NMA REPORT #R-395-B

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Asserting our right "…to petition the Government for redress of grievances."
Amendment 1, U.S. Constitution, Dec. 15, 1791

SUPPORTING DOCUMENTATION
For NMA Report #R-395

This document supports the "Safe Potable Water" portion of the latest revision of our Report #R-395 Safe Potable Water and Food Service for Commercial Vessels of Less than 1,600 Gross Register Tons – An Appeal to Congress.

Item #1 – We excerpt only Chapter 1 titled Coast Guard Water Supply Afloat and Chapter 3, Testing Water of the U.S. Coast Guard Water Supply and Wastewater Sanitation Manual, COMDTINST M6240.5

For further information please also refer to our Report #R-205, Report to Congress: Outstanding Failures to Protect the Safety, Health & Welfare of 126,000 Limited Tonnage Merchant Mariners. Turn to Topic #1 ï **Safe and Adequate Potable Water.**

CHAPTER 1: COAST GUARD WATER SUPPLY AFLOAT.

A. Introduction and Policy.

1. Purpose. This Chapter explains how to handle potable water safely and properly aboard vessels to help prevent waterborne diseases. Enclosure (1) describes the bacteriological, physical, and chemical characteristics of potable water. All personnel who fill, treat, store, distribute, and medically monitor potable water should be familiar with the current policies and regulations in this Manual.

2. Policy. Preventing waterborne disease transmission requires high-quality potable water. Potable water for shipboard use comes from the ship's distillation plant or reverse osmosis (RO) systems. Present distillation plants aboard Coast Guard cutters, designed to make the ship as self-sufficient as possible, can produce potable water from bacteriologically contaminated water if the system operator follows the specific procedures set forth in the * Naval Ships' Technical Manual (NSTM), Chapter 531. The system operator must properly disinfect all distillate to be used as potable water and avoid distilling water from harbors or polluted sea water except in emergencies. Assume water is polluted when ships operate in close formation. While making potable water, do not empty bilges or sewage tanks forward of the water intakes. Operational checks of distillation plants afloat and inspecting and approving watering points ashore constitute only some 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 water's source, the Engineering and Medical Departments must effectively enforce standards and monitoring to assure adequate protection from subsequent contamination.

3. Responsibilities.

   a. COMDT (G-SEN). COMDT (G-SEN) designs, constructs, and maintains shipboard potable water supply and distribution systems, including treatment facilities and processes, to assure safe drinking water is available at all times.

   b. COMDT (G-WKS). COMDT (G-WKS) establishes and promulgates standards and instructions for water quality afloat and publishes appropriate instructions, notices, or other publications to reflect water quality requirements.

   c. Area Commanders. Area commanders or their designees issue necessary implementing directives to ensure each ship within the command has and enforces adequate water sanitation standards.

   d. Commanders of Maintenance and Logistics Commands. Commanders of Maintenance and Logistics Commands (MLCs) provide technical support and medical oversight for all afloat potable water systems. MLC(k) particularly emphasizes identifying and abating class-wide health hazards. Additionally, each respective MLC(k) ensures unit-level potable water systems monitoring and periodically conducts sanitary surveys.

e. Commanding Officer, Engineering Logistics Center. The Commanding Officer, Engineering Logistics Center, reviews policy and provides assistance with shipalt/boatalts and Authorized Equipment Listings development.

f. Commanding Officer. Each ship's Commanding Officer (CO) promulgates a water sanitation bill to ensure engineering and medical personnel follow procedures to receive, transfer, treat, store, distribute, and monitor potable water. Appendix 1.C. contains a Sample Potable Water Sanitation Bill.

g. Engineering Department. Reporting to the CO, the ship's Engineering Department implements the shipboard water supply system's operation and maintenance, produces an adequate amount of water, and ensures proper disinfection.

h. Medical Department Representative. The Medical Department Representative (MDR) comprehensively monitors the potable water system for health and safety, including adequacy of disinfecting procedures, collecting samples for bacteriological analysis, and monitoring required halogen residuals from the distribution system. The MDR shall notify the CO of any discrepancies he or she observes in the water distribution system. For units without assigned corpsmen, the Executive Officer/Executive Petty Officer, as the unit medical officer, must ensure these requirements are met.

4. Potable Water Sources for Coast Guard Vessels.

a. Distillation or other approved method, e.g., reverse osmosis.

b. Shore-to-ship delivery from an approved source.

c. Shore-to-ship delivery from an unapproved source if an approved source does not exist; see * Paragraph B.3.

d. Ship-to-ship.

5. Water Use and Quality.

a. Potable water, i.e., water of drinking quality, is used aboard ship for drinking, cooking, laundry, medicine, personal hygiene, and other purposes.

b. Water quality standards include physical, chemical, and bacteriological requirements. * Paragraph 1.J. discusses limited testing procedures to evaluate pertinent physical, chemical, and bacteriological quality of shipboard water.

c. Using non-potable water in any food service space, including sculleries, is prohibited at all times unless the commanding officer obtains specific written approval to do so from the area Maintenance and Logistics Command (k) before installation. The dangers in using water polluted through cross connection from overboard sources cannot be over-emphasized. Regardless of source, cross connections between potable water and non-potable water are not permitted. Non-potable water connections are prohibited on food service equipment.

d. Non-potable water is used aboard ships in the fire mains and for general sanitary purposes. Since constant potable water conservation is required, it is impractical to use potable water for all purposes. Therefore, a ship uses sea water under certain controlled circumstances, e.g., flushing weather decks, water closets, urinals, laundry, and decontamination showers. Engineering personnel selecting a potable water source must consider water in harbors, off-shore from habitations, and when operating in fleet strength polluted and fit for use only in fire and flushing systems; do not use it for other purposes. If in an emergency a ship needs to produce water from contaminated sources, the Medical and Engineering Departments must monitor the system for halogen residual, pH, and bacteriological contamination more frequently.

6. Potable Water Usage Requirements.

a. Properly indoctrinating the crew in water conservation and reducing leaks and waste should limit potable water consumption to reasonable amounts. At times water hours may become necessary on some ships, limiting personal hygiene practices. Members may keep clean and live under sanitary conditions, even with a limited water supply, if their supervisor adequately indoctrinates and properly supervises them. If unusual conditions require drastically restricting potable water use, the minimum allowance should be two gallons per person per day for drinking and cooking.

b. Table 1.1. lists the quantities of potable water generally required aboard ship. Actual consumption varies widely, depending on vessel type, where it operates, and what work members do. If using potable water for all purposes, consumption may expend 12 to 35 gallons per person per day, though the higher figure might be considered wasteful.

Table 1.1. Recommended Amounts of Potable Water Aboard Ship

Type of Use	Gallons per Person per Day
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

B. Receipt and Transfer.

1. Preventing Contamination. When receiving or transferring water from an external source, improper filling techniques and multiple handling can contaminate potable water. If water received aboard does not have the required disinfectant residual, the system operator must add enough chlorine or bromine to produce the proper residual. If the water contains the correct disinfectant residual, the receiving ship need not disinfect. *The designated MDR or EDR must determine the chlorine or bromine residual immediately before the water is transferred.*

Authorized personnel must make or supervise all water connections between shore and ship. Potable water hoses must not be submerged in harbor water.

2. Approved Sources. Procure potable water from these approved shore facilities or other vessels:

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

   b. Water points listed in the joint U.S. Public Health Service and Food and Drug Administration publication, *Acceptable Vessel Watering Points Interstate Conveyance Official Classification List.* The MDR should attempt to obtain this information before the ship departs from CONUS. U.S. Embassies and area MLC (kse)s also may have accurate information.

3. Doubtful Sources. The MDR and EDR should consider all water supplied by public or private unapproved systems of doubtful quality. If in doubt about water quality, he or she or a responsible officer must investigate the source and examine the water as thoroughly as possible with the means available. The MDR must then advise the CO about necessary procedures, safeguards, and disinfection. If the ship must receive suspect water, the MDR or EDR will disinfect it in accordance with * Paragraph 1.D.

4. Care of Shipboard Potable Water Hoses and Equipment.

   a. Potable water hoses must not be used for any other purpose. The EDR must properly label, store, and protect them from sources of contamination at all times and routinely examine them and remove them from use if cracks develop in the lining or leaks occur. * Paragraph 1.D.10. describes how to disinfect potable water hoses.

   b. Each hose connection must be fitted with a cap and keeper chain. Ship risers must be properly labeled, color-coded, and disinfected before each use.

   c. Sounding tubes for potable water tanks must have screw caps attached to keeper chains secured with a lock. On ships with sounding rods, when not in actual use the rod should remain in the tube at all times. On ships using steel tapes, the EDR must sanitize the tape before each use and use it to measure potable water only. EDRs shall store steel tapes in a clean, dry location.

5. Connection Procedures.

   a. In transferring potable water shore-to-ship and ship-to-ship these connection procedures are general guidelines; the Engineering Officer may want or need to modify these procedures due to ship configuration or operating conditions.

b. Shore-to-Ship.

(1) Remove cap and flush pierside potable water outlet for 15 to 30 seconds. Immerse outlet and rinse fitting in a solution containing 100 ppm free available chlorine for at least 2 minutes. See * Paragraph 1.D.13. and Enclosure (2) on preparing chlorine solution. Flush to waste for 15 to 30 seconds.

(2) Just before connecting, deliver a clean, disinfected potable water hose to the outlet. Remove hose caps or uncouple hose ends and disinfect if necessary. Connect to pierside outlet and flush.

(3) Using the solution described in * Paragraph 1.D.13., disinfect shipboard riser connections. Connect hose to the potable water shipboard riser and deliver potable water.

(4) When the transfer is completed, secure the shore water source, remove the ship connection, and then remove the shore connection. Thoroughly flush the potable water outlet and recap. Drain the potable water hose thoroughly, replace caps or couple ends, and store in the potable water hose storage locker.

c. Ship-to-Ship Transfers.

(1) Personnel trained in handling potable water must transfer potable water ship-to-ship. Normally, the supplying ship provides potable water hoses.

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

(3) When the receiving ship secures the potable water hose, the EDR removes the cap and disinfects the hose coupling.

(4) Both ships disinfect their respective potable water riser connections.

(5) The supplying ship connects its end and flushes the hose.

(6) 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.

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

C. Potable Water Storage Tanks.

1. Design and Construction. Potable water tanks' construction and location should prevent contamination of the contents. To use space optimally, on most ships potable water is stored 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 possibly heavily polluted water and is vulnerable to leakage. The plating over the inner bottom tanks often

serves as deck 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 require the EDR to carefully maintain the quality of water stored in skin tanks, particularly those located in inner bottoms.

2. Introducing Non-Potable Water. Do not fill potable water tanks with ballast water unless absolutely necessary for the ship's survival. If introducing non-potable water into potable water tanks, the EDR must disconnect all tanks, lines, fittings, and pumps from the potable water system, plug or cap them, and reconnect them only after adequate disinfection.

3. Interior Coating. Contractors and authorized maintenance personnel shall paint potable water tanks' interior with an epoxy coating system complying with the * Coast Guard Coatings and Color Manual, COMDTINST M10360.3A, Chapter 12, Table 19. Potable water tanks shall be coated in accordance with NSTM, Chapter 631, "Preservation of Ships In-Service (Surface Preparation and Painting)." All potable water tank coatings must be approved by and applied in accordance with National Sanitation Foundation (NSF) International Standards.

4. Vents and/or Overflow Lines.

   a. 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 mesh 18 or more non-corrosive metal wires.

   b. Vents and/or overflow lines must not terminate in food service, medical, toilet, or other spaces that may transmit contamination or odors to the water, nor in any space where electrical or electronic equipment is located.

   c. Potable water tanks shall not vent outside the ship. ***Exception:*** Where such vents exist in the current fleet, an exception may be granted if vent location and ship design make shipalt impractical.

5. Manholes.

   a. Manholes' construction and location 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.

   b. The cover must have an intact gasket and a device to secure it in place. Normally, manholes not exposed to the weather decks are fitted with a flush manhole cover or a raised, bolted-plate cover. The latter is preferable for potable water tanks.

6. Measuring the Water Level.

   a. There are several methods to measure water in tanks, including automatic level gauges, petcocks, and sounding tubes. Many ships have more than one system.

   b. On ships with sounding rods, when not in actual use the rod should remain in the tube at all times.

   c. On ships using steel tapes, the EDR must sanitize the tapes before each use; store them in a clean, dry location; and use them only to measure potable water.

   d. Sanitize sounding tapes by soaking the entire tape apparatus in a solution of 100 ppm chlorine for two minutes.

7. Filling Lines.

   a. Potable water lines must never cross-connect to any non-potable line or system. If a common line is used to load and distribute potable water to non-potable tanks, an air gap must deliver the non-potable water to non-potable tanks.

   b. Filling lines that have a common piping arrangement to direct potable water from an approved source to non-potable water systems by means of valves or interchangeable pipe fittings are not acceptable.

   c. Filling connections (hose valves) must be clearly labeled and color-coded to comply with * NSTM, Chapter 505, and the Coast Guard Coatings and Color Manual, COMDTINST M10360.3A. Screw caps attached with keeper chains must secure filling connections.

   d. 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.

8. Potable Water Piping.

   a. Potable water tanks are usually installed low in the ship. The EDR must pay careful attention to the piping installed in the bilge area, particularly piping on the suction side of the potable water pumps where leakage could contaminate the potable water system.

   b. When piping potable water through non-potable tanks and non-potable liquid through potable water tanks, a sloped, self-draining pipe tunnel must surround the pipe.

c. An adequate air gap must separate any 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 * Paragraph 1.H.3.

d. All potable water pumps should be airtight and have no cross-connections. Never use non-potable water to prime pumps or maintain packing gland seals. The EDR must disinfect pumps dismantled for repair after reassembly and before returning them to service.

e. Do not connect charcoal-impregnated or other filters to potable water piping outlets. Some of these devices remove required trace halogen (chlorine or bromine) residual from the potable water and defeat the purpose of residual halogen protection. The EDR must remove any filtration equipment already installed.

f. Paint potable water piping, including valve bodies, to match the surrounding areas to comply with the * Coast Guard Coatings and Color Manual, COMDTINST M10360.3A (series), Chapters 10-A-23 and 12, Table 16.

g. If feasible, identify potable water piping to indicate contents, destination, and flow direction to comply with the * Coast Guard Coatings and Color Manual, Chapter 10-A-23.a. through h.

h. Paint potable water valve handles and levers dark blue (Fed. Std. 595, Color Number 15044) to comply with the * Coast Guard Coatings and Color Manual, Chapters 10-15-A-23.g. and 12, Table 17.

i. Do not paint potable water valve packing glands, valve stems, threads, and other similar working surfaces.

9. Repairs.

a. If any accidental or intentional break occurs in the potable water system, or a potable water tank is entered for any reason, the Engineering Department must disinfect all involved tanks, parts, and lines before returning the system to use. The EDR must notify the MDR of the break or entry and the Department's disinfection procedure.

b. The Engineering Department shall not repair potable water piping or butter up flanged joints with white lead or other lead-containing substances or putty because these are toxic. Sealants for use in potable water piping systems must meet NSF International Standards. Confirm sealants by contacting the nearest MLC.

10. Potable Water Tank Coatings. To avoid difficulties with taste, odors, and the danger of contamination by toxic chemicals, use only those tank lining materials specified in * NSTM, Chapter 631, and NSF International Standards. Follow proper application methods, including the coat's thickness, touch-up material, ventilation, temperature, humidity, and curing time, etc., or taste and odors may result.

11. Labeling Potable Water Systems.

    a. Clearly label potable water sounding tubes with an identification plate. Color-code the sounding tube cover dark blue to comply with the * Coast Guard Coatings and Color Manual. Ships using steel tapes to sound potable water tanks must color-code in dark blue, label, or otherwise identify the tape handle POTABLE WATER USE ONLY.

    b. Conspicuously designate valves that receive or supply potable water by a warning plate inscribed POTABLE WATER ONLY in 1-inch-high letters.

    c. Hoses receiving and discharging potable water shall be constructed of material meeting NSF International Standards and approved for that purpose. Potable water hoses must be labeled POTABLE WATER ONLY approximately every 10 feet and the end couplings painted dark blue. An approved potable water hose (NSN: 4710-01-248-8828) is available through the Federal stock system.

    d. Potable water hose storage lockers must be identified and labeled POTABLE WATER HOSE AND FITTINGS STORAGE ONLY in letters at least one-half ()-inch high.

    e. Potable water lines passing through any given space must be appropriately labeled to indicate the type of service and an arrow to indicate flow direction.

12. Potable Water Hose Lockers.

    a. When not in use, potable water hoses must be coupled or capped and stored in designated self-draining, smooth, non-toxic, corrosion-resistant, easily cleaned, vermin-proof, locked lockers used for no other purpose and elevated at least 18 inches off the deck when located on weather decks.

    b. Printed instructions outlining step-by-step methods to disinfect potable water hoses and risers must be posted conspicuously inside the hose storage locker.

    c. Where it is not practical to use designated lockers due to space limitations, the EO must ensure potable water hoses are stored separately from other hoses in a secure and sanitary location.

D. Disinfecting Potable Water Supplies.

1. Purpose. Disinfecting water destroys pathogenic organisms. Maintaining a halogen residual (either chlorine or bromine) is the usual method of guarding against sanitary defects or accidents that may occur in producing, handling, storing, and distributing potable

water. The residual's presence provides a safety factor but does not correct unsanitary practices or conditions. The absence of a free available chlorine (FAC) or total bromine residual (TBR) in the ship's potable water may indicate contamination. In pure water, free halogen residual concentrations as high as 2.0 ppm usually do not cause objectionable tastes and odors, but if certain organic substances are present, very small concentrations combined with chlorine or bromine can produce undesirable tastes or odors, though these do not affect the safety of water if the halogen residual (FAC or TBR) is at least 0.2 ppm.

2. Procedure. Disinfect shipboard water by adding sufficient chlorine or bromine compound to produce at least 0.2 ppm FAC or TBR after 30 minutes' contact time. The amount of chlorine or bromine required to do so can vary widely because of halogen demand, the amount of chlorine or bromine used in reactions with substances present in the water. All water-even distilled water produced by the evaporators-has some halogen demand.

3. Disinfectants (Halogens).

   a. Chlorine is available for shipboard use as granular solid calcium hypochlorite (HTH-65 to 70% available chlorine) or liquid sodium hypochlorite in varying strengths (common household bleach is a 5.25% sodium hypochlorite solution). Calcium hypochlorite (HTH) is used most frequently because of its relatively long shelf life and smaller space requirements. However, calcium hypochlorite presents a potential hazard because it is corrosive and chemically active in nature. This material is dangerous and requires special storage precautions. Handle and stow it to comply with * NSTM, Chapter 670. Contact between calcium hypochlorite and oxidizable material may result in spontaneous combustion. Because calcium and sodium hypochlorite lose strength gradually with age and more rapidly when opened and stored in hot spaces, procure in 6-ounce plastic containers.

   b. The Engineering Department must stow its issued stock of ready-to-use, 6-ounce bottles in a locked box, preferably metal, such as a first-aid locker, mounted on a bulkhead, preferably in Department office space. Never install the box in a machinery space, flammable liquids storeroom, berthing space, storeroom, or the oil and water test laboratory areas. Department personnel shall drill vent holes, e.g., three -inch holes, in the bottom of the box to allow the release of any chlorine products. The Department shall maintain a maximum of a seven-day supply of ready-to-use stock at any time.

   c. Engineering Department personnel must store calcium hypochlorite stocks in labeled, ventilated lockers or bins located where they are not subject to condensation or water accumulation. The maximum temperature must not exceed 100 F (37.8 C) under normal operating conditions and the lockers and bins must be located at least five (5) feet distant from any heat source or surface that may exceed 140 F (60 C). The bins must not be located adjacent to a magazine or in a storage area for paints, oils, grease, or other combustible organic materials. An individual locker or bin may contain a maximum of 48 6-ounce bottles. Supervisors will issue bottles only to personnel designated by the MDR or Engineering Officer.

d. Label all lockers, bins, and enclosures containing calcium hypochlorite with red letters on a white background, HAZARDOUS MATERIAL: CALCIUM HYPOCHLORITE.

e. Bromine comes in a slightly corrosive bromine-impregnated resin cartridge requiring proper handling and storage procedures. Store bromine cartridges in a clean, dry, ventilated storeroom. Bromine storage lockers require a hazardous warning plate described in NSTM, Chapter 533, Figure 6. Bromine cartridges have a shelf life of two years from the manufacturing date; Engineering personnel can use cartridges exceeding that shelf life, but the cartridges may not be as effective.

4. Mechanical Treatments. At present, two halogen compounds, chlorine and bromine, are the only approved methods to disinfect shipboard potable water. Mechanical treatment methods are preferable to batch treatment procedures, which are less reliable, require more time and effort, and are generally less effective; a batch treatment with bromine does not exist.

5. Chlorinators. Coast Guard vessels use several types of chlorinators, which may be installed in the distilling plant, distillate line, the shore fill line, or jointly on the distillate and shore fill lines.

   a. The distillate line generally has an electric motor-driven chlorinator with controls that activate the chlorinator in conjunction with the distillate pump motor and water flow past the chlorinator.

   b. The shore fill line generally has either a hydraulically actuated or electric motor-driven chlorinator. Both units inject hypochlorite solution into the water system proportionally to the flow of water through a meter.

   c. A fill line chlorinator may serve the distillate line and the fill line if the distilling plant is large enough to permit sufficient flow through the unit. This type of installation generally has either a hydraulically actuated or electric motor-driven chlorinator.

6. Brominators. Brominator treatment installations are of two types, one used on the distillate discharge line and the other used to recirculate water in the potable water tanks during treatment.

   a. Distillate discharge line brominators-called automatic proportioning brominators-are capable of feeding bromine at two feed rates. Dual-feed rate automatic proportioning brominators feed a fixed rate of either 0.7 ppm total bromine residual (TBR) or 2.7 TBR at the high feed rate, the latter used if the ship is distilling water from a contaminated source.

b. The recirculation brominator system treats water in potable water tanks by recirculating it from a potable water tank through the brominator and back to the same tank. This treatment offers flexibility in recirculating and brominating shipboard water from external sources or increasing bromine levels if necessary. As the selected tank's water recirculates, a portion of the recirculated water is automatically diverted to flow through the bromine cartridge. A timing device limits flow through the cartridge to achieve the required bromine feed into the selected tank. After a pre-set period of time based on individual tank volume and water temperature, the timing device terminates the bromine feed into the water. Water continues to recirculate for an additional pre-calculated duration to completely, evenly disperse bromine through the tank. The system operator also can pre-set this recirculation unit to deliver 0.7 ppm bromine to recirculating water. A sampling tap is present to test the bromine residual after recirculation. If the first process does not achieve the desired bromine level, the system operator can reset the timer and recirculate the water until it reaches the desired TBR level; however, efforts to achieve 2.0 or more ppm bromine levels may not be practical due to the length of time required. It may be more convenient to use batch chlorination procedures to rapidly chlorinate the water supply, particularly if the water is contaminated or requires superhalogenation.

7. Batch Chlorination.

a. Engineering personnel can use "batch chlorination" disinfection methods if mechanical treatment methods are not available. However, this is the least desirable method to disinfect potable water because it may result in over-chlorination due to an inability to properly mix the water and hypochlorite solution. Engineering personnel must determine the proper chemical dosage for the volume of water to be disinfected; see the * Chlorine Dosage Calculator, Enclosure (2). If using 65 to 70% calcium hypochlorite, dissolve the calculated amount in a non-glass container of warm water (80 to 100 F) and allow the suspended matter to settle out, discarding the remaining sediment. When the tank is about one-quarter full, add one gallon of potable water to flush the sounding tube and introduce the clear fluid (supernatant) into the sounding tube or fill connection. Never attempt to chlorinate by adding the solution to the brominator cartridge container. The stirring action of the incoming water as the tank fills generally mixes the water and chlorine solution sufficiently; the ship's motion and recirculation also mix the water slightly. If introducing the chlorine solution into a full tank, recirculating through a pump is the only way to mix adequately. If using pumps that are not an integral part of the potable water system, disinfect them first.

b. The system operator should sample the water and test it for an FAC residual 30 minutes or more after the tank is filled or mixing is completed. If the tank has no sampling petcocks, for sampling purposes the system operator may use a potable water outlet in the distribution system nearest the tank. If the FAC residual is less than required, the system operator must add more chlorine, mix it into the water and, after 30 minutes, determine the FAC residual again. One ounce of full-strength calcium hypochlorite added to 5,000 gallons of water is the approximate dose to achieve a 1.0

ppm initial chlorine concentration. Exposure to air rapidly reduces the amount of active chlorine in 65 to 70% calcium hypochlorite, so use all the contents as soon as possible after opening the container. This "rule of thumb"-one ounce per 5,000 gallons-is helpful in calculating dosages for batch chlorination and is a suggested starting point only; the actual required amount depends on temperature, pH, and the water's chlorine demand. **NEVER** remove the manhole cover to batch-chlorinate a tank; introduce the chlorine into the tank through sounding tubes or air vents or by other methods.

c. Chlorination or bromination procedures are not adequate until the water contains the required FAC or TBR after 30 minutes. * Paragraph 1.D.13. lists required residuals.

d. Ships with bromine systems may add bromine to previously chlorinated water with no harmful effect.

8. Halogen Requirements.

a. To assure safe potable water throughout the ship's distribution system, all parts of that system must contain a measurable trace halogen residual. Sometimes this standard is difficult to achieve in certain sections of the ship, particularly in the O level with its reduced usage of potable water. In the absence of bacteriological contaminants, a lack of measurable residual in less-used outlets should not be a matter of concern, but requires close bacteriological monitoring.

b. All water delivered to the tanks, whether from approved sources or produced on board, must be chlorinated or brominated to provide at least 0.2 ppm halogen residual (FAC or TBR) after 30 minutes' contact time.

c. If obtaining potable water from approved sources that use chloramines to disinfect, the Engineering Officer shall contact the area MLC (kse) about required testing, treatment, and monitoring. As is FAC, chloramines are a chlorine residual, albeit slower and less effective than FAC. Produced by combining chlorine and ammonia, chloramines are bactericides but their disinfection rate is 60 to 100 times slower than FAC. To measure chloramine levels, follow the procedures for testing combined residual chlorine using the DPD test kit.

d. The system operator must chlorinate or brominate water received from an unapproved source, one of doubtful quality, or an area where amoebiasis or infectious hepatitis is endemic to achieve between 2.0 to 5.0 ppm halogen residual (FAC or TBR) in the tanks after 30 minutes. In these instances, if the ship's brominator cannot achieve a TBR of 2.0 ppm, the system operator must chlorinate the water by the batch method to at least 2.0 ppm FAC after 30 minutes' contact time. Once the water in the tank meets this criterion, it is safe to use.

9. Disinfecting Potable Water Tanks and Systems.

a. The two types of disinfection procedures are mechanical cleaning combined with chemical disinfection and chemical disinfection alone.

b. Mechanically cleaning tanks includes all measures necessary to remove existing foreign materials, rust, and other substances from the tanks.

c. Contractors or authorized maintenance personnel will mechanically clean and chemically disinfect the tanks when their condition has deteriorated to the point at which chlorine demand has increased significantly and bacteriological evidence indicates the tank has become grossly polluted. After mechanically cleaning any tank, workers will chemically disinfect it. Perform mechanical cleaning and chemical disinfection under these conditions:

(1) New tanks, including those on new vessels;

(2) Rehabilitated or repaired tanks;

(3) Sludge or rust accumulation seriously impairs the quality of water delivered.

(4) Tanks have been loaded with non-potable ballast water.

(5) Voids or tanks converted from non-potable water to potable water tanks.

CAUTION: Tanks are confined spaces and entry could immediately endanger life or health. Always ensure a gas-free engineer or competent person has evaluated and approved entry and work procedures before workers enter.

d. Butter-worthing-mechanical cleaning at sea with sea water-is permitted, but always follow it with chemical disinfection. Mechanical cleaning, especially if using sea water, promotes rust in the tanks and is laborious and time-consuming.

e. Chemical disinfection is required under these conditions:

(1) Tanks show evidence of continued bacteriological contamination after normal disinfecting procedures;

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

(3) Tanks have been entered.

(4) New or contaminated hoses.

f. To chemically disinfect a system, engineering or maintenance personnel must take these steps:

(1) Introduce enough chemical into the tanks to produce at least 100 ppm FAC; see the Chlorine Dosage Calculator in * Enclosure (2).

(2) Fill tank with potable water.

(3) Using the ship's pumps, drain chlorinated water from each outlet to ensure this treatment reaches all contaminated system components (pumps, valves, lines and hoses).

(4) After four hours' contact time in the tanks and system, the FAC residual must be at least 50 ppm; test the water once an hour to ensure it maintains the proper FAC. If ever during the four hours the FAC residual falls below 50 ppm, add chlorine to bring the residual to 100 ppm and start the four-hour contact time again.

(5) Pump potable water from the lowest opening in the tanks through the contaminated lines, pumps, and valves, and return it to the tank or dispose.

g. If chemically disinfecting two or more tanks, re-use the highly chlorinated water from the first tank to disinfect other polluted tanks; the system operator may need to add more chlorine to maintain desired residual until all have been treated.

h. If it is impractical to disinfect a potable water tank as described above, follow this procedure:

(1) Thoroughly clean and rinse the tank.

(2) Swab all tank surfaces with a solution of 100 ppm chlorine or pump the solution through hoses so it reaches all tank surfaces. Use adequate personal protective measures, including appropriate respirators as recommended by the gas-free engineer; see * caution below.

(3) Flush all water used for super-chlorination from the tank.

(4) Rinse with potable water, and the tank is ready for use. Engineering personnel must maintain an FAC residual of at least 2.0 ppm in water transported and stored in these tanks.

CAUTION: Chlorine at 100 ppm may generate vapors dangerous to persons working in these tanks. The gas-free engineer must authorize entry into these tanks. See * NSTM, Volume 3, Chapter 74.

10. Disinfecting Potable Water Hoses and Appurtenances

a. Disinfect potable water hoses by filling with a solution containing at least 100 ppm FAC. The solution must contact the entire internal surface of the hose for at least two minutes. Flush the hose with potable water 30 to 60 seconds; then use.

b. Before connecting the potable water to either the ship riser or shore source, disinfect the fittings' interior by at least two minutes' contact with a solution of 100 ppm FAC. Flush the shore water source to waste 15 to 30 seconds before hooking up the ship's water hose.

c. Disinfect both sounding tapes and rods by wiping with a 100 ppm chlorine solution.

11. Disinfecting Water for Emergency Drinking and Cooking.

a. If potable water is not available during an emergency, it may be necessary to treat poor-quality water for drinking and cooking. Such water should be clean and as free of turbidity as possible. Before using this water, chlorinate 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 sure the water is safe. Another way to make safe water is to boil it at a rolling boil for two minutes; however, it is impractical to boil adequate quantities of water.

b. If the water is excessively contaminated or turbid, consider using canned or other emergency drinking water sources or water purification tablets (NSN: 6850-00-985-7166).

12. Chlorine Dosage Calculator.

a. Theory of Operation. This chart, Enclosure (2), contains the chlorination "dosage rate." The water quality, e.g., the organic and inorganic materials present, will affect the final chlorine residual. "Chlorine demand" is the amount of chlorine required to react with and be absorbed by these materials. The absorbed or neutralized chlorine 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 active disinfecting agent, to produce the chlorine reading, determined with the colorimetric test kit. A dosage rate of roughly 1 ounce of 65 to 70% calcium hypochlorite per 5,000 gallons yields 1.0 ppm. Due to chlorine demand, this dosage rate probably will produce a FAC residual of about 0.2 ppm after a 30-minute contact period.

b. Instructions for Use.

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

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

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

c. In determining the volume of a hose for disinfecting purposes, a standard 2" water hose has a volume of 0.25 gallons per foot. * "Water Supply Ashore," Chapter 2, Table 2.1, lists volumes for other hose sizes.

13. Required Halogen Residuals. This chart lists the required halogen residuals for various disinfection needs:

		Dosage and Time Requirements	
		Chlorination (FAC)	**Bromination (TBR)**
	Treatment Required	**Dose and Time**	**Dose and Time**
1.	Minimum residual required for potable water produced on board or obtained from an approved source	0.2 ppm after 30 minutes in tanks	
2.	Water from unapproved source or area where amebiasis or hepatitis is endemic.	2.0 ppm after 30 minutes in tanks	
3.	Water in potable water distribution system.	Trace readings throughout. Measurable trace halogen residuals-detectable color changes noted when using a DPD comparator-are acceptable provided bacteriological test results are consistently negative.	
4.	Disinfecting tanks and system.	100 ppm initially; 50 ppm after 4 hours	Not applicable
5.	Disinfecting hoses, couplings, and water connections before connecting to potable water system.	100 ppm for 2 minutes	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 potable cargo water.	2.0 ppm at destination	Not applicable

E. Ballast and Cargo Water.

1. Policy. Engineering personnel must disconnect and seal off at the tanks any potable water tanks and pipelines that will be filled with any non-potable liquid for ballast or other emergency purposes. Do not reconnect until the contaminated tank, piping, and fittings have been properly cleaned and disinfected. Disinfect this system as described in * Paragraph 1.D.13. Do not use water from these tanks for drinking or cooking until it has been adequately disinfected and a bacteriological analysis is negative. If these tests are positive, repeat the disinfection process as often as needed until the bacteriological analysis is negative before placing the system in service.

2. Cargo Water. Follow these provisions when handling water transported in bladders and/ or temporary storage vessels:

   a. All containers used to treat, store, transport, and distribute potable water must be clean and clearly labeled POTABLE WATER.

   b. Interior surfaces must be constructed of smooth, non-toxic, non-corrosive materials and free from rust and chips. Containers must have tight-fitting caps, lids, or closures that close securely. Any gaskets must be easily cleaned.

   c. Do not use potable water containers for any other purpose. Inspect, clean, and disinfect whenever necessary, but at least monthly.

   d. Mechanically clean and chemically disinfect under any of these circumstances:

      (1) Before placing a new container or system into service.

      (2) Before using containers or systems that have accumulated rust, scale, or sludge.

      (3) There is evidence of human, animal, or chemical contamination.

      (4) The system components have been dismantled or replaced for repair or alteration.

   e. Follow these procedures to mechanically clean and chemically disinfect:

      (1) Drain the container or system.

      (2) Scrub the interior surfaces, including all gaskets, lids, and spigot openings, with a soft brush and detergent solution.

      (3) If available, use high-pressure water or steam to rinse the container.

      (4) Open all valves, lids, taps, or spigots and allow the detergent solution to drain out through the system.

      (5) Rinse all surfaces thoroughly, several times if necessary, with potable water.

      (6) Super-chlorinate the container or system as described in * Paragraph 1.D.9.

   f. Water vessels will deliver potable water with a halogen residual of at least 0.2 ppm from an approved watering source to receiving ships. If the halogen residual is less than 0.2 ppm, add sufficient chlorine or bromine to ensure at least 0.2 ppm halogen residual is present in the water when delivered.

   g. Disinfect water received from an unapproved source to at least 2.0 ppm after 30 minutes' contact time; thereafter, maintain the residual at or above 0.2 ppm.

3. Receiving Cargo or Transferred Water.

a. The receiving ship's MDR must test the water's halogen residual before loading. The received water should have a minimum residual of 0.2 ppm.

b. If the water does not contain a halogen residual of at least 0.2 ppm, the Engineering Department must treat the received water before using it in the distribution system.

c. If the water source is unapproved, the MDR must bacteriologically test the water before and after adequate disinfection to 2.0 ppm to ensure bacteriological quality.

d. The MDR must complete the Potable Water Quality Log, CG-5648, to adequately document sources, halogen residual, bacteriological examinations, and recommendations; Appendix 1.A. shows a locally reproducible sample Log.

e. If the water transferred to the ship does not contain the required halogen residual, the MDR should officially notify the area MLC (kse).

F. Emergency Water Supplies.

1. Battle Dressing Stations.

a. To provide an alternate water source in emergency situations some ships' battle dressing stations are equipped with built-in, sufficiently large, gravity-flow, potable water storage tanks isolated from the main potable water system. A piping diagram is provided for each tank with appropriate instructions for filling and emptying.

b. Maintenance.

(1) Once each quarter the Engineering Department must drain and refill all potable water emergency storage tanks with potable water containing 0.2 ppm halogen residual.

(2) At least every three years, the Engineering Department must open all emergency potable water tanks, disinfect them, and inspect them for evidence of sludge or foreign material. Based on the results of this visual inspection, Department personnel may have to thoroughly clean the tank's interior. A new gasket may be required each time the tank is opened for inspection; replace the gasket if any cracking is visible.

(3) After filling and monthly thereafter the MDR must bacteriologically analyze water from each tank. If this analysis indicates a tank is contaminated, the Engineering Department must open, inspect, clean if necessary, and disinfect it.

(4) Routine halogen residual tests are not required.

2. Emergency Potable Water, 5-Gallon Containers.

a. Some small ships store emergency potable water supplies in 5-gallon containers because they lack an emergency tank in battle dressing stations. Fill these containers with water produced on board or from approved shore facilities. This storage is acceptable if the containers have been properly cleaned and disinfected before filling.

b. Currently one heavy-gauge plastic, 5-gallon potable water storage container is available in the stock system. **NEVER** use 5-gallon containers previously used to store gasoline or other petroleum products as emergency potable water containers aboard ship.

c. Examining Water Containers Before Disinfecting and Filling.

(1) First, carefully examine containers to ensure they have been used only to store potable water and for no other purpose. Each container's exterior surface must carry the inscription POTABLE WATER ONLY in letters at least 1 inch high either embossed or painted on it.

(2) Then physically inspect each container for these conditions:

(a) Evidence of open seams or surface breaks.

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

(c) Carefully inspect the cap to ensure it seats properly to the sealing surface.

(d) Ensure the gasket is properly fitted and structurally intact. If the gasket has deteriorated, replace it before using the container.

(e) If present, ensure the locking lever works properly by engaging the seat or lock ring cam lugs.

(f) Ensure the carrying handles are properly attached and in good repair.

d. Wash manually in warm water (110 to 125 F), using the recommended amount of approved dishwashing detergent *only* and a suitable long-handled, slender brush. Then thoroughly rinse with potable water. Use only approved dishwashing detergent to clean emergency water containers.

e. Disinfect all interior surfaces by exposing them to 100 ppm FAC solution for at least two minutes.

f. Potable water used to fill emergency containers must contain a 0.2 ppm FAC or TBR.

g. Label each can with fill date and potable water source.

h. Store the 5-gallon containers in a clean, dry place in the immediate vicinity of their anticipated use, e.g., a battle dressing station without emergency potable water tanks.

i. Every three months Engineering personnel must empty, flush, and refill these containers with potable water containing a 0.2 ppm FAC or TBR.

j. Halogen residual and bacteriological tests are not required.

3. Boats, Rafts and Battle Stations.

a. The MDR must inspect canned drinking water stored for emergency use in boats, rafts, battle stations, battle dressing stations, or storerooms as indicated below. However, these inspections need not include water supplies in encapsulated rafts if the raft is opened and repacked at selected shore facilities.

b. At least quarterly the MDR must inspect drinking water can exteriors for rust, dents, and general appearance to ensure the water is properly stored and safe to consume. Do not use cans dented across the ends or side seams or crinkled to a point or edge. Rusted cans may be used if the rust does not penetrate the can; rust that can be wiped off is not penetrating. Replace any containers showing evidence of leakage or severe distortion.

G. Evaluating Taste or Odor Problems in Shipboard Potable Water.

1. General. Though taste and odor problems are primarily aesthetic, they are worrisome aboard ship because they impair members' morale. Most people are extremely sensitive to taste and poor-tasting water will affect coffee and other beverages. Shipboard water treatment processes do not easily control taste or odor problems that develop. Generally, water produced by the ship's distillation plant is good quality and the least likely source of problems. As a mobile environment, a ship must rely on various water sources, e.g., shore, barges, or other ships. A ship's variety of piping systems, if not isolated, can cause severe problems. The uniqueness of the shipboard environment, the complexity of piping systems, and multiple water sources individually or jointly may be factors in the source of taste or odor problems aboard ship.

2. Causes of Taste or Odor in Potable Water. These conditions or factors may contaminate potable water, resulting in severe taste or odor problems aboard ship. Consider each individual situation as a possible source of taste or odor problems.

a. Cross-connections with non-potable systems.

b. Leaks in common bulkheads between potable water 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. Using potable water hoses for non-potable liquids.

f. Water stored in tanks an excessively long time.

g. Improper distillation processes in harbors contaminated with industrial or biological wastes.

h. Inadequate disinfection procedures resulting in development of chloramines.

i. Transfer of water with taste or odor problems from shore facilities or barges.

j. Improperly cleaned or disinfected potable water tanks used for ballast or other liquids.

k. Deteriorated or improperly applied tank coatings.

l. Distilling plants producing potable water while stripping JP-5 tanks, pumping oily bilges overboard forward of the distilling plant feed pumps' suction, or in close proximity to other ships.

3. Indicators of Taste or Odor Problems.

a. The MDR is directly responsible for monitoring the potable water system. Usually he or she performs this function by daily determining chlorine or bromine residuals in representative areas of the ship and performing weekly bacteriological analyses of the potable water. These tests, as well as complaints from the crew, can be very helpful in identifying and locating the source of taste or odor problems.

(1) Crew Complaints. If the potable water supply has taste or odor problems, Medical and Engineering personnel usually are the first to know, since the crew will very helpfully draw their notice to the problems. These initial complaints can provide important data, particularly if the complaints are confined to a segment of the crew, a specific location, or a specific time pattern. An MDR or EDR can pinpoint all these factors to a particular tank in use, its disinfection processes, and its associated piping system. Each item of information is important when evaluating taste and odor problems.

(2) Bacteriological Analysis. If the taste or odor problem's cause or source is due to biological growth in the tanks, the Colilert or Membrane Filter Technique may not necessarily assist in identifying the biological source. The MDR tests to identify bacteriological contamination by coliform organisms that indicate fecal contamination. The culture medium used in testing restricts the growth of many organisms that may contribute to taste or odor problems. Therefore, although bacteriological tests of the ship's water supply consistently may be negative, the source of taste or odor problems nonetheless could result from biological growth in the tanks. Other testing methods will determine the source of the problem.

(3) Halogen (Chlorine or Bromine) Residuals. Perhaps the most effective, practical tool in evaluating problems associated

with a water system is the halogen test for chlorine or bromine. It can be performed rapidly and provides a great deal of information about conditions in the potable water tanks and distribution system. Presuming water received from an external source or produced within the ship has been disinfected properly, the tanks contain an initial amount of chlorine or bromine. As the tanks are placed on line, the chlorine or bromine residual should be detectable at points throughout the distribution system. The MDR can measure halogen residuals at the tank and various points in the distribution system to identity the loss of disinfectant in the system and possible sources of problems.

b. Disinfectants, including chlorine and bromine, react with virtually any substance in water; this process may neutralize them. The water supply's halogen demand varies with the amount of interfering or neutralizing substances present, since they reduce the initial supply of chlorine or bromine added to the water. This complex problem can be simplified for medical surveillance purposes as follows: if the proper amount of chlorine or bromine was added to the tanks and no halogen residual is present or it disappeared somewhere in the distribution system, this indicates some substance has used or neutralized the system's disinfectant. The tanks' or potable water system's lack of ability to maintain a halogen residual indicates the chlorine or bromine is reacting with some substance that may cause the taste or odor problem. While the causes of taste or odor problems vary widely, a systematic approach may resolve the problem or at least provide helpful initial data for more experienced investigators.

4. Initially Evaluating Taste or Odor Problems. These statements and questions represent a standardized approach to complaints received or experienced with taste or odor in the potable water supply. Medical and Engineering Department personnel may identify the source of the problem by evaluating these questions. If this evaluation does not reveal the source, the Medical and Engineering Department will have conducted a great deal of the initial evaluation and provide a baseline of information for personnel from MLC (kse) or other organizations tasked to evaluate the problem.

a. When was the problem first noticed or initial complaints received* This date and time may correlate to a particular tank, section of the piping system, or repairs and maintenance performed on the system.

b. What is the water source*

(1) Shore (direct pressure).

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

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

(4) Barged water.

(5) Another ship.

(6) Produced by ship's distiller.

c. Does the water have a characteristic taste or odor* This is quite vague, but sometimes it is possible to determine the source of a water problem by a distinctive taste or odor.

d. Is the problem isolated in one section of the ship or does it occur throughout* If the problem affects only a particular section, concentrate the investigation on occurrences affecting the piping system or tank supplying that section. Cross-connections, repairs to, or maintenance on the piping system, sounding tubes, or a particular tank are possible sources of the problem.

e. Is the problem continuous or does it occur only while a particular tank is on-line* If the problem appears to be cyclic, compare the record of complaints and the particular tank(s) supplying water to different sections of the ship. Additionally, use halogen residual testing to observe whether the tank or particular sections of the piping system display increased halogen demand.

f. Can the system maintain halogen (chlorine or bromine) residuals* Routine surveillance using halogen residual testing should have identified this problem in the system. It is important now to test the on-line tank and several points in the system. If the proper residual is not present in a tank after adequate disinfecting and contact time, the problem may be inside the tank or indicate inadequate disinfection practices.

g. Has the ship experienced similar taste or odor problems in the past* Discussion with Engineering personnel may provide information about a history of similar problems.

h. Review the potable water log to identify fluctuations that might occur in the potable water distribution system. To do so, plot a simple graph with halogen residual levels on the vertical axis and days on the horizontal. In plotting this data for the past three months, the MDR can develop an accurate picture. Compare this data with the water source and tanks on-line at the time. A pattern associated with a particular water source or individual tank may emerge.

i. Identify potable water tanks with common bulkheads to fuel, ballast, or other tanks or bilges. The source could be a small leak that creates persistent taste or odor problems in a potable water tank with such a common bulkhead. Do not overlook identifying these tanks or associated non-potable liquids that may contaminate the potable water system as the source of the problem.

j. Identify any non-potable piping permanently installed through potable water tanks. Any piping through potable water tanks should be enclosed in self-draining pipe tunnels to avoid contaminating the water system. In many instances, an EDR can evaluate this piping only by entering the tanks, but engineering records should show the location and existence of this type of piping.

k. Evaluate water disinfection procedures to ensure Engineering personnel used proper amounts of disinfectants. While the Engineering Department treats water, including disinfecting, MDRs

must understand the system and review disinfection procedures to ensure Engineering personnel are adding proper amounts of halogens to achieve the necessary chlorine or bromine residuals in the distribution system.

l. Identify any repairs to or maintenance operations on the potable water distribution system that could have contributed to the taste or odor problem. Numerous points in the potable water system can contaminate through either cross-connections or as a result of repairs or maintenance. The MDR should review these operations and correlate their location in the system as possible contaminants.

m. Has the MDR monitored the water remaining in potable water tanks while the ship is at the pier on direct service* It is possible to ignore water remaining in potable water tanks when the ship is tied up to the pier. Consequently, the water may sit for a long time, become stagnant, and cause taste or odor problems immediately on resuming tank use.

n. Did the MDR evaluate potable water tanks by halogen testing or bacteriological analysis before the Engineering Department filled them with shore water* If shore water mixes with water that sat in the tanks for extended periods, taste or odor problems may occur. It is advisable to check the water in the tanks for adequate halogen residual and bacteriological analysis before filling with shore water.

o. Identify each potable water tank's coating type and application date and location. An improperly applied or cured potable water tank coating may cause a temporary or permanent taste or odor problem. Usually shipboard personnel cannot easily evaluate a tank coating. A temporary taste problem after applying new tank coatings is not unusual, but should resolve after using the tank. In contrast, lack of ability to maintain halogen residuals in the tanks accompanied by persistent taste and odor problems may directly relate to an improperly applied or uncured tank coating.

5. Controlling Taste or Odor Problems.

a. As previously noted, mechanical processes to control taste or odor are quite limited aboard ship. Identifying and eliminating the source of foul taste or odor is of the utmost importance to members. In a ship at sea whose system must be used, increasing the residual chlorine levels can aid in controlling taste or odor problems.

b. Municipal water systems ashore use increased residuals as a control measure for bad taste and odor. The elevated chlorine residuals often satisfy the halogen demand existing in the tanks or pipes. Therefore, ships unable to identify a source of taste or odor should add sufficient chlorine to produce 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 tanks' or system's halogen demand and resolve temporary taste and odor problems.

6. Request for Outside Assistance.

   a. An MDR who has evaluated the situation as outlined in * Paragraph 1.G.2. and has been unable to determine the source of the taste or odor problem should contact the area MLC for technical assistance by either telephone or submitting a Potable Water Discrepancy Report as shown in * Appendix 1.B. Medical and appropriate Engineering personnel should be prepared to discuss their evaluation of specific items listed in * Paragraph 1.G.2.

   b. MLC (kse) personnel will thoroughly evaluate all aspects of the taste or odor problem aboard the ship. If they cannot assist the MDR in person due to geographic location, MLC(kse) will request the closest Navy Preventive Medicine Department or Unit to provide onboard assistance in reviewing the problem.

   c. MLC (kse) personnel will thoroughly review the situation and recommend appropriate steps to resolve it. If they either cannot resolve the problem or suspect tank coatings as the cause, they will summarize their investigative results and provide them and recommendations to COMDT (G-WKS) through the chain of command.

H. Cross-Connections.

1. Scope. Improperly cross-connected piping has contaminated potable water and caused numerous water-borne disease outbreaks. In recent years, the potential for cross-connections between potable and non-potable systems has significantly increased due to back-flushing sewage collection tanks and associated piping. The MDR must constantly monitor potential cross-connection problems from 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 numerous separate piping systems carrying fuel, sewage, salt water, potable water, etc., offer distinct possibilities for cross-connections, particularly during repair, modification, or negligent operations.

2. Definitions.

   a. Cross-Connection. Any connection between two separate piping systems, one containing 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, contaminating the potable water supply.

   b. Backflow. The unwanted reverse flow of liquids, solids, or gases into the potable water system. Backflow can refer either to back-siphonage or backflow caused by back-pressure.

   c. Back-Pressure. A pressure greater than the supply pressure that may cause backflow in the potable water system.

d. Back-Siphonage. Negative pressure in the potable water system drawing non-potable water or other substances "by suction" into the potable water system through cross-connections or outlets. The risk of back-siphonage increases when the potable water system is secured during water hours or for any other purpose.

e. 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.

f. Air Gap. 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 separation actual distance must be at least twice the diameter of the potable water supply pipe between the outlet and the highest possible liquid level in the receiving object but always at least one inch (1").

g. Backflow Preventer Devices. Devices designed to prevent backflow and subsequent contamination of the potable water supply. These devices are installed at locations requiring direct connections to the potable water system, e.g., dishwashing machines and water closets. Several types of backflow prevention devices are available. Choose the proper application to protect the water supply from among these approved types:

(1) Atmospheric Vacuum Breaker. This backflow prevention device is necessary on a potable water outlet designed for an attachment that does not have a shutoff downstream from the vacuum breaker. It is not designed for continuous pressure.

(2) Hose Connection Vacuum Breaker. This device attaches directly to a hose bibb. It has a single check with an atmospheric vacuum breaker vent. It is not designed for continuous pressure.

(3) Specialty Backflow Preventer with Intermediate Atmospheric Vents. A device with two independent check valves-an intermediate vacuum breaker and a relief valve. Used in low-hazard situations, it is effective under constant pressure.

(4) Reduced Pressure Zone (RPZ) Backflow Preventer. This device has two independent check valves with an intermediate relief valve for use in high hazard situations and continuous pressure applications. It is supplied with shut-off valves and ball-type test cocks. It must be tested annually; attach the annual test record to the RPZ or file it with the maintenance records.

3. Selecting and Installing Backflow Prevention Devices.

a. When potable water is supplied under pressure, vacuum breakers, backflow preventers, or air gaps between the water delivery point and the equipment overflow rim must protect the system against backflow or other contamination. In general, any type of potable water supply connection to equipment allowing the flow of toxic liquid or contaminated water into the potable water system is not permissible. The Engineering Department must install vacuum

breakers or backflow preventers if air gaps are impractical or water under pressure is required.

b. Atmospheric Vacuum Breakers. Install these devices under these conditions:

(1) No valves can be installed downstream.

(2) Critical level must be 6 inches above the highest point downstream where back-pressure could be created.

(3) Critical level must be 6 inches above the receptor's flood level rim.

(4) Only suitable for back-siphonage situations; not appropriate for back-pressure conditions.

(5) Nominal diameter is at least equal to the line size.

c. Hose Connection Vacuum Breakers. Install these devices under these conditions:

(1) No continuous pressure can be applied to the device.

(2) Must be installed on the control valve's discharge side.

(3) Maximum working pressure is 125 psig.

(4) Temperature range is 33 to 180 F.

(5) Will prevent back-siphonage or maximum back-pressure of 4 psig (10 feet of head pressure.

(6) Can be used in low- to high-degree hazard situations.

d. RPZ Backflow Preventers. Install these assemblies under these conditions:

(1) Control valves are required upstream and downstream.

(2) An air gap must be provided for discharge from vent port.

(3) The assembly must be tested before initial use and annually thereafter.

(4) Maximum back-pressure cannot exceed twice the device's rated working pressure.

(5) Suitable for continuous pressure.

(6) Can be used in low- to high-degree hazard situations.

(7) The Engineering Department must provide drainage.

e. Double-Check Valve Assemblies. Install these assemblies under these conditions:

(1) Can be used as backflow preventer only in fire protection systems.

(2) Cold devices' temperature range: 33 to 110 F; hot devices' temperature range: 40 to 180 F.

(3) 150 psi working pressure.

(4) Use only in low-hazard situations.

f. Other Backflow Prevention Devices. Consult with area MLC (kse) staff for guidance in properly selecting and installing other types of backflow preventers.

4. Defective Piping Installation. Observers have identified these examples of defective piping installations that have caused disease outbreaks aboard ship:

a. Backflow.

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

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

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

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

b. Back-Siphonage.

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

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

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

(4) Improperly installed water-operated waste ejectors, e.g., potato peelers and garbage grinders.

(5) Potable water hose connections installed without vacuum breakers, or with attached rubber hoses allowed to remain in sinks or photo tanks.

5. Potential Contamination Sites. Both ship and shore MDRs should review these locations, conditions, equipment, and concerns to determine their potential to contaminate the potable water system through cross-connections to non-potable water, backflow, or back-siphonage:

a. Potable water supply lines to swimming pools, whirlpools, hot tubs, bathtubs, and similar facilities.

b. Photography laboratory developing machines and utility sinks.

c. Beauty or barber shop spray and rinse hoses.

d. Potable water faucets where hoses are or are likely to be connected, e.g., deep sinks, food preparation sinks, and weatherdeck hose bibbs, including hoses to tanks containing chlorine and other chemicals.

e. Garbage grinders.

f. Dish- and glass-washing equipment.

g. Sick bay and laundry equipment.

h. Air conditioning supply tanks.

i. Boiler feedwater tanks.

j. Fire systems.

k. Potable water, bilge, and sanitary pump priming.

l. Fresh- or saltwater ballast systems.

m. Bilge or other waste water.

n. Air gaps between all potable and non-potable systems.

o. Lines to divert potable water to other systems by valves or interchangeable pipe fittings, acceptable only when an air gap follows a valve.

p. A common compressed air system supplying pressure to both non-potable and potable water pneumatic tanks; the air supply must be through a press-on type of air valve or hose manually held in place. A fixed connection for this valve is allowed only if the air supply is from a separate compressor used exclusively for potable water pneumatic tanks.

q. Vacuum breakers located on the discharge side of the last control valve (flushing device) and at least 6 inches above the fixture's flood-level rim must protect any potable water supply connected to a toilet system.

r. Feedwater to hot wells.

s. Feedwater to oily water separators.

t. X-ray developer connections.

6. Monitoring and Inspecting Potable Water Supplies.

   a. Garbage grinders, x-ray developing machines, photographic chemical mixing tanks, and photographic film and print processing machines normally are hard-plumbed or have a permanent flexible hose installed to receive potable water through a reduced-pressure backflow preventer installed above the overflow level.

   b. Throughout the ship, install an atmospheric or hose-bibb vacuum breaker anywhere a hose bibb faucet permits a hose connection to the potable water system; e.g., at deep sinks and galley and weather deck washdown faucets.

   c. MDRs should routinely check for cross-connections during water surveillance, water sample collections, sanitation inspections, and halogen residual tests. Modifying or repairing existing potable water systems aboard ship should alert the MDR to potential cross-connection problems. Frequent discussion with Engineering personnel about the potable water system and any proposed repairs or changes may be extremely beneficial in preventing cross-connections. If an MDR suspects or identifies a cross-connection he or she must quickly, effectively determine whether the condition is unsatisfactory. The MDR should thoroughly discuss the problem with the Engineering Officer and review the suspected site and ship diagrams. An MDR identifying a cross-connection has the primary responsibility to prevent a disease outbreak from occurring so he or she should recommend the EO secure the affected part of the potable water system until the Engineering Department can eliminate the cross-connection and disinfect the potable water system, if necessary.

I. Manufacturing and Handling Ice.

1. Manufacture. Most ships use ice cube machines or ice makers to make ice, though a few small pantries, galleys, general messes, and very small ships still use ice cube trays. To reduce bacterial growth, use potable water to prepare all ice used for food or drink or to maintain food at acceptable temperatures. Regardless of the end use, prepare all ice in a sanitary manner and protect it identically to water. See the * Food Service Sanitation Manual, COMDTINST M6240.4 (series), for additional sanitary requirements.

2. Special Precautions. Because ice is vulnerable to contamination, special handling and storage precautions are necessary.

   a. Prepare all ice from potable water.

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

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

d. Use an ice scoop to remove ice from the storage hopper. Store the ice scoop outside the ice storage compartment.

3. Cleaning and Disinfecting. The * Food Service Practical Handbook, COMDTINST P4061.4 (series), contains disinfection procedures for ice cube machine hoppers and flaking devices.

4. Bacteriological Quality.

a. The MDR must collect ice samples monthly for bacteriological examination; ice must conform to the standards for potable water.

(1) If ice samples collected for bacteriological analysis test positive for coliform organisms, food service personnel should empty, clean, and disinfect the storage bin.

(2) Improper handling techniques or dirty storage bins usually cause contaminated ice.

b. The MDR must enter results of bacteriological examinations of ice samples in the Potable Water Quality Log, CG-5648, shown in Appendix 1.A.

J. Water Testing Requirements and Procedures.

1. Scope.

a. All testing requirements and procedures must comply with *Standard Methods for the Examination of Water and Wastewater,* most current edition, published jointly by the American Public Health Association (APHA), American Water Works Association (AWWA), and Water Pollution Control Federation (WPCF). The tests described here are minimal for water from approved sources; supplement them with additional tests if the water source is of doubtful quality.

b. Analyzing water for suspected chemical contaminants is very complex. The equipment necessary to perform these determinations is not available aboard ship. If an MDR suspects chemical contamination, with or without illness, he or she must request outside assistance from the area MLC (kse) immediately.

2. Temperature and pH.

a. These tests are important to the Engineering Department because water temperature and pH deviations may affect treatment or disinfection procedures. Halogenation is more effective at lower, more acidic pH values and warmer temperatures. Alkaline pH levels (8.5 or higher) adversely affect chlorine's or bromine's disinfecting properties. When chlorine enters water, it forms hypochlorous acid (HOCl) and hypochlorite ions (OCl^-) in proportions depending on the pH: the lower the pH, the more hypochlorous acid. Since hypochlorous acid is chemically neutral,

it diffuses more readily through microorganisms' membranes than does the charged hypochlorite ion. Thus chlorine is more effective as a bactericide at a low pH. Water temperature affects the amount of bromine the cartridge releases; high temperatures may deplete the cartridge more rapidly.

b. Test for pH when testing for halogen residual; enter the results in the Potable Water Quality Log, CG-5648, shown in * Appendix 1.A.

c. The MDR also can test for pH using the DPD chlorine-bromine-pH combination test kit, it is a standard stock item (NSN 6630-01-067-3827).

3. Salinity. When operating in sea water, the chloride content of water from a distilling plant shall be 0.065 equivalent per million (epm) or less, 0.25 grains of sea-salt per gallon, or less than 2.3 ppm. See the individual distilling plant's technical manual for testing procedures.

4. Halogen Residual (Chlorine or Bromine) Testing.

a. This is an extremely important test since potable water's bacteriological safety depends on residual concentrations of free available chlorine (FAC) or total bromine residual (TBR). FAC and TBR represent the amount of halogen present in potable water after adequate disinfection. FAC refers to hypochlorous acid, a far more effective disinfecting agent than combined chlorine (chloramines). In a colorimetric test, the combined chlorine is distinguished from FAC by the length of time before the color appears after adding the color indicator chemical to the water sample. FAC and TBR react rapidly; therefore, an immediate reading of the result is necessary (60 or fewer seconds).

b. Regardless of water source, ships must maintain as a minimum, a trace FAC or TBR throughout the potable water distribution system after initial treatment. MDRs shall test for halogen residuals under these conditions:

(1) Before receiving potable water on board.

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

(3) Daily, from various sampling points that represent the ship's distribution system, e.g., forward, amidships, aft, below deck, and in the superstructure.

(4) As part of evaluating the treatment process, the Engineering Department tests chlorine or bromine residuals in potable water tanks after 30 minutes' contact time.

c. DPD Test. The DPD (diethyl-p-phenylene diamine) test determines chlorine or bromine residuals. The test kit comparator gives direct readings for both chlorine and bromine, read over two ranges.

	Chlorine	**Bromine**
Low Range	0.1 to 1.0 ppm	0.2 to 2.2 ppm
High Range	2.0 to 10.0 ppm	4.4 to 22.2 ppm

To read the low range put 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 high range put the sample tube in one of the openings located on top of the comparator and make the reading. Move the test sample tube from one position to another until a color match is made. Different DPD test kits are available, e.g., LaMotte model LP-NS (NSN: 6630-01-067-3827); follow the specific test's instructions. Use this general procedure to obtain both FAC and TBR:

(1) Open potable water tap and let flow at least 2 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 because this affects the color. Immediately compare the test sample color with the color standards in the comparator. Complete the color matching within one minute after adding the DPD No. 1 tablet.

(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 the 5.0 ppm chlorine or 11.0 ppm bromine color standard, add one (1) additional DPD No. 1 tablet to obtain a full color response. No formulation is required for the extra tablet; take a direct reading and record.

(7) When testing a water supply disinfected with chloramines, determine the total residual chlorine by using DPD tablet No. 4. The reading from this tablet will not differentiate among types of chlorine, but will indicate the total levels of disinfectant present. If it is necessary to determine the type of chlorine present other than FAC (total chlorine residual), obtain specific guidance from the area MLC (kse). This is the test procedure for total chlorine residual:

(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 disintegrate rapidly (it will effervesce); then cap the test tube and shake to mix.

(c) The resulting color 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 after testing.

(9) When testing for extremely high levels of chlorine, i.e., superchlorination, it is necessary to dilute the water sample 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, multiply the test reading by 10.

(10) Record halogen residual test results in the Potable Water Quality Log, CG-5648, shown in *Appendix 1.A.. Report absence of halogen residuals in the potable water system to the CO with a copy to the Engineering Officer. Prepare and submit a Potable Water Quality Discrepancy Report if halogenation problems are not immediately corrected. See * Paragraph 1.J.6. for details.

5. Bacteriological Collecting and Testing.

a. The shipboard test measure to determine the suitability of water for human consumption is bacteriological purity, which ascertains whether disinfection has fully destroyed pathogenic organisms in the water.

b. Units without assigned health service duty technicians are exempt from conducting bacteriological testing if the ship's water system provides a documented, reliable disinfectant trace residual throughout the distribution system at an effective pH level (6.8-7.8). If water meets these criteria, bacteriological contamination is rare or non-existent.

c. Units with assigned independent duty health services technicians will perform weekly bacteriological tests on samples collected at representative points throughout the distribution system including potable water tanks, ice machines, and potable water retained in storage tanks when under direct service from shorelines. Take tank samples from petcocks on the tank; if not available, collect the sample from the outlet nearest the tank. On ships so equipped, use the brominator recirculation test taps to obtain samples from each tank. Record all results in Part II of the Potable Water Quality Log shown in * Appendix 1.A.

d. Base the number of samples on the size of the ship's storage and distribution system, crew size, potential for disease outbreak from water sources, mission duration and complexity, the ability to conduct underway replenishment (UNREP), and other high-risk activities. Cutters with assigned independent duty health services technicians must perform bacteriological testing and daily halogen residual testing. Vessels required to conduct bacteriological testing will collect at least four (4) samples per month in accordance with * Chapter 3.B. Collect and test special samples more frequently when chlorine demand increases or contamination is suspected, after cleaning and disinfecting tanks, and on completing system repairs. When collecting samples, follow the procedures in * Chapter 3.

e. Coliform microorganisms indicate fecal contamination. EPA-approved tests for total coliforms include the minimal media ONPG MUG (MMO-MUG) Colilert test and the Membrane Filter (MF) technique; see * Chapter 3.

(1) The Coast Guard has adopted Colilert Test (MMO-MUG), described in * Chapter 3, as the method of choice to determine whether coliforms are present in shipboard potable water distribution systems.

(2) The Maximum Contaminant Level (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. The MCL for ships analyzing fewer than 40 samples per month is no more than one sample per month may be total coliform-positive. However, all total coliform-positive samples require prompt retesting and reporting as indicated in this section. The presence of *any* coliform organism is a danger sign.

(3) Each shipboard potable water system must be sampled as required by * Paragraph 1.J.5.c. above.

(4) For each total coliform-positive sample repeat the test and analyze for total coliforms. Take at least one repeat sample from the same tap as the original sample. Collect two additional repeat samples, one each up-and downstream, from within five service connections of the original positive sample. If the original positive sample is at the end of the distribution system, collect both samples downstream. If total coliforms are absent in these samples, the water is safe to use.

(5) Analyze any routine or repeat total coliform-positive sample culture for fecal coliforms or *E. coli* using EPA-approved methods. * *Standard Methods for the Examination of Water and Wastewater* contains test methods for fecal coliforms. Analyze *E. coli* using methods described in the * 8 Jan 91 *Federal Register* (56 FR 642) and/or * *Standard Methods.* If, however, the MDR considers all coliform-positive samples also fecal coliform-or *E. coli*-positive, he or she need not further test shipboard systems. If so, the MDR also considers each total coliform-positive sample fecal coliform- or *E. coli*-positive and counts it in the monthly Potable Water Quality Log. Smaller ships not capable of performing confirming fecal coliform or *E. coli* analyses must consider all total coliform-positive cultures as fecal coliform- or *E. coli*-positive. Ships that can perform confirmation tests for fecal coliforms or *E. coli* have two options: either perform fecal coliform or *E. coli* confirmation tests of all coliform-positive cultures or consider each total coliform-positive culture as fecal coliform- or *E. coli*-positive.

(6) Prepare and submit a Potable Water Quality Discrepancy Report shown in * Appendix 1.B. through the appropriate command channels to the supporting area MLC (kse) if coliform bacteria test results are positive. Continue to submit these reports until two consecutive coliform bacterial tests are negative. See * paragraph 1.J.7. for details.

6. Potable Water Quality Log.

a. Maintain a two-year chronological record of potable water monitoring. On larger ships with a Health Services (HS) Technician, the HS will maintain all potable water records; on other ships the Medical Department Representative will do so.

b. Prepare and submit the Potable Water Quality Log (PWQL), CG-5648, to the unit Commanding Officer monthly; * Appendix 1.A. shows a sample authorized for local reproduction. Make chronological entries; they must include at least this information:

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

(2) Ship's location: at sea, in harbor, at anchorage, or in port; if in port, its name.

(3) Source of ship's water: the ship's distilling apparatus, water barge, shore using direct pressure, or ship's tanks filled with ashore water. Also note the water source (approved or non-approved), its halogen residual, and whether disinfected.

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

(5) Tests Performed.

(a) Halogen Residual. Specify if bromine or chlorine, amount or absence of residual, reason taken, e.g., daily, bacteriological analysis, before receiving water, or after disinfecting tanks or lines. Include any follow-up action taken for negative readings.

(b) pH. Record the results of pH tests.

(c) Bacteriological Analysis. Record all test results, including positive and negative controls. If performed, record the results as total coliform-present or total coliform-absent if fecal coliform or *E. coli* has not been confirmed. State the reason to perform the test, e.g., weekly, special, or after disinfecting tanks, lines, or systems. Record action taken and results for positive samples even if another activity performed the tests.

(d) Initials. The person performing the tests should record his or her initials.

(e) Problems. Record any taste or odor problems and their resolution on the reverse side of the Log.

(f) Inspection and Surveys. Include results, discrepancies, and action taken on the reverse side of the Log.

7. Potable Water Quality Discrepancy Report. All commands will submit a Potable Water Quality Discrepancy Report (PWQDR) through command channels to the servicing area MLC(kse) if product water fails to meet the quality requirements listed in this Chapter or product water quality is suspect, except *only* if a halogenation deficiency is corrected immediately. Use a message format for this report; * Appendix 1.B. contains a sample. Continue to submit PWQDRs until satisfactory water test results verify the problem has been resolved.

K. Water Sanitation Bill.

Each ship should have a Water Sanitation Bill developed to meet its individual, unique conditions. The Commanding Officer should promulgate the Water Sanitation Bill and post it conspicuously in areas where potable water and associated materials are processed, treated, or stored. * Appendix 1.C. presents a sample bill offered as a guide only.

Appendix 1.A. Potable Water Quality Log

Month: _____ Unit: _____
Submitted by (Print or Sign Legibly): _____ Date: _____

	Date	Time	Ship's Location	Water Source	Sampling Site	FAC/TBR (ppm)	pH	Initials
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								

Part II: Bacteriological Test Results

MF = Membrane Filter Method (result: number of colonies per 100 ml)
CL = Colilert Method (result: presence or absence)

Collected Date	Time	Sample Location	Type Reg	Cntrl	Analysis Date	Time	Method MF or CL	Results Total/Fecal	Analyst's Name

NOTE: Submit a Potable Water Discrepancy Report to MLC (kse) if results do not meet standards found in the Water Supply and Wastewater Disposal Manual, Chapter 1.J.

Appendix 1.B. Sample Potable Water Quality Discrepancy Report

FM (UNIT NAME)
TO COMCOGARD MLC LANT(PAC)//K//
BT
UNCLAS//NO5100//
SUBJ: POTABLE WATER QUALITY DISCREPANCY REPORT
REF A COMDTINST M6240.5 (series), WATER SUPPLY AND WASTEWATER DISPOSAL MANUAL

1. AS REQUIRED BY REF A, RESULTS OF BACTERIALOGIC TESTING OF SHIP'S EVAP SYSTEM CONDUCTED ON [insert date] WERE POSITIVE FOR TOTAL COLIFORM BACTERIA BUT NEGATIVE FOR E-COLI. CAUSE OF SUPECTED CONTAMINATION IS UNKNOWN. SHIP'S TOTAL BROMINE RESIDUAL WAS ZERO WHEN SAMPLES WERE TAKEN. SHIP IN TRANSIT TO PANAMA AND MAY HAVE TAKEN ON CONTAMINATED WATER AT RECENT PORT CALL IN MEXICO.

2. SHIP TOOK THESE CORRECTIVE ACTIONS TO ELIMNATE POSSIBLE CONTAMINATION: SUPERCHLORINATED SYSTEM TO 100 PPM RESIDUAL CHLORINE, RINSED, AND INCREASED BROMINE RESIDUAL FROM 0.2 PPM TO 2.0 PPM.

3. WILL CONTINUE TO TEST FOR BACTERIAL, BROMINE RESIDUAL, AND PH LEVELS AND SUMBMIT PWQD REPORT UNTIL PROBLEM RESOLVED. POC IS THE SHIP'S EO AT [insert telephone number].

BT
NNNN

Appendix 1.C. Sample Potable Water Sanitation Bill
USCGC ALWAYSSAIL

1. Responsibility.

   a. The Engineering Department supplies potable water and treats it as required; the Department also operates and maintains the equipment that produces potable water.

   b. The Medical Department Representative (MDR) monitors all aspects of potable water treatment, handling, and storage to ensure they comply with current instructions to protect the potable water supply. Additionally, the Medical Department collects and examines representative samples to monitor potable water for quality.

2. Sources.

   a. Processing Sea Water. Do not distill or use reverse osmosis (RO) to process harbor water or polluted sea water except in emergencies. Assume sea water is polluted when ships are operating in close formation. While making potable water, take care not to strip fuel waste tanks or empty bilges or sewage forward of the salt water intakes.

   b. Potable Water. Potable water may be received from shore facilities or other ships from these approved sources:

      (1) U.S. military-owned and/or -operated facilities.

      (2) Water points listed in the joint U.S. Public Health Service and Food and Drug Administration publication * *Acceptable Vessel Watering Points Interstate Conveyance Official Classification List.* The Area Maintenance and Logistics Command (kse) and Navy Environmental and Preventive Medicine Units (NAVENPVNTMEDUs) can provide this list; contact them as necessary. Obtain other source data from the U.S. military representatives ashore or the MLC (kse) having area responsibility.

3. Procedures for Ship-to-Shore and Ship-to-Ship Connections.

   a. When available trained shore-based personnel should make or supervise all shore connections; however in many instances ship personnel must assume this responsibility. Personnel trained in handling potable water also shall transfer potable water ship-to-ship.

   b. Cutters should furnish their own potable water hoses in ship-to-shore connections. In sea transfers, the supplying ship normally provides hoses.

   c. An MDR must ensure an adequate halogen residual is present in the water before the water is transferred.

d. Flush the potable water outlet for 15 to 30 seconds and disinfect with a solution of 100 ppm free available chlorine (FAC). Let stand for two minutes and flush again.

e. Flush the hose for 15 to 30 seconds; then connect to the ship.

f. Conspicuously designate potable water ship risers by a warning plate with the inscription POTABLE WATER ONLY in one-inch letters. The connection shall be at least 18 inches above the deck and covered with a screw cap attached by a keeper chain when not in use.

g. The member hooking up the intake hose must ensure it is connected **ONLY** to a shipboard potable system.

h. Never submerge the hose in harbor water.

i. Follow the precautions and procedures above when making ship-to-ship potable water hose connections.

4. Potable Water Hoses. Use only potable water hoses for potable water. Mark potable water hoses POTABLE WATER ONLY approximately every 10 feet. Transfer potable water only through hoses disinfected by filling for 2 minutes with 100 ppm FAC solution. After disinfecting, couple or cap hose ends and store in lockers at least 18 inches above the deck and protected from weather, dust, and vermin.

5. Storage Tanks. Except in extreme emergencies, do not fill potable water tanks with ballast water. If tanks have been used for ballast water, disinfect tanks, pipes, fittings, and pumps used before refilling with potable water.

6. Disinfecting. Use only these halogens to disinfect potable water:

Table 1.A.1.: Disinfectants

Type	NSN Stock Number	Unit Size
Calcium hypochlorite technical 65 to 70% (HTH)	6810 00 255 0471	6-ounce jar
Sodium hypochlorite (5%)	6810 00 598 7316	1-gallon bottle
Sodium hypochlorite (5%)	6810 00 900 6276	5-gallon pail
Bromine 4610 01 022 9970	Cartridge	

a. Calcium Hypochlorite. In a container mix enough chemical in warm water to obtain the required residual and allow it to settle. When the tank is one-quarter full, pour the clear chlorine solution into it. Never introduce this solution into the tank by using brominating equipment. If adding chlorine solution to a full tank, circulate the water through a pump to ensure adequate mixing. If the required level of chlorine is not present after a 30-minute contact period, add more chlorine solution.

b. Sodium Hypochlorite. When the tank is one-quarter full, add enough chemical solution to obtain the required residual directly to the tank; no prior mixing or dilution is required.

c. Hypochlorinators. Refer to the manufacturer's literature for operational instructions and requirements.

d. Brominators. Brominating a potable water system requires two different brominators: one is used in the distillate discharge line from the Evaporator or RO system; the other treats water in the tank while recirculating potable water.

7. Residual Halogen Testing.

a. The MDR or designee must determine the halogen residual in the potable water daily by performing chlorine or bromine tests. The stock system includes a DPD chlorine-bromine-pH combination test kit, e.g., NSN 6630-01-067-3827. Perform tests at random locations to ensure adequate coverage of the entire system. Every week the MDR will test the potable water distribution system and ice machines with storage compartments.

b. Record halogen residual test results in the water log. Report continual absence of halogen levels to the Commanding Officer (CO) with a copy to the Engineering Department.

8. Bacteriological Testing.

a. Weekly the MDR will perform bacteriological tests on samples collected at representative points throughout the distribution system and from potable water tanks. Sampling locations include potable water in storage tanks while the ship is in port, while the system receives direct service from shore potable water lines, emergency potable water tanks in the battle dressing station, and one-fourth of the ice machines. Perform special or more frequent tests whenever chlorine demand increases, contamination is suspected, after cleaning and disinfecting tanks, and on completing repairs to the system.

b. If the results of a sample are total coliform-positive, take a set of repeat samples for each total coliform-positive sample and analyze for total coliforms. At least one repeat sample must be from the same tap as the original positive sample. Collect two additional repeat samples, one each upstream and downstream, from within five service connections of the original positive sample. If the original positive sample is at the end of the distribution system, collect two downstream samples. If total coliforms are absent in these samples, the water is safe to use.

c. Submit a report of the bacteriological test results to the CO and EO and enter the results in the Potable Water Quality Log.

9. Temperature, pH, and Salinity. Because temperature, pH, and salinity variations may affect the water treatment procedure, the Engineering Department must perform these tests at least daily.

10. Disinfecting Tanks and Distribution System. If mechanical cleaning and chemical disinfection are required, superchlorinate the potable water tank and, if necessary, the distribution system. Determine the volume of water in the tank and/or distribution system and add enough chlorine to raise the residual to 100 ppm FAC. Let stand four hours. During this interval, test hourly and then after four hours to make sure the water maintains the proper FAC of at least 50 ppm. If at any time during this period the FAC residual falls below 50 ppm, add sufficient chlorine to bring the residual to 100 ppm and restart the four-hour period.

11. Distribution System.

    a. Use potable water lines *only* for potable water.

    b. Do not cross-connect the potable water distribution system to any possible source of contamination.

    c. Supply potable water to be used as boiler feedwater 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 potable water tanks unless a sloping, self-draining pipe tunnel surrounds the lines.

    e. Label potable water lines as to the type of service and an arrow indicating the flow direction.

    f. If any accidental or other break occurs in the potable water system, disinfect the affected parts after reassembly and before placing that part of the system back in service. The Engineering Department must notify the MDR about any break in the water distribution system.

    g. Prime potable water pumps only with potable water.

    h. Potable water must be used to manufacture all ice.

12. Required Records.

    a. The Engineering Department shall maintain adequate records to furnish documentary evidence of having fulfilled its potable water production, treatment, and distribution responsibilities.

    b. The MDR will maintain a two-year, chronological Potable Water Quality Log, e.g., CG-5648, with this information about potable water surveillance:

        (1) For all water samples taken, the time and date, ship's location, ship's water source, and sampling site's location.

(2) For halogen residual tests, type of halogen; reason taken, e.g., daily, bacteriological analysis, before receiving water, disinfecting tanks or lines; results; and any follow-up action taken for negative readings.

(3) For all bacteriological analyses, including controls, reason performed, e.g., weekly, special, or disinfecting tanks or lines; results; and action taken on positive samples, even if another activity performed the tests.

(4) Any repairs or modifications to the potable water system or tanks; any taste or odor problems and their resolution; and inspection and survey findings and any action taken.

c. The MDR shall submit a Potable Water Quality Discrepancy Report through command channels to the servicing area MLC (kse) if product water fails to meet the Water Supply and Wastewater Disposal Manual's quality requirements or is suspect, except only for halogenation problems corrected immediately.

d. The Medical Department Representative must frequently inspect the potable water procedures and system to ensure this Bill's provisions are followed. The MDR must report any discrepancies in writing to the CO with a copy to the EO.

CHAPTER 3. TESTING WATER

A. Introduction.

Obtaining consistently reliable, valid test results is crucial in determining whether shipboard or shoreside water is palatable and potable or carries possible taste and odor problems or disease-causing organisms, thereby impairing morale and health. This Chapter describes the universal procedures to use in collecting water samples and performing either of the Coast Guard's two approved tests. The techniques described here are adopted from * *Standard Methods for the Examination of Water and Wastewater*, current edition, published jointly by the American Public Health Association (APHA), American Water Works Association (AWWA), and Water Pollution Control Federation (WPCF).

B. How to Collect Bacteriological Water Samples.

In collecting all bacteriological samples follow these procedures to prevent accidental contamination:

1. Containers. For bacteriological analysis use only containers prepared for coliform sampling, properly sterilized, with a screw cap or an EPA-approved water sampling bag containing sodium thiosulfate for microbiological sampling to neutralize any remaining chlorine or bromine. Containers are sterile; do not open or rinse them before use because the sodium thiosulfate will wash out. Commercially prepared, Environmental Protection Agency-approved, sterile plastic water collection bags containing sodium thiosulfate are available from standard stock and are acceptable substitutes for glass bottles. Follow all instructions for sample container handling and storage.

2. Sodium Thiosulfate. Be sure the sampling container holds sodium thiosulfate before collecting the sample; many manufacturers add powdered sodium thiosulfate to their collection containers. If not, to prepare a 10% sodium thiosulfate solution, dissolve 10 gm sodium thiosulfate in 100 ml distilled water. Put 2 to 3 drops in 4-oz. capacity bottles and 4 to 6 drops in 8-oz. bottles. Loosely cap or stopper the bottles and autoclave at 121 C for 15 minutes at 15 psi. Cool to approximately room temperature. Then tighten the caps or stoppers. Or, * see *Standard Methods for the Examination of Water and Wastewater,* current edition.

3. Sample Size: For most purposes, a 100 to 120 ml sample will suffice, but check beforehand with the testing facility to be sure.

4. Faucets. Take samples at the faucet.

   a. Avoid these types of faucets:

      (1) Faucets with aerators, swivel spouts, or add-on devices; remove them first;

      (2) Taps served by water treatment units such as water softeners; and

(3) Leaking faucets that permit water to run over the outside of the faucet.

b. If sampling taps are clean, free of attachments, and in good repair and if the water is allowed to flow at a uniform rate before sampling, flaming water taps before collecting potable water samples is not necessary. Do not alter the valve setting to change the flow rate during collection because doing so could affect the sample quality. Superficially passing a match flame or an alcohol-soaked cotton applicator over the tap a few times may have a psychological affect on observers, but will not kill attached bacteria; applying intense heat may damage the valve-washer seating or create a fire hazard if combustible materials are next to the tap. If successive samples from the same tap continue to show coliforms, disinfect the tap with a hypochlorite solution to reduce external contamination as the source of these organisms.

5. Procedure.

a. Always allow the water to flow moderately from a faucet for at least 3 minutes before taking the sample. Before collecting the sample, reduce the water flow to prevent splashing. Grasp the outside of the cap or stopper and carefully remove it.

b. Hold the sample container at the base, keeping hands away from the container neck. Be sure the inside of the container cap is protected and does not touch anything. Hold the cap in the hand.

c. Without adjusting the flow, fill the sample container to within -inch of the neck; leave about 20 percent air space at the top. Replace the cap immediately. If the sample is taken incorrectly, use another new sample container; do not reuse the original container.

d. Take a second sample using the same technique as the first, measure the pH and chlorine/bromine residual and record relevant information, e.g., date, time, disinfectant used, concentration, location, sampler's name, etc. For afloat units, record this information by filling out the Potable Water Quality Log. See * Appendix 1.A.

6. Handling.

a. Package the bacteriological sample for delivery. On a form and on the sample container label record all pertinent field information. If sending individual potable water samples to the laboratory by courier, the maximum allowable elapsed time between collection and examination shall not exceed 6 hours, except for samples mailed from distant installations; hold these samples for a maximum lapsed time of 30 hours.

b. Samples must remain cool-at 4 C-during transit. Ship in insulated boxes, if needed, or refrigerate during transit. Allow 30 hours at most between sampling and test times when shipping from a distant location. Ensure the samples can be processed

immediately. Record all samples' storage time and temperature; when interpreting data the examiner must consider these factors.

C. Accepted U.S. Coast Guard Bacteriological Testing Protocol: Colilert Test Technique.

1. Colilert Test Prodedure.

a. Adhere to good laboratory practice throughout the test procedure. Avoid touching the reagent or the inside of the reaction vessels or caps.

b. Carefully separate one Colilert Snap Pack from the strip; take care not to accidentally open the next pack. Tap the Pack so all the Colilert powder falls to the bottom.

c. Aseptically open one Pack by snapping back the top at the indicated score line. The top remains attached to the rest of the Pack. Caution: Do not touch the Pack opening.

d. Add the contents to a water sample of correct volume in a sterile, transparent, non-fluorescent borosilicate glass container or equivalent. Use a 100 ml sample with Catalog Nos. WP0200 and WP200 and a 50 ml sample with Catalog Nos. W050 and W050B. Aseptically cap and seal the vessel.

e. Shake vigorously by repeated inversion to help the reagent dissolve. Some particles may not dissolve but dissolution continues during incubation.

f. Incubate the reagent-sample mixture at 35 C 0.5 C for 24 hours.

g. Read the reaction at 24 hours. Color should be uniform throughout vessel. If not, mix by inversion before reading. If yellow color is present, check for fluorescence; see Steps b. and c. below.

2. Test Results and Interpretation.

a. At 24 hours, dispense the color comparator into an identical vessel and compare each reaction vessel to it. If the test vessel contains no yellow, the test is negative for total coliforms and *E.coli.* A yellow color equal to or greater the comparator confirms the presence of coliforms. The comparator shows the palest yellow and least fluorescence to indicate a positive test, which is typically much more intense than the comparator.

b. If after 24 hours a sample is yellow, observe for fluorescence in a dark environment. Using only the UV lamp from the kit, check each yellow vessel by placing the UV lamp three to five inches in front of the sample; make sure the lamp faces away from the eyes and toward the vessel. Fluorescence equal to or greater than the comparator's fluorescence specifically confirms the presence of *E. coli* in that vessel(s).

c. If a after 24 hours a sample is slightly less yellow than the positive comparator or indeterminate, incubate up to 4 more hours (a maximum of 28 hours total). In a coliform-positive sample, the

color will intensify. If it does not, consider the sample negative. If the sample color remains indeterminate, consider the sample invalid and request another sample from the same site. Some water samples containing humic material may have an innate color. If a water sample has background color, compare the inoculated Colilert vessel to a control blank of the same water sample.

d. If an inoculated Colilert vessel is inadvertently incubated more than 28 hours, these guidelines apply: no yellow color is a valid negative test. Verify or repeat a yellow color after this incubation period.

D. Accepted U.S. Coast Guard Bacteriological Testing Protocol: Membrane Filter (MF) Technique.

1. Test Materials and Preparation.

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

b. * *Standard Methods for the Examination of Water and Wastewater* specifies two separate stock solutions are required to prepare a working solution of the phosphate buffer rinse. For convenience, these stock solutions are Solution A and Solution B.

(1) To prepare manually, make one (1) liter of Solution A*also called Phosphate Buffer Solution, available commercially by dissolving 34 grams of potassium dihydrogen phosphate, KH2PO4, in 500 ml of distilled water. Then, to 500 ml distilled water, add 20 grams of sodium hydroxide, NaOH and add this solution to the first one to adjust its pH to 7.2.

(2) Prepare Solution B by dissolving 38 grams of magnesium chloride, MgCl2, in one liter of distilled water.

(3) Prepare the working rinse solution 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. Most MDRs will want to arrange for a shore medical activity to make these solutions as most ships are not capable of adjusting Solution A's pH. Solutions A and B keep almost indefinitely if stored protected from contamination and out of direct sunlight.

c. In most cases, filters and absorbent pads are packaged together in a packet ready to be sterilized. Sterilize by autoclaving at 121 C for 15 minutes. Filters and pads also are available in pre-sterilized packages. Either type is satisfactory provided the filters and pads are sterile when used.

d. Sterile plastic petri dishes are available and recommended. If it is absolutely necessary to re-use these dishes, wash them, completely immerse opened dishes in 70% ethyl alcohol for at least

30 minutes, remove, place on a sterile towel, protect from dust, allow to air-dry, and reassemble.

e. Dipping forceps tips in alcohol and igniting the fluid adequately sterilizes them. Repeat this procedure after handling each filter. **Caution:** Allow forceps to cool a few seconds; membrane filters are extremely flammable.

f. Ready-to-use M-Endo broth in 2-ml vials, available through the Federal Stock Catalog, is recommended. Or prepare this medium by adding 1.2 grams of dehydrated M-Endo or MF Coliform powder to 24.5 ml distilled water containing 0.5 ml of 95% ethyl alcohol. *Do not substitute* any other alcohol for ethyl alcohol (ethanol), because other types often kill bacteria. Heat the solution to boiling, boil up to1 minute, remove from heat, and cool before using. Store this solution in a refrigerator up to 96 hours.

2. Conducting the Test. Follow this step-by-step procedure to perform the total coliform test with the membrane filter.

a. Collecting and testing the water for a chlorine or bromine residual is not a part of the coliform test; however, the MDR normally measures and records a disinfectant residual after the water has run 2 or 3 minutes and before he or she collects it in a bacteriological test sample bottle or bag containing sodium thiosulfate.

b. Clean the work area with potable water and allow the surface to dry.

c. Prepare fresh medium for the day's testing. If using ampuled media (M-Endo broth in ready-to-use 2-ml vials), use one ampule for each sample filtration.

d. Arrange and prepare certain equipment and supplies from the bacteriological water testing kit (Figure 3-A) for use as follows:

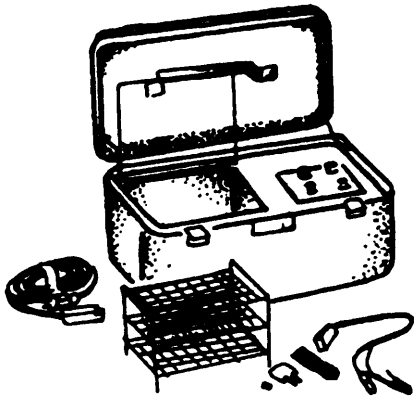


Figure 3-A Bacteriological water test kit

Figure 3-A Bacteriological water test kit

(1) Before each filtration series sterilize the field test kit by removing the stainless steel flask from the funnel base assembly to expose the absorbent ring around the holder 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, igniting the *entire* ring. Invert the filter cup over the funnel and burning absorbent ring for 15 minutes; the combustion produces formaldehyde, which sterilizes the filter cup; remove it; rinse the funnel thoroughly with sterile water; and the unit is ready for use. It is not necessary to sterilize this assembly between successive filtrations or between a series of samples unless 30 or more minutes elapse between them. To reduce the probability of contaminating each succeeding sample with bacteria present in the previous one, properly flush the funnel walls with sterile buffered water.

(2) Open the bottle of methanol; immerse the forceps in the methanol to about 1 inch.

(3) Before using the forceps, burn the alcohol off the tips in the Bunsen or alcohol burner. Hold the forceps in the flame only long enough to ignite the alcohol, as excessive heat will damage the forceps.

(4) Label the petri dishes to correspond to the sample number recorded on the analysis report.

e. Place one sterile absorbent pad in each petri dish, manipulating with the forceps.

f. Using a sterile pipette, deliver enough laboratory-prepared culture medium-approximately 2 ml-to saturate each absorbent pad or empty the contents of one ampule of medium on each absorbent pad (Figure 3-B). The proper amount of culture medium should allow a large drop to freely drain from the pad when the petri dish is tipped. Adequate medium is necessary for the organisms filtered out of the water to grow properly and provide valid results. On the other hand, using too much medium will cause the colonies to run together.

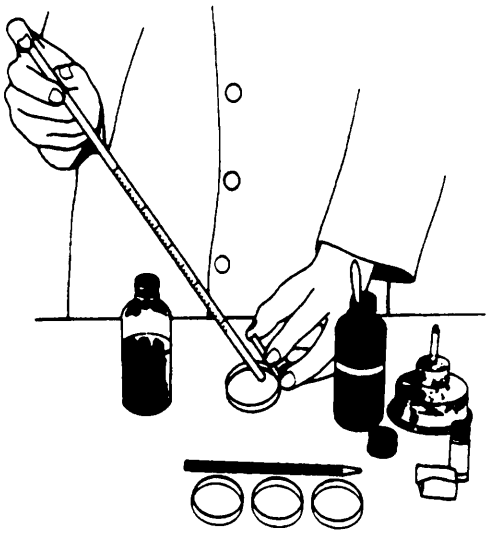


Figure 3-B Delivering culture medium to absorbent pad

g. Put a sterile membrane filter disk grid-side-up on the filter base and center it over the porous part of the membrane support plate (Figure 3-C). A membrane filter damages easily so always use a sterile forceps to grasp the outer part of the membrane filter to prevent damage to the porous part through which the sample is to be filtered.

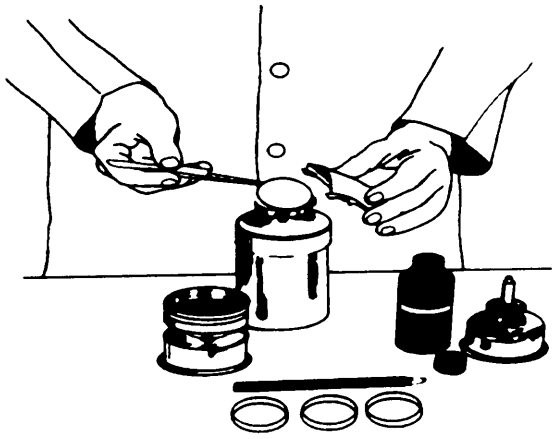


Figure 3-C Placing sterile membrane filter on filter holder

h. Attach the funnel element to the filter holder. To avoid damaging the membrane filter, never turn or twist the funnel element while seating and locking it to the filter holder. In securing the funnel element to a filter holder with a bayonet joint and locking ring, take special care to turn the locking ring sufficiently to fit snugly but not excessively tightly.

i. Filter the first water sample. Use a sterile graduated cylinder to measure sample and pour it into the funnel (Figure 3-D); then enter the volume of sample filtered in the appropriate space on the analysis report.

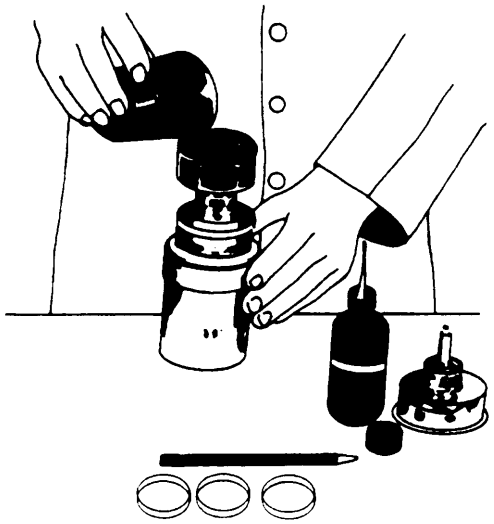


Figure 3-D Pouring the measured water sample into the funnel

j. Connect the hand suction pump to the filter base and pump to withdraw air; this helps the sample to pass through the filter (Figure 3-E).

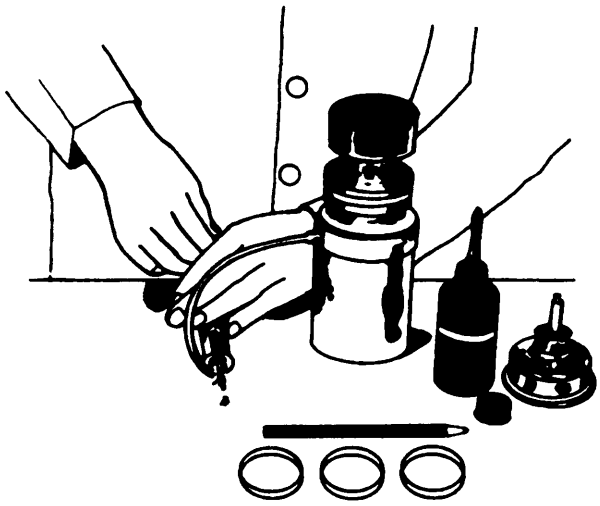


Figure 3-E Applying suction to the filter holder

k. After all sample has passed through the membrane filter, rinse funnel walls with at least 20 milliliters of sterile buffered water (Figure 3-F). If filtering several samples, rinse again after all the first rinse has passed through funnel to remove minute droplets from funnel walls and avoid contaminating subsequent samples. Stop pumping the filter assembly as soon as all the water of any sample has filtered because continued suction with no sample may introduce airborne contamination.

Figure 3-F Rinsing down funnel walls

l. Remove the funnel from the filter holder.

m. Use sterile forceps to remove the membrane filter from the filter holder (Figure 3-G) and carefully place it grid-side-up on the saturated pad, taking care not to trap air bubbles between the membrane and the pad (Figure 3-H); then close the petri dish. To avoid air bubbles, which hamper the culture medium from diffusing throughout the membrane filter, have enough culture medium on the absorbent pad and roll the membrane filter into position. If necessary, reseat the filter on the absorbent pad to eliminate bubbles.

Figure 3-G Removing the membrane filter from the filter holder

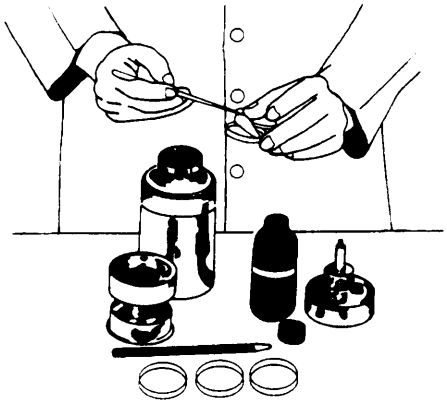


Figure 3-H Placing membrane filter on the absorbent pad saturated with culture medium

n. After placing all the membrane filters in petri dishes, put the dishes grid-side down in the incubator and incubate at 35 C 0.5 for 22 to 26 hours. Put a wet sponge in the incubator to maintain approximately 90 percent relative humidity during incubation.

o. After incubation, remove the cultures from the incubator (Figure 3-I).

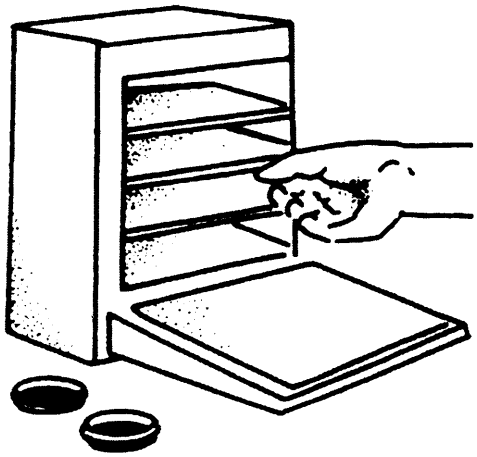


Figure 3-I Removing petri dishes from incubator

p. A greenish-gold metallic sheen indicates colonies (Figure 3-J). To interpret results, see * Paragraph 3.D.4.

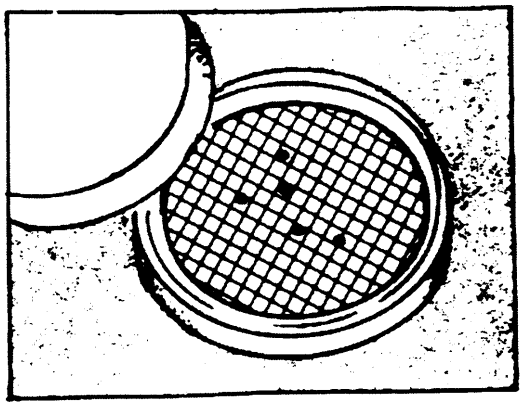


Figure 3-J Observing petri dishes for colonies

3. Optional Membrane Field Monitor Method. Follow this step-by-step procedure to perform the total coliform test with the microbiological analysis monitor.

   a. The membrane field monitor consists of a monitor, membrane filter, and absorbent pad encased in plastic with top and bottom holes fitted with plastic plugs, a syringe, a sterile sampling tube, and a long ampule of medium with one tip covered with a short plastic tube. Remove the plugs from the monitor; save them. Attach the syringe pump valve connection into the hole in the monitor's bottom (the side with spokes).

   b. Remove the sterile sampling tube end with the nylon valve tip from its plastic sleeve and attach the nylon tip into the inlet hole on the side of the monitor (Figure 3-K).

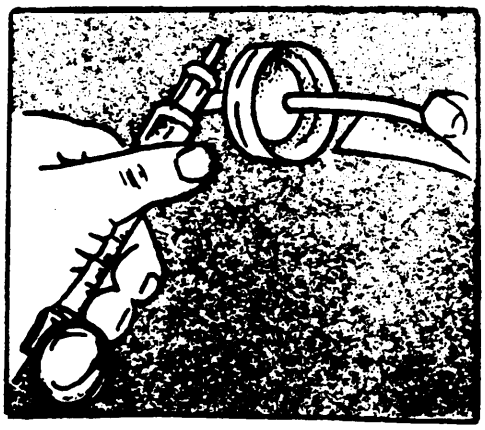


Figure 3-K Attaching nylon valve tip into monitor inlet hole

   c. From the other end of the sterile sampling tube remove the plastic sleeve and put 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.

d. Remove and discard the sampling tube; do not remove the monitor from the syringe (Figure 3-L).

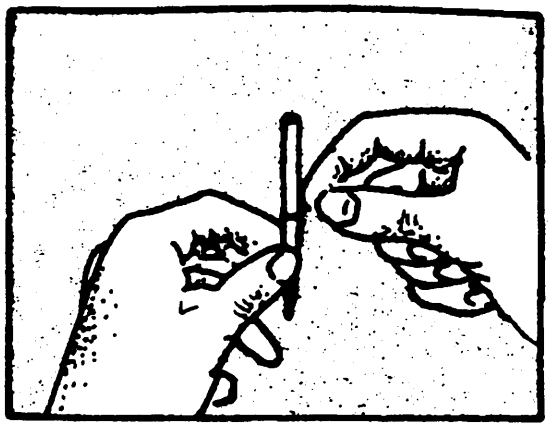


Figure 3-L Removing sampling tube

e. From an ampule of medium break off the tip covered with the short plastic tube. Place the forefinger over the end of the plastic tube as if it were a pipette. Break off and discard the other end of the ampule (Figure 3-M).

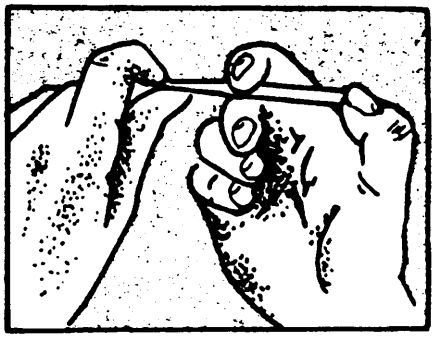
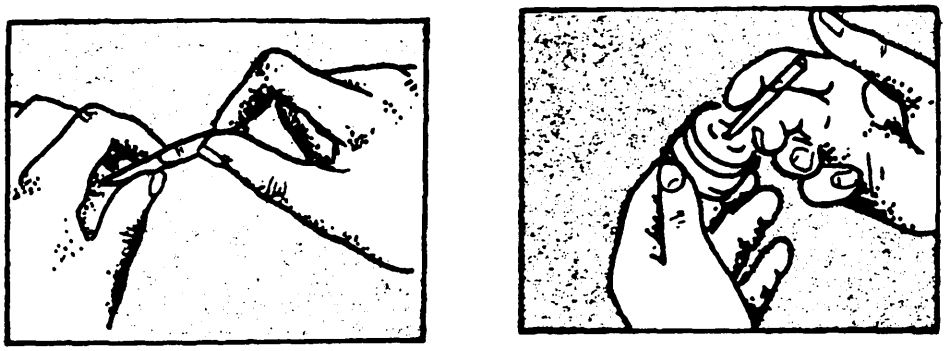


Figure 3-M Breaking off end of ampule

f. Remove the monitor from the syringe; insert the ampule's free end in the hole in the bottom of the monitor; press it gently against the absorbent pad. Release the forefinger and slowly release the pressure against the absorbent pad, allowing the medium to flow into the pad (Figures 3-N and 3-O).



Figures 3-N, 3-O Allowing media to flow into absorbent pad

g. Replace the plastic plugs, invert the monitor, place in an incubator at 35 C 0.5 for 24 hours. Pry off the top, observe for the presence or absence of coliform colonies, and record as previously described (Figures 3-P and 3-Q).

Figures 3-P, 3-Q Removing monitor top and observing for colonies

4. Interpreting Total Coliform Test Results. Colonies on the membrane filter appear as dark, various-sized dots with a metallic, usually greenish-gold, sheen that may appear only at the center, only on the edge, or over the entire colony. Pararosalinine, a dye in the medium, reacts with coliform-produced aldehydes to create the metallic sheen. Non-coliform colonies appear as clear, colorless, or dark colonies that may glisten but do not have a metallic sheen. Report non-coliforms as "background". Occasionally, coliforms do not produce a metallic sheen. Therefore, tests consistently producing high colony counts but no metallic sheen warrant further examination of these background colonies.

5. Controls. Perform fresh positive and negative controls for each group of samples processed.

a. To obtain a negative control, substitute 100 ml sterile distilled water for a sample and process exactly the same as a sample. If the control is positive, the technique has an error and the methods should be examined.

b. To obtain a positive control, place a fecal-contaminated swab in 100 ml of phosphate buffer. Shake the solution well; filter a small portion of the suspension. If this method produces too many colonies, 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. Record the results of positive controls in the water log as total coliforms present or absent. If the positive control test procedures produce only a few colonies, check whether laboratory practices, procedures, and supplies, e.g., phosphate buffer solution, culture medium, are satisfactory.

6. Reporting. For afloat units, enter bacteriological testing results in the Potable Water Quality Log and report to the unit Commanding Officer, with a copy to the Engineering Officer. See * Appendix 1.A. For ashore units, report results as required by State/EPA regulations.

Appendix 3.A.
Remedial Actions for Contaminated Water Samples

Condition	Possible Cause	Recommendations
I. No known sanitary defects, health hazards, or incidents of gastrointestinal disease.	The contaminated samples might indicate a localized situation within the building piping where the sample was collected or a faulty sampling technique.	1. Collect repeat samples promptly. 2. Expedite sample shipment to obtain a prompt report from the laboratory. 3. Investigate immediately to determine whether any unusual conditions have occurred, e.g., water main, faucet, or piping repairs within the building or near the sampling point. 4. Test for chlorine at various outlets to ensure proper dosage. 5. If this investigation shows the need, flush the portion of the system by opening outlets until a proper chlorine residual is recorded; chlorinate locally if needed. 6. Resample. 7. If examination shows any conditions listed in Paragraph II below, follow the remedial actions recommended there.
II. Occurrence of a major disaster, e.g., inundation of the source, break-down in treatment plant units, a cross-connection grossly contaminates the system, underwater crossing failure, earthquake damage, etc.	Self-evident	1. Immediately reject water supply system. Institute an emergency treatment program. Treat all drinking and cooking water. 2. Complete all necessary repairs. Super-chlorinate and flush the entire system. 3. Collect samples from representative points throughout the system until at least two consecutive sets of standard samples collected on different days yield negative microbiological results. 4. Remove restrictions on water use.
III. Occurrence of an outbreak of one of the so-called waterborne diseases.	Water system contaminated at the source, in reservoirs, treatment facilities, or distribution system and not generally obvious at the onset of the outbreak.	1. Implement Condition I recommendations; especially emphasize investigating the source, reservoirs, treatment processes, and distribution system. 2. Increase the system's chlorine dosage and residual. 3. If the conditions causing the contamination are serious, e.g., direct sewage contamination, reject the supply and institute emergency treatment until the condition is corrected.