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Manual of Naval Preventive Medicine

Chapter 6 Water Supply Afloat

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Chapter 6

WATER SUPPLY AFLOAT

Section I. INTRODUCTION

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6-1. Scope.

1. This chapter provides information for safe and proper potable water handling procedures aboard vessels. Bacteriological, physical, and chemical characteristics of potable water for the Navy are set forth in current BUMED/OPNAV Instructions. The basic principles outlined in the following sections will help prevent water-borne diseases.

2. All personnel concerned with loading, treatment, storage, distribution, and medical surveillance of potable water should be familiar with current OPNAV, Fleet, Type, Area, Force, and Command Instructions and Notices which supplement this chapter.

6-2. Responsibilities

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

2. The Naval Facilities Engineering Command (NAVFACENG COM) 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.

3. Chief, Bureau of Medicine and Surgery (BUMED) is responsible for establishing and promulgating standards for water quality

ashore and afloat. BUMED will promulgate appropriate instructions, notices, or other publications to reflect water quality requirements. Additionally, BUMED will insure medical surveillance of potable water distribution systems aboard ship and overseas activities.

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

5. The Commanding Officer of each ship is responsible for promulgating a water sanitation bill to insure that procedures for receipt, transfer, treatment, storage, distribution, and surveillance are provided and followed.

6. The Engineering Department of the ship is responsible to the Commanding Officer 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 insuring bacteriological purity through disinfection.

7. 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 Depart-

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ment shall notify the Commanding Officer of any discrepancies observed in the water distribution system.

6-3. Shipboard Potable Water.

1. Potable water for shipboard use comes from the ship's distillation plant or from sources ashore. Present distillation plants aboard Naval Ships are designed to make the ship as self-sufficient as possible. These plants are capable of producing potable water from bacteriologically contaminated sea water, provided the specific procedures set forth in Chapter 531 of Naval Ships' Technical Manual are followed. All distillate to be used as potable water must be adequately disinfected. Distillation of water from harbors or from polluted sea water is to be avoided except in emergencies. Sea water must 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 salt water intakes. To prevent the transmission of waterborne diseases, it is essential that potable water be of high quality. Operational checks of distillation plants afloat, inspection, and approval of watering points ashore furnish 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 effective enforcement of standards and surveillance to assure adequate protection from subsequent contamination.

2. Potable water for Naval Ships is obtained by the following means:

- a. Distillation or other approved method.
- b. Shore-to-ship delivery from an approved source.
- c. Shore-to-ship delivery from an unapproved source (when approved source does not exist), refer to Article 6-7.

d. Ship-to-ship.

3. Potable water (water of drinking quality) is used aboard ship for drinking, culinary, laundry, medical, and other purposes.

4. Standards of water quality include physical, chemical, and bacteriological requirements. (Limited testing procedures for evaluating pertinent physical, chemical, and bacteriological quality of shipboard water are discussed in Section XI of this chapter.)

5. Use of sea water in all food services spaces including sculleries is prohibited at all times unless specific written approval for use is obtained from BUMED prior to installation. Sea water outlets in these spaces must be removed. These dangers of cross connections and of using polluted overboard water cannot be overemphasized. Cross connections between the potable water and sea water of other systems are not permitted. Specific garbage grinders which use sea water have been approved by BUMED for use in designated sculleries. Installation of these garbage grinders precludes storage of clean dishware or other items in the scullery. Additionally, salt water connections are permitted on ice cream machines and ice machines for cooling purposes.

6. Seawater (non-potable) is used aboard ships in the fire mains and for general sanitary purposes. Since conservation of potable water is a constant requirement, it is impractical to provide potable water for all purposes. Therefore, it is necessary to use sea water under certain controlled circumstances, such as: flushing weather decks, water closets, urinals and garbage chutes; decontamination showers; and laundering. Water in harbors or off-shore from habitations and when operating in fleet strength must be considered polluted and unfit for uses other than in fire and flushing systems and must not be used for other purposes. If it is necessary in an emergency situation to produce water from contaminated sources, the Medical

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Department must insure that increased surveillance of the system is instituted.

6-4. Potable Water Usage Requirements.

1. 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 result in a reduction of 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 adequate indoctrination and proper supervision are provided. If unusual conditions require drastic restrictions in the use of potable water the allowances should be not less than two gallons per man per day to be used for drinking and cooking purposes.

2. Although modernization of ships is reducing the necessity for this action, the use of sea water in the laundry can effect material savings in the quantities of potable water consumed. Because of the danger of using

polluted water for these purposes and the hazard of cross-connections, judgment and careful supervision must be exercised.

3. The values listed below are general guidelines of the quantities of potable water required aboard ship. Actual consumption will vary widely, depending on the type of the ship, the area in which it is operating, and the type of work personnel are performing. When potable water serves all uses, the consumption rate may be between 12 and 35 gallons per man per day, although the higher figure might be considered wasteful.

Recommended Amounts of Potable Water Aboard Ship

<i>Type of use</i>	<i>Gallons per man Per day</i>
Drinking water.....	0.5- 1.0
Galley and Scullery.....	1.5-4.0
Personal and Hygiene.....	5.0-20.0
Laundry.....	5.0-10.0
Total.....	12.0-35.0

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Section II. RECEIPT AND TRANSFER OF POTABLE WATER

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6-5. General.

1. When receiving or transferring water from an external source improper loading techniques and multiple handling can result in contamination or pollution of potable water. If water taken aboard does not have the required residual, the ship must chlorinate or brominate to the proper residual upon receipt. When the water contains the proper disinfectant residual, the receiving ship is not required to disinfect. A chlorine or bromine

residual determination should be performed prior to the initial transfer of water.

2. All water connections between shore and ships must be made or supervised by authorized shore station personnel. In the event shore personnel are unavailable, ship personnel must assume this responsibility. The individual making the hook-up must insure the hose is not connected to a nonpotable system.

3. When water is being transferred from external sources, all water connections must

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be made by personnel trained in the care of potable water. The Medical Department Representative will determine if the correct halogen residual is present in the water, if not, he must notify the engineering officer.

4. Potable water hoses must not be submerged in harbor water.

6-6. Approved Sources.

1. Potable water may be received from shore facilities or other vessels. The following sources are approved for the procurement of potable water:

a. Facilities owned and/or operated by the U.S. military.

b. Water points listed in U.S. Public Health Service, Food and Drug Administration, publication, "Acceptable Vessel Watering Points Interstate Conveyance Official Classification List." Contact the area Navy Environmental and Preventive Medicine Unit (NAVENPVNTMEDU).

c. 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 war-time 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, STNAG 2136, Minimum Requirements of Water Potability for Short Term Issue (STNAG 2136 is under revision and the new title will probably be, Minimum Standards of Water Potability in Emergency Situation).

d. Other extracontinental source data may be obtained from U.S. military represen-

tatives ashore or NAVENPVNTMEDUS having area responsibility. It is advisable that the Medical Department attempt to obtain this information prior to departure from CONUS.

6-7. Sources of Doubtful Quality.

1. 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 Medical Officer, Medical Department Representative (MDR), or a responsible officer must investigate the source and examine the water as thoroughly as possible with the means available; he must then advise the Commanding Officer 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 6-21.2.d.

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

1. Potable water hoses must 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 of potable water hoses is covered under Article 6-23.

2. The receiving connection of ship potable water risers shall be at least 18 inches above the deck and turned down, except when the risers are located within the ship, such as in submarines. Each hose connection must be fitted with a cap and keeper chain. Ship risers must be properly labeled, color coded, and disinfected prior to each use.

3. Sounding tubes for potable water tanks will be equipped with screw caps attached to keeper chains and must be secured with a lock. On those ships with sounding rods, when not in actual use, the rod should remain in the tube at all times. On those ships utilizing steel

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tapes, the tape must be sanitized prior to each use and must be used for potable water measurements only.

6-9. Connection Procedures.

1. These connection procedures covering shore-to-ship and ship-to-shore transfer of potable water are presented as general guidelines; modification of these procedures may be necessary or required due to ship configuration or operating conditions.

2. Shore-to-Ship.

a. Remove cap and flush pierside potable water outlet for 15 to 30 seconds. Immerse outlet and rinse fitting in a solution containing 100 ppm chlorine for at least 2 minutes. Flush to waste for 15 to 30 seconds.

b. 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 necessary. Connect to pierside outlet and flush.

c. Disinfect shipboard riser connections. Connect hose to the potable water shipboard riser and deliver potable water.

d. When the transfer is completed, se-

cure the shore water source, remove the ship connection, then the shore connection. Thoroughly flush the potable water outlet and recap. Drain the potable water hose thoroughly and store in the potable water hose storage locker.

3. Ship-to-ship transfer of potable water must be accomplished by personnel trained in the handling of potable water. Normally, potable water hoses are provided by the supplying ship.

a. The leading potable water hose should have the cap in place during the high-line procedure.

b. When the potable water hose is secured by the receiving ship, the cap is removed and the hose coupling is disinfected.

c. Both ships disinfect their respective potable water riser connections.

d. The supplying ship connects its end and flushes the hose.

f. 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.

g. The supplying ship then retrieves, couples or caps, and properly stores the potable water hose.

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f. 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.

g. The supplying ship then retrieves, couples or caps, and properly stores the potable water hose.

*h. Iodine can be used
See 247-*

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6-10. Potable Water Production.

1. Distilling plants installed on naval vessels are of three general types, depending on

the source of heat used to evaporate raw water.

a. Steam distilling plants are operated

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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. Another type of water production application approved for shipboard use is the process of reverse osmosis. This application is being installed on several classes of ships and may be the primary mechanism of potable water production for ships of the future.

3. Although the process of potable water production is an engineering responsibility, the Medical Department must be cognizant of the process in order to adequately provide surveillance and recommendations associated with potable water.

6-11. Potable Water Tanks.

1. The construction and location of potable water tanks should prevent contamination of the contents. For full utilization of space, potable water is stored on most ships in inner bottom tanks, other skin tanks, and peak tanks. The ship's bottom, which serves as the outer shell of 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.

2. 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 disinfected.

6-12. Vents and/or Overflow Lines.

1. 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.

1. 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.

1. There are several methods for measurement of water 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

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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.

2. Sounding tapes may be sanitized by soaking the entire tape apparatus in a solution of 100 ppm chlorine for two minutes. Another method which can be used involves wiping the tape with a clean rag soaked in a disinfectant solution such as food service disinfectant, iodine disinfectant or alcohol sponges.

6-15. Filling Lines.

1. Potable waterlines must never be cross-connected to any non-potable line 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. 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.

2. Filling connections (hose valves) must be clearly labeled and color coded in accordance with Naval Ships' Technical Manual (NSTM) Chapter 505. They will be secured with screw caps attached with keeper chains.

3. 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.

6-16. Potable Water Piping.

1. Potable water tanks are usually installed low in the ship and special consideration must be given to the piping that is installed in the bilge area, particularly the piping on the suction side of the potable water pumps where leakage could result in contamination of the potable water system.

2. Piping potable water through non-potable tanks and piping non-potable liquid through potable water tanks must have the

pipe surrounded by sloped self-draining pipe tunnel.

3. Insure that an adequate air gap is provided between the potable water outlet and a non-potable water system, fixture or machine; permanent direct connections must be installed only with approved back flow prevention devices (See Article 6-42.5).

4. All potable water pumps should be airtight 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 and prior to being returned to service.

5. To avoid injuries, the setting for the hot water heaters serving habitability spaces must limit the minimum and maximum temperature of the water at the plumbing fixture to 130°F and 140°F respectfully. Hot water heaters serving other areas (food service, laundry, etc.) are set at appropriately higher temperatures.

6. Charcoal impregnated or other filter equipment shall not be connected to potable water piping outlets. These devices remove required trace halogen residual (dehalogenate) from the potable water and defeat the purpose of residual halogen protection. Dehalogenation equipment already installed must be removed.

6-17. Repairs.

1. If any break, accidental or intentional, occurs in the potable water system, or a potable water tank is entered for any reason, all involved tanks, parts and lines must be disinfected prior to returning the system to use. The Medical Department must be notified of the break or entry and the disinfection procedure accomplished by the engineering department.

2. Potable water piping repairs or the butting-up of flanged joints shall not be accomplished with the use of white lead, or other lead containing substances or putty because

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these contain toxic chemicals. Sealants for use in potable water piping systems must be approved by the National Sanitation Foundation (NSF). Confirmation concerning approved sealants may be obtained by contacting the nearest Naval Sea Support Center (NAVSEACEN).

6-18. Potable Water Tank Coatings.

1. To avoid difficulties with taste, odors, and the danger of contamination by toxic chemicals, only those tank lining materials which are specified by Naval Ships' Technical Manual, Naval Sea Systems Command, and NSF shall be used. Taste and odors may result if the proper methods of application are not followed. The thickness of the coat, the touch-up material, ventilation, temperature, humidity, curing time, etc., are important for proper application.

6-19. Labeling and Color Coding.

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

2. Valves for receiving or supplying potable water must be conspicuously designated

by a warning plate bearing the inscription "POTABLE WATER ONLY" in 1 inch-high letters.

3. Hoses for receiving and discharging potable water must be approved for that purpose by NAVSEASYSCOM, BUMED, OR NSF. Potable water hoses must be labeled "POTABLE WATER ONLY" approximately every 10 feet the end couplings painted dark blue.

4. Potable water hose storage lockers must be identified and labeled "POTABLE WATER ONLY."

5. Potable water lines 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 Lockers.

1. 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.

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6-21. Disinfection of Potable Water Supplies.

1. General.

a. Disinfection of water is required to insure the destruction of pathogenic organisms. Maintenance of a halogen residual is the usual method of guarding against sanitary defects 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 residual provides a safety factor but does not correct unsanitary practices or conditions. In pure water, free halogen residual concentrations as high as 2.0 ppm usually do not cause objectionable 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 of water if the halogen residual (FAC or TBR) is at least 0.2 ppm.

b. Shipboard water is disinfected by the addition of sufficient chlorine or bromine compound to produce not less than 0.2 ppm FAC or TBR after thirty minutes contact time. The amount of chlorine or bromine required to produce a FAC or TBR of not less than 0.2 ppm after thirty minutes can vary widely because of halogen demand (the amount of chlorine or bromine used through reaction with substances present in the water). All water has some halogen demand, even distilled water produced by the evaporators.

c. Disinfectants (halogens).

(1) Chlorine is available for shipboard use as calcium hypochlorite (HTH-65 to 70% available chlorine), 6 ounce bottle, a granular solid or sodium hypochlorite in varying strengths, as a liquid. Common household bleach is a 5.25% solution of sodium hypochlorite. Calcium hypochlorite (HTH) is most frequently used because of its relatively long shelf life and lesser space requirements. However, it should be noted that calcium hypochlorite presents a potential hazard due to its corrosiveness and chemically active nature. This material is classified as dangerous and requires special storage precautions and should be handled and stowed in accordance with Naval Ships' Technical Manual, Chapter 670. Contact between calcium hypochlorite and oxidizable material may result in spontaneous combustion. Calcium or sodium hypochlorite lose strength gradually with age and more rapidly when opened and stored in hot spaces. Calcium hypochlorite should be obtained in six-ounce containers and stored in a cool, dry, well-ventilated place where there is no danger of contact with oxidizable materials.

(2) The ready use stock of six-ounce 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 store-room, berthing space, storeroom, or in the oil and water test laboratory areas. A metal box, such as first aid locker, is recommended for this purpose. Vent holes (such as three ¼ inch holes) shall be drilled in the

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bottom of the box to allow release of any chlorine products. No more than seven day supply shall be maintained in ready use stock at any time.

(3) Storeroom stocks of calcium hypochlorite 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 and bins must be located at least five 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 48 six-ounce bottles shall be stowed in any individual locker or bin. Issue will be made only to personnel designated by the Medical or Engineering Officer.

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

(5) 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 clean, dry, ventilated storeroom. Bromine storage lockers require a hazardous warning plate described, in NSTM 533, Figure 6. Bromine cartridges have shelf life of two years from the date of manufacture. Cartridges exceeding the shelf life can still be used, but may not be as effective.

d. At present, two halogen compounds, chlorine and bromine, are the only approved methods for disinfecting shipboard potable water. Mechanical methods of treatment are preferable to batch treatment procedures (there is no batch treatment with bromine), which are less reliable, require a greater time and effort, and are generally less effective.

e. 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) Brominator treatment installations use two types of brominators. One type is used on the distillate discharge line and the other is used to recirculate water in the potable water tanks during treatment.

(a) The distilling plant brominator is equipped with an orifice that gauges a predetermined proportion of the flow through a bromine cartridge. This device is preset to deliver 0.7 ppm bromine to the water. An additional orifice is being installed on most brominators that allows manual adjustment of flow through the cartridge. The larger orifice is used to increase the bromine absorption rate when an increase of TBR is required or the water has higher than normal halogen demand (see Article 6-21.1.b.). Elemental bromine is washed from the cartridge into the bypassed water stream. One brominator is required for each distilling plant.

(b) The recirculation brominator

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system is designed to treat water in potable water tanks. 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 sources external to the ship or to increase the bromine levels 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. Flow through the cartridge is limited by a timing device to achieve the required bromine feed into the selected tank. After a precalculated period of time, the timing device terminates the bromine feed into the water. Recirculation of water continues for an additional precalculated 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 obtain rapid levels of chlorine in the water supply, particularly in the event of contamination or necessity to superhalogenate.

f. 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 potable water 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 (Refer to the chlorine dosage cal-

culator, Article 6-25). When 65 to 70% calcium hypochlorite 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. The clear fluid (supernatant) is introduced into the sounding tube when the tank is about one-quarter full, add one 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. Sufficient mixing usually will be obtained by 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 one ounce of full strength calcium hypochlorite added to five-thousand gallons of water is the approximate dose for 1.0 ppm initial chlorine concentration. (NOTE: The amount of active chlorine in 65 to 70% calcium hypochlorite 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" (one ounce per five thousand 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

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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.

g. Chlorination or bromination procedures are not adequate until the required FAC/TBR is obtained after the allotted contact time. Required residuals are listed in Article 6-26.

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

2. Halogen Requirements.

a. To assure safe potable water throughout the ship's distribution system, a measurable trace halogen residual must be maintained in all parts of the distribution system. It should be recognized that this requirement is sometimes not achievable in certain sections of the ship, particularly the O levels, where constant usage of potable water is reduced. In the absence of bacteriological contaminants, this lack of measurable residual in the less used outlets should not be a matter of concern, but requires close bacteriological monitoring.

b. 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 thirty-minute contact time.

c. When potable water is obtained from approved sources which use chloramines for disinfection, the area NAVENPVNTMEDU should be contacted concerning testing, treatment and surveillance requirements.

d. 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) in the tanks at the end of a thirty-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 not less than 2.0 ppm FAC

after thirty-minutes contact time. After 2.0 ppm halogen is maintained for 30 minutes in the tank, the water is considered safe for use.

6-22. Disinfection of Potable Water Tanks and Systems.

1. There are two types of disinfection procedures:

a. Mechanical cleaning and chemical disinfection.

b. Chemical disinfection only.

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

3. Mechanical cleaning and chemical disinfection will be accomplished when the condition of the tanks has deteriorated to the point where the chlorine demand has increased significantly and bacteriological evidence indicates that the tank has become grossly polluted. After any tank has been mechanically cleaned, it will be chemically disinfected. Mechanical cleaning and chemical disinfection must be accomplished under the following conditions:

a. Tanks of new ships or tanks which have been rehabilitated or repaired.

b. Where sludge or rust accumulation seriously impairs the quality of water delivered.

c. Tanks which have been loaded with non-potable ballast water.

d. Voids or tanks converted from nonpotable water to potable water tanks. Note: Procedures for converting fuel or similar tanks for storage and transport of potable water are covered in Article 6-31.

4. Butterworthing or mechanical cleaning at sea with sea water is permissible, but must always be followed by chemical disinfection. Mechanical cleaning, especially when done with sea water, promotes rusting of the tanks and is a laborious and time-consuming procedure.

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

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a. Tanks in which there is continued bacteriological evidence of contamination after normal disinfecting procedures.

b. Pipelines, valves, pumps, etc., that have been dismantled, repaired or replaced.

c. Tanks which have been entered.

d. New or contaminated hoses.

6. Tanks which have been filled with clean sea water ballast (not in harbors or within twelve miles from the harbor) do not require mechanical cleaning, but must be chemically disinfected before reloading with potable water. This disinfection is accomplished by chlorinating the ballast water to 100 ppm. Water must be tested at hourly intervals to ensure maintenance of the proper FAC residual. After four hours contact time, the FAC must not be less than 50 ppm. If at anytime during this four-hour period the FAC residual falls below 50 ppm, sufficient chlorine must be added to bring the residual to 100 ppm and the four-hour period started again. The chlorinated sea water ballast may be carried to the destination and discharged upon arrival. The tank is ready for use after flushing with potable water. After filling, it is recommended bacteriological testing be conducted.

7. To chemically disinfect a system, the following steps are required:

a. Introduce sufficient chemical into the tanks to provide at least 100 ppm FAC (refer to Article 6-25, Chlorine Dosage Calculator).

b. Fill tanks with water.

c. All equipment including pumps, valves, lines, and hoses that have been used to carry polluted water must be included in this process in order to disinfect the entire system. Using the ship's pumps, chlorinated water must be drained from each outlet to ensure that all the contaminated parts of the system are subjected to this treatment.

d. The FAC residual after four hours contact time within the tanks and system must be not less than 50 ppm and must be tested at hourly intervals to ensure maintenance of the proper FAC. If at any time during this period

the FAC residual falls below 50 ppm, chlorine must be added to bring the residual to 100 ppm and the four-hour period started again.

e. Water should be pumped out of the lowest opening in the tanks, through the contaminated lines, pumps, and valves and returned to the tank.

8. When more than one tank is to be chemically disinfected, the highly chlorinated water from the first tank should be reused in disinfecting other polluted tanks (additional chlorine must be added to maintain desired residual until all have been treated).

9. If essential to retain this highly chlorinated water for potable water, it can be dechlorinated with sodium thiosulfate or sodium bisulfite; however, large quantities of these chemicals are required with superchlorinated water. If all the chlorine in the water is removed during the dechlorination process, rechlorinate the water to the proper FAC residual to ensure that the required minimum residual is maintained.

10. If it is impractical to disinfect a potable water tank as described above, the following procedure may be used:

a. Thoroughly clean and rinse the tank.

b. Swab all surfaces of the tank with a solution of 100 ppm chlorine, or pump the solution through hoses, and apply to all surfaces of the tank. Adequate personal protective measures and respirators must be used.

(1) Chlorine at 100 ppm may generate vapors that are dangerous to personnel working in these tanks. Entry into these tanks must be authorized by the gas free engineer. (See Naval Ships' Technical Manual, Chapter 074, Volume 3).

c. Strip all water used for superchlorination from the tank.

d. Allow eight hours to dry; forced ventilation may be necessary.

e. Rinse with potable water, and the tank is ready for use. FAC residual of at least 2.0 ppm must be maintained in water transported and stored in these tanks.

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6-23. Disinfection of Potable Water Hoses and Appurtenances.

1. Potable water hoses are disinfected by filling with a solution containing not less than 100 ppm FAC. The solution must be in contact with the entire internal surface of the hose for not less than two minutes. Flush the hose 30 to 60 seconds with potable water prior to use.

2. Prior to connecting the potable water to either the ship riser or the shore source the interior of the fittings must 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 15-30 seconds prior to hookup of the water hose.

3. Disinfection of sounding tapes or rods may be accomplished by wiping the rod or tape with a 100 ppm chlorine solution or other suitable disinfectant compatible with potable water, (e.g., chlorine type disinfectant, food service, liquid iodine, or alcohol sponges).

6-24. Emergency Disinfection of Water for Drinking and Cooling Purposes.

1. If potable water is not available during an emergency, it may be necessary to treat poor quality water for drinking and cooking purposes. The water to be treated should be clean and as free of turbidity as possible. Before this water can be used, it must be chlorinated initially to at least 5.0 ppm FAC with a final residual of at least 2.0 ppm FAC after a 30 minute contact time to make the water safe. Water can also be made safe by holding at a rolling boil for two minutes; however, it would be inconvenient to boil adequate quantities of water. If the water is excessively contaminated or turbid (muddy), consideration should be given to the use of canned or other emergency drinking water sources.

6-25. Chlorine Dosage Calculator.

1. Theory of operation.

a. The figures on the following chart give the "dosage rate" for chlorination. 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 calorimetric test kit.

b. As a rough calculation, a dosage rate of 1 ounce of calcium hypochlorite (65 to 70%) per 5,000 gallons yields 1.0 ppm. Because of chlorine demand, this dosage rate will probably produce a FAC residual of about 0.2 ppm after a 30-minute contact period.

2. Instructions for use.

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

b. The 5% and 10% listings are liquid sodium hypochlorite; thus, the measurements are expressed as volume.

c. The 65 to 70% listings are granular calcium hypochlorite; thus, the measurements are expressed as weight.

3. The standard 2½" 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 are outlined in Chapter 5 of this manual.

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CHLORINE DOSAGE CALCULATOR

PPM	1		5		25		50		100		200						
Avail Chlorine*	65 to		65 to		65 to		65 to		65 to		65 to						
Quantity (Gal)	5%	10%	70%	5%	10%	70%	5%	10%	70%	5%	10%	70%					
50,000	1 Gal	2 Qt	10 Oz	5 Gal	10 Qt	3 lb	25 Gal	50 Qt	15 lb	50 Gal	25 lb	100 Gal	50 Gal	59 lb	200 Gal	100 Gal	119 lb
25,000	2 Qt	1 Qt	5 Oz	10 Qt	5 Qt	1 lb	50 Qt	25 Qt	7 lb	25 Gal	50 Qt	15 lb	50 Gal	25 lb	29 lb	100 Gal	50 Gal
10,000	26 Oz	13 Oz	2 Oz	1 Gal	2 Oz	10 Oz	5 Gal	10 Qt	3 lb	10 Gal	5 Gal	6 lb	20 Gal	10 Gal	12 Gal	40 Gal	20 Gal
5,000	13 Oz	7 Oz	1 Oz	2 Gal	1 Oz	5 Oz	10 Gal	5 Qt	1 lb	5 Gal	10 Qt	3 lb	10 Gal	5 Gal	6 Gal	20 Gal	10 Gal
2,000	6 Oz	3 Oz	26 Oz	13 Oz	2 Oz	1 Gal	2 Gal	10 Qt	2 Oz	2 Gal	1 Gal	1 lb	4 Gal	2 Gal	2 lb	8 Gal	4 Gal
1,000	3 Oz	1.5 Oz	13 Oz	7 Oz	1 Oz	2 Qt	1 Qt	5 Oz	1 Gal	2 Gal	10 Qt	2 Oz	1 Gal	1 lb	4 Gal	2 Gal	2 lb
500	2 Oz	1 Oz	7 Oz	4 Oz	1 Oz	1 Pt	3 Oz	2 Oz	1 Gal	5 Oz	1 Gal	2 Oz	10 Gal	2 Oz	1 Gal	1 Gal	1 lb
200	1 Tbs	2 Tbs	3 Oz	2 Oz	13 Oz	7 Oz	1 Oz	26 Oz	13 Oz	2 Oz	1 Qt	26 Oz	4 Oz	3 Oz	1 Qt	1 Qt	8 Oz
100	2 Tsp	1 Tsp	2 Oz	1 Oz	7 Oz	4 Oz	13 Oz	7 Oz	1 Oz	26 Oz	13 Oz	2 Oz	1 Qt	26 Oz	4 Oz	1 Qt	26 Oz
50	1 Tsp		1 Oz	1/2 Oz	4 Oz	2 Oz	7 Oz	4 Oz	13 Oz	7 Oz	1 Oz	26 Oz	13 Oz	2 Oz	1 Qt	26 Oz	13 Oz
25			1 Tbs	2 Tsp	2 Oz	1 Oz	4 Oz	2 Oz	7 Oz	4 Oz	1 Oz	26 Oz	13 Oz	2 Oz	1 Qt	26 Oz	13 Oz
10				1 Tsp	1 Oz	1 Oz	3 Oz	2 Oz	7 Oz	4 Oz	1 Oz	26 Oz	13 Oz	2 Oz	1 Qt	26 Oz	13 Oz
5					1 Tbs	5 Tsp	2 Oz	1 Oz	3 Oz	2 Oz	7 Oz	4 Oz	1 Oz	26 Oz	13 Oz	2 Oz	26 Oz

* The 5% and 10% columns are liquid sodium hypochlorite and the quantities shown are by volume. The label on the bottle will indicate the percentage of chlorine available. Chlorine percentages other than 5% or 10% can be apportioned. The 65-70% column is granular calcium hypochlorite (HTH) and the quantities shown are by weight.

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6-26 Required Halogen Residuals.

Treatment Required	Chlorination Dosage and Time Requirements (FAC)	Bromination Dosage and Time Requirements (TBR)
1. Minimum residual required for potable water produced onboard or obtained from an approved source.	0.2 ppm after 30 minutes in tanks	0.2 ppm after 30 minutes in tanks
2. Water from area where amebiasis or hepatitis is endemic or unapproved source is used	2.0 ppm after 30 minutes in tanks	2.0 ppm after 30 minutes in tanks
3. Water in potable water distribution system.	*Trace readings throughout	*Trace readings throughout
4. Disinfecting tanks and system.	100 ppm initially; 50 ppm after 4 hr	Not applicable
5. Disinfecting hoses, couplings, and water connections prior to connection to potable water system.	100 ppm for 2 min	Not applicable
6. Scrubbing interior of contaminated tanks when potable water is scarce.	100 ppm	Not applicable
7. Emergency water supply for drinking and cooking.	5.0 ppm after 30 minutes	Not applicable
8. Fuel cargo tanks converted to carry cargo water.	2.0 ppm at destination	Not Applicable

*Note: Measureable trace halogen residuals are acceptable providing bacteriological test results are consistently negative. Measureable trace halogen residuals are defined as detectable color changes noted when using a DPD comparator.

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Section V - POTABLE WATER, SUBMARINES/YARD CRAFT

Submarines	-----	Article 6-27
Yard Craft	-----	6-28

6-27. Submarines.

1. Submarines are exempted from routinely halogenating potable water supplies while at sea. However, should bacteriological analysis show evidence of contamination of the potable water supply, it must be chlorinated using calcium hypochlorite (HTH) 65 to 70% until a residual of 0.2 ppm FAC is obtained after a 30-minute contact time. This residual must be maintained until the source of contamination is identified and corrected. When using calcium hypochlorite, 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.

2. Cleaning and disinfecting tanks is outlined in Article 6-22.

3. The storage level of 65 to 70% calcium hypochlorite for submarine use is contained in the Type Commander Medical Guide.

4. The individual bottles of calcium hypochlorite must be sealed in plastic bags and stored only in a medical instrument box, plastic rigid, size 9% x 9 x 7 inches, NSN 6545-00-131-6992. 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.

5. Each bottle of calcium hypochlorite must be inspected prior to deployment or at least every three months. Bottles with deteriorated seals must be discarded and replaced.

6. Bacteriological examination of potable water must be performed weekly on a minimum of four samples representative of the distribution system. The current method of analysis is the test for total coliform, using the

membrane filter technique (MF); however, the multiple tube fermentation technique (MTF), the Pressense-Absence Coliform Test (PA) and the Minimal Media ONPG-MUG Test) have been authorized by the Environmental Protection Agency (EPA) (beginning 31 December 1990) and may be used if desired. The results of all testing will be reported as "presence" or "absence". See Appendix F, Chapter 5, of this manual.

a. 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.

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

c. The Medical Department Representative will maintain a waterlog and enter water source, date, bacteriological testing and any disinfection procedure used, and halogen readings if accomplished.

7. Color coding, labeling, disinfection, and storage of potable water hoses are covered under Sections III and IV of this chapter.

6-28. Yard Craft.

1. Yard craft usually have no water producing capability potable water is transferred from ashore facility and used. Most yard craft are equipped with a potable water storage tank and a limited distribution system. Disinfection of the water should not be required if adequate and safe potable water is transferred from the shore facility. Most problems associated with contamination of water aboard yard craft are usually the result of improper transfer procedures.

2. Routine testing for halogen residual,

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pH, and salinity is not usually performed due to the lack of personnel and equipment. Medical Department personnel (preventive medicine department) shall maintain close contact with the Port Services Officer and will provide surveillance procedures to ensure a safe water supply.

3. The Port Services Officer, the Medical Department (local preventive medicine department) of each group of yard craft, and the local Medical Department must develop a system for collection and examination of water

samples. 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 Medical Department (local preventive medicine department) shall investigate the source of contamination and provide recommendations regarding correction and disinfection. It may be necessary for the Medical Department to supervise disinfection operations.

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Section VI — CARGO WATER

	<i>Article</i>
Handling of Ballast Water	6-29
Handling of Cargo Water	6-30
Temporary Water Ships	6-31

6-29. Handling of Ballast Water.

1. 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. Disinfection of this system shall be accomplished as described in Section IV of this chapter.

2. Water placed in these tanks must not be used for drinking or culinary purposes until it has been adequately disinfected and a bacteriological analysis is negative. 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.

6-30. Handling of Cargo Water.

1. Water Ships, Barges, and Yard Craft.

a. Water must be taken from approved watering points (see Article 6-6) whenever possible.

b. The water must be loaded in a manner that prevents contamination see Article 6-9).

c. Vessels transporting potable water-

must maintain records of the following.

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

(2) Daily halogen residual.

(3) Daily pH.

(4) Results of bacteriologic testing.

d. Water vessels will 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 must be added to ensure that at least 0.2 ppm halogen residual is present in the water when delivered.

e. Water received from an unapproved source must be halogenated to at least 2.0 ppm after 30 minutes contact time; thereafter, the residual must be maintained at or above 0.2 ppm.

2. Receipt of Cargo or Transferred Water.

a. The Medical Department of the receiving ship must test the halogen residual of the water prior to loading. It should be received with a minimum residual of 0.2 ppm.

b. If the water does not contain a halogen residual of at least 0.2 ppm, it will be neces-

CHAPTER 6. WATER SUPPLY AFLOAT

sary for the Engineering Department to treat the water in the receiving tanks prior to use in the distribution system.

c. If the water is from an unapproved source, the Medical Department must conduct bacteriological examination of the water prior to and after adequate disinfection to 2.0 ppm to ensure bacteriological quality.

d. The Medical Department must ensure that appropriate entries are adequately documented in the water log regarding source, halogen residual, bacteriological examinations, and recommendations.

e. If the water transferred to the ship does not contain the required halogen residual, appropriate local naval health authorities and the area NAVENPVNTMEDU should be officially notified.

6-31. Temporary Water Ships. When it is necessary to convert tanks commonly used for other liquids for transporting potable water in emergency situations, the following procedure is designed to provide temporary storage and transfer of potable water:

1. Tank Selection and Preparation.

a. Tank Selection Procedures.

(1) Tanks selected for transport or storage of emergency potable water must be coated with a coating approved by NAVSEASYSKOM or NSF for potable water tanks. Approved potable water tank coating systems are listed in Naval Ships' Technical Manual, Chapter 631. Coatings not on the approved list will be referred to BUMED (listing manufacturing company and chemical ingredients) for approval. This request must include a history of past cargo carried in the tanks.

(2) BUMED and NAVSEASYSKOM will review the request for tentative approval of the coatings for use in transporting potable water. If the coatings are incompatible for use with potable water, the request will be disapproved. If the coatings are acceptable, tentative approval may be granted to proceed with additional evaluations of the tank conditions.

b. Tank Preparation Procedures.

(1) Prior to entering port and restricted water, the tanks should be "butterworthed" to provide some initial cleaning.

(2) Machine wash tanks with warm (100°—125° F), uncontaminated sea water according to the methods described in the "Cargo Tank Cleaning Manual, "NAVSHIPS 0900-016-0010. Type commanders can supply this manual to each ship selected for water-carrying missions.

(3) Pump the warm sea water overboard through the fueling station valves giving special attention to all lines, pumps, and strainer boxes.

(4) Ventilate tanks until a gas-free condition exists. (See Naval Ships' Technical Manual, Chapter 074, Volume 3.) Observe all safety precautions prior to entering the tanks.

(5) Strip tanks of all remaining water.

(6) Mucking may be necessary. The sludge and sediment must be removed from the tank after scraping the scale from the tank surfaces.

c. When the tanks are cleaned and all surfaces are viewable, they must be inspected by designated engineering personnel for the following conditions:

(1) Well-adhered coating.

(2) Total dry-film thickness.

(3) Excessive rust.

(4) Completeness of coatings,

(5) Blistering and peeling.

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

(7) Any other potable water degrading conditions.

d. 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:

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(1) Using high pressure spray, clean all tank surfaces with fresh water and detergent.

(2) Remove all scaling and rust.

(3) Pumps must be dismantled and cleaned with fresh water and detergent. Remove and replace all gaskets. The replacement gaskets shall be of material approved for use with potable water.

(4) All lines must be flushed with fresh water and detergent.

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

(a) 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 Naval Ships' Technical Manual, Chapter 505, Piping Systems.

(b) 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.

(c) Identify water collection points on each tank for testing purposes.

(d) Identify chlorine introduction points for each tank.

(6) Complete tank cleaning and repair.

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

(8) Disinfect tanks and related piping in accordance with Article 6-22. Strip super-chlorinated water from the tanks. Force-ventilate the tanks for eight hours to air dry.

(9) Vents to all potable water tanks must be screened with 18-mesh or finer noncorrosive wire and must not terminate in spaces where contamination may be transmitted to the water. Since most fuel tank vents are outside the ship, the locations of the vents should be identified and observed for possible external contamination which could be introduced into the tanks.

(10) Proper care and storage of potable

water hoses is discussed in Articles 6-20. and 6-23.

(11) Hoses used for previous transfer of fuel or other liquids will not be used for transfer of potable water. Only hoses approved for contact with potable water will be used for transferring potable water.

2. Transporting and Storage of Potable Water.

a. The water will be loaded aboard the ships from approved watering points (Article 6-6.).

b. Potable water loaded aboard converted ships must be chlorinated to 5.0 ppm. If available at the watering point, an in-line hydraulically-actuated or an electric motor-driven chlorinator should be used. If a chlorinator is not available, the "batch chlorination" method will be used (Article 6-21.1.f.).

c. On initial loading, an adequate number of tanks should be left empty or several tanks should not be filled to capacity in order that the potable water can be pumped from one tank to another to provide aeration and agitation.

d. Lead and hydrocarbon determinations must be made on all tanks after filling to ensure that the water is free from contaminants and to provide a baseline for future testing and analysis. Type command medical officers will arrange for collection of samples and laboratory analysis.

e. Thirty minutes after filling, check all tanks for FAC. If any tank has less than 2.0 ppm. "batch chlorinate" until the tank is restored to 2.0 ppm FAC.

3. Transfer of Water for Use.

a. Water transferred from the ship for human consumption will contain 2.0 ppm FAC.

b. Water transferred from the ship for human consumption will be bacteriologically negative. A bacteriological analysis must be conducted no later than one week prior to transfer.

c. Qualified medical personnel should monitor the procedures used for transfer of

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potable water from the ship. Hoses previously used for fuel or other liquids will not be used for the transfer of potable water. Only

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Section VII — EMERGENCY WATER SUPPLIES

	Article
Battle Dressing Station -----	6-32
Emergency Potable Water, 5-Gallon Container _____	6-33
Boats, Rafts, and Battle Stations -----	6-34

6-32. Battle Dressing Stations.

1. Most ships are equipped with built-in potable water storage tanks of sufficient size in battle dressing stations to provide an alternate source of water in emergency situations. The tanks are designed for gravity flow and are isolated from the main potable water system. A piping diagram is provided for each tank with appropriate instructions for filling and emptying.

2. Maintenance.

a. Once each quarter all emergency potable water storage tanks must be drained and refilled with potable water containing a trace halogen residual.

b. At least every three years, all emergency potable water tanks must be opened and inspected for evidence of sludge or foreign material. Based on the results of this visual inspection, it may be necessary to thoroughly clean the interior of the tank. A new gasket may be required each time the tank is opened for inspection. These tanks must be disinfected, in accordance with Article 6-22, each time they are opened.

c. Bacteriological analysis of water from each tank, must be performed after filling and monthly thereafter. If this analysis indicates a tank is contaminated, the tank must be opened, inspected, cleaned, if necessary, and disinfected.

d. Routine halogen residual tests are not required.

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

1. Some small ships store emergency potable water supplies in 5-gallon 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.

2. There are currently two types 5-gallon containers in the stock system available for the storage of potable water; one is of a heavy gauge plastic type material and the other is metal. Under no circumstances will 5-gallon containers previously used for gasoline or other petroleum products be used as emergency potable water containers aboard ship.

3. Examination of Water Containers Prior to Disinfection and Filling.

a. The initial step consists of careful examination of the containers to insure the containers have not been used for any purpose other than the storage of potable water. Each container shall have the word "WATER" either embossed or painted on the exterior surface in letters at least 0.25 inches high.

b. Each container will then be physically inspected for the following conditions:

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

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

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

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

(5) Carefully inspect the cap to insure that it seats properly to the sealing surface.

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

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

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

4. Manual washing is accomplished with warm water (110-125°F), the recommended amount of approved hand dishwashing detergent, and a suitable long-handled, slender brush. (General purpose detergent must not be used to clean emergency water containers.) Thorough rinsing with potable water is necessary.

5. All interior surfaces must be disinfected by exposure to a chemical disinfectant solution for at least two minutes. Approved chemical disinfectants for these containers include: calcium/sodium hypochlorite, chlorine-iodine type disinfectant (food service), or liquid iodine (25 ppm).

6. Potable water used for filling emergency containers must contain a trace FAC or TBR.

7. Each can must be labeled with date of filling and source of the potable water.

8. The 5-gallon containers should be stored

in a clean dry place in the immediate vicinity of anticipated use (battle dressing station without emergency potable water tanks).

9. These containers must be emptied, flushed and refilled with potable water containing a trace FAC or TBR every 3 months.

10. Halogen residual and bacteriological tests are not required.

6-34. Boats, Rafts and Battle Stations.

1. If canned drinking water is stored for emergency use in boats, rafts, battle stations, battle dressing stations or storerooms, it must be inspected as indicated below. However, these inspections must not include water supplies in encapsulated rafts where the raft is opened and repacked at selected shore facilities.

a. Exterior Inspection. The exterior inspection of canned drinking water is a Medical Department function which must be conducted at least quarterly to insure that the water is properly stored and safe for consumption. The exterior of the can must be examined for general appearance, dents and rust. Cans having dents which cross the ends or side seams, or which crinkle the metal to a point should not be used. Rusted cans maybe used provided the rust does not penetrate the can; rust that can be wiped off is not penetrating. Any containers that exhibit evidence of leakage or are severely distorted must be replaced.

b. Interior Inspection. The interior inspection of canned drinking water is a Supply Department responsibility which should be performed approximately every two years. This requirement and inspection criteria is specifically outlined in NAVSUP Pub 486.

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Section VIII. EVALUATION OF TASTE AND ODOR PROBLEMS IN SHIPBOARD POTABLE WATER

Table with 2 columns: General and Article. Rows include: General (6-35), Causes of Taste and Odor in Potable Water (6-36), Indicators of Taste and Odor Problems (6-37), Initial Evaluation of Taste and Odor Problems (6-38), Control Measures for Taste and Odor Problems (6-39), Request for Outside Assistance (6-40).

6-35. General

1. 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 a poor tasting water will affect coffee, and other beverages. Aboard ship, there are no water treatment processes to easily control taste and odor problems which develop. Generally, water produced by the ship distillation plant is good quality and is the least likely source of problems. A ship is a mobile environment and must rely on a variety of water sources; shore, barge, other ships, etc. Aboard ships there is a variety of piping systems which, if not isolated, maybe a source of severe problems. 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.

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

1. The following conditions or situations have been identified as a source of potable water contamination resulting in severe taste and odor problems aboard ship. Each individual item must be considered as a possible source of taste and odor.

- a. Cross-connections with non-potable systems.
b. Leaks in common bulkheads between potable water tanks and fuel tanks, ballast tanks, bilges, and wastewater tanks.

- c. Leaks in non-potable piping through water tanks.
d. Improper disposal of chemicals or liquids through potable water-sounding tubes.
e. Utilization of potable water hoses for non-potable liquids.
f Excessive storage time of water in tanks.
g. Improper distillation processes in harbors which are contaminated with industrial or biological wastes.
h. Inadequate disinfection procedures resulting in development of chloramines.
i. Transfer of water from shore facilities or barges which have taste and odor problems.
j. Potable water tanks used for ballast or other liquids, and not cleaned or disinfected properly.
k Deteriorated or improperly applied tank coatings.
1. Distilling plants producing potable water while stripping JP-5 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.

1. The Medical Department has a direct responsibility 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 analysis of the potable water on a weekly

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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.

a. Crew complaints. If there is a taste and odor problem in the potable water supply, medical and engineering personnel will usually be the first to know, since a variety of complaints will be forthcoming from crewmembers. These initial complaints can provide important data, particularly if the complaints are associated to a segment of the crew, a specific location, or 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 evaluating the problem of taste and odor.

b. Bacteriological analysis. If the cause or source of the taste and odor problem is a result of biological growth in the tanks, the membrane filter technique may not necessarily be of assistance in identifying the biological source. The bacteriological testing performed is designed to identify bacteriological contamination of coliform organisms which are indicators of fecal contamination. The culture media used in testing is restrictive to the growth of many organisms, which may contribute to taste or odor problems. 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 biological growth in the tanks. There are other methods which can be utilized to determine the source of the problem.

c. Halogen (chlorine or bromine) residuals. Perhaps the most effective and practical tool in the evaluation of problems associated with a water system is the halogen test for chlorine or bromine. It can be performed rapidly and provide a great deal of information regarding the conditions within the potable water tanks and distribution system. Presuming that water received from an external source or produced within the ship has been properly disinfected, there is an initial

amount of chlorine or bromine within the tanks. All water received from external sources to the ship would be treated with chlorine, since there are no shore facilities utilizing bromine for disinfection at the present time. As the tanks are placed on-line, the chlorine or bromine residual should be detectable at points throughout the distribution system, the halogen determinations can be accomplished at the tank and at various points in the distribution system to identify possible sources of problems by measuring the loss of disinfectant in the system.

2. Disinfectants, such as chlorine or bromine, react with virtually any substance in water and, through this process, may be neutralized. The utilization 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 tanks and no halogen residual is present or it disappears at some point in the distribution system, this is indicative that some substance has used or neutralized the disinfectant 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/questions represent a standardized approach to complaints received or experienced with taste and odor in the potable water supply. The evaluation of these items by medical department person-

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nel 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 NAVENPVNTMEDUS or other organizations tasked to evaluate the problem.

1. When was the problem first noticed or initial complaints received?

a. This date and time maybe related to a particular tank, a section of the piping system or repairs/maintenance associated with the system.

2. What is the source of the water? “

- a. Shore (direct pressure).
- b. Ship's tanks filled with shore water.
- c. Mixture of water remaining in ship's tanks and shore water.
- d. Barged water.
- e. Another ship.
- f. Produced by ship's distiller.

3. Does the water have a characteristic taste or odor?

a. This is quite vague, but it is sometimes possible to determine the source of a water problem through a characteristic taste or odor.

4. Is the problem isolated to one section of the ship, or does it occur throughout the ship?

a. If the problem is limited to a particular section of the ship, the investigation should be oriented to occurrences effecting 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.

5. Is the problem continuous or does it occur only while a particular tank is on-line?

a. 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. Additionally, use halogen residual testing to observe if there is increased halogen demand in the tank or particular sections of the piping system.

6. Can halogen (chlorine or bromine) residuals be maintained in the system?

a. The routine surveillance program using halogen residual testing should have identified this problem in the system. It is important at this time to make sure that testing is conducted at the tank which is on line and several points in the system. If the proper residual is not present within a tank after adequate disinfection and contact time, the problem may be within the tank or related to inadequate disinfection practices.

7. Has the ship experienced similar taste and odor problems in the past?

a. Discussion with engineering personnel may provide information associated with a similar problem in the past.

8. Review the potable water log to identify fluctuations which may be occurring in the potable water distribution system.

a. 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 three 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.

9. Identify potable water tanks with common bulkheads to fuel, ballast, other tanks or bilges.

a. 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 nonpotable liquids which may contaminate the potable water system must not be overlooked as the source of that problem.

10. Identify any non-potable piping which has been permanently installed through potable water tanks.

a. 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 en-

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trance to the tanks, but medical personnel should be aware of the location and existence of this type of piping.

11. Evaluate water disinfection procedures by engineering personnel to ensure that proper amounts of disinfectants are used.

a. While treatment of water, including disinfection, is an engineering department responsibility, it is necessary for Medical Department personnel to have an understanding of the system and review the procedures for disinfecting to insure that the proper amounts of halogens are being added to achieve the necessary chlorine or bromine residuals in the distribution system.

12. Identify any repair/maintenance operations conducted on the potable water distribution system which could have contributed to the taste and odor problem.

a. 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/maintenance procedures. The operations should be reviewed and correlated to the location within the system as possible sources of contamination.

13. Has medical surveillance been maintained on the water remaining in potable water tanks while the ship is at the pier on direct service?

a. Too often, 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.

14. Are potable water tanks evaluated through halogen testing or bacteriological analysis prior to filling the tanks with shore water?

a. 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.

15. Identify the type of coating, date and location of application for each potable water tank.

a. 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.

1. 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 of utmost importance to the ship. 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.

2. 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 which may be present in the tanks or piping system. Therefore, ships which have not been able to identify a source of the taste and odor should add sufficient chlorine to provide a dosage of 5 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.

3. The use of steam application has been successfully used in treatment of taste and

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odor problems associated with uncured potable water tank coatings. The actual steam application procedure is accomplished by ship personnel with outside assistance from the area NAVENPVNTMEDU and the Naval Sea Systems Command (NAVSEASYS COM).

a. 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 one 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.

b. The use of steam application to identify uncured coatings should not be accomplished without prior approval of NAVSEASYS COM.

6-40. Request for Outside Assistance.

1. 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 engi-

neering personnel should be prepared to discuss the evaluation of specific items outlined in Article 6-38.

2. NAVENPVNTMEDU personnel will thoroughly evaluate all aspects of the taste and odor problem on board the ship, if possible. If the NAVENPVNTMEDU personnel cannot provide onboard assistance due to geographical location, the closest preventive medicine department will be requested to provide onboard assistance in reviewing the problem.

3. 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 the Naval Sea Systems Command (NAVSEASYS COM), Washington, 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 NAVSEASYS COM representatives in the evaluation and testing of tank coatings aboard the ship.

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a. 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 one 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.

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Section IX. CROSS-CONNECTIONS

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Defective Piping Installations	6-43
Medical Department Surveillance	6-44

6-41. General.

1. 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. Constant inquiry and surveillance are required by the Medical Department Representative in the identification of potential cross-connection problems due to biological or chemical sources. In contrast to a shore facility, plumbing aboard ship is a maze of piping systems fitted into a relatively compact space. The

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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.

6-42. Definitions.

1. 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.

2. 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.

a. Backflow. Nonpotable water or other substances enter a potable water system through a cross-connection when the pressure of the nonpotable system becomes greater than the pressure in the potable water system.

b. Back-siphonage. Nonpotable 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.

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

4. 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 two potable water supply pipe diameters between the outlet and the highest possible liquid level in the receiving object but never less

than one inch.

5. 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, dishwashing machines, etc. There are numerous types of backflow or backsiphonage prevention devices, the most common being vacuum breakers. (*A valve located between a potable and nonpotable system is not an acceptable method of cross-connection control.*)

6-43. Defective 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 defective piping installations of potable water systems that have been observed or identified as the cause of disease outbreaks aboard ship are as follows:

1. Backflow.

a. Salt and potable waterlines connected to a common line or outlet.

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

c. Boiler feedwater and potable water lines connected to a common line.

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

2. Back-siphonage.

a. Laundry trays, wash basins, service sinks and deep sinks with faucets below the fill level.

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

c. Therapeutic tubs or steam tables with inlets below the fill level.

d. Improperly installed water-operation waste ejectors, i.e., dental units, potato peel-

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ers, and garbage grinders.

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

6-44. Medical Department Surveillance:

1. The following equipment is normally hardplumbed or has permanent flexible hose installed and is to be provided potable water via a reduced pressure backflow preventer installed above the overflow level: garbage grinders, x-ray developing machines, photographic chemical mixing tanks, and photographic film and print processing machines.

2. Throughout the ship, where ever a hose bibb faucet permits connection of a hose to the potable water system, a reduced pressure backflow preventer must be installed. Examples are deep sinks, and galley and weather deck washdown faucets. The reduced pressure backflow preventer must be a model approved by the Foundation for Cross-connection Control and Hydraulic Research, University of Southern California, Los Angeles, CA 90012.

3. During the course of sanitation inspections, water surveillance inspections, and while collecting water samples and performing halogen residual tests, Medical Department Representatives should routinely observe for cross-

connections. Modification or repairs to existing potable water systems aboard ship should alert the Medical Department Representative 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, the primary responsibility of the Medical Department is to prevent a disease outbreak from occurring. Therefore, recommendations to secure the affected part of the potable water system would be appropriate until such time as the cross-connection is eliminated and the potable water system disinfected, if necessary.

a. Only Environmental Protection Agency (EPA) or NSF approved tracer dyes are to be used in potable water systems. Fluorescein sodium USP and Rhodamine WT(trade name) are EPA approved dyes and must be used as labeled. The area NAV-ENPVNTMEDU can provide additional information concerning safe use of tracer dyes. Standard sea marker dye is not approved for use in potable water systems.

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ers, and garbage grinders.

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

6-44. Medical Department Surveillance:

1. The following equipment is normally hardplumbed or has permanent flexible hose installed and is to be provided potable water via a reduced pressure backflow preventer installed above the overflow level: garbage grinders, x-ray developing machines, photographic chemical mixing tanks, and photographic film and print processing machines.

2. Throughout the ship, where ever a hose bibb faucet permits connection of a hose to the potable water system, a reduced pressure backflow preventer must be installed. Examples are deep sinks, and galley and weather deck washdown faucets. The reduced pressure backflow preventer must be a model approved by the Foundation for Cross-connection Control and Hydraulic Research, University of Southern California, Los Angeles, CA 90012.

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Section X — MANUFACTURE AND HANDLING OF ICE

	<i>Article</i>
Manufacture _____	6-45
Special Precautions _____	6-46
Cleaning and Disinfecting _____	6-47
Bacteriological Quality _____	6-48

6-45. Manufacture.

1. Manufacture of ice aboard ships is accomplished with ice cube machines or ice makers in most instances. A few small pantries, galleys, general messes and very small ships still maintain ice cube trays for the

manufacture of ice. All ice to be used for food or drink and for maintaining food at acceptable temperatures must be prepared from potable water in order to reduce bacterial growth. Regardless of the end use, all ice must be prepared in a sanitary manner and

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afforded the same protection as water.

6-46. Special Precautions.

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

a. All ice must be prepared from potable water.

b. Ice machines must be plumbed properly to eliminate the possibility of cross-connections and back-siphonage.

c. The ice machine drain from the ice storage compartment must be provided with an air gap between the ice storage compartment and the deck drain.

d. Ice must be removed from the storage hopper by the use of an ice scoop. The ice scoop must 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.

e. The ice scoop is considered to be food service equipment and, therefore, should be washed, rinsed, and sanitized at least daily. For this reason the permanent installation of ice scoops with chains or other permanent attachments is discouraged.

f. Some ice cube machines are fitted with salt water cooling systems. The discharge

from this system should be hardplumbed or extend into the deck drain without an air gap to prevent or reduce space contamination. This is an acceptable salt water connection, but the Medical Department Representative should be aware of the salt water piping above the storage hopper and monitor the system for salt water leakage and subsequent contamination of the ice.

6-47. Cleaning and Disinfecting.

1. Disinfection procedures for ice cube machine hoppers and flaking devices are contained in NAVMED-P-5010, Food Service Sanitation.

6-48. Bacteriological Quality.

1. Samples of ice must be collected from $\frac{1}{4}$ of the ice machines weekly for bacteriological examination and must conform to the standards for potable water.

a. If samples of ice collected for bacteriological analysis are positive for coliform organisms, the storage bin should be emptied, cleaned and disinfected.

b. Ice samples which are contaminated are usually the result of improper ice handling techniques or dirty storage bins.

2. Results of bacteriological examinations of ice samples must be entered on the potable water log.

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Section XI — WATER TESTING REQUIREMENTS AND PROCEDURES

	<i>Article</i>
Scope	6-49
Temperature and pH	6-50
Salinity	6-51
Halogen Residual (Chlorine/Bromine)	6-52
Bacteriological Collecting and Testing	6-53
Potable Water Log	6-54

6-49. Scope.

1. 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 Waterworks Association (AWWA), and the Water Pollution Control Federation (WPCF). The tests indicated here are minimal for water from approved sources and must be supplemented by additional tests when the water source is of doubtful quality.

2. The analysts of water for suspected chemical contaminants is very complex. The equipment necessary for performing these determinations is not available aboard ship. In the event that chemical contamination is suspected, with or without illness, it will be necessary to request outside assistance as soon as possible. Request for such assistance should be directed to the appropriate type commander with a copy to the area NAV-ENPVNTMEDU.

6-50. Temperature and pH.

1. 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 high temperatures may rapidly affect

cartridge utilization.

2. Testing for pH is routinely performed by the Ship’s Engineering department on boiler feedwater. The test may be used for potable water and is outlined in the Naval Ships’ Technical Manual, Chapter 220, Volume 2.

3. 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.

1. When operating in sea water, the 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 must be instituted.

a. Salinity testing is routinely accomplished by the engineering department on boiler feedwater, they must also test the potable 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.

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6-52. Halogen Residual (Chlorine/Bromine).

1. This is an extremely important test since the biological safety of potable water is dependent upon residual concentrations of free available chlorine (FAC) or total bromine residual (TBR). 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 calorimetric 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 reset rapidly therefore, an immediate reading of the result is necessary (60 seconds or less).

2. Surface ships must maintain a minimum trace FAC or TBR in the potable water distribution system after initial treatment. 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 or an area where amebiasis or infectious hepatitis is endemic, the initial treatment in the storage tanks shall be 2.0 ppm after 30 minutes contact time.

3. Testing for halogen residuals should be routinely performed by Medical Department personnel under the following conditions:

a. Prior to receiving potable water on board.

b. In conjunction with each potable water sample collected for bacteriological analysis.

c. 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 will be determined by the size of the ship; no less than four samples will be collected. On DD, DDG,

FFG, LST, MSO, and other ships with complements below 500, four samples are required. On LPH, LHA, LSD, and other ships with complements over 500 and below 4,000, 8 samples are required. On CV, CVN, and other ships with complements above 4,000, 12 samples are required.

4. The Engineering Department has a responsibility for testing chlorine or bromine residuals in the potable water tanks after thirty minutes contact time. This testing should be considered as part of the evaluation of the treatment process.

5. Chlorine or bromine residuals are determined by using the DPD (diethyl-p-phenylene diamine) test.

a. DPD Test. The comparator supplied with this test kit gives direct readings for both chlorine and bromine. This chlorine/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 instructions for testing should be followed. The following general procedure is used to obtain both FAC and TBR:

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

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

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

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

(5) REMOVE THE CAP FROM THE TEST TUBE and immediately compare the test sample color with the color standards in

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the comparator. Color matching should be completed within sixty seconds after addition of the DPD No. 1 tablet. Delays of 2 minutes or more must be avoided.

(6) 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.

(7) When testing a water supply that uses chloramines as the disinfecting agent, the total residual chlorine can be determined by using DPD tablet No. 4. The use of this tablet will not differentiate the type of chlorine, but will indicate the level of total disinfectant present. If it is necessary to determine the type of chlorine present other than FAC or total chlorine residual, specific guidance may be obtained from the area NAV-ENPVNTMEDU or local preventive medicine department. The test procedures for total chlorine residual are as follows:

(a) Rinse the test tube with the test sample, then fill to the mark.

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

(c) The color that results represents the total residual chlorine.

(8) 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.

(9) When testing for extremely high levels of chlorine, such as superchlorination, it will be necessary to dilute the water to be tested in order to determine the chlorine residual. A 1:10 dilution using distilled water as the diluent is satisfactory for this purpose; to determine the chlorine residual a multiplication factor of 10 is necessary.

(10) 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.

6-53. Bacteriological Collecting and Testing.

1. The test measure aboard ship for determining the suitability of water for human consumption is bacteriological purity. The main purpose of the disinfection procedure is to destroy pathogenic organisms present in the water. Adequate disinfection is demonstrated by bacteriological testing.

2. Bacteriological examinations must be performed 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 shorelines. 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.

3. The number of samples should be based on the size of the ship's distribution system. In no instance should less than four samples be examined weekly. On DD, DDG, FFG, LST, MSO, and other ships with complements below 500, four samples are required. On LPH, LHA, LSD, and other ships with complements over 500 and below 4,000, 8 samples are required. On CV, CVN, and other ships with complements above 4,000, 12 samples are required to provide adequate representation. Special or more frequent samples will be collected and tested whenever chlorine demand increases, contamination is suspected, after cleaning and disinfecting tanks, and upon completion of repairs to the system.

4. Microorganisms of the coliform group are indicators of fecal contamination. Approved (by EPA) methods of testing for total coli-

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forms include the 10-tube multiple tube fermentation technique (MTF), the membrane filter technique (MF), the Presence-Absence Coliform Test (P-A) and the minimal media ONPG-MUG test (MMO-MUG).

The membrane filter technique has been the method of choice to determine whether or not coliforms are present in potable water distribution systems aboard ship and will be discussed in this chapter:

a. Effective 31 December 1990, the Maximum Contaminant Limit (MCL) for coliform bacteria (also called Total Coliforms) is based on the presence or absence of coliforms in a sample rather than on an estimate of coliform density.

(1) The MCL for systems analyzing fewer than 40 samples per month: no more than one sample per month may be total coliform-positive.

(2) The MCL for systems analyzing at least 40 samples each month: no more than 5 percent of the monthly samples may be total coliform positive.

b. Each shipboard potable water system must be sampled as required by Paragraph 6-53.3 above.

c. Each system must collect a set of repeat samples for each total coliform-positive sample and analyze them for total coliforms. At least one repeat sample must be from the same tap as the original sample. Two other repeat samples must be collected from within five service connections of the original positive sample. One sample must be upstream and another downstream. If the original positive sample is at the end of the distribution system, two samples will be collected downstream.

d. If any routine or repeat sample is total coliform-positive, that culture must be analyzed for fecal coliforms or *E. coli* using EPA approved methods. Test methods for fecal coliforms are found in *Standard Methods for the Examination of Water and Wastewater*.

E. coli analysis must be conducted using methods described in the Federal Register of 8 Jan 91 (56 FR 642) and/or Standard Methods. However, if all coliform-positive samples are also considered fecal coliform/*E. coli*-positive, farther testing for shipboard systems is not required. In this case, each total coliform-positive sample is also considered fecal coliform/*E. coli*-positive and is counted in the monthly MCL. Smaller ships will probably not be capable of fecal coliform or *E. coli* confirmation analysis. They must consider all total coliform-positive cultures as fecal coliform/*E. coli* positive. Fecal coliform/*E. coli* confirmation of total coliform-positive cultures or considering each total coliform-positive 'culture as fecal coliform/*E. coli*-positive remains optional for ships with the capability of confirmation testing for fecal coliforms/*E. coli*.

5. Weekly ice samples must be collected from ¼ of the ice machines on a rotating basis for bacteriological examination. Ice must conform to the standards for potable water.

6. Materials and Preparation for Membrane Filter Test.

a. Most ships will be equipped with a membrane filter bacteriological testing kit. Kits and replacement parts are available from the standard stock catalog.

b. Glass collection bottles should be clean and well rinsed to remove all traces of detergent. Into each bottle with a 4 ounce capacity, place 2-3 drops of the 10% sodium thiosulfate solution (prepared by dissolving 10 gm sodium thiosulfate in 100 ml distilled water). Use 4-6 drops of 10% sodium thiosulfate for an 8 ounce bottle. Loosely cap or stopper the bottles and autoclave at 121° C for 15 minutes at 15 psi. After autoclaving and cooling, tighten the caps or stoppers. Commercially prepared, Environmental Protection Agency approved, plastic water collection bags containing sodium thiosulfate are available from standard stock and may be used instead of glass bottles.

c. "*Standard Methods for the Examination of Water and Wastewater*" specifies that

two separate stock solutions are required to prepare a working solution of the phosphate buffer rinse. For convenience, these two stock solutions will be designated "Solution A" and "Solution B".

(1) "Solution A" is prepared by dissolving 34 grams of potassium dihydrogen phosphate, KH_2PO_4 , in 500 ml of distilled water. Adjust the pH to 7.2 with sodium hydroxide, 1N NaOH, and then dilute to one liter with distilled water.

(2) "Solution B" is prepared by dissolving 38 grams of magnesium chloride, MgCl_2 , in one liter of distilled water.

(3) The working rinse solution is prepared by adding 1.25 ml of "Solution A" and 5 ml of "Solution B" to one liter of distilled water. Autoclave this solution at 121°C for 10 minutes at 15 PSI before use. Note: it is recommended that the MDR make arrangements to have these solutions prepared in a medical shore activity. Most ships do not have the capability for adjusting the pH of "Solution A".

d. Sterilization of filters and absorbent pads is accomplished by autoclaving at 121°C for 15 minutes. In most cases, the pads and filters are packaged together in a packet ready to be sterilized. Filters and pads are also available in pre-sterilized packages. Either type is satisfactory for use as long as the filters and pads are sterile when used.

e. Sterile plastic petri dishes are available and are recommended. If re-use of these dishes is absolutely necessary, do the following wash, treat by completely immersing opened dishes in 70% alcohol for not less than 30 minutes, remove and place on a sterile

towel, protect from dust, allow to air dry and reassemble.

f. The forceps maybe adequately sterilized by dipping the tips in alcohol and igniting the fluid. This procedure should be repeated between handling of each filter. Caution Allow forceps to cool a few seconds; membrane filters are extremely flammable.

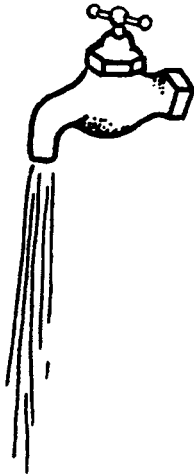
g. Ready-to-use M-Endo broth in 2 ml vials is available through the federal stock catalog and is recommended. Media can also be prepared by adding 1.2 grams of dehydrated M-Endo or MF Coliform powder to 24.5 ml distilled water which contains 0.5 ml of 95% ethyl alcohol. No other alcohol may be substituted for ethyl alcohol (ethanol), as other types are often toxic to bacteria. Heat the solution to boiling, remove from heat, and allow to cool before use. Do not boil for more than 1 minute. It may be stored in a refrigerator for no more than 96 hours.

h. The filter funnel and filter support units should be wrapped and sterilized in an autoclave. Assembly of the unit should be done immediately and aseptically before testing of water.

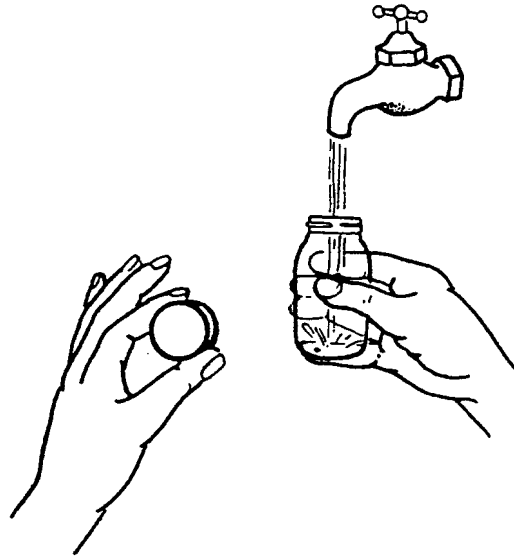
7. Collecting and Testing for Chlorine/Bromine Residual. Collection and testing of the water for a chlorine or bromine residual is not apart of the coliform test; however, a step-by-step procedure is shown to demonstrate that the residual reading must be taken after the water is allowed to run 2 or 3 minutes and before it is collected in the bacteriological test sample bottle or bag containing sodium thio-sulfate.

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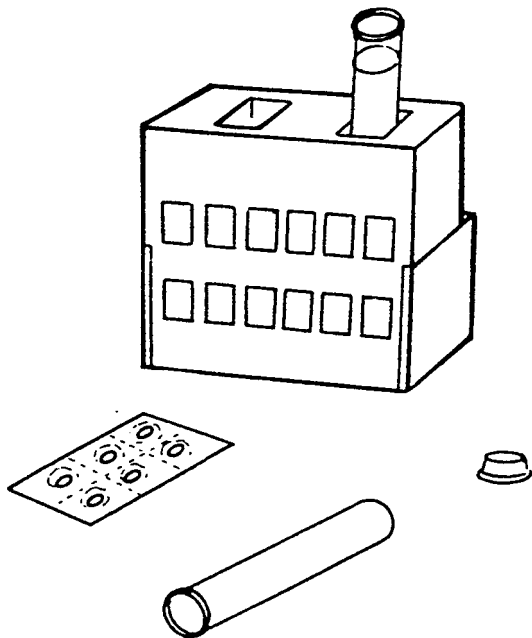
a. Open tap fully and let water run to waste for 2 or 3 minutes, or for a time sufficient to permit clearing the service line.



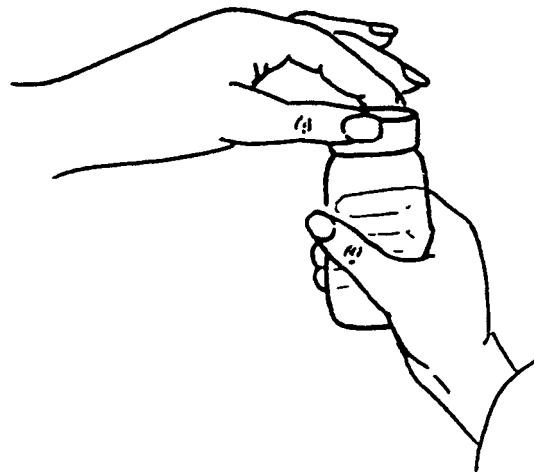
c. Collect the sample for the bacteriological test in bottles prepared according to instructions in Article 6-53. 6.b.



b. Determine the chlorine or bromine residual and record findings.

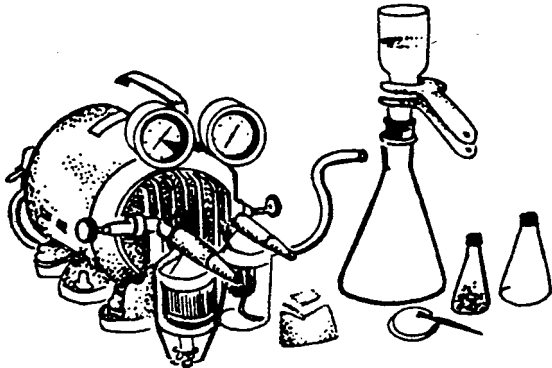


d. Replace the cap, taking care not to contaminate the sample, cap the bottle, shake vigorously, label the sample for identification, record appropriate information including sampling site, and time of sampling in the water log or on DD Form 686, if the sample is to be tested by another activity.



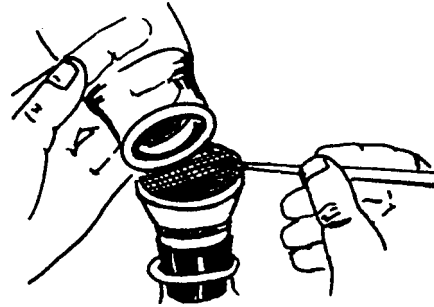
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8. The following step-by-step procedure illustrates the total coliform tests performed with the membrane filter in a laboratory.

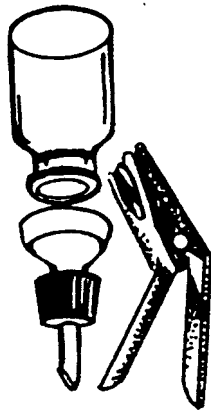
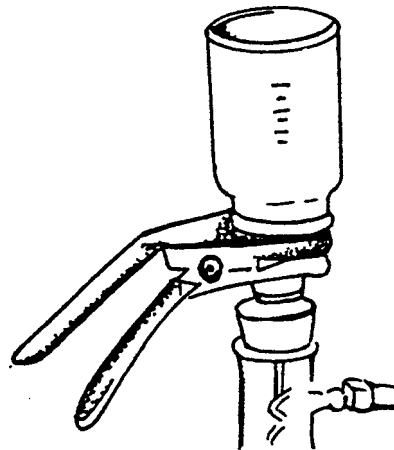


Materials required with a properly assembled membrane filter unit.

b. Place sterile membrane filter on top of filter support.



c. Clamp the funnel on top of filter support.

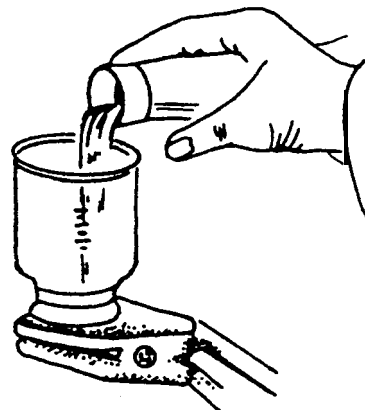


Close-up of filtration unit showing placement of individual components.

a. Place about 2 ml M-Endo broth onto absorbent pad placed on bottom half of petri dish.

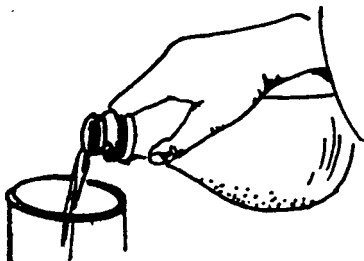


d. Pour 100 ml of water sample into funnel. Apply suction to unit until water filters through.



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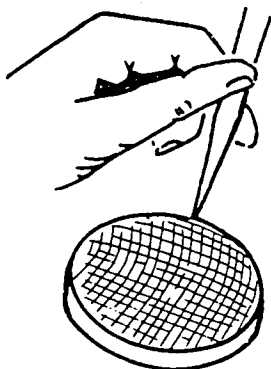
e. Pour about 50 ml buffered water to rinse inside walls of funnel. Apply suction to flush buffered water through membrane filter.



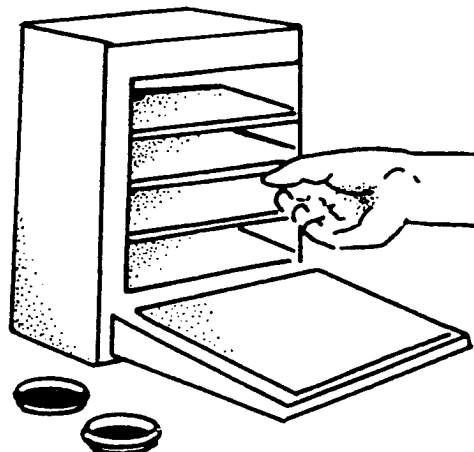
f. Dismantle funnel from filter support by removing clamp. Remove membrane filter.



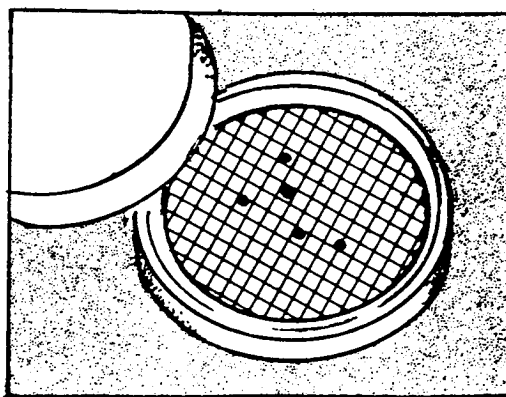
g. Place membrane filter on top of broth saturated absorbent pad. Avoid trapping air bubbles between filter and pan. Close the petri dish with its top.



h. *Invert* the petri dish and place in incubator at 35° C for 22 to 24 hours.



i. Observe for presence or absence of colonies with greenish gold metallic sheen.



9. Some smaller ships without laboratory facilities are equipped with membrane filter field test kits or a membrane filter field monitor. These units contain all of the basic test equipment. When operated properly, these units will give satisfactory results. Operating procedures for the field test kit and the field monitor are listed below.

a. The field test kit is sterilized prior to each use by removing the stainless steel flask from the funnel base assembly. This will expose an absorbent ring around the holder

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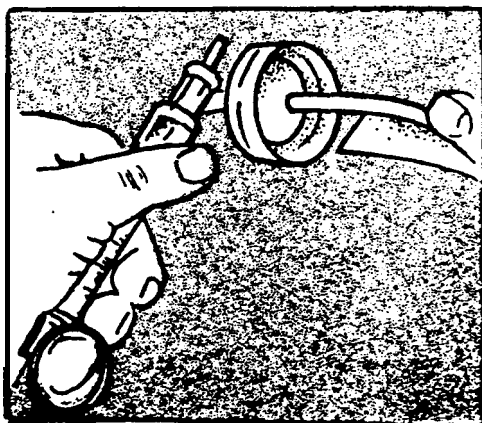
base. Saturate the absorbent ring with approximately one-half capful of methanol (do not substitute any other alcohol). Set flame to the methanol on the absorbent ring. Make sure the entire ring is ignited. Place the filter cup, in an inverted position, over the funnel and the burning absorbent ring. Let the cup stay in place for 15 minutes; remove it and rinse the funnel thoroughly with sterile water and the unit is ready for use. Sterilization is accomplished by formaldehyde produced by incomplete combustion of methanol.

(1) The test technique is outlined in Articles 6-53.8.(a) through (i); however, suction is applied with a syringe rather than a pump.

b. The membrane field monitor consists of a monitor, membrane filter and absorbent pad encased in plastic with holes top and bottom fitted with plastic plugs, a syringe, a sterile sampling tube and a long ampoule of media with one tip covered with a short plastic tube.

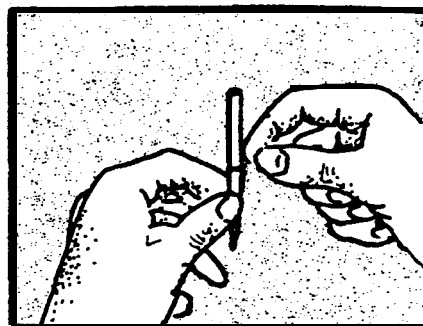
(1) Remove the plugs from the monitor; save them. Attach the syringe pump valve connection into the hole in the bottom of the monitor (the bottom is the side with spokes).

(2) Remove the end of the sterile sampling tube with the nylon valve tip from its plastic sleeve and attach the nylon tip into the inlet hole on the side of the monitor.

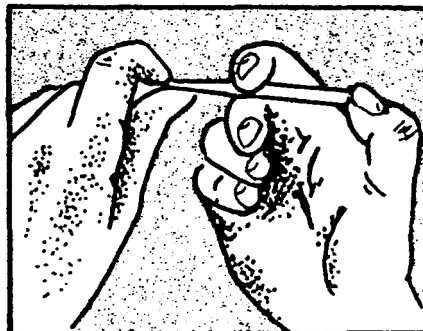


(3) Remove the plastic sleeve from the other end of the sterile sampling tube and place the tube end into the water sample. Draw the syringe plunger slowly on the first stroke to avoid an air lock. Hold back on the plunger until the syringe fills. Push forward on the plunger to expel the filtered water from the syringe. Filter the sample, normally 100 ml through the monitor. Invert the assembly and use short quick strokes to pull any remaining water from the sample.

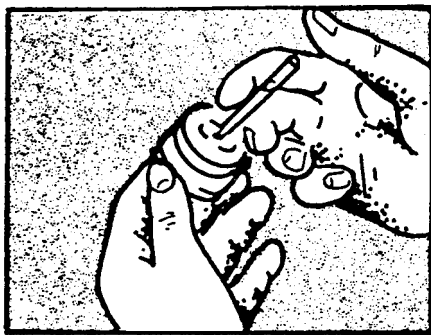
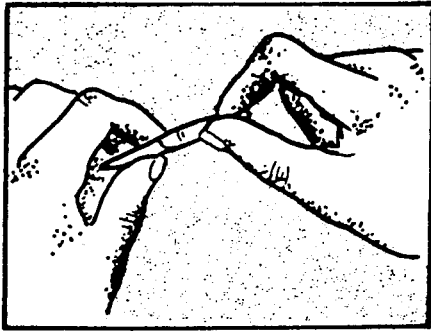
(4) Remove and discard the sampling tube; do not remove the monitor from the syringe.



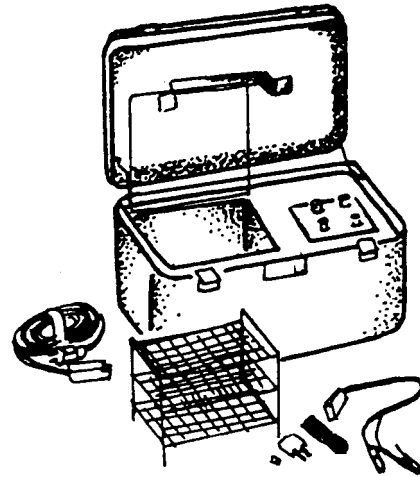
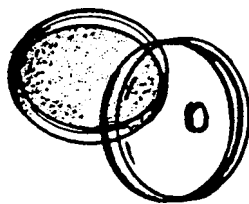
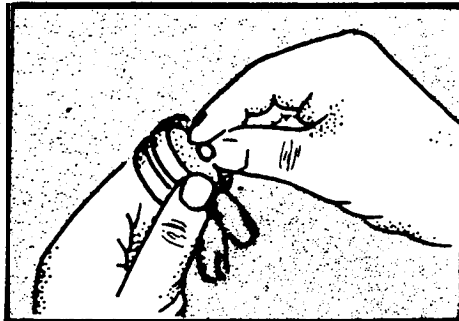
(5) Break off the tip of an ampoule of media (the tip covered with the short plastic tube). Place forefinger over the end of the plastic tube as if it were a pipette. Break off and discard the other end of the ampoule.



(6) Remove the monitor from the syringe; insert the free end of the ampoule into the hole in the bottom of the monitor and press it gently against the absorbent pad. Release the forefinger and slowly release the pressure against the absorbent pad, allowing the media to flow into the pad.



(7) Replace the plastic plugs, invert the monitor, place in an incubator at 35°C for 24 hours. Pry off the top, observe for the presence or absence of coliform colonies, and record as previously described.



10. Interpretation of Total Coliform Test Results. Colonies on the membrane filter will appear as dots of various sizes. Coliform colonies are dark with a metallic sheen. The metallic sheen is usually greenish-gold and may be present only on the center of the colony, only on the edge, or over the entire colony. The metallic sheen is produced by a dye, pararosalinine, in the media, which reacts with aldehydes produced by the coliforms. Non-coliform colonies will appear as clear, colorless, or dark colonies which may glisten but will not have a metallic sheen. The non-coliforms are termed "background" and should be reported as such. Occasionally, coliforms will not produce a metallic sheen. Therefore, if consistent high counts of colonies without the metallic sheen are obtained, further examination of these background colonies is warranted.

11. Controls. Positive and negative controls should be performed for each group of samples processed. A negative control may be obtained by substituting 100 ml sterile distilled water for a sample. This negative control should be processed in exactly the same manner as a sample. If the negative is positive, there is an error in the technique and the methods should be examined. A positive control is prepared by obtaining a rectal swab and placing the swab in 100 ml phosphate buffer. Shake the solution well, and filter a small portion of the suspension. If too

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many colonies are obtained by this method”, pipette 1 ml of the positive control buffer solution into 99 ml of sterile phosphate buffer to dilute the number of bacteria in the control, and filter 10 ml of this dilution. Prepare fresh controls each time tests are performed. The results of positive controls should be recorded in the water log as total coliforms present or absent. If there are only a few colonies observed using the above positive control test procedures, check laboratory practices and supplies (e.g., phosphate buffer solution, culture media) for procedural errors or unsatisfactory media.

12. Results of bacteriological testing shall be entered in the water log with a report to the Commanding Officer and a copy to the Engineering Officer.

6-54. Potable Water Log.

1. The Medical Department will maintain a two 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 Medical Department Representative.

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

a. Time and date each water sample was taken.

b. Location of the ship: at sea, in harbor, at anchorage, or in port; include the name of the port.

c. Sampling site; include location of outlet, ice machine, emergency potable water tank or supply, and identification number of potable water tank, etc.

d. Source of ships water: from the ship’s

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

e. Tests.

(1) 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 lines. Include any follow-up action taken when negative readings are obtained.

(2) Bacteriological Analysis. Record the results of all testing, including the positive and negative controls. Record the results as total coliform-present or total coliform-absent if fecal coliform/*E. coli* confirmation has not been accomplished. If accomplished, record as fecal coliform-present or absent/*E. coli*-present or absent. State reason test performed, such as weekly, special or in connection with disinfecting tanks, lines or systems. Record action taken and results in the case of positive samples even if the tests were performed by another activity.

f. Any problems concerning taste and odor and their resolution.

g. Inspection and surveys, include results, discrepancies and action taken.

3. The use and maintenance of a separate file of DD-686 Bacteriological Examination of Water forms is not considered necessary or required if the potable waterlog is satisfactorily maintained. Water samples submitted for bacteriological analysis to shore facilities should be accompanied by this form. Results of bacteriological analysis submitted to shore facilities should be recorded in the potable water log.

Section XII-SAMPLE WATER SANITATION BILL

Sample Water Sanitation Bill -----

Article
6-55

6.55. Sample Water Sanitation Bill.

1. Each ship should have a Water Sanitation Bill developed to meet the individual and unique aspects of the individual ship's conditions. It is recommended that the Commanding Officer promulgate the Water Sanitation Bill and that the bill be posted conspicuously in areas where potable water and associated materials are processed, treated or stored. The following sample bill is provided herein and is offered as a guide only.

Water Sanitation Bill

1. Responsibility.

a. The Engineering Officer is responsible for supplying potable water and for its treatment as required; he is also responsible for the operation and maintenance of the equipment related to potable water production. He shall be guided by Naval Ships' Technical Manual and other pertinent references.

b. The Medical Officer (or Medical Department Representative) is responsible for monitoring all aspects of potable water treatment, handling, and storage to ensure compliance with current instructions for protection of the potable water supply. Additionally, he is responsible for quality surveillance of the potable water through collection and examination of representative samples. He must be guided by the Manual of Naval Preventive Medicine, NAVMED P-5010, Chapter 6 and other pertinent directives.

2. Sources.

a. Processing of Sea Water. Distillation of or processing by reverse osmosis (RO) of water from harbors or from polluted seawater is to be avoided except in emergencies. Sea water 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.

b. Potable Water. Potable water maybe received from shore facilities or other ships. The following is a list of approved sources for potable water:

(1) Facilities owned and/or operated by the U.S. Military.

(2) Water points listed in U.S. Public Health Service, Food and Drug Administration, publication "Acceptable Vessel Watering Points Interstate Conveyance Official Classification List". Area Navy Environmental and Preventive Medicine Units (NAV-ENPVNTMEDU's) can provide this list and may be contacted as necessary.

(3) 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 current Quadripartite Standardization Program, ABC NAVSTAG 23, Quality Standards for Potable Water. Under certain emergency or wartime conditions shore water sources may be under the cognizance of the American, British, Canadian, Australian Armies Standardization Program (QSTAG 245), Minimum Requirements for Water Potability(Short and Long Term Use) or the NATO Standardization Agreement (STNAG 2136) Minimum Standards for Water Potability.

(4) Other extracontinental source data may be obtained from U.S. military representatives ashore or NAVENPVNTMEDU's having area responsibility.

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

CHAPTER 6. WATER SUPPLY AFLOAT

ship personnel must assume this responsibility. Ship-to-ship transfer of potable water shall also be accomplished by personnel trained in the handling 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. A Medical Department Representative must ensure that an adequate halogen residual is present in the water prior to the initial transfer to water.

d. The potable water outlet must be flushed for 15-30 seconds and disinfected with a solution of 100 ppm free available chlorine (FAC). Let stand for two 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 one-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.

a. Potable water tanks will not be filled

with ballast water except in cases of extreme emergency. When tanks have been used for ballast water, the tanks, pipes, fittings, and pumps used must be disinfected prior to refilling with potable water.

6. Disinfection.

a. Only the following halogens may be used for disinfecting potable water:

- (1) Calcium Hypochlorite technical 65 to 70% (HTH) NSN 681000255 0471,6 ounce jar
- (2) Sodium hypochlorite NSN 681000598 7316, 1 gallon bottle (5%) NSN 6810009006276,5 gallon pail (5%)
- (3) Bromine cartridges NSN 4610-01-022-9970

b. Calcium Hypochlorite. Enough chemical to obtain the required residual will be mixed with warm water in a container and allowed to settle. Introduce the clear fluid 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 circulated through a pump to ensure adequate mixing. If the required level of chlorine is not present after a 30-minute contact period, 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 literature for 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 Testing.

a. The Medical Department must per-

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form color comparator tests daily to determine the halogen residual in the potable water. Tests will be performed at random locations to ensure adequate coverage of the entire system. The number of samples required will be determined by size of the ship; no less than four samples will be collected. On DD, DDG, FFG, LST, MSO, and other ships with complements below 500, 4 samples are required. On LPH, LHA, LSD, and other ships with complements over 500 and below 4,000, 8 samples are required. On CV, CVN, and other ships with complements above 4,000, 12 samples are required.

b. A DPD chlorine-bromine-pH combination test kit is required for performing halogen residual determinations.

c. Results of halogen residuals will be recorded in the waterlog. 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 examinations are collected and performed weekly. Samples will be collected at representative points throughout the distribution system as well as from potable water tanks. This includes potable water in storage tanks while the ship is in port and the system is receiving direct service from shore potable water lines. Emergency potable water tanks in battle dressing station and $\frac{1}{4}$ of the ice machines must be sampled and tested weekly. Special or more frequent tests will be performed whenever chlorine demand increases, contamination is suspected, after cleaning and disinfection of 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 downstream. 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 to 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.

a. When mechanical cleaning and chemical disinfection are required (see NAVMED P-5010-6, Article 6-22), the potable water tank will be superchlorinated. If necessary, the distribution system will be superchlorinated, as well. Determine the volume of water in the tank and distribution system and add sufficient chlorine to raise the residual to 100 ppm FAC. Let stand four hours. The FAC residual, after four hours contact time, must not be less than 50 ppm and must be tested at hourly intervals to ensure maintenance of the proper FAC. If at any time during this period the FAC residual falls below 50 ppm, sufficient chlorine must be added to bring the residual to 100 ppm and the four-hour period starting again.

11. Distribution System.

a. Potable water lines 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 lines must not pass through non-potable liquid storage tanks and non-potable liquid lines must not pass through

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potable water tanks unless the lines are surrounded by a sloping, self-draining pipe tunnel.

e. Potable waterlines 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 Medical Department 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 Medical Department will maintain a potable waterlog the entries must be a two-year chronological record of potable water surveillance.

(1) Entries are made in chronological order and must contain the following:

(a) 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.

(b) 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.

(c) 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.

(d) 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 Medical Department 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 with a copy to the Engineering Officer.

CHAPTER 6. WATER SUPPLY AFLOAT

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Section XIII-REFERENCES

References

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6-56

6-56. References.

1. 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 surveillance of potable water aboard ship. When making recommendations, other Naval manuals, publications, and notices may be referenced and quoted to support this chapter.

2. 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.

a. OPNAVINST 5090.1 Series, Environmental and Natural Resources Protection Manual.

b. NAVFACINST 11330.11 Series, Backflow Preventers, Reduced Pressure

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Principle Type.

- c. NAVMEDCOMINST 5450.28 Series, Environmental and Preventive Medicine Units; Mission and Functions of.
- d. NAVMEDCOMINST 6240.1 Series; Standards for Potable Water.
- e. Type Command Medical Guides, 6000.1 Series.
- f. Naval Ships' Technical Manual, Chapter 074, Vol. 3, Gas Free Engineering.
- g. Naval Ships' Technical Manual, Chapter 090, Inspections, Tests, Records, and Reports.
- h. Naval Ships' Technical Manual, Chapter 220, Vol. 1, Water Chemistry-Vol. 2, Test and Treatment.
- i. Naval Ships' Technical Manual, Chapter 505, Piping Systems.
- j. Naval Ships' Technical Manual, Chapter 531, Distilling Plants.
- k. Naval Ships' Technical Manual, Chapter 533, Potable Water Systems.
- l. Naval Ships' Technical Manual, Chapter 631, Preservation of Ships in Service.
- m. Naval Ships' Technical Manual, Chapter 670, Stowage, Handling, and Disposal of Hazardous General Use Consumables.
- n. NAVSEA 048-LP-122-9010, Technical Manual, Brominator.
- o. NAVSHIPS 0900-016-000, Manual for Cargo Tank Cleaning.
- p. NAVSUP Publication 486, Vol. 1, Food Service Management.
- q. Quadripartite Standardization Agreement 245, Edition 2, American, British, Canadian, and Australian Armies Standardization Program, Minimum Requirements for Water Potability (Short and Long Term Use) The short title for this document is QSTAG 245, Edition 2.
- r. Standardization Agreement (STNAG 2136), Minimum Standards of Water Potability. This Document is currently under revision; The new title will probably change to, Minimum Standards of Water Potability in Emergency Situations.
- s. American, British, Canadian, Australian Naval Quadripartite Standardization Program (ABCA NAVSTAG 23) Quality Standards for Potable Water.
- t. General Specifications for Ships of the U.S. Navy.
- u. U.S. Army Field Manual, Field Hygiene and Sanitation (FM 21-10).
- v. EPMU-26240.5/2A (9-77) Sample Collection and Bacteriological Analysis of Potable Water.
- w. U.S. Public Health Service, Food and Drug Administration Publication, Acceptable Vessel Watering Points Interstate Conveyance Official Classification List.
- x. U.S. Environmental Protection Agency, EPA 570/9-89-007, Cross-Connection Control Manual.
- y. *Standard Methods for the Examination of Water and Waste Water*, Current Edition, by (APHA), (AWWA), and (WPCF).
- z. *Sanitarian's Handbook* By Ben Freedman, M.D.,M.P.H..
- aa. *Municipal and Rural Sanitation*, By Victor M. Ehlers, C.E. and Ernest Steel, C.E.
- bb. *Field Procedure in Water Microbiology*, Cat. No. Lab3140/P Millipore Corporation, Bedford, MA..
- cc. *Total Coliform Analysis*, Cat. No. AB311, Millipore Corporation, Bedford, MA.
- dd. *Bacteriological Testing in the Field with Millipore Field Monitors*, Publication No. MRP-3, Millipore Corporation, Bedford, MA.