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REPORT 2325

INVESTIGATION OF CLEANING PROCEDURES FOR CONVERTING
PETROLEUM TANKERS TO POTABLE WATER SERVICE

by
Janet O. Hall

May 1981

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report covers an investigation conducted to determine the feasibility of converting 5,000-gallon petroleum tankers to potable water service. The objectives of the study were to determine: (a) The adequacy of the cleaning procedures for converting petroleum tankers to potable water service; (b) the quality of the water transported and stored in these tankers; (c) any restrictions such as maximum storage time for the water in the tankers. (Continued)		

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The results of the study indicate:

- (a) The two cleaning procedures tested were adequate for converting 5,000-gallon petroleum tankers to potable water service.
- (b) The quality of the water transported and stored in the test tankers met the minimum acceptable standards for potable water as defined in TB MED 229.
- (c) The water picked up trace fuel contamination which made the water unpalatable to taste and odor panelists.
- (d) The passage of this contaminated water through granular activated carbon removed all taste and odor and made the water palatable.

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PREFACE

This investigation was conducted as part of the TRADOC Concept Evaluation Program, No. TRMS9CEP011. The test, partially supported by the Quartermaster School, Fort Lee, Virginia, was conducted at USAMERADCOM, Fort Belvoir, Virginia, during the period 13 to 26 June 1979.

The project was coordinated by Major William Brewster, Quartermaster School and Mr. Maurice Pressman, Petroleum and Environmental Technology Division, MERADCOM.

The cleaning procedures were under the supervision of SFC George A. Washburn, Quartermaster School and Mr. Joe E. Brisco, Chief, Maintenance Branch, Services and Support Directorate, USAMERADCOM.

The water analyses were done by Ms. Janet O. Hall, Ms. Elizabeth A. Radoski, and Ms. Anne M. Smucker of the Petroleum and Environmental Technology Division.

The cooperation of TARADCOM, Warren, Michigan, in furnishing the two tankers is acknowledged.

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INVESTIGATION OF CLEANING PROCEDURES FOR CONVERTING PETROLEUM TANKERS TO POTABLE WATER SERVICE

I. INTRODUCTION

1. **Subject.** A requirement for a 5,000-gallon semitrailer bulk water transporter was identified during a TRADOC logistics analysis in 1975. The objective of this investigation was to evaluate the adequacy of prescribed cleaning methods and procedures for converting 5,000-gallon petroleum tankers to potable water service.

A joint investigation was conducted by the US Army Quartermaster School and the Petroleum and Environmental Technology Division, Energy and Water Resources Laboratory, MERADCOM, at Fort Belvoir, Virginia, during the period 12 to 26 June 79.

II. INVESTIGATION

2. **Equipment.** Two M857 series tankers were obtained through USATARADCOM, Warren, Michigan. Both 5,000-gallon semitrailers (Figure 1) had contained full loads of petroleum fuels while undergoing initial production tests at Aberdeen Proving Ground, Maryland, prior to being transported to MERADCOM. The tankers used in this investigation are identified as follows:

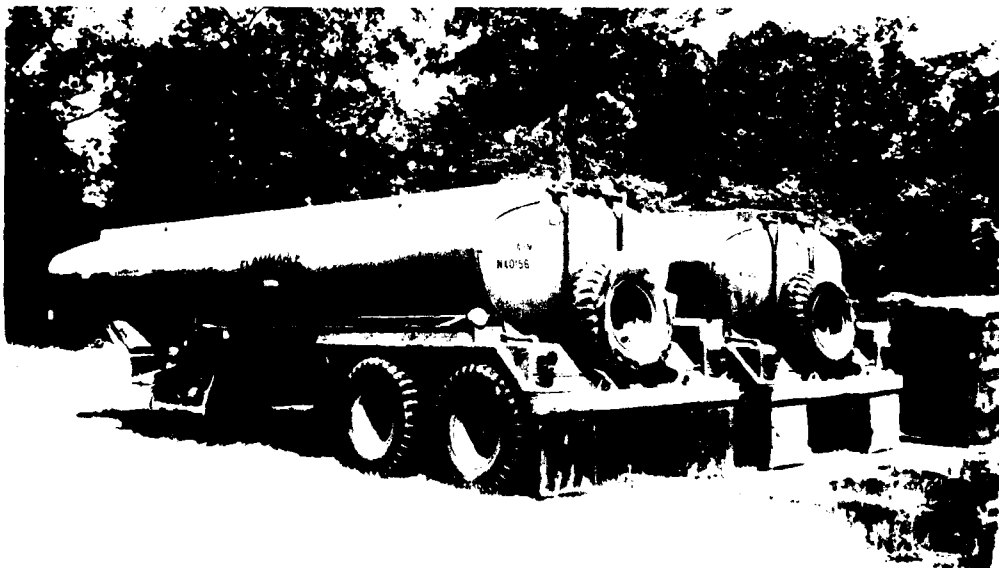


Figure 1. Semitrailer tankers (5,000-gallon) used in this investigation.

- a. **Semitrailer Tank, 5,000 gallons**
M967 Bulk Haul Model
Vehicle ID No. 923-319
Model No. NX0156
Tanker A
- b. **Semitrailer Tank, 5,000 gallons**
M969 Automotive Fuel Dispensing Model
Vehicle ID No. 929-393
Model No. NX017C
Tanker B

3. **General Procedure.** The general test procedure is outlined in the Test Plan (Appendix A). The objectives of the investigation were to determine: (a) If the cleaning procedures are adequate for converting petroleum tankers to potable water services; (b) if the quality of potable water transported and stored in the test semitrailers, subsequent to cleaning, will meet the minimum acceptable standards for potable water as defined in Technical Bulletin MED 229 and in the National Interim Primary Drinking Water Regulations (40 CFR 141); (c) the minimum requirement for the level of acceptability of potable water transported in petroleum tankers to support contingency missions; and (d) any restrictions such as maximum storage time of water in semitrailers. The three parts of the investigation were designated as follows: Cleaning Procedures, Analytical Procedures, and Treatment Procedures.

4. **Cleaning Procedures.** Both semitrailers had contained loads of diesel fuel and leaded mogas at Aberdeen Proving Ground prior to being transported to MERAD-COM. The semitrailers were cleaned at the Engineer Proving Ground at Fort Belvoir under the direction of the Petroleum Project NCO, Directorate of Combat Development, Materiel System Division, USA Quartermaster School, Fort Lee, Virginia. Two different cleaning procedures were used to compare the effectiveness of each method.

a. **Method 1: Detergent and Steam.** The M967 (Bulk Haul) Model semitrailer (designated as Tanker A for test purposes) was first cleaned with detergent using Technical Bulletin ORD 1031 as guidance and then steam cleaned in accordance with paragraph 52a(3) of Technical Manual 5-700. These procedures were partially modified by the process described below. The cleaning process and sequence of events were accomplished as follows:

(1) **12 Jun 79, Afternoon.** The tanker was filled to overflow with fresh hydrant water (approximately 6,000 gallons) and then drained in order to flush residual fuel from the tank compartment and manifold piping. The tanker was left overnight with the top compartment hatch and the bottom manifold valves open to aerate vapor fumes.

(2) **13 Jun 79, Morning.** Five gallons of detergent (MIL-D-16791C, Type I) was poured into the tank compartment through the top hatch opening (bottom valves, closed). Approximately 5,000 gallons of potable water from a water hydrant was added by dropping a hose through the top hatch opening to the bottom of the tank compartment. Water was added until detergent foam and suds overflowed the compartment. The top hatch was closed. A 5-ton tractor was connected to the semitrailer and the tanker was driven around the test area for 30 minutes to thoroughly slosh the detergent-water mixture within the tank compartment. The detergent and water solution was further agitated within the tanker by recirculating the mixture through the pump and hose on the tanker for 30 minutes. The tanker was then drained completely and then refilled to overflow with fresh hydrant water. Once the tanker began to overflow, the bottom valves were partially opened and fresh water was allowed to flow through the tanker continuously for a period of 1 hour.

(3) **13 Jun 79, Afternoon.** The tanker was completely drained and allowed to dry and aerate overnight with the top hatch and bottom valves open.

(4) **14 Jun 79, Morning.** Prior to steam cleaning, combustible vapor tests were conducted using an MSA explosive meter, combustible gas indicator, Navy Type E. Internal air mixture samples were drawn from the center compartment through the top hatch cover, from each end compartment through vent pipe openings on top of the tanker, and from the manifold through the gravity discharge outlet. Each reading showed that no combustible vapors remained within the tanker and that it was safe to commence steam cleaning. Steam was applied to the interior of the tank compartment through the top compartment hatch for a total of 90 minutes.

(5) **14 Jun 79, Afternoon.** The M967 tanker was filled with 5,000 gallons of fresh hydrant water (potable) and then drained completely.

(6) **15 Jun 79.** Seals and gaskets within the tank compartment manifold and discharge lines were replaced. Approximately 500 gallons of water was flushed through the manifold from the tank compartment down as a final rinsing of the piping system subsequent to changing seals and gaskets.

(7) **18 Jun 79, Morning.** The tanker was loaded with 5,000 gallons of potable water for sampling and test procedures and then delivered to MERADCOM's Energy and Water Resources Laboratory, a distance of about 8 miles.

b. Method 2: Chemical Solvent. The M969 (Automotive Refueler) model semitrailer (designated as Tanker B for test purposes) was cleaned with a chemical solvent using Technical Bullentin 750-1047/TO36731-1-6, dated 26 Apr 72, as guidance. This procedure was partially modified by the process described below. The cleaning process and sequence of events were accomplished as follows:

(1) **12 Jun 79, Afternoon.** The tanker was filled to overflow with fresh hydrant water (approximately 6,000 gallons) and then drained completely in order to flush residual fuel from the tank compartment and manifold piping. The tanker was then left overnight with the top compartment hatch and the bottom outlet valves open in order to aerate vapors and fumes from the tank interior.

(2) **13 Jun 79, Morning.** Approximately 25 gallons of Product-Sol No. 913 was poured into the tank compartment through the top hatch opening (bottom valves closed). Product-Sol No. 913 is an emulsified solvent/detergent mixture manufactured by Product-Sol, Inc., 2010 Cole, Birmingham, Michigan, 48008. Approximately 5,000 gallons of potable water was added from a water hydrant by dropping a water hose through the top hatch opening to the bottom of the tank compartment. Water was added until the emulsifying solvent foamed up through the compartment hatch. The semitrailer was then pulled around the test area for 30 minutes to thoroughly slosh the cleaning mixture within the tanker. The cleaning mixture was further agitated within the tanker by recirculating the liquid through compartments by the use of the delivery pump and discharge hoses. This process continued for 30 minutes. The tanker was then drained completely and then refilled to overflow with fresh hydrant water. Once the tanker began to overflow, the bottom outlet valves were partially opened and the water was allowed to flow continuously through the tanker for approximately 1 hour.

(3) **13 Jun 79, Afternoon.** The fresh water was allowed to drain from the tanker. However, as the tanker drained, some of the cleaning mixture agent in the form of suds and foam clung to the walls of the tank compartment. The top hatch cover was removed to allow entry into the tank compartment, subsequent to vapor test. The supervisor of the cleaning operation then entered the tank with the water hose and sprayed the tank's interior to loosen and remove the remaining cleaning agent. To insure that the cleaning mixture was thoroughly flushed from the tank compartment, the tanker was refilled to overflow. Fresh water was allowed to flush through the tanker in this manner for a period of 1 hour. The M959 tanker was then drained completely and left overnight with the top hatch and bottom valves open to aerate and dry the tank compartment.

(4) 14 Jun 79, Morning. The M969 was refilled with fresh potable water and then drained. This was the fourth and final rinsing of this tanker prior to filling with potable test water.

(5) 15 Jun 79, Morning. The M969 was filled with 5,000 gallons of potable water and then driven from the Engineer Proving Ground to the Energy and Water Resources Laboratory (a distance of about 8 miles) for subsequent sampling and water analysis.

5. **Analytical Procedures.** A sample of the potable water used for cleaning and filling the tankers was taken 12 Jun 79. The water was analyzed and the results were used to evaluate changes in water characteristics. An analysis of the water used (14 Jun 79) for filling the tankers follows:

Hydrogen Ion Concentration	7.3
Apparent Color	5 units
Turbidity	0.4 FTU's
Alkalinity	27 mg/l CaCO_3
Total Hardness	78 mg/l CaCO_3
Free Available Chlorine	0.4 mg/l
Sulfate	50 mg/l
Chloride	13 mg/l
Total Dissolved Solids (by Presto-Tek Meter)	70 mg/l
Conductivity	140 $\mu\text{mhos/cm}$
Detergent	0.012 mg/l
Grease and Oil	1 mg/l
Chemical Oxygen Demand	3 mg/l
Total Organic Carbon	3 mg/l
Lead	0.001 mg/l

Water from each of the semitrailers was sampled twice daily at 1000 hours and 1400 hours during the testing period 18-26 June, except Saturday, 23 June and Sunday, 24 June. A sample was drawn from the top of each tank compartment through the hatch opening by submerging the sample bottle 6 inches below the surface of the water (Figure 2).



Figure 2. Sampling from top of tanker.

Another sample was taken from the gravity discharge line (Figure 3) to evaluate possible leaking of undesirable contaminants from gaskets and seals within the manifold. The tankers were both parked outdoors in an unshaded area and exposed to as much solar radiation as possible to generate the elevated temperatures expected under field conditions. Ambient temperatures for the testing period are given in Table 1.



Figure 3. Sampling from bottom of tanker.

Table 1. Ambient Temperature During Testing Period 14-26 Jun 79

Date	High Temp (°F (°C))	Low Temp (°F (°C))
14 June	79° (26.1°)	48° (8.9°)
15 June	81° (27.2°)	55° (12.8°)
16 June	81° (27.2°)	66° (18.9°)
17 June	75° (23.9°)	64° (17.8°)
18 June	86° (30.0°)	64° (17.8°)
19 June	76° (24.4°)	60° (15.6°)
20 June	78° (25.6°)	57° (13.9°)
21 June	67° (19.4°)	55° (12.8°)
22 June	82° (27.8°)	63° (17.2°)
23 June	86° (24.4°)	59° (15.0°)
24 June	69° (20.6°)	62° (16.7°)
25 June	74° (23.3°)	50° (10.0°)
26 June	74° (23.3°)	48° (8.9°)

Analytical determinations were in accordance with *Standard Methods for the Examination of Water and Wastewater*, 14th Edition, 1975. Determinations were made of temperature, hydrogen ion concentration, color, turbidity, alkalinity, hardness, residual chlorine, sulfate, chloride, total dissolved solids (TDS) conductivity, detergent, grease and oil, chemical oxygen demand (COD), total organic carbon (TOC), and lead. In addition, a Model 7620A Hewlett-Packard Research Chromatograph was used to monitor the water for low level fuel contamination. The lead determinations were made with a Model 503 Perkin-Elmer Atomic Absorption Spectrophotometer. TOC determinations were made with a Model DC-50 Dohrmann Total Organic Carbon Analyzer. TDS values were obtained using a Model DP-03 Presto-Tek Conductivity-TDS Meter. Grease and oil determinations were made by the partition-infrared method using a Model 297 Perkin-Elmer Infrared Spectrophotometer. Conductivity was measured with a Model RC 16B2 Beckman Conductivity Bridge. A Model 801 Orion Digital pH Meter was used to record pH. Turbidity measurements were made with a Model 2100A Hach Turbidimeter.

The barium sulfate turbidimetric method was used to determine the sulfate concentration. The mercuric nitrate method was used to measure the chloride concentration. The detergent concentration determinations were made by the crystal violet method using a Hach DR/2 Spectrophotometer. The total hardness as CaCO_3 was determined by titration with ethylenediaminetetraacetic acid. Total alkalinity as CaCO_3 was obtained by titration with 0.02N sodium hydroxide.

6. **Treatment.** To evaluate the effectiveness of granular carbon adsorption for taste and odor removal and for removal of trace lead contaminants, water from the tankers containing trace quantities of fuel was passed through an activated carbon column of Calgon Filtersorb 300 with an empty bed flow-through contact time of 2 minutes.

III. RESULTS

7. **Test Data.** The results obtained in the investigation of cleaning procedures for converting petroleum tankers to potable water service are given in Tables 1 through 3, Figures 1 through 3, and Appendix B.

IV. DISCUSSION

8. **Chemical Analyses.** Chemical Analyses (Tables 1 through 3) showed that the inorganic content of the water did not change significantly. Elevated levels of turbidity, alkalinity, hardness, and total dissolved solids noted in a sample from Tanker B after 96 hours storage time were probably due to some undissolved calcium hypochlorite used for chlorination.

TABLE 2. CHEMICAL ANALYSIS TANK A (MODEL

Characteristics	Potable Water Source	Storage Time-Hours									
		2 Hours ¹		4 Hours		24 Hours		28 Hours		48 Hours	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Temperature °C	ND	25.0°	25.0°	24.5°	30.0°	24.0°	20.5°	26.2°	24.0°	24.0°	21.0°
pH	7.3	7.7	7.7	8.0	7.7	8.0	8.0	7.9	7.9	7.7	7.8
Apparent Color (Units)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Turbidity (FTU)	0.4	0.5	0.5	0.5	0.7	0.5	0.7	0.5	0.6	0.7	0.8
Alkalinity (Mg/l CaCO ₃)	27	33	32	36	31	37	35	36	35	34	36
Total Hardness (Mg/l CaCO ₃)	78	83	87	90	72	ND	ND	ND	ND	ND	ND
Free Available Chlorine (mg/l)	0.4	0.4	0.2	10.0	<0.1	5.0	2.5	8.0	6.0	5	4
Sulfate (mg/l)	50	48	48	47	43	ND	ND	ND	ND	ND	ND
Chlorine (mg/l)	13	13	12	21	10	ND	ND	ND	ND	ND	ND
*TDS (Mg/l)	70	90	90	97	90	109	92	100	100	110	100
Conductivity (umhos/cm)	140	162	ND	190	165	221	ND	218	215	215	210
TOC (mg/l)	3	13	13	21	23	ND	4	10	6	ND	ND
COD (mg/l)	3	9	9	8	12	ND	ND	ND	ND	ND	ND
Detergent (mg/l)	0.012	0.017	0.018	0.045	0.018	ND	ND	ND	ND	ND	ND
Grease & Oil (mg/l)	<1	<1	<1	ND	ND	ND	ND	ND	ND	ND	ND
Lead (mg/l)	0.001	0.001	0.003	0.002	0.008	ND	0.005	0.007	0.010	0.010	0.00

ND: Not Determined

* By Presto-Tek Meter

¹ Sample Taken Prior to Chlorination

#M967)

hrs Bottom	52 Hours		72 Hours		76 Hours		96 Hours		100 Hours		168 Hours		172 Hours		Top
	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	
0°	29.5°	27.0°	24.0°	19.2°	24.0°	19.0°	22.2°	19.0°	29.0°	26.0°	22.8°	17.5°	27.8°	23.8°	23.8°
.8	7.7	7.8	7.9	7.7	7.9	7.8	7.8	7.7	7.8	7.6	7.6	7.6	7.7	7.6	7.6
2.5	<5	<5	<5	7	<5	7	<5	<5	<5	<5	<5	<5	<5	<5	<5
.8	0.7	0.6	0.6	0.5	0.5	0.6	0.5	0.6	0.3	0.6	0.3	0.7	0.5	ND	0.5
36	35	34	38	35	35	35	36	34	35	36	33	34	33	34	35
ND	ND	ND	ND	ND	ND	ND	93	93	92	93	85	103	90	93	ND
4	5	4	5	3	9	3	5	1.6	6	1.8	3	1.6	3	0.8	3
ND	ND	ND	ND	ND	ND	ND	45	44	47	48	50	50	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	19	20	16	16	20	19	16	17	ND
00	112	105	118	100	105	103	100	105	110	110	110	100	110	110	103
10	212	ND	211	215	216	220	181	192	166	176	189	217	215	ND	190
													F130		
ND	ND	ND	ND	ND	23	16	19	9	ND	ND	ND	ND	ND	ND	5
ND	ND	ND	ND	ND	ND	ND	5	8	9	9	6	0	7	13	ND
ND	ND	ND	ND	ND	ND	ND	0.030	0.040	0.058	0.090	0.020	0.018	0.042	0.087	ND
ND	ND	ND	ND	ND	ND	ND	<1	<1	ND	ND	ND	ND	ND	ND	1
0.006	0.006	0.009	0.003	0.007	0.008	0.010	0.001	0.004	ND	0.012	0.002	0.009	0.005	0.020	0.0

6 Hours Bottom	96 Hours		100 Hours		168 Hours		172 Hours		192 Hours		196 Hours	
	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
0° 19.0°	22.2°	19.0°	29.0°	26.0°	22.8°	17.5°	27.8°	23.8°	23.0°	19.0°	28.0°	24.0°
9 7.8	7.8	7.7	7.8	7.6	7.6	7.6	7.7	7.6	7.6	7.5	7.7	7.6
5 7	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
5 0.6	0.5	0.6	0.3	0.6	0.3	0.7	0.5	ND	0.5	1.4	0.6	1.2
5 35	36	34	35	36	33	34	33	34	35	36	35	35
ND ND	93	93	92	93	85	103	90	93	ND	ND	ND	ND
9 3	5	1.6	6	1.8	3	1.6	3	0.8	3	0.8	3	1.8
ND ND	45	44	47	48	50	50	ND	ND	ND	ND	ND	ND
ND ND	19	20	16	16	20	19	16	17	ND	ND	ND	ND
5 103	100	105	110	110	110	100	110	110	103	100	110	106
6 220	181	192	166	176	189	217	215 F130	ND	190	181	176	190
3 16	19	9	ND	ND	ND	ND	ND	ND	5	6	12	4
ND ND	5	8	9	9	6	0	7	13	ND	ND	ND	ND
ND ND	0.030	0.040	0.058	0.090	0.020	0.018	0.042	0.087	ND	ND	ND	ND
ND ND	<1	<1	ND	ND	ND	ND	ND	ND	1	1	ND	ND
08 0.010	0.001	0.004	ND	0.012	0.002	0.009	0.005	0.020	0.003	0.010	0.006	0.020

TABLE 3. CHEMICAL ANALYSES TANKER B (MODEL

Charateristics	Potable Water Source	Before 2 Hours		Chlorination 20 Hours		92 Hours		96 Hours		116 Hours		Storage 120 Hours	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Temperature °C	ND	ND	ND	25.0°	23.5°	26.2°	23.5°	26.5°	28.0°	24.0°	19.0°	26.8°	2
pH	7.3	8.0	7.8	7.4	7.5	7.5	7.5	8.0	8.9	7.7	8.5	7.5	
Apparent Color (Units)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	
Turbidity (FTU)	0.4	0.7	25 *By C	0.5	1.0	0.5	0.6	0.5	17.5	0.8	1.0	0.6	
Alkalinity (mg/l CaCO ₃)	27	55	60	29	29	32	29	32	169	32	50	30	
Total Hardness (mg/l CaCO ₃)	78	51	83	80	79	79	79	96	329	ND	ND	ND	
Free Available Chlorine (mg/l)	0.4	0	0	0.1	0.1	0.1	0.1	8.0	0.1	7	0.7	7	10
Sulfate (mg/l)	50	24	25	47	47	47	48	44	47	ND	ND	ND	
Chloride (mg/l)	13	12	5	14	12	12	13	16	ND	ND	ND	ND	
*TDS (mg/l)	70	118	130	75	70	86	90	89	390	108	160	100	12
Conductivity (umhos/cm)	140	181	180	175	171	160	148	185	ND	215	280	211 215	21 25
TOC (mg/l)	3	8	29	20	19	13	14	11	21	5	9	8	
COD (mg/l)	3	13	53	6	18	8	14	5	16	ND	ND	ND	
Detergent (mg/l)	0.012	0.038	2.5	0.058	0.20	0.078	0.069	ND	ND	ND	ND	ND	
Grease & Oil (mg/l)	<1	ND	ND	<1	15	15	<1	ND	ND	ND	ND	ND	
Lead (mg/l)	<0.001	0.005	0.013	0.002	0.010	0.001	0.005	0.001	0.017	0.004	0.015	0.003	0

ND: Not Determined

*By Presto-Tek Meter

(MODEL #M969)

Storage Time-Hours										188 Hours		192 Hours		260 Hours		264 Hours	
120 Hours		140 Hours		144 Hours		160 Hours		168 Hours		Top Bottom		Top Bottom		Top Bottom		Top Bottom	
Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
26.8°	23.0°	25.0°	21.0°	30.5°	26.0°	24.2°	19.3°	24.2°	19.0°	22.5°	18.5°	28.5°	25.0°	22.5°	17.0°	27.5°	22.5°
7.5	8.2	7.5	8.1	7.7	7.9	7.8	8.0	7.7	8.0	7.7	8.0	7.6	7.9	7.7	7.9	7.7	7.9
<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
0.6	1.1	0.8	1.1	0.5	0.7	0.5	0.6	0.8	0.7	0.5	0.7	0.5	0.7	0.4	1.2	0.4	0.7
30	30	34	33	33	35	33	36	35	36	33	34	35	33	33	37	36	34
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	79	87	91	90
7	10.0	4	10	7	8	9	6	10	6	5	3	6	5	5	1.8	5	1.8
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	42	39	39	30
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	19	19	18	14
100	123	118	110	120	110	100	95	100	100	100	95	100	100	100	108	105	100
211	230	ND	ND	214	212	207	213	205	210	186	175	189	198	206	200	ND	205
215	250																F 150
8	9	ND	ND	ND	ND	ND	14	12	ND	6	8	ND	ND	ND	ND	ND	ND
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0	0	7	27
ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.190	0.075	0.075
ND	ND	<1	<1	ND	ND	ND	ND	ND	ND	1	1	ND	ND	ND	ND	ND	ND
5	0.003	0.013	ND	ND	0.013	0.040	0.005	0.020	0.007	0.003	0.020	ND	0.012	0.005	0.020	ND	0.020

	140 Hours		160 Hours		188 Hours		192 Hours		260 Hours		264 Hours		284 Hours		288 Hours	
	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
0°	24.2°	19.3°	24.2°	19.0°	22.5°	18.5°	28.5°	25.0°	22.5°	17.0°	27.5°	22.2°	23.0°	19.0°	28.0°	24.0°
9	7.8	8.0	7.7	8.0	7.7	8.0	7.6	7.9	7.7	7.9	7.7	7.7	7.6	7.5	7.7	7.6
5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
7	0.5	0.6	0.8	0.7	0.5	0.7	0.5	0.7	0.4	1.2	0.4	0.8	0.4	0.6	0.4	0.6
	33	36	35	36	33	34	35	33	33	37	36	34	31	34	33	32
	ND	ND	ND	ND	ND	ND	ND	ND	79	87	91	90	ND	ND	ND	ND
	9	6	10	6	5	3	6	5	5	1.8	5	1.6	5	1.8	5	3
	ND	ND	ND	ND	ND	ND	ND	ND	42	39	39	38	ND	ND	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	19	19	18	14	ND	ND	ND	ND
100	95	100	100	100	100	95	100	100	100	108	105	100	100	98	100	100
207	213	205	210		186	175	189	198	206	200	ND F 150	205	188	138	159	205
	ND	14	12	ND	6	8	ND	ND	ND	ND	ND	ND	11	13	12	19
	ND	ND	ND	ND	ND	ND	ND	ND	0	0	7	21	ND	ND	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.190	0.075	0.117	ND	ND	ND	ND
	ND	ND	ND	ND	1	1	ND	ND	ND	ND	ND	ND	<1	<1	ND	ND
40	0.005	0.020	0.007	0.008	0.003	0.020	ND	0.012	0.005	0.020	ND	0.020	0.001	0.008	0.003	0.002

The contaminant of major concern was lead because both tankers had contained loads of leaded mogas and diesel fuel prior to being delivered to MERAD-COM. Only one sample contained lead as high as 0.04 mg/l which is below the TB MED 229 maximum allowed level of 0.05 mg/l. All other samples were considerably lower in lead content.

Total organic carbon and chemical oxygen demand analyses showed the presence of organic contamination in the water in low levels. The TOC of the water used for filling the tankers increased from 3 mg/l to a maximum of 21 mg/l. The COD values showed a correlation with the TOC values.

Attempts were made to utilize the gas chromatograph for characterization of the fuel contamination. However, the levels of contamination were below the detectable level. Experiments with fuel and solvent mixtures indicated that this level was approximately 0.2 ml fuel/1000 ml solvent.

9. Taste and Odor. Six panelists were chosen to sample the water for taste and odor. Results of the taste and odor observations (Appendix B) show that while the water met potability standards as defined in TB MED 229 it did have taste and odor that made it unacceptable to most of the panel. However, passing this water through granular carbon columns made the water acceptable to all panel members.

10. Visual Observations. The surface of Tanker A cleaned with detergent and steam had a typical oil sheen. This layer was skimmed and analyzed by gas chromatography. The analysis showed trace amounts (detectable quantities) of the high boiling components of the fuel. The surface of the water in Tanker B, cleaned with Product-Sol, did not show this sheen. Instead, isolated minute patches of a white foam (froth) could be observed. This material was skimmed and it appeared to be grease.

11. Treatment. Laboratory tests showed that passage of the water contaminated with trace quantities of fuel through an activated carbon column removed the taste and odor and made the water acceptable. This treatment also removed traces of tetraethyl lead contamination. Standard granular carbon columns are available for the removal of these organic contaminants.

V. CONCLUSIONS

12. **Conclusions.** Based on the data obtained during this investigation, the following conclusions were drawn:

- a. Both cleaning procedures are acceptable for converting 5,000-gallon fuel tankers to potable water service.
- b. Even though chemical analysis indicated that the water stored in the tankers met the potable water standards of TB MED 229, the water acquired taste and odor which made it unpalatable.
- c. Water stored in the tankers made unpalatable by traces of residual fuel can be made palatable by passing it through granular activated carbon.



APPENDIX A
DEPARTMENT OF THE ARMY
U S ARMY QUARTERMASTER SCHOOL
FORT LEE, VIRGINIA 23801

S: 9 May 79

ATSM-CD-M

2 MAY 1979

SUBJECT: Test Design Plan for CEP Testing of Cleaning Procedures for
Converting Petroleum Tankers to Potable Water Service

SEE DISTRIBUTION

1. Reference letter, ATSM-CD-M, USAQMS, 20 Mar 79, subject: CEP Testing of Cleaning Procedures for Converting Petroleum Tankers to Water Service.
2. The inclosed Test Design Plan (TDP) was initially distributed in draft form for review and comment per above reference. Subject TDP was revised to incorporate pertinent comments and recommendations and is being forwarded for final coordination and concurrence.
3. Requisite arrangements, preparations, and coordination of this CEP test are to be accomplished in accordance with paragraph 9 and Annexes A and B of the inclosed TDP.
4. Request written concurrence and/or nonconcurrence with this plan be submitted to the QMS NLT 9 May 79. It is further requested that any additional comments and/or recommendations be submitted on DA Form 2028, to include complete rationale.

FOR THE COMMANDANT:

1 Incl
as

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ATTN: ATCD-TM

Gene E. Fundula
GENE E. FUNDULA
1 LT, AGC
Assistant Adjutant General

ATS:1-CD-M

SUBJECT: Test Design Plan for CEP Testing of Cleaning Procedures for
Converting Petroleum Tankers to Potable Water Service

CF:

CDR, USAEHA, ATTN: HSE-EW-C

CDR, USALOGC, ATTN: ATCL-MS

ATTN: ATCL-CLT

CDR, USAOCC&S, ATTN: ATSL-CD-MS

CDR, USATARCOM, ATTN: DRSTA-GBW

CDR, USATECOM, ATTN: SPEAP-MT-U

CMDT, USAES, ATTN: ATSE-CD

CMDT, USATSCH, ATTN: ATSP-CD-MS

SUPT, AHS, USA, ATTN: HSA-IPM

ANNEX B
COORDINATION POINTS OF CONTACT

US Army Quartermaster School, ATTN: ATSM-CD-M, AUTOVON 687-4426/1623,
SFC Washburn/MAJ Brewster

US Army Mobility Equipment Research and Development Command, ATTN:
DRDME-GS, AUTOVON 354-5359/5320, Mr. Pressman/Mr. Eskelund

HQDA, Office of the Surgeon General, ATTN: DASG-PSP-E, AUTOVON 227-2796,
MAJ Borphal

Academy of Health Sciences, USA, ATTN: HSA-IPM, AUTOVON 471-4903, MAJ
Kenison

US Army Environmental Hygiene Agency, ATTN: HSE-EW-C, AUTOVON 584-
3816/3845, LTC Gensten/CPT McCarthy

*US Army Tank-Automotive Research and Development Command, ATTN: DRDTA-
RTR, AUTOVON 273-1447/1728, Mr. Bodner/Mr. Ash

*US Army Test and Evaluation Command, APG, ATTN: SPEAP-MT-U, AUTOVON
283-5151, Mr. Silks

*Points of contact for test semitrailers; M967 and M969

TEST DESIGN PLAN FOR CEP TESTING
OF CLEANING PROCEDURES FOR CONVERTING PETROLEUM TANKERS
TO POTABLE WATER SERVICE

1. **Purpose.** To obtain test data to evaluate the adequacy of prescribed cleaning methods and procedures for converting 5,000-gallon petroleum tankers to potable water service. Test results will be used, if positive, to establish doctrine and policies governing the conversion and usage of petroleum tankers as potable water tankers to support contingency requirements.

2. **Background.** A requirement for a 5,000-gallon semitrailer bulk water transporter was identified during a TRADOC logistics analysis, in 1975, of the ME II SCORES scenario and subsequent LOGC/TRADOC two-phased study "Flexible Pipeline for Water Distribution." TRADOC's Phase I report, recommended a mix of flexible water pipelines and 5,000-gallon semitrailers for water distribution for contingency operations in a arid environment. The QMS was tasked to prepare a requirements document for a bulk water transporter to satisfy this requirement. A draft Letter Requirement (LR) for a Semitrailer, Tank, 5,000-Gallon Bulk Water Transporter (ACN 44056) was prepared and submitted to TRADOC for staffing on 26 Oct 77. It was determined at subsequent Joint Working Group meetings that a need existed to develop a "quick-fix" water distribution capability using existing assets. The QMS initiated a Concept Evaluation Program (CEP) to determine the suitability of cleaning petroleum tank trucks for potable water usage, which was approved by HQ TRADOC in Jul 78. The test was originally scheduled to take place at Warren, Michigan, using a GOER tank truck to be provided by USATARCOM during the period Aug-Oct 78. However, funding for this test did not become available until November 78, which necessitated the rescheduling of the test to the summer of 1979 in order to meet the Surgeon General's requirement that the tank truck undergoing test be exposed to as much solar radiation as possible. Test vehicle was changed from a GOER to an M967 and an M969 5,000-gallon semitrailer due to their availability through USATARADCOM at Aberdeen Proving Ground, Maryland, and their close proximity to MERADCOM at Fort Belvoir. The 5,000-gallon semitrailer is better suited to meet the bulk water distribution requirements.

3. **Objectives.**

a. To determine if the cleaning procedures prescribed in paragraph 5 are adequate for converting petroleum tankers to potable water service.

b. To determine if the quality of potable water transported and stored in the test semitrailers, subsequent to cleaning, will meet the minimum acceptable standards for potable water as defined in TB MED 229 and in the National Interim Primary Drinking Water Regulations (40 CFR 141).

c. To determine the minimal level and/or degree of acceptability required of potable water transported in petroleum tankers to support contingency missions.

d. If the cleaning methods and procedures are found to be adequate, what restrictions would apply to the use of petroleum tanker as potable water tankers? Would the potable water transported and/or stored in petroleum tankers, subsequent to cleaning have to be used within a specific time frame?

4. **Scope.** The test will consist of cleaning two M857 series, 5,000-gallon semitrailers that have previously contained petroleum products. The tankers will be cleaned by the methods and procedures outlined in paragraph 5b. Subsequent to cleaning, the tankers will be filled with potable water, which will be sampled and tested over a two-week period as outlined in paragraphs 5c and 5d. Water quality test data and analyses will be included in the final test report for evaluation by the Office of the Surgeon General. The test will be conducted by the Energy and Water Resources Laboratory, USA Mobility Equipment Research and Development Command at Fort Belvoir, Virginia, in coordination with the US Army Quartermaster School, US Army Tank-Automotive Research and Development Command, and the Office of the Surgeon General. The results of the test, if positive, will be used to establish doctrine and procedures for the usage and employment of 5,000-gallon petroleum tankers as potable water tankers to support contingency requirements.

5. **Test Conditions and Strategy.**

a. **Test Equipment and Conditions.**

(1) Two M857 series, 5,000-gallon semitrailers; one M967 Bulk Haul model and one M969 Automotive Fuel Dispensing model will be used to conduct the test. The semitrailers will be provided by the USATARADCOM, on temporary loan to the USAMERADCOM during the period indicated in the Milestone schedule at paragraph 9. These tankers are currently undergoing Initial Production Test (IPT) at the Aberdeen Proving Ground, Maryland.

(2) Each semitrailer will have contained (received, stored, transported, and dispensed) loads of diesel fuel and leaded mogas at Aberdeen Proving Ground, prior to being picked up and hand receipted to MERADCOM.

b. Cleaning Methods and Procedures.

(1) The M969 model semitrailer will be cleaned in accordance with the methods and procedures prescribed in TB 750-1047/TO 36T31-1-6, Elimination of Combustibles from Interiors of Metal or Plastic Gasoline and Diesel Fuel Tanks, dated 26 Apr 72. (Xerox copy attached as inclosure 1).

(2) The M967 model semitrailer will first be cleaned in accordance with TB ORD 1031, dated 23 Aug 67, (Xerox copy attached as inclosure 2), then steamed cleaned in accordance with paragraph 52a(3) of TM 5-700, dated Jul 67. (Xerox copy of paragraph 52 attached as inclosure 3).

c. Preliminary Test Conditions and Operational Factors.

(1) Subsequent to cleaning, each tanker will be filled to capacity (5,000 gallons) with clear, fresh, potable water chlorinated to a level of 5 milligrams per liter to simulate field production requirements and to generate the harsh oxidation-reduction (REDOX) potentials expected in the tank under field conditions.

(2) A control sample will be drawn from the potable water source (hydrant from which the tankers are filled) for analysis and subsequent comparison to test samples drawn from the tankers. The hydrant water (source) used must meet the potability standards prescribed in TB MED 229, and the National Interim Primary Drinking Water Regulations (40 CFR 141).

(3) Subsequent to filling the tankers with potable water and prior to parking them at the test site/storage area, they will be driven around the Fort Belvoir area to thoroughly slosh the water around within the tankers.

(4) The tankers will be parked outdoors in an unshaded area and exposed to as much solar radiation as possible to generate the elevated temperatures expected under field conditions.

d. Water Sampling Conditions and Test Analysis.

(1) Two water samples will be drawn daily, except weekends, from each semitrailer, over a two-week period. (See Milestone Schedule) One sample will be drawn from the top of each tank compartment through the hatch opening. Another sample will be taken from the gravity discharge line to evaluate the pattern of undesirable leachates from gaskets and seals within the manifold should they occur. Samples will be drawn at 0730 hrs and at 1630 hours, and/or as close to the beginning and end of the work day as practical. The midday ambient and water temperatures will also be recorded at sampling times.

(2) Tests: Water samples will be analyzed for the following characteristics in accordance with procedures described in Standard Methods for the Examination of Water and Wastewater: (Std. Meth.) the National Interim Primary Drinking Water Regulations (NIPDWR), the National Secondary Drinking Water Regulations (NSDWR).

Taste/Odor - For these determinations subjective acceptability assessments of a panel of tasters will be recorded.

Temperature, °C
pH (Std. Meth.)
Total Hardness, mg/l CaCO₃ (Std. Meth.)
Chloride, mg/l (NSDWR)
Sulfate, mg/l (NSDWR)
Alkalinity, mg/l (Std. Meth.)
Conductivity, umhos/cm (Std. Meth.)
Total Organic Carbon, mg/l (Std. Meth.)
Chemical Oxygen Demand, mg/l (Std. Meth.)
Lead, mg/l (NIPDWR)
Chlorine, mg/l FAC (DPD method, Std. Meth.)
Surfactants (Foaming Agents) mg/l LAS (NSDWR)
Oil and Grease, mg/l (Std. Meth.)
Turbidity, TU (NIPDWR)
Color, CU (NSDWR)
Organic content by gas chromatography and high pressure liquid chromatography.

(3) Test Report. At the completion of the analyses a report covering all the analytical data will be prepared for inclusion in the final coordinated test report prepared by QMS.

(4) Sampling and test analyses will be conducted by qualified chemists and laboratory technicians at the Energy and Water Resources Laboratory at the USAMERADCOM at Fort Belvoir.

6. Test Issues.

a. Do test results from water quality analysis derived from samples taken from the test semitrailers meet the minimum potability standards prescribed in TB MED 229, the National Interim Primary Drinking Water Regulations (NIPDWR), and/or the National Secondary Drinking Water Regulations (NSDWR).

b. Does the water quality sampled and tested from the test tankers meet the Surgeon General's minimum water potability standards required to support contingency missions?

c. Is the cleaning method and procedure prescribed in TB 750-1047, 26 Apr 72, referenced in paragraph 5b(1), used to clean the M969 model semitrailer adequate for converting petroleum tankers to potable water service?

d. Is the cleaning method and procedure prescribed in TB ORD 1031, 23 Aug 67, referenced in paragraph 5b(2), used to clean the M967 model semitrailer adequate for converting petroleum tankers to potable water service?

e. Is there a significant difference in the quality of water tested from the M969 semitrailer cleaned in accordance with TB 750-1047 from the quality of water tested from the M967 semitrailer, cleaned in accordance with TB ORD 1031?

f. Do test results indicate which cleaning procedure, if either, is superior for the purpose of converting petroleum tankers to water service?

g. Assuming that one or both of the cleaning procedures prove satisfactory, what conditions or restrictions, if any, would apply to the use and employment of petroleum tankers as potable water tankers? Would additional precautions, safeguards, and/or quality control measures be required before petroleum tankers, subsequent to cleaning, could be used to transport and distribute potable water to troops in the field during contingency operations?

7. Safety Issues.

a. The safety precautions outlined in TB 750-1047, and TB ORD 1031, attached as inclosures 1 and 2, respectively, will be adhered to during the cleaning process.

b. Additional safety precautions and instructions pertinent to the cleaning of petroleum tank vehicles are found in Chapter 7, FM 10-20, May 74, and in paragraph 52 of TM 5-700, Jul 67. Chapter 6 of FM 10-20 provides instructions for the use of Safety Equipment Set and Explosimeter.

c. All personnel involved in the cleaning of the test semitrailers will familiarize themselves with the publications prior to beginning the cleaning process.

8. **Environmental Considerations.** Applicable local, state, and federal environmental codes, laws, and/or statutes will be adhered to.

9. **Milestones/Schedules.**

Event	Date	Action/Coordination
Prepare Draft Test Design Plan	7 Mar 79	QMS/MERADCOM
Prepare Input to Draft Test Design Plan	16 Mar 79	MERADCOM/QMS
Coordinate Draft TDP for Review and Comment	19 Mar-9 Apr 79	QMS/MERADCOM, TARADCOM, OSG, USAES, TARCOM, LOGC, TRADOC, USAOCC&S, USATSCH, AHS, EHA
Revise and finalize TDP and Distribute for Coordination	4 May 79	QMS/same as above
Obtain semitrailers for test	29 May-1 Jun	MERADCOM/TARADCOM, TECOM APG, QMS
Purge & Clean Tankers as indicated in paragraph 5b	11-15 Jun	MERADCOM/QMS
Start Water Quality Test (Sampling, Testing & Water Analysis)	18-29 Jun	MERADCOM/QMS
Return Tankers to APG	2-6 Jul	MERADCOM/TECOM APG/TARADCOM
Complete Water Analysis Report	1 Sep 79	MERADCOM/QMS
Prepare Test Report & Submit to the Office of the Surgeon General for Evaluation	15 Sep 79	QMS, OSG/MERADCOM, TARADCOM, USAES, USATSCH, AHS, TARCOM, TRADOC, LOGC, USAOCC&S EHA
Review, Evaluate, TR, and provide recommendations, conclusions, & determinations	1 Nov 79	OSG, AHS/QMS, MERADCOM, EHA

Event	Date	Action/Coordination
Prepare Final CEP Test Report w/conclusions and recom- mendations to HQ TRADOC	1 Dec 79	QMS, LOGC, TRADOC/OSG, AHS, EHA, MERADCOM, TARCOT, TARADCOM, USAES, USAOCC&S USATSCH

**ANNEX A
ACTION/COORDINATION ANNEX**

Event	Action	Coordination
Distribute finalized Test Design Plan	QMS	MERADCOM, TARADCOM, OSG, EHA, USAES, USATSC, USAOCC&S, TARCOM, AHS, LOGC, & TRADOC
Arrange for pickup and hand receipt of test semitrailers points of contact	MERADCOM (Mr. Pressman) 354-5320	TARADCOM/TECOM APG/QMS (Mr. Ash)(Mr. Silks)(SFC Washburn) 273-1728 283-5151 687-4426
Provide test semitrailers that have contained loads of diesel fuel and leaded MOGAS. Drain tankers completely prior to pickup by MERADCOM. Also provide a set of gaskets and seals for the M967 model tanker.	TARADCOM/ TECOM APG	MERADCOM/QMS
Provide facilities, equipment & materials and personnel to perform cleaning and subsequent water test analysis	MERADCOM	QMS will provide Safety Equipment Set and Explosimeter for cleaning process. Personnel to assist in the cleaning process will be provided if required.
Monitor, observe, and/or provide input to test where applicable.	QMS, OSG, AHS, EHA	MERADCOM
Conduct Test.	MERADCOM, QMS	OSG, AHS, EHA
Record analytical data and prepare water analysis report.	MERADCOM	QMS
Prepare Preliminary Test Report covering all phases of the CEP Test and forward to the OSG for evaluation, conclusions, and recommendations.	QMS, MERADCOM	OSG, AHS, EHA

Event	Action	Coordination
Evaluate Preliminary Test Report and provide conclusions, determinations, and recommendations.	OSG, AHS, EHA	QMS, MERADCOM
Prepare Final Test Report and submit to HQ TRADOC with applicable recommendations	QMS	TRADOC, MERADCOM, TARADCOM, OSG, USAES, USATSCH, USAOCC&S, TARCOM, AHS, EHA, and LOGC

APPENDIX B

CONSOLIDATED DATA

TASTE AND ODOR OBSERVATIONS

STORAGE TIME: Tanker A 24 Hours
Tanker B 116 Hours

SAMPLE	YES			NOT ACCEPTABLE	COMMENTS
	NONE	ACCEPTABLE			
A TOP	TASTE	1	2	2	Strong odor and taste
	ODOR	1	2	2	Strong fuel smell and taste Chlorine taste No odor -- no taste Oil smell Visible oil
A BOTTOM	TASTE	1	3	1	Diesel smell
	ODOR	1	3	1	No odor No taste
B TOP	TASTE	1	2	2	Strong chlorine taste
	ODOR	1	3	1	No fuel taste Chlorine odor No odor No taste

CONSOLIDATED DATA
TASTE AND ODOR OBSERVATIONS (CONT'D)

STORAGE TIME: Tanker A 24 Hours
Tanker B 116 Hours

SAMPLE	YES			NOT ACCEPTABLE	COMMENTS
	NONE	ACCEPTABLE			
TASTE		2	3		Most objectional taste Strong chlorine taste Gasoline smell and taste
ODOR		2	3		Strong petroleum products odor and taste Gasoline smell Chlorine

CONSOLIDATED DATA
TASTE AND ODOR OBSERVATIONS (CONT'D)

STORAGE TIME: Tanker A 48 Hours
Tanker B 140 Hours

SAMPLE		YES		NOT ACCEPTABLE	COMMENTS
		NONE	ACCEPTABLE		
A TOP	TASTE	1	6		High chlorine taste Diesel fuel odor Chlorine taste
	ODOR	1	3	3	Barely acceptable
A BOTTOM	TASTE	1	2	4	Diesel fuel taste Chlorine taste
	ODOR	2	2	3	Petrol taste and odor
B TOP	TASTE		5	2	Petroleum taste Chlorine odor Slightly medicinal
	ODOR	1	5	1	Fuel-gasoline taste High chlorine but no other taste or odor
B BOTTOM	TASTE		2	5	Bad news Definite taste - perhaps petroleum
	ODOR		2	5	Fuel and odor taste Fishy Petroleum taste Gasoline taste

CONSOLIDATED DATA
TASTE AND ODOR OBSERVATIONS (CONT'D)

STORAGE TIME: Tanker A 48 Hours
Tanker B 140 Hours

TAP WATER Blank	TASTE	6	1	Chlorine odor
	ODOR	5	2	Good water
				Slight chlorine taste

CONSOLIDATED DATA
TASTE AND ODOR OBSERVATIONS (CONT'D)

STORAGE TIME: Tanker A 72 Hours
Tanker B 160 Hours

SAMPLE	YES			COMMENTS
	NONE	ACCEPTABLE	NOT ACCEPTABLE	
A TOP	TASTE	1	2	Chlorine taste
	ODOR	1	1	No fuel taste Diesel Odor
A BOTTOM	TASTE	1	2	Slight fuel taste and odor Diesel taste and odor
	ODOR	1	1	Fuel taste
B TOP	TASTE	2	1	Chlorine odor
	ODOR	2	1	Slight chlorine taste Very slight taste
B BOTTOM	TASTE	1	1	Fuel taste and odor
	ODOR	1	1	Gasoline taste Distinct taste and odor, but acceptable for field army

CONSOLIDATED DATA
TASTE AND ODOR OBSERVATIONS (CONT'D)

STORAGE TIME: Tanker A 72 Hours
Tanker B 160 Hours

SAMPLE	YES			COMMENTS
	NONE	ACCEPTABLE	NOT ACCEPTABLE	
TASTE	3			
TAP WATER				
Blank	3			
ODOR	3			

CONSOLIDATED DATA
TASTE AND ODOR OBSERVATIONS (CONT'D)

STORAGE TIME: Tanker A 96 Hours
Tanker B 188 Hours

SAMPLE	YES			COMMENTS
	NONE	ACCEPTABLE	NOT ACCEPTABLE	
A TOP	TASTE	2	4	"Oil" floating on surface
	ODOR	1	4	Chlorine odor Petroleum taste Diesel taste
A BOTTOM	TASTE	1	5	Slight color Definite off-taste, but acceptable in today's world
	ODOR	1	3	Fuel taste and odor Petroleum taste and odor
B TOP	TASTE	1	2	Slight taste
	ODOR	1	1	Slight chlorine odor Petroleum taste Slight odor Basically o.k., slight taste
B BOTTOM	TASTE	1	5	Probably o.k.
	ODOR	1	5	Fuel taste and odor Petroleum taste and odor

CONSOLIDATED DATA
TASTE AND ODOR OBSERVATIONS (CONT'D)

STORAGE TIME: Tanker A 96 Hours
Tanker B 188 Hours

SAMPLE	YES			COMMENTS
	NONE	ACCEPTABLE	NOT ACCEPTABLE	
TASTE	6			
ODOR	5	1		Slight odor

CONSOLIDATED DATA
TASTE AND ODOR OBSERVATIONS (CONT'D)

STORAGE TIME: Tanker A 168 Hours
Tanker B 260 Hours

SAMPLE	YES			COMMENTS	
	NONE	ACCEPTABLE	NOT ACCEPTABLE		
A TOP	TASTE	1	2	1	I can also see the pretty colors
	ODOR	1	2	1	Diesel odor
A BOTTOM	TASTE	1	2	1	Very slight taste
	ODOR	1	2	1	Slight organic taste Light odor and taste Fuel taste
B TOP	TASTE	1	3		Slight organic aftertaste; would drink in emergency
	ODOR	1	2	1	Chlorine taste Marginally acceptable; chlorine odor
B BOTTOM	TASTE		1	3	Fuel taste and odor
	ODOR		2	2	Strong gasoline taste taste and odor there, but not too bad

CONSOLIDATED DATA
TASTE AND ODOR OBSERVATIONS (CONT'D)

STORAGE TIME: Tanker A 168 Hours
Tanker B 260 Hours

SAMPLE	YES			COMMENTS
	NONE	ACCEPTABLE	NOT ACCEPTABLE	
TASTE	4			
TAP WATER				
Blank	4			
ODOR				

CONSOLIDATED DATA
TASTE AND ODOR OBSERVATIONS (CONT'D)

STORAGE TIME: Tanker A 192 Hours
Tanker B 284 Hours

SAMPLE		NONE	YES		COMMENTS
			ACCEPTABLE	NOT ACCEPTABLE	
A TOP	TASTE	4	2	1	This one's o.k. Petroleum taste
	ODOR	4	1	2	Slight chlorine taste Strong fuel odor
A TOP Filtered*	TASTE	2	5		Very slight odor and taste Pretty good water
	ODOR	3	3	1	Petroleum odor Slight fuel taste
B BOTTOM	TASTE		2	5	Slight taste, not bad Slight taste and odor
	ODOR		2	5	Fuel taste and odor Petroleum taste Chlorine odor
B BOTTOM	TASTE	5	2		Good water
	ODOR	6	1		Petroleum taste

CONSOLIDATED DATA
TASTE AND ODOR OBSERVATIONS (CONT'D)

STORAGE TIME: Tanker A 192 Hours
Tanker B 284 Hours

SAMPLE	YES			COMMENTS
	NONE	ACCEPTABLE	NOT ACCEPTABLE	
TASTE	6	1		Slight odor
TAP WATER				Good water
Blank	6	1		I like it!

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