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RDT&E PROJECT NO. ________________

USATECOM PROJECT NO. 7-7-0862-01/02/03/04/05

INTEGRATED ENGINEERING AND SERVICE TEST OF CONTAINER, WATER, PLASTIC, 5-GALLON

FINAL REPORT

BY

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FEBRUARY 1968

U S ARMY
GENERAL EQUIPMENT TEST ACTIVITY
FORT LEE, VIRGINIA

FOR INFORMATION ONLY

ACTION BY HIGHER AUTHORITY PENDING

DEPARTMENT OF THE ARMY
HEADQUARTERS, U. S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

AMSTE-GE

23 APR 1968

SUBJECT: Final Report of Integrated Engineering and Service Test of Container, Water, Plastic, 5-Gallon, USATECOM Project Nos. 7-7-0862-01/02/03/04/05

Commanding General
U. S. Army Materiel Command
ATTN: AMCRD-J
Washington, D. C. 20315

1. Reference U. S. Army General Equipment Test Activity Final Report, "Integrated Engineering and Service Test of Container, Water, Plastic, 5-Gallon", February 1968.

2. Inclosed are five copies of subject final report as approved by this headquarters.

3. This headquarters concludes that:

a. The Container, Water, Plastic, 5-Gallon tested is suitable for use by the U. S. Army in temperate, tropical and desert environments.

b. The Container, Water, Plastic, 5-Gallon tested is not suitable for use by the U. S. Army under arctic winter conditions because they were destroyed (melted by heat) when attempts were made to thaw frozen water contained inside.

4. This headquarters recommends that:

a. The Container, Water, Plastic, 5-Gallon be considered for type classification as Standard "A" for use in temperate, tropical and desert environments.

b. The Container, Water, Metal, 5-Gallon remain type classified as Standard "A" for use in arctic environment and be considered for type classification as Standard "B" for use in temperate, tropical and desert environments.

AMSTE-GE 23 APR 1968

SUBJECT: Final Report of Integrated Engineering and Service Test of Container, Water, Plastic, 5-Gallon, USATECOM Project Nos. 7-7-0862-01/02/03/04/05

c. As many as feasible of the shortcomings listed in Appendix III of subject report be corrected.

FOR THE COMMANDER:

JAMES O. DAULTON
Colonel, GS
Director, General Equipment Testing Directorate

1 Incl
as (5 cys)

Copies furnished:
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RDT&E PROJECT NO. ______________________

USATECOM PROJECT NO. 7-7-0862-01/02/03/04/05

INTEGRATED ENGINEERING AND SERVICE TEST
CONTAINER, WATER, PLASTIC, 5-GALLON

TEST REPORT

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GENERAL EQUIPMENT TEST ACTIVITY
FORT LEE, VIRGINIA

U. S. ARMY GENERAL EQUIPMENT TEST ACTIVITY
FORT LEE, VIRGINIA

USATECOM 7-7-0862-01/02/03/04/05

Final Report of Integrated Engineering and Service Test of Container, Water, Plastic, 5-Gallon

Conducted at Fort Lee and Camp Pickett, Virginia; Panama Canal Zone and Rio Hato Training Area, Republic of Panama; Fort Greely, Alaska; Fort Bragg, North Carolina; and Yuma Proving Ground, Yuma, Arizona

February 1968

Abstract

An Integrated Engineering and Service Test of Container, Water, Plastic, 5-Gallon, was conducted during the period September 1966 - 21 December 1967 to determine technical performance and safety characteristics of the container as described in the Military Characteristics and as indicated by the particular design and to determine the suitability of the container for use by the Army.

It was concluded that the plastic water container: is not suitable for arctic use; is more suitable than the steel container for tropic and desert use; is suitable for temperate use; and is safe for its intended use. It was also concluded that full plastic containers are suitable for airdrop and internal and external air transport and that the redesigned cap satisfies the requirement to fill canteens without waste of water but it leaks at the air vent.

It is recommended that the plastic water container be considered: suitable for use by the U.S. Army in temperate, tropical, and desert environments; not suitable for use in arctic winter environment; and as suitable as the steel container for airdrop and internal and external air transport. It is also recommended that: the plastic material be changed to preclude deterioration when subjected to extended uncovered desert storage and to reduce flammability characteristics; the hollows in the handle and hollow humps at top of the container be eliminated; the redesigned cap be modified to prevent leakage and air vent retaining pin failures; the bottom be redesigned to increase stability of the container; one or two additional handles be added to the top to facilitate handling; the shape be made more uniform and rectangular, the surface of the containers be made less slippery, and the top and bottom be made compatible for better stacking characteristics; and the V-shaped cap seal be made U-shaped to reduce cuts and tears.

FOREWORD

The U.S. Army General Equipment Test Activity was the executive agency responsible for publication of the test plan and completion of the final report. Portions of the test were written, executed, and reported by the U.S. Army Tropic Test Center, the U.S. Army Arctic Test Center, the Yuma Proving Ground, and the U.S. Army Airborne Electronics and Special Warfare Board.

The test was authorized by letter, AMSTE-GE, Headquarters U.S. Army Test and Evaluation Command, Aberdeen Proving Ground, Maryland, 1 July 1966, subject: "Test Directive, Integrated Engineering/Service Test of Container, Water, Plastic, 5-Gallon". That directive was amended by letter, AMSTE-GE, USATECOM, 23 November 1966, subject: "Test Directive, Integrated Engineering/Service Test of Container, Water, Plastic, 5-Gallon--USATECOM Project No. 7-7-0862". Supplemental testing on the redesigned cap was authorized by letter, AMSTE-GE, USATECOM, 26 May 1967, subject: "Test Directive (Amendment), Integtated Engineering/Service Test of Container, Water, Plastic, 5-Gallon, USATECOM Project No. 7-7-0862-01/02/03/04/05".

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SECTION 1. INTRODUCTION

1.1 BACKGROUND

a. Comparison test of the U.S. Army standard steel, Type I, and a U.S. Marine Corps aluminum 5-gallon water container was completed in February 1948. Results of that test showed that the aluminum container was equal or superior to the steel container for most normal uses, but less durable. A major defect was in the closure locking device.

b. A second comparison test of the aluminum versus the U.S. Army steel 5-gallon water container was completed in November 1963. The purpose of this test was to determine whether the aluminum water container, with modified closure, or the standard steel 5-gallon water container was best suited for use by all military services within the DOD. Results showed that the aluminum water container was considered suitable for type classification as Standard A.

c. Subsequent to the second test of the aluminum water container, it became apparent that both the Australian and Canadian Armies had approached high success potential with a 5-gallon plastic water container. Based on this situation, Natick Laboratories recommended that type classification action of the aluminum water container be deferred until final resolution of the plastic container development could be effected. Headquarters USAMC and Headquarters USACDC both concurred in the Natick recommendation. Two hundred of the Canadian-developed plastic 5-gallon water containers (X65A) were made available to the Natick Laboratories for in-house evaluation, and 500 containers were purchased for the integrated engineering and service tests. Subsequently, an additional 625 containers were purchased for the stacking, storage, airdrop, and air portability tests.

d. One of the essential military characteristics states, "The plastic water container shall incorporate a means to fill canteens without waste of water." The original container (and cap) did not fulfill this requirement, and action to overcome this problem resulted in the procurement of a redesigned cap, which was made available after testing was initiated.

1.2 DESCRIPTION OF MATERIEL

a. The experimental 5-gallon plastic water container (X65A) is 18 3/8 inches high, 13 1/2 inches long, 6 3/8 inches wide, and weighs approximately 5 pounds. The opening for filling and pouring is 3 1/2 inches in diameter. The cap is of the screw type with a captive strap around the neck. The open end of the strap snaps into a recess around the opening, thereby providing attachment to the container. The body is blow-molded from high density polyethylene plastics, and the cap and strap are injection molded from a blend of medium and low density polyethylene plastics. Three types of caps were used during the test, each an intended improvement on its predecessor: Cap #1, an OD cap which had no canteen spout; Cap #2, a black cap which had a molded-in and capped canteen spout and air vent and which erroneously contained iron oxide instead of carbon black in an attempt to preclude deterioration from solar radiation; and Cap #3, a black cap which had a molded-in and capped canteen spout and air vent and which contained carbon black to preclude deterioration from solar radiation.

b. The experimental plastic water container (and cap) and the standard U.S. Army 5-gallon steel water can are shown in Figures 1 through 6 of Appendix V.

1.3 TEST OBJECTIVES

To determine the technical performance and safety characteristics of the 5-gallon plastic water container as described in the Military Characteristics and as indicated by the particular design and to determine the suitability of the container for use by the Army. Specific objectives are as follows:

a. To determine the suitability of the 5-gallon plastic water container to fulfill all tactical and logistical requirements of the U.S. Army units operating under field conditions in arctic, tropic, desert, and temperate environments.

b. To compare the performance, durability, and reliability of the test items with the U.S. Army standard 5-gallon steel water container, Military Specification MIL-C-13984B (Type I).

c. To determine suitability of the filled 5-gallon plastic water container for airdrop and for internal and external air portability.

d. To determine if the redesigned cap satisfies the requirement to fill canteens without waste of water.

e. To determine if the redesigned cap has any adverse effects from the standpoint of overall test objectives.

1.4 SUMMARY OF RESULTS

a. Preoperational Inspection

(1) The plastic and steel containers had approximately the same physical dimensions; however, the plastic containers weighed only an average of 5 pounds 9 ounces as compared to 9 pounds 1 ounce for the steel containers (a difference of 3 pounds 8 ounces).

(2) Although many of the plastic containers contained plastic shavings left from the manufacturing process, these were readily washed out; and almost all containers were in satisfactory condition for testing upon their receipt.

(3) Caps (#1) originally supplied with the plastic containers were of green plastic. (Those caps were later replaced with black caps (#2) which erroneously contained iron oxide, and the #2 caps were subsequently replaced with proper caps (#3) which contained carbon black as a deterrent against the damaging effects of solar radiation).

(4) Cap #3 leaked at the air vent on 95 to 100 percent of the plastic containers. The closure of the steel container initially leaked on 2 percent of the items at USAATC, 10 percent at USATTC, and 75 percent at USAGETA

b. Storage

(1) The plastic container was found to have satisfactory storage characteristics in the temperate and arctic environments under unsheltered conditions.

(2) In the tropic environment, the plastic container proved to be superior to the standard steel container. The captive strap on the #1 cap deteriorated after 47 days outside storage (USATTC will provide a separate supplementary report on the #3 cap). However, corrosion and fading were observed on the exterior and mouth of the steel containers after 30 days of storage. After 77 days of storage, all steel containers had rusted to the extent that they were declared unserviceable by medical personnel.

(3) In the desert environment, plastic containers underwent extreme deterioration after 4 months of unsheltered storage. After 4

months of similiar storage, steel containers containing water rusted around the inside seams and cover hinge, and their closure gaskets rotted.

c. Water Palatibility

Both plastic and steel containers were found to impart a taste to water stored at high temperatures for 2 weeks; however, the taste of water from the plastic containers was not objectionable, and it was more acceptable than the taste of water similarly stored in steel containers.

d. Stacking

Although the plastic containers did not stack as well as steel containers, they exhibited satisfactory stacking characteristics. The redesigned cap (cap #3) had no effect on stacking characteristics.

e. Design Characteristics

(1) Filled plastic containers sustained temporary deformations when subjected to freezing and thawing cycles, while filled steel containers sustained permanent deformations of a greater magnitude.

(2) Steel containers with non-deteriorated gaskets and properly fitted closures withstood higher internal pressures without leakage than the plastic containers.

(3) Steel containers were found to have a higher mechanical strength to resist crushing; however, the plastic containers recovered their original shape after crushing while the steel containers did not.

(4) The melting point of the plastic container material was 262°F.; and the material supported combustion.

f. Functional Suitability

The plastic container was functionally suitable under tactical conditions in the temperate, tropical, and desert environments. It was not suitable for use in the arctic winter environment, since water frozen in the containers could not be thawed by placing the containers near stoves or open flames: the containers melted.

g. Transportability

(1) The plastic container was found to have satisfactory transportability characteristics in the temperate, tropical, and desert environments.

Full plastic containers were preferred for manual carrying over full steel containers because of their lighter weight; however, it was inconvenient for two people to carry one full container because it had only one handle. In addition, three to four empty steel containers could be carried more easily by one man than a comparable number of plastic containers because the steel container had more than one handle.

(2) The handle on the plastic container was incompatible with the arctic mitten set, and most test participants preferred to hand carry steel containers despite their greater weight.

(3) Because of their lightness, empty plastic containers had a tendency to bounce around when loosely packed in vehicles; however, test personnel favored the plastic container for vehicular transport because of its lighter weight and quietness.

h. Durability

The plastic container was sufficiently durable to meet the requirements of its intended use in the temperate, tropical, desert, and arctic environments. It has an estimate service life of at least 2 years. Tears or cuts develcped on the "V" shaped seal of the cap (#1) after 4 1/2 months of tropic use.

i. Adaptability for Airdrop

No characteristics were discrovered in either the plastic or steel containers that would adversely affect adaptability for rigging for airdrop when rigged as container or platform loads.

j. Airdrop

(1) The plastic containers performed as well as or better than the steel containers when airdropped in A-7A containers using both high and low velocity techniques.

(2) The plastic containers performed as well as the steel containers when airdropped in A-22 containers. Although high velocity techniques caused greater loss in water from the plastic containers, the plastic containers sustained less permanent damage than the steel containers.

(3) Both types of containers performed equally well when dropped by platform, and the plastic containers performed better during freedrop.

(4) No failure of experimental or control items could be attributed to the effects of cumulative airdrops.

k. Internal Air Portability

Plastic and steel containers were successfully transported in a C-130 aircraft and a UH-1D helicopter.

l. External Air Portability

Both types of containers were found suitable for external air portability by U. S. Army helicopters.

m. Human Factors

(1) The plastic container was easier to clean and sterilize than the steel container; however, it was difficult to determine whether the container was clean in the areas that could not be visually inspected.

(2) The canteen spout on the plastic container greatly reduced water spillage during pouring operations.

(3) The steel container was more convenient to fill because the closure did not get in the way.

n. Maintenance Evaluation

(1) The plastic container was easier to maintain than the steel container.

(2) Very small holes or tears in the plastic container could be reparied in the field using a hot soldering iron or heat from other sources.

o. Value Analysis

The cap locking device on the plastic container was found to be nonessential.

p. Branch Application

The representatives from USCONARC, USACDC, The Surgeon General, and U. S. Marine Corps all indicated that the plastic container appeared favorable and in some aspects, superior to the steel container. However, it was suggested that the bottom of the container be redesigned for better stability.

q. Safety

The plastic container had no unsafe features when properly sterilized prior to use. Neither the plastic nor the steel container was toxic or irritating to test participants; and after initial cleaning, neither container had any objectionable or toxic odors.

1.5 CONCLUSIONS

a. The plastic container is not suitable for use under arctic winter conditions. Water frozen in the container cannot be readily thawed for use because the plastic container is flammable.

b. Overall, the plastic container is superior to the steel container in the tropical environment. Although it is inferior with regard to transportability, it is superior with respect to storage characteristics, operational suitability, durability, reliability, and maintainability.

c. The plastic container cannot be stored in unsheltered areas for long periods of time in the desert. In all other aspects the plastic container is more suitable than the steel container for desert use.

d. The plastic container is suitable for temperate use. Although the plastic container is inferior to the steel container with regard to stacking, it is, however, still satisfactory. Further, it is essentially equal to or better than the steel container with regard to other temperate characteristics.

e. The full plastic container is suitable for airdrop and internal and external air transport.

f. The redesigned cap satisfies the requirement to fill canteens without waste of water and has no adverse effects from the standpoint of overall test objectives (USATTC will provide a separate supplementary report on the redesigned cap); however, the cap does leak at the air vent.

g. The plastic container is safe for its intended use.

1.6 RECOMMENDATIONS

It is recommended that:

a. The plastic water container be considered suitable for use by the U. S. Army in the temperate, tropical, and desert environments.

b. The plastic container be considered not suitable for use in the arctic winter environment.

c. The plastic container be considered as suitable as the steel container for airdrop and internal and external air transport.

d. The plastic material be changed to preclude deterioration of the containers when subjected to extended exposed storage under desert conditions and to reduce its flammability characteristics.

e. The hollows in the handle and the hollow humps at the top of the plastic container be eliminated.

f. The present design of the container cap be modified to prevent leakage through the air vent and to preclude air vent retaining pin failures.

g. The bottom of the plastic water container be redesigned to increase the stability of the container.

h. One or two additional handles be added to the top of the plastic container to facilitate handling.

i. The shape of the containers be made more uniform and rectangular, the surface of the containers be made less slippery, and top and bottom of containers be made compatible so as to provide better stacking characteristics.

j. The V-shaped cap seal be made U-shaped to reduce cuts and tears.

SECTION 2. DETAILS OF TEST

2.1 INTRODUCTION

a. An integrated engineering and service test was conducted on the 5-gallon plastic water container; and the standard U.S. Army Water Can, Steel, 5-Gallon, FSN 7420-242-6153, was used as a standard of comparison. The plastic containers will be referred to herein as the "experimental items," and the steel cans will be referred to as the "control items." The term "test items" will be used when both the experimental and control items are indicated.

b. Four hundred seventy-five plastic water containers and 100 steel containers were subjected to engineering and temperate service tests at the General Equipment Test Activity, Fort Lee, Virginia, during the period 3 April 1967 through 21 December 1967; and additional service testing was accomplished at Camp Pickett, Virginia, with the aid of Reserve ANACDUTRA units, during the period 19 May 1967 through 26 August 1967. USAGETA employed plastic container caps #1, #2, and #3 during various test phases.

c. One hundred plastic and 100 steel containers were service tested under tropic environmental conditions in the Panama Canal Zone and the Rio Hato Training Area, Republic of Panama, by the U.S. Army Tropic Test Center during the period 27 September 1966 through 27 March 1967. USATTC test results reported herein pertain only to the use of plastic container caps #1; test results of cap #3 will be included in a supplementary report.

d. One hundred plastic and 100 steel water containers were service tested under arctic winter conditions at the U.S. Army Arctic Test Center, Fort Greely, Alaska, from the period 21 November 1966 through 18 April 1967. USAATC employed only plastic container cap #1.

e. One hundred plastic and 100 steel containers were service tested for airdrop and air portability by the U.S. Army Airborne, Electronics, and Special Warfare Board, Fort Bragg, North Carolina, during the period March through August 1967. USAAESWBD employed only plastic container cap #1.

f. One hundred plastic and 100 steel containers were service tested in the hot dry climate at the Yuma Proving Ground, Yuma, Arizona, during the period 30 March 1967 through 6 December 1967. YPG employed plastic container caps #2 and #3 during various test phases.

2.2 PREOPERATIONAL INSPECTION AND PHYSICAL CHARACTERISTICS (ES-USAGETA, USATTC, USAATC, YPG)

2.2.1 Objectives

To determine the physical characteristics of the test items and to insure that all containers were in satisfactory condition prior to initiation of the test.

2.2.2 Method

2.2.2.1 Temperate Phase.

a. The 475 plastic and the 100 steel containers allocated to USAGETA were individually marked in three locations: on the two large flat sides and on the flat surface just behind the carrying handle. Each marking consisted of "GETA STD____", numbered 1 through 475 for plastic containers and 476 through 575 for steel containers. A felt-tipped marker was used on the plastic containers, and white paint was used on the steel containers.

b. All test items were visually inspected for imperfections, damages, and corrosion; and all defects were recorded. Each experimental and control item was filled with water to determine the capacity of the container and to determine if the container was free of visually undetected holes or cracks that would allow leakage.

c. Each container was weighed empty on a 0- to 100-pound scale. For both types of containers, the average, maximum, and minimum weights were established.

d. The 10 lightest and the 10 heaviest of both types of containers were filled to maximum capacity (container opening horizontal), and the weights were recorded. Comparisons were made to determine if the heavier or lighter items had greater fluid capacities.

e. All containers were filled to capacity, capped, placed upright in drying racks for 15 minutes, and then checked for leaks. The containers were then inverted for another 15 minutes and checked again for leaks. Thirty-six plastic containers were selected at random and stored for 65 hours--18 upright and 18 inverted. At the end of the storage period, all containers were checked for leaks; and data were recorded.

f. The handle cavities in all plastic containers were measured with a wire depth gage, and depths were recorded.

2.2.2.2 Tropic Phase.

a. Upon receipt of the experimental and control items, they were inspected for damage, design differences, and for construction defects. The weights, measurements, and colors of 100 experimental and 100 control items were compared.

b. All containers were filled with water and inverted for 2 hours to check for leakage at the top.

c. The experimental items were numbered with consecutive odd numbers from 1 through 199; the control items were numbered with consecutive even numbers from 2 through 200. All control items were labeled with the word "WATER" in compliance with paragraph 4 of AR 385-30.

2.2.2.3 Arctic Phase.

a. One hundred experimental and 100 control items were inspected upon arrival at the Arctic Test Center to determine that all items were in proper condition for testing and to determine the physical characteristics of the experimental items.

b. All experimental items were filled with water to determine capacity.

c. The experimental items were opened and closed ten times each to determine the ease of opening and closing the cap.

d. Both the experimental and control items were photographed and marked for identification.

2.2.2.4 Desert Phase.

a. One hundred experimental items and 100 control items were received for test. The experimental items were numbered with consecutive odd numbers from 1 to 199, and the control items were numbered with consecutive even numbers from 2 to 200.

b. All original container caps (#1) on the experimental items were replaced with redesigned caps (#2) containing 2 percent iron oxide prior to initiation of testing.

c. All test items were visually inspected for imperfections, damages, and corrosion. Each experimental and control item was filled with water to determine the capacity of the container and to determine if the container was free of visually undetected holes or cracks that allow leakage.

d. Overall dimensions and weights were determined for both filled and empty test items.

2.2.3 Results

2.2.3.1 Temperate Phase.

a. Two of the 475 plastic containers had cracked cap-retaining straps (cap #1), and all 475 containers had uneven surfaces on the interior of the spouts. Thirty-six steel containers were dented; one had a defective hinge; and one was missing a rivet.

b. The computed average weight of the 475 plastic containers was 5 pounds 9 ounces; the minimum weight recorded was 4 pounds 15 ounces; and the maximum weight recorded was 6 pounds 3 ounces. The computed average weight of the steel containers was 9 pounds 1 ounce; the minimum weight recorded was 8 pounds 9 ounces; and the maximum weight recorded was 9 pounds 15 ounces.

c. The 10 lightest and the 10 heaviest plastic containers were weighed while empty and while filled. The results are shown in Tables I and II.

TABLE I
WEIGHTS OF LIGHTEST PLASTIC CONTAINERS

Number	Weight Empty		Weight Filled	
	Pounds	Ounces	Pounds	Ounces
82	4	15	50	13
81	5	0	50	8
113	5	0	51	3
133	5	0	50	10
141	5	0	50	13
221	4	15	51	5
238	4	15	51	14
360	5	0	50	12
391	5	0	51	9
193	5	0	51	1
AVERAGE	5	0	51	1

Average weight of contents: 46 pounds 1 ounce

TABLE II
WEIGHTS OF HEAVIEST PLASTIC CONTAINERS

Number	Weight Empty		Weight Filled	
	Pounds	Ounces	Pounds	Ounces
409	6	0	49	10
107	6	2	51	1
115	6	1	49	2
160	6	1	49	5
235	6	3	49	7
344	6	1	48	14
474	6	3	49	13
51	6	0	48	11
123	6	0	48	13
301	6	0	49	5
AVERAGE	6	1	49	7

Average weight of contents: 43 pounds 6 ounces

d. The 10 lightest and the 10 heaviest steel containers were also weighed while empty and filled. The results are shown in Tables III and IV.

e. All containers were filled and placed upright for more than 15 minutes; then they were inverted for more than 15 minutes. Neither type of container leaked while upright. Eighty-three plastic containers (17 percent) leaked while inverted, and 58 (12 percent) continued to leak after the caps (#1) were retightened. Seventy-five steel containers (75 percent) leaked in the inverted position; however, the caps could not be retightened. With both types of containers, the caps were the principal source of leaks. Nonvented caps (#1) on the plastic containers then were replaced with vented caps (#2), and the test was repeated. Approximately 95 percent of these vented caps leaked slightly at the air vent (Fig. 7, App. V). This evaluation was not repeated using #3 caps since the design and construction of #2 and #3 caps were identical.

f. Thirty-six plastic containers with nonvented caps (18 upright and 18 inverted) were stored for 16 hours, and another 36 containers were stored similarly for 65 hours. All observed leaks occurred within the first 15 minutes and are discussed in paragraph 2.2.3.1e above.

g. The handle cavities in the plastic containers varied in depth from 0 to 1 1/2 inches.

2.2.3.2 Tropic Phase.

a. Of the 100 steel containers received, 1 leaked due to a perforation at the base of the handle, 19 had minor indentations on the body of the containers, and 3 had major indentations on the sides. Light rust was evident on the outside of all of the steel containers and small areas of bare surfaces. The bare surfaces occurred where there was metal-to-metal contact between the containers when banded for shipment. Closures of two of the steel containers leaked around the gasket when initially filled and inverted. Most gaskets on the steel containers had an appearance of age. The steel containers were olive drab in color and had a semigloss finish.

b. No leaks were observed in the plastic containers with #1 caps when they were filled and inverted. One cap retainer had a 1-inch horizontal tear or break. No other defects were found.

TABLE III
WEIGHTS OF LIGHTEST STEEL CONTAINERS

Number	Weight Empty		Weight Filled	
	Pounds	Ounces	Pounds	Ounces
553	8	9	55	6
575	8	10	55	2
538	8	10	54	11
512	8	11	54	13
574	8	12	55	10
565	8	12	55	5
539	8	12	54	11
566	8	12	55	5
516	8	12	55	12
537	8	12	54	11
AVERAGE	8	11	55	2

Average weight of contents: 46 pounds 7 ounces

TABLE IV
WEIGHTS OF HEAVIEST STEEL CONTAINERS

Number	Weight Empty		Weight Filled	
	Pounds	Ounces	Pounds	Ounces
482	9	11	54	10
493	9	15	55	1
490	9	10	52	9
508	9	11	54	9
532	9	10	56	1
503	9	10	54	12
506	9	9	54	6
486	9	8	55	9
498	9	8	55	4
505	9	8	55	3
AVERAGE	9	10	54	13

Average weight of contents: 45 pounds 3 ounces

c. The interior of both the plastic and the steel containers had a strong odor of "paint".

d. The interior of the plastic containers contained plastic shavings left from the manufacturing process, and most of the #1 caps contained plastic shavings on and around the threads.

2.2.3.3 Arctic Phase. Five plastic containers were not in proper condition for testing upon arrival at USAATC, and four plastic containers had caps (#1) which would not lock into position.

2.2.3.4 Desert Phase.

a. All experimental items contained small pieces of loose plastic. The container cover fit well and did not leak around the closure, but the air vent on all caps (#2) leaked water. No other defects were noted.

b. The control items had the following defects:

(1) Ten of the items had broken gaskets and leaked.

(2) Five of the items had dents, but the paint was not cracked inside.

(3) All items had small amounts of corrosion on the exterior of the item where the paint had been scratched, but none had corrosion inside the item.

c. The average dimensions and weights of the test items are listed in Table V.

TABLE V

AVERAGE DIMENSIONS AND WEIGHTS

Dimension/Weight	Experimental Item	Control Item
Height (in.)	18.75	18.5
Length (in.)	13.75	13.5
Width (in.)	6.5	6.38
Weight, full (lb.)	49.9	47.8
Weight, empty (lb.)	4.7	9.7
Diameter of opening (in.)	3.5	3.56
Volume (gal.)	5.38	4.57

2.2.4 Analysis

a. The plastic water containers were more uniform in weight and weighed approximately 3 1/2 pounds less, on the average, than the steel containers.

b. Measurements of the 10 lightest and the 10 heaviest plastic containers indicated that the lighter plastic containers had a greater fluid capacity.

c. The plastic cap is a suitable closure, although there was slight leakage at the cap air vent.

d. Quality assurance standards and procedures should be adjusted to assure that plastic containers are cleaned of loose shavings and cuttings prior to leaving the manufacturer.

2.3 STORAGE (ET-USAGETA, USATTC, USAATC, YPG)

2.3.1 Objectives

a. To determine the effects of exposed storage on the experimental items under temperate, tropic, desert, and arctic conditions.

b. To compare those effects with those on the control items.

c. To determine what effect exposed storage has on the redesigned caps under temperate and tropic conditions.

2.3.2 Method

2.3.2.1 Temperate Engineering Phase.

a. Ten steel and nine plastic containers were strapped upright in a single layer on a 40- x 48-inch pallet and stored at the USAGETA Weathering Facility during the period 17 May to 30 November 1967--approximately 6 1/2 months. The original green caps on the plastic containers were replaced with redesigned black caps #2 containing iron oxide prior to storage of the containers.

b. Eight additional steel containers and ten additional plastic containers were similarly palletized and stored during the period 18 July to 30 November 1967--approximately 4 1/2 months. The original green caps on these plastic containers were replaced with redesigned black caps #3 containing carbon black prior to storage of the containers.

c. During each storage period, a continuous record was maintained of temperature, humidity, precipitation, and solar radiation to which the test items were exposed.

d. Immediately prior to storage and at the time of withdrawal, the following tests were performed on selected containers of each type to determine material changes during exposure:

Test	Method
Durometer Hardness	ASTM D1706-61
Chlorine and Trisodium Phosphate Resistance	MIL-C-13984C
Mar Resistance	ASTM D968-51
Abrasion	ASTM D1044-56
Color Fastness	ASTM D2244-64T

(Corrosion and puncture tests were not conducted for reasons indicated in paragraphs 2.3.3.1f and g.)

e. In addition to the above, all containers on each pallet were inspected upon withdrawal to determine visible defects, damage, or deterioration.

2.3.2.2 Tropic Phase.

a. Plastic and steel containers were divided into three groups each and placed in an uncovered storage area:

(1) Group A comprised those containers which were stored for the duration of the test. These containers were inspected monthly for deterioration by corrosion and/or biotic attack. After the

containers were examined, five of each type were filled with soft chlorinated water, and five of each type with soft unchlorinated water. Thereafter, for 14 consecutive days, a sample of water from each container was tasted by five test personnel. Tasters were questioned as to whether there was any foreign taste to the water and as to which type container had the more acceptable water.

(2) Group B comprised those containers which were used for controlled transportability testing when not in storage. They were subjected to the same monthly inspection and taste tests as explained above.

(3) Group C comprised those containers which were placed in storage only when not being used during the Functional Suitability Tests (Par. 2.7). These containers were inspected prior to issue to the participating units and prior to return to storage.

b. Tests were conducted on the experimental and control items to determine whether they could be successfully stacked in open storage. These tests were conducted with the items empty and filled, and with the items vertically and horizontally oriented (with respect to the ground).

2.3.2.3 Arctic Phase. Five plastic and five steel containers were filled with water, and five each additional plastic and steel containers were three-fourths filled with water. These containers were stored in an open storage area at existing ambient (arctic winter) conditions for a period of 120 days. The containers were stacked two high and immediately adjacent to each other. At the end of the 120-day storage period, each water container was inspected for damage.

2.3.2.4 Desert Phase. The test items numbered 1 to 50 and 76 to 83 were placed in an outdoor unsheltered area on standard 40- by 48-inch wooden pallets and stored for 6 months as shown in Table VI. The test items were visually inspected every 2 months. After 3 months of storage, redesigned caps #3 containing 2 percent carbon black were received and were substituted for caps #2 containing 2 percent ferric oxide.

TABLE VI

DESERT STORAGE CONDITIONS

Container No.	Condition	How Stored
1 - 16	Filled with water	In line
17 - 32	Filled with water	Stacked flat
33 - 50	Filled with water	Stacked vertically
76 - 83	Empty	In line
84 - 91	Empty	Stacked flat
92 - 100	Empty	Stacked vertically

2.3.3 Results

2.3.3.1 Temperate Engineering Phase.

a. Durometer Hardness.

(1) Comparison hardness tests were not performed on the original green plastic caps #1 since they were replaced by black plastic caps #2 containing iron oxide before the start of the exposure test (App. I-F). Comparison tests on caps #2 indicated that no changes occurred in their hardness as a result of the 4-month exposure (App. I-G, Part 2).

(2) Comparison hardness tests between plastic caps #3 containing 2 percent carbon black which were exposed to the weather for approximately 4 1/2 months and new unexposed #3 caps indicated that the durometer hardness increased slightly as a result of the exposure (App. I-G, Part 4, Par. 1 and 2).

(3) Comparison hardness data from new unexposed plastic containers and containers exposed for 4 1/2 months and 6 months were inconclusive (App. I-G, Part 4).

b. Chlorine and Trisodium Phosphate Resistance. A comparison of hardness data taken from unexposed plastic containers and from containers exposed to chlorine and trisodium phosphate before and after weathering showed no conclusive trends (App. I-G, Parts 1 and 3).

c. Mar Resistance. Mar resistance tests of a plastic container before and after exposure to the weather for 6 1/2 months showed no detectable change in gloss measurement due to exposure (App. I-H).

d. Abrasion. A Taber Abrasion Test was performed on a new container, on a container exposed to the weather for 4 months, and on a container exposed for 9 months. Due to the shape of the containers, the flat plastic samples of uniform thickness needed for the test were not obtainable. As a result, the somewhat divergent test results do not present any conclusive results (App. I-I).

e. Color Fastness. The exposure of the steel containers and metal caps for 4 and 9 months produced a slight lightening of their color, although the hue (i.e., wave length of the reflected light) was not changed. The plastic containers displayed definite changes in hue (yellowing), an effect caused by a loss in red and blue reflectance. No changes in color difference were noted in either the green or the #2 black caps (App. I-J).

f. Corrosion. Corrosion tests utilizing the Meseran (surface roughness tester by Cleanometer Corporation) were cancelled due to the absence of any apparent corrosion inside either the plastic or the steel containers, as determined by visual and Engis Roughness Meter measurements. The fact that the steel cans were, in essence, comparable to the plastic in this respect is due to the plastic lining (coating) of the steel containers.

g. Puncture. Puncture tests of the plastic and steel containers were not performed because the strength of the containers exceeded the capacity of the puncture tester (pendulum type by Testing Machines, Inc.).

h. Storage. Both the plastic and steel containers were visually inspected at the conclusion of the 4 1/2- and 6 1/2-month storage periods for the following aspects: interior and exterior corrosion, ease of opening and closing, gasket condition (steel container), and color change. Slight corrosion was observed on exteriors of most of the steel containers, primarily around the closure hinge and locking lever rivet after both storage periods. The steel containers were generally difficult to open due to the gaskets sticking; however, only one gasket from each storage period was damaged. The interiors of steel containers were all in good condition. There was no visually noticeable color change in any of the steel or plastic containers after both storage periods. All plastic containers and caps from both storage periods were in good condition and were easy to open. Overall, both steel and plastic containers were judged suitable for use after both storage periods; but the plastic containers were more suitable due to the absence of any corrosion.

2.3.3.2 Tropic Phase.

a. No adverse effects of atmosphere and/or biotic attack were noted on the plastic containers. No deterioration due to the tropical environment (App. I-C and I-D), such as rust, corrosion, rot, or color fading, was observed during the storage phase.

b. Rust, corrosion, and fading were observed on the exterior and mouth of the steel containers after a 30-day storage. After a 77-day storage, all steel containers had rusted to the extent that it was deemed necessary to contact a medical officer to get medical opinion on the continued use of the containers. A medical officer inspected all steel containers and declared them unserviceable for issue or use by troops unless in an extreme emergency. As a result, all steel containers issued initially with the plastic containers were withdrawn from the test. Units were instructed to use their own basic stock of steel containers for comparison.

c. Test personnel (tasters) noticed no foreign taste to the soft chlorinated or unchlorinated water.

d. No difficulties were encountered with respect to horizontal stacking in an uncovered dump or as a palletized load on standard 40- by 48-inch pallets when the loose plastic containers were full or empty. Difficulties did arise with respect to vertical stacking in uncovered dumps or as palletized loads on standard 40- by 48-inch pallets when the loose plastic containers were full or empty. The bases and tops of the plastic containers were not compatible, and the plastic containers had a tendency to be blown over or to fall over easily when stacked one or more high. This is a shortcoming. The steel containers could be stacked vertically or horizontally.

2.3.3.3 Arctic Phase. The 10 plastic and 10 steel containers stored for 120 days at existing ambient temperatures (App. I-N) in an open storage area were not damaged in any way. It was observed, however, that the steel containers were easier to stack because the handles provided a base for stacking, whereas the plastic containers were easily blown over.

2.3.3.4 Desert Phase.

a. Plastic containers

(1) The experimental items and caps showed no damage, defects, deterioration, corrosion, biotic attack, or soil contamination after 2 months of desert storage. No deterioration was noted in the black iron oxide caps (#2) after 3 months of storage. After 3 months of storage, faint cracks appeared on the experimental items that received direct sunlight. After 4 months of desert storage, 23 of the 37 experimental items exhibited more pronounced cracking on the surface of the items and softening of the plastic at the top of the experimental item (EPR L5-1, Ref. 22, App. VI). Nine of the items with softened surfaces could be punctured easily with pressure of the thumb.

(2) Those experimental items not exposed to the sunlight did not develop the cracking or softening of the surface. One item developed a crack 1/2 inch long across the threads of the item opening.

(3) The experimental items filled with water were stacked vertically, two containers high, and were stable on the wooden pallet through the 6 months of storage. The items when stacked vertically and in line had expanded in width from 6.5 to 7 inches due to the water pressure. These items were difficult to restack and caused the stack to be slightly unstable. The empty items would fall over due to the wind. Those items filled with water and stacked flat were stable when stacked 5 items high. All the items stacked flat leaked water out of the vent fitting. Approximately 1/2 gallon of water was lost from each item. The leakage stopped due to the minerals in the water clogging the leak or to the action of the water swelling the cover material.

b. Steel containers

(1) The control items that had water stored inside rusted around the inside seams of the item after 2 months of storage. Also,

rust developed around the cover hinge of the item. After 4 months of storage all gaskets of items that contained water rotted. The gaskets could easily be broken with light pressure of the fingernail.

(2) All control items could be stacked easily and were stable when stacked vertically or flat. During stacking the paint on the items was scratched, which in turn resulted in rusting the bare metal.

c. Meteorological data. Temperatures, humidity, precipitation, and solar radiation are included in Appendix I-E.

2.3.4 Analysis

a. The plastic container was resistant to rust, corrosion, rot, humidity, mold, fading, mildew, and fungus when stored in the naturally humid tropical environment. It had better durability characteristics in tropic storage than the steel container.

b. The steel container did not satisfy the military requirements for rust resistance, corrosion, and fading when stored in the naturally humid tropical environment.

c. The plastic container was not suitable for open storage in the desert environment.

d. The results of exposed storage under desert conditions (wherein the plastic containers softened after 4 months) appear to be in conflict with the results of the Durometer hardness tests, which indicated a slight increase in hardness as a result of temperate exposure. At least three possible reasons exist for the difference in results: first, the environmental storage conditions were different in the desert and temperate phases; second, the Durometer hardness test may not indicate the weakness identified in the desert exposure test--that is, surface hardness may not correlate with material strength or rigidity; third, uncontrolled variables may have existed which caused divergent results.

e. Both plastic and steel containers exhibited satisfactory temperate storage characteristics; however, because of the slight corrosion of the exterior of the steel containers, the plastic container is considered more suitable. The changes in color and hue of the steel and plastic containers, respectively, which were identified in the instrumented engineering tests were not visually detectable by the unaided human eye.

f. The plastic container could safely undergo storage at below freezing ambient temperatures.

g. The steel containers were undamaged and in good serviceable condition after 6 1/2 months exposure under temperate conditions, which indicates satisfactory temperate storage characteristics.

h. The steel container had better stacking characteristics than the plastic container.

2.4 WATER PALATABILITY (ET-USAGETA, USATTC, YPG)

2.4.1 Objective

To determine if any toxic or objectionable odors or taste will result from storage of hard or soft water, chlorinated or unchlorinated, when stored in plastic containers for 2 weeks under high temperatures.

2.4.2 Method

2.4.2.1 Temperate Engineering Phase.

a. Four plastic and four steel containers were cleaned (Par. 2.15.1.2a) and filled with commercially purchased untreated water. The water in two of the plastic containers and in two of the steel containers was chlorinated, and the water in the other containers was not chlorinated. The containers were closed and stored at 120°F. $\pm$ 5°F. for 14 days. After the storage period, samples of water from all containers were analyzed for contamination by the Fort Lee Army Hospital Preventive Medicine Branch; and the water was found to be safe for human consumption.

b. In addition to the above, a taste test was conducted in which approximately 64 soldiers sampled and rated the acceptability of each of six paired combinations of water sample. Samples served were taken from both fresh and chlorinated water which had been stored in metal, plastic, and glass containers. A total of four sessions were conducted over a 2-day period. In each session, each of 32 participants was required to taste and rate two different pairs of water samples.

2.4.2.2 Tropic Phase. Five plastic and five steel containers were filled with soft chlorinated water, and another five containers of each type were filled with soft unchlorinated water. After a storage period of 6 months under natural tropical conditions, these containers were examined for corrosion and biotic attack. Thereafter, for 14 consecutive days, a sample of water from each container was tasted by five test personnel. Tasters were questioned as to whether there was any foreign taste to the water and as to the type of container from which the water was more acceptable.

2.4.2.3 Desert Phase. Five plastic and five steel containers numbered 121 to 130 were rinsed and filled with hard water, and water purification tablets were added. Five plastic and five steel containers numbered 131 to 140 were filled with 5 gallons of hard water only. The containers were stored in an unsheltered area. The water was tasted by five persons and the taste was compared to that of fresh water from the same source (Table VII).

TABLE VII

DESERT PHASE TASTE TEST TIME INCREMENTS (DAYS)

Set No.	Container No.	Filled	Tasted	Emptied and Refilled	Tasted	Emptied	Filled	Tasted
1	121 - 124) 131 - 134)	X	X/1	X/1	X/7	X/7	X/13	X/14
2	125 - 128) 135 - 138)	X			X/7	X/7	X/7	X/14
3	129 - 130) 139 - 140)	X						X/14

2.4.3 Results

2.4.3.1 Temperate Engineering Phase.

a. All water samples analyzed after the storage period were safe for human consumption.

b. The distribution of "acceptable" and "unacceptable" taste test responses for each of the six pairs of samples tested is shown in

Table VIII. A Chi-Square test was used to determine whether the difference in the response distribution for each pair was statistically significant at the 95-percent confidence level. Results of the statistical analysis are summarized in Appendix I-M.

2.4.3.2 Tropic Phase. No difference in the taste of water from the two types of containers was noticed by the tasters.

2.4.3.3 Desert Phase. No contamination in the test items due to deterioration of containers, chemical reaction with water dissolved material, or bacterial growth was observed. Items from Set 3 (Table VII) had the largest difference in taste from fresh water, Set 2 was less different, and Set 1 was least different after 14 days. The water stored in the experimental items tasted of plastic; and the water stored in the control items tasted of paint. The taste of the water was not objectionable after 14 days of storage.

2.4.4 Analysis

Results in Table VIII and Appendix I-M indicate that both the plastic and steel containers impart a taste to water stored for 2 weeks at high temperatures, as compared to the same water stored in glass containers. However, water from the plastic container was generally acceptable; and a comparison between the steel and the plastic containers showed that the water from the plastic containers was rated as significantly (95 percent) more acceptable than water from the steel containers.

2.5 STACKING (ST-USAGETA)

2.5.1 Objectives

To determine if the 5-gallon plastic water container could be stacked on pallets, and to determine if the redesigned cap had any adverse effect on stacking the containers.

2.5.2 Method

a. Both the plastic and steel containers were stacked separately in empty-loose and filled-loose conditions. The following configurations were attempted for both plastic and steel containers:

(1) Containers were stacked in 7x7x7 pyramids as shown in Figure 8 of Appendix V.

TABLE VIII

SUMMARY OF SOLDIER PANEL PREFERENCE TEST OF WATER STORED AT 120°F. IN PLASTIC, STEEL, AND GLASS CONTAINERS

Water Sample*	Total Answers by Code						Code Significantly Better**
	Acceptable		Unacceptable		Total		
	Quantity	Percent of Total	Quantity	Percent of Total	Quantity	Percent of Total	
UM	18	28.6	45	71.4	63	100.0	UP
UP	34	54.0	29	46.0	63	100.0	
UP	31	48.4	33	51.6	64	100.0	UG
UG	58	90.6	6	9.4	64	100.0	
UM	11	17.2	53	82.8	64	100.0	UG
UG	53	82.8	11	17.2	64	100.0	
CM	21	32.8	43	67.2	64	100.0	CP
CP	52	81.2	12	18.8	64	100.0	
CP	38	59.4	26	40.6	64	100.0	CG
CG	57	89.1	7	10.9	64	100.0	
CM	7	10.9	57	89.1	64	100.0	CG
CG	56	87.5	8	12.5	64	100.0	

*KEY:
UM Untreated water in metal container.
UP Untreated water in plastic container.
UG Untreated water in glass container.
CM Chlorinated water in metal container.
CP Chlorinated water in plastic container.
CG Chlorinated water in glass container.
** Significant at the 95-percent confidence level.

(2) Containers were stacked in alternating vertical and horizontal layers as shown in Figures 9 and 10 of Appendix V.

(3) Containers were stacked horizontally as shown in Figure 11 of Appendix V.

(4) Containers were stacked horizontally with the layers reversed, as shown in Figures 12 and 13 of Appendix V.

(5) Containers were stacked horizontally with adjacent layers rotated as shown in Figure 14 of Appendix V.

b. Various modified configurations which appeared feasible were also attempted, including a combination of the two types of loose containers in the same stack. One combination (Fig. 15, App. V) was composed of alternating adjacent steel and plastic containers in a pyramid; and a second configuration (Fig. 16, App. V) consisted of a pyramid with alternating steel and plastic layers.

c. Loose plastic containers were palletized using 3/4-inch steel banding material. The containers were placed on 40- by 48-inch pallets with 7 containers per layer and 9 layers per pallet, as shown in Figure 17 of Appendix V.

d. Plastic and steel containers were banded separately with 1/2-inch and 5/8-inch, 0.02 gage steel banding material into 5-container bundles. Each bundle had two bands placed in accordance with MIL-C-13984C, 4 January 1966.

e. Both types of bundled containers were stacked in the following configurations:

(1) Pyramids of 5x2x5 (5 bundles wide, 2 bundles long, 5 bundles high) as shown in Figure 18 of Appendix V.

(2) Pyramids of 6x2x6 as shown in Figure 19 of Appendix V.

(3) Straight stack of upright containers in four layers with ten bundles per layer, as shown in Figure 20 of Appendix V.

(4) Straight stack of containers on edge with four layers of 11 bundles each as shown in Figure 21 of Appendix V.

(5) Straight stack of containers on their sides, as shown in Figure 22 of Appendix V.

f. The 5-container bundles of plastic and steel containers were palletized and stacked in various configurations:

(1) Three layers of three bundles per layer in an upright position on a 40- by 48-inch pallet, as shown in Figure 23 of Appendix V.

(2) Same configuration as above, with the exception that the second layer was inverted, as shown in Figure 24 of Appendix V.

(3) Three bundles on edge per layer and three layers per 40- by 48-inch pallet, with several pallets stacked one upon another, as shown in Figure 25 of Appendix V. Bundles were stacked with container caps in random directions and with all caps facing inward. Pallets were also stacked on level floors and on grass and rocks to test their stability.

(4) Five bundles on edge per layer, four layers per 48- by 60-inch pallet, as shown in Figure 26 of Appendix V.

g. Containers were banded with 1/2-inch and 5/8-inch banding material into bundles of six containers each. Bundles were palletized using 3/4-inch banding material and stacked on edge as shown in Figure 27 of Appendix V.

h. Containers of both types were banded with 1/2-inch and 5/8-inch banding material into bundles of seven containers each. Bundles were palletized using 3/4-inch banding material and stacked on edge as shown in Figure 28 of Appendix V.

2.5.3 <u>Results</u>

a. When plastic and steel containers were stacked separately in both empty-loose and filled-loose conditions, various degrees of success were attained:

(1) Steel containers were easily stacked in stable pyramids of up to seven layers, but plastic containers could not be stacked satisfactorily in more than three layers when empty or in more than five layers when filled.

(2) Steel containers were easily stacked with alternating vertical and horizontal layers as shown in Figure 9 of Appendix V;

however, this configuration is not recommended for filled steel containers since the horizontal containers leaked excessively. Plastic containers were unstable when stacked in this configuration; only six layers could be satisfactorily attained with empty containers and only four layers with full containers. The plastic containers were slippery, had uneven bottoms (Fig. 3, App. V), and the horizontal containers leaked slightly.

(3) Steel containers were easily stacked horizontally with caps facing in the same direction (similar to the plastic containers shown in Fig. 11, App. V), but full horizontal steel containers leaked excessively. Empty plastic containers were stacked in this configuration; but the containers were found to be narrower on the cap side than on the opposite side, which resulted in the stack of containers leaning toward the cap side. To compensate for this leaning of containers, the outermost columns were placed with container caps facing inward as shown in Figure 11 of Appendix V. Filled plastic containers could be stacked only six layers high with this configuration. The leaning tendency was more acute with filled containers, since the water shifted in the direction of the tilt.

(4) Both steel and plastic containers could be stacked easily with layers reversed as shown in Figures 12 and 13 of Appendix V. The containers were stacked 8 layers high while empty and while filled; however, the steel containers leaked excessively and the plastic containers were unstable.

(5) Both types of containers were easily stacked horizontally with adjacent layers rotated as shown in Figure 14 of Appendix V. Although the full horizontal steel containers leaked excessively, all plastic and steel stacks were highly stable. Both types of containers were stacked up to 12 layers high on concrete, grass, and rocks up to 2 inches in diameter.

b. Both attempts to combine loose steel and plastic containers into one vertical stack resulted in unstable configurations. The plastic containers were taller than the steel containers and therefore caused unstable pyramids when adjacent containers were alternated (Fig. 15, App. V). The pyramid with the alternating layers of steel and plastic containers (Fig. 16, App. V), proved to be the better of the two configurations; however, even this configuration was unstable.

c. Both types of containers were easily palletized (separately). The rounded flexible sides of the plastic containers resulted in a curved surface at the top of the stack (Fig. 17, App. V).

d. Both the plastic and the steel containers were readily and satisfactorily banded into 5-container bundles using 1/2-inch and 5/8-inch banding material; however, the steel containers were easier to band since their weight facilitated greater control of the banding material. The 1/2-inch banding material was preferred to the 5/8-inch material since it was more easily handled by one man. Use of adhesive nylon-filament strapping tape as a banding material yielded unsatisfactory bundles. The containers could not be squeezed together tight enough, and the tape was too flexible. Consequently, the containers rotated slightly within the bundles.

e. Various degrees of success were achieved when attempting to stack the 5-container bundles in various configurations. A pyramid proved stable for both types of containers (Figs. 18 and 19, Appendix V). The straight-stacks with containers upright or on edge (Figs. 20 and 21, App. V) proved to be highly stable for each type of container; however, steel containers leaked when stacked in other than an upright position. A straight stack with the containers on their sides proved unstable for both types of containers (Fig. 22, App. V).

f. A 5-bundle palletized stack was not always successful. A pallet load made up of rows and columns of bundled containers as shown in Figure 23 of Appendix V was successful; however, multiple tiers of these pallet loads proved to be unstable. Pallet loads and stacks as shown in Figure 25 of Appendix V proved stable for filled plastic containers although leakage was evident. This is a recommended configuration for empty plastic containers: stable stacks were made on grass, concrete, and rocks up to 2-inches in diameter. A similar configuration with five bundles per layer on a 48- by 60-inch pallet (Fig. 26, App. V) was also stable.

g. Six-container bundles were made with each type of container. The steel containers proved easier to band, and the 1/2-inch banding material was easier to use than the 5/8-inch material. The 6-container bundles were palletized as shown in Figure 27 of Appendix V, and they proved to be stable; however, this configuration exceeded the 40- by 48-inch dimensions of the pallets.

h. Seven-container bundles were made with each type of container. The steel containers proved easier to band, and the 1/2-inch banding material was easier to use. The 7-container bundles were palletized as shown in Figure 28 of Appendix V, and they proved to be stable. However, this configuration wasted pallet space.

i. The redesigned cap had no adverse effects on the stacking of the plastic water containers.

2.5.4 <u>Analysis</u>

a. The configuration shown in Figure 14 of Appendix V was the best for both types of loose empty containers since it was the most stable on concrete, grass, and small rocks.

b. The pyramid configuration shown in Figure 10 of Appendix V was best for stacking filled loose steel containers since it was the most stable upright stack.

c. The configuration shown in Figure 14 of Appendix V was best for stacking filled plastic containers if storage was not to be for a long period of time. For storage over a longer period of time, the pyramid configuration shown in Figure 8 of Appendix V was better since leakage from the air vent or cap was precluded.

d. A stack containing both types of containers is not recommended. However, if they must be combined, the pyramid stack shown in Figure 16 of Appendix V should be used.

e. Banded containers were readily palletized but loose containers were not. If loose containers must be palletized, only one tier should be used.

f. One-half inch banding material was more suitable than wider banding material for banding container bundles.

g. The best configuration for palletized bundles is shown in Figure 25 of Appendix V: the stack was vertical, stable, and efficient of floor space.

h. Plastic containers did not stack as well as steel containers; however, they did have satisfactory stacking capabilities. The redesigned cap had no effect on stacking characteristics.

2.6 DESIGN CHARACTERISTICS (ET-USAGETA)

2.6.1 <u>Normal Expansion and Contraction</u>

2.6.1.1 Objective. To determine if any major change in container configuration or leakage would result from exposure of the containers to freezing of water and thawing.

2.6.1.2 Method. Five plastic and five steel containers were filled to maximum capacity (container upright). Container closures were secured, and all containers were weighed, measured, and visually checked for leaks by inverting them for 5 minutes. The containers were then placed in USAGETA's Environmental Test Chamber and exposed to five 24-hour cycles of alternating -50°F. and 115°F. temperatures (12 hours at each extreme). Upon completion of the cycling, the containers were weighed, emptied, and examined for damage. Changes in container configuration were determined by refilling the containers and weighing.

2.6.1.3 Results.

a. The pre-test inspection showed that all containers were in good condition, free from defects, and watertight when inverted.

b. Data pertaining to the physical characteristics of the containers before and after the test are shown in Table IX.

c. After the freezing and thawing cycles, the sides of the plastic containers were bulged, four containers lost an average of 1 pound of water due to leakage from the closures, and one container lost 18 pounds 14 ounces of water from a 3 1/2-inch split which developed in the side. The capacity of the containers increased an average of 1 pound 4 ounces of water per container; however, the plastic containers did not retain bulges--they returned to normal configuration after 24 hours at room temperature.

d. After the freezing and thawing cycles, the sides and bottoms of the steel containers were bulged. The bottom seams flared out and took a permanent set of approximately 1 inch. One container lost 1 1/2 pounds of water when the internal pressure of the freezing water deformed the closure; but the other four containers lost an average of less than 1 ounce of water. The capacity of the steel containers increased an average of 5 pounds 1 1/2 ounces of water per container.

2.6.1.4 Analysis. Freezing and thawing of water in the containers causes permanent deformation in the steel containers, temporary deformation in the plastic containers, and may result in failures of both types of containers. The deformation of the steel containers was greater than that of the plastic containers.

2.6.2 <u>Internal Pressure</u>

2.6.2.1 Objective. To determine the comparative reliability of the closure seals and the ability of the containers to withstand internal pressures.

TABLE IX

RESULTS OF EXPANSION AND CONTRACTION SHOWING CHANGES IN DIMENSIONS AND WEIGHTS BEFORE AND AFTER FIVE CYCLES IN CLIMATIC ENVIRONMENTAL CHAMBER

CONTAINER NO.	START OF TEST			AFTER 5 CYCLES			WEIGHT					
							FILLED START OF TEST		AFTER 5 CYCLES		REFILLED AFTER 5 CYCLES	
	HEIGHT	WIDTH	LENGTH	HEIGHT	WIDTH	LENGTH	LBS.	OZ.	LBS.	OZ.	LBS.	OZ.
Plastic 1	18 15/16	6 5/8	14	18 15/16	7 5/16	14	49	5	48	13	50	8
Plastic 2	18 7/8	6 7/8	13 7/8	18 11/16	7 3/8	13 13/16	49	10	49	4	51	0
Plastic 3	18 3/4	6 11/16	13 15/16	18 3/4	7 3/16	13 13/16	49	14	31	0	*	
Plastic 4	18 3/4	6 5/8	13 7/8	18 3/4	7 5/16	13 7/8	48	13	48	7	50	8
Plastic 5	18 7/8	6 3/4	13 7/8	18 13/16	7 6/16	13 7/8	50	4	49	1	50	15
Steel 1	18 3/8	6 11/16	13 7/16	18 1/2	7 3/8	13 11/16	55	9	54	4	58	12
Steel 2	18 1/2	6 3/4	13 3/4	18 7/8	7 7/8	13 9/16	55	2	55	2	60	14
Steel 3	18 3/8	6 3/4	13 3/4	19 1/8	7 13/16	13 9/16	54	6	54	4	61	1
Steel 4	18 7/16	6 3/4	13 3/4	18 3/4	7 11/16	13 3/4	53	13	53	12	57	4
Steel 5	18 7/16	6 11/16	13 11/16	18 3/4	7 3/4	13 11/16	54	4	54	4	58	9

*One container developed a 3 1/2-inch split during testing.

2.6.2.2 Method. Three plastic and three steel containers were equipped with air valves and tested for leaks and expansion when subjected to hydraulic and pneumatic pressure.

2.6.2.3 Results.

a. Static Head Pressure

Neither the steel nor the plastic containers leaked water at the closure when inverted (no additional pressure applied).

b. Pneumatic Pressure

(1) Steel Containers. The closures of the three steel containers were airtight at 1.0 psig, but they all leaked before the air pressure reached 1.3 psig.

(2) Plastic Containers. Air leaked from around the vent plug threads of all three containers when the air pressure reached 0.25 psig. One plastic cap assembly leaked around the cap threads when the air pressure reached 0.50 psig; but the other two containers were airtight around the center pour spout and the container cap up to 8.0 psig air pressure.

c. Hydropneumatic Pressure.

(1) Steel Containers. The closures of the steel containers leaked water at 5.5 to 6.0 psig.

(2) Plastic Containers. The vent plugs on all of the caps leaked water at 0.25 psig, and one of the containers leaked water around the cap thread at 2.0 psig. No other leaks were observed at pressures up to 8.0 psig.

2.6.2.4 Analysis. Both types of containers were comparable with regard to leaks under a static head. When additional pressure was applied, the vent plugs on the plastic containers leaked readily. The steel containers, which had nondeteriorated gaskets and proper fitting closures, produced more favorable results.

2.6.3 <u>Crush Resistance</u>

2.6.3.1 Objectives.

a. To determine the ability of the plastic and steel containers to resist external forces.

b. To determine the force required to produce irreparable damage.

2.6.3.2 Method. Crush tests were performed on five plastic and five steel containers. Each container was filled to the lip with water, closed, and placed upright between two steel plates. Pressure was applied by closing the plates at a rate of 1/8-inch per minute until the container failed and leaked water. The total displacement of the steel plates at the moment of leakage was recorded.

2.6.3.3 Results. Data pertaining to the pounds of crush resistance and the total plate displacement at the moment of failure are shown in Table X.

2.6.3.4 Analysis. Table X shows that the steel containers have a higher crushing strength than the plastic containers. However, the plastic containers recovered their original shape after the pressure was released while the steel containers were irreparably damaged. With both types of containers, the deformations of the containers caused leaks around the closures.

2.6.4 Flammability and Melting Point Tests

2.6.4.1 Objective. To determine the fire resistant properties of the plastic water container.

2.6.4.2 Method.

a. A flammability test was conducted on the plastic water container according to ASTM Method D635. Specifically, three samples of material were taken from each of four different containers and subjected to prescribed tests to determine the rate at which the material would burn.

b. The melting point of the plastic material was also determined using the Fisher-Johns Melting Point Apparatus.

2.6.4.3 Results.

a. Results of the flammability test, showing the burning rate of the plastic in inches per minute, are summarized in Table XI. Basic data are prescribed in Appendix I-K.

TABLE X
POUNDS OF CRUSH RESISTANCE AND AMOUNT OF DISPLACEMENT FOR PLASTIC AND STEEL CONTAINERS

	PLASTIC WATER CONTAINERS		STEEL WATER CONTAINERS	
Sample	Pounds of Crush Resistance	Plate Deflection (inches)	Pounds of Crush Resistance	Plate Deflection (inches)
1	1500	3.39	7500	4.73
2	2500	1.93	2700	4.26
3	1200	2.40	8400	3.32
4	1500	1.89	8200	2.66
5	2100	2.87	9300	2.54
AVERAGE	1760	2.52	8220	3.50

TABLE XI
RESULTS OF FLAMMABILITY TEST ACCORDING TO ASTM METHOD D635

BURNING RATES IN INCHES PER MINUTE

Plastic Container Number	SAMPLE NUMBERS			Average*
	1	2	3	
1	0.719	0.686	0.727	0.711
2	0.660	0.703	0.648	0.670
3	0.571	0.454	0.615	0.547
4	0.499	0.564	0.585	0.549

* Overall average: 0.619

b. The melting point of the plastic was 262°F.

2.6.4.4 Analysis. The rate of burning and the melting point are not considered unusual for the type of plastic used in the experimental containers. However, the material does support combustion; consequently, precautions must be exercised during storage and use of this item. These data suggest definite limitations on the use of the container under arctic conditions where it is common practice to thaw frozen water by placing the container on a stove.

2.7 FUNCTIONAL SUITABILITY (ST-USAGETA, USATTC, USAATC, YPG)

2.7.1 Objectives

a. To determine the functional suitability of the plastic container when employed in its normal role under tactical conditions in the temperate, tropic, arctic, and desert areas.

b. To compare the functional suitability of the experimental item with the control item.

c. To determine if the redesigned cap enabled canteens to be filled without waste of water.

2.7.2 Method

Experimental and control items were issued to TOE units for use during tactical exercises in the temperate, tropic, desert, and arctic areas; and user and test team personnel (observers) recorded comments on the following areas of concern: ease of cleaning and sterilizing; convenience of hand-carry, backpack carry, and transport by vehicle; water taste; economy of transportation space; convenience of filling and pouring water without waste; convenience and simplicity of operation of the opening; leakage; safety; effect of solar radiation on container surface; and other aspects that pertained to operational suitability, durability, transportability, maintainability, and human factors.

2.7.2.1 Temperate Phase. Plastic and steel water containers were issued to U.S. Army Reserve units undergoing their annual summer training at Camp Pickett, Virginia, from 19 May to 26 August 1967.

Functional suitability data were gathered by a team of observer/recorders and recorded on appropriate forms.

2.7.2.2 Tropic Phase. Test items were issued to units of the U.S. Army Forces Southern Command for use during tactical exercises. Units used standard steel containers from their basic stock for control purposes due to the withdrawal of the "test" steel containers from the evaluation (Par. 2.3.3.2b). Type operations in which the experimental and control items were used were noted throughout the test period and participating units maintained transportation logs. Experimental and control items were subjected to the same usage.

2.7.2.3 Arctic Phase. Personnel of an Infantry Platoon were required to sustain themselves during one 4-day or two 7-day field exercises, using an equal number of steel and plastic water containers. The following methods were used to thaw ice inside both types of water containers:

a. Containers were placed directly on Yukon stoves inside arctic 10-man tents.

b. Containers were placed directly on open squad fires.

c. Containers were placed immediately adjacent to the Yukon stove and at 1/2-foot, 1-foot, 2-foot and 3-foot distances from the stove inside arctic 10-man tents.

d. Containers were placed next to open squad fires at distances of 1/2 foot, 1 foot, 1 1/2 feet, 2 feet, and 3 feet.

2.7.2.4 Desert Phase.

a. One hundred five test items (No. 51-75, 101-120, and 141-200) were given to the Arizona National Guard Howitzer Battalion in approximately equal quantities for use during tactical exercises in the desert.

b. Questionnaries were given to the leaders in the units in order to obtain information on the areas of concern listed in paragraph 2.7.2.

2.7.3 Results

2.7.3.1 Temperate Phase. The results from the questionnaires were as follows:

a. Out of 84 questioned Reservists, none had any trouble filling the plastic container. Three men reported difficulties in pouring from the "canteen spout" (of caps #2 and #3) because of interference of the spout in the flow of water. The other 81 soldiers liked the spout because it reduced water waste. All 84 soldiers felt that the opening of the plastic container was convenient and simple to operate, and none reported leakage through the seals.

b. The plastic container was appreciated because it did not have a gasket to lose or deteriorate.

c. The plastic container was favored over the steel container.

2.7.3.2 Tropic Phase.

a. The plastic container was easier to handle during the cleaning and sterilizing process. No breakdown of fading of the coloring was noted during the cleaning and sterilization phase.

b. The plastic container handle was more comfortable than the steel container handle due to the fact that it was larger and its connection seam was not as rough. When exposed to the sun's rays, the outside surface of the plastic container was less heated than the outside surface of the steel container.

c. Troops were able to hand carry two empty or filled plastic containers for short distances without difficulty. Three or four empty containers were difficult to hand carry because the distance between the two handles of adjacent containers was too large for the normal sized hand to span. Troops could hand carry four empty steel containers or two filled steel containers without difficulty. Two soldiers could carry one steel container more conveniently than one plastic container. This is attributed to the presence of two additional handles (ribs) on the steel container (total of three ribs) (Fig. 1, 2, 11, and 12, App. V).

d. The steel containers were easier to fill because the closures stayed in place when opened. Also, due to the closeness or crowded condition in the transportation pattern (upright transportation), the steel containers were easier and more convenient to open.

e. The plastic containers were more difficult to fill because the closures would not stay in place when opened. In addition, more hand space was required when opening and closing due to the threaded closure.

f. The plastic container was preferred by test personnel for pouring water into a canteen or canteen cup without waste when the container was sitting on the ground. (USATTC employed only cap #1, which had no canteen spout). Test personnel stated that the flow of water from the container mouth was smaller and easier to control. Test personnel preferred the steel container for pouring water into a canteen or canteen cup when the container was full and sitting on the tailgate of a vehicle. When the plastic container was tilted, its base had a tendency to slide backward, causing more spillage and less control. In addition, the closure of the plastic container got in the way when water was poured from containers which were one-half to three-fourths full.

g. There was less noise created when using the plastic container than when using the steel container. This is especially significant during tactical problems where silence is of primary concern.

h. There were no unsafe features associated with the use of the plastic container or the steel container.

2.7.3.3 Arctic Phase.

a. Eighteen plastic containers, as compared to one steel container, sustained permanent damage when test personnel attempted to thaw ice inside the containers. Under arctic winter conditions, water carried in a water container freezes rapidly in storage or while being transported. Primary consideration must be given to the amount of time required to thaw the ice inside the water container. Ice inside the steel container could be thawed rapidly without damage to the container. The plastic containers placed too close to heat sources were permanently damaged and destroyed before any appreciable amount of ice had thawed.

b. Loss of water was encountered during all field exercises when water was transferred from plastic and steel containers to canteens (USAATC employed only cap #1, which had no canteen spout).

2.7.3.4 Desert Phase. The test items were used to transport water from the bivouac area to the firing areas. The transported water was primarily used for drinking purposes and for cleaning a 155mm howitzer. The questionnaires given to the group yielded the following results:

a. The experimental items were cleaned externally by wiping the items with a damp cloth. The control items had to be washed with soap and water and then wiped dry to prevent rusting. Neither the experimental nor the control items were sterilized.

b. The experimental items were convenient to fill, and they poured water without waste. The control items were convenient to fill, but considerable water was wasted while pouring.

c. The closures of the test items were easy to operate.

d. One experimental item was punctured in an unknown manner. All other experimental items did not leak.

e. No gaskets on the control items were lost, but two were broken. The control items which had broken gaskets leaked.

f. The taste of water from the experimental items was preferred to the taste of water from the control items.

g. The ability to fill canteens without waste was excellent from the experimental items (with caps #2 or #3), but a considerable amount of water spillage was experienced when filling canteens from the control items.

h. In the opinion of the group leaders, the experimental items were superior to the control items in operational suitability, durability, transportability, and maintainability.

2.7.4 <u>Analysis</u>

2.7.4.1 Temperate Phase. The plastic container was found to be compatible with the skills, aptitudes, and training of the average soldier; and it was generally acknowledged to be superior to the steel container for the following reasons: less water waste when filling canteens--due to the redesigned cap; and no gasket to lose or deteriorate.

2.7.4.2 Tropic Phase.

a. The plastic water container was easier to clean, sterilize, and handle. No breakdown or fading of the coloring was noted during the cleaning and sterilizing process.

b. The cap (#[illegible]) would not stay in place while filling and pouring; consequently, test personnel preferred the steel container for filling and pouring.

c. The capability of the plastic container for stacking was unsatisfactory; but operationally, the plastic container was more suitable than the steel container.

2.7.4.3 Arctic Phase. The only meaningful difference between the steel and plastic containers when used under arctic winter conditions was that ice in the plastic containers could not be thawed as rapidly as ice in the steel containers. Water in both types of containers froze rapidly when the containers were exposed to low ambient temperatures; however, it was possible to thaw the ice in the steel containers by placing the containers near direct or indirect heat, whereas the plastic containers melted under such circumstances. For this reason, the plastic container is considered inferior to the steel container and unsuitable for U.S. Army use under arctic winter conditions.

2.7.4.4 Desert Phase. The plastic containers were considered superior to the steel containers in overall functional suitability; and the redesigned cap enables canteens to be filled without waste of water.

2.8 TRANSPORTABILITY (ST-USAGETA, USATTC, USAATC, YPG)

2.8.1 Objectives

a. To determine if the experimental item could be conveniently carried by an individual soldier and loaded onto, transported on, and unloaded from vehicles during normal operations.

b. To determine the ease of transporting the water container by ahkio (USAATC).

c. To compare the transportability characteristics of the experimental item and the control item.

2.8.2 Method

2.8.2.1 Temperate Phase.

a. Plastic and steel containers were hand carried and backpack carried by individual soldiers during field exercises. Comments on the weight distribution, method of carrying, ease of carrying, and distance carried were obtained from the users for both empty and full containers. Comments were obtained as to whether the three handles on the control item were superior to one handle on the experimental item for lifting four empty containers at one time (two in each hand), and for distribution of weight when carrying full containers.

b. During field exercises, empty and full containers were transported by vehicles over primary and secondary roads as well as cross-country. Mileage was recorded according to the type of road traversed. Data were obtained concerning damage, leakage, type of transport vehicle, economy of space, and stability of the containers in the transport vehicles.

c. Information was recorded on the ease of loading and unloading both types of containers from transport vehicles.

d. Plastic and steel containers were placed in "Jerry Can" holders on tactical vehicles and were transported over primary and secondary roads and cross-country. Mileage was recorded according to type of road. Any difficulties in the loading and unloading process, leakage, and damages were recorded.

2.8.2.2 Tropic Phase.

a. Twenty plastic and 20 steel containers were filled to capacity with water and subjected to road shock on primary and secondary roads and cross-country terrain for 1,095 miles over a 10-day period at Fort Sherman, C.Z., and Rio Hato Training Area, Republic of Panama, and vicinities. The containers were loaded in vertical and horizontal patterns adaptable to the 2 1/2-ton truck and the 1/2-ton trailer. In addition, user units logged 2,072 miles during the test period over primary and secondary roads, cross-country, and jungle terrain in various types of Army vehicles, to include Army personnel carriers (M113).

b. Twenty empty plastic and 20 empty steel containers were transported over primary and secondary roads, cross-country, and jungle terrain for 337 miles during the test period at Fort Sherman, C.Z., and the Rio Hato Training Area, Republic of Panama.

2.8.2.3 Arctic Phase. Plastic and steel containers were used by a TOE Infantry Platoon during normal field operations during the test period. The containers were carried by soldiers wearing the arctic mitten set, snowshoes, and skis; using packboards, rucksacks, hand-carry and shoulder-carry methods. Water containers were transported in the field on ahkios and on wheeled and tracked vehicles.

a. Wheeled and tracked vehicles each transported 20 plastic and 20 steel containers filled with water 100 miles over secondary roads and cross-country. The containers were unloaded and loaded every 20 miles.

b. Soldiers unloading the containers dropped the containers from the vehicle bed to the road surface each time they were unloaded. In addition, one full plastic container was transported cross-country and on tank trails by the Armored Reconnaissance Airborne Assault Vehicle, M551, for 250 miles; and another full plastic container was similarly transported on the Combat Engineer Vehicle, M728, for 1,500 miles. The plastic containers were inspected for damage after each of the above transportation exercises.

2.8.2.4 Desert Phase. Test method was similar to that described in paragraph 2.8.2.1.

2.8.3 Results

2.8.3.1 Temperate Phase.

Data were obtained from Reservist personnel during the period 19 May 1967 through 26 August 1967 concerning the transportability characteristics of the two types of containers. During the course of the summer field exercises, plastic and steel containers were manually carried a total of approximately 12,500 feet and 13,700 feet, respectively.

a. Twenty of 28 participating Reservists who had carried both types of containers preferred the plastic container for hand carrying, two preferred the steel container, and six had no preference.

b. Data on the comparative acceptability of the plastic and steel containers for backpack carry were inconclusive.

c. The following comments were indicative of troop reaction to the plastic container:

(1) The plastic container was lighter and easier to handle.

(2) The pouring spout on the plastic container greatly reduced spillage.

(3) The plastic container should have more than one handle to facilitate carrying more than one empty container at a time in each hand.

(4) The bottom design of the plastic container made the container unstable on anything but a smooth surface.

(5) The plastic container was quieter, an advantage in tactical situations.

(6) The plastic container was less apt to produce bodily injury if dropped while being loaded onto a vehicle.

d. The plastic container was transported over primary and secondary roads, and cross-country, in 1/4-, 1/2-, 3/4-, and 2 1/2-ton trucks, APC's, and M60 tanks. Although the plastic container was less stable than the steel container, it was easy to load and unload, and no damages or failures were reported other than those described in paragraph 2.15.2.3a(2). Some difficulty was experienced with the external "Jerry Can" holder on the M113 armored personnel carrier, which has a protruding shelf designed to hold the lip on the bottom of the steel container. The absence of a lip on the bottom of the plastic container made it incompatible with that holder.

2.8.3.2 Tropic Phase.

a. No problems arose while hand carrying two empty plastic containers. However, despite the weight, test personnel were able to carry four empty steel containers for short distances due to the presence of outside carrying handles.

b. Both the hand-carry and the shoulder-carry methods of portage were inferior to the packboard method and pack-carry method of portage. Arm and shoulder fatigue made frequent rest stops necessary. In both pack methods of carrying, the plastic container was easier to carry than the steel container.

c. Test personnel could not shift the weight of the plastic container when holding it by its handle and carrying it on the hip. The metal container with three handles allowed this to be effected. In addition, the three handles allowed two persons to carry the steel container with more comfort and ease than the plastic container, which had only one carrying handle.

d. Empty plastic containers were very light, bounced around, and fell over easily when being transported loose in the back of a vehicle. In two instances, an empty plastic container bounced out of the rear of a vehicle.

e. No difficulties arose in loading and unloading the plastic containers; in fact, test personnel preferred to load and unload the plastic containers due to their lightness.

f. The plastic containers were shipped in bulk from U.S. Army Natick Laboratories, Natick, Massachusetts, via air freight to Charleston Air Force Base, Charleston, South Carolina (approximately 800 miles), and then by MAC to Howard Air Force Base, Canal Zone (approximately 1,500 miles). Containers were loosely packed in standard cardboard cartons, five in each carton. The containers arrived in good condition.

2.8.3.3 Arctic Phase.

a. Ninety-six percent of the completed questionnaries revealed that the individual soldier preferred to hand and shoulder carry the standard steel water container--regardless of weight--because the handle of the steel water container was easier to grasp with the arctic mitten set. Seventy-two percent of the completed questionnaires revealed that more steel than plastic containers could be carried for short distances. The plastic containers were preferred when carried by packboard and rucksack because of their lighter weight.

b. The plastic and steel containers were easily carried in ahkios and in tracked and wheeled vehicles. Two of 20 plastic containers sustained significant damage, 7 of 20 steel containers were significantly damaged, and all steel containers received some minor damage (chipped paint and small dents). The plastic containers carried by the M551 and M728 were not damaged.

2.8.3.4 Desert Phase.

a. The weight distribution was equal for both test items. The experimental containers were easier to hand carry both full and empty than the control items. The experimental item with rounded edges did not have the hitting effect on the legs of the carrier when the containers were lifted and carried as did the control item. The handle on the experimental item was easier to grip when four empty containers were carried at one time; that is, the weight difference between the plastic and steel containers (plastic was 3 1/2 pounds lighter) was considered more significant for ease of carry than the awkwardness of the plastic container positions when two containers were carried in each hand.

b. No damage or leakage to the test items was found after the containers were transported over 80 miles of primary roads, 40 miles of secondary roads, and 40 miles of cross-country by 2 1/2-ton trucks and 1/4-ton jeeps. The experimental items, stacked in a single tier or stacked two high, were not as stable as the stacked control items when the test items were full or empty. None of the empty experimental items remained in an upright position during cross-country transportation, whereas 50 percent of the control items remained in an upright position.

c. The experimental containers were easier to load on and off trucks because of their lighter weight and easier-to-grip handles.

2.8.4 Analysis

2.8.4.1 Temperate Phase. The plastic container was preferred over the steel container for hand carry, backpack carry, and vehicular transport.

2.8.4.2 Tropic Phase. No problems arose while carrying two empty plastic containers; however, three handles were more desirable because more than two empty plastic containers then could be carried at once with ease. The lack of additional handles is considered a shortcoming. The packboard method and pack carrier method of portage is preferred over the hand and shoulder carrying methods of portage. The plastic and steel containers can be transported equally well in bulk by land and air transport.

2.8.4.3 Arctic Phase. The steel container was preferred for hand and shoulder carrying when personnel wore the arctic mitten set; but the plastic container survived vehicle transport better.

2.8.4.4 Desert Phase. Not applicable.

2.9 DURABILITY (ES-USAGETA, USATTC, USAATC, YPG)

2.9.1 Objectives

a. To determine whether the experimental item was sufficiently durable to meet the requirements of its intended use.

b. To compare the durability of the experimental item with the control item.

c. To determine whether the redesigned cap was sufficiently durable and to compare its durability with that of the cap on the control item.

2.9.2 Method

2.9.2.1 Temperate, Tropic, and Desert Phases.

a. Plastic and steel containers were subjected to normal handling and usage under field conditions during the Functional Suitability and Transportability subtests (Pars. 2.7 and 2.8). Prior and subsequent to each use, the containers were inspected for the following: seam breaks; dents, punctures, or distortions; corrosion, particularly in the interior; loss or fading of camouflage coloring; and leakage, particularly about the opening.

b. All pertinent data on accidental droppings were recorded.

c. All failures which incapacitated the plastic and steel containers were recorded.

d. From the durability data obtained on the plastic container, an estimate was made as to the expected service life.

2.9.2.2 Arctic Phase.

a. Operations were conducted and containers were employed as described in paragraph 2.7.2.3 above.

b. In addition, the containers were filled full and 1/2 full of water and dropped from the following: tracked and wheeled vehicles; ahkios; packs and rucksacks; and personnel carry positions.

2.9.2.3 Engineering Phase.

a. Vibration Test. Ten filled plastic and 10 filled steel containers were vibrated on a package testing machine for 60 hours at a constant 1-inch double amplitude at 2 1/2 G's acceleration.

b. Drop Test. Eight plastic and eight steel containers were filled to maximum capacity with water. Four plastic and four steel containers were dropped from a height of 18 inches, and four containers of each type were dropped from a height of 36 inches, onto a steel plate mounted on concrete. For both the 18-inch and 36-inch tests, the drop cycle consisted of the following:

1st Drop - on bottom

2nd Drop - on welded side (steel container only)

3rd Drop - on flat side

4th Drop - on bottom corner opposite closure

5th Drop - on top corner under closure

6th Drop - on top corner opposite closure

7th Drop - on bottom corner on the same side as the closure

c. Closure and Handle Durability Test. The closure mechanisms of five filled plastic and five filled steel containers were actuated 1,200 times (each container) from the fully opened to the fully closed position. The vent plugs and the canteen pouring spouts on the plastic container caps were also actuated 1,200 times. In addition, the retainer straps on the plastic caps were flexed through 180 degrees for 10,000 cycles in an Instron Universal Tester.

2.9.3 Results

2.9.3.1 Temperate Phase.

a. Only three plastic containers out of 200 were badly dented in 3 months of field usage.

b. It was judged that the plastic container has a life expectancy of at least 2 years. Also, the mean time between failures discussed in paragraph 2.15.2.4a(1) indicates that the life expectancy may be as long as 3 years.

c. There was no evidence of corrosion in 3 months of field usage.

d. The camouflage coloring of the plastic container did not appear to fade during 3 months of field usage.

e. The plastic containers were able to withstand loading and unloading from transport vehicles under field conditions.

f. The opening and seal on the plastic containers performed satisfactorily during 3 months of field usage.

g. Three plastic containers out of 200 developed leaks due to accidental dropping while filled with water. These incidents were as follows:

(1) Container #22 was being transported in the back of a 2 1/2-ton truck when it fell off and hit the ground. The bottom edge cracked as a result of the fall.

(2) Container #143 was being transported on a tank when it fell off and hit the ground. The lower left corner was punctured as a result.

(3) Container #123 was being transported in the back of a 2 1/2-ton truck when it fell during handling. The lower edge cracked when it hit the ground.

2.9.3.2 Tropic Phase.

a. Four plastic containers were punctured during loading and unloading. These failures were located on the body near the handle.

b. Sixty horizontal tears were observed on the captive strap on the cap (#1) of the plastic containers during the test period. Forty of these containers were in outside storage and 20 were in use by test units.

c. One plastic container was punctured in two places on the body while it was being transported loose with other field equipment (machinegun mount).

d. One plastic container was split when it was being used as a seat (chair). The container was turned upside down and was empty at the time of failure.

e. One plastic container was punctured in two places on the upper body and cap when it fell approximately 5 1/2 feet while filled with water.

f. Although the thinnest areas in the plastic container appeared to be at the bottom corner (0.090 inches), no breaks occurred in these areas during the test period except when the corner drop phase of the test was conducted. Containers were dropped from heights of 1 to 6 feet in 1-foot increments. Failures occurred at 6 feet.

g. No splitting of the plastic container bottom along the pinch-off seams occurred during the test period; however, one container was split on the body by an unknown cause.

h. Containers were unstable when stacked two high in a vertical position; however, stability was increased when containers were full rather than empty.

i. No variation in the color shade of the plastic container was noted throughout the test period.

j. No degradation due to rot, rust, corrosion, fading, or mildew was noted on the plastic container throughout the test period.

k. No shrinkage or expansion of the plastic containers was noted during the test period.

l. Several tears or cuts were noted on the seal of the cap (#1) of the plastic container. This is a shortcoming.

m. No tears or cuts were noted on the mouth or opening of the plastic container during the test period. No stripping of the threads occurred during the test period.

n. Seventy-five percent of the gaskets on the steel containers pulled loose from the closure during the test period. The gaskets that did not pull loose were on containers filled or partially filled with water; however, the gaskets on those containers rotted during the test period.

o. All steel containers had rust or corrosion spots that were confined mostly to the bottom seam and the pouring spout. Minor scratches were discovered on most plastic containers after field use.

p. The Battalion S-4 Supply Sergeant, 508th (Airborne) Infantry, gave the opinion that: "The approximate life of the steel container is 30 days of field training. The battalion will go to the field for approximately 2 weeks at a time. After two of these field trips, 85 percent of the steel containers are ready for salvage. Either the top is excessively bent or the interior is chipped. The exterior needs painting and the gasket needs to be replaced. The plastic container is more durable than the steel container all the way around."

2.9.3.3 Arctic Phase. The plastic water container was more durable than the steel container when dropped from vehicles, personnel carry positions, ahkios, and aircraft (with or without parachute). Four plastic containers sustained permanent damage (three torn or broken hinges and one gash in the side of the container), as compared to 14 steel containers, during the course of the durability and airdrop subtests.

2.9.3.4 Desert Phase.

a. One experimental item was damaged, cause unknown. This container had a small hole at the bottom. All control items had paint scratches, and rust had developed at these places.

b. The cap (#2) of the experimental items permitted filling canteens without waste of water and appeared quite durable.

c. The camouflage coloring did not fade.

d. No deterioration of the experimental items was observed after 8 months of testing.

2.9.3.5 Engineering Phase.

a. Vibration Test.

(1) During the test, one steel container failed when the bottom seam cracked. The exterior painted surfaces of all the steel containers were worn down to bare metal at the points of contact.

(2) The exterior surfaces of the plastic containers were marred at the points of contact, but the serviceability of the containers was not impaired.

b. Drop Test.

(1) Eighteen-inch Drop Test. All the steel containers showed minor indentations and bottom bulges upon completion of the 18-inch drop test. Slight loosening of the closure levers was evident,

but all four steel containers maintained their watertight integrity when the containers were inverted. The four plastic containers were not visibly affected by the drop cycle.

(2) Thirty-six-inch Drop Test. All four steel containers failed the 36-inch drop test. Each container was dented severely, and all leaked freely at the closures. In addition, three steel containers developed seam splits. The four plastic containers showed indentations at each corner, but were otherwise undamaged.

c. Closure and Handle Durability Test. The closure assemblies on both the steel and plastic containers were undamaged by the closure test. None of the containers leaked when inverted, and the plastic retaining straps were undamaged by the flexing test.

2.9.4 Analysis

2.9.4.1 Temperate Phase.

The plastic container exhibited the following qualities:

a. Sufficient strength to prevent accidental crushing, broken seams, and dents.

b. An expected service life of at least 2 years.

c. Corrosion resistance.

d. A durable and proper camouflage color.

e. Ability to withstand loading and unloading from transport vehicles.

f. An opening and cap (#3) that had the following properties:

(1) Permitted convenient filling and pouring without waste.

(2) Was convenient and simple to operate.

(3) Did not leak.

(4) Had no separate gasket.

(5) Appeared to be as durable as the container.

2.9.4.2 Tropic Phase. The captive strap (cap #1) was too weak and did not stand up in tropical environments. Except for this factor, the plastic container was more durable than the standard steel container in the tropical environment.

2.9.4.3 Arctic Phase. The plastic container withstood dropping better than the steel container under arctic winter conditions.

2.9.4.4 Desert Phase. Not applicable.

2.9.4.5 Engineering Phase

a. Vibration Test. The vibration test showed that the finish of the steel containers was less durable than the finish of the plastic containers.

b. Drop Test. The drop tests indicated that the plastic container had more impact resistance than the steel container, and was strong enough to resist damage from falls up to 36 inches.

c. Closure and Handle Durability Test. Both types of closure assemblies were found to be equally durable over 1,200 opening and closing cycles.

2.10 ADAPTABILITY FOR AIRDROP (USAAESWBD)

2.10.1 Objective

To determine the adaptability of the plastic container for rigging for airdrop.

2.10.2 Method

a. The plastic and steel containers were examined, weighed, and photographed.

b. Physical characteristics of the experimental item were compared with the physical characteristics of the control item.

c. The experimental item was inspected and studied with reference to adaptability to standard rigging procedures for airdrop and compatibility with the following standard containers and platforms.

(1) Container loads:

(a) A-7A Cargo Sling

(b) A-21 Cargo Bag

(c) A-22 Cargo Bag

(2) Platform loads:

(a) Type II aluminum modular platform

(b) Combat expendable platform

2.10.3 Results

a. Weights and measurements are contained in Table V (Par. 2.2.3.4).

b. Inspection and study of the experimental and control items disclosed no characteristics that would adversely affect adaptability for rigging for airdrop when rigged as container or platform loads.

2.10.4 Analysis

Experimental and control items are both favorably adaptable for rigging for airdrop.

2.11 AIRDROP (USAAESWBD, USAATC)

2.11.1 Objectives

a. To determine suitability of the experimental item for airdrop.

b. To determine suitable airdrop procedures.

c. To determine suitability of the experimental item to withstand free fall and low and high velocity airdrops under arctic winter conditions.

2.11.2 Method

2.11.2.1 USAAESWBD Phase.

a. The plastic and steel containers were airdropped under identical conditions of flight (1100-1500 feet altitude and 130 KIAS for low and high velocity airdrops):

(1) Rigged in A-7A Cargo Slings, using low velocity procedures.

(2) Rigged in A-7A Cargo Slings, using high velocity procedures.

(3) Rigged in A-22 Cargo Bag, using low velocity procedures.

(4) Rigged in A-22 Cargo Bag, using high velocity procedures.

(5) Rigged on 8-foot modular platform, using low velocity procedures.

(6) Rigged on combat expendable platform, using ground proximity procedures (low level extraction from C-7A Aircraft).

(7) Freedropped from a hovering UH-1D helicopter onto a sod surface. Drops were made at 5-foot intervals from altitudes of 10 to 45 feet.

b. Each container was inspected prior to and after each airdrop. When damage or water loss was discovered on post-drop inspection, the damage was recorded and water loss determined.

c. Experimental and control items were numbered in order that pairs could be subjected to identical treatment.

d. Motion pictures were taken and analyzed.

2.11.2.2 Arctic Phase. Airdrop exercises were conducted as indicated in Table XII.

TABLE XII. ARCTIC AIRDROP CONDITIONS

Quantity of Containers		Altitude (ft.)	Type Aircraft	Type Delivery
Plastic	Steel			
10	10	1500	CV-2	Low velocity parachute drop
3	3	500	CV-2	High velocity parachute drop
3	3	175	CV-2	Freedrop

2.11.3 Results

2.11.3.1 USAAESWBD Phase.

a. Airdrop data are contained in Table XIII.

b. The experimental item performed as well as or better than the control item when airdropped in A-7A containers using both high and low velocity techniques.

TABLE XIII. AIRDROP DATA

DROP NUMBER	LOAD	DELIVERY TECHNIQUE	RIGGING METHOD	NO. OF CONTAINERS	NO. OF CONTAINERS DAMAGED	WATER LOSS (GAL)
1 1a	Test Items Control Items	Low Velocity Low Velocity	A-7A A-7A	8 8	0 0	0 0
2 2a	Test Items Control Items	Low Velocity Low Velocity	A-7A A-7A	8 8	0 0	0 0
3 3a	Test Items Control Items	Low Velocity Low Velocity	A-22 A-22	36 36	1* 16*	0 0
4 4a	Test Items Control Items	Low Velocity Low Velocity	A-22 A-22	36 36	1 1	3 0.4
5	<u>Mixed Load</u> Test Items Control Items	Low Velocity	8-Foot Modular Platform	36 36	0 0	0 0
6	<u>Mixed Load</u> Test Items Control Items	Low Velocity	8-Foot Modular Platform	36 36	0 0	0 0
7 7a	Test Items Control Items	LOLEX LOLEX	Combat Expendable Platforms	49 49	0 0	0 0
8 8a	Test Items Control Items	LOLEX LOLEX	Combat Expendable Platforms	49 49	0 0	0 0
9 9a	Test Items Control Items	High Velocity High Velocity	A-7A A-7A	8 8	3 8	0 5
10 10a	Tect Items Control Items	High Velocity High Velocity	A-7A A-7A	8 8	0 8	0 0
11 11a	Test Items Control Items	High Velocity High Velocity	A-22 A-22	42 42	18 Test invalidated by parachute malfunction.	90
12 12a	Test Items Control Items	High Velocity High Velocity	A-22 A-22	42 42	17 24	82 53
13 13a	Test Items Control Items	Freedrop Freedrop	N/A N/A	8 8	2 8	5 1

* Loads were dragged by parachutes on the ground.

c. Overall, the experimental item performed as well as the control item when airdropped in A-22 containers. However, when high velocity techniques were used more water was lost from the experimental items than from the control items; but fewer of the experimental items were permanently damaged. Some of the control item closures were crushed and could not be opened readily.

d. The experimental and control items performed equally well when airdropped by platform.

e. All control items sustained damage during freedrop. At altitudes from 10 to 40 feet, no water was lost. At 45 feet, the closure was bent and 1 gallon of water was lost. Only two experimental items were damaged during freedrop, and this occurred at altitudes of 40 and 45 feet. At 40 feet, a hairline crack occurred in the experimental item; but no water was lost. At 45 feet, the experimental item ruptured; and all water was lost.

f. No failure of experimental or control items could be attributed to the effects of cumulative airdrops.

g. Time, number of personnel, and procedures required for rigging and de-rigging the experimental and control items were approximately the same.

h. Standard procedures used for rigging the control item were suitable for rigging the experimental item.

2.11.3.2 Arctic Phase. No plastic containers sustained damage during the three types of airdrop exercises, whereas seven steel containers were damaged. All steel containers used during the high velocity parachute drop and freedrop exercises were damaged.

2.11.4 Analysis

2.11.4.1 USAAESWBD Phase.

a. The experimental item was suitable for airdrop using standard techniques, and it compared favorably with the control item.

b. The effects of cumulative airdrops were insignificant. A more important factor in damage was the position of the items in the rigged load relative to the attitude of the load at ground impact.

2.11.4.2 Arctic Phase. There was no difference in the airdrop capabilities of the two types of water containers.

2.12 INTERNAL AIR PORTABILITY (USAAESWBD)

2.12.1 Objective

To determine the suitability of the experimental item for internal air portability.

2.12.2 Method

a. The experimental and control items were stacked two high in separate loads with 3/4-inch plywood between layers and restrained in a C-130 aircraft. The loads were subjected to maximum performance takeoff, flown, subjected to assault landing, and unloaded.

b. Single layer loads of experimental and control items were flown in a UH-1D helicopter.

c. Loads were inspected and data recorded following each flight.

2.12.3 Results

a. The experimental and control items were successfully transported in a C-130 aircraft and a UH-1D helicopter. Inspection following flight revealed no damage.

b. The stacked load of experimental items leaned slightly aft during maximum performance takeoff and remained so during normal flight. They returned to their original position during assault landing. This instability presented no unsafe condition, and standard restraint procedures were considered suitable.

2.12.4 Analysis

The experimental item is considered suitable for internal air transport.

2.13 EXTERNAL AIR PORTABILITY (USAAESWBD)

2.13.1 Objective

To determine the suitability of the experimental item for external air portability by U.S. Army helicopters.

2.13.2 Method

Similar sling loads of the experimental and control items were rigged utilizing the Standard Sling, Cargo Net, Metallic, Octagonal, 5,000-Pound capacity. The loads were hooked up to a hovering UH-1D helicopter, flown, landed, and inspected for damage and water loss. Conditions of flight, weather, and handling for the test and control items were similar.

2.13.3 Results

a. The experimental item performed as well as the control item.

b. No damage occurred to the experimental item or the control item. The closure of one control item was loosened when it caught in the cargo net as the load was landed, and 1 gallon of water was lost.

2.13.4 Analysis

The experimental item is considered suitable for external air portability by helicopter.

2.14 HUMAN FACTORS EVALUATION (ST-USAGETA, USATTC, USAATC, YPG)

2.14.1 Objectives

a. To determine if the experimental item was suitable from a human factors standpoint, and to compare its suitability with that of the control item.

b. To determine if the redesigned cap was easy to use and if it enabled canteens to be filled without waste of water.

2.14.2 Method

During all testing, general observations were made regarding the features and characteristics of the water containers which appeared to be incompatible with the skills, aptitudes, and limitations of the using soldiers; and questionnaires were completed by the users. Items of particular importance were the taste of water and the ease of cleaning, transporting, filling and pouring from the containers, and opening and closing the lid.

2.14.3 Results

a. The plastic container was easier to clean and sterilize than the steel container.

b. The plastic and steel containers both were convenient to hand carry and backpack carry. It was more convenient to hand carry three or four steel containers than three or four plastic containers. The addition of two more handles (ribs) on the plastic container may improve its hand carrying and stacking characteristics.

c. Both items were convenient to fill and pour from, although the steel container was more convenient because the cover did not tend to get in the way.

d. The redesigned cap was easy to use and enabled canteens to be filled without waste of water. However, it was often difficult to tighten the cap so that the locking cam was properly positioned; and if the cap was tightened enough for the cam to "lock", it was often very difficult to unscrew the cap (with cam lock released). Consequently, caps often were not tightened completely, with the result that the pouring spout was not in its most forward position. Nevertheless, pouring without waste of water was easily accomplished.

e. The plastic water container was rated by all troops using the containers as very acceptable for use in the field; it was the preferred item.

f. The plastic and steel containers were not toxic nor irritating to test participants; and after initial cleaning, neither type had objectionable or toxic odors.

g. The plastic container was found to be incompatible with the arctic mitten set, and it was unsuitable for use under arctic winter conditions.

2.14.4. Analysis

a. The plastic container was suitable from a human factors standpoint under all but arctic conditions.

b. The cam lock on the cap frequently was not used because the cap often was difficult to tighten sufficiently; consequently, the cam lock could be eliminated.

2.15 MAINTENANCE EVALUATION (ES-USAGETA, USATTC, USAATC, YPG)

2.15.1 Maintainability

2.15.1.1 Objectives.

a. To determine if the experimental item required more maintenance or more difficult maintenance than the control item.

b. To determine if the maintenance performed on the test items was sufficient to keep them clean and in good condition.

c. To establish the effects of cleaning and sterilization on the test items.

2.15.1.2 Method.

a. Engineering Phase. Containers used in the Water Palatability subtest (Par. 2.4.2.1) were cleaned with hot water and GI soap and with hot water and dishwashing compound for 10 cleaning cycles. During each cleaning process the containers were agitated for 2 minutes with the cover closed, after which they were rinsed with clean water and drained. Live steam was then directed around the mouth of the container and the closure gasket for 1 minute. Upon completion of the cleaning cycle, an inspection was made of the closure gasket; and the containers, filled to normal capacity were weighed and placed in storage with the closure end down for a 24-hour period. Upon completion of the storage period, the containers were visually inspected and weighed to check for loss of water from leakage, and contents were analyzed for bacterial and other contamination.

b. Temperate, Tropic, Arctic, and Desert Phases.

(1) During service testing, all scheduled and unscheduled maintenance was performed according to prescribed procedures.

(2) Servicing difficulties, as well as favorable aspects, were recorded for the experimental and control items. A comparison of the ease and effectiveness of maintenance of the two types of containers was made.

(3) Records were kept on the length of time required for maintenance and of the time intervals between maintenance.

(4) Safety aspects involved in maintenance procedures and results of maintenance were studied.

(5) Maintenance under extreme hot and cold environments was performed and commented upon by users and supervisors.

(6) Repairs of container damages were attempted by YPG.

2.15.1.3 Results

a. Engineering Phase. All of the water samples analyzed were declared safe for human consumption.

b. Temperate Phase.

(1) No scheduled or unscheduled maintenance was required or performed; only servicing (cleaning) of the containers was accomplished.

(2) All except one of 41 participating Reservists who had cleaned the plastic containers (24 had cleaned plastic only; 17 had cleaned both plastic and steel) stated that no difficulties were encountered in cleaning the containers; the other participant stated that the plastic scuffed during use and consequently appeared dirty even when it was clean. Nine of the 17 participants who had cleaned both types of containers preferred to clean the plastic container because it was lighter in weight (therefore easier to handle), had no crevices to clean, and did not rust; 6 had no preference; and 2 preferred the steel container because it looked better after cleaning and it could be painted to improve its appearance.

(3) Two hundred plastic and 100 steel water containers were cleaned every 2 weeks for 3 months under supervision of the test team. The operation was conducted at a simulated Army wash point which consisted of four 32-gallon GI cans. A four-step wash process was used: wash, rinse, chlorine solution dip, and a final rinse. No problems were encountered.

c. Tropic Phase.

(1) Rust, corrosion, and fading were observed on the exterior and mouth of the standard containers after 30 days of storage.

(2) After 77 days of storage, all standard containers had rusted to the extent that it was deemed necessary to get a medical opinion on the continued use of the containers. A medical officer inspected all standard containers and declared them unserviceable for issue or use by troops unless in an extreme emergency (paragraph 2.3.3.2b).

(3) During operations, the plastic container was cleaned (interior and exterior) with hot soapy water using a brush and agitative motion, particularly in those areas that could not be visually inspected. After completion of cleaning with hot soapy water, the containers were sterilized with boiling hot clear water. The plastic container was easier to handle during cleaning and sterilizing than the steel container because of its lighter weight. It was easier to clean because no rust or corrosion or chipping of paint existed. In addition, no gasket replacement was necessary.

(4) There were no maintenance requirements for the plastic container other than those associated with normal cleaning procedures of Food Service Equipment (Par. 5, 1st Ind, Ref. 15, App. VI).

(5) Very small holes or tears could be repaired in the field using a hot soldering iron or heat from other sources.

(6) Several test participants stated that they felt that over a period of time and continuous use that sediment would form in the beads on the bottom of the container, creating a problem in cleaning that area.

d. Arctic Phase. Maintenance consisted only of cleaning the water containers. Damaged plastic containers could not be repaired at organizational level.

e. Desert Phase.

(1) During service testing no scheduled maintenance was performed on the test items.

(2) The test items were punctured at different positions and then repaired. The control item was repaired by soldering small holes (1/8 inch in diameter) and cracks along seams. Larger holes could not be repaired by this method. The inside was not repainted in either case since the type of paint inside the container was not known. Holes punctured in the plastic containers were repaired by using a soldering iron and fusing the plastic together. For holes greater than 1/8 inch in diameter, pieces of plastic from another container were fused to the defective container. Repairs of both plastic and steel containers did stop leakage. The repair of the experimental test item was easier, since the only equipment needed to repair the container was a heated piece of metal which was used to fuse the plastic.

(3) The plastic container was easy to clean, except in the hollow handle where it could not be inspected or easily reached. It was necessary to use a strong cleanser such as hydrochloric acid to remove rust from the control items.

2.15.1.4 Analysis. The plastic container was cleaned, sterilized, and repaired satisfactorily and more easily than the steel container. Accumulated dirt or grime was effectively removed by hot soapy water with no apparent effect on the color or strength of the container.

2.15.2 Reliability

2.15.2.1 Objectives

a. To assess the reliability of the experimental item under normal operations and to derive information regarding expected service life and required logistical support.

b. To compare the reliability of the experimental item with that of the control item.

2.15.2.2 Method

a. All tests on the containers were performed under close observation, and inadequacies were recorded and evaluated.

b. For reliability purposes, a failure was defined as any damage or deterioration which rendered a container unsuitable for use.

c. Mean Time Between Failures (MTBF) was computed for both types of containers.

d. Maintenance and usage records were used to evaluate the reliability of the experimental and control items.

2.15.2.3 Results

a. Temperate Phase.

(1) While the containers were being used in the field by Army Reserve ANACDUTRA Units, the number of use-days was recorded for each container. Valid data were obtained for 250 plastic containers combined was 7,751; and the average number of use-days per plastic container was 31.

(2) During the period of field usage, a total of seven plastic containers failed (EPR's L7-8 through L7-14, Ref. 22, App. VI). None of the failures were attributable to wear-out, deterioration, or manufacturing defect; rather, all were "accidental" type failures: the containers were punctured or cut by tools; broken or punctured when dropped (while full) from vehicles; and crushed by vehicles. For the failed plastic containers, use-days ranged from 24 to 55, totaled 288, and averaged 44.

(3) Considering all use-days for the plastic containers, the MTBF for the plastic container was 7,751 divided by 7, or 1,107 use-days--slightly more than 36 months.

(4) Valid use-day data were obtained for 74 steel containers: use-days ranged from 7 to 21; total use-days for all steel containers was 1,072; and the average number of use-days per steel container was 14. Usage of the steel containers was much less than for the plastic containers (compare par. (1) above) because many of the units which participated in the test refused to accept the steel "test" items since they had steel containers of their own. Consequently, valid use data were not available in those instances; and use-days were not accumulated on the steel "test" items.

(5) During the period of field usage, there were no reported failures of the steel containers; consequently, MTBF could not actually be computed. However, it would be in excess of 1,072 use-days, which is in excess of 35 months.

b. Tropic Phase.

(1) Unscheduled maintenance for the experimental item consisted of normal cleaning and sterilizing after use and was not considered excessive based upon similar items.

(2) There were seven failures in durability which rendered the experimental items unsuitable for continued use. The MTBF for the 60 experimental items that were used by troops was 119 days. The experience in the Canal Zone indicates that the standard steel container can be expected to last for approximately 30 days in field operation.

(3) There were no failures for the plastic containers in storage that would render the test items unserviceable; therefore, the MTBF would be at least 120 days.

(4) All 100 steel containers failed after 77 days of outside uncovered storage. Items had rusted to the extent that they were declared unserviceable by a medical officer.

c. Arctic Phase. MTBF was not computed; however, the durability of the plastic container (paragraph 2.7.3.3) made it unsuitable for use under arctic conditions.

d. Desert Phase.

(1) The deterioration of the experimental item during outdoor storage rendered 25 percent of the containers unsuitable for use after 4 months.

(2) The deterioration of the control item gaskets during outdoor storage rendered all containers filled with water useless after 4 months.

2.15.2.4 Analysis

a. Temperate Phase.

(1) The maximum number of days of actual field usage for any single plastic container was 59, and there were no failures during the test which resulted from wear-out or time-related deterioration; consequently, expected service life could not be determined. Nevertheless, the MTBF indicates that the plastic container would survive approximately 3 years of use if wear-out or deterioration were not a factor.

(2) The steel container was comparable to the plastic container.

b. Tropic Phase. The plastic container in storage can be expected to last at least 120 days, which exceeds the expected storage life of the steel container. The plastic container can be expected to last 119 days in usage, which greatly exceeds the expected service life of the steel container.

c. Arctic Phase. Plastic container not suitable.

d. Desert Phase. The expected storage life of the plastic container under exposed conditions would be 4 months. The expected life of the steel container gaskets under exposed storage and filled condition would be 4 months.

2.15.3 Tools and Test Equipment

2.15.3.1 Objective. To determine whether appropriate common and special tools and test equipment were suitable for their intended use and maintenance level.

2.15.3.2 Method. Test personnel performed all maintenance required and evaluated the tools and extent of maintenance required to keep the plastic and steel containers serviceable.

2.15.3.3 Results.

a. No common or special tools were furnished with the test items for evaluation.

b. Materials necessary for cleaning the containers consisted of hot water, soap, brush, either boiling water or a chlorine solution, and 32-gallon GI cans. The control item required cleaning with a strong cleaner such as hydrochloric acid to remove rust; and it required painting to prevent rust.

c. Repair of the intentional punctures in the test items was accomplished using a soldering iron to fuse the plastic or to melt solder (for the steel container). Gaskets of the control items will have to be replaced on approximately 10 percent of the containers.

2.15.3.4 Analysis. Not Applicable.

2.15.4 Technical Manuscripts and Manuals

2.15.4.1 Objective. To determine whether the maintenance instructions received with the water containers were adequate.

2.15.4.2 Method. No maintenance instructions were received with the containers; consequently, no evaluation could be made.

2.15.4.3 Results. Not Applicable.

2.15.4.4 Analysis. Not Applicable.

2.16 VALUE ANALYSIS (ALL TEST AGENCIES)

2.16.1 Objective

To determine whether the plastic container had any unnecessary, costly, or nice-to-have features that might be eliminated without adversely affecting essential performance requirements, reliability, quality, or safety (USATECOM Regulation 700-1).

2.16.2 Method

Observations relative to value improvement were made during the conduct of the other subtests.

2.16.3 Results

Test participants and test supervisory personnel felt that although the locking feature to prevent loosening of the cap was included with good intent, it was seldom used because it was very difficult to screw the cap all the way down to make the locking device effective. In addition, the cap was very difficult to remove when tightened sufficiently to make the lock engage. No leaks were noted when the locking device was not used.

2.16.4 Analysis

The locking device was found to be nonessential.

2.17 BRANCH APPLICATION (ST-USAGETA)

2.17.1 Objective

To obtain opinions and advice from appropriate USCONARC branch schools, USAMC agencies, and the U.S. Marine Corps as to the utilization of the plastic water container.

2.17.2 Method

The following commands and agencies were invited to send representatives from subordinate units to witness the test and submit comments: CG, USCONARC, Fort Monroe, Virginia; CG, USACDC, Fort Belvoir, Virginia; The Surgeon General, Washington, D.C.; and U.S. Marine Corps Landing Force Development Center, Quantico, Virginia.

2.17.3 Results

a. The representative of USCONARC indicated that the plastic container appeared favorable in that it was corrosion proof and lighter than the steel container. He observed that the tightly screwed cap frequently was not in a position where the lock was operative; also, that when the cap was water tight, the canteen spout was in a position such that it would be difficult to fill canteens. In addition, he indicated that the bottom of the container should be made stronger and be redesigned for better stability.

b. The representative of USACDC stated that the plastic container seemed to have several advantages of the steel container: lighter in weight, less noisy in use and transport, and the water seemed to be more palatable.

c. The representative of the Surgeon General commented that the water from the plastic container tasted better and seemed to stay cooler than water in the steel container and that the plastic container was easier to maintain.

d. The U.S. Marine Corps representative indicated that the plastic container appeared to be an improvement over the steel container. The plastic container seemed durable enough for Marine Corps use, it did not seem to impart taste to water, it was lighter than the steel container, and the canteen spout facilitated more economical use of water.

2.17.4 Analysis

Results of the other test phases indicated the following: the bottom of the plastic container is adequately strong, but the present design of the bottom (Fig. 1, App. V) does contribute to its instability and its poorer stacking characteristics (relative to the steel container); the lock was not necessary and can be deleted; and canteens can be filled satisfactorily even when the spout is not in the most forward position.

2.18 SAFETY (ES-USAGETA, USATTC, USAATC, YPG)

2.18.1 Objectives

To determine whether the experimental item had any safety hazards and to accomplish the safety confirmation required by USATECOM Regulation 385-7.

2.18.2 Method

a. Users of the test items complied with the safety precautions as set forth in the Safety Release. Care was exercised in checking the interior of the plastic and steel containers for dirt, bacteria, and corrosion.

b. Individual soldiers were blindfolded and asked to distinguish the two types of water containers (plastic and steel) when they were randomly mixed with gasoline containers.

2.18.3 Results

a. The plastic container had no unsafe features when properly sterilized prior to use. Good field sanitation practices were adhered to during the course of the tests.

b. Neither the plastic container nor the steel container was toxic or irritating to test participants; and after initial cleaning, neither container had any objectionable or toxic odors.

c. The plastic container was easier for users to clean and sterilize than the steel container.

d. No difficulty was encountered by the six blindfolded test participants in recognizing and identifying the five plastic water containers from the standard steel water containers and the standard steel gasoline containers. All of the plastic containers were quickly and easily identified by the test participants due to the single carrying handle, screw cap, and plastic material.

e. Test participants were able to recognize and identify the steel water container by the difference in closures from that of the gasoline container.

f. The plastic material did support combustion (paragraph 2.6.4); consequently, normal precautions for storage and use of combustible materials should be followed.

2.18.4 Analysis

a. The plastic water container had no features which caused safety hazards.

b. The plastic container met all safety requirements to a satisfactory degree, and the safety of the item is confirmed. Only normal precautions for storage and use of combustible materials should be employed.

SECTION 3. APPENDICES

APPENDIX I - TEST DATA

- A Tropic Test Center Distribution Data
- B Tropic Test Center Questionnaire Data
- C Tropic Test Center Solar Radiation Data
- D Tropic Test Center Climatic Data
- E Yuma Proving Ground Meteorological Data
- F USAGETA Environmental Data
- G Durometer Hardness and Chlorine and Trisodium Phosphate Resistance Data
- H. Mar Resistance Data
- I Abrasion Data
- J Color Fastness Data
- K Flammability Data
- L Chemical, POL, and Radiation Effects
- M Taste Preference Analysis
- N USAATC Ambient Air Temperatures
- O USAATC Container Damage Data

APPENDIX II - FINDINGS

APPENDIX III - DEFICIENCIES AND SHORTCOMINGS

APPENDIX IV - MAINTENANCE EVALUATION

APPENDIX V - PHOTOGRAPHS

APPENDIX IV - REFERENCES

APPENDIX VII - DISTRIBUTION LIST

APPENDIX I. TEST DATA

APPENDIX I-A

U. S. ARMY TROPIC TEST CENTER CONTAINER DISTRIBUTION LIST

Unit	Number of Plastic Containers Used		
	Original Issue	Withdrawn From Test	Finished Test
4th Bn (Mech), 20 Inf	12	0	12
3d Bn Abn, 508th Inf	12	1	11
4th Bn, 10th Inf	12	0	12
Btry "B" (105MM) 22nd Arty	12	3	9
4th Missile Bn (HAWK-AW) 517 Arty	12	4	8
Tropic Test Center Storage Test and (Transportability Test)	40	0	40
TOTAL	100	8	92

APPENDIX I-B

U. S. ARMY TROPIC TEST CENTER QUESTIONNAIRE DATA

Container, Water, Plastic, 5-Gallon

NAME & RANK: Personnel of Infantry and Artillery Units DATE:

UNITS: 4th Battalion, 10th Infantry; 4th Battalion (Mechanized), 20th Infantry; 3d Battalion (Airborne) 508th Infantry; Battery "B" (105MM), 22nd Artillery; 4th Missile Battalion (HAWK-AW), 517th Artillery.

CODE NUMBER OF CONTAINER: PLASTIC 1 thru 119 (odd numbers)

STANDARD 2 thru 120 (even numbers)

GROUP: C

You will help the U.S. Army to determine the suitability and the durability of an experimental Container, Water, Plastic, 5-Gallon, for Army use in a tropical climate by answering all the following questions. The answers you give should be your personal opinion, based upon your experience in using the test container while performing your duties during the test period. If you do not understand any question, please ask the test supervisor for an explanation.

If you need extra space to answer a question, please use the back of the last page of this questionnaire.

---

1. a. Estimate number of days containers were used in the field.

119 days

b. What type exercise were you engaged in? All type of field exercises and training.

c. What kind of weather? See chart

d. What kind of terrain? Tropical savanna, deciduous forest, and tropical rain forest.

2. a. Do the indentations affect cleaning of the container? Yes 1 No 81*

* Although there were only 60 test items issued to troops, there are 82 complete questionnaries. Some test items were used by more than one person.

APPENDIX I-B

Remarks: One test participant stated the indentation "WATER" should not be as deeply labeled.

b. Compare ease of cleaning the new container (plastic) with the old container (steel). The new container is:

73	6	3		
Much Easier	A Little Easier	About the Same	A Little Harder	Much Harder

c. Was hot soapy water used to clean the new container? Yes 82 No___

d. Did you notice any effects that the hot soapy water or other detergent had on the container? Yes ___ No 82

e. Was the test container easy to clean and sterilize, particularly in those areas that cannot be visually inspected (these areas are located above the interior of the handle and in the carrying handle which are hollow)?

Yes 82 No __

How did you clean these areas? Hot soapy water using a brush and agitative motion.

3. Compare the screw-down top on the plastic container to the snap-down top on the steel container. The screw-down top is:

57	12	7	6	
Highly Superior	A Little Superior	About the Same	A Little Inferior	Highly Inferior

4. Compare the one carrying handle on the plastic container to the three-handle system on the steel container. The one carrying handle is:

9	10	2	27	34
Highly Superior	A Little Superior	About the Same	A Little Inferior	Highly Inferior

Remarks: Inconvenient to carry more than two containers at one time when empty.

5. Would you prefer a larger handle on the test container? Yes 16 No 56

6. a. Did you have any problems opening the top on the test container?

Yes 18 No 64

Remarks: Was hard to open when screwed down to make locking device effective.

b. Did you have any problems closing the top on the test container?

Yes 19 No 63

Remarks: Was very hard to close all the way down to make locking device effective.

c. Did water leak from the pouring spout of the test container when the top was screwed down tight? Yes 1 No 81

Remarks: Approximately 1 drop per minute.

7. Did the cap hinder pouring from the test container? Yes 39 No 43

8. During transportation, did the test container remain stacked when filled with water? Yes 31 No 51

9. Compare ease of carrying the container with old container.

The test container was:

41	23	17	1	
Much Easier To Carry	A Little Easier to Carry	About the Same	A Little Harder to Carry	Much Harder to Carry

10. During use, did you notice any rust, corrosion or mildrew on any of the containers? Yes ___ No 82

If so, state what was found and the type container on which it was found: See paragraph 2.2.4

11. Did you notice any fading or discoloring of the containers during use?

    Yes __ No 82. See paragraph 2.2.3.

12. a. Did you notice any peculiarity in the taste of the water from the test container? Yes ___ No 82

    b. If so, do you think the taste was caused by the material of the container? Yes __ No ___ N/A

13. Were any unsafe features noticed in handling the test container?

    Yes __ No 82

14. a. Was the container dropped? Yes 48 No 34

    b. If so, what was the approximate drop height and what effect did dropping it have on the container? From 1' to 8'. See paragraph 2.5.3 for effects.

15. Did water leak through the walls or the seams when there was no apparent puncture, rip, or tear? Yes ___ No 82

16. Did sharp instruments penetrate the container during use? Yes 2 No 80

17. Did the cap retainer on the plastic container break during any operation?

    Yes 27 No 55

18. Considering all the characteristics of each type container, rate the two containers for overall tropical use.

	Plastic Container	Standard Container
Outstanding	27	
Superior	47	
Better than Average	6	

APPENDIX I-B

	Plastic Container	Standard Container
Average	______	______
Poorer than Average	______	______
Inferior	______	______
Useless	______	______

19. State any comments, or suggested improvements, about the plastic container.

1. Captive strap should be more durable.

2. Add two additional carrying handles.

3. Design carrying handle to eliminate the hollow.

APPENDIX I-C

U. S. ARMY TROPIC TEST CENTER SOLAR RADIATION DATA

Station: Panama Canal Zone
Site: Gun Hill

Solar Radiation in Langley (measured with Vertical Eppley)

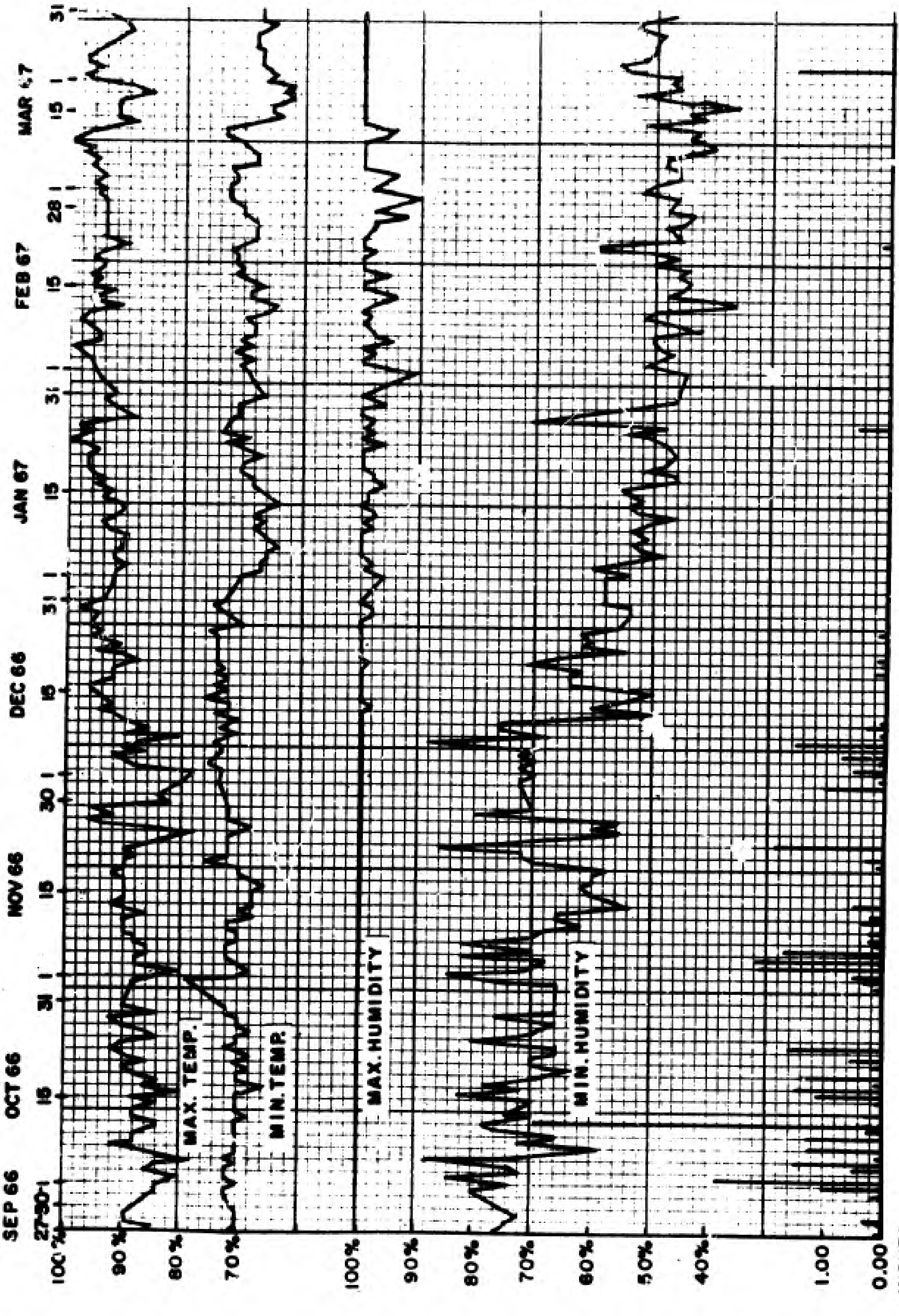
DAILY TOTAL

Month (1966)	Mean	Maximum	Minimum
September	376	543	149
October	328	573	137
November	372	574	127
December	363	534	126

Note: Solar radiation data for the months January, February, and March 1967 are not available.

APPENDIX I-D

U.S. ARMY TROPIC TEST CENTER CLIMATIC DATA

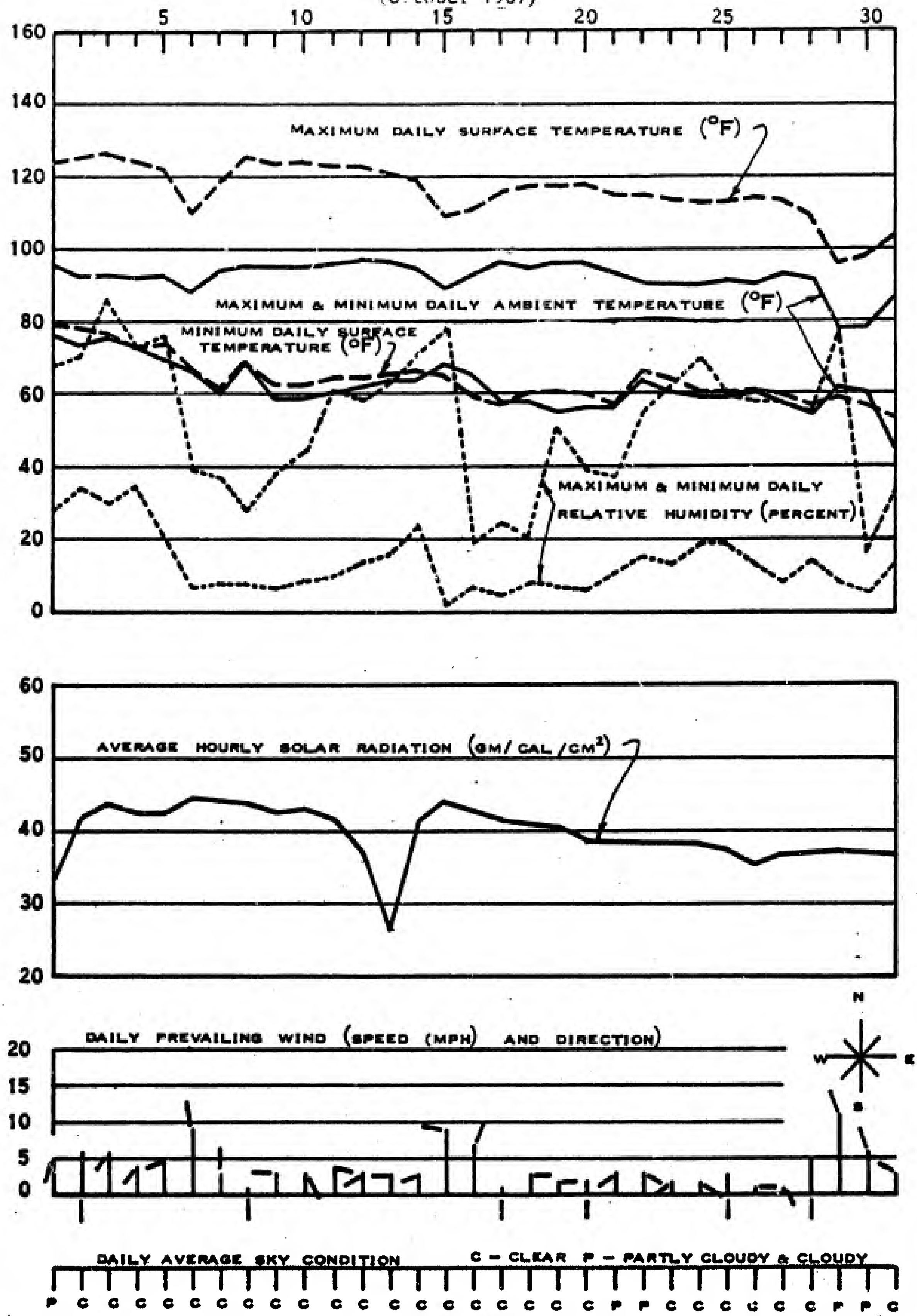


DAILY RAINFALL
CLIMATIC DATA 27 SEP 66 THRU MAR 67
FORT CLAYTON C.Z. & VICINITY

APPENDIX I-E

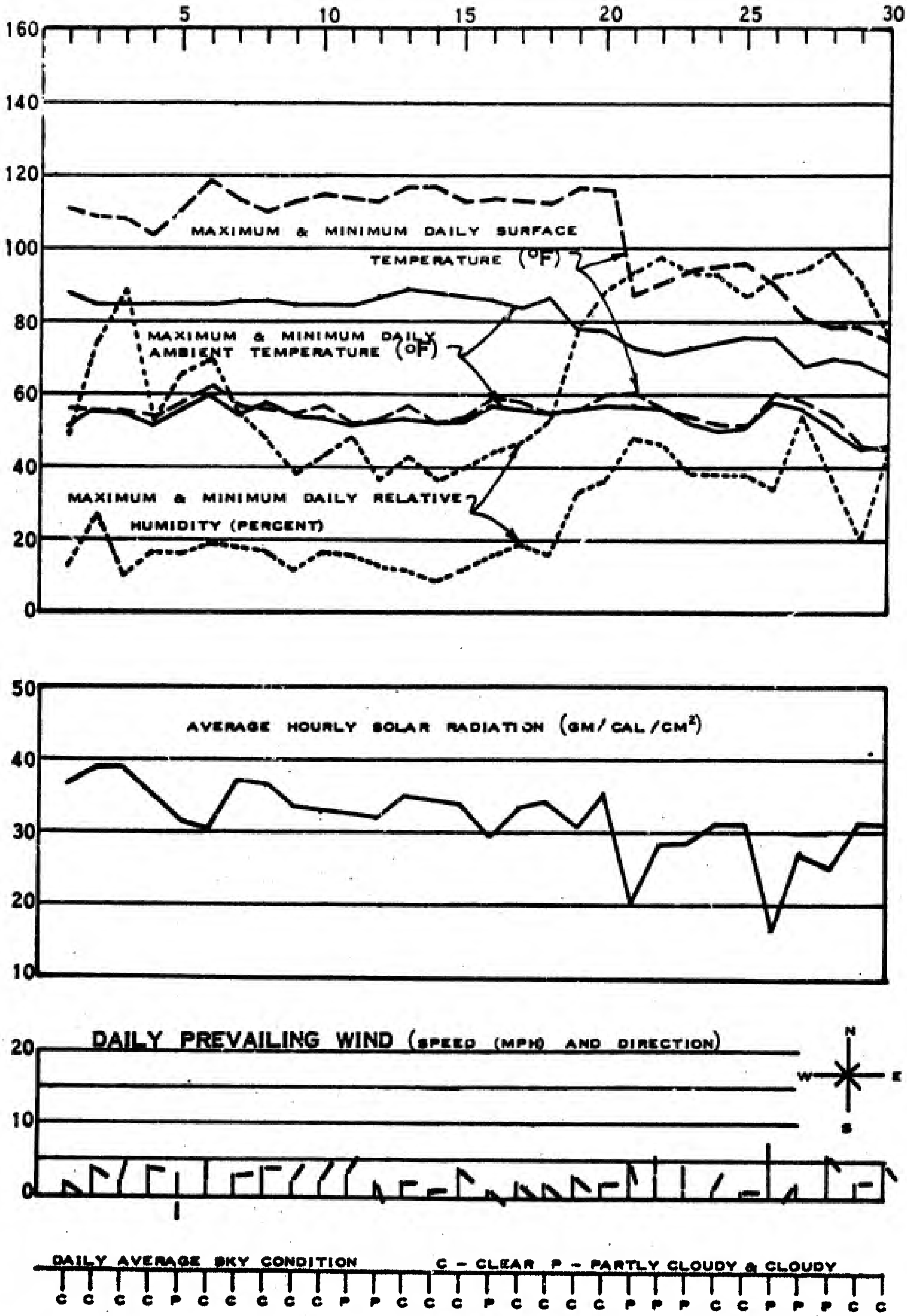
YUMA PROVING GROUND METEOROLOGICAL DATA

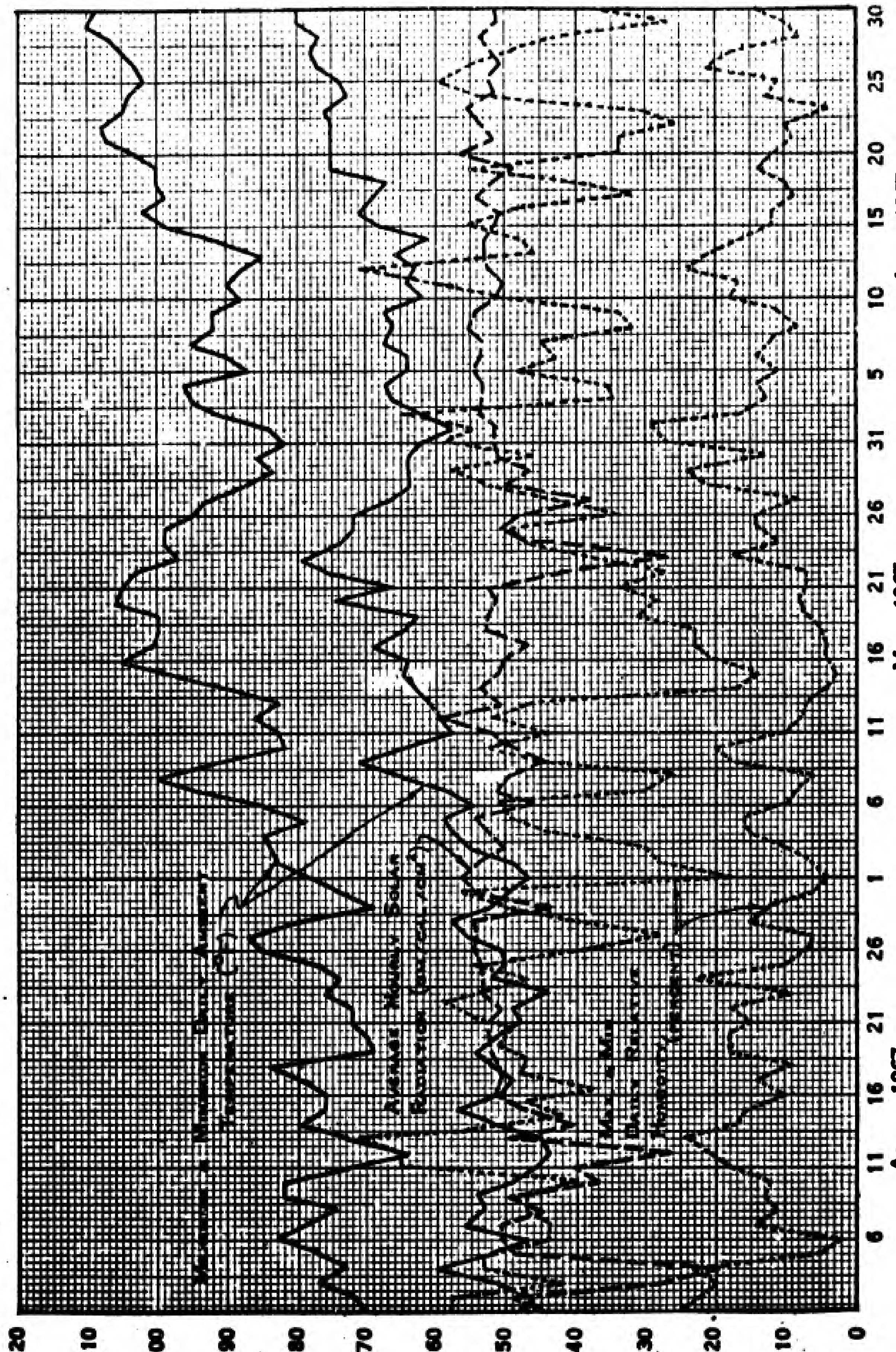
(October 1967)

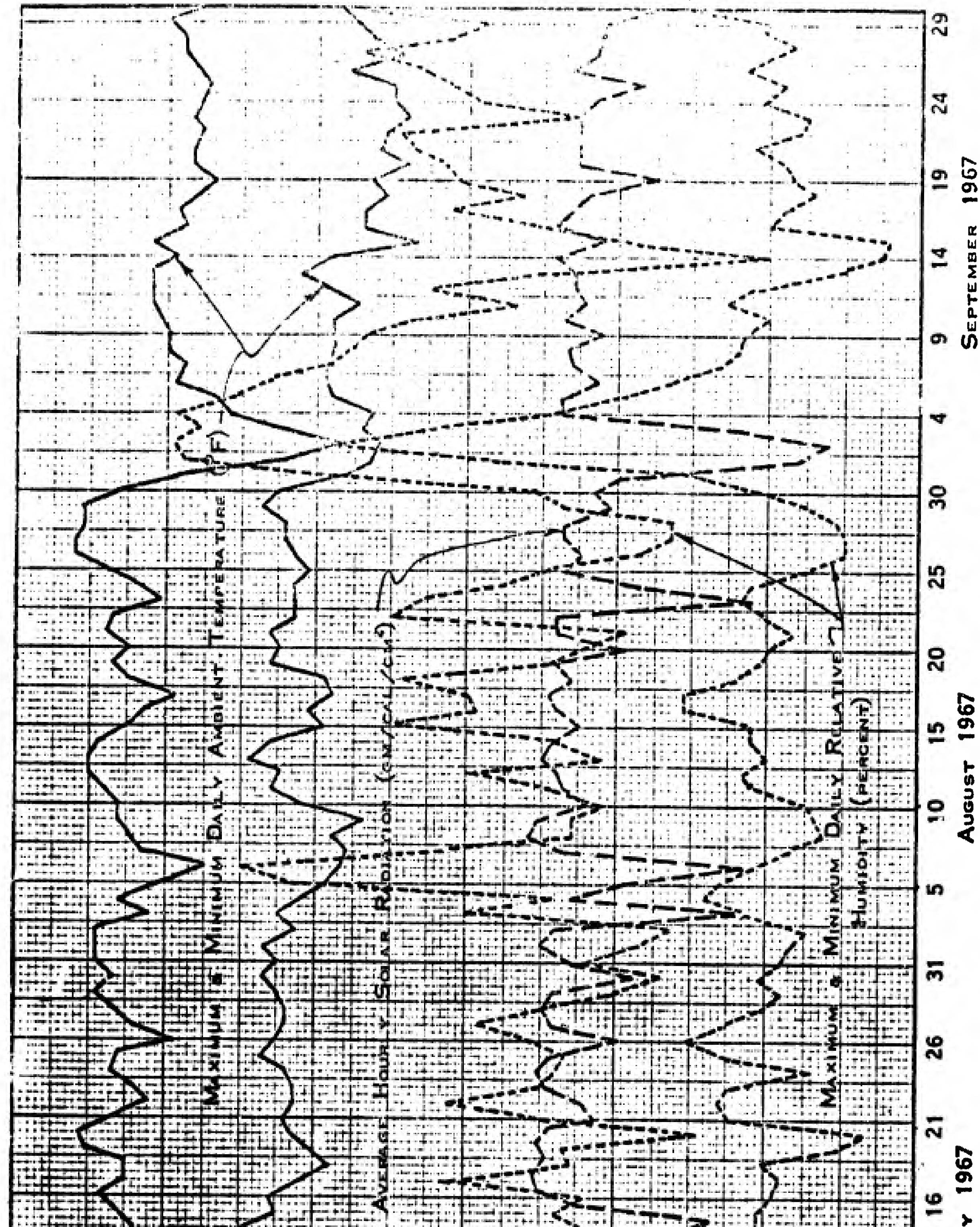


APPENDIX I-E

(November 1967)




120
110
100
90
80
70
60
50
40
30
20
10
0
April 1967
May 1967
June 1967
6
11
16
21
26
1
6
11
16
21
26
31
5
10
15
20
25
30


Maximum & Minimum Daily Ambient Temperature (°F)
Average Hourly Solar Radiation (cal/cal/cm)
Maximum & Minimum Daily Relative Humidity (percent)
120
110
100
90
80
70
60
50
40
30
20
10
0
6
11
16
21
26
31
5
10
15
20
25
30
4
9
14
19
24
29
July 1967
August 1967
September 1967

APPENDIX I-F

U. S. ARMY GENERAL EQUIPMENT TEST ACTIVITY ENVIRONMENTAL DATA

MONTHLY SUMMARY OF SIGNIFICANT ENVIRONMENTAL FACTORS

MAY 1967

DATE	TEMPERATURE (°F.)			AVG REL HUM (%)	WIND SPEED (MPH)		PRECIPITATION (IN)		MAX CLDS (%)	FABRIC WET (HRS)	SOLAR RADIATION (LGYS)			
	MAX	MIN	AVG		AVG	MAX GUST	TYPE	AMT			45°S	45°E	HORIZ	
1	83	56	68	71	2	20	R-	T	100	7	377	476	443	
2	82	60	71	63	5	28	R-	.02	100	2	398	445	462	
3	69	45	58	70	2	20	R-	.09	100	10	463	473	520	
4	63	38	52	72	2	11	R-	T	100	13	234	291	295	
5	70	42	58	75	2	13	0	0	90	9				
6	69	52	60	86	4	19	0	0	Sat	9				
7	74	51	58	82	*	*	R	1.46	Sun	14	897	916	1047	***
8	66	48	56	71	6	19	R	.05	100	5	306	474	389	
9	63	46	53	75	3	17	R-	.03	100	1	353	388	433	
10	70	45	56	61	2	17	0	0	50	0	563	551	638	
11	81	46	64	67	6	32	R-	T	100	1	227	155	256	
12	73	54	66	69	2	13	0	0	100	0				
13	58	49	55	81	1	9	0	0	Sat	7				
14	73	53	61	93	2	11	R-	.03	Sun	2	686	632	814	***
15	88	59	67	78	5	41	R-	.02	100	12	432	409	501	
16	69	44	57	62	2	16	0	0	70	3	476	571	574	
17	71	38	56	67	2	18	0	0	80	8	429	537	525	
18	76	43	60	65	1	12	0	0	10	7	567	620	690	
19	83	53	69	63	5	29	R-	T	80	6				
20	82	57	70	66	2	20	0	0	Sat	8				
21	61	49	54	80	*	*	R	.18	Sun	10	982	1104	1193	***
22	55	49	52	94	2	10	R	.53	100	21	76	86	98	
23	65	50	56	71	4	19	R-	.04	100	9	479	533	565	
24	57	46	52	74	5	16	0	0	100	0	131	167	170	
25	73	38	57	59	3	17	0	0	0	0	549	605	685	
26	76	42	60	65	3	17	0	0	0	5				
27	81	43	63	66	1	9	0	0	Sat	8				
28	89	59	73	66	2	13	0	0	Sun	0	1522	1616	1871	***
29	86	54	69	73	3	17	R	.26	90	5				
30	62	55	58	86	2	14	0	0	HOLIDAY	3	589	588	709	**
31	57	48	55	94	1	9	R	.39	100	17	88	93	110	
TOT	-	-	-	-	Max Gust		-	3.10	-	202	10,824	11,730	12,988	
AVE	72	49	60	73	3	41	-	-	-	-	349	378	419	

* - Missing due to instrument failure
** - 2 days total solar radiation
*** - 3 days total solar radiation

DUST FALL (ASTM D 1739-60 T)

DUSTFALL (g/m²)	WATER INSOLUBLES (%)			WATER SOLUBLES (%)	pH
	COMBUSTIBLE & VOLATILE MATTER	BENZENE SOLUBLES	INORGANIC INSOLUBLE MATTER		
25.48	54.02	1.82	13.98	30.16	6.5

FREQUENCY SUMMARY

ELEMENT	NO. OF DAYS
PRECIP., 0.01" OR MORE	12
MAX TEMP, 90° OR ABOVE	0
MIN TEMP, 32° OR BELOW	0

APPENDIX I-F

JUNE 1967

DATE	TEMPERATURE (°F.)			AVG REL HUM (%)	WIND SPEED (MPH)		PRECIPITATION (IN)		MAX CLDS (%)	FABRIC WET (HRS)	SOLAR RADIATION (LEYS)			
	MAX	MIN	AVG		AVG	MAX GUST	TYPE	AMT			45°S	45°E	HORIZ	
1	64	46	56	73	1	9	0	0	100	10	233	273	297	
2	76	40	59	68	1	11	0	0	50	11	WEEKEND			
3	76	45	62	73	1	13	0	0	M	9	WEEKEND			
4	78	53	66	75	2	15	0	0	M	10	1544	1617	1928	**
5	79	55	66	72	2	14	0	0	40	12	540	563	684	
6	77	53	66	76	1	13	C	0	100	10	432	441	526	
7	80	52	67	74	1	14	0	0	100	9	436	386	532	
8	82	52	69	69	1	11	0	0	50	8	527	632	680	
9	85	58	70	68	2	13	0	0	30	7	WEEKEND			
10	88	60	74	64	2	12	0	0	M	6	WEEKEND			
11	87	58	74	67	2	14	0	0	M	7	1557	1745	2031	**
12	89	54	73	72	1	11	0	0	60	8	437	542	586	
13	90	62	77	68	1	13	0	0	30	9	457	459	582	
14	76	62	70	85	1	11	0	0	100	8	227	232	278	
15	86	64	73	76	1	9	0	0	100	2	473	459	575	
16	89	64	76	74	2	10	0	0	100	9	WEEKEND			
17	87	64	76	74	2	12	0	0	M	6	WEEKEND			
18	84	70	74	86	1	13	R	.14	M	18	1089	1137	1345	**
19	79	66	73	83	4	17	R-	T	100	10	281	240	333	
20	82	63	70	77	1	11	0	0	100	10	385	376	466	
21	88	64	77	74	2	16	0	0	100	6	444	502	558	
22	86	69	78	77	3	18	R	1.30	100	1	426	376	504	
23	84	69	79	85	1	10	R	.25	100	12	WEEKEND			
24	92	68	79	73	1	10	0	0	M	8	WEEKEND			
25	92	72	78	75	2	14	R	.28	M	3	1266	1266	1588	*
26	77	58	69	66	3	15	0	0	100	7	474	400	581	
27	79	53	67	76	1	10	0	0	90	9	442	541	561	
28	78	51	58	63	1	14	0	0	100	7	522	546	659	
29	78	52	66	76	C	10	0	0	100	7	367	305	441	
30	83	66	75	79	C	7	R-	T	100	7	WEEKEND			
31														
TOT	-	-	-	-	-	Max Gust	-	1.97	-	246	12599	13038	15735	
AVG	82	59	71	74	2	18	-	-	-	-	433	450	543	

** Two days total solar radiation

DUST FALL (ASTM D 1739-60 T)

DUSTFALL (g/M²)	WATER INSOLUBLES (%)			WATER SOLUBLES (%)	pH
	COMBUSTIBLE & VOLATILE MATTER	BENZENE SOLUBLES	INORGANIC INSOLUBLE MATTER		
19.9	36.5	1.2	19.3	43.0	6.5

FREQUENCY SUMMARY

ELEMENT	NO. OF DAYS
PRECIP., 0.01" OR MORE	4
MAX TEMP, 90° OR ABOVE	3
MIN TEMP, 32° OR BELOW	0

APPENDIX I-F

JULY 1967

DATE	TEMPERATURE (°F.) Max	Min	Ave	AVG REL HUM (%)	WIND SPEED (MPH) Ave	Max Gust	PRECIPITATION (IN) Type	Amt	MAX CLDS (%)	FABRIC WET (HRS)	SOLAR RADIATION (LGYS) 45°S	45°E	Horiz	
1	88	63	71	*92	1	10	0	0	M	9	WEEKEND			
2	87	64	74	87	2	18	R	1.60	M	11	1149	972	1342	***
3	84	66	75	83	1	11	0	0	100	12	HOLIDAY			
4	79	63	69	84	1	19	R	.28	M	13	629	517	748	**
5	80	49	66	67	1	10	0	0	80	8	514	599	667	
6	81	58	70	69	1	13	0	0	100	0	412	378	489	
7	76	59	70	84	2	13	R--	T	100	5	WEEKEND			
8	85	68	75	84	1	12	0	0	M	11	WEEKEND			
9	88	70	78	81	2	14	R	.10	M	9	979	846	1198	***
10	89	71	80	76	3	19	0	0	100	4	479	487	574	
11	89	70	80	81	2	16	R	.31	100	8	447	349	520	
12	93	71	83	66	1	12	0	0	90	0	490	521	599	
13	81	71	72	81	1	11	R--	T	100	3	163	158	201	
14	73	68	73	91	2	11	R--	.04	100	10	WEEKEND			
15	78	66	65	90	1	9	R-	.06	M	16	WEEKEND			
16	82	64	72	84	C	6	0	0	M	16	638	588	767	***
17	83	61	74	76	C	9	0	0	100	8	405	471	491	
18	82	65	73	79	1	11	0	0	100	6	320	300	367	
19	84	63	73	84	C	11	R	.39	100	11	379	402	468	
20	86	66	75	78	C	17	R-	.03	100	10	417	436	499	
21	85	65	74	81	1	10	R-	.48	100	14	WEEKEND			
22	87	63	75	88	C	7	0	0	M	11	WEEKEND			
23	90	66	79	72	2	13	0	0	M	10	1219	1209	1424	***
24	91	68	80	75	2	17	0	0	100	8	437	448	525	
25	87	73	79	78	3	19	0	0	100	2	310	404	392	
26	91	72	79	75	1	11	R--	T	100	0	376	288	423	
27	90	66	78	77	1	13	0	0	100	9	415	485	495	
28	88	69	79	79	2	15	0	0	100	9	WEEKEND			
29	88	69	76	83	2	27	R	.80	M	14	WEEKEND			
30	80	68	72	89	1	7	R-	.16	M	14	914	958	1090	***
31	88	64	76	78	1	19	R-	.02	100	11	438	472	516	
Tot	-	-	-	-	-	Max Gust	-	4.27	-	272	11530	11288	13795	
Ave	85	66	75	80	1	27	-	-	-	-	37[illegible]	364	445	

* Part of data missing

** Two days total solar radiation

*** Three days total solar radiation

DUST FALL (ASTM D 1739-60 T)

Dustfall (g/M²)	Water Insolubles (%) Combustible & Volatile Matter	Benzene Solubles	Inorganic Insoluble Matter	Water Solubles (%)	pH
33.2	20.9	0.8	4.2	74.1	6.5

FREQUENCY SUMMARY

Element	No. of Days
Precip., 0.01" or more	12
Max Temp, 90° or above	5
Min Temp, 32° or below	0

AUGUST 1967

DATE	TEMPERATURE (°F.)			AVG REL HUM (%)	WIND SPEED (MPH)		PRECIPITATION (IN)		MAX CLDS (%)	FABRIC WET (HRS)	SOLAR RADIATION (LGYS)			
	MAX	MIN	AVG		AVG	MAX GUST	TYPE	AMT			45°S	45°E	HORIZ	
1	88	65	75	78	1	10	0	0	80	11	474	484	547	
2	90	62	77	75	1	14	0	0	100	9	513	494	581	
3	91	70	81	75	2	18	0	0	100	5	394	465	496	
4	90	70	77	86	2	19	R	.70	100	9	WEEKEND			
5	84	68	73	90	1	12	R	1.39	M	17	WEEKEND			
6	85	66	74	84	1	8	0	0	M	15	898	824	988	*
7	84	66	74	83	C	10	0	0	100	19	384	303	419	
8	85	63	74	78	1	8	0	0	80	9	473	460	518	
9	88	65	76	79	2	18	R-	.04	100	13	449	430	495	
10	82	69	75	90	2	18	R	.12	100	13	221	178	249	
11	76	64	69	85	2	15	R	.17	100	17	WEEKEND			
12	74	63	65	81	1	13	0	0	M	15	WEEKEND			
13	74	61	68	86	1	13	0	0	M	9	737	626	827	*
14	81	57	69	75	C	11	0	0	90	10	530	469	559	
15	82	56	69	77	1	12	0	0	100	12	486	444	516	
16	84	57	70	77	1	12	0	0	100	12	519	477	546	
17	85	58	72	79	C	10	0	0	100	9	389	375	421	
18	88	69	78	78	1	13	0	0	90	2	WEEKEND			
19	90	70	78	84	1	16	0	0	M	12	WEEKEND			
20	84	71	77	86	1	14	R-	.04	M	10	1130	999	1175	*
21	82	70	74	92	1	10	R	.51	100	17	188	215	256	
22	77	69	72	95	C	13	R	.16	100	24	123	131	143	
23	78	69	72	91	C	11	R	.32	100	24	167	169	212	
24	78	69	72	94	C	5	R	1.67	100	19	160	152	188	
25	86	70	76	88	1	11	R-	.01	100	19	WEEKEND			
26	87	69	78	81	1	11	0	0	M	14	WEEKEND			
27	86	70	75	89	2	14	R	.58	M	17	1200	1011	1207	*
28	79	61	71	79	1	12	0	0	100	15	483	345	473	
29	82	58	70	79	C	7	0	0	100	14	440	419	458	
30	83	59	71	76	1	11	0	0	100	14	489	442	498	
31	84	62	73	82	1	15	R	.06	100	16	331	326	343	
TOT	-	-	-	-	-	Max Gust	-	5.77	-	421	11178	10238	12115	
AVG	83	65	73	83	1	19	-	-	-	-	361	330	391	

*3-day accumulation of Solar Radiation

DUST FALL (ASTM D 1739-60 T)

DUSTFALL (g/m²)	WATER INSOLUBLES (%)			WATER SOLUBLES (%)	pH
	COMBUSTIBLE & VOLATILE MATTER	BENZENE SOLUBLES	INORGANIC INSOLUBLE MATTER		
3.0689	16.5	0.9	35.7	46.9	6.9

FREQUENCY SUMMARY

ELEMENT	NO. OF DAYS
PRECIP., 0.01" OR MORE	13
MAX TEMP, 90° OR ABOVE	4
MIN TEMP, 32° OR BELOW	0

APPENDIX I-F

SEPTEMBER 1968

DATE	TEMPERATURE (°F.) Max	Min	Avg	AVG REL HUM (%)	WIND SPEED (MPH) Avg	Max Gust	PRECIPITATION (IN) Type	Amt	MAX CLDS (%)	FABRIC WET (HRS)	SOLAR RADIATION (LGYS) 45°S	45°E	Horiz
1	72	52	63	70	3	18	R--	T	100	6	WEEKEND		
2	75	48	61	72	1	14	0	0	M	12	WEEKEND		
3	78	46	62	73	C	8	0	0	M	12	HOLIDAY		
4	79	51	65	74	C	4	0	0	M	13	1799	1563	1680
5	82	54	67	78	C	8	0	0	100	13	475	370	447
6	81	56	67	77	1	11	0	0	100	10	532	406	486
7	83	54	68	80	C	17	0	0	100	12	443	389	412
8	82	61	69	83	1	10	0	0	100	14	WEEKEND		
9	75	66	70	93	2	8	R	.29	M	16	WEEKEND		
10	78	64	68	90	3	17	R	.25	M	8	741	667	735
11	64	49	60	77	1	14	0	0	100	8	327	373	343
12	68	43	55	80	1	17	0	0	90	16	445	359	437
13	73	50	60	78	1	13	0	0	90	14	561	383	497
14	78	46	61	75	1	13	0	0	50	13	564	426	489
15	80	46	64	76	4	13	0	0	10	9	WEEKEND		
16	72	64	67	87	3	20	R-	.06	M	9	WEEKEND		
17	74	63	68	94	C	16	R-	T	M	7	675	519	607
18	81	62	68	86	C	9	0	0	100	16	473	294	408
19	85	58	70	83	C	7	0	0	100	15	373	356	361
20	81	61	69	89	4	10	R--	T	100	14	246	229	260
21	84	65	73	83	2	18	R--	.03	100	13	399	324	355
22	74	56	66	76	2	14	0	0	100	10	WEEKEND		
23	66	42	55	72	1	16	0	0	M	3	WEEKEND		
24	73	42	57	76	1	16	0	0	M	10	1280	1015	1067
25	69	43	56	67	1	17	0	0	100	11	589	424	457
26	73	43	57	75	1	13	0	0	60	14	592	414	458
27	75	52	65	88	1	12	0	0	100	9	226	246	234
28	80	67	72	90	2	18	R	.64	100	10	227	142	222
29	75	55	67	73	2	15	0	0	90	10	WEEKEND		
30	66	44	54	71	1	13	0	0	M	3	WEEKEND		
31													
Tot	2276	1603	1924	2386	39	Max. Gust	-	1.27	-	330	10,967	8,893	9,955
Avg													

DUST FALL (ASTM D 1739-60 T)

DUSTFALL (g/M²)	WATER INSOLUBLES (%) Combustible & Volatile Matter	Benzene Solubles	Inorganic Insoluble Matter	WATER SOLUBLES (%)	pH
8.525	29.1	1.1	15.3	54.5	5.2

FREQUENCY SUMMARY

ELEMENT	NO. OF DAYS
Precip., 0.01" or more	5
Max Temp, 90° or above	0
Min Temp, 32° or below	0

OCTOBER 1967

DATE	TEMPERATURE (°F.)			AVG REL HUM (%)	WIND SPEED (MPH)		PRECIPITATION (IN)		MAX CLDS (%)	FABRIC WET (HRS)	SOLAR RADIATION (LGYS)		
	MAX	MIN	AVG		AVG	MAX GUST	TYPE	AMT			45°S	45°E	HORIZ
1	77	46	61	71	1	13	0	0	M	4	*1650	*1140	*1234
2	74	44	58	79	C	6	0	0	90	13	527	369	396
3	81	48	64	80	1	11	0	0	100	13	506	334	356
4	84	53	68	78	C	8	0	0	100	12	490	342	356
5	85	58	69	77	1	10	0	0	100	12	534	353	377
6	78	57	66	85	2	15	0	0	100	9			
7	59	53	56	95	2	12	R-	.08	M	15			
8	67	57	62	93	C	5	0	0	M	15	* 367	* 356	* 331
9	76	63	67	87	1	13	0	0	100	11	272	175	236
10	68	49	61	96	1	18	R	.37	100	23	76	67	69
11	65	45	55	79	1	8	0	0	100	10	289	298	219
12	59	49	54	75	1	9	0	0	100	0	139	134	163
13	64	45	53	77	C	7	0	0	100	11			
14	71	42	56	77	1	13	0	0	M	9			
15	71	46	57	94	C	12	0	0	M	13	*1137	* 767	* 749
16	75	48	59	87	1	9	0	0	100	14	352	174	267
17	73	52	64	91	C	7	R-	T	100	16	130	121	129
18	72	46	62	78	4	30	R	.05	100	13	182	118	144
19	64	38	50	64	2	17	0	0	100	0	472	353	327
20	62	30	46	69	1	13	0	0	100	7			
21	71	39	53	68	2	14	0	0	M	2			
22	66	33	48	72	1	13	0	0	M	11	*1689	*1014	*1041
23	66	32	48	79	C	9	0	0	100	13	549	334	336
24	72	38	52	86	C	8	0	0	100	11	362	210	253
25	73	46	58	91	2	26	R	.55	100	20	125	135	119
26	62	37	48	78	1	14	0	0	100	13	528	313	311
27	67	36	52	72	1	16	0	0	100	8			
28	54	35	46	73	1	10	0	0	M	8			
29	60	29	43	76	1	8	0	0	M	4	*1310	* 841	* 834
30	63	32	46	79	C	6	0	0	100	14	479	252	296
31	63	33	50	78	C	7	0	0	100	9	351	282	265
TOT	2142	1359	1732	2484	29	Max Gust		1.05	-	333	12516	8482	8808
AVE	69	44	56	80	1	30	-	-	-	-	404	274	284

* 3-Day total solar radiation.

DUST FALL (ASTM D 1739-60 T)

DUSTFALL (g/M²)	WATER INSOLUBLES (%)			WATER SOLUBLES (%)	pH
	COMBUSTIBLE & VOLATILE MATTER	BENZENE SOLUBLES	INORGANIC INSOLUBLE MATTER		
4.38	36.5	4.2	13.7	45.6	6.2

FREQUENCY SUMMARY

ELEMENT	NO. OF DAYS
PRECIP, 0.01" OR MORE	4
MAX TEMP, 90° OR ABOVE	0
MIN TEMP, 32° OR BELOW	3

NOVEMBER 1967

DATE	TEMPERATURE (°F.)			AVG REL HUM (%)	WIND SPEED (MPH)		PRECIPITATION (IN)		MAX CLDS (%)	FABRIC WET (HRS)	SOLAR RADIATION (LGYS)		
	MAX	MIN	AVG		AVG	MAX GUST	TYPE	AMT			45°S	45°E	HORIZ
1	69	41	55	79	1	11	0	0	80	8	450	275	280
2	63	49	57	97	C	6	R	.62	100	22	49	58	56
3	66	49	56	88	C	8	0	0	100	14			
4	64	32	53	71	1	14	0	0	M	9			
5	50	27	37	68	1	11	0	0	M	1	1393	828	865
6	45	22	31	74	C	10	0	0	100	0	466	215	271
7	44	21	31	70	1	13	0	0	100	2	513	253	288
8	48	20	32	64	1	15	0	0	100	2	535	298	300
9	65	26	45	56	2	18	0	0	0	0			
10	66	31	48	69	C	7	0	0	M	5			
11	66	40	53	65	2	14	0	0	M	0			
12	73	48	60	66	4	20	0	0	M	0	1761	1094	870
13	59	41	50	54	1	16	0	0	100	0	403	250	235
14	52	31	42	69	1	12	0	0	100	5	305	157	196
15	45	26	38	54	4	25	0	0	90	0	546	287	286
16	39	18	28	58	1	15	0	0	100	0	434	287	255
17	54	26	42	49	3	21	0	0	100	0			
18	64	34	48	50	3	26	0	0	M	6			
19	55	32	43	43	2	16	0	0	M	0	1092	606	584
20	50	30	40	54	1	11	0	0	100	0	360	227	216
21	55	39	45	65	C	12	R	T	100	3	151	143	124
22	56	39	48	88	1	10	R	T	100	10			
23	56	30	46	77	2	17	RW	.28	M	12	443	235	298
24	48	25	38	85	1	12	R	.42	100	11			
25	62	37	50	80	1	14	0	0	M	15			
26	68	34	48	78	M	M	0	0	M	12	1141	639	605
27	58	41	51	60	2	14	0	0	100	0	151	117	134
28	43	25	35	41	2	16	0	0	80	0	430	284	229
29	48	21	34	48	C	8	0	0	0	0	528	273	250
30	36	32	34	85	2	16	R	.51	100	24	12	22	10
31	XX	XX	XX	XX	X	XX	X	XXX	XXX	XX	XXXX	XXXX	XXX
TOT	1667	967	1318	2005	XX	Max. Gust	XXX	1.83	XXX	161	11163	6548	6352
AVG	56	32	44	67	1	26	XXX	XXXX	XXX	XXX	372	218	212

DUST FALL (ASTM D 1739-60 T)

DUSTFALL (g/M²)	WATER INSOLUBLES (%)			WATER SOLUBLES (%)	pH
	COMBUSTIBLE & VOLATILE MATTER	BENZENE SOLUBLES	INORGANIC INSOLUBLE MATTER		
21.0	21.9	2.2	5.1	70.8	4.45

FREQUENCY SUMMARY

ELEMENT	NO. OF DAYS
PRECIP. 0.01" OR MORE	4
MAX TEMP, 90° OR ABOVE	0
MIN TEMP, 32° OR BELOW	18

DUROMETER HARDNESS AND CHLORINE AND TRISODIUM PHOSPHATE RESISTANCE DATA

DISPOSITION FORM

(AR 340-15)

REFERENCE OR OFFICE SYMBOL	SUBJECT
STEGE-TS	USATECOM Project No. 7-7-0862-04, 5-Gal Water Can

THRU: Dir, Tech Svcs

FROM Materials Anal Division DATE 21 Dec 67 CMT 1

Cleveland/ras/3691

TO: ETD

ATTN: Mr. Tom Burt

1. Durometer hardness tests were performed on the exposed plastic cans, Series 100 and 300 to determine whether changes in hardness had occurred due to exposure. Readings were taken on the exterior body of the can and on the cap.

2. In addition, chlorine and trisodium phosphate resistance tests were performed in accordance with paragraphs 4.4.3.5 and 4.4.3.6 in MIL-C-13904C. Shore Durometer, Type D, readings were taken before and after exposure to the solutions described. Readings were made according to ASTM D1706-61.

a. Can number:

										Avg
315	exterior	68	66	67	67	69	67	67	68	67.4
	cap	49	51	52	53	54				51.8
313		70	71	70	69	70	68	69	69	69.5
		53	53	53	54	54				53.4
319		68	67	68	69	70	70	69	70	68.9
		53	54	56	56	55				54.8
105		64	65	60	69	67	62	69	69	65.6
		50	52	52	52	50				51.2
102		69	66	67	66	68	66	67	68	67.4
		49	48	55	56	54				52.4
101		68	68	70	69	68	68	70	68	68.6
		52	49	56	54	55				53.2

b. Cl - ion exposure:

	Before					Avg	After					Avg
315	68	70	68	69	67	68.4	69	70	68	69	66	68.4
313	67	69	69	69	68	68.4	66	69	70	69	68	68.4
319	67	66	67	68	68	67.2	68	67	67	69	66	67.4

DA FORM 1 FEB 62 2496 REPLACES DD FORM 96, EXISTING SUPPLIES OF WHICH WILL BE ISSUED AND USED UNTIL 1 FEB 63 UNLESS SOONER EXHAUSTED.

STEGE-TS
SUBJECT: USATECOM Project No. 7-7-0862-04, 5-Gal Water Can

	Before					Avg	After					Avg
105	63	65	63	69	69	65.8	66	68	65	65	64	65.6
102	68	69	68	67	68	68.0	65	65	65	70	69	65.8
101	69	68	68	67	66	67.6	67	68	66	65	68	66.8

c. Trisodium Phosphate exposure:

	Before					Avg	After					Avg
311	74	75	75	76	75	75.0	72	73	71	72	74	72.4
312	70	72	71	71	73	71.4	75	72	73	71	74	73.0
314	73	75	76	75	74	74.6	75	76	74	75	75	75.0
101	70	72	71	71	72	71.2	73	70	71	71	72	71.4
104	71	70	70	72	72	71.0	70	71	73	73	72	71.8
109	70	71	70	69	71	70.2	68	69	66	70	70	68.6

R. T. Muse

ROBERT T. MUSE
Chief, Materials Analysis Division

DISPOSITION FORM

(AR 340-15)

REFERENCE OR OFFICE SYMBOL	SUBJECT
STEGE-TS-M	USATECOM Project Number 7-7-0862-04 5 Gallon Plastic Water Container

THRU: ~~Dir., Tech Svcs~~

FROM Materials Analysis Div. DATE 8 September 67 CMT 1

Fennell/sdm/1498

TO: Mr. J. Brugh
ETD

1. Internal surface roughness measurements of the 5 Gallon Plastic Water Containers were measured according to specifications of MIL-STD-10A. The Containers had been exposed to the weather for 4 months.

DATA: (microinches)

Ridge (Left)	110, 120, 119	AVERAGE 116.3
Ridge (Right)	120, 117, 121	AVERAGE 119.3
Valley (Left)	110, 118, 99	AVERAGE 109
Valley (Right)	118, 122, 110	AVERAGE 116.7
Front	102, 108, 122, 123	AVERAGE 113.7
Back	105, 115, 105, 102	AVERAGE 106.8

2. Some 5 Gallon Plastic Water Containers which were exposed to the weather for 4 months were tested according to ASTM D1706-61 with a Shore Durometer Type D, for indentation hardness (outside).

DATA:

NEW CONTAINERS	AVERAGE
a. 63, 67, 63, 67, 67, 64, 69, 66	65.8
b. 63, 63, 62, 56, 68, 66, 67, 58	64.1
c. 65, 69, 57, 68, 68, 68, 71, 57	65.4
CAPS (NEW)-IRON OXIDE	
a. 46, 47, 45, 43, 41	44.4
b. 45, 47, 52, 45, 48	47.4

EXPOSED CONTAINERS	AVERAGE
a. 67, 67, 62, 66, 68, 65, 56, 64	64.4
b. 62, 68, 67, 66, 67, 68, 69, 65	66.5
c. 61, 68, 62, 67, 70, 68, 70, 66	66.5
CAPS (EXPOSED)	
a. 43, 46, 44, 47, 48	45.6
b. 47, 46, 48, 47, 48	47.2

R.T. Muse

R. T. MUSE
Chief, Materials Analysis Division

DA FORM 2496 1 FEB 62 — REPLACES DD FORM 96, EXISTING SUPPLIES OF WHICH WILL BE ISSUED AND USED UNTIL 1 FEB 63 UNLESS SOONER EXHAUSTED.

DISPOSITION FORM

(AR 340-15)

REFERENCE OR OFFICE SYMBOL	SUBJECT
STEGE-TS	Container, Water, Plastic, 5 Gallon

THRU: Dir, [illegible] Sycs

FROM Materials Analysis Div. DATE 3 February 1967 CMT 1
Muse/dm/4424

TO: Mr. J. Brugh
ETD

Chlorine Resistance and Trisodium Phosphate Resistance tests were performed as outlined in paragraphs 4.4.3.5 and 4.4.3.6 in Mil-C-13984C.

In addition to the evaluations described in these paragraphs, Shore Durometer, Type D, readings were made on the interior of the containers according to ASTM D1706-61. These results are listed and compared against those made on new containers.

	DUROMETER READINGS	
New Containers (35 readings)		AVG. 68.0
Chlorine	62,64,67,64,64	AVG. 64.2
Chlorine	65,65,67,67,66	AVG. 66.0
Chlorine	66,64,67,66,67	AVG. 66.0
Trisodium Phosphate	62, 67, 66,64,64	AVG. 64.6
Trisodium Phosphate	64,65,67,64,65	AVG. 65.0
Trisodium Phosphate	66,65,66,67,66	AVG. 66.0

This indicates a slight softening of the surfaces.

R. T. Muse

R. T. MUSE
CHIEF
Materials Analysis Division

DA FORM 1 FEB 63 2496 REPLACES DD FORM 96, EXISTING SUPPLIES OF WHICH WILL BE ISSUED AND USED UNTIL 1 FEB 63 UNLESS SOONER EXHAUSTED.

DISPOSITION FORM

(AR 340-15)

REFERENCE OR OFFICE SYMBOL	SUBJECT
STEGE-SS	Durometer Hardness Test of Plastic Water Container, USATECOM Project No. 7-7-0862-01

TO R.G. Byerly, TA
FSE Div, STD

FROM MAD DATE 7 Feb 68 CMT 1

1. The following Durometer "D" hardness readings were obtained on five new (unused) plastic containers and five new black plastic caps containing 2% carbon black (all items unused and not exposed to solar radiation).

								Average
Container	#1	top	67	67	67	70	70	68.2
		side	69	70	70	65	70	68.8
		cap	55	55	55	50	55	54.0
Container	#2	top	69	69	70	70	69	69.4
		side	70	69	68	70	70	69.4
		cap	55	57	45	55	55	53.4
Container	#3	top	69	69	69	70	68	69.0
		side	69	69	68	68	69	68.6
		cap	52	55	55	57	52	54.2
Container	#4	top	67	68	67	63	66	66.2
		side	71	70	70	70	71	70.4
		cap	55	57	56	50	50	53.6
Container	#5	top	71	64	63	70	71	67.8
		side	70	70	66	67	69	68.4
		cap	55	57	52	55	50	53.8

2. The following Durometer "D" hardness readings were obtained on the "300" series plastic containers and black (2% carbon black) exposed approximately 4 1/2 months to the weather:

Container #311	top	67	73	74	73	72	71.8
	side	70	70	68	72	69	69.8
	cap	55	60	55	62	62	58.8
Container #313	top	71	73	72	73	74	72.6
	side	74	74	72	68	73	72.2
	cap	58	57	60	62	61	59.6

STEGE-SS
SUBJECT: Durometer Hardness Test of Plastic Water Container, USATECOM Project No. 7-7-0862-01

							Average
Container #314	top	73	67	72	74	72	71.6
	side	67	68	70	63	71	57.8
	cap	61	59	61	55	59	59.0
Container #315	top	48	63	62	65	69	61.4
	side	72	73	67	59	59	66.0
	cap	56	60	60	61	61	59.6
Container #316	top	73	74	75	65	73	72.0
	side	72	70	71	71	70	70.8
	cap	60	60	60	60	60	60.0

3. The following Durometer "D" hardness readings were obtained on "100" series plastic containers and black (iron oxide) plastic caps exposed for 6 months to the weather:

Container #101	top	72	74	71	61	62	68.0
	side	73	71	72	66	62	58.8
	cap	60	63	59	62	63	61.4
Container #102	top	71	73	73	71	70	71.6
	side	70	71	71	74	70	71.2
	cap	60	62	62	60	62	61.2
Container #103	top	68	73	70	73	71	71.0
	side	72	74	72	73	73	72.8
	cap	59	59	61	61	61	60.2
Container #104	top	72	73	72	74	72	72.6
	side	72	70	70	70	68	70.0
	cap	60	61	60	61	62	60.8

4. A comparison of the results indicates that there was a slight increase in hardness of carbon black caps due to exposure and very slight increase in hardness of container due to exposure.

R. T. Muse

R. T. MUSE
Chief, Materials Analysis Division

DISPOSITION FORM

(AR 340-15)

REFERENCE OR OFFICE SYMBOL	SUBJECT
STEGE-TS	USATECOM Project No. 7-7-0862-04, 5-Gal Water Can

THRU: Dir, ~~Tech Svcs~~

FROM Materials Anal Division DATE 21 Dec 67 CMT 1

TO: ETD
ATTN: Mr. Tom Burt

1. The mar resistance test was run on a 5-Gallon Plastic Water Container according to ASTM D968-51. The method of evaluation was changed from that indicated in the ASTM to gloss measurements because there was not a film thickness on the plastic cans to measure. A gloss meter was used to find the gloss value before the abrasive was introduced. Another reading was taken afterwards.

2. Results and Conclusion: The results of the mar test are listed only by number and not by any specific units. In conclusion with the data there seems to be no detectable change in the cans due to storage.

Number	Before (Mar)	After
105-1	1	1/2
105-2	1	1
105-3	1 1/2	1
106-1	1/2	1/2
106-2	1 1/2	1
106-3	1	1
107-1	1	1
107-2	1	1
107-3	2	1 1/2
128-1	1 1/2	1 1/2
128-2	1 1/2	1
128-3	1 1/2	.9
317-1	1 1/2	1
317-2	1	.75
317-3	1 1/2	1
318-1	1	1/2
318-2	1 1/2	1 1/2
318-3	1 1/2	1.1
320-1	2	1 1/2
320-2	1 1/2	.9
320-3	2	1 1/2

R. T. Muse
ROBERT T. MUSE
Chief, Materials Analysis Division

DA FORM 1 FEB 62 2496 REPLACES DD FORM 96, EXISTING SUPPLIES OF WHICH WILL BE ISSUED AND USED UNTIL 1 FEB 63 UNLESS SOONER EXHAUSTED.

DISPOSITION FORM

(AR 340-15)

REFERENCE OR OFFICE SYMBOL	SUBJECT
STEGE-TS-M	Taber Abrasion D1044-56 7-7-0862-04/ 5 Gal. Plastic Water Container

THRU: ~~Dir., Tech Svcs~~

FROM Materials Analysis Div. DATE 18 Dec 1967 CMT 1

Schneider/jwb/4424

TO: T. Burt
ETD

Tests of the resistance to abrasion were conducted for samples from the walls of the 5 gallon plastic water container. Half of the samples were from water containers which had been stored in the exposure area for four months, half from containers exposed for nine months. The tests used the Taber Abraser (Model 174), according to the directions contained in ASTM D1044-56. The abrasive wheels used were Taber cat. no. S-32 NEMA rubber wheels, on which were mounted S-33 NEMA sandpaper strips. The sandpaper strips were standardized according to directions accompanying each box of 100 strips. Each sample was subjected to 3500 abrasion cycles, with the sandpaper being changed every 500 cycles. A 1000 gram load was used with each abrasive wheel. The samples were weighed before and after the test, and the difference in weight was used to ascertain the resistance to abrasion. The results are somewhat divergent because the samples had neither a completely plane surface nor a uniform thickness. These irregularities affected the amount of surface which came under the direct action of the abrasive wheels. The results are as follows:

	New Containers	Container Exposed 4 Months	Container Exposed 9 Months
	0.338grams	0.437grams	0.360grams
	0.235	0.385	0.262
	0.157	0.433	0.226
	0.297	0.249	0.386
		0.354	0.308
Average	0.257grams	0.372grams	0.308grams

R. T. Muse

R. T. MUSE
Chief, Materials Analysis Division

DA FORM 2496 1 FEB 63 REPLACES DD FORM 96, EXISTING SUPPLIES OF WHICH WILL BE ISSUED AND USED UNTIL 1 FEB 63 UNLESS SOONER EXHAUSTED.

DISPOSITION FORM

(AR 340-15)

REFERENCE OR OFFICE SYMBOL	SUBJECT
STEGE-TS-M	USATECOM Project Number 7-7-0862-04 Subject: Water Cans - Color Difference

THRU: ~~Dir., Tech. Svcs.~~
TO: Mr. Tom Burt
ETD

FROM Materials Analysis Div. DATE 19 Dec 67 CMT 1
N. Hill/nab/4424

1. Color differences of plastic and metal H_2O cans exposed for 4 and 9 months versus non-exposure were measured according to ASTM Standard D 2244 (replacing std. D 1365-60T), utilizing the Gardner Color Difference Meter, Model AC-2A. The water cans were examined at five points as per the former DF's on original and 4-month exposed cans; A-front, B-right side, C-rear, D-left side, E-cap. For the validity of original, 4 and 9 month comparisons, the caps have been evaluated separately; therefore, only the four readings of A, B, C, D comprise the can averages noted herein. So as to eliminate differences between testers, formerly submitted 4 month readings have been replaced by newly acquired data for the 4 month period. Therefore, the enclosed data tables are referenced to original color differences, lightness and chromaticity readings as reported in the DF dated 16 Dec 66. For clarity, the original data is included again in this report so that, in essence, this analysis may be considered entire, superseding the foregoing work submitted on color difference of the H_2O cans in question. Both metal and plastic cans and caps were referenced to the yellow-green standard plate CDY0077 which is calibrated to the following settings for lightness and chromaticity: R_d=8.1, (L=28.4), a=0.1 (negative), b=20.3 (positive).

2. Color differences (E) over 9 months of exposure were of the magnitude <u>4.1</u> and <u>4.6</u> for the plastic and metal cans, respectively, and of the magnitude <u>1.6</u> for the plastic cans after 4 months exposure. Interpolation of color difference for the metal cans at 4 months shows it to be of the magnitude <u>2.0</u>.

Color Difference* (referenced to std.)

Exposure:	$E_{plastic}$	$\Delta E_{plastic}$	L	-a	b	E_{metal}	ΔE_{metal}	L	-a	b
0	10.6		34.9	2.2	10.8	12.9		16.1	0.0	6.5
		1.6					(2.0)			
4	12.2		35.8	3.4	11.2		4.6			
		2.5					(2.6)			
9	14.7		35.4	3.9	12.4	17.5		19.0	0.0	5.6
	TOTAL (4.1)					TOTAL (4.6)				

*Color difference ($E=\sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2}$)

Lightness ($L=10\sqrt{R_d}$)

Chromaticity (a(-) green, b (+) yellow)

DA FORM 1 FEB 58 2496 REPLACES DD FORM 96, EXISTING SUPPLIES OF WHICH WILL BE ISSUED AND USED UNTIL 1 FEB 63 UNLESS SOONER EXHAUSTED.

APPENDIX I-J

STEBE-TS-M
SUBJECT: Continuation of a Water Cans-Color Difference Comment

19 Dec 67

3. Data:

Plastic Cans

	Original			4-month			9-month		
	R_d	-a	b	R_d	-a	b	R_d	-a	b
A	11.9	1.8	10.9	13.0	3.5	11.5	13.0	4.2	12.8
B	12.7	2.2	10.9	13.0	3.3	11.2	12.1	4.0	14.7
C	11.6	2.3	10.8	12.3	4.6	11.3	12.5	3.1	11.3
D	12.8	2.3	10.8	12.7	2.1	11.0	12.3	4.3	10.8
Avg.	12.2	2.2	10.8	12.8	3.4	11.2	12.5	3.9	12.4
Green Caps	8.3	3.4	12.2	8.7	2.6	11.3			
Black Caps				1.2	0.0	0.1	1.2	0.0	0.1

Metal Cans

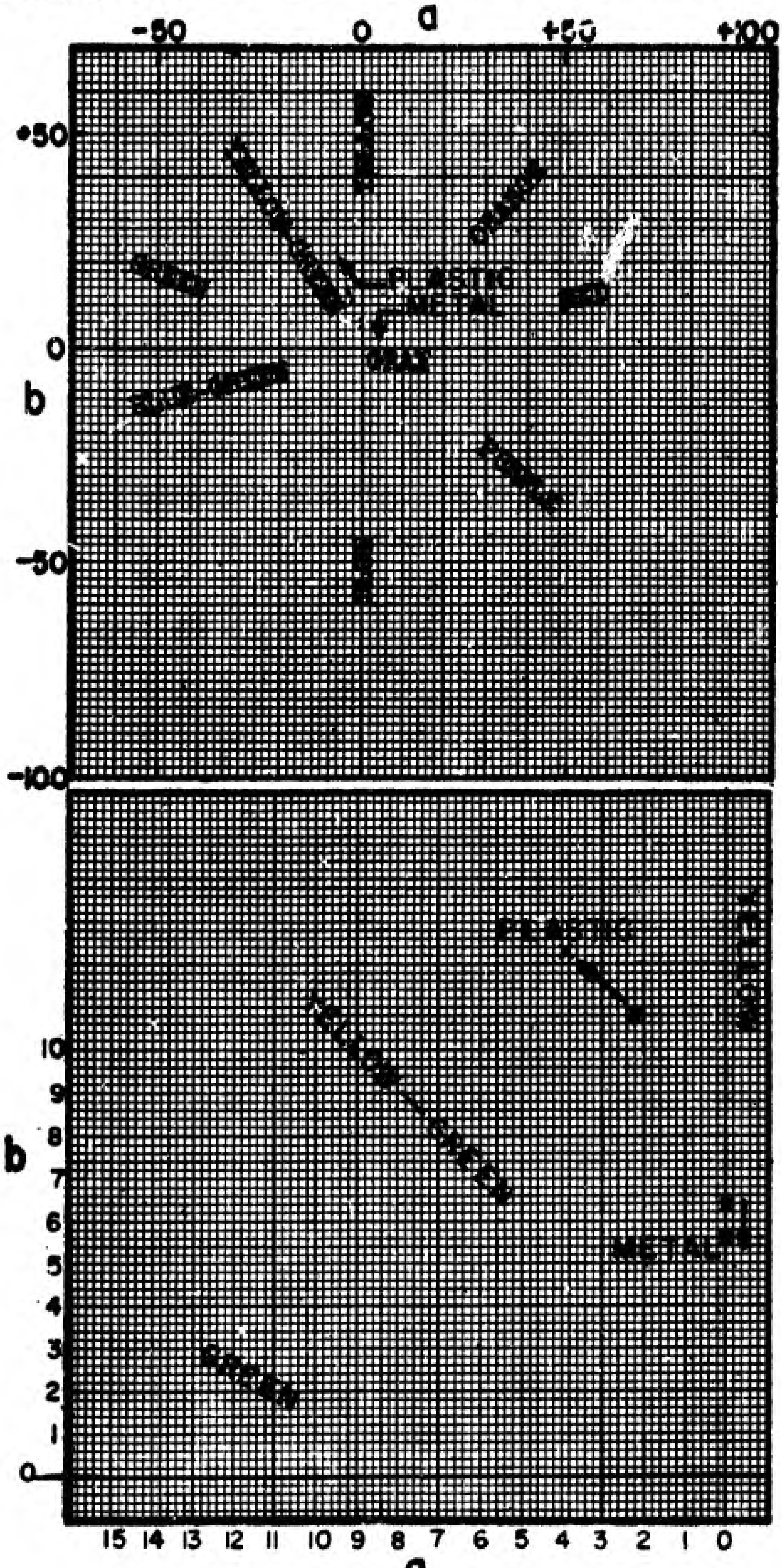
	Original			9-month		
	R_d	-a	b	R_d	-a	b
A	2.8	0.0	7.0	4.2	0.1	5.8
B	2.4	0.0	6.6	3.0	0.0	5.3
C	2.8	0.0	6.3	3.6	0.0	5.2
D	2.4	0.0	6.2	3.5	0.0	6.0
Avg.	2.6	0.0	6.5	3.6	0.0	5.6
Metal Caps	2.4	0.0	6.1	3.4	0.0	5.6

4. In terms of hue, value, and intensity, the noted increases in color difference denote a shift in value in the metal cans; that is, the hue was not changed, merely lightened (16.1 to 19.0). The plastic cans reveal definite hue (chromaticity) changes with only a slight shift to a lighter tint of the original hue (34.9 to 35.4). It would appear that loss in red and blue reflectance in the plastic cans augments the definite yellowing effects of exposure.

4.1. The metal caps revealed a change in lightness (L) comparable to that noted in the cans. No significant changes in color difference were noted in either the green or the black plastic caps.

R. T. Muse
Chief, Materials Analysis Div.

DATA AND GRAPH SHEET FOR GARDNER COLOR-DIFFERENCE METER



DISPOSITION FORM

(AR 340-15)

REFERENCE OR OFFICE SYMBOL

STEGE-TS

SUBJECT

7-7-0862-04

Container, Water, 5 gallon, Plastic

THRU: ~~Dir., Tech Svcs~~

FROM Materials Analysis Div.

DATE 11 January 1967

CMT 1

Fennell/sdm/4424

TO: Mr. J. Brugh
ETD

The flammability test was run on a 5 gallon water container according to ASTM D635. A sample was taken from four (4) different water containers. The pieces were divided into ten (10) 1/2" x 5" strips. After burning three (3) strips from each sample these values were obtained.

				AVERAGE
1.	4:10.5 min/3in.	4:22.3 min/3in.	4:07.5 min/3in.	4:13.4 min/3in.
2.	4:32.7 min/3in.	4:16.2 min/3in.	4:37.7 min/3in.	4:28.9 min/3in.
3.	5:15 min/3in.	6:36.6 min/3in.	4:52.6 min/3in.	5:34.7 min/3in.
4.	6:00.4 min/3in.	5:19.4 min/3in.	5:07.5 min/3in.	5:42.4 min/3in.

From all apparent indications, the plastic water can is judged to be burning by this test. The test was performed according to instructions by ASTM D635. The sample burned at the following rates:

				AVERAGE
1.	1:25.5 min/in.	1:27.4 min/in.	1:22.5 min/in.	1:24.5 min/in.
2.	1:30.9 min/in.	1:25.4 min/in.	1:32.6 min/in.	1:29.6 min/in.
3.	1:45 min/in.	2:12.2 min/in.	1:37.5 min/in.	1:51.6 min/in.
4.	2:00 min/in.	1:46.5 min/in.	1:42.5 min/in.	1:54.1 min/in.

The melting point of the plastic material was found to be 128°C or 262°F by means of a Fisher Johns melting point apparatus.

R. T. Muse

R. T. MUSE
CHIEF
Materials Analysis Division

DA FORM 1 FEB 62 2496 REPLACES DD FORM 96, EXISTING SUPPLIES OF WHICH WILL BE ISSUED AND USED UNTIL 1 FEB 63 UNLESS SOONER EXHAUSTED.

APPENDIX I-L

CHEMICAL, POL, AND RADIATION EFFECTS

The following information relative to the effects of chemical agents, POL, and radioactive and laser radiation on the plastic water container was extracted from first indorsement to Reference 18, Appendix VI:

1. The material in the plastic 5-gallon water container is polyethylene, the same material used in the 1,000 cc plastic canteen. The material in the 1,000 cc canteen is penetrated by liquid mustard (H) in 83 minutes and by GB in more than 15 hours but less than 24. Penetration in the 5-gallon container would be slower since it is a function of the thickness.

2. Some commercial POL containers are made of polyethylene and the polyethylene is not affected by the POL. Such containers do not fully contain the vapors of gasoline and hence such containers are not recommended for military use. Since the use of the container for POL would prevent it from being used again for potable water, expected contact with POL should only be an occasional splash. No effect should be noted.

3. No effect on the polyethylene would be noted from the radioactive potassium common to drinking water. If the container is exposed in an atomic pile, transformation of all the elements in the polyethylene can be expected in accordance with the normal reactions of the elements involved.

4. Depending on the laser source and intensity, the effect would range from none to complete disintegration over the beam's area of contact.

APPENDIX I-M

TASTE PREFERENCE ANALYSIS

Serving No.	Codes Compared	Calculated Chi-Square Value	Code	Answers By Code: Preferred – Acceptable	Preferred – Unacc.	Not Preferred – Acceptable	Not Preferred – Unacc.	No Preference – Acceptable	No Preference – Unacc.	Total
I	222/333	41.40*	222	2	0	3	23	2	1	31
			333	19	7	0	2	2	1	31
	333/444	39.27*	333	2	2	12	15	1	0	32
			444	26	1	0	4	1	0	32
	222/444	43.21*	222	2	0	4	23	2	1	32
			444	26	1	0	2	2	1	32
	555/666	33.87*	555	3	0	5	19	4	1	32
			666	23	1	2	1	4	1	32
	666/777	21.45*	666	4	1	10	9	7	1	32
			777	20	0	2	2	7	1	32
	555/777	52.28*	555	1	0	2	27	1	1	32
			777	28	1	0	1	1	1	32
	888/8884	2.48	888	7	0	2	3	20	0	32
			8884	4	1	4	3	20	0	32
II	222/333	13.62*	222	9	1	0	17	2	3	32
			333	8	9	3	7	2	3	32
	333/444	40.61*	333	1	0	8	15	7	1	32
			444	23	0	1	0	7	1	32
	222/444	54.00*	222	0	0	1	26	2	3	32
			444	23	4	0	0	2	3	32
	555/666	44.87*	555	0	1	6	19	3	3	32
			666	20	5	0	1	3	3	32
	666/777	32.71*	666	1	0	7	12	9	3	32
			777	18	1	1	0	9	3	32
	555/777	58.00*	555	0	0	3	26	0	3	32
			777	27	2	0	0	0	3	32
	888/8884	2.20	888	6	0	2	1	22	1	32
			8884	3	0	3	3	22	1	32

* This indicates a significant difference (95-percent confidence level) between the two codes compared. The appropriate Chi-Square table value is 11.07.

Code: UM 222 CP 666
UP 333 CG 777
UG 444 888- water stored in glass containers under refrigeration
CM 555 8884 - same as 888

APPENDIX I-N

U. S. ARMY ARCTIC TEST CENTER AMBIENT AIR TEMPERATURES

Bolio Lake Test Site, Fort Greely, Alaska
(21 November 1966 through 20 March 1967)

Date	November High	November Low	December High	December Low	January High	January Low	February High	February Low	March High	March Low
1	-	-	-2	-7	11	-11	-7	-40	23	-17
2	-	-	-34	-47	3	-7	-4	-26	37	16
3	-	-	-7	-47	-7	-37	5	-16	36	27
4	-	-	4	-8	2	-37	4	-18	44	30
5	-	-	-1	-18	5	-8	33	5	34	4
6	-	-	-12	-32	31	-8	37	0	38	-4
7	-	-	-31	-53	31	-16	37	22	25	10
8	-	-	-52	-58	16	-16	23	7	21	13
9	-	-	-54	-58	15	-10	12	-9	20	-3
10	-	-	-51	-56	5	-14	8	-26	22	-23
11	-	-	-52	-58	5	-17	3	-36	20	-25
12	-	-	-46	-53	4	-12	-2	-34	25	-5
13	-	-	-30	-45	0	-23	-7	-42	21	-4
14	-	-	4	-30	-27	-43	-10	-44	33	-7
15	-	-	26	-12	-14	-45	-12	-46	39	-11
16	-	-	30	15	-1	-14	1	-43	36	-12
17	-	-	25	8	6	-5	10	-14	28	20
18	-	-	8	-6	3	-9	9	-10	25	27
19	-	-	0	-23	-10	-24	24	-7	18	32

APPENDIX I-N

Date	November High	November Low	December High	December Low	January High	January Low	February High	February Low	March High	March Low
20	-	-	-15	-25	10	-17	34	-7	21	26
21	22	17	-12	-24	13	5	36	13		
22	21	15	-3	-17	20	11	22	10		
23	33	9	-2	-18	14	-24	18	4		
24	12	-3	6	-27	-10	-28	7	-6		
25	6	-2	18	-27	2	-25	4	-32		
26	-2	-37	17	0	7	-26	5	-37		
27	-29	-39	41	6	-7	-35	27	-20		
28	-7	-38	31	-12	-36	-48	15	-23		
29	-13	-22	33	-13	-40	-51	-	-		
30	0	-20	13	-4	-22	-37	-	-		
31	-	-	5	10	-25	-40	-	-		

APPENDIX I-O

U. S. ARMY ARCTIC TEST CENTER CONTAINER DAMAGE DATA

Permanent Damage Sustained by Plastic Water Containers During Attempts to Thaw Ice Inside Containers

Number of Damaged Containers	Time Damage Sustained (Minutes)	Outside Temperature (°F.)	Test Environment	Distance from Heat Source (inches)
2	12	-36	Squad Fire (Outside)	On heat source
1	15	-36	Yukon Stove*	On heat source
1	50	-45	Yukon Stove*	6
1	180	-45	Yukon Stove*	10
1	150	-56	Yukon Stove*	18
1	210	-56	Yukon Stove*	-24
11**	Unknown	13 to-58	Yukon Stove*	6-24

* Yukon stove was inside an arctic 10-man tent.

** During scheduled field exercises these 11 containers were permanently damaged by Infantry soldiers in their attempts to thaw ice contained inside of the containers.

APPENDIX II. FINDINGS

Test Criteria (Paragraph references refer to App. VI)	Met	Not Met	Not Tested	Remarks (Paragraph references refer to body of this report)
1. The plastic container shall be of minimum weight (not to exceed the weight of either the steel or aluminum 5-Gallon water container), with sufficient strength not to be easily crushed, broken at seams, or badly dented (Par. 2a(1), Ref. 11; Par 2a, Ref. 13).	X			The weights of the plastic, steel, and aluminum containers were 5 lb 9 oz, 9 lb 1 oz, and 5 lb 11 oz, respectively (Pars, 2.2.4 and 2.9.4).
2. The plastic container shall be designed to permit stacking in uncovered dumps and as a palletized load on standard 40- by 48-inch pallets when either filled or empty (Par. 2a(2), Ref. 11; Par. 2b, Ref. 13).	X			Plastic containers had satisfactory stacking capabilities; however, they did not stack as well as the steel containers (Par. 2.5.4h).
3. The plastic container shall have a service life expectancy of 2 years (Par. 2a(3), Ref. 11; Par 2c, Ref. 13).	X			Insufficient data to accurately determine expected service life. However, it is judged that the plastic container would last for 2 years (Pars. 2.9.3 and 2.15.2.3).
4. The plastic container shall have a minimum storage life of 5 years without requiring instorage maintenance (Par. 2a(3), Ref. 11; Par. 2c, Ref. 13).			X	Storage life to be determined under separate test (Foreword, Par. 4 of Test Directive dated 23 Nov 66).
5. The plastic container shall be nontoxic (particularly interior, lid assembly, and exterior around lid (Par. 2b(1), Ref. 11).	X			Paragraph 2.4; and Reference 7 and 16, Appendix VI.
6. The plastic container shall be corrosion resistance (Par. 2b(2), Ref, 11).	X			Paragraphs 2.3.4 and 2.9.4.1.

Test Criteria (Paragraph references refer to App. VI)	Met	Not Met	Not Tested	Remarks (Paragraph references refer to body of this report)
7. The plastic container shall be durably camouflaged of proper color (Par. 2b(3), Ref. 11).	X			Paragraph 2.9.4.1.
8. The plastic container shall not impart "taste" to hard or soft water, chlorinated or unchlorinated, when stored for 2 weeks under high temperatures (Par. 2c(1), Ref. 11; Par. 2d, Ref. 13).		X		Both plastic and steel containers imparted a taste to water; however, water from the plastic containers was rated as more acceptable (Par. 2.4.4).
9. The plastic container shall withstand loading and unloading on trucks under field conditions without causing distortions which incapacitate the container (Par. 2c (2), Ref. 11).	X			Partially met (USATTC): Serveral containers were punctured during loading, unloading, and transport (Par. 2.9).
10. The plastic container shall not leak as a result of accidental dropping, filled or partially filled with water or empty (Par. 2c(3), Ref. 11).		X		Some containers cracked when they fell off moving vehicles (Par. 2.9.3).
11. The plastic container shall be easy to clean and sterilize particularly in those areas that cannot be visually inspected. These areas are located about the interior of the handle, which may be hollow (Par. 2c(4), Ref. 11; Par 2e, Ref. 13).	X			No cleaning problems existed during the test; however, if containers had not been maintained in a clean condition, partially hollow handles may have harbored dirt and bacteria that may have been difficult to remove. Consequently, the manufacturing process should assure non-hollow handles (Pars. 2.14.3, 2.15.1.3, and 2.18.3).

APPENDIX II

Test Criteria (Paragraph references refer to App. VI)	Met	Not Met	Not Tested	Remarks (Paragraph references refer to body of this report)
12. The plastic container shall be convenient to hand carry, backpack, and transport by truck, and economical of transportation space (Par. 2c(5), Ref. 11).	X			The plastic container was incompatible with the arctic mitten set; and it was difficult for one person to carry more than two containers (Pars. 2.8.4 and 2.14.3).
13. The plastic container shall be able to withstand freezing of water and thawing over open fire (Par. 2c(6), Ref. 11).		X		Thawing tests showed that the plastic container is unsuitable for arctic use (Pars. 2.6.1.4 and 2.7.4c.
14. The plastic container shall be clearly distinguishable from gasoline containers in complete blackout, or at any other time (Par. 2c(7), Ref. 11).	X			Paragraph 2.18.3.
15. The plastic container shall provide an opening and seal (Par. 2c(8) (a)-(e), Ref. 11) that:				Paragraphs 2.7.4 and 2.9.4.1
(a) Permits convenient filling and pouring of water without waste.	X			Steel container was easier to fill (Pars 2.7.3, 2.9.3, 2.9.4, and 2.14.3).
(b) Is conveniently and simply operated.	X			Steel container was easier to open (Pars. 2.7.3, 2.9.3, 2.9.4, and 2.14.3).
(c) Does not leak when closed.	X			
(d) Does not lose gasket.	X			Plastic container does not have a separate gasket.
(e) Lasts for probable life of body of container.	X			Insufficient data to accurately determine service life of cap #3; however, it is judged that the cap would last for the life of the container.

Test Criteria (Paragraph references refer to App. VI)	Met	Not Met	Not Tested	Remarks (Paragraph references refer to body of this report)
16. The filled plastic container shall be capable of air delivery (Par. 3a, Ref. 13):				
(a) As an internal aircraft load.	X			Paragraph 2.12.
(b) As a helicopter "hook load."	X			Paragraph 2.13.
(c) As a low velocity drop load.	X			Paragraphs 2.10 and 2.11.
(d) As a load prepared for "Ground Proximity" technique	X			Paragraphs 2.10 and 2.11.
17. The plastic container shall incorporate a means to fill canteens without waste of water (Par. 3b, Ref. 13).	X			Paragraph 2.7.3.
18. The plastic container shall function equally as well as, or better than, the Can, Military, Steel, 5-Gal, when employed in climatic conditions stated in par. 7a, b, and c of AR 705-15 (Par. 3e, Ref. 13).		X		The plastic container was equal or superior to the standard steel container in temperate and tropic zones; however, the plastic container was inferior to the steel container in the arctic, and is unsuitable for arctic use (Par. 2.7.4).
19. The plastic container shall compare favorably with the steel container in physical characteristics pertaining to adaptability for rigging for airdrop (USAAESWBD).	X			Paragraph 2.10.4.

APPENDIX II

Test Criteria (Paragraph references refer to App. VI)	Met	Not Met	Not Tested	Remarks (Paragraph references refer to body of this report)
20. The plastic container shall compare favorably with the steel container in withstanding the forces due to restraint, extraction, retardation, and impact encountered with standard airdrop systems (USAAESWBD).	X			Paragraph 2.11.4.
21. The plastic container, after airdrop by standard techniques, shall perform its intended functions at least as well as the steel container after identical method of delivery (USAAESWBD).	X			Paragraph 2.11.4
22. Under arctic conditions, the filled plastic container shall be at least 75 percent recoverable after each of the following types of airdrop: parachute (low velocity and high velocity); and freedrop (USAATC).	X			Paragraph 2.11.4
23. The plastic container, during and after internal air portability, shall perform its intended functions at least as well as the steel container under similar conditions (USAAESWBD).	X			Paragraph 2.12.4

APPENDIX II

Test Criteria (Paragraph references refer to App. VI)	Met	Not Met	Not Tested	Remarks (Paragraph references refer to body of this report)
24. The plastic container, during and after external air delivery, shall perform its intended function at least as well as the steel container under similar conditions (USAAESWBD).	X			Paragraph 2.13.4.
25. The plastic container shall function equally as well as, or better than, the Can, Military, Steel, 5-Gallon (USAGETA).	X			Paragraphs 2.3.4, 2.6.4, and 2.6.3.

APPENDIX III. DEFICIENCIES AND SHORTCOMINGS

1. DEFICIENCIES

Deficiency	Suggested Corrective Action	Remarks
1.1 Containers were destroyed when personnel attempted to thaw ice contained inside.	Use material with a higher melting point.	EPR's KC-3, -3(-2), and -3(-4). Plastic container is unsuitable for arctic use.

2. SHORTCOMINGS

Shortcoming	Suggested Corrective Action	Remarks
2.1 Container cannot be stored in unsheltered areas for long periods of time in the desert.	Use different material.	EPR L5-1. Containers could be punctured with thumb pressure after 4 months exposed storage.
2.2 Captive strap on cap #1 deteriorated.	Use different material.	EPR's KC-3, -3(-2), -3(-4); and L3-1. This occured on 60 percent of the containers tested at USATTC; USATTC will submit supplementary report on evaluation of cap #3.
2.3 The air vents on redesigned caps (#2 and #3) leaked both air and water	Redesign air vent.	None.

APPENDIX III

Shortcoming	Suggested Corrective Action	Remarks
2.4 Retaining pin in cap air vent bent and came out when vent was tightened to stop leakage.	Redesign air vent.	EPR L7-6
2.5 The handle on the container was difficult to grasp with arctic mittens.	None.	None.
2.6 The partially hollow handles and hollow humps at top of container were difficult to clean and inspect.	Eliminate hollow spaces and humps.	None.
2.7 Container unstable.	Use different configuration for container bottom.	Container fell over easily on irregular ground and during transport; it was less stable than the steel container.
2.8 Container was difficult to stack.	Make shape of container more uniform, rectangular, and less slippery; and make container top and bottom compatible.	Plastic container was more difficult to stack than steel container; front and back of container were different widths; top was not level and lacked surface contact area at sides; bottom was not flat and did not have

APPENDIX III

Shortcoming	Suggested Corrective Action	Remarks
		its lowest area around its periphery.
2.9 Container when full was inconvenient for two people to carry for a long distance.	Add one or two additional handles.	None.
2.10 The seal of the cap had tears or cuts from usage.	Redesign the seal more like a "U" shape instead of a "V" shape.	None.
2.11 The lock on the cap was unnecessary and often difficult to employ.	Eliminate the locking feature.	EPR KC-1.
2.12 The plastic material supported combustion.	Use less flammable material.	None.
2.13 Some containers and caps suffered damage that rendered them unserviceable.	Use tougher material.	Nevertheless, many instances the plastic container was more satisfactory that the steel container. Containers and caps were damaged by dropping when full, puncturing with tools and equipment, and by being run over by vehicles (EPR's KC-2(-3) and 4; L7-5 and 8 through 14).

APPENDIX IV. MAINTENANCE EVALUATION

(Not Applicable)

APPENDIX V. PHOTOGRAPHS

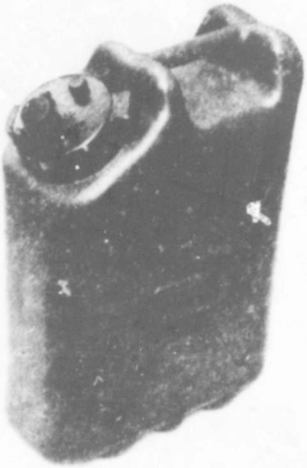


Figure 1. Plastic water container with black cap containing pour spout and vent.

Figure 2. Standard steel water container.

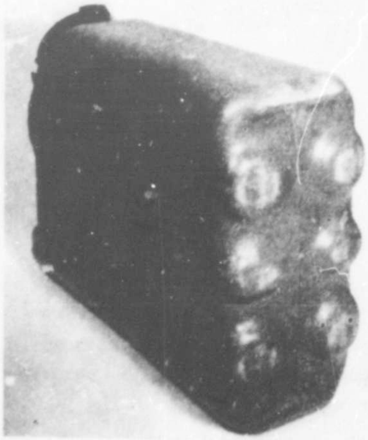


Figure 3. Plastic water container, bottom view.

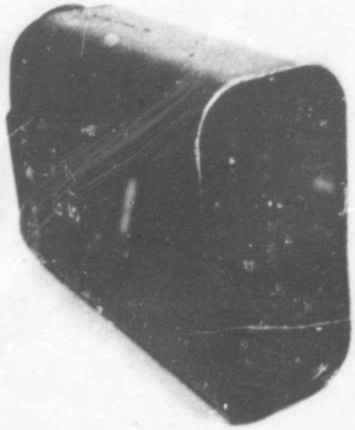


Figure 4. Steel water container, bottom view.

US ARMY
GETA
FORT LEE, VA.

TECOM 7-7-0862-01/02/03/04/05

NEGATIVE 127,179,182,183

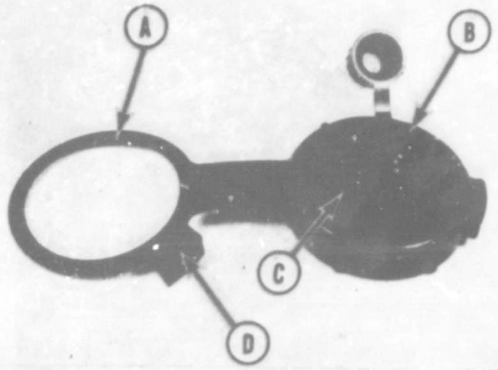


Figure 5. Plastic cap, top view, with canteen spout and air vent both in open positions.

A Captive strap
B Canteen spout
C Air vent
D Cap locking device (cam)

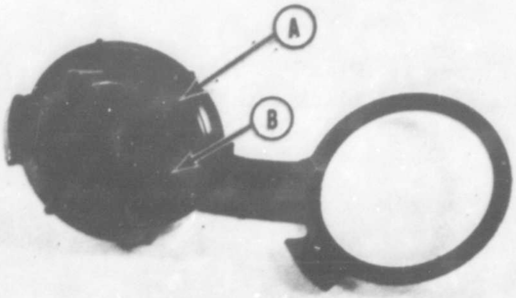


Figure 6. Plastic cap, bottom view.

A V-shaped seal
B Air vent locking device

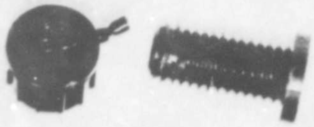


Figure 7. Broken air vent cap retaining pin. Pin failure resulted when the vent was tightened in an attempt to stop water leaking from the vent.

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NEGATIVE 186,184,88

Figure 8. Filled loose plastic containers in the fifth level of an attempted 7x7x7 pyramid.

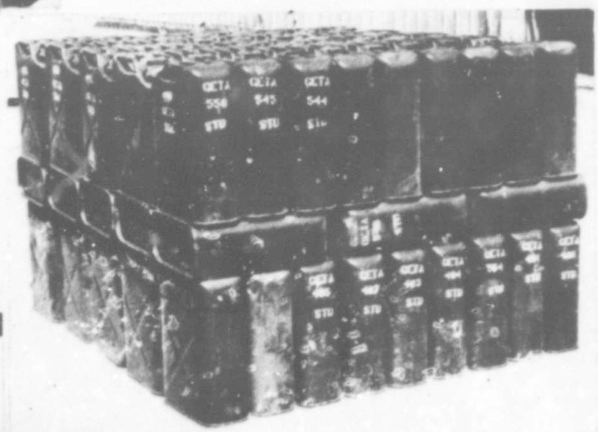

Figure 9. Empty loose steel containers in alternating vertical and horizontal layers.

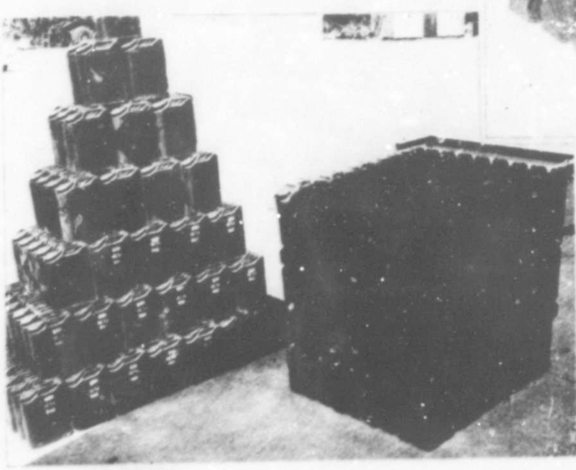

Figure 10. Empty loose steel containers in pyramid configuration and empty loose plastic containers in alternating vertical and horizontal layers.

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NEGATIVE 22,21,12

APPENDIX V

Figure 11. Empty loose plastic containers stacked on their sides: 5 containers deep, 4 wide, and 8 high.

Figure 12. Filled loose steel containers stacked on on their sides: 5 containers deep, 4 wide, and 8 high.

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NEGATIVE 30,44

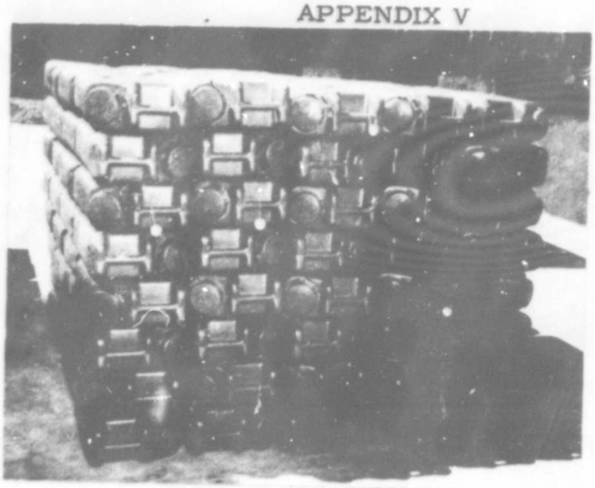

Figure 13. Empty loose plastic containers stacked horizontally 5 deep, 4 wide, and 8 high, with adjacent layers resting on alternate sides.

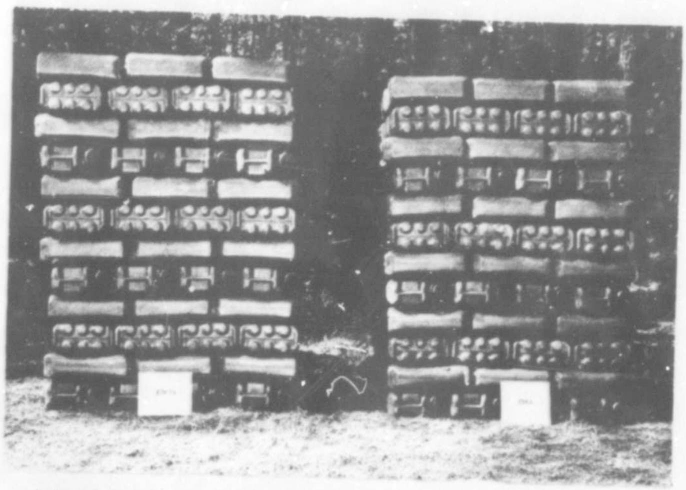

Figure 14. Empty and filled loose plastic containers stacked horizontally, with adjacent layers rotated.

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NEGATIVE 28,56

Figure 15. Plastic and steel containers combined in same stack by alternating adjacent containers.

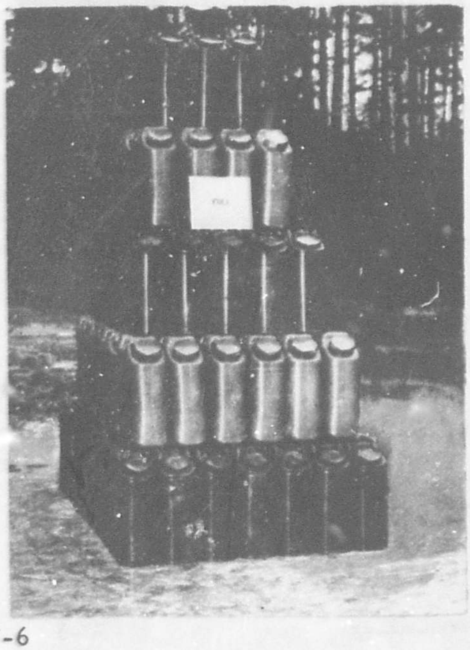

Figure 16. Alternated layers of plastic and steel containers stacked in pyramid.

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NEGATIVE 37,38

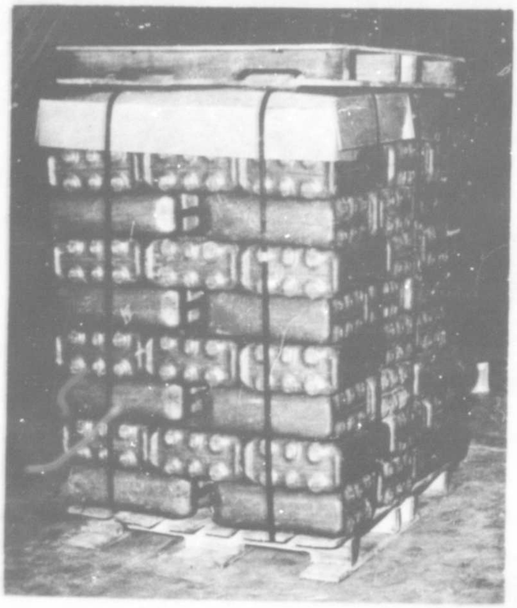

Figure 17. Palletized loose plastic containers: 9 layers with 5 containers per layer.

Figure 18. Bundled plastic containers stacked upright in a 5x2x5 pyramid.

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NEGATIVE 77.71

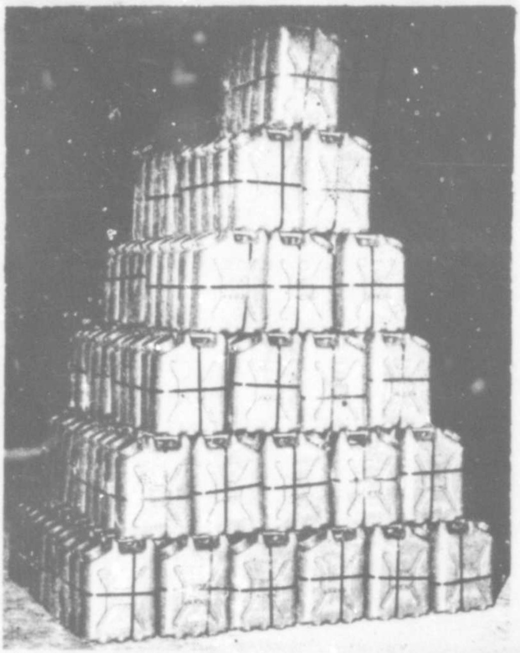

Figure 19. Bundled plastic containers stacked upright in a 6x2x6 pyramid.

Figure 20. Bundled plastic containers stacked upright in a straight stack, four layers with ten 5-container bundles per layer.

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NEGATIVE 75,68

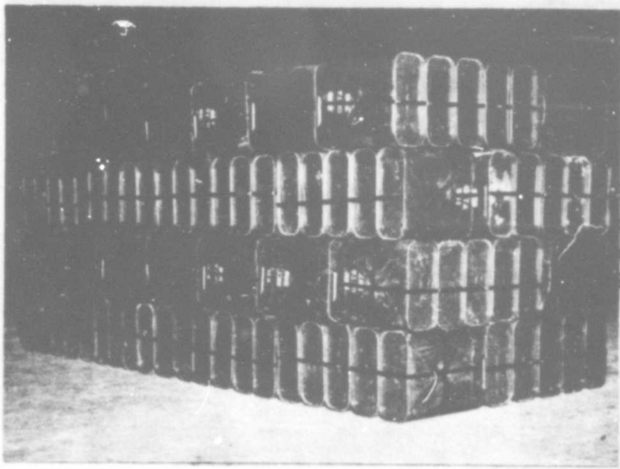

Figure 21. Straight stack of bundled steel containers stacked on edge in four layers with eleven 5-container bundles per layer.

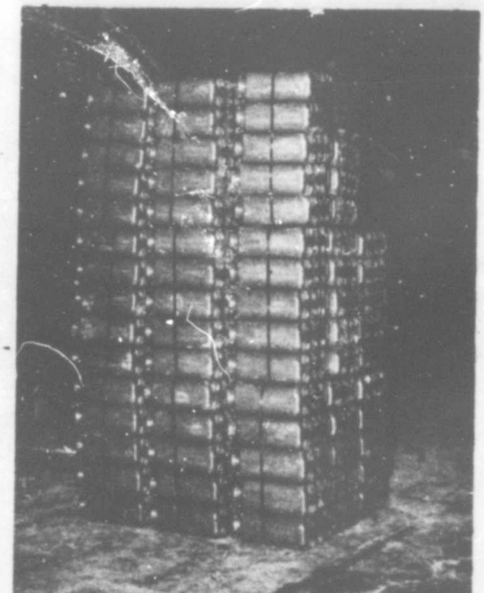

Figure 22. Straight stack of plastic containers utilizing 5-container bundles stacked on their sides.

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NEGATIVE 76,72

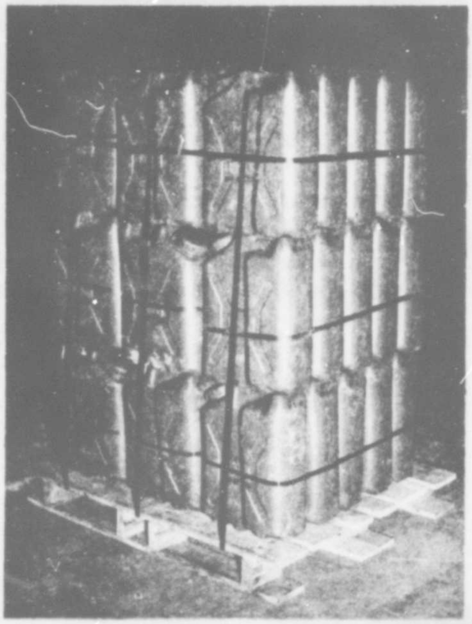

Figure 23. Palletized 5-container bundles of plastic containers in upright position with three bundles per layer and three layers per 40- by 48-inch pallet.

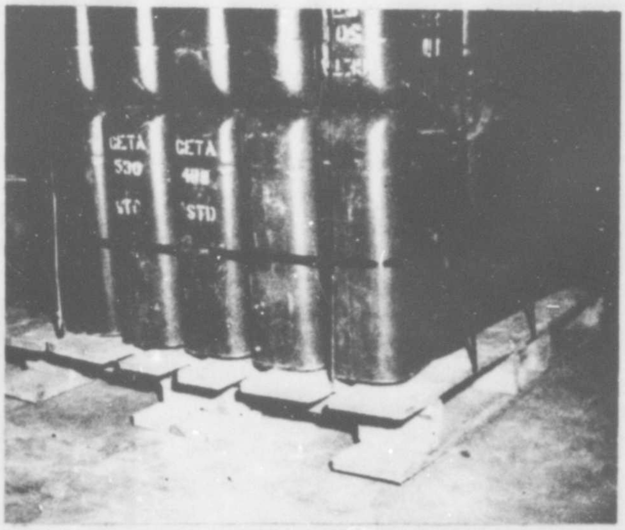

Figure 24. Palletized 5-container bundles of steel containers, utilizing three bundles per layer, three layers per 40- by 48-inch pallet, first and third layers upright and second layer inverted.

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NEGATIVE 66,67

Figure 25. Five-container bundles, palletized with three bundles on edge per layer, three layers per 40- by 48-inch pallet. Both plastic and steel stacks shown.

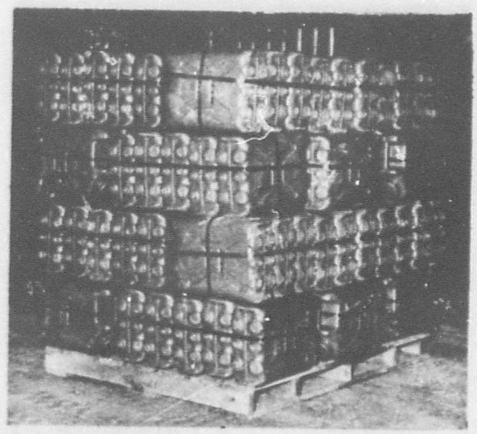

Figure 26. Pallet load of five 5-container bundles on edge per layer, four layers per 48- by 60-inch pallet.

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NEGATIVE 82,61

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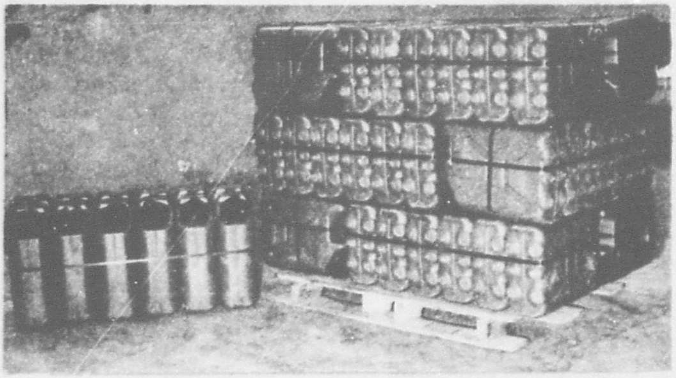

Figure 27. Pallet load of three 6-container bundles of plastic containers on edge per layer, three layers per 40- by 48-inch pallet.

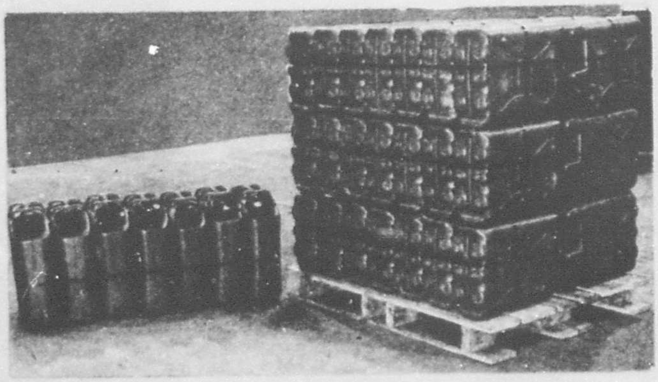

Figure 28. Configuration utilizing two 7-container bundles of plastic containers on edge per layer, three layers per 48- by 60-inch pallet.

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NEGATIVE ______

APPENDIX VI. REFERENCES

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2. Report No. QMBT 4666-626 (50-23-01) Test of Can, Water, 5-Gallon, Aluminum Alloy, 3 February 1948. The Quartermaster Board, Fort Lee, Virginia.

3. Report of USATECOM Project No. 7-3-0263-01K, Engineering/Service Test of Can, Water, Military, 5-Gallon, Aluminum, January 1964.

4. Letter, AMSTE-GE USATECOM, 19 February 1964, subject: Report of USATECOM Project No. 7-3-0264-01K, Engineering/Service Test of Can, Water, Military 5-Gallon, Aluminum.

5. Letter, AMXRE-MSP, U.S. Army Natick Laboratories, 19 May 1965, subject: "Can, Water, Military, 5-Gallon, Plastic," with 1st indorsement thereto, AMCRD-DM-E, U.S. Army Materiel Command, 7 July 1965, with inclosures withdrawn.

6. Letter, CRD-AC/QM-3167(U), U.S. Army Standardization Group, U.K., Box 65, Navy 100FPO N.Y., 24 November 1965, subject: "Plastic, 5-Gallon water Container."

7. Letter, AMXRE-CRP, NLABS to OTSG, 23 Dec 65, subject: "Toxicity Clearance - 5-Gallon Plastic Water Container," with 1st ind, MEDPS-PE, OTSG to NLABS, 9 Jan 67, which granted toxicity clearance and approved the design configuration of the subject item.

8. Military Specification, Cans, Water, Military, 5-Gallon, MIL-C-13984C, 4 January 1966.

9. Letter, AMXRE-MGE, U.S. Army Natick Laboratories, 14 March 1966, subject: "5-Gallon Plastic Water Can (Canadian Development)."

10. Letter, AMSTE-GE, Headquarters, USATECOM, 3 May 1966, subject: "USATECOM Project No. 7-7-0862-01, Can, Plastic, Water, 5-Gallon," with inclosures (classified portion withdrawn).

11. Letter, AMSTE-GE, Headquarters, USATECOM, 27 June 1966, subject: "Military Characteristics, Containers, Water, Plastic, 5-Gallon."

12. Letter, AMSTE-GE (7-7-0862), USATECOM, 7 July 1966, subject: "Engineering Service Test of Container, Water, Plastic, 5-Gallon.

13. Letter, CDCMR-O, USACDC, 30 August 1966, subject: "Military Characteristics, Containers, Water, Plastic, 5-Gallon.

APPENDIX VI

14. Letter, AMXRE-MGE, U.S. Army Natick Laboratories, 1 September 1966, subject: "Container, Water, Plastic, 5-Gallon, USATECOM Project No. 7-7-0862-02."

15. Letter, AMSTE-GE, Headquarters, USATECOM, 16 September 1966, subject: "Engineering/Service Test of Container, Water, Plastic, 5-Gallon," with 1st indorsement, AMXRE- MGE, U.S. Army Natick Laboratories, 17 October 1966; 2nd indorsement, AMSTE-GE, Headquarters USATECOM 31 October 1966 (without inclosures) and 3rd indorsement, AMCRD-DM-E, U.S. Army Materiel Command, 14 November 1966.

16. Unclassified Message 20757, AMSTE-GE, Headquarters, USATECOM, 2 Dec 66, subject: "Safety Release Information - Container, Water, Plastic, 5-Gallon, USATECOM Project No. 7-7-0862-04."

17. Letter, STEAC-TA, USAATC, 6 December 1966, subject: "Arctic Service Test of Container, Water, Plastic, 5-Gallon, USATECOM Project No. 7-7-0862-04.

18. Letter, AMSTE-GE, USATECOM to NLABS, 13 July 1967, subject: "Container, Water, Plastic, 5-Gallon, USATECOM Project No. 7-7-0862," with 1st indorsement, AMXRE-GFS, NLABS to USATECOM, 8 Aug 67.

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20. TM 55-450-8, "Air Transport of Supplies and Equipment; External Transport Procedures," May 1966.

21. TM 55-450-9, "Air Transport of Supplies and Equipment: Internal Procedures," December 1965.

22. Equipment Performance Reports (EPR's) for Integrated Engineering and Service Tests of Container, Water, Plastic, 5-Gallon, USATECOM Project No. 7-7-0862-01/02/03/04/05.

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is suitable for temperate use; and is safe for its intended use. It was also concluded that full plastic containers are suitable for airdrop and internal and external air transport and that the redesigned cap satisfies the requirement to fill canteens without waste of water but it leaks at the air vent.

It is recommended that the plastic water container be considered: suitable for use by the U.S. Army in temperate, tropical, and desert environments; not suitable for use in arctic winter environment; and as suitable as the steel container for airdrop and internal and external air transport. It is also recommended that: the plastic material be changed to preclude deterioration when subjected to extended uncovered desert storage and to reduce flammability characteristics; the hollows in the handle and hollow bumps at top of the container be eliminated; the redesigned cap be modified to prevent leakage and air vent retaining pin failures; the bottom be redesigned to increase stability of the container; one or two additional handles be added to the top to facilitate handling; the shape be made more uniform and rectangular, the surface of the containers be made less slippery, and the top and bottom be made compatible for better stacking characteristics; and the V-shaped cap seal be made U-shaped to reduce cuts and tears.

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FINAL REPORT OF INTEGRATED ENGINEERING AND SERVICE TEST OF CONTAINER, WATER, PLASTIC, 5-GALLON, by Frank H. Baggs, Michael L. Silber, Joseph F. Brugh, Columbus Sims, Jr., Henry A. Parkhurst, Carroll M. Coomer, Barry C. Lucht, February 1968, 143p, -tables, -illus., -graphs 7 Appendices p77-143. (TECOM Proj. No. 7-7-0862-01/02/03/04/05) Unclassified Report

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It was concluded that the plastic water container: is not suitable for arctic use; is more suitable than the steel container for tropic and desert use;

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1. CONTAINERS - WATER
2. WATER CONTAINER - PLASTIC
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Brugh, Joseph F.
Sims, Jr, MSG Columbus
Parkhurst, MAJ Henry A.
Coomer, CPT Carroll M.
Lucht, SP4 Barry C.
II. Title
III. USATECOM 7-7-0862-01/02/03/04/05

is suitable for temperate use; and is safe for its intended use. It was also concluded that full plastic containers are suitable for airdrop and internal and external air transport and that the redesigned cap satisfies the requirement to fill canteens without waste of water but it leaks at the air vent.

It is recommended that the plastic water container be considered: suitable for use by the U.S. Army in temperate, tropical, and desert environments; not suitable for use in arctic winter environment; and as suitable as the steel container for airdrop and internal and external air transport. It is also recommended that: the plastic material be changed to preclude deterioration when subjected to extended uncovered desert storage and to reduce flammability characteristics; the hollows in the handle and hollow humps at top of the container be eliminated; the redesigned cap be modified to prevent leakage and air vent retaining pin failures; the bottom be redesigned to increase stability of the container; one or two additional handles be added to the top to facilitate handling; the shape be made more uniform and rectangular, the surface of the containers be made less slippery, and the top and bottom be made compatible for better stacking characteristics; and the V-shaped cap seal be made U-shaped to reduce cuts and tears.

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