Bureau of
Medicine and Surgery
Washington, DC 20372-5300

NAVMED P-5010-6 (Rev. 7-2005)
0510-LP-103-9057

Manual of Naval Preventive Medicine

Chapter 6

WATER SUPPLY AFLOAT

DISTRIBUTION STATEMENT "A"

This publication supersedes NAVMED P-5010-6 of 1990 S/N 0510-LP-206-6300

NAVMED P-5010-6

Chapter 6
Manual of Naval Preventive Medicine
Water Supply Afloat
25 Jul 2005

To: Holders of the Manual of Naval Preventive Medicine

1. **Purpose.** This revision reflects information for safe and proper potable water handling procedures for United States Naval Ships (USNS).

2. **Action.** Replace entire chapter 6 with this version.

D. C. ARTHUR
Chief, Bureau of
Medicine and Surgery

CHAPTER 6
WATER SUPPLY AFLOAT

CONTENTS

CONTENTS
(Continued)

CHAPTER 6
WATER SUPPLY AFLOAT

TABLES **Page**

LIST OF APPENDICES

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION I. INTRODUCTION

6-1. Scope

a. This chapter provides information for safe and proper potable water handling procedures for United States Naval Ships (USNS). Applicable potable water quality standards are set forth in current Office of the Chief of Naval Operations (OPNAV), Bureau of Medicine and Surgery (BUMED), and Military Sealift Command (MSC) instructions. The basic principles outlined in the following sections will help prevent water-borne disease outbreaks. The use of trademark names in this publication does not imply endorsement by the Department of Navy (DON), but is intended only to assist in identifying specific products.

b. All personnel concerned with loading, treatment, storage, distribution, and medical surveillance of potable water should be familiar with current applicable naval instructions and directives, which supplement this chapter.

6-2. Responsibilities

a. The Naval Sea Systems Command (NAVSEASYSCOM) is responsible for the design, construction, and maintenance of the shipboard potable water systems, including treatment facilities and processes to assure that safe drinking water is available at all times.

b. The Naval Facilities Engineering Command (NAVFACENGCOM) is responsible for promulgating instructions for ship-to-shore potable water connections and for providing potable water from an approved source when the ship is berthed at a naval facility.

c. Chief, BUMED is responsible for establishing and promulgating health standards for water quality afloat. BUMED will promulgate appropriate instructions, notices, or other publications to reflect afloat water quality requirements. Additionally, BUMED will set forth shipboard requirements for medical surveillance of potable water systems.

d. Area, fleet, and subordinate commanders are responsible for issuing the necessary implementing directives to ensure that adequate water sanitation standards are provided and enforced in each ship within the command.

e. The commanding officer, master, or other applicable responsible party of each ship is responsible for promulgating a water sanitation bill to ensure that procedures for receipt, transfer, treatment, storage, distribution, and surveillance are provided and followed.

f. The engineering department of the ship is responsible to the commanding officer or master for implementing the requirements of the NAVSEASYSCOM. This responsibility includes the supply and treatment of potable water and for the system components that receive, store, distribute, produce, and treat potable water. The engineering officer shall ensure that all ship-to-shore connections are made only by authorized shore personnel, when available, or in their absence, ship personnel who are properly supervised by authorized shore personnel; and that all connections required for ship-to-ship potable water transfer are made by personnel trained in handling potable water.

The engineering officer is responsible for the chloride and hydrogen ion (pH) testing of the ship's potable water. The engineering department shall ensure minimum halogen residuals are maintained at a potable water tank before placing the tank on-line to the potable water distribution system.

g. The medical department representative (MDR) is responsible for conducting a medical surveillance program of the potable water system including collection of samples for coliform bacteria testing as prescribed and daily halogen residuals from the distribution system. The MDR shall notify the commanding officer or master of any discrepancies observed in the potable water distribution system.

6-3. Shipboard Potable Water

a. Shipboard potable water primarily comes from approved ashore sources and ships water production plants which include distillation plants or reverse osmosis (RO) plants. Present water plants aboard naval ships are designed to make the ship as self-sufficient as possible. Generally, ship water treatment plants are capable of producing potable water from bacteriologically contaminated seawater, provided the specific procedures set forth in Chapters 531 and 533 of the Naval Ships Technical Manual (NSTM) are followed. In addition, potable water must be adequately disinfected to maintain the required halogen residual level in the potable water tanks and distribution system.

b. Avoid making water while operating in harbors or from polluted seawater. Seawater shall be assumed polluted when ships are operated in close formation. While making potable water, care must be taken not to strip fuel waste tanks or empty bilges forward of the saltwater intakes. Source water in harbors or ship navigation lanes is likely to be contaminated by fuel/oil slicks or other pollutant sources. Volatile Organic Chemicals (VOCs), which have a lower boiling point than water and which could be present in contaminated unapproved source waters, can vaporize and mix with the water vapor during the distillation process, carrying over into the condensate chamber and distillate reservoir.

c. Distilled water tends to be mineral free and can be highly corrosive to metal piping and storage tanks. The leaching of lead and copper from plumbing fixtures and service lines and any other sources in contact with potable water (lead-based paint) is of special concern. Operational checks of shipboard water plants afloat, inspection, and approval of watering points ashore are only a part of the precautions necessary to assure a safe water supply. Many points of possible contamination exist within the ship and may contribute to waterborne disease outbreaks. Therefore, regardless of the source of the water, there must be vigilant surveillance to assure adequate protection from subsequent contamination.

d. Potable Water Sources for Naval Ships:

(1) Distillation, RO, or other NAVSEA approved water production technology.

(2) Shore-to-ship delivery from an approved source.

(3) Shore-to-ship delivery from an unapproved source (when approved source does not exist), refer to Article 6-7.

(4) Ship-to-ship.

e. Potable water is used aboard ship for drinking, cooking, laundry, medical, personal hygiene, and other purposes.

f. Health concerns regarding potable water quality may include physical, chemical, and bacteriological parameters. Direct chemical additives to potable water systems afloat should be tested/certified by the product manufacturer in accordance with National Sanitation Foundation International Standard known as NSF/ANSI Standard 60: *Drinking Water Treatment Chemicals – Health Effects*.

Likewise, indirect chemical additives to potable water systems afloat should be tested/certified by the product manufacturer in accordance with NSF/ANSI Standard 61: *Drinking Water System Components – Health Effects*. Manufacturers should meet other applicable NSF/ANSI potable water public health standards as indicated.

g. Use of seawater in food services spaces including sculleries is prohibited and seawater outlets in these spaces must be removed. The dangers of cross connections and of using polluted overboard water cannot be overemphasized. Cross connections between the potable water and seawater of other systems are not permitted. ***Exception****:* specific garbage grinders, which use seawater flush and have been approved by BUMED for use in designated sculleries. Installation of salt water flush garbage grinders precludes storage of clean dishware or other items in the scullery because of concerns for aerosol contamination.

h. Seawater is used aboard ships such as in the fire mains, decontamination, and for marine sanitation devices (MSDs) flushing. Since conservation of potable water is a constant requirement, it is impractical to provide potable water for all purposes.

6-4. Potable Water Usage Requirement

a. Proper indoctrination of the crew and attention to leaks and waste should limit potable water consumption to reasonable amounts. Water hours may at times become necessary on some ships and this may adversely impact personal hygiene practices. This is particularly applicable to troop-carrying ships loaded beyond their water-producing capacity. Personnel may keep clean and live under sanitary conditions, even with a limited water supply. If unusual conditions require drastic restrictions in the use of potable water, the allowances should not be less than 2 gallons per man per day to be used for drinking and cooking purposes. In hot environments it is necessary to provide sufficient drinking water quantity to prevent heat casualties.

b. For new ship constructions, 50 gallons per day per man is specified by NAVSEA for design considerations. This encompasses a broad spectrum of potable water uses including drinking water, galley and scullery, personal hygiene, and laundry.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION II. RECEIPT AND TRANSFER

6-5. Receipt and Transfer of Potable Water

a. When receiving or transferring potable water via approved sources, proper procedures must be followed to prevent contamination.

(1) A free available chlorine (FAC), chloramines (total chlorine), or total bromine residual as applicable shall be completed prior to the initial transfer of water.

(2) If water taken aboard the ship does not have the required halogen residual, the ship must boost halogen residual, or have shore facility boost halogen residual in source water to obtain the proper residual.

(3) When potable water from the transferring source contains the proper halogen residual, no further treatment is required.

b. Potable water connections between shore and ships must be made or supervised by authorized shore station personnel. In the event shore personnel are unavailable, properly trained ship personnel will complete this responsibility. The individual making the potable water hose connections shall ensure hoses are not connected to a non-potable system. Engineering will notify the MDR prior to making potable water hose connections. The MDR shall determine if the correct halogen residual is present in the source water and if it is not, he or she must notify the engineering department representative.

c. Potable water hoses shall not be submerged in harbor water.

6-6. Approved Sources. Potable water may be received from approved shore facilities or other vessels. The following are approved potable water sources:

a. Environmental Protection Agency (EPA) (State and territory) approved public water systems.

b. Approved U.S. military sources including establishments under the cognizance of the British Royal Navy, Canadian Forces, and the Royal Australian Navy. These sources are subject to termination or modification. See the current American-British-Canadian-Australian Naval Quadripartite Standardization Agreement Program, ABCA NAVSTAG 23, Quality Standards for Potable Water. Under certain emergency or wartime situations, shore water sources may be under the cognizance of Quadripartite Standardization Agreement 245, Edition 2, of the American-British-Canadian-Australian Armies Standardization Program, Minimum Requirements for Water Potability (Short and Long Term Use) or the NATO Standardization Agreement, STANAG 2136, Minimum Requirements of Water Potability for Short Term Issue.

c. OCONUS water source information may be obtained from U.S. military representatives ashore or Navy Environmental Preventive Medicine Units (NAVENPVNTMEDUs) having area responsibility.

d. Bottled water must be obtained from DOD approved sources.

6-7. Sources of Doubtful Quality. All water supplied by public or private systems not listed in Article 6-6 should be considered of doubtful quality. When doubt exists as to the quality of water, the MDR, or a responsible officer must investigate the source and examine the water as thoroughly as possible with the means available; he or she must then advise the commanding officer or master relative to necessary procedures, safeguards, and disinfection. In instances where the ship must receive water of doubtful quality, disinfection will be accomplished in accordance with Article 6-21.

6-8. Care of Shipboard Potable Water Hoses and Equipment

a. Potable water hoses shall not be used for any other purpose. They must be properly labeled, stored, and protected from sources of contamination at all times. They must be examined routinely and removed from use when cracks develop in the lining or leaks occur. Disinfection procedures for potable water hoses are found in Articles 6-9 and 6-23.

b. Shipboard potable water risers shall be at least 18 inches above the deck and turned down, except when risers are located within the ship, such as in submarines. Potable water riser must be properly labeled and fitted with a cap and keeper chain. Potable water riser valve or valve handles must be properly color coded in accordance with NSTM Chapter 505. Riser hose connections shall be disinfected prior to connection.

c. Potable water tank sounding tubes will be equipped with screw caps attached to keeper chains. Screw caps will be secured with a lock. On those ships with sounding rods, the rod should remain in the tube at all times. Potable water sounding tapes must be sanitized prior to each use and shall only be used for potable water tank volume measurements.

6-9. Connection Procedures. Table 6-1 provides guidelines for connection procedures covering ship-to-shore and ship-to-ship transfer of potable water. Modification of these procedures may be necessary or required due to ship configuration or operating conditions.

Table 6-1. Potable Water Transfer Procedures for Ship-to-Shore and Ship-to-Ship*

Ship-to-Shore	Ship-to-Ship
Remove shore cap and flush pier side potable water outlet for 15-30 seconds. Immerse outlet and rinse fitting in solution containing 100-ppm FAC (free available chlorine) for at least 2 minutes. Flush water to waste for 15-30 seconds.	Both ships disinfect their respective potable water riser connections. The leading potable water hose shall have the hose cap in place during the high-line procedure.
Deliver a clean disinfected potable water hose to the outlet just before the connection is made (potable water hoses should be provided by the shore facility). Remove hose caps or uncouple hose ends and disinfect if not previously disinfected. Connect hose to pier side outlet and flush.	When the receiving ship secures the potable water hose, the cap is removed and the hose coupling is disinfected.
Disinfect shipboard riser connections with 100-ppm FAC solution. Connect hose to the potable water shipboard riser and deliver potable water. Other FDA listed food contact surface disinfectants such as iodine may be used if approved by the MDR.	The supplying ship connects its end and flushes the hose.
When the transfer is completed, secure the shore water source; remove the ship connection, then the shore connection. Thoroughly flush the potable water outlet and recap.	When the transfer is completed, the receiving ship removes the potable water hose and replaces the caps on the receiving connection and the potable water hose.
Drain the potable water hose thoroughly and properly store in the potable water hose storage locker.	The supplying ship then retrieves, couples or caps, and properly stores the potable water hose.

*Tables read top to bottom, not left to right.

SECTION III. STORAGE AND DISTRIBUTION

6-10. Potable Water Production

a. **Types of Water Production Plants**

(1) **Distillation plants.** Installed on naval vessels are three general types, depending on the source of heat used to evaporate seawater.

(a) Steam distilling plants are operated by steam supplied directly or indirectly from a power plant or auxiliary boiler. They are subdivided into two groups, submerged type and flash type. These subdivisions differ mainly in the pressure in the heating elements and evaporator shell.

(b) Waste heat distilling plants are submerged tube type and use heat derived from diesel engine jacket water.

(c) Vapor compression type distilling plants require primarily only electrical energy for operations; however, additional heat exchangers that use waste heat (exhaust gas or cooling water) may be installed.

(2) **Reverse osmosis (RO).** Single and triple pass RO plants are another type of shipboard water production technology. RO consists of a pre-filtration section that typically includes, in surface ships, a coarse strainer, a centrifugal separator and cartridge filters that remove suspended particles as small as 1 micron in some cases. Triple pass RO plants used for submarines do not have a separator but are fitted with cartridge filters nominally rated at 3 micron to remove suspended particles. The RO water treatment technology in lieu of distillation will likely be the technology of choice for fresh water production for new construction ships. A brief discussion of RO treatment is below.

(a) Through a high-pressure pump, the filtered water is then boosted up in pressure to as much as 1000 psi where it is introduced into the RO pressure vessels that contain circularly wrapped polyamide thin film RO membranes. A portion of the filtered water, typically 20-25 percent, permeates through the membrane to become fresh water. The remaining brine, which does not pass through the RO membrane, is discharged from the RO unit as waste.

(b) Although the RO membrane is theoretically capable of removing all viruses and bacteria from the source water under optimal operating conditions, membrane fouling does occur and can compromise the integrity of the membranes. Reverse osmosis is not solely relied upon for accomplishing pathogen removal in single pass RO plants thus additional disinfection such as chlorination or bromination is required.

(c) In triple pass RO plants additional disinfection requirement is waived because it is assumed that the redundancy of three membranes, connected in series, would accomplish adequate removal of pathogenic organisms. Triple pass RO water quality is comparable to distilled water and often may be better.

b. NSTM Chapter 533, Potable Water Systems (1995), and NSTM Chapter 531, Desalination, Volume 3 Reverse Osmosis Desalination Plants (1999), RO treated water from a single pass RO unit ranges in purity from 350 to 500 ppm Total Dissolved Solids (TDS), while distilled water purity is on the order of 1 to 2 ppm TDS and a third pass RO unit can produce water with less than 1.0 ppm TDS. Low TDS distilled water and multi pass RO water can be more corrosive to plumbing and storage tanks than single pass RO water. In addition, water high in dissolved gasses (e.g., carbon dioxide and oxygen), after multiple passes through RO membranes, can also be corrosive.

c. Although potable water production/ treatment is an engineering responsibility, the MDR must be cognizant of the process to adequately provide surveillance and recommendations.

6-11. Potable Water Tanks

a. The construction and location of potable water tanks should prevent contamination of the water. For full utilization of space, potable water is stored on most ships in inner bottom tanks, other skin tanks, and peak tanks. The ship bottom, which serves as the outer shell of the inner bottom tanks, is subjected to maximum external pressure from water that may be heavily polluted, and is vulnerable to leakage. The plating over the inner bottom tanks often serves as the deck in machinery spaces. Inner bottom and other skin tanks may have common bulkheads with ballast tanks, fuel tanks, or other storage spaces. These potential sources of contamination make it necessary to devote careful attention to maintaining the quality of water stored in skin tanks, particularly those located in inner bottoms.

b. Potable water tanks should not be filled with ballast water unless absolutely necessary for the survival of the ship. When non-potable liquid (water) is introduced into potable water tanks, all tanks, lines, fittings, and pumps must be disconnected from the potable water system, plugged or capped, and not reconnected until adequately cleaned, flushed, disinfected, and tested as applicable in accordance with Article 6-22. Cross connections between potable and non-potable water must be prevented for force health protection.

6-12. Vents and/or Overflow Lines. Vents and/or overflow lines provided on potable water tanks will be located to reduce the possibility of contamination. The openings must be screened with 18-mesh or finer non-corrosive metal wire. They must not terminate in food service, medical, toilet, or other spaces where contamination or odors may be transmitted to the water, nor in any space where electrical or electronic equipment is located. In no instance will potable water tanks vent outside the ship.

6-13. Manholes. The construction and location of manholes should minimize the possibility of contamination. If a manhole is located on the side of the tank, flush-type construction is acceptable. If located on the top (including the deck, if the deck forms the top of the tank), a coaming or curb rising at least one-half inch above the top of the tank must be provided and the manhole cover must extend to the outer edge of the curb or flange. The cover must have an intact gasket and a device for securing it in place. Normally, manholes not exposed to the weather decks are fitted with the flush-type manhole cover or the raised, bolted-plate cover. The latter is preferable for potable water tanks.

6-14. Measurement of Water Level

a. There are several methods for measurement of water volume in tanks including automatic level gauges, petcocks, and sounding tubes. Many ships have more than one system. On those ships with sounding rods, when not in actual use, the rod should remain in the sounding tube at all times. On those ships using steel tapes, the tapes must be sanitized prior to each use, stored in a sanitary manner, and used only for potable water measurements in accordance with Article 6-23.

b. Soaking the entire tape apparatus in a solution of 100-ppm FAC (free available chlorine) solution for 2 minutes may be used to sanitize potable water sounding tapes. Another method, which can be used, involves wiping the tape with clean gauze soaked in an approved disinfectant solution such as food service contact surface disinfectant in accordance with Article 6-23, such as iodine (Wescodyne) disinfectant or alcohol swab.

6-15. Filling Lines

a. Potable water lines/piping must never be cross connected to any non-potable piping or system. Where a common line is used to load and distribute potable water to non-potable tanks, the delivery to the non-potable tanks must be through an air gap or approved and appropriate backflow prevention device. Filling lines that have common piping arrangement for directing potable water from an approved source to non-potable water systems by means of valves or interchangeable pipe fittings are not acceptable.

b. Filling connections (hose valves) must be clearly labeled and color-coded in accordance with NSTM Chapter 505. They will be secured with screw caps attached with keeper chains in accordance with Article 6-8.

c. Filling connection hose valves must have the potable water receiving connection at least 18 inches above the deck and turned down to protect it from contamination following Article 6-8.

6-16. Potable Water Piping

a. Special attention must be given to potable water piping located in the bilge area, particularly the piping on the suction side of the potable water pumps where leakage could result in contamination. This piping should be hydrostatically tested in accordance with the preventive maintenance system, and kept in sound material condition.

b. Shipboard design specifications stipulate potable water piping through non-potable tanks and piping non-potable liquid through potable water tanks must have the pipe surrounded by sloped self-draining pipe tunnel.

c. Ensure adequate air gap or approved backflow prevention device is provided between the potable water outlet and a non-potable water system, fixture, or machine. Article 6-42 provides more information on cross connection control.

d. All potable water pumps should be air-tight and free from cross connections. Non-potable water should never be used for priming pumps or maintaining packing gland seals. Pumps that have been dismantled for repair must be disinfected after reassembly prior to being returned to service.

e. To avoid scald injuries, the temperature setting for the hot water heaters serving habitability space showers and lavatories must be set not to exceed 120°F at the water tap. Hot water heaters serving other areas such as the galley (Gaylord Hoods), laundry, etc., are set at appropriately higher temperatures.

f. Point of use potable water treatment devices such as charcoal impregnated or other filter equipment use are generally not recommended. Only NSF certified point of use devices shall be used. These devices remove required trace halogen residual from the potable water and defeat the purpose of residual halogen protection. In addition, charcoal filtration devices can promote bacterial growth, especially when not used on a daily basis or when not changed at proper intervals. Point of use water treatment devices shall be used and maintained in accordance with the manufacturer's directions.

6-17. Repairs

a. In the event of a break or compromise in the potable water system, or a potable water tank is entered for any reason, all involved tanks, parts, and lines must be cleaned, flushed, and disinfected prior to returning the system to use. The MDR must be notified of the break or entry and the disinfection procedure accomplished by the engineering department.

b. For potable water piping repairs including flanged joints, only sealants and lubricants certified to NSF/ANSI Standard 61 shall be used. Confirmation concerning authorized sealants and lubricants may be obtained by contacting NAVSEASYSCOM.

6-18. Potable Water Tank Coatings

a. Only potable water tank coatings that are listed within NSTM Chapter 631 and NSF/ANSI Standard 61 are approved for use. Taste and odor problems with water quality are often associated with improper application and curing procedures. Paint thickness, the touch-up material, ventilation, temperature, humidity, curing time, etc., are important application factors that can contribute to taste and odor complaints. Taste and odor are further discussed in Section VIII.

b. The shipyard or contractor may wish to complete potable water taste/odor testing, after construction or repair of potable water tanks. Water taste complaints are not uncommon from ships which have undergone recent potable water tank painting.

6-19. Labeling and Color-Coding

a. Potable water sounding tubes will be clearly labeled with an identification plate. The sounding tube cap will be color-coded dark blue. On ships using steel tapes for sounding potable water tanks, the tape handle must be color-coded dark blue, labeled, or otherwise identified “POTABLE WATER USE ONLY."

b. Valves for receiving or supplying potable water must be conspicuously designated by a warning plate bearing the inscription “POTABLE WATER ONLY" in ¼ inch high letters.

c. Potable water hoses must be labeled “POTABLE WATER ONLY" with 1-inch high letters approximately every 10 feet and the end couplings painted dark blue in accordance with NSTM Chapter 505.

d. Potable water piping passing through any given space must be appropriately labeled to indicate the type of service and with an arrow indicating the direction of the flow.

6-20. Potable Water Hose Storage Lockers. Potable water hose storage lockers must be identified and labeled "POTABLE WATER HOSE." When not in use, potable water hoses must be coupled or capped and stored in designated lockers. The lockers must be vermin proof, locked, and be elevated at least 18 inches off the deck when located on weather decks and sponsons. Printed instructions outlining step-by-step methods for disinfection of potable water hoses and risers must be posted in a conspicuous location inside the hose storage locker in accordance with Article 6-55, Sample Water Sanitation Bill.

SECTION IV. DISINFECTION

6-21. Disinfection of Potable Water Supplies

a. **General**

(1) Disinfection of water is required to ensure the destruction of pathogenic organisms. Maintenance of a halogen residual is the usual method of guarding against contamination or accidents that may occur during the production, handling, storage, and distribution of potable water. The absence of a Free Available Chlorine (FAC) or total bromine residual (TBR) in the ship's potable water may indicate contamination. The presence of a halogen residual provides a safety factor but does not correct unsanitary practices or conditions. FAC residual concentrations as high as 1.0 ppm at the tap usually do not cause objection-able tastes and odors, but where certain organic substances are present, very small concentrations of combined chlorine or bromine can produce undesirable tastes or odors. These undesirable tastes and odors do not affect the safety (potability) of water but may impact palatability (taste) of water, thus discourage water consumption. While the National Primary Drinking Water Standards are not applicable for shipboard potable water systems, EPA has established a maximum contaminant level (MCL) for all disinfectants at 4 ppm.

(2) All water has some halogen demand which is the amount of chlorine or bromine used through reaction with substances present in the water. Shipboard water is disinfected by the addition of sufficient chlorine or bromine to produce not less than 0.2 ppm FAC or TBR after 30 minutes contact time measured at the potable water tank. The amount of chlorine or bromine required to produce a FAC or TBR of not less than 0.2 ppm after 30 minutes can vary widely because of halogen demand, water temperature, and other factors. Again, these chemical reactions may impact water palatability.

(3) **Halogen types.** Chlorine and bromine are approved methods for disinfecting shipboard potable water. Mechanical methods of treatment are preferable to chlorine batch treatment procedures. Batch chlorination procedures are less reliable, require greater time and effort, and are generally less effective. Many municipal water sources use chloramine for disinfection which needs to be considered when doing halogen testing pier side. Chlorine or bromine can be added to chloramine treated municipal water.

(a) **Chlorine**

1. Chlorine is available for shipboard use as calcium hypochlorite (HTH 65-70% available chlorine), 6-ounce bottle, a granular solid or sodium hypochlorite in varying strengths, as a liquid. Common household bleach (unscented) is a 5.25% solution of sodium hypochlorite. HTH is most frequently used because of its relatively long shelf life and reduced storage space requirements. However, it should be noted that HTH presents a potential personnel and fire hazard due to its corrosiveness and chemically active nature. This material is classified as hazardous and requires special storage precautions and shall be handled and stowed in accordance with NSTM, Chapter 670.

Contact between HTH and oxidizable material may result in spontaneous combustion (fire). HTH should be obtained in 6-ounce containers and stored in a cool, dry, well-ventilated place where there is no danger of contact with oxidizable materials. Calcium or sodium hypochlorite will lose strength gradually with age and more rapidly when opened or stored in hot spaces or sunlight.

2. The ready use stock of 6-ounce HTH bottles issued to the engineering department must be stowed in a locked box mounted on a bulkhead, preferably in the department office space. Under no circumstances is the box to be installed in a machinery space, flammable liquids storeroom, paint locker, berthing space, storeroom, or in the oil and water test laboratory areas. A metal box, such as a first aid locker, is recommended for this purpose. Vent holes (such as three 1/4 inch holes) shall be drilled in the bottom of the box to allow release of any chlorine products. No more than a 7-day supply shall be maintained in ready use stock at any time.

3. Storeroom stocks of HTH must be stowed in labeled, ventilated lockers or bins. The lockers or bins must be located in an area where the maximum temperature will not exceed 100°F (37.8°C) under normal operating conditions and is not subject to condensation or water accumulation. The area must not be adjacent to a magazine and the lockers or bins must be located at least 5 feet from any heat source or surface, which may exceed 140°F (60°C). They must not be located in an area used for stowage of paints, oils, grease, or other combustible organic materials. No more than forty-eight 6-ounce bottles shall be stowed in any individual locker or bin. Issue will be made only to personnel designated by the MDR or engineering officer.

4. All lockers, bins, and enclosures containing HTH must be labeled with red letters on a white background, (HAZARDOUS MATERIAL, CALCIUM HYPOCHLORITE).

5. Electrolytic disinfectant generator (EDG) uses brine electrolysis chemical process to produce a sodium hypochlorite solution (FAC) for injection. Chemical additives, including salt shall be certified to NSF/ANSI Standard 60.

(b) **Bromine.** Bromine is provided by a bromine impregnated resin cartridge, which is classified as slightly corrosive and requires proper handling and storage procedures. Bromine cartridges must be stored in a clean, dry, ventilated storeroom. Bromine storage lockers require a hazardous warning plate described, in NSTM Chapter 533, Figure 6. Bromine cartridges have a shelf life of 2 years from the date of manufacture. Cartridges exceeding the shelf life can still be used, but chemical disinfection efficiency may be reduced.

b. **Mechanical Methods of Disinfection**

(1) **Naval vessels use several types of chlorinator installations.** Chlorinators may be installed in the distilling plant, distillate line, and the shore fill line. The chlorinator may also serve both the distillate line and the shore fill line.

(a) The distillate line is generally provided with an electric, motor-driven chlorinator. These chlorinators will have controls, which energize the chlorinator in conjunction with the distillate pump motor and water flow past the chlorinator.

(b) The shore fill line is generally provided with a hydraulically actuated chlorinator or an electrical motor driven chlorinator. The hydraulically actuated unit injects hypochlorite solution into the water system in proportion to the flow of water through a meter.

(c) The distillate line and the fill line may be served by a fill line chlorinator unit if the distilling plant is large enough to permit sufficient flow through the unit. This type of installation is generally provided with a hydraulically actuated or an electric motor-driven chlorinator.

(2) **Bromine treatment installations use two types of brominators.** One type is used on the discharge line and the other is used to recirculate water in the potable water tanks during treatment.

(a) The in-line (proportioning) brominator is used when the desalination unit is online and making water. Multiple vendors manufacture these devices. Dependent on design, the unit is either provided with a set of orifices that gauges a predetermine proportion of flow through a bromine cartridge or via a throttle valve design which controls flow. In line brominator units contain an orifice preset to deliver 0.7 ppm bromine to the water during normal operating procedures and an orifice to deliver 2.0 ppm bromine to the water when an increase in total bromine is required as detailed in Article 6-21a(3)(b). The throttle valve design also allows for adjustment of bromine feed. Bromine is washed from the cartridge into the bypassed water stream. One in-line brominator is required for each water plant.

(b) The recirculation brominator unit is designed to boost bromine residual for water in a potable water tank. Treatment is accomplished by the recirculation of potable water from a potable water tank through the brominator and back to the same tank. This treatment offers diversity in recirculation and bromination of water received from external water sources as well as providing capability to boost bromine levels from ship produced water when necessary. As the water in a selected tank is recirculated, a portion of the recirculated water is automatically proportioned to flow through the bromine cartridge. A timing device to achieve the required bromine feed into the selected tank limits flow through the cartridge. After a pre-calculated period of time, the timing device terminates the bromine feed into the water. Recirculation of water continues for an additional pre-calculated time period to complete an even dispersion of bromine through the tank. These time period calculations are based on individual tank volume and temperature of the water. This recirculation unit is also preset to deliver 0.7 ppm bromine to the water being recirculated. A sampling tap is present to test the bromine residual after recirculation; if the desired level of bromine has not been achieved through the initial recirculation process, the timer may be reset and the water recirculated until the desired level of TBR is achieved; however, efforts to achieve bromine levels at the 2.0 or higher ppm level may not be practical due to the length of time required. It may be more convenient to use batch chlorination procedures to rapidly raise the levels of chlorine in the water supply, particularly in the event of contamination or necessity to achieve higher chlorine levels.

(3) **The batch chlorination method of disinfection may be used if mechanical methods for treatment are not available.** However, this is considered the least desirable method of disinfecting a potable water tank because it may result in over-chlorination due to the inability to properly mix the water and hypochlorite solution. The proper dosage of chemical must be determined for the volume of water to be disinfected. Article 6-25 provides guidance for determining the chlorine dosage. When 65-70% strength HTH is used, the calculated amount is dissolved in a non-glass container of warm water (80°F to 100°F) and the suspended matter is allowed to settle out. Only the clear fluid (supernatant) is introduced into the sounding tube when the tank is about 1/4 full, add 1 gallon of potable water to flush the sounding tube. Under no circumstances should chlorination be attempted by adding the solution to the brominator cartridge container. The remaining sediment is discarded as waste. Sufficient mixing of chlorine and water usually will be obtained by the stirring action of the incoming water as the tank is being filled. The motion of the ship will make a small contribution to mixing, and additional mixing may

be obtained by recirculation. If the chlorine solution must be introduced into a full tank, recirculation through a pump is the only way to achieve adequate mixing. If pumps are used which are not an integral part of the potable water system, they must be disinfected as described in Article 6-22. Thirty minutes or more after the tank is filled or mixing is completed; the water should be sampled and tested for a FAC residual. If there are no sampling petcocks on the tank, a potable water outlet in the distribution system nearest the tank may be used for sampling purposes. If the FAC residual is less than required, additional chlorine must be added and mixed into the water, after the required contact time, the FAC residual must be determined again. A convenient figure to remember is that 1-ounce of full strength HTH added to 5,000 gallons of water is the approximate dose for 1.0 ppm initial chlorine concentration. (Note: The amount of active chlorine in 65-70% HTH is reduced rapidly by exposure to air; therefore, all the contents should be used as soon as possible after opening the container.) This rule of "thumb" (1-ounce per 5,000 gallons) becomes a tool in calculating dosages for “batch chlorination” and is suggested as a starting point only; the required amount will depend on temperature, pH, and the chlorine demand of the water. In no instance should the manhole cover be removed to batch chlorinate a tank. Sounding tubes, air vents, or other methods should be used to introduce the chlorine into the tank.

(4) Chlorination or bromination procedures are not adequate until the required FAC/TBR is obtained after the allotted contact time at the potable water tanks. Required halogen residuals are listed in Article 6-26.

(5) Ships with bromine systems may add bromine to water that has been previously chlorinated without any harmful effect.

c. **Halogen Requirements**

(1) Halogen residual of 0.2 ppm throughout the distribution system should be maintained. However, due to halogen demand and other factors it is recognized that this requirement is sometimes not achievable in certain sections of the ship, such as the highest 0-levels on large platform ships, where constant usage/flow of potable water is reduced. In the absence of bacteriological contaminants, this lack of measurable (trace) residual in the less used outlets should not be a matter of concern, but requires close bacteriological monitoring.

(2) Water without a halogen residual received from approved sources or water produced on board must be chlorinated or brominated to provide at least 0.2 ppm halogen residual (FAC/TBR) at the end of a 30-minute contact time (CT) in the potable water tanks.

(3) Chloramines in lieu of chlorine are used in many municipal public water systems to reduce disinfection by-products. To determine disinfectant residual for systems which use chloramines measure the total chlorine residual in lieu of FAC. At least 2.0 ppm total chlorine residual should be present in the municipal water source at the pier riser.

(4) Water received from an unapproved source, a source of doubtful quality, or an area where amebiasis or infectious hepatitis is endemic, must be chlorinated or brominated to provide at least a 2.0 ppm halogen residual (FAC/TBR) at the potable water tanks at the end of a 30-minute contact time. In these instances, if the ship's brominator cannot achieve a TBR of 2.0 ppm, the water must be chlorinated by the “batch method” to obtain not less than 2.0 ppm FAC at the potable water tank after 30-minute contact time. After 2.0 ppm halogen is maintained for 30 minutes in the potable water tank, the water is considered safe for use.

6-22. Disinfection of Potable Water Tanks and Systems

a. Mechanical cleaning of tanks includes all measures necessary to clean tanks of foreign materials, rust, and other substances that are present within the tanks.

b. There are two types of disinfection procedures:

(1) Mechanical cleaning with chemical disinfection.

(2) Chemical disinfection.

c. Mechanical cleaning and chemical disinfection will be accomplished when the condition of a tank has deteriorated to the point where the chlorine demand has increased significantly and bacteriological test results indicate the tank water quality is unacceptable. After any tank has been mechanically cleaned, it will be chemically disinfected in accordance with Table 6-2. Mechanical cleaning and chemical disinfection must be accomplished under the following conditions:

(1) Tanks of new ships or tanks which have been repaired.

(2) Where sludge or rust accumulation seriously impairs the quality of water.

(3) Tanks that have been loaded with non-potable, ballast water.

d. Chemical disinfection is required when the following conditions exist:

(1) Tanks in which there is continued bacteriological evidence of contamination after normal disinfecting procedures.

(2) Pipelines, valves, pump, etc., that have been dismantled, repaired, or replaced.

(3) Tanks which have been entered.

**Table 6-2. Methods for Disinfection of Potable Water Tanks*
(Reference: ANSI/AWWA** Standard C652-02)**

METHOD 1	METHOD 2	METHOD 3
Fill tank to over flow level	Spray/apply directly 200 ppm FAC to all tank surfaces	Fill 5% of tank volume with 50 ppm FAC solution
Add chlorine to achieve 10 ppm FAC throughout the tank	Flush inlet/outlet pipes with 10 ppm FAC	Hold solution for 6 hours
Hold this solution for 24 hours	Disinfected surfaces shall remain in contact with chlorine solution for a minimum of 30 minutes	Add potable water to chlorine solution to fill tank; hold this water for 24 hours
Drain tank	Refill tank with potable water with required halogen residual level	Drain tank
Refill tank with potable water with required halogen residual level		Refill tank with potable water with required halogen residual level
Perform bacteriological testing of potable water		
Upon satisfactory bacteriological testing and asthetic quality water may be delivered to the system		

* Table reads from top to bottom, not left to right.

** American Water Works Association (AWWA).

e. Highly chlorinated water discharges shall comply with Federal, State, local, or host nation environmental regulations. Special provisions or permits may be required prior to discharge of highly chlorinated water. Local authorities shall be contacted prior to disposal of highly chlorinated water. American Water Works Association Standard ANSI/AWWA C652-02, Appendix B provides guidance for neutralizing highly chlorinated water.

6-23. Disinfection of Potable Water Hoses, Tapes, and Rods

a. Potable water hoses are disinfected by filling with a solution containing 100 ppm FAC. The solution must be in contact with the entire hose interior for 2 minutes. Flush the hose for a minimum of 30 seconds with potable water prior to use.

b. Prior to connecting the potable water to either the ship riser or the shore source, the interior of the fittings shall be disinfected by not less than 2 minutes contact with a solution of 100 ppm FAC. The shore water source should be flushed to waste 30 seconds prior to hookup of the water hose.

c. Disinfection of sounding tapes or rods may be accomplished by wiping the rod or tape with a 100 ppm FAC solution or other suitable disinfectant compatible with potable water, (for example, food contact surface disinfectant such as liquid iodine, or isopropyl alcohol soaked gauze).

6-24. Emergency Disinfection of Water for Drinking and Cooking Purposes. If an approved potable water source is not available it may be necessary to treat an unapproved water source for drinking and cooking purposes in an emergency situation. The water to be treated should be as clear as possible. Before human consumption, this water shall be chlorinated initially to at least 5.0 ppm FAC with a minimum 30 minute contact time. Water at the point of consumption shall have a final residual of at least 2.0 ppm FAC. Water can also be made safe by holding at a rolling boil for 2 minutes. Water taste complaints may be anticipated with chlorine residuals above 1.0 ppm FAC but higher levels of FAC needed to ensure water is safe to drink. If the water is excessively contaminated or turbid, consideration should be given to the use of canned, bottled, or other emergency drinking water sources.

6-25. Chlorine Dosage Calculator

a. **Theory of operation**

(1) Tables 6-3, 6-4, and 6-5 provide chlorine dosage rate information. The quality of water, e.g., the organic and inorganic materials present, will affect the final chlorine residual. The amount of chlorine required to react with and be absorbed by these materials is called the "chlorine demand." The chlorine absorbed or neutralized has no disinfectant value, so it is necessary to add enough chlorine (adequate dosage rate) to satisfy the "chlorine demand" and still provide FAC. The FAC is the active disinfecting agent and is the chlorine reading determined with the colorimetric test kit. Table 6-6 provides required halogens residuals.

(2) As a rough calculation, a dosage rate of 1-ounce of HTH (65-70%) mixed with 5,000 gallons of water yields 1.0 ppm FAC. Because of chlorine demand, this dosage rate will probably produce a FAC residual of about 0.2 ppm after a 30-minute contact time.

b. **Instructions for use**

(1) Select desired parts per million. Determine strength of chemical to be used. Compute number of gallons to be chlorinated. Read across to obtain quantity of material to be used.

(2) The 5% and 10% listings are liquid sodium hypochlorite (unscented); thus, the measurements are expressed as volume. (Table 6-4 and Table 6-5 respectively.)

(3) The 65-70% listings are granular calcium hypochlorite; thus, the measurements are expressed as weight. (Table 6-6).

c. The standard 2 ½ inch water hose has a volume of 0.25 gallons per foot of hose. This figure may be used in determining the volume of a hose for disinfecting purposes. Volumes for other size hoses may be found in the NAVMED P-5010-5, Water Supply Ashore.

Table 6-3. Chlorine Dosage Calculator for 5% Liquid Sodium Hypochlorite (Unscented)

Tsp = teaspoon Tbsp = tablespoon 3 Tsp = 1 Tbsp 2 Tbsp = 1 Oz Qt = quart Gal = Gallon

QUANTITY (GAL.)	PPM 1	PPM 5	PPM 25	PPM 50	PPM 100	PPM 200
50,000	1 Gal.	5 Gal.	25 Gal.	50 Gal.	100 Gal.	200 Gal.
25,000	2 Qt.	10 Qt.	50 Qt.	25 Gal.	50 Gal.	100 Gal.
10,000	26 Oz.	1 Gal.	5 Gal.	10 Gal.	20 Gal.	40 Gal.
5,000	13 Oz.	2 Qt.	10 Qt.	5 Gal.	10 Gal.	20 Gal.
2,000	6 Oz.	26 Oz.	1 Gal.	2 Gal.	4 Gal.	8 Gal.
1,000	3 Oz.	13 Oz.	2 Qt.	1 Gal.	2 Gal.	4 Gal.
500	2 Oz.	7 Oz.	1 Qt.	2 Qt.	1 Gal.	2 Gal.
200	1 Tbsp.	3 Oz.	13 Oz.	26 Oz.	52 Oz.	103 Oz.
100	2 Tsp.	2 Oz.	7 Oz.	13 Oz.	26 Oz.	52 Oz.
50	1 Tsp.	1 Oz.	4 Oz.	7 Oz.	13 Oz.	26 Oz.
25		1 Tbsp.	2 Oz.	4 Oz.	7 Oz.	13 Oz.
10			1 Oz.	3 Tsp.	3 Oz.	6 Oz.
5			1 Tsp.	5 Tsp.	2 Oz.	3 Oz.

Table 6-4. Chlorine Dosage Calculator for 10% Liquid Sodium Hypochlorite (Unscented)

QUANTITY (GAL.)	PPM 1	PPM 5	PPM 25	PPM 50	PPM 100	PPM 200
50,000	2 Qt.	10 Qt.	50 Qt.	25 Gal.	50 Gal.	100 Gal.
25,000	1 Qt.	5 Qt.	25 Qt.	50 Qt.	25 Gal.	50 Gal.
10,000	13 Oz.	2 Qt.	10 Qt.	5 Gal.	10 Gal.	20 Gal.
5,000	7 Oz.	1 Qt.	5 Qt.	10 Qt.	5 Gal.	10 Gal.
2,000	3 Oz.	13 Oz.	2 Qt.	1 Gal.	2 Gal.	4 Gal.
1,000	1.5 Oz.	7 Oz.	1 Qt.	2 Qt.	1 Gal.	2 Gal.
500	1 Oz.	4 Oz.	1 pt.	1 Qt.	2 Qt.	1 Gal.
200	2 Tsp.	2 Oz.	7 Oz.	13 Oz.	26 Oz.	55 Oz.
100	1 Tsp.	1 Oz.	4 Oz.	7 Oz.	13 Oz.	26 Oz.
50		0.5 Oz.	2 Oz.	4 Oz.	7 Oz.	13 Oz.
25		2 Tsp.	1 Oz.	2 Oz.	4 Oz.	7 Oz.
10		1 Tsp.			2 Oz.	3 Oz.
5					1 Oz.	2 Oz.

Table 6-5. Chlorine Dosage Calculator for 65-70% Powder Calcium Hypochlorite

Weight: 16 Oz. = 1 lb.

QUANTITY (GAL.)	PPM 1	PPM 5	PPM 25	PPM 50	PPM 100	PPM 200
50,000	10 Oz.	3 lb.	15 lb.	30 lb.	59 lb. 9 Oz.	119 lb. 4 Oz.
25,000	5 Oz.	24 Oz.	7.5 lb.	15 lb.	29 lb.12 Oz.	59.5 lb.
10,000	2 Oz.	10 Oz.	3 lb.	6 lb.	12 lb.	23 lb. 13Oz.
5,000	1 Oz.	5 Oz.	1.5 lb.	3 lb.	6 lb.	11 lb. 15 Oz.
2,000		2 Oz.	10 Oz.	19 Oz.	2 lb. 7 Oz.	4 lb.13 Oz.
1,000		1 Oz.	5 Oz.	10 Oz.	20 Oz.	2 lb. 7 Oz.
500			3 Oz.	5 Oz.	10 Oz.	19 Oz.
200			1 Oz.	2 Oz.	4 Oz.	8 Oz.
100				1 Oz.	2 Oz.	4 Oz.
50					1 Oz.	2 Oz.
25						1 Oz.

6-26. Required Halogen Residuals

Table 6-6. Required Halogen Residuals

Treatment Required	Chlorination Dosage And Contact Time Requirements (FAC)	Bromination Dosage Requirements (TBR)
Water in potable water distribution system	0.2 ppm Note: trace allowed in far ends of distribution (pipng) system for large water distribution systems such as found in an aircraft carrier.	0.2 ppm Note: trace allowed in far ends of distribution (piping) system for large distribution systems such as found in an aircraft carrier.
Water from unapproved source (emergency-use)	2.0 ppm at point of consumption	Not applicable
Disinfecting tanks and system	See Table 6-3	Not applicable
Disinfecting hoses, couplings, and water connections prior to connection to potable water system.	100 ppm with 2 min. contact time	Not applicable

SECTION V. POTABLE WATER, SUBMARINE/YARD CRAFT

6-27. Submarines

a. Submarines are generally exempted from routinely halogenating potable water. However, some submarines have been retrofitted with an in-line brominator unit. If bacteriological testing indicates positive coliform bacteria then the potable water supply shall be treated with either calcium hypochlorite (65-70%) or bromine until a residual of 0.2 ppm FAC or TBR as applicable is obtained with a minimum 30 minutes contact time. Halogen residual must be maintained until repeat bacteriological testing indicates water is safe. When using calcium hypochlorite (HTH), the submarine atmosphere must be monitored for chlorine gas. If the gas exceeds safe limits, the emergency procedures described in the Atmospheric Control Manual must be followed.

b. Cleaning and disinfecting tanks are outlined in Article 6-22.

c. In accordance with COMSUBLANT/ COMSUBPAC 6000.2 series, the following minimum storage quantity of HTH will be carried on board submarines of the Force:

(1) SSN - 9 six oz. bottles.

(2) SSBN – 12 six oz. bottles.

d. The individual bottles of HTH must be sealed in plastic bags and stored only in a medical instrument box, plastic rigid, size 9½ x 9 x 7 inches, NSN 6545-00131-6992. The case must be painted white and labeled: "HAZARDOUS MATERIAL, CALCIUM HYPOCHLORITE" in red letters. The case must be vented at the bottom and be stored in any area away from engineering spaces.

e. Each bottle of HTH shall be inspected prior to deployment or at least every 3 months. Bottles with deteriorated seals must be discarded and replaced.

f. Bacteriological examination of potable water shall be performed weekly on a minimum of four samples representative of the distribution system. Any EPA approved method for bacteriological testing may be used. Either Colilert® or Colisure ® Tests are generally used for simplicity considerations. The results of all testing will be reported as "presence" or "absence."

(1) Submarines alongside a tender may establish a schedule for weekly testing of potable water samples by the tender while in port. But in all cases, weekly testing will be accomplished while at sea or in port.

(2) Daily halogen residuals will be performed and recorded while in port using a shore water supply.

(3) The MDR shall maintain a potable water log including water source, date, bacteriological testing, any disinfection procedure used, and halogen readings.

g. Color-coding, labeling, disinfection, and storage of potable water hoses are covered under Section III, Articles 6-19 and 6-20 and Section IV, Article 6-21 of this chapter.

6-28. Yard Craft

a. Yard craft has been defined to include barges, tugs, and other vessels capable of independent movement within the harbor, but not routine ocean-going travel. These vessels usually have no water producing capability; potable

water is transferred from a shore facility. Most yard craft are equipped with a potable water storage tank and a limited distribution system. Disinfection of the water is not necessary when water is transferred from an approved potable water source. Most problems associated with contamination of water aboard yard craft are usually the result of improper transfer procedures.

b. Daily testing for halogen residual is not usually performed due to the lack of personnel and equipment. The MDR shall maintain close contact with the port services officer (PSO) and will provide surveillance procedures to ensure a safe water supply.

c. The PSO and the local MDR shall develop and implement a system for collection and examination of water samples for each group of yard craft. Water samples for bacteriological analysis must be collected from each craft water tank and distribution system on a weekly basis. In the event of bacteriological contamination of the water supply, the MDR shall investigate the source of contamination and provide recommendations regarding correction and disinfection. It may be necessary for the MDR to supervise disinfection operations.

SECTION VI. CARGO WATER

6-29. Emergency Use of Potable Water Tanks for Ballast

a. Potable water tanks and pipelines which will be filled with any non-potable liquid for ballast or other emergency purposes must be disconnected and sealed off at the tanks. It shall not be reconnected until the contaminated tank, piping, and fittings have been properly cleaned and disinfected.

b. Water placed in these tanks must not be used for drinking or cooking purposes until it has been adequately cleaned/disinfected and a bacteriological analysis confirms water is safe for human consumption. If bacteriological tests are positive, the disinfection process must be repeated until such time as bacteriological analysis is negative prior to the system being placed in service. Chemical testing of water may be also necessary to ensure water is safe for human consumption if there is concern for chemical contamination.

6-30. Handling of Cargo Water

a. **Water Ships, Barges, and Yard Craft**

(1) Water must be taken from approved watering sources as specified in Article 6-6.

(2) The water must be transferred in a manner that prevents contamination in accordance with Article 6-9.

(3) Vessels transporting potable water must maintain records of the following:

(a) Source of water (indicate whether or not from an approved source).

(b) Daily halogen residual.

(c) Results of bacteriologic testing.

(d) Above information shall be provided to the receiving ship prior to transfer.

(4) Water vessels shall deliver potable water to receiving ships with a halogen residual of at least 0.2 ppm when the source is an approved watering point. If the halogen residual is below 0.2 ppm, sufficient chlorine or bromine shall be added to by the receiving ship to boost halogen residual to 0.2 ppm with a 30-minute contact time at the potable water tank.

(5) Water received from an unapproved source must be halogenated to provide at least 2.0 ppm residual with a 30-minute contact time at the potable water tank.

b. **Receipt of Cargo or Transferred Water**

(1) The MDR of the receiving ship shall test the halogen residual of water to ensure minimum halogen residual of 0.2 ppm is present.

(2) If the water does not contain a halogen residual of at least 0.2 ppm, it will be necessary for the engineering department to treat the water in the receiving tanks prior to piping to the distribution system.

(3) If the water is from an unapproved or questionable source, the MDR shall conduct bacteriological testing of the water prior to and after adequate disinfection to 2.0 ppm in the distribution system to ensure bacteriological quality.

(4) The MDR shall ensure that appropriate entries are documented in the potable water log regarding source, halogen residual, bacteriological testing, and recommendations.

6-31. Temporary Water Tanks. In emergency situations to convert tanks commonly used for other liquids for transporting potable water, the following considerations should be taken into account for temporary storage and transfer of potable water:

a. **Tank Selections and Preparation**

(1) Paint coating of tanks for transport shall be listed with NSF/ANSI Standard 61 for potable water tanks and NSTM, Chapter 631.

(2) When the tanks are cleaned and all surfaces are viewable, they must be inspected by designated engineering personnel. The following conditions should be considered:

(a) Well-adhered coating.

(b) Total dry-film thickness.

(c) Excessive rust.

(d) Completeness of coatings.

(e) Blistering and peeling.

(f) Water-tight integrity, especially inner-bottom tanks.

(g) Any other potable water degrading conditions.

(3) Following the results of the inspection of all tanks, the appropriate Type Commander should decide on the approval or disapproval of these tanks for transporting and storage of potable water. If final approval is granted, necessary repairs, maintenance, and cleaning identified during the inspection should be instituted. A thorough cleaning of all tank surfaces, piping, pumps, etc., will be necessary using the following guidelines:

(a) Using high-pressure spray, clean all tank surfaces with potable water. When cleaning chemicals are used, they shall be listed in NSF/ANSI Standard 60 as approved additives.

(b) Remove all scaling and rust.

(c) Pumps shall be dismantled and cleaned with potable water and approved additive. Remove and replace all gaskets. The replacement gaskets shall be of material approved for use with potable water system NSF/ANSI Standard 61.

(d) All lines shall be flushed with potable water and approved additive as referenced above.

(e) Obtain a diagram of the pumping and distribution system, and complete the following procedures:

1. Identify all parts of the system to be used for potable water handling, and color code for identification. The color code for potable water systems is dark blue, as outlined in NSTM, Chapter 505, Piping Systems.

2. Using blank flanges or caps, blank off all piping, which is not to be used for potable water transfer. Separation by valve closure is not considered adequate safeguard against cross connections.

3. Identify water collection points on each tank for testing purposes. Identify chlorine introduction points for each tank.

(f) Complete tank cleaning and repair.

(g) A final inspection should be conducted to assure that all repairs and cleaning have been adequately accomplished.

(h) Disinfect tanks and related piping in accordance with Article 6-22. Force ventilate the tanks for 8 hours to air dry.

(i) Vents to all potable water tanks must be screened with 18-mesh or finer non-corrosive wire and must not terminate in spaces where contamination may be transmitted to the water.

b. **Transfer of Water for Use**

(1) Water transferred from the ship for human consumption will contain 2.0 ppm FAC.

(2) Water transferred from the ship for human consumption will be absent of total and fecal coliform bacteria. A bacteriological analysis must be conducted no later than 1-week prior to transfer.

(3) Properly trained shipboard personnel shall monitor the procedures used for transfer of potable water from the ship. Hoses previously used for fuel or other liquids shall not be used for the transfer of potable water. Only hoses approved for contact with potable water shall be used for transferring potable water.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION VII. EMERGENCY WATER SUPPLIES

6-32. Battle Dressing Stations

a. Ships are equipped with built-in potable water storage tanks in battle dressing stations to provide an emergency potable water source. The tanks are designed for gravity flow and are isolated from the main potable water system. A piping diagram shall be provided for each tank with appropriate instructions for filling and emptying.

b. Follow all Maintenance Requirement Card (MRC) procedures. Once a quarter all emergency potable water storage tanks must be drained and refilled with potable water containing a minimum trace halogen residual.

6-33. Emergency Potable Water, 5-Gallon Containers

a. Some small ships store emergency potable water supplies in 5-gallon potable water approved containers due to the lack of an emergency tank in the battle dressing stations. These containers may be filled with water produced on board or from approved shore facilities. This storage is acceptable provided the containers have been properly cleaned and disinfected prior to filling.

b. Only approved 5-gallon potable water containers shall be used for the storage of potable water. Under no circumstances will 5-gallon containers previously used for gasoline or other petroleum products be used as emergency potable water containers aboard ship.

c. Examination of water containers prior to disinfection and filling.

(1) The initial step consists of careful examination of the containers to ensure the containers have not been used for any purpose other than the storage of potable water. Each container shall have the word “POTABLE WATER” either embossed or painted on the exterior surface in letters at least 1-inch high.

(2) Each container will then be physically inspected for the following conditions:

(a) Evidence of rust or corrosion, either interior or exterior.

(b) Evidence of open seams or breaks in the surface.

(c) Interior coating of metal container not uniform, cracked, pitted, or peeled away.

(d) Any evidence of dirt, grit, organic matter, or other substance embedded in the interior surface of the container.

(e) Carefully inspect the cap to ensure that it seats properly.

(f) Inspect the gasket to ensure that it is properly fitted and not deteriorated. If deterioration of the gasket is evident, it must be replaced prior to use.

(g) Inspect the locking lever to ensure that it works properly by engaging the seat or lock ring cam lugs.

(h) Inspect the carrying handles to ensure that they are properly attached and in good repair.

d. Manual washing is accomplished with warm water (110-125° F), the recommended amount of approved food service dishwashing detergent, and a suitable long-handled, slender brush. (General-purpose detergent shall not be used to clean emergency water containers because it may cause adverse health effects.) Thorough rinsing with potable water is necessary after cleaning.

e. All interior surfaces shall be disinfected by exposure to a chemical disinfectant solution for at least 2 minutes. Approved chemical disinfectants for these containers include: calcium and sodium hypochlorite. Refer to Article 6-25 for guidance in chlorine dosage calculation.

f. Potable water used for filling emergency containers must contain a trace FAC or TBR (preferably 0.2 ppm or greater).

g. Each can shall be labeled with date of filling and source of the potable water.

h. The 5-gallon containers shall be stored in a clean dry place in the immediate vicinity of anticipated use (battle dressing station without emergency potable water tanks).

i. These containers shall be emptied, flushed, and refilled with potable water containing a trace FAC or TBR (preferably 0.2 ppm or greater) quarterly.

j. Halogen residual and bacteriological tests are not required.

6-34. Can and Bottle Drinking Water. If canned drinking water is stored for emergency use in boats, rafts, battle stations, battle dressing stations, or storerooms it must be inspected in accordance with PMS requirements. Bottle water shall be procured only from DOD approved sources.

SECTION VIII. EVALUATION OF TASTE AND ODOR PROBLEMS

6-35. General Evaluation of Taste and Odor Problems. A ship is a mobile vessel and must rely on a variety of water sources: shore, barge, other ships, etc. There is a variety of shipboard piping systems, which, if not isolated, may be a source of unsafe cross connections to the potable water system. The uniqueness of the shipboard environment, the complexity of piping systems, and multiple sources of water may individually, or in combination, be a factor in the source of taste and odor problems aboard ship. Taste and odor problems are primarily aesthetic, but are causes for concern aboard ship due to the negative effect in the morale of personnel. Most individuals are extremely sensitive to taste and odor. Aboard ship, there are no water treatment processes to easily control taste and odor problems that may develop. Water produced by the ship water plant is good quality and is the least likely source of problems.

6-36. Causes of Taste and Odor in Potable Water

a. The following conditions or situations have been identified as causes of potable water contamination resulting in severe taste and odor problems aboard ship. Taste and odors potable water problems may be related to below factors:

(1) Cross connections with non-potable systems.

(2) Leaks in common bulkheads between potable water tanks and fuel tanks, ballast tanks, bilges, and wastewater tanks.

(3) Leaks in non-potable piping through water tanks.

(4) Improper disposal of chemicals or liquids through potable water-sounding tubes.

(5) Potable water hoses used for non-potable liquids.

f. Excessive storage time of water in tanks.

g. Shipboard water production from contaminated raw water source.

h. Inadequate disinfection procedures resulting in development of chlorine by products.

i. Transfer of water from shore facilities or barges, which have taste and odor problems.

j. Potable water tanks used for non-potable water liquids.

k. Deteriorated, improperly applied (cured/ vented) tank coatings.

l. Shipboard water treatment plants producing potable water while stripping fuel tanks, pumping oily bilges overboard forward of the distilling plant feed pumps suction or when in close proximity to other ships.

6-37. Indicators of Taste and Odor Problems

a. The MDR is responsible for surveillance of the potable water system. Usually this function is accomplished through determination of chlorine or bromine residuals from representative areas of the ship on a daily basis and bacteriological testing of the potable water on a weekly schedule. This testing, as well as complaints from the crew, can be very helpful in identifying and locating the source of the taste and odor problems.

(1) **Crew Complaints.** Initial complaints from the crew can provide important data, particularly if the complaints are associated to a specific location and related to a specific time pattern. All of these factors can be compared to a particular tank in use, the disinfection processes for the tank, and the piping system associated with the tank. Each item of information is important when investigating taste and odor complaints.

(2) **Bacteriological Testing.** If the cause or source of the taste and odor problem is a result of organic growth (biofilm) in the tanks, the standard shipboard bacteriological test (Colilert®) is not useful in identifying taste and odor-causing bacteria. The bacteriological testing method performed by MDR is designed solely to identify the presence or absence of coliform bacteria, which is the indicator organism for bacteriological drinking water quality. Therefore, bacteriological testing of the ship water supply may be consistently negative, but the source of taste and odor problems could still be the result of growth of other microorganisms in the tanks and distribution system.

(3) **Halogen Residuals (FAC/TBR).** Maintenance of halogen residual is directly affected by the microbiological and chemical quality of the water. Loss of halogen residual may be an indicator of contamination or biofilm buildup in tanks or piping.

b. Chlorine or bromine, react with virtually any substance in water and through this process, may be neutralized. The use of the disinfectant in a water supply is referred to as “halogen demand.” The halogen demand in any water supply will vary with respect to the amount of interfering or neutralizing substances present, which will reduce the initial supply of chlorine or bromine added to the water. This is a complex problem, which can be summarized for medical surveillance purposes as follows: if the proper amount of chlorine or bromine has been added to the potable water tanks and no halogen residual is present or it dissipates in the distribution system, this is indicative that some substance has used or neutralized the halogen in the system. The lack of ability to maintain a halogen residual in the tanks or the potable water system indicates that the chlorine or bromine is reacting with some substance, which may be the source of the taste and odor problem. The causes of taste and odor problems are quite varied; however, a systematic approach may lead the resolution, or at least provide initial data for more experienced investigators.

6-38. Initial Evaluation of Taste and Odor Problems. The following statements and questions represent an investigative approach to taste and odor complaints. The evaluation of these items by MDR may result in identification of the source of the problem. If not, a great deal of initial evaluation has been conducted and will provide a baseline of information for personnel from Navy Environmental and Preventive Medicine Units (NAVENPVNTMEDUs) or other organizations tasked to assist.

a. When was the problem first noticed or initial complaints received? This date and time may be related to a particular tank, a section of the piping system or repairs and maintenance associated with the system.

b. What is the source of the water?

(1) Shore (direct pressure).

(2) Ship’s tanks filled with shore water.

(3) Mixture of water remaining in ship's tanks and shore water.

(4) Barged water.

(5) Another ship.

(6) Produced by ship's water plant.

c. Does the water have a characteristic taste or odor? It is sometimes possible to determine the source of a water problem through a characteristic taste or odor.

d. Is the problem isolated to one section of the ship, or does it occur throughout the ship? If the problem is limited to a particular section of the ship, the investigation should be oriented to occurrences affecting the piping system or tank supplying that section of the ship. Cross-connections, repair or maintenance of the piping systems, sounding tubes, and a particular tank are possible sources of the problem.

e. Is the problem continuous or does it occur only while a particular tank is on-line? If the problem appears to be cyclic, compare the record of complaints and the particular tank(s), which are supplying water to different sections of the ship. Ongoing halogen residual testing may indicate increased halogen demand in the tank or particular sections of the piping system.

f. Can halogen residuals (FAC/TBR) be maintained in the potable water tank? Engineering halogen testing at the potable water tanks may indicate increased halogen demand due to contaminants.

g. Has the ship experienced similar taste and odor problems in the past? Discussion with engineering personnel may provide information associated with a similar problem in the past.

h. Review the potable water log to identify fluctuations, which may be occurring in the potable water distribution system. This is easily accomplished by plotting a simple graph with halogen residual levels on the vertical axis and days on the horizontal axis. If this data can be plotted for the past 3 months, an accurate picture can be developed. Compare this data with the source of the water and tanks, which were on-line at the time. Perhaps a pattern will develop associated with a particular source of water or an individual tank.

i. Identify potable water tanks with common bulkheads to fuel, ballast, other tanks, or bilges. A potable water tank with a common bulkhead to bilges or other tanks containing fuel or ballast and small leaks could be a persistent source of taste and odor problems. Identification of these tanks or associated non-potable liquids, which may contaminate the potable water system, must not be overlooked as the source of that problem.

j. Identify any non-potable piping, which has been permanently installed through potable water tanks. Any piping through potable water tanks should be enclosed in self-draining pipe tunnels to avoid contamination of the water system. In many instances, evaluation of this piping can only be accomplished upon entrance to the tanks, but MDR should be aware of the location and existence of this type of piping.

k. Review potable water disinfection procedures to ensure that engineering personnel follow proper procedures. The engineering department is responsible for potable water treatment. The MDR shall have a basic understanding of the system and review the procedures for disinfecting to ensure that the proper amounts of halogens are being added to achieve the prescribed halogen residuals in the distribution system.

l. Identify any repair or maintenance operations conducted on the potable water distribution system, which could have contributed to the taste and odor problem. There are numerous points in the potable water system, which can become a source of contamination through either cross-connections or as a result of repair or maintenance procedures. The operations should be reviewed and correlated to the location within the system, for possible sources of contamination.

m. Has medical water quality surveillance been maintained for the potable water tanks while the ship is at the pier on direct service? Water remaining in potable water tanks is ignored when the ship is tied up to the pier. Consequently, the water sits for long periods of time and may become stagnant and provide a source for taste and odor problems immediately upon resumption of tank usage.

n. Are potable water tanks evaluated through halogen testing or bacteriological analysis prior to filling the tanks with shore water? If the tanks are filled with water from a shore source and mixed with water, which has remained in the tanks for extended periods of time, taste and odor problems may occur. It is recommended that the water in the tank be evaluated for adequate halogen residual and bacteriological analysis prior to filling with shore water.

o. Identify the type of paint coating, date, and location of application for each potable water tank. An improperly cured or applied potable water tank coating may be the source of a temporary or permanent taste and odor problem. Usually the evaluation of the tank coating is not a function which can easily be conducted by shipboard personnel. A temporary taste problem following application of new tank coatings is not unusual, but should resolve following usage of the tanks. In contrast, lack of ability to maintain halogen residuals in the tanks accompanied by persistent taste and odor problems may be directly related to an improperly applied or uncured tank coating.

6-39. Control Measures for Taste and Odor Problems

a. As previously indicated, mechanical processes for the control of taste and odor are quite limited aboard ship. Identification and elimination of the source of the taste and odor is an important quality of life issue and may be a significant health concern. If the ship is at sea and the system must be used, increasing the residual chlorine levels can be used to aid in the control of taste and odor problems.

b. Increased residuals have been and are still being used as a control measure for taste and odor in municipal water supplies ashore. The elevated chlorine residuals often satisfy the halogen demand that may be present in the tanks or piping system. Therefore, ships that have not been able to identify a source of the taste and odor, should add sufficient chlorine to provide a dosage of 5.0 ppm in the potable water tanks, with the intent of providing 2.0-ppm free residual chlorine in the water distribution system. This procedure may satisfy the halogen demand in the tanks or system and resolve taste and odor problems of a temporary nature.

c. Steam application has been successfully used in treatment of taste and odor problems associated with improperly applied potable water tank coatings. Ship personnel with outside assistance from NAVSEASYSCOM can accomplish the actual steam application procedure. The use of steam application to identify uncured coatings should not be accomplished without prior approval of NAVSEASYSCOM. Prior to use of steam application to any potable water tank, it is necessary to have at least some idea as to the success of the operation. This may be readily accomplished by boiling some of the bad tasting water for approximately 1 minute. If the taste and odor have been resolved through heating the water, there is a reasonable measure of success implied in the use of steam treatment of the tanks. If the taste and odor have not been eliminated through boiling of the water, steam treatment will most likely be unsuccessful.

6-40. Request for Outside Assistance

a. If the evaluation procedures outlined in Article 6-36 have been conducted and no source can be determined for the taste and odor problem, it is recommended that the area NAVENPVNTMEDU be contacted via the type command medical officer for technical assistance. Medical and appropriate engineering personnel should be prepared to discuss the evaluation of specific items outlined in Article 6-38.

b. NAVENPVNTMEDU personnel will provide consultative assistance for shipboard taste and odor problem upon request. If the NAVENPVNTMEDU personnel cannot provide onboard assistance due to geographical location, the preventive medicine assistant (PMA) from the nearest naval hospital may be requested to provide onboard assistance in reviewing the problem.

c. Following a thorough review of the situation, the NAVENPVNTMEDU personnel will provide appropriate recommendations for resolution of the taste and odor problem. If the problem cannot be resolved, or is suspected to involve tank coatings, a summary of investigative results will be provided to the ship with a recommendation to notify NAVSEASYSCOM, Washington DC, via the chain of command. The NAVSEA chain of command includes the applicable Naval Sea Support Center (NAVSEACEN) or In-Service Engineering Agent (ISEA). NAVENPVNTMEDU personnel will assist engineering personnel or NAVSEASYSCOM representatives in the evaluation and testing of tank coatings aboard the ship.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION IX. CROSS-CONECTIONS

6-41. General Cross-Connections. Contamination of potable water through the presence of piping cross-connections has been responsible for numerous water-borne disease outbreaks. In recent years, the potential for cross-connections between potable and non-potable systems has significantly increased due to the back fitting of sewage collection tanks and associated piping. The MDR and engineering personnel must ensure constant surveillance of the potable water system to prevent cross-connections. In contrast to a shore facility, plumbing aboard ship is a maze of piping systems fitted into a relatively compact space. The numerous separate piping systems carrying fuel, salt water, sewage, potable water, etc., offer distinct possibilities for cross-connections, particularly during repair, modification, or through negligence in operation. List of approved backflow prevention assemblies may be obtained from the Foundation for Cross-connection Control and Hydraulic Research, University of Southern California, Los Angeles, CA 90089-2513.

6-42. Cross-Connection Definitions

a. **Cross-Connection.** A cross-connection is any connection between two separate piping systems, one of which contains potable water, and the other water of unknown or questionable quality or some other substance. This condition may result in the flow of liquid from one system to the other, resulting in contamination.

b. **Backflow and Back-Siphonage.** Both terms indicate a reversal in the direction of flow in a potable water system and the entry of non-potable water or other substances into the potable water.

(1) **Backflow.** Non-potable water or other substances enter a potable water system through a cross-connection when the pressure of the non-potable system becomes greater than the pressure in the potable water system.

(2) **Back-Siphonage.** Non-potable water or other substances are drawn "by suction" into a potable water system through cross-connections or outlets as a result of negative pressure in the potable water system. The risk of back-siphonage is increased when the potable water system is secured during water hours, or for any other purpose.

c. **Submerged Inlet.** A potable water faucet or other outlet, including an attached hose located below the fill level of a sink, tub, container, tank, machine, etc.

d. **Air Gap.** An air gap is the actual vertical separation between a potable water supply outlet and the highest possible level of liquid in the sink, tub, container, tank, machine, etc., receiving the water. The actual distance of separation must be at least twice the diameter of the potable water supply pipe, but never less than 1-inch between the outlet and the highest possible liquid level in the receiving object.

e. **Backflow Preventer.** A device designed to prevent backflow and subsequent contamination of the potable water supply. These devices are installed at locations where there are limited alternatives to cross-connections, e.g., water closets, dish-washing machines, etc. There are numerous types of backflow or back-siphonage prevention devices, the most common being

vacuum breakers. The degree of health hazard including whether or not the system is under continuous pressure will dictate the type of backflow prevention device needed. A valve located between a potable and non-potable system is not an acceptable method of cross-connection control.

6-43. Improper Piping Installation. In general, any type of water supply connection that permits the return of used or contaminated water into the potable water system is not permissible. Some examples of improper piping installations of potable water systems that have been observed or identified as the cause of disease outbreaks aboard ship are as follows:

a. **Backflow**

(1) Seawater and potable water lines connected to a common line or outlet.

(2) Direct potable water connections (without backflow prevention devices) to machines, equipment, and non-potable systems.

(3) Boiler feed-water and potable water lines connected to a common line.

(4) Drains from ice machines or food service equipment plumbed directly to the deck drainage or sewage system with no air gap.

b. **Back-Siphonage**

(1) Laundry trays, washbasins, service sinks, and deep sinks with faucets below the fill level.

(2) Drinking fountains with orifice below the fill level, or the vertical jet or orifice supply line surrounded by the waste drain line.

(3) Therapeutic tubs, sitz bath, or steam tables with inlets below the fill level.

(4) Improperly installed water-operation waste ejectors, i.e., dental units, potato peelers, and garbage grinders.

(5) Potable water hose connections installed without vacuum breakers, (backflow preventers) with rubber hoses attached that are allowed to remain in scups, sinks, photo tanks, etc.

6-44. Medical Department Cross-Connection Surveillance

a. The following equipment is normally hard-plumbed or has permanent flexible hose installed and is to be provided potable water via an approved reduced pressure backflow prevention device installed above the overflow level: garbage grinders, x-ray developing machines, photographic chemical mixing tanks, chill water expansion tanks, diesel-engine cooling jacket, and photo-graphic film and print processing machines.

b. Throughout the ship, wherever a hose bib faucet permits connection of a hose to the potable water system, a hose connection vacuum breaker must be installed. Examples are deep sinks, and galley and weather deck wash down faucets.

c. MDR and engineering personnel shall be alert to prevent cross-connections. Modification or repairs to existing potable water systems aboard ship should alert the MDR to the potential for cross-connection problems. Frequent discussion with engineering personnel regarding the potable water system and any repairs or proposed changes may be extremely beneficial in preventing cross-connections. If a cross-connection is suspected or identified, act quickly and effectively to determine if an unsatisfactory condition exists. This is best accomplished through discussion with the engineering officer, a review of the suspected site, and review of ship diagrams. If a cross-connection is identified, immediate action by the MDR and engineering personnel are required. Securing the affected part of the potable water system is appropriate until such time as the cross-connection is eliminated and the potable water system is disinfected, if necessary.

(1) NSF approved tracer dyes are to be used in potable water systems. Fluorescein sodium USP™ and Rhodamine WT™ are EPA-approved dyes and must be used as labeled.

(2) The area NAVENPVNTMEDU can provide additional information concerning safe use of tracer dyes. Standard sea marker dye is not approved for use in potable water systems.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION X. MANUFACTURE AND HANDLING OF ICE

6-45. Manufacture of Ice. This is accomplished aboard ships with ice cube machines or icemakers in most instances. A few small pantries, galleys, general messes and very small ships still maintain ice cube trays for the manufacture of ice. Ice to be used for food or drink and for chilling food must be from a potable water source. Regardless of the end use, all ice must be handled in a sanitary manner and afforded the same protection as water.

6-46. Special Precautions for Handling of Ice

a. Due to the vulnerability of ice to contamination, special precautions regarding handling and storage are necessary.

(1) All ice shall be prepared from potable water.

(2) Ice machines shall be plumbed properly to eliminate the possibility of cross-connections and back-siphonage.

(3) The ice machine drain from the ice storage compartment shall be provided with an air gap between the ice storage compartment and the deck drain.

(4) Ice shall be removed from the storage hop by the use of an ice scoop. The ice scoop shall be stored inside the machine on a bracket above the maximum ice level or outside the ice storage compartment with the handle up in a free draining metal bracket. The design of some ice machines precludes proper storage of the ice scoop inside the machine.

(5) The ice scoop is considered to be food service equipment and, shall be washed, rinsed, and sanitized at least daily as described in NAVMED P-5010-1, Food Safety. For this reason the permanent installation of ice scoops with chains or other permanent attachments is not permitted.

6-47. Cleaning and Disinfecting Ice Machines. Cleaning and disinfection procedures for ice cube machine hops and flaking devices are detailed in Tables 6-7 and 6-8.

Table 6-7. Bulk Ice-Making Machine Cleaning/Disinfection Instructions

STEP	PROCEDURES
1. Turn off motor.	Empty, defrost, and clean. Make certain overflow pipes carry off water used for defrosting.
2. Wash all parts, including ice storage bin.	Use a plastic bristle brush to scrub inside and outside of bins with mild detergent solution.
3. Rinse.	Rinse with water containing at least 50 ppm chlorine to preclude bad odors and the accumulation of film deposits from detergents. Water drain should be clear and free to allow proper rinse.
4. Check Water Control.	Clean to prevent clogging of holes of water flow control.

Table 6-8. Ice Dispensing Machine Cleaning/Disinfection Instructions
(cleaning instruments without unit disassembly)

STEP	PROCEDURES
1. Shut off water.	Pour 1 qt. cleaning solution slowly into water reservoir.
2. Place a container below ice chute in bin and start ice machine.	Ice will be formed from cleaning solution. Discard ice. Shut off machine.
3. Flush ice-making system.	Add 1 qt. cleaning water to reservoir. Catch ice in a container. Discard.
4. Wash down storage bin with mild detergent solution. Rinse.	Scrub interior with a plastic brush and detergent solution. Thoroughly rinse with clean water.

6-48. Bacteriological Quality of Ice

a. Samples of ice shall be collected from 1/4 of the ice machines weekly for bacteriological testing. Ice bacteriological quality shall be absent of both total coliform and fecal coliform bacteria.

(1) Ice sample contamination is usually the result of improper ice handling techniques or dirty storage bins. If samples of ice collected for bacteriological analysis are positive for coliform organisms, the storage bin should be emptied, cleaned, and disinfected.

(2) If samples of ice collected for bacteriological analyses are positive for coliform organisms, the storage bin should be cleaned in accordance with NAVSUP Publication 486. Article 6-22 provides guidance for sanitizing if applicable.

b. Bacteriological examinations of ice samples shall be recorded in the potable water log.

SECTION XI. WATER TESTING REQUIREMENTS AND PROCEDURES

6-49. Scope

a. All testing requirements and procedures are to conform to the latest edition of "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association (APHA), American Water Works Association (AWWA), and the Water Pollution Control Federation (WPCF).

b. The analysis of water for suspected chemical contaminants is complex. The equipment and properly trained personnel necessary for performing these determinations are not available aboard ship. Chemical water quality standards have not been established for shipboard product drinking water. Establishment of chemical potable water quality standards for a moving platform i.e., a ship is problematic. However, bunkering water from a shore facility should meet the EPA, Final Governing Standards, or Overseas Environmental Guidance Baseline Document drinking water quality standards as applicable. EPA has promulgated National Primary and Secondary Drinking Water Standards for pubic water systems. EPA has established Maximum Contaminant Level (MCL) for specific contaminants. However, the risk assessment model used for establishment of MCL health standards is based on the assumption of a person drinking a fixed water source daily for 70 years. Clearly, this is not consistent with health-related exposures for shipboard drinking water. The United States Army Center for Health Promotion and Preventive Medicine Technical Guide 230, "Chemical Exposure Guidelines for Deployed Military Personnel" may be a useful reference in evaluating concerns and complaints regarding the chemical quality of shipboard drinking water. This document sets forth military exposure guidelines (MEG) for drinking water for short-term exposure. While this reference may be helpful in conducting an operational risk management analysis for a shipboard environment one needs to keep in mind this risk assessment model is based on military unit consuming water from a fixed facility such as a field reverse osmosis water purification unit (ROWPU). Afloat commands requiring assistance for a water quality complaints/problems should contact the nearest Navy Environmental and Preventive Medicine Unit.

6-50. Temperature and pH Testing

a. These tests are important to engineering department personnel since deviations of temperature and pH of water may affect the treatment or disinfectant procedures. Halogenation is more effective at lower pH values and at warmer temperatures. High pH levels (8.5 or above) will adversely affect the disinfectant properties of chlorine or bromine.

Water temperature affects the amount of bromine that is released from the cartridge and warmer water temperatures may rapidly affect cartridge utilization.

b. Testing for pH is routinely performed by the Ship's engineering department for boiler feed-water. The test may be used for potable water and is outlined in the Naval Ships Technical Manual, Chapter 220, Volume 2.

c. Testing for pH may also be accomplished using the DPD chlorine-bromine-pH combination test kit, which is a standard stock item.

6-51. Salinity (Chloride Content). Chloride content of water from a distilling plant shall be at or below 0.065 equivalent per million (epm), 0.25 grains of sea-salt per gallon or less than 2.3 ppm. Whenever chloride levels in the potable water exceed those of water produced by distilling plants or initial levels for potable water obtained from shore facilities, contamination of potable water by sea water through leakage may be occurring. Appropriate action including investigation, repair, cleaning, and disinfecting, shall be instituted.

a. Salinity testing is accomplished by the engineering department on ship-produced water.

b. Salinity testing must not be conducted on halogenated water. Water halogenated with calcium hypochlorite may result in false positive readings and titration end points cannot be determined on brominated water. Therefore, routine testing of skin tanks is no longer recommended.

6-52. Halogen Residual (Chlorine/Bromine)

a. FAC and TBR represent the amount of halogen present in potable water following adequate disinfection. FAC is more effective as a disinfecting agent when compared to combined chlorine (chloramines). In contrast, bromamines are very effective disinfecting agents. In the colorimetric test for chlorine the combined halogen is distinguished from FAC by the time at which the color appears after the addition of the color indicator chemical to the water sample. FAC and TBR react rapidly; therefore, an immediate reading of the result is necessary (60 seconds or less).

b. Surface ships must maintain a 0.2 ppm FAC or TBR in the potable water distribution system after initial treatment. Ships with large potable water distribution systems such as aircraft carriers shall maintain at least a trace level of chlorine in the distal ends of the distribution systems. This halogen residual is to be maintained regardless of the source of the water. The initial treatment required must be increased depending on the geographic location of the ship. If water is received from an unapproved source, a source of doubtful quality, the halogen residual at point of consumption shall be a minimum of 2.0 ppm FAC.

c. Chloramines in lieu of FAC are used by many shore water sources because of concerns related to disinfection byproducts formation. The MDR must verify what type of halogen is being used for water treatment. Different testing methods, materials, kits, meters, etc. exist for measuring FAC vs. chloramines (total chlorine). Follow the manufacturer’s recommendations for testing water for the applicable halogen residual.

d. Testing for halogen residuals should be routinely performed by MDR under the following conditions:

(1) Prior to receiving potable water onboard.

(2) In conjunction with each potable water sample collected for bacteriological analysis.

(3) Daily, from sampling points that are varied and are representative of the ship's distribution system (i.e., forward, midships, aft, below deck, and in the superstructure). The number of samples required as specified in Table 6-9.

Table 6-9. Routine Testing Procedure Summary

TESTING	PERSONNEL < 400 CREW	PERSONNEL 400-800 CREW	PERSONNEL > 800 CREW
Halogen Residual (FAC/TBR)	4 Tests Daily	8 Tests Daily	12 Tests Daily
Bacteriological (Potable Water Tanks)	1/4 of Total Number of Potable Water Tanks Weekly		
Bacteriological (Distribution System)	4 Tests Weekly	8 Tests Weekly	12 Tests Weekly
Bacteriological (Ice)	1/4 of Total Number of Ice Machines Weekly		
Emergency Potable Water Tanks	1 Bacteriological Sample Per Tank Monthly		

e. The engineering department is responsible for testing chlorine or bromine residuals in the potable water tanks after 30 minutes contact time. This testing should be considered as part of the evaluation of the treatment process.

f. Chlorine or bromine residuals are determined by using the DPD (diethyl-p-phenylene diamine) test. The DPD test varies in accuracy depending on whether it is formed using a comparator test kit or a portable spectrophotometer. Since the comparator test kits rely on a visual comparison to a color slide or disc, the results depend on the visual acuity of the operator. Consequently, the results from the comparator test kits tend to be semi-quantitative with a $\pm$10% accuracy. Spectrophotometric determination of the halogen residuals alleviates the need to depend on the visual acuity of the operator and can provide an accuracy of +2%. In addition, a number of the DPD test kits provide for the direct determination of both a low range (i.e., 0.1 - 1.00 ppm chlorine) and a high range (i.e., 2 - 10 ppm).

(1) **DPD Test.** The comparator supplied with this test kit gives direct readings for both chlorine and bromine. This chlorine and bromine comparator is read over two ranges. To read the test in low range (0.1 - 1.0 ppm chlorine or 0.2 - 2.2 ppm bromine) place the sample test tube in a slot directly behind one of the colorless windows located on the back of the comparator and read the low-range comparison. To read the test sample in high range (2.0 - 10.0 ppm chlorine or 4.4 - 22.2 ppm bromine) place the sample tube in one of the openings located on top of the comparator and make the reading. The test sample tube is moved from one position to another until a color match is made. A variety of DPD test kits are available and the specific manufacturer's instructions for testing should be followed. The following general procedure is used to obtain both FAC and TBR:

(a) Open potable water tap and let flow not less than 2 or 3 minutes.

(b) Rinse the test tube with the water to be tested.

(c) Fill test tube with sample water to the marked line (10 ml).

(d) Add one DPD No. 1 tablet, cap the test tube, and shake to dissolve.

(e) Remove the cap from the test tube and immediately compare the test sample color with the color standards in the comparator. Color matching shall be completed within 60 seconds after addition of the DPD No. 1 tablet.

(f) Record the value of the matching color standard. If the color falls between consecutive color standards, take an intermediate value. If the color is deeper than 5.0-ppm chlorine or 11.0-ppm bromine color standard, add an additional DPD No. 1 tablet to obtain a full color response. No formulation is required with the extra tablet; take a direct reading and record.

(g) When testing a water supply that uses chloramines as the disinfecting agent, the total residual chlorine can be determined by using a DPD No. 4 tablet. The use of this tablet will not differentiate the type of chlorine, but will indicate the level of total disinfectant present. The test procedures for chloramines (total chlorine) residual are as follows:

1. Rinse the test tube with the test sample, then fill to the mark.

2. Add one DPD No. 4 tablet and allow the tablet to effervesce for rapid disintegration, then cap the test tube and shake to mix.

3. The color that results represents the total residual chlorine.

4. When testing for halogens in the water supply, determine whether bromine or chlorine is being used and record as either bromine or chlorine following testing.

5. When testing for extremely high levels of chlorine, such as superchlorination, it will be necessary to dilute the water to be tested to determine the chlorine residual. Following both the "Standard Methods for the Examination of Water and Wastewater" as well as the "Fourth Edition of the Handbook of Chlorination and Alternative Disinfectants" samples with residuals greater than 4 mg/L must be diluted with halogen-demand-free (distilled) water. A 1:10 dilution using distilled water as the dilutent is satisfactory for this purpose. To determine the chlorine residual a multiplication factor of 10 is necessary.

6. Results of halogen residual tests will be recorded in the water log. Continual absence of halogen residuals in the potable water system must be reported to the commanding officer with a copy to the engineering officer.

(2) **Portable Spectrophotometer** (NSN 6630-01-457-4027) A typical portable spectrophotometer is 3.2 x 6.1 x 15.2 cm (1.25 x 2.4 x 6 inches) in dimension, weighs around 0.19 kg (0.43 lbs) and is battery operated. The advantage for these instruments is they help eliminate human visual subjectivity which occurs with traditional used color comparators kits.

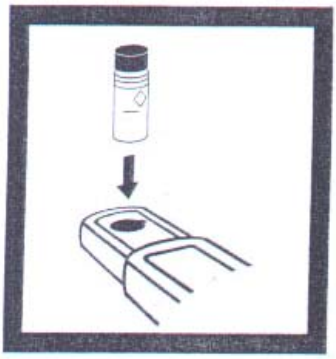
Specific sample volumes, reagents, sample cells and timing intervals for a given procedure depend on the make and model of the instrument. Detailed setup instructions are included with each instrument and should be strictly followed to ensure valid measurements and to prevent damage to the instrument. Portable spectrophotometers are often referred to as portable colorimeters. The NSN number provided is for a pocket colorimeter designed for measuring free and total chlorine only. The manufactured specified reagent must be used for measuring free available chlorine. Pocket colorimeters are available for testing various chemicals. The instrument shown above is microprocessor controlled. The typical procedure for using a portable spectrophotometer consists of the following steps:

1. If your Pocket Colorimeter Instrument requires you set a range before testing, read the **"HI or LO Range Mode"** section in the instrument manual, and set the appropriate range.

2. Fill a clean sample cell to the 10-mL mark with the blank solution (usually untreated sample).

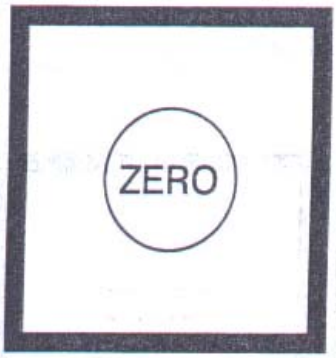
3. Fill another clean sample cell to the 10-mL mark with sample.

4. Add appropriate reagents and mix.

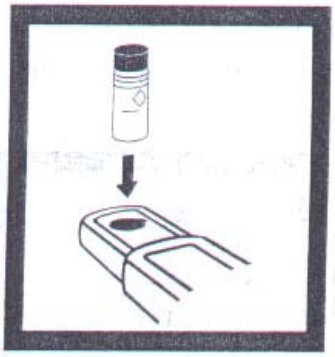


5. Place the blank in the cell compartment with the diamond mark facing the keypad and cover the cell with the light shield.

Note: When covering the sample cell, place the curved surface of the light shield closest to the keypad to provide a good seal against stray light.



6. Press the **ZERO** key. After 2 seconds the display will read: 0.00.



7. Place the sample cell containing the sample into the cell compartment (diamond mark facing the keypad) and cover with the light shield.

8. Press the **READ** key. After about 2 seconds the instrument will display the results.

Typical Concentration Ranges for Halogen Determination Using Pocket Colorimeters Determined by the DPD Method

ELEMENT	RANGE (PPM)	SMALLEST INCREMENT
Bromine	0 – 4.5	0.01
Bromine	0 – 10	0.1
Chlorine, free and total	0 – 10 (w/dilution)	0.01
Chlorine, total	0 – 4.5	0.1

6-53. Bacteriological Collection and Testing

a. The bacteriological water quality standard is absence of total coliform and fecal coliform bacteria. The main purpose of the disinfection procedure is to destroy pathogenic organisms present in the water. Adequate water treatment and disinfection is demonstrated by negative bacteriological testing.

b. Bacteriological testing must be completed weekly on samples collected at representative points throughout the distribution system and from one-fourth of the potable water tanks and ice machines on a rotating basis; including potable water retained in storage tanks when under direct service from shore piping. Tank samples should be from petcocks on the tank; if none are available, collect the sample from the outlet nearest the tank. Samples may be obtained from each tank by using the brominator recirculation test taps on ships so equipped. Sample frequency is depending on crew size and shall be done in accordance with routine testing requirements set forth in Table 6-9.

c. Microorganisms of the coliform group are indicators of water contamination. There are numerous EPA-approved methods of testing for total coliforms and fecal coliform. Any EPA approved method may be used. Generally Coliert ® or Colisure ® is used by the fleet.

d. Weekly ice samples must be collected from one-fourth of the ice machines on a rotating basis for bacteriological examination. Bacteriological quality standard for ice is absence of total and fecal coliforms.

e. Collecting and testing for chlorine and bromine residual. Collection and testing of the water for a chlorine or bromine residual is not a part of the coliform test; however, a step-by-step procedure is shown in Appendix C to demonstrate that the residual reading must be taken after the water is allowed to run 2 or 3 minutes and before it is collected in the bacteriological test sample bottle or bag containing sodium thiosulfate.

f. Results of routine medical surveillance bacteriological testing in accordance with Table 6-9 shall be entered in the water log with a weekly report to the commanding officer and a copy to the engineering officer.

g. The presence or absence of total coliform bacteria is the microbiological water quality standard for potable water. The most effective method for minimizing the potential transmission of pathogens is to maintain the required halogen residual levels.

h. Biofilm is the growth of non-pathogenic microorganisms within the ship's potable water system. As these microorganisms grow they can become attached to the surfaces of potable water tanks and piping. Biofilm growth will negatively impact the halogen disinfection efficiency and more importantly may lead to positive bacteriological test results. These biofilms can range from a few organisms scattered along a pipe section to very thick layers reaching several hundred microns in thickness. Maintaining a minimum .2 ppm FAC or .2 ppm TBR residual in the potable water system will help minimize biofilm growth.

i. The bacteria that make up the biofilms are collectively referred to as heterotrophic plate count (HPC) organisms. "Standard Methods for the Examination of Water and Wastewater" (Standard Methods) provides a procedure for enumerating these microorganisms. The HPC method is designed to determine the density of aerobic and facultatively anaerobic heterotrophic bacteria in water. In general, HPC levels greater than 500 bacterial colonies per milliliter are an indication of a loss of microbial control within the potable water piping as well as an indication of potential interference with the coliform measurements. Contact area NAVENVPREV-MEDU for laboratory assistance if HPC testing is indicated.

6-54. Potable Water Log

a. The MDR will maintain a 2-year chronological record of potable water surveillance. On larger ships with preventive medicine personnel, the preventive medicine technician should be responsible for entries. On other ships, the log will be maintained by the MDR.

b. Entries are made in chronological order and must include, as a minimum, the following information:

(1) Time and date each water sample was taken.

(2) Location of the ship: at sea, in harbor, at anchorage, or in port, include the name of the port.

(3) Sampling site: include location of outlet, ice machine, emergency potable water tank or supply, and identification number of potable water tank, etc.

(4) Source of ship's water from the ship's distilling apparatus, water barge, shore using direct pressure or ships tanks filled with ashore water. Also include information concerning the source of the water (approved or non-approved), its halogen residual and if disinfection was accomplished.

(5) **Medical Surveillance Tests**

(a) **Halogen Residual.** Specify if bromine or chlorine, amount of residual or absence of, reason taken, e.g., daily, bacteriological analysis, water prior to receiving, or in connection with disinfecting tanks or pipes. Include any follow-up action taken when negative readings are obtained.

(b) **Bacteriological Analysis.** Record the results of all testing, including the positive and negative controls. Record the results as total coliform-presence or total coliform-absence. If total coliforms are present then record results of fecal coliform/ E. coli as presence or absence. State reason test performed, such as weekly, special or in connection with disinfecting tanks, pipes or systems. Record action taken and results in the case of positive samples even if the tests were formed by another activity.

(6) Any problems concerning taste and odor and their resolution.

(7) Inspection and surveys include results, discrepancies, and action taken.

c. The use and maintenance of a separate file of DD 686 Bacteriological Examination of Water form is not required if the potable water log is satisfactorily maintained. However, this form should accompany water samples submitted for bacteriological analysis to shore facilities. Results of bacteriological analysis submitted to shore facilities should be recorded in the potable water log. Potable water log documentation using either Shipboard Automated Medical System (SAMS) or using a manual log book is acceptable.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION XII. SAMPLE WATER SANITATION BILL

6-55. Sample Water Sanitation Bill. Each ship shall have a Water Sanitation Bill. The commanding officer should promulgate the Water Sanitation Bill. The bill shall be posted conspicuously in areas where potable water and associated materials are processed, treated, or stored. A sample bill is provided in Appendix D as a guide.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION XIII. REFERENCES AND APPENDICES

6-56. References

a. Although the Manual of Naval Preventive Medicine is widely quoted in reports and publications as an authoritative source, this chapter is published as a guide to aid Medical Department personnel with the inspection and medical surveillance of potable water aboard ship. When making recommendations, other naval manuals, publications, and notices may be referenced and quoted to support this chapter.

b. The following reference materials were used in the preparation of this chapter. It is recommended that each Medical Department procure copies, as needed, for reference and guidance.

(1) OPNAVINST 5090.1 Series, *Environmental and Natural Resources Protection Manual.*

(2) Naval Facilities Engineering Service Center: *Cross-Connection Control and Backflow Prevention Program Implementation at Navy Shore Facilities, User's Guide,* UG-2029-ENV (May 1998).

(3) BUMEDINST 5450.157 Series, *Missions, Functions, and Tasks of Navy Environmental Health Center and its Subordinate Commands.*

(4) BUMEDINST 6240.10 Series, *Standards for Potable Water*.

(5) Type Command Medical Guides, 6000.1 Series.

(6) Naval Ships Technical Manual, Chapter 074, Vol. 3, *Gas Free Engineering*.

(7) Naval Ships Technical Manual, Chapter 090*, Inspections, Tests, Records, and Reports.*

(8) Naval Ships Technical Manual, Chapter 220, Vol. 1, *Water Chemistry* - Vol. 2, *Test and Treatment.*

(9) Naval Ships Technical Manual, Chapter 505, *Piping Systems*.

(10) Naval Ships Technical Manual, Chapter 531, *Desalination,* Vol. 1, *Low-pressure Distilling Plants.*

(11) Naval Ships Technical Manual, Chapter 51, *Desalination,* Vol. 2, *Vapor Compression Distilling Plants.*

(12) Naval Ships Technical Manual Chapter 531, *Desalination,* Vol. 3, *Reverse Osmosis Desalination Plants.*

(13) Naval Ships Technical Manual, Chapter 533, *Potable Water Systems*.

(14) Naval Ships Technical Manual, Chapter 631, *Preservation of Ships in Service*.

(15) Naval Ships Technical Manual, Chapter 670, *Stowage, Handling, and Disposal of Hazardous General Use Consumables.*

(16) NAVSUP Publication 486, Vol.1, *Food Service Management*.

(17) QSTAG 245, Edition 2, American-British-Canadian-Australian Quadripartite Standardization, *Minimum Requirements for Water Potability (Short and Long Term Use).*

(18) NATO Standardization Agreement: STANAG 2136, *Minimum Standards of Water Potability in Emergency Situations.*

(19) NATO Standardization agreement: STANAG 2885, *Emergency Supply of Water in War.*

(20) USACHPPM Technical Guide 230, "Chemical Exposure Guidelines for Deployed Military Personnel."

(21) U.S. Public Health Service, Food and Drug Administration Publication, *Acceptable Vessel Watering Points Interstate Conveyance Official Classification List.*

(22) U.S. Environmental Protection Agency, EPA 570/9-89-007, *Cross-Connection Control Manual.*

(23) Standard Methods for the Examination of Water and Waste Water, Current Edition, by APHA, AWWA, and WPCF.

(24) Department of Defense, *Overseas Environmental Baseline Guidance Document* (OEBGD), current edition.

(25) Handbook of Chlorination and Alternative Disinfectants. G.C. White. 4th Edition.

(26) National Sanitation Foundation International, NSF/ANSI Standard 60: *Drinking Water Treatment Chemicals - Health Effects.*

(27) National Sanitation Foundation International, NSF/ANSI Standard 61: *Drinking Water System Components - Health Effects.*

(28) American Water Works Association Standard, ANSI/AWWA C652-02: *Disinfection of Water-Storage Facilities.*

6-57. Appendices

a. Appendix A – Abbreviations

(1) ANSI	American National Standards Institute
(2) APHA	American Public Health Association
(3) AWWA	American Water Works Association
(4) BUMED	Bureau of Medicine and Surgery
(5) CT	Contact Time
(6) DON	Department of the Navy
(7) DST	Defined Substrate Technology
(8) EDG	Electrolytic Disinfectant Generator
(9) EPA	Environmental Protection Agency
(10) FAC	Free Available Chlorine
(11) FDA	Food and Drug Administration
(12) HPC	Heterotropic Plate Count
(13) HTH	Calcium Hypochlorite
(14) ISEA	In-Service Engineering Agent
(15) MCL	Maximum Contaminant Level
(16) MDR	Medical Department Representative
(17) MRC	Maintenance Requirement Card
(18) MSC	Military Sealift Command
(19) MSD	Marine Sanitation Devices
(20) mg/L	Milligrams per Liter (same as ppm for water)
(21) NAVENPVNTMEDUs	Naval Environmental Preventive Medicine Units
(22) NAVFACENGCOM	Naval Facilities Engineering Command
(23) NAVSEACEN	Naval Sea Support Center
(24) NAVSEASYSCOM	Naval Sea Systems Command
(25) NSF	National Sanitation Foundation International
(26) NSTM	Naval Ships Technical Manual
(27) OPNAV	Office of the Chief of Naval Operations
(28) PMA	Preventive Medicine Authority
(29) POE	Point of Entry
(30) POU	Point of Use
(31) PPM	Parts Per Million (same as mg/L for water)
(32) RO	Reverse Osmosis
(33) SAMS	Shipboard Automated Medical System
(34) SDWA	Safe Drinking Water Act
(35) TBR	Total Bromine Residual
(36) TCR	Total Coliform Rule
(37) TDS	Total Dissolved Solids
(38) TOC	Total Organic Carbon
(39) VOCs	Volatile Organic Chemicals
(40) WPCF	Water Pollution Control Federation

b. **Appendix B – Definitions**

(1) **Coaming.** A raised frame (as around a hatchway in the deck of a ship) to keep out water.

(2) **Distillation.** The total process the distilling plant forms, including evaporation and condensations.

(3) **Free Available Chlorine (FAC).** Chlorine available (after demand is met) in the forms of Hypochlorous acid and Hypochlorite ions.

(4) **Micron.** A unit of length. One millionth of a meter or one thousandth of a millimeter. One micron equals 0.00004 of an inch.

(5) **Point of Use (POU).** A treatment device applied to a single tap used for the purpose of reducing contaminants in drinking water at that one tap.

(6) **Potable Water.** Water that is suitable for human consumption, bathing, laundry, personal hygiene.

(7) **Reverse Osmosis (RO).** The reverse of the natural osmosis achieved by external application of sufficient reverse pressure to cause the solvent to flow in its unnatural direction.

(8) **Colilert ®.** Uses the patented Defined Substrate Technology® (DST®) to simultaneously detect total coliforms and *E. coli*. Two nutrient-indicators, ONPG and MUG, are the major sources of carbon in Colilert and can be metabolized by the coliform enzyme *ß*-galactosidase and the *E. coli* enzyme *ß*-glucuronidase, respectively.

(9) **Colisure ®**. Uses Defined Substrate Technology® (DST®) nutrient indicators CPRG and MUG to detect total coliforms and *E.coli*. Coliforms use their *ß*-galactosidase enzyme to metabolize CPRG and change it from yellow to magenta. *E.coli* use ß-glucuronidase to metabolize MUG and create fluorescence.

(10) **Total Coliform.** Are a group of closely related, mostly harmless bacteria that live in soil and water as well as the gut of animals. The extent to which total coliforms are present in the source water can indicate the general quality of that water and the likelihood that the water is fecally contaminated. The presence or absence of total coliform bacteria is the drinking water standard.

(11) ***E. Coli.*** Is a type of fecal coliform bacteria commonly found in the intestines of animals and humans. *E. coli* is short for *Escherichia coli*. The presence of *E. coli* in water is a strong indication of recent sewage or animal waste contamination. Sewage may contain many types of disease-causing organisms.

(12) **Heterotrophic Plate Count (HPC)** (microbiological) (35^{o} C, 48 hours) in drinking water should not exceed 500 colonies per ml. The HPC is a microbiological test used to determine the quality of the water in terms of its general bacterial content. This test is used as a supplement to the routine analysis for coliform bacteria. HPCs can also be used to monitor disinfection efficiency at water treatment plants and as a measure of water quality deterioration in distribution lines (e.g., biofilm formation) and reservoirs.

c. **Appendix C – Water Sampling Technique**

Collecting a Halogen Sample	Collecting a Bacteriological Sample
Open tap fully and let water run for 2-3 minutes or for a time sufficient to permit clearing the service line.	Use aseptic technique to collect the sample in approved bottles or whirl packs. Do not rinse bottle prior to collection.
Collect the sample and add the appropriate DPD tablet (dependant on halogen type)	Label the sample for identification, including sampling site and time of sampling in the potable water log.
Take the reading within the first 30 seconds of adding the DPD tablet. The sampling tube should be read uncovered and at eye level.	Prepare the sample in accordance with Appendix D or E, as appropriate.
Determine the halogen level and record findings in potable water log.	Incubate the sample as prescribed. Record results in potable water log.

d. **Appendix D - Sample Potable Water Sanitation Bill**

(1) **Responsibility**

(a) The engineering department of the ship is responsible to the commanding officer/master for implementing the requirements of the Naval Sea Systems Command. This responsibility includes the operation and maintenance of the shipboard water supply system, production of an adequate amount of water, and disinfection.

(b) The Medical Department is responsible for conducting a comprehensive medical surveillance program of the potable water system including adequacy of disinfecting procedures, collection of samples for bacteriological analysis, and daily halogen residuals from the distribution system. The Medical Department shall notify the commanding officer/master of any discrepancies observed in the potable water distribution system.

(2) **Sources**

(a) **Processing of Seawater.** Distillation or RO processing of seawater from harbors or polluted seawater is to be avoided except in emergencies. Seawater must be assumed polluted when ships are operating in close formation. While making potable water, care must be taken not to strip fuel waste tanks or empty bilges forwarded of the salt-water intakes. Naval Ships Technical Manual, Chapter 533, provides additional details.

(b) **Potable Water.** Potable water may be received from approved shore facilities or other ships. The following is a list of approved sources for potable water:

1. EPA-approved public water systems.

2. Approved U.S. military sources including water utility establishments under the cognizance of the British Royal Navy, Canadian Forces, and the Royal Australian Navy. These sources are subject to termination or modification. See the current American-British-Canadian-Australian Naval Quadripartite Standardization Agreement Program, ABCA NAVSTAG 23, Quality Standards for Potable Water. Under certain emergency or wartime situations, shore water sources may be under the cognizance of Quadripartite Standardization Agreement 245, Edition 2, of the American-British-Canadian-Australian Armies

Standardization Program, Minimum Requirements for Water Potability (Short and Long Term Use) or the NATO Standardization Agreement, STANAG 2136, Minimum Requirements of Water Potability for Short Term Issue (STANAG 2136 is under revision and the new title will probably be, Minimum Standards of Water Potability in Emergency Situation).

3. Other extra-continental source data may be obtained from U.S. military representatives ashore or NAVENPVNTMEDUs having area responsibility. It is advisable that the Medical Department attempt to obtain this information prior to departure from CONUS.

(3) **Procedures for Ship-to-Shore and Ship-to-Ship Connections**

(a) All shore connections should be made or supervised by trained shore based personnel when available; however in many instances ship personnel must assume this responsibility. Personnel trained in the handling of potable water shall also accomplish ship-to-ship transfer of potable water.

(b) Potable water hoses should be furnished by shore establishments; hoses are normally provided by the supplying ship if the transfer is at sea.

(c) MDR must ensure that an adequate halogen residual is present in the water prior to the initial transfer of water.

(d) The potable water outlet must be flushed for 15-30 seconds and disinfected with a solution of 100-ppm FAC. Let stand for 2 minutes and reflush.

(e) The hose must be flushed for 15-30 seconds prior to connecting to the ship.

(f) Ship risers for potable water must be conspicuously designated by a warning plate with the inscription "POTABLE WATER ONLY" in 1-inch letters. The connection shall be no less than 18 inches above the deck and covered with a screw cap attached by a keeper chain when not in use.

(g) The individual making the hook-up must ensure the intake hose is not connected to a non-potable system aboard ship.

(h) The hose must not at any time be submerged in the harbor water.

(i) The above precautions and procedures must be followed when making ship-to-ship potable water hose connections.

(4) **Potable Water Hoses**

(a) Potable water hoses must be marked "POTABLE WATER ONLY" approximately every 10 feet and must be used for potable water only. Transfer of potable water will be accomplished through disinfected hoses. Hoses are disinfected by filling for 2 minutes with 100 ppm FAC solution. After disinfection, hose ends must be coupled or capped and stored in lockers at least 18 inches above the deck and protected from weather dust, and vermin.

(5) **Storage Tanks.** Potable water tanks should not be filled with ballast water unless absolutely necessary for the survival of the ship. When non-potable water is introduced into potable water tanks, all tanks, lines, fittings, and pumps must be disconnected from the potable water system plugged or capped and not reconnected until adequately cleaned, flushed, disinfected, and tested.

(6) **Disinfection**

(a) **Only the following halogens may be used for disinfecting potable water**

1. Calcium Hypochlorite (technical 65/70% HTH), NSN 6810-00-255-0471, 6-ounce jar.

2. Sodium Hypochlorite (unscented), NSN 6810-00-598-7316, 1 gallon bottle (5%); NSN 6810-00-900-6276, 5 gallon pail (5%).

3. Bromine Cartridges, NSN 4610-01-022-9970.

(b) **Calcium Hypochlorite.** Automatic/mechanical disinfection is preferred. For batch chlorination prescribed chemical dosage to obtain the required residual will be mixed with warm water in a container and allowed to settle. Introduce only the clear fluid (supernatant) into the tank when it is one-fourth full. Under no circumstances is this solution introduced into the tank by using brominating equipment. If chlorine solution is added to a full tank, the water must be recirculated to ensure adequate mixing. If the required level of chlorine is not present after a 30-minute contact period at the tank then additional chemical must be added.

(c) **Sodium Hypochlorite.** Enough chemical solution is added directly to the tank when it is one-fourth full to obtain the required residual. No prior mixing or dilution is required.

(d) **Hypochlorinators.** Refer to manufacturer's operational instructions and requirements.

(e) **Brominators.** Bromination of a potable water system requires two types of brominators. One type is used in the distillate discharge line and the other is used to treat water in the tank while recirculating potable water.

(7) **Halogen Residual and Bacteriological Testing**

Routine Testing Procedure Summary

TESTING	PERSONNEL < 400 CREW	PERSONNEL 400-800 CREW	PERSONNEL > 800 CREW
Halogen Residual (FAC/TBR)	4 Tests Daily	8 Tests Daily	12 Tests Daily
Bacteriological (Potable Water Tanks)	1/4 of Total Number of Potable Water Tanks Weekly		
Bacteriological (Distribution System)	4 Tests Weekly	8 Tests Weekly	12 Tests Weekly
Bacteriological (Ice)	1/4 of Total Number of Ice Machines Weekly		
Emergency Potable Water Tanks	1 Bacteriological Sample Per Tank Monthly		

(a) The MDR must check the disinfectant residual in the distribution system daily to determine that halogen residual is maintained. Tests will be formed at random locations to ensure adequate coverage of the entire system. The number of samples required will be determined by crew number onboard the ship; no less than four samples will be collected.

(b) A DPD chlorine-bromine-pH combination test kit or digital chlorine analyzer is required for forming halogen residual determinations.

(c) Results of halogen residuals will be recorded in the water log. Continual absence of halogen levels must be reported to the commanding officer with a copy to the engineering officer.

(8) **Bacteriological Testing**

(a) The Medical Department will ensure that bacteriological water samples are collected and tested weekly. Samples will be collected at representative points throughout the distribution system as well as from potable water tanks and ice machines. This includes potable water in storage tanks while the ship is in port and the system is receiving direct service from shore potable water pipes. Special or more frequent tests are required whenever chlorine demand increases; contamination is suspected, after cleaning and disinfection of potable water tanks and upon completion of repairs to the system.

(b) When the results of a sample are total coliform-positive, a set of repeat samples for each total coliforms-positive sample must be taken and analyzed for total coliforms. At least one repeat sample must be from the same tap as the original positive sample. Two other repeat samples must be collected from within five service connections of the original positive sample. One sample must be taken upstream and the other downstream. If the original positive sample is at the end of the distribution system, two samples will be collected upstream. If total coliforms are absent in these samples, the water is safe to use.

(c) A report of the bacteriological examinations will be submitted to the commanding and engineering officers and the results entered in the potable water log.

(9) **Temperature, pH, and Salinity.** These tests are be conducted at least daily by the engineering department. Variations in temperature, pH, and salinity may affect the water treatment procedure.

(10) **Disinfection of Tanks and Distribution System.** When mechanical cleaning and chemical disinfection are required the potable water tank will be disinfected. When indicated the potable water distribution system will be disinfected as well. Follow one of the three methods of disinfection below.

Methods For Disinfection Of Potable Water Tanks Per ANSI/AWWA Standard C652-02*

METHOD 1	METHOD 2	METHOD 3
Fill tank to over flow level	Spray/apply directly 200 ppm FAC to all tank surfaces	Fill 5% of tank volume with 50 ppm FAC solution
Add chlorine to achieve 10 ppm FAC throughout the tank	Flush inlet/outlet pipes with 10 ppm FAC	Hold solution for 6 hours
Hold this solution for 24 hours	Disinfected surfaces shall remain in contact with chlorine solution for a minimum of 30 minutes	Add potable water to chlorine solution to fill tank; hold this water for 24 hours
Drain tank	Refill tank with potable water with required halogen residual level	Drain tank
Refill tank with potable water with required halogen residual level		Refill tank with potable water with required halogen residual level
Perform bacteriological testing of potable water.		
Upon satisfactory bacteriological testing and asthetic quality water may be delivered to the system.		

*Table reads from top to bottom, not left to right

Highly chlorinated water discharges shall comply with Federal, State, local, or host nation environmental regulations. Special provisions or permits may be required prior to discharge of highly chlorinated water. The proper authorities shall be contacted prior to disposal of highly chlorinated water. American Water Works Association Standard *ANSI/AWWA C652-02 Appendix B* provides guidance for neutralizing highly chlorinated water.

(11) **Distribution System**

(a) Potable water piping must not be used for any purpose other than potable water.

(b) The potable water distribution system must not be cross-connected to any possible source of contamination.

(c) Potable water to be used as boiler feed water must be supplied through an air gap.

(d) Potable water piping must not pass through non-potable liquid storage tanks and non-potable liquid pipes must not pass through potable water tanks unless the pipes are surrounded by a sloping, self-draining pipe tunnel.

(e) Potable water piping must be labeled as to the type of service with an arrow indicating the direction of flow.

(f) If any break occurs in the potable water system, accidental or otherwise, the parts concerned must be disinfected after reassembly and prior to placing that part of the system back in service. The MDR must be notified concerning any break in the water distribution system.

(g) Potable water pumps must not be primed with other than potable water.

(h) Potable water must be used in the manufacture of all ice.

(12) **Records**

(a) The engineering department should maintain adequate records to furnish documentary evidence of engineering responsibilities concerning production, treatment, and distribution of potable water.

(b) The MDR will maintain a potable water log; the entries must be a 2-year chronological record of potable water surveillance. Entries are made in chronological order and must contain the following:

1. Each time a water sample is taken, record the time and date, the location of the ship, location of the sampling site, the source of the ship's water, and whether or not from an approved source.

2. Results of halogen residual test (state type of halogen) and reason taken, e.g., daily, in connection with bacteriological analysis, prior to receipt or in connection with disinfection of tanks or lines. Include any follow-up action taken when negative readings are obtained.

3. Results of all bacteriological analysis including controls. State reason test performed such as weekly, special, or in connection with disinfection of tanks or lines. Record action taken in the case of positive samples, even if the tests were performed by another activity.

4. Record any repairs or modification to the potable water system or tanks, any problems with taste or odor and their resolution, the findings of inspections and surveys and any action taken.

(13) The MDR must make frequent inspections of the potable water procedures and system to ensure that the provisions of this bill are being carried out. Any discrepancies must be reported in writing to the commanding officer as applicable with a copy to the engineering officer.