TECHNICAL BULLETIN

WATER SUPPLY AFLOAT

Approved for public release; distribution is unlimited.

*This manual supersedes TB 43-0153, dated 20 February 1990 including all changes.

HEADQUARTERS, DEPARTMENT OF THE ARMY
01 September 2002

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DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

WATER SUPPLY AFLOAT

Headquarters, Department of the Army, Washington, D.C.

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Section I. GENERAL

1. General. Army watercraft will use the procedures contained herein to provide and maintain a safe potable water supply. Bacteriological, physical, and chemical requirements of potable water will meet the criteria set forth in AR 40-5 and TB MED 576. Assistance in monitoring these requirements must be obtained from medical facilities ashore since this is beyond the capability of personnel normally assigned to Army watercraft. The basic procedures and criteria outlined in this bulletin will aid in the maintenance of a safe water supply and will prevent the transmission of waterborne disease. This bulletin is to be used in conjunction with AR 56-9.

2. Scope. This section provides information to afloat personnel operating potable water systems. "Potable water systems" are often called "freshwater systems". This identification is not correct because fresh water is not potable unless it is safe for human consumption. This section covers the measures and precautions that shall be taken to maintain the quality of water in the potable water system. Only by ensuring acceptable potable water quality can the health of the crew be protected.

3. Potable Water Systems. The size, arrangement, and operation of potable water system components vary greatly among vessels. References shall be made to the applicable technical manuals for detailed information on specific potable water systems and their components. The following items, however, are common to most Army vessels.

a. An arrangement that will allow shore water to be taken onboard for storage, distribution, or both.

b. Storage capabilities.

c. A method of delivering water from storage tanks to the distribution system.

d. A method of distributing water to various outlets on the vessel.

e. The capability of distilling seawater to make fresh water.

f. The capability of treating fresh water to make it potable.

4. Disinfecting Potable Water. Potable water is defined as water that is suitable for human consumption. Potable water may be produced onboard or received from shore facilities. This water must be disinfected before consumption to inactivate disease-carrying microorganisms called pathogens. Contamination may occur during production, handling, storage, or distribution. Army policy requires the introduction of a disinfecting halogen (i.e., chlorine, bromine). The use of a halogen is preferred to other common disinfection techniques because residual (trace, excess) halogen levels can be easily detected and maintained.

5. Responsibilities.

a. **Shore Station/Post Commander.** The shore station/post commander is responsible for the delivery of potable water from the shore station to the Army vessel. The shore station/post commander shall ensure that only trained shore personnel are used to make up water connections, that the potable

water supply has been properly disinfected, and that all shore connection components are correctly used, supplied, maintained, and marked.

b. **Chief Engineer.** The vessels Chief Engineer is responsible for the supply and treatment of onboard potable water and for the onboard system components that receive, store, distribute, produce, and treat potable water. The Chief Engineer shall also ensure that all ship-to-shore connections are made up by trained shore personnel, when available, or in their absence, qualified crewmembers that are supervised by authorized shore personnel.

c. **Medical Personnel.**

(1) The vessels medical department representative (if assigned) is responsible for monitoring the handling, treatment, and storage of onboard potable water.

(2) Assistance from medical facilities ashore will be required for testing the quality of potable water since this is beyond the capability of personnel normally assigned to Army watercraft.

(3) Medical personnel ashore will evaluate the adequacy of treatment and disinfection of shore potable water prior to its receipt.

6. Reporting Errors and Recommending Improvements.

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Submit your DA Form 2028 (Recommended Changes to Equipment Technical Publications and Blank Forms), through the Internet, on the Army Electronic Product Support (AEPS) website. The Internet address is http://aeps.ria.army.mil. If you need a password, scroll down and click on "ACCESS REQUEST FORM". The DA Form 2028 is located in the ONLINE FORMS PROCESSING section of the AEPS website. Fill out the form and click on "SUBMIT". Using this form on the AEPS website will enable us to respond quicker to your comments and better manage the DA Form 2028 program. You may also mail, E-mail or fax your letter or DA Form 2028 directly to: AMSTA-LC-CI/TECH PUBS, TACOM-RI, 1 Rock Island Arsenal, Rock Island, IL 61299-7630. The E-mail address is TACOM-TECH-PUBS@ria.army.mil. The fax number is DSN 793-0726 or Commercial (309) 782-0726.

Section II. DESCRIPTION, OPERATION, AND SAFETY PRECAUTIONS

7. Receipt of Water From an External Source.

a. Improper techniques associated with the receipt of water can result in contaminated water being introduced into the potable water system. The following actions shall be accomplished prior to receipt of water from any external source.

(1) The free available chlorine (FAC) in the water source shall be determined using the chlorine test kit, which is available on all watercraft. If the water does not contain a FAC

residual of at least 1.0 ppm, then the watercraft commander will be responsible for the addition of sufficient chlorine to maintain at least a 1.0 ppm FAC residual in the potable water system.

(2) When water is obtained from a foreign source or is of doubtful quality, sufficient chlorine shall be added to the potable water tanks to raise the FAC to 5.0 ppm, after a 30-minute contact time.

b. Water supplied by public/private systems outside the United States is suspect and should be considered of doubtful quality. Medical authorities ashore should be requested to evaluate the water source and provide recommendations to the watercraft commander as to its use. If there are no local medical authorities present, the watercraft commander shall use the batch Chlorination method as explained in paragraph 12, resulting in a FAC of 5.0 ppm.

8. Ship to Shore Potable Water Connections. The following procedure will be used when making ship to shore potable water connections:

a. Before making a potable water connection, the potable water risers on the watercraft and the shore facility must be disinfected. This may be accomplished by preparing a 100-ppm chlorine solution (Table 2) in a container and swabbing the riser with or immersing the riser in the solution.

b. Hoses will be disinfected by subjecting their interior surface to a 100-ppm chlorine solution for at least 2 minutes using the following procedure:

(1) Determine the hose diameter.

(2) Convert the hose diameter to gallons-per-foot (Table 1).

(3) Determine the water holding capacity (gallons) of the hose by multiplying gallons-per-foot by length (feet) of the hose.

(4) From the water holding capacity, determine the amount of chlorine agent required to obtain a 100-ppm solution using the chlorine dosage chart (Table 2).

(5) Elevate both ends of the hose to ensure the disinfecting liquid remains inside the hose during the disinfecting process.

(6) Pour the required quantity of chlorine agent into either end of the hose. The solid agent is to be in solution (dissolved) before pouring into the hose. See paragraph 12a for solution procedure.

(7) After pouring the chlorine agent into the hose, completely fill the hose with water. Take care to avoid spillage.

(8) Ensure the solution of chlorine sets in the hose for at least 2 minutes and then drain the hose.

c. Open the shore potable water supply valve to flush the supply piping for 15-30 seconds to remove debris/prevent discoloration.

d. Verify that the watercraft and shore facility risers and potable water hoses have been disinfected and that the shore facility supply piping has been flushed. Connect the potable water hose to the shore facility riser. The transfer of water from the shore facility to the watercraft may now be initiated.

e. If at any time during the transfer of water/connection procedure, the potable water hose becomes contaminated, such as through contact with the harbor water, transfer operations shall be stopped and the hoses disinfected.

9. Potable Water Hoses/Risers.

a. Hoses shall be labeled "POTABLE WATER ONLY" at 10 foot intervals. Potable water hoses shall be used to transfer potable water only, and for no other purpose.

b. Hoses shall be kept in good condition at all times, examined routinely, and removed from service if cracks develop in the lining.

c. Hoses shall be stored with the ends coupled or closed with screw-type caps, in padlocked, vermin-proof lockers. Lockers shall be labeled "POTABLE WATER HOSE". Lockers shall be located out of the weather, if practicable, and at least 18 inches off the deck. Printed instructions outlining step-by-step procedures for the disinfection of potable water hoses shall be posted in a conspicuous location in the hose storage area.

d. The end coupling of the hoses shall be colored coded light blue.

e. Potable water risers shall be labeled "POTABLE WATER" and color coded light blue. All risers shall be equipped with screw-type caps with keeper chains.

10. Storage Tanks. Although potable water tanks are constructed and situated to prevent content contamination, they may be inner-bottom or skin tanks or they may have a common bulkhead with ballast tanks, fuel tanks, or other storage spaces. Special attention must be given to monitoring and maintaining the quality of potable water in these tanks because of their susceptibility to contamination.

11. Potable Water Piping. Special consideration shall be given to potable water piping installed in bilge areas, particularly piping on the suction side of potable water pumps. Because this piping is subject to immersion in bilge water, any leakage will result in contamination. This piping shall be kept in good, sound, working order. All potable water piping that is normally pressurized shall also be kept in good working order because the piping may occasionally lose pressure, or be under no pressure, which could allow contaminated water to enter the pipes.

WARNING

Lead-containing materials, such as putty and white lead, are hazardous to personnel and shall not be used for piping repairs or for buttering-up flanged or threaded joints.

a. Repairs. Piping repairs and buttering-up of flanged and threaded joints shall be performed with a silicone-based compound (e.g. silicone adhesive, National Stock Number (NSN) 8040–00–118–2695).

12. Desalinators.

a. General. Distillers (evaporators) produce fresh water from seawater for use in boiler make-up, electronic cooling, and potable water. Reverse Osmosis (RO) desalinators produce fresh water from seawater for potable water and, when combined with a second RO stage or a demineralizer, produce higher-grade water for boiler make-up and electronic cooling. The product water from a distiller is called "distillate," whereas the product water from an RO unit is referred to as "permeate." Only after the distillate/permeate ("product water") is treated in the brominator, should it be referred to as "potable water".

(1) Distillate is very pure. It contains less than 2.3 parts per million (ppm) chloride ions, which is equivalent to 4.6 ppm Total Dissolved Solids (TDS). A concentration of 4.6 ppm TDS yields a conductivity of 9.2 micromhos/cm.

(2) Permeate from a single stage RO unit ranges in purity from 350 to 500 ppm TDS. The limit for TDS in potable water is 500 ppm.

b. Distillers. Distillers (also referred to as evaporators) installed on watercraft fall into one of the following three classes:

(1) **Low Pressure Steam Distilling Plants.** Examples include submerged tube, vertical basket, and flash-type distilling units.

(2) **Vapor Compression Distilling Plants.** Examples include vertical tube and rising-film distilling units.

(3) **Heat Recovery Distilling Plants (also referred to as waste heat evaporators).**

c. Polluted Water. Unless determined otherwise, water in harbors, rivers, inlets, bays, landlocked waters, and the open sea within 12 miles of the entrance to these waterways, shall be considered to be polluted. Other areas may be declared to be polluted as well by medical personnel. The desalination of polluted harbor water/seawater for human consumption shall be avoided except in emergencies. If distillation of polluted harbor water/seawater becomes necessary, the procedures in paragraph 11f below shall be followed.

d. Operation in Seawater. Desalinators are designed to operate on full strength seawater in the open ocean. Each desalinator has a salinity panel, which monitors the product water, with an associated automatic dump valve. An increase in salinity (or TDS) above the normal range will activate an alarm and signal the automatic dump valve to dump the product water to the bilge. An increase in salinity (or TDS) while operating in full strength seawater indicates that the product water may have been contaminated as a result of seawater leakage or carryover. This product water may be disease-carrying if the seawater feed is contaminated.

Carryover (also called priming) is the process in which salt-laden moisture is carried along with the vapor as it passes through the moisture separators/demisters.

e. Operation in Fresh or Brackish Water. The salinity of fresh water and brackish water is much lower than that of seawater. When a desalination unit is operated in these types of waters, the microbiological and chemical purity of the product water cannot be assured. Since fresh and brackish water contain so little salt, a small leak/carryover may not result in an excessive salinity reading. Thus, a salinity alarm might not be received and the automatic dump valve might not dump the potentially contaminated product water to the bilge. Under such conditions, the procedures in paragraph 11f below shall be followed.

f. Operation in Polluted Water. If it becomes necessary to operate the distilling plant/RO unit while in polluted waters, the following steps will be taken to minimize the risk to the health of the ship's crew:

(1) Distilling plants shall be operated at or below rated capacity.

(2) Maintain evaporator shell water level low in the normal operating band to minimize the possibility of carryover (submerged tube and vertical basket distilling plants).

(3) Maintain first-effect shell temperature at or above 165 F (submerged tube and vertical basket distilling plants) at all times. This temperature is necessary in view of the fact that a small leak/carryover may not result in a high salinity reading since fresh and brackish water contain so little salt. Thus, under these conditions, a chloride content of less than 2.3 ppm is not a reliable indication that the distillate is free from contamination.

- When flash-type distilling units are operated in brackish water, contamination from carryover is automatically avoided because the feedwater in the feedwater heater is maintained at a temperature between 165 F and 170 F.

- Heat recovery distilling units do not heat the feedwater to 165 F; however, most units are equipped with a sterilizer that heats the distillate to between 210 F and 215 F.

The above temperature requirements guard against contamination of the distillate resulting from carryover.

WARNING

Heat recovery distilling units not equipped with a sterilizer are not to be operated in polluted waters.

(4) Do not transfer distillate ("product water" from the distiller/evaporator) to the ship's potable water tank if the chloride content exceeds 2.3 ppm.

(5) Do not transfer permeate ("product water" from the RO) to the ship's potable water tanks if the conductivity exceeds 1000 micromhos/cm (500-ppm total dissolved solids).

g. Disinfection of Distilled Water. Regardless of the method of distilling plant operation, the resulting distillate water shall be disinfected by the addition of a halogen compound before the water is considered safe for human consumption.

Section III. DISINFECTION AND CLEANING

13. Disinfection of Water (Batch Chlorination Method).

WARNING

All personnel performing chlorinating procedures shall wear safety gloves, an apron, and a face shield. Smoking is not permitted during chlorinating procedures.

a. If a shore facility's water supply does not contain a FAC residual of at least 1.0 ppm, then the watercraft commander will be responsible for the addition of sufficient chlorine to maintain at least a 1.0 ppm FAC residual in the potable water distribution system. Since there is no automatic disinfection equipment aboard, the below batch chlorination procedure must be used.

(1) Determine the capacity (in gallons) of the potable water tanks from nameplate data or applicable technical manual.

(2) Using the chlorine dosage chart (Table 2), determine the amount of chlorine necessary to treat the water. (Consult local medical authorities for additional information).

(3) Prepare the chlorine solution. Calcium hypochlorite and chlorinated lime are solids, which do not readily dissolve in water. Use of either agent will require mixing with the appropriate amount of water to form slurry, allowing the solids to settle for 10-15 minutes, and using the supernatant liquid (clean liquid) to accomplish disinfection. The remaining solids can be dissolved in more water and used for disinfection, or discarded. If the solid matter is not to be reused, it will be handled and disposed of as a hazardous waste. If sodium hypochlorite (common household bleach) is used, no mixing is necessary. It may be introduced directly into the potable water tanks.

(4) Add the chlorine solution (not solid material) into the tank preferably when empty or 1/4 full of water. The chlorine solution may be introduced through the potable water riser or sounding tube. The addition of water should provide sufficient mixing of the chlorine solution in the tank.

(5) Allow the treated water to set for 30 minutes then test for adequate FAC residual in the system using the chlorine test kit. If the test reveals a FAC of less than 1.0 ppm the entire process must be repeated until this residual remains. Unexpectedly low FAC residual levels

occur when organic materials in the system exert a demand on the available chlorine. If the FAC chlorine residual is at least 1.0 ppm the water may be used.

b. In cases where a 5 ppm FAC residual is required, the procedure outlined in "a" above should be followed, appropriately adjusting the chlorine dosage.

c. Should it be determined that contamination of the potable water supply exists, the potable water tank has been entered for maintenance or repair, or the potable water tank has been filled with non-potable water (such as for ballasting), superchlorination of the potable water tanks must be accomplished. The superchlorination procedure is similar to the disinfection procedure, but an increased amount of chlorine is utilized over a longer period of time. Superchlorination is to be performed in accordance with the following steps:

(1) Determine the capacity of the tank in gallons.

(2) Using the chlorine dosage chart (Table 2), determine the amount of chlorine necessary to obtain 100-ppm chlorine in the potable water tank.

(3) Mix the chlorine in warm water. Allow the mixture to settle before introducing into the potable water tank.

(4) Completely fill the potable water tank with water to ensure for adequate mixing. Allow the mixture to set for 4 hours.

(5) After 4 hours, determine if a chlorine residual exists. If there is no chlorine residual, drain the contents of the potable water tank and repeat steps (1) through (4).

(6) After 4 hours, if a chlorine residual exists, drain the contents of the potable water tank and refill the tank with potable water. The potable water distribution system may now be used.

d. Mechanical cleaning and chemical disinfection of the potable water tanks may be required under certain circumstances.

(1) When extensive repairs have been completed.

(2) When sludge or rust accumulations impair the quality of water.

(3) When the tanks have been loaded with contaminated water (such as for ballast).

e. Mechanical cleaning requires entry into the potable water tanks and physically scrubbing the interior of the tanks with detergent and water. This is a hazardous operation and it is not considered a routine procedure. Thus it should only be accomplished at facilities where proper procedures can be employed to insure adequate breathing air is supplied to the tank and a hazardous atmosphere does not exist within the tank (installation, safety and/or industrial hygiene personnel may aid in this determination).

14. Disinfectant Agent/Storage.

a. The following chlorine disinfectants may be procured and used aboard Army watercraft:

(1) Calcium hypochlorite (70% by weight chlorine), NSN 6840-00-255-0471, 6 oz. bottle (granules).

(2) Sodium hypochlorite solution (5% by weight chlorine), NSN 6810-00-598-7316, 1 gal bottle (liquid).

(3) Sodium hypochlorite solution (5% by weight chlorine), NSN 6810-00-900-6276, 5 gal pail (liquid)

(4) Chlorinated lime, technical (25% by weight chlorine), NSN 6810-00-242-4768, 100 lb drum (powder)

(5) Chlorinated lime, technical (25% by weight chlorine), NSN 6810-00-255-5917, 25 lb can (powder)

(6) In the event of an emergency, any name brand commercial liquid bleach (which is a 5% sodium hypochlorite solution) may be used.

b. Storage of calcium hypochlorite:

(1) Granular calcium hypochlorite is an effective disinfectant for water, but it is an oxidizing agent, which is very corrosive and may result in spontaneous combustion when in contact with paint, oils, or other oxidizable material.

WARNING

Due to the hazardous nature of calcium hypochlorite, no more than three 6 oz bottles of the material will be carried onboard Army watercraft.

CAUTION

Special storage requirements for calcium hypochlorite are necessary to eliminate the potential fire hazard. Calcium hypochlorite should be stored in a cool, dry area outside of engineering or machinery spaces, flammable storerooms, or with organic products.

(2) In contrast to calcium hypochlorite, sodium hypochlorite liquid may be stored in a general storage areas.

Section IV. POTABLE WATER SYSTEM MONITORING

15. Free Available Chlorine Testing.

a. Use of the below test kit is required to provide daily assurance that the vessels potable water system contains the required amount of disinfecting agent.

b. The following kit, which is available through the federal supply system, is authorized for use onboard Army watercraft:

(1) Comparator, Color, NSN 6630-01-067-3827 (also referred to as the DPD Test Kit), for free chlorine /total bromine detection. Set detects chlorine in the range of 0.1 to 10.0 ppm, pH in the range of 6.8 to 8.2, and bromine in the range of 0.2 to 22.2 ppm. Kit uses the diethyl-p-phenylenediamine (DPD) test method.

(2) For replacement Phenol Red pH Test Tablets, order NSN 6550-01-095-6757.

(3) For replacement Chlorine Test Tablets, order NSN 6810-01-044-0315.

16. Bacteriological Analysis.

a. Free available chlorine testing for the presence of a FAC residual in the potable water system is the most practical means of ensuring for a safe water supply on Army watercraft. However, a more definitive means of ensuring for a safe water supply is performing a bacteriological analysis.

b. The conduct of laboratory analyses is beyond the capability of watercraft personnel. Samples must be submitted to a local medical facility for testing. Samples will be submitted at a frequency determined by the Director of Health Services. The shore medical facility is responsible for providing sterile containers and performing the bacteriological analysis. A record of sample results will be maintained by the watercraft.

Section V. TRAINING

17. Training.

a. To properly provide for the surveillance of the potable water supply through chlorine testing, storage of disinfectants, treatment of water, and potable water hose storage and handling, training of watercraft personnel is absolutely essential.

b. Each vessel commander and at least one crewmember will be trained by medical authorities in potable water sanitation practices.

APPENDIX A – REFERENCES

1. Department of the Army Regulations.

a. AR 56-9, Watercraft.

b. AR 40-5, Preventive Medicine.

2. Other Documents.

a. TB Med 576, Occupational and Environmental Health, Sanitary Control and Surveillance of Water Supplies at Fixed Installations.

b. TB Med 577, Occupational and Environmental Health, Sanitary Control and Surveillance of Field Water Supplies.

c. TB Med 530, Occupational and Environmental Health, Food Service Sanitation.

d. 40 CFR Parts 141-144 and 146.

APPENDIX B - TABLES

Table 1. Volume of Water Contained in Various Sized Pipes/Hoses

Pipe/Hose Diameter	Gallons per Foot of Pipe/Hose
2 inches	0.16 gallons
2.5 inches	0.26 gallons
3 inches	0.37 gallons
3.5 inches	0.50 gallons
4 inches	0.65 gallons
5 inches	1.02 gallons
6 inches	1.47 gallons
8 inches	2.61 gallons
10 inches	4.08 gallons
12 inches	5.87 gallons
14 inches	8.00 gallons
16 inches	10.44 gallons

Conversions:
One cubic foot of water = 7.48 U.S. gallons.
One U.S. gallon = 3,785 ml.

APPENDIX B – TABLES

Table 2. Chlorine Dosage Chart

PPM FAC	1 ppm			5 ppm			25 ppm		
Gallons to be Treated	5%	25%	70%	5%	25%	70%	5%	25%	70%
10,000	25.6 Oz.	5.5 Oz.	1.91 Oz.	128 Oz.	27.5 Oz.	9.55 Oz.	640 Oz.	137.5 Oz.	47.75 Oz.
5,000	12.8 Oz.	2.75 Oz.	.955 Oz.	64 Oz.	13.75 Oz.	4.775 Oz.	320 Oz.	68.75 Oz.	23.875 Oz.
2,000	5.12 Oz.	1.1 Oz.	.382 Oz.	25.6 Oz.	5.5 Oz.	1.91 Oz.	128 Oz.	27.5 Oz.	9.55 Oz.
1,000	2.56 Oz.	.55 Oz.	.191 Oz.	12.8 Oz.	2.75 Oz.	.955 Oz.	64 Oz.	13.75 Oz.	4.775 Oz.
500	1.28 Oz.	.275 Oz.	.0955 Oz.	6.4 Oz.	1.375 Oz.	.4775 Oz.	32 Oz.	6.875 Oz.	2.3875 Oz.
200	.512 Oz.	.11 Oz.		2.56 Oz.	.55 Oz.	.191 Oz.	12.8 Oz.	2.75 Oz.	.955 Oz.
100	.256 Oz.			1.28 Oz.	.275 Oz.	.0955 Oz.	6.4 Oz.	1.375 Oz.	.4775 Oz.
50	.128 Oz.			.64 Oz.	.1375 Oz.		3.2 Oz.	.6875 Oz.	.2388 Oz.
25	.064 Oz.			.32 Oz.			1.6 Oz.	.3438 Oz.	.1194 Oz.
10	.0256 Oz.			.128 Oz.			.64 Oz.	.1375 Oz.	
5	.0128 Oz.			.064 Oz.			.32 Oz.		

*Note: The 5% column is sodium hypochlorite (liquid) and the quantities shown are by volume. The label on the bottle will indicate the percentage of chlorine available. When using a chlorine percentage other than 5%, quantities should be calculated using linear interpolation. The 25% and 70% columns are chlorinated lime (solid) and calcium hypochlorite (solid), respectfully, and the quantities shown are by weight.

Mass Conversions:
1-pound = 16-ounces
1-ounce = 28.35 grams

Volume Conversions:
1-gallon = 128-ounces
1-quart = 32-ounces
1-pint = 16-ounces.

***Mass or Volume Conversions:**
1-ounce = 6-teaspoons
1-ounce = 2-tablespoons
1-tablespoon = 3-teaspoons

* These conversions are valid for liquids/solids having a density similar to that of water.

APPENDIX B – TABLES

Table 2. Chlorine Dosage Chart (continued)

PPM FAC	50 ppm			100 ppm			200 ppm		
Gallons to be Treated	5%	25%	70%	5%	25%	70%	5%	25%	70%
10,000	1280 Oz.	275 Oz.	95.5 Oz.	2560 Oz.	550 Oz.	191 Oz.	5120 Oz.	1100 Oz.	382 Oz.
5,000	640 Oz.	137.5 Oz.	47.75 Oz.	1280 Oz.	275 Oz.	95.5 Oz.	2560 Oz.	550 Oz.	191 Oz.
2,000	256 Oz.	55 Oz.	19.1 Oz.	512 Oz.	110 Oz.	38.2 Oz.	1024 Oz.	220 Oz.	76.4 Oz.
1,000	128 Oz.	27.5 Oz.	9.55 Oz.	256 Oz.	55 Oz.	19.1 Oz.	512 Oz.	110 Oz.	38.2 Oz.
500	64 Oz.	13.75 Oz.	4.775 Oz.	128 Oz.	27.5 Oz.	9.55 Oz.	256 Oz.	55 Oz.	19.1 Oz.
200	25.6 Oz.	5.5 Oz.	1.91 Oz.	51.2 Oz.	11 Oz.	3.82 Oz.	102.4 Oz.	22 Oz.	7.64 Oz.
100	12.8 Oz.	2.75 Oz.	.955 Oz.	25.6 Oz.	5.5 Oz.	1.91 Oz.	51.2 Oz.	11 Oz.	3.82 Oz.
50	6.4 Oz.	1.375 Oz.	.4775 Oz.	12.8 Oz.	2.75 Oz.	.955 Oz.	25.6 Oz.	5.5 Oz.	1.91 Oz.
25	3.2 Oz.	.6875 Oz.	.2388 Oz.	6.4 Oz.	1.375 Oz.	.4775 Oz.	12.8 Oz.	2.75 Oz.	.955 Oz.
10	1.28 Oz.	.275 Oz.	.0955 Oz.	2.56 Oz.	.55 Oz.	.191 Oz.	5.12 Oz.	1.1 Oz.	.382 Oz.
5	.64 Oz.	.1375 Oz.		1.28 Oz.	.275 Oz.	.0955 Oz.	2.56 Oz.	.55 Oz.	.191 Oz.

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* These conversions are valid for liquids/solids having a density similar to that of water.

APPENDIX B – TABLES

Table 3. Required Halogen Residuals

Treatment Requirement	Chlorination Dosage and Time Requirements	Bromination Dosage and Time Requirements
Minimum residual required for all potable water.	*0.2 ppm after 30 minutes in potable water tanks.	*0.2 ppm after 30 minutes in potable water tanks.
Water in potable water distribution system.	**Trace readings throughout.	**Trace readings throughout.
Water from area where amebiasis or hepatitis is endemic or if an unapproved water source is used.	2.0 ppm after 30 minutes in potable water tanks.	2.0 ppm after 30 minutes in potable water tanks.
Disinfecting tanks/potable water distribution system.	100 ppm initially; 50 ppm after 4 hours (superchlorination).	Not applicable.
Disinfecting hoses, couplings, and water connections prior to connecting to potable water system.	100 ppm for 2 minutes.	Not applicable.
Scrubbing the interior of contaminated potable water tanks.	100 ppm.	Not applicable.
Emergency water supply for drinking and cooking.	5.0 ppm after 30 minutes.	Not applicable.

*The amount of halogen compound added will produce an initial concentration of 1.0-ppm chlorine or 0.7-ppm bromine. These initial concentrations are necessary to obtain a minimum concentration of 0.2-ppm FAC or total bromine residual (TBR) after a 30-minute contact period in the potable water tanks. The amount of chlorine/bromine required to produce a 30-minute FAC/TBR residual of 0.2 ppm can vary because of halogen demand. Halogen demand is defined as the depletion of chlorine/bromine through reactions with substances in water. In other words, the amount of halogen required to react with these substances is called halogen demand. All water, including distilled water, has some halogen demand. Additional bromine/chlorine may be used on treated water to achieve correct halogen residual level.

**Trace readings are any detectable color changes on the DPD Test Kit's colorimeter.

By Order of the Secretary of the Army:

ERIC K. SHINSEKI
General, United States Army
Chief of Staff

Official:

JOEL B. HUDSON
Administrative Assistant to the
Secretary of the Army

DISTRIBUTION:

To be distributed in accordance with Initial Distribution Number (IDN) XXXXX, requirements for TB 43-0153.

These are the instructions for sending an electronic 2028.

The following format must be used if submitting an electronic 2028. The subject line must be exactly the same and all fields must be included; however, only the following fields are mandatory: 1, 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17 and 27.

From: "Whomever" whomever@avma27.army.mil
To: TACOM-TECH-PUBS@ria.army.mil

Subject DA Form 2028

1. ***From:*** Joe Smith
2. ***Unit:*** **home**
3. ***Address:*** 4300 Park
4. ***City:*** Hometown
5. ***St:*** MO
6. ***Zip:*** 77777
7. ***Date Sent:*** 19-OCT-93
8. ***Pub no:*** 55-1915-200-10
9. ***Pub Title:*** TM
10. ***Publication Date:*** 11-APR-88
11. ***Change Number:*** 12
12. ***Submitter Rank:*** MSG
13. ***Submitter Fname:*** Joe
14. ***Submitter Mname:*** T
15. ***Submitter Lname:*** Smith
16. ***Submitter Phone:*** 123-123-1234
17. ***Problem:*** 1
18. ***Page:*** 1
19. ***Paragraph:*** 3
20. ***Line:*** 4
21. ***NSN:*** 5
22. ***Reference:*** 6
23. ***Figure:*** 7
24. ***Table:*** 8
25. ***Item:*** 9
26. ***Total:*** 123
27. ***Text:***
This is the text for the problem below line 27.

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 25-30; the proponent agency is OAASA	Use Part II *(reverse)* for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).	DATE
TO: *(Forward to proponent of publication or form) (Include ZIP Code)*	**FROM:** *(Activity and location) (Include ZIP Code)*	

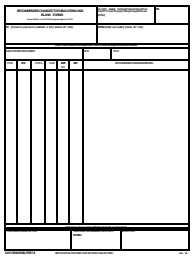
PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER	DATE	TITLE
TB 43-0153	01 September 2002	TECHNICAL BULLETIN WATER SUPPLY AFLOAT

ITEM	PAGE	PARA-GRAPH	LINE	FIGURE NO.	TABLE	RECOMMENDED CHANGES AND REASON

** Reference to line numbers within the paragraph or subparagraph.*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE



The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter= 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 Meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = 0.35 ounce
1 dekagram = 10 Grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliliters = .34 fluid ounce
1 deciliter = 10 centiliters = 3.38 fluid ounces
1 liter = 10 deciliters = 33.81 fluid ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 27.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq millimeters = .155 sq. inch
1 sq. decimeter= 100 sq centimeters = 125.5 sq. inches
1 sq. meter (centare) = 100 sq decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. decimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. Feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	3.280
yards	meters	.914	meters	feet	.394
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29.573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pounds-inches	Newton-meters	.11296			

Temperature (Exact)

?F	**Fahrenheit temperature**	**5/9 (after subtracting 32)**	**Celsius temperature**	**?C**