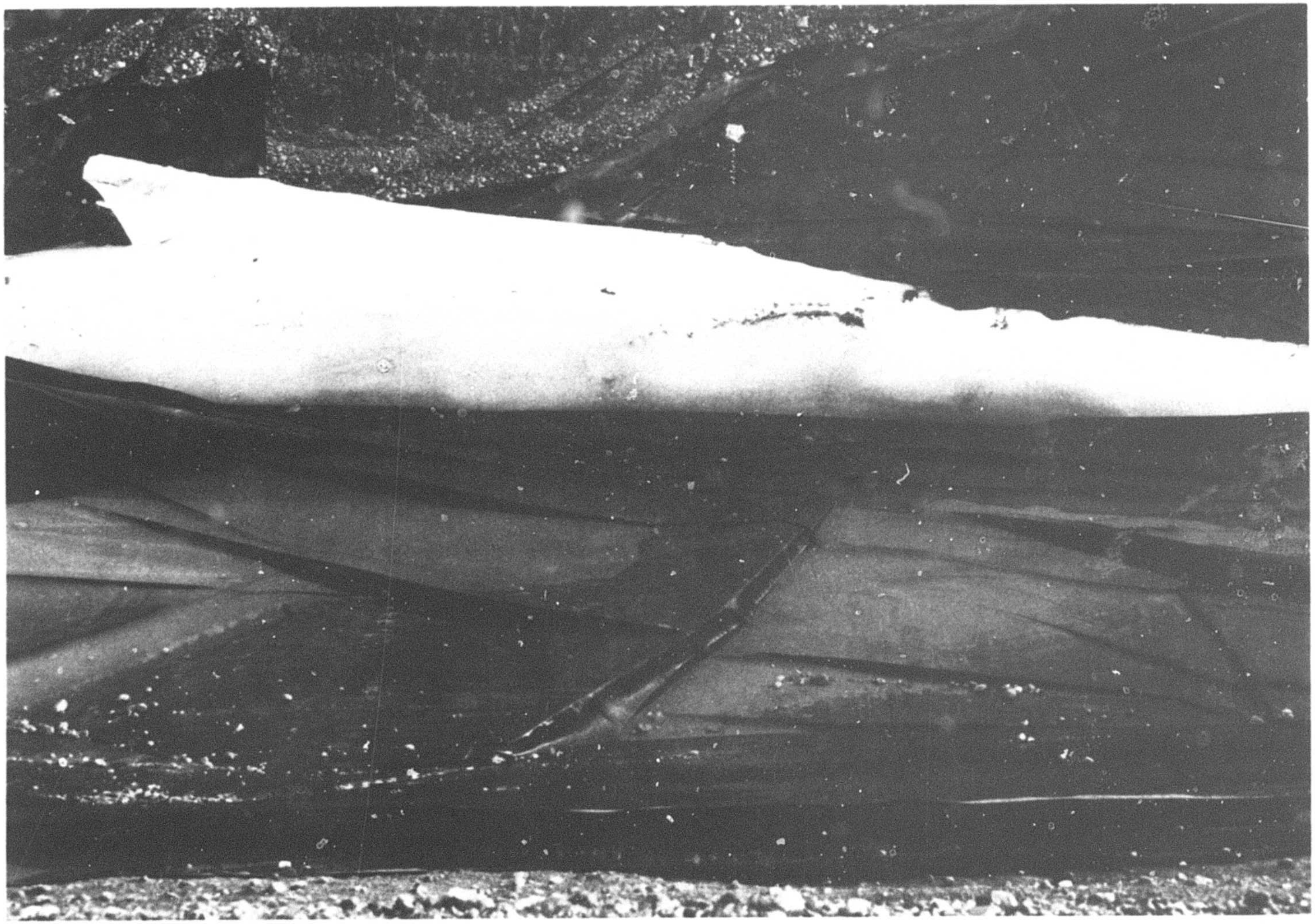

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Fig. 10. Ice formation from water pool on the top surface of a hasty fuel storage reservoir.

vapor between the tank fabric and the top surface of the contained fuel (Fig. 8). The vapor pockets caused the tank fabric to float and, as a result, displaced the dewatering tubes, causing misalignment. The vapor pockets also caused the water to pool in depressions formed in fabric folds, which was the start of a large pool.

The dewatering system was not tested during winter conditions. Previous experience with hasty storage reservoir operations during freezing weather has shown that snow accumulations on the top surface of the reservoir interfere with dewatering operations. Accumulations of snow slid down the walls into the pit and piled up on the top surface of the tank (Fig. 9). Accumulations of snow in the area of the fill-draw fitting prevented withdrawal of fuel from the reservoir.

When the snow melted, a different problem existed. When the temperature was above freezing, the melted snow formed pools of water that could be pumped off using the dewatering system. During freezing temperatures, the pools of water froze (Fig. 10). Ice formation over the tank surface near the fill-draw fitting prevented fuel from being withdrawn from the reservoir. The tank fabric was also susceptible to puncture by sharp protruding edges of the ice formation, especially when the ice sheets broke up. The dewatering system is incapable of removing any amount of snow accumulation or ice formation from the top surface of the reservoir.

IV. CONCLUSIONS

6. **Conclusions.** The test showed that with the system of necessary hoses, manifolds, and suitable dewatering pumps, better dewatering results could be obtained with a single-tube configuration than with a double-tube configuration. The test also showed that the following factors prevent successful dewatering operations on hasty fuel storage reservoirs under field conditions:

a. Time to begin dewatering after the start of a rainfall is critical. If dewatering is not started immediately, pools of water will form on the tank top surface and will eventually form a "tear-drop" and trap the water between folds in the fabric.

b. The weight of large volumes of collected surface water, if not removed immediately, will cause pull-up straps in the tank to break or induce tears in the tank fabric.

c. The starting and priming operation of the dewatering pumps is not reliable. During heavy rainfalls, enough water can collect on the top surface of the reservoir to cause damage to the tank fabric while trying to achieve pump prime.

d. Pump design, such as the "trash pumps" is essential to handle debris because of dirt and rocks from the berm freeboard erosion and dust that blows onto the reservoir surface.

e. During a dewatering operation, there is always the danger of puncturing the tank fabric with the "free" hose or with the dewatering tubes.