(4) If vents and/or overflow lines are provided on tanks, the opening shall be so located as to reduce possibilities of contamination to an absolute minimum, and the opening shall be screened with 16-mesh or finer corrosion-resistant wire and shall not terminate in food service, hospital, toilet, or other spaces where contamination or odors may be transmitted to the water.

(5) Potable water tanks and distribution lines must be disinfected if the tanks are entered or the lines contaminated. (See sec. IV.)

(6) In order to avoid difficulties with taste and the danger of toxic chemicals, only those tank lining materials which are specified by the Bureau of Ships as satisfactory for potable water tanks shall be used. After a new coating or lining material has been applied, tanks shall be cleaned, flushed, and disinfected.

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

(8) The construction features for measurement of water level in potable water tanks shall be such as to prevent the entrance of contaminating substances into the water system. All tanks with sounding tubes are supplied with individual sounding rods permanently stored in the tubes. All sounding rods shall be handled in a sanitary manner prior to insertion back into the tanks. Other rods or tapes shall not be used for sounding potable water tanks.

6-9. Distribution of Potable Water

(1) The potable water system is designed as an independent water system to deliver potable water to galleys, sculleries, and pantries; to the sick bay and other medical facilities; to laundries, scrub decks, showers, and washrooms; and to drinking water coolers distributed throughout the ship. The potable water system must be absolutely free of interconnection with all nonpotable water systems and be protected against contamination from back-siphonage, backflow or leakage into any part of the system. Potable water lines shall not be used for nonpotable liquids nor shall they be piped through nonpotable liquids unless protected by a sleeve or tunnel as prescribed in article 6-8(3). Lead pipe or fittings shall not be used in potable water systems. If any break occurs, accidental or otherwise, the parts concerned shall be disinfected after reassembly and prior to placing that part of the system back in service. The medical officer or his representative shall be notified concerning the break and the measures being taken to disinfect the section of the system involved.

(2) All potable water pumps suction lines should be air tight and free of cross-connection. Packing gland seals should be maintained by using water identical in quality to that handled by the pump. Water inferior in quality to that pumped must never be used for priming of pumps. If higher quality is used for priming purposes, it must be admitted to the pump casing through an air gap. Pumps that have been dismantled for repair should be disinfected after reassembly and before being put into service.

(3) All hose valves and other connections used for loading potable water must be stenciled as required by current BUSHIPS Manual and Directives. Hydrants on the fire and flushing system are painted red, to prevent confusion in emergency and also to forestall cross-connection of the fire and flushing system with the potable water system ashore.

(4) In order to trace and identify the various water and other pipe systems and to warn against improper connections, all pipes are stenciled to indicate the liquid carried. Arrows indicate the direction of flow. Each line should have at least one designation in each compartment through which it passes. The identification of piping aboard ship shall be in accordance with BUSHIPS Technical Manual instruction.

Section III. CARGO WATER

6-10. Handling of Ballast Water

(1) Potable water tanks and pipelines which have been filled with any polluted water (all sea water is to be considered polluted) for ballast purposes shall be disconnected and blanked off at the tank and shall not be reconnected until the contaminated tank, pipe, and fittings have been properly disinfected. Disinfection of this system shall be accomplished as described in article 6-14 of this manual. If there is a water shortage it would be

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impractical to disinfect a large potable water tank as prescribed in article 6–14. The following procedure may be used:

(a) Thoroughly clean and rinse the tank.

(b) Swab all surfaces of the tank with a solution of 200 p.p.m. chlorine.

(c) Allow to dry.

(d) Rinse with potable water and the tank is ready for use.

Potable water tanks and pipelines shall not be used for drinking purposes until the above procedure is carried out and bacteriological analysis of the water is negative. If the bacteriological tests are positive, then the process must be repeated before this system is placed in service.

6–11. Handling of Cargo Water

(1) *Water Ships.* AW's, YW's, and stationary water barges shall take on water from approved watering points (see art. 6–6) whenever possible. The water shall be loaded in such a manner that it is not contaminated. Upon completion of loading, the following data will be entered in the log:

(a) Determine the residual chlorine in p.p.m. of each tank.

(b) Determine the pH and temperature of the water in each tank.

(c) Source of water: from an approved watering point or not.

(d) Date and location of water samples taken for bacteriological examination. (Samples for bacteriological testing must be dechlorinated and should be refrigerated if delay of more than 6 hours will occur before delivery to the laboratory.) Bacteriological determinations must be accomplished at least once each month. This is considered to be the minimum requirement, and it is recommended that more frequent samples be collected for bacteriological analysis to insure delivery of safe water. Bacteriological testing shall be accomplished when there is doubt as to the quality as reflected by an increase in the chlorine demand or when received from an unapproved source.

AW's, YW's, and stationary water barges shall deliver water to receiving ships with a free chlorine residual of at least 0.2 p.p.m. when the source is from an approved watering point. (See art. 6–7.) If the chlorine residual is below this, the water shall be chlorinated or rechlorinated to ensure that at least 0.2 p.p.m. free chlorine is available in the water when delivered. Water received from an *unapproved* source shall be chlorinated or rechlorinated (as the case may be) so that after a 30-minute contact time the free chlorine residual shall be at least 2.0 p.p.m. The free chlorine residual shall be at least 0.2 p.p.m. when the water is delivered. Refer to chapter 5, article 5-6 for chlorination as to time, temperature, and pH factors affecting this process.

(2) *Temporary Water Ships.* When it is necessary to use AO's, AOG's, or YO's in emergency for transporting potable water, the tanks of these ships shall be cleaned as prescribed in appendix B of section IV. Lead determinations shall be made of all tanks to insure that the amount of lead in the water is not more than 0.05 p.p.m. (mg./1). Chlorination shall be accomplished as prescribed in section IV. A log shall be maintained the same as for water ships, article 6–11(1).

(3) *Hose and Fittings.* Sufficient hose for complete disinfection circuits and for loading and discharge lines shall be carried. Washered male and female caps shall be provided for these hoses and shall be secured to the hoses with keeper chains. All hose and fittings used for potable or disinfected water shall be handled in such a manner as to prevent contamination. Particular care will be exercised to prevent the hose from dipping into the harbor water. *Potable water hoses shall not be used for any other purpose.* When not in use, all hose will be capped with washers in place and stored as directed in article 6–6(2). The plugs and washers and caps shall be kept clean to prevent contamination of the hose. Before water is delivered, hose ends shall be washed with a 50 p.p.m. chlorine solution and then flushed with potable water.

6–12. Management of Cargo Water During Storage and Discharge

(1) When the water cargo is to be transported or when it will be held in protracted storage, the free residual chlorine shall not be permitted to drop below 0.2 p.p.m. until delivered. Chlorination shall be accomplished as prescribed in section IV of this chapter and the residual maintained by the addition of liquid chlorine or High Test Hypochlorite as needed. Salinity tests shall be routinely made when the ship is under way, at least weekly.

(2) All ships used to transport, store, or issue water shall determine and log every 24 hours, the chlorine residual in p.p.m. and the saline content of the water in every tank. A sharp increase in salinity over the initial salinity determination shall be considered a sign of possible leakage of sea water into the tank and may indicate pollution from sea water. YW's, YO's, and AOG's, used for local delivery of water taken from an approved source, shall determine and log only chlorine residual of each load. When the facilities are available, bacteriological examination of all water tanks shall be made weekly on all YW's, YO's, and stationary barges used as water carriers. The results of these tests shall be recorded, entered in the ship's log, and voyage or a monthly report submitted to the commander of the service squadron to which attached.

Section IV. DISINFECTION

6–13. Disinfection of Potable Water Supplies

(1) Water is usually disinfected by the addition of sufficient chlorine compound to produce 1.0 p.p.m. chlorine with a residual of not less than 0.2 p.p.m. free chlorine after a 30-minute contact time. The contact time can be reduced to some extent by the use of higher residuals (refer to ch. 5, figs. 5–1, 5–2, and 5–3). The chlorine dosage is controlled by testing the residual chlorine in the water after the required contact time has lapsed, by the Ortho-tolidine-Arsenite (OTA) method. A standard chlorine residual test kit is used for this purpose.

(2) Disinfection by chlorination is recommended as a routine method of guarding against the sanitary defects or accidents that may occur during the production, handling, storage, and distribution of water. Such use of disinfection shall be considered as providing an added factor of safety and not as constituting a satisfactory substitute for the correction of sanitary defects or insanitary practices. The absence of free chlorine in the ship's potable water might indicate contamination; therefore it would be necessary to add sufficient chlorine to maintain the required residual.

(3) Grade A calcium hypochlorite originally contains 60 to 70 percent available chlorine. The compound loses strength gradually with age, however, especially when opened and/or stored in a hot space. Hypochlorites should be obtained in small containers, usually 6 ounces or 3¾ pounds, and stored in a cool, dry, ventilated place. About one-fifth of an ounce of full-strength Grade A hypochlorite is required to dose 1,000 gallons of water with 1.0 p.p.m. chlorine, although older stocks of hypochlorite may require a greater amount. This amount of hypochlorite is only a suggested starting point, and the amount to be added to the water will depend on temperature, pH, and the chlorine demand of the water. Solutions for feeding through hypochlorinator machines may be from 1 to 10 percent strength. *The solution should be made up and allowed to clarify, and then decanted, using the clear supernatant solution for chlorination.* Additional chlorine compounds are available that may be used in lieu of the calcium hypochlorite (art. 6–22, table 2).

(4) Provided automatic chlorinators are not available in the ship, chlorination of the potable water tanks may be accomplished by the batch method. The estimated amount of chlorine compound required to produce 1.0 p.p.m. is dissolved in a bucket of water, and after settling the supernatant fluid is introduced into the tank when it is about one-quarter full. Sufficient mixing usually will be obtained by the stirring action of the incoming water as the tank is filled. Additional mixing may be obtained by recirculation. *If the chlorine solution must be introduced into a full tank, mixing by recirculation through a pump is necessary.* Thirty minutes or more after the tank is filled or mixing is completed, the water is sampled and tested for residual free chlorine. If the free residual is less than 0.2 p.p.m. additional chlorine must be mixed into the water, and after the required contact time the free residual must be determined again. As an alternate method, the dry powder of the chlorine compound may be added directly to the tank before or during filling. The motion of the ship will provide adequate mixing.

(5) Hypochlorinators which inject chlorine solution in proportion to flow of water have been adapted to shipboard use. These may be used to chlorinate water entering the potable water tanks or may be installed to inject chlorine solution into the water as it enters the distribution system. Chlorination of the water as it enters the potable water distribution system provides a greater degree of safety but requires a delay of use of the water in order to permit sufficient contact time.

(6) The chlorine dose required to produce a 30-minute free chlorine residual of not less than 0.2 p.p.m. varies widely because of the chlorine demand. This is true even for distilled water. If ammonia is present, to obtain a free chlorine residual in distilled water sufficient chlorine must be added to destroy the ammonia. This requires a chlorine dose in p.p.m. of at least 10 times the p.p.m. of ammonia (measured as nitrogen) present in the water. Unfortunately, the ammonia in sea water goes over into the distillate; and, since the ammonia in natural water varies widely, the ammonia content of distilled water also may be expected to vary. In the absence of information concerning the amount of ammonia and other chlorine demanding substances in the water, a dose of not less than 1.0 p.p.m. chlorine should be used initially for at least a 0.2 p.p.m. free residual. If this does not produce a free chlorine residual of 0.2 p.p.m. after a 30-minute contact time, more chlorine solution must be added. If de-

sired the chlorine demand or the dose required can be determined by adding various amounts of chlorine solution of known strength to samples of the water to be treated. Determination of residuals in these samples after a 30-minute contact time will indicate the proper dose. When weighing the chemical for batch chlorination of water, it is convenient to remember that 1 ounce of full-strength Grade A calcium hypochlorite (HTH, Perchloron, etc.) added to 5,000 gallons of water, or one pound to 80,000 gallons, is the approximate dose for 1.0 p.p.m. of chlorine. (NOTE: The amount of chlorine in Grade A calcium hypochlorite is reduced once a container has been opened and all the contents not immediately used. Therefore, assume that the amount of chlorine remaining in the container has been reduced and increase the amount needed to reach the required strength.)

(7) *It is imperative to understand that unless an adequate free chlorine residual is obtained after the proper contact time, it is impossible to determine whether or not the chlorination procedures have been adequate.*

6–14. Disinfection of Potable Water Tanks and Systems

(1) There are two types of disinfection procedures: (a) mechanical cleaning and chemical disinfection and (b) chemical disinfection. Disinfection of tanks and pipelines shall be done as indicated below before any potable water is taken aboard.

(a) Mechanical cleaning and chemical disinfection shall be accomplished in the following tanks:

1. All tanks of new ships or tanks which have been rehabilitated or repaired.

2. Tanks where sludge or rust accumulation seriously impairs the quality of water being delivered.

3. Tanks which have been loaded with nonpotable ballast water.

4. Voids and tanks converted from nonpotable to potable water tanks.

(b) Chemical disinfection only is required in the following tanks:

1. Tanks in which cargo or potable water still shows pollution by bacteriological examination after normal chlorinating procedure for cargo or potable water.

2. Pipelines, valves, pumps, etc., which have been dismantled or replaced for purposes of repair or alteration.

3. Tanks which have been entered.

(2) Tanks which have not carried ballast water and in which the cargo water has been satisfactory in the previous trip will not undergo disinfection, but will be kept closed to avoid accidental contamination. Tanks which have been filled with clean sea water ballast (not in harbors or within 10 miles of the harbor) need not be mechanically cleaned, but must be chemically disinfected before reloading with fresh water. This disinfection is accomplished by adding chlorine at the rate of 100 p.p.m. to the ballast water. After 4 hours' contact time the free residual chlorine shall not be less than 50 p.p.m. This chlorinated sea water ballast may be carried to the destination and discharged upon arrival. After flushing with potable water and after bacteriological tests have determined it safe, the tank is ready for use without further treatment.

(3) Mechanical cleaning of tanks includes all measures necessary to clean tanks of foreign materials, rust, and other substances that are present within the tanks. After the tank has been thoroughly cleaned, it shall be chemically disinfected. Mechanical cleaning and chemical disinfection shall be accomplished when the chlorine demand has increased or bacteriological evidence indicates that the tank has become contaminated. Mechanical cleaning, especially when done with sea water, promotes rusting of the tanks; it is a laborious and time-consuming procedure and must be followed by chemical disinfection.

(4) Butterworthing or mechanical cleaning at sea with sea water (see app. B), is permissable but shall always be followed by chemical disinfection.

(5) Chemical disinfection of tanks is to be performed after each mechanical cleaning of the tanks and whenever indicated by conditions listed in paragraph (1). The process utilizes the disinfecting action of free chlorine. Chlorine for this purpose is furnished in the form of High Test Hypochlorite (HTH, Hypochlor, or Perchloron ®—available free chlorine 65 to 70 percent). Where High Test Hypochlorite is not available, chloride of lime may be substituted, but it must be remembered that the maximum available chlorine produced from chloride of lime is 25 percent and that this material is subject to rapid deterioration in storage. Appendix A indicates the amounts of High Test Hypochlorite or chloride of lime to be used in order to obtain desired concentrations of chlorine in parts per million (p.p.m.) in varying quantities of water.

(6) In all chemical disinfection procedures the tank shall be completely filled with water. Chlorine shall be added at the rate of 100.0 p.p.m. while water is entering a tank, and after the tank is full, the water shall be circulated. The chlorine residual after 4 hours' contact time shall not be less than 50.0 p.p.m. All valves and lines that have been used to carry polluted water must be included in this circulation process in order to disinfect the entire system. Samples of the circulating water are tested at hourly intervals to insure maintenance of the proper chlorine residual.

(7) The circulation period is essential to good disinfection procedure. Water should be pumped out of the lowest opening in the tanks, through the contaminated lines, pumps, and valves and returned

through the top lines into the tank through the ullage hole or manhole. Contaminated hoses should be placed in the circuit to accomplish disinfection of the entire polluted system.

(8) When more than one tank is to be disinfected the highly chlorinated water from the first tank should not be turned overboard but should be reused in disinfecting other polluted tanks (additional chlorine must be added to maintain desired residual) until all have been treated. If sea water has been used for the disinfection process it will, of course, then be pumped overboard. However, when fresh water has been used for chemical disinfection, it will be pumped overboard unless a critical water shortage exists. If it is necessary to retain this highly chlorinated water for potable water, then it must be dechlorinated using sodium thiosulfate (X-ray fixer) or sodium bisulfite; or the water may be evenly distributed throughout the storage tanks. If all the chlorine in the water is removed during the dechlorination process, it will be necessary to rechlorinate the water to the proper residual.

6–15. Stowage, Handling and Disinfection of Potable Water Hoses

(1) In no case shall filling hoses be cross-connected with any other pipe system. Inlets shall be clearly labeled and, when not in use, covered with screw caps. Hose lines for taking aboard fresh water must not be used for any other purpose and shall be capped or plugged at all times except when actually in use. If provided by the ship, they shall be stowed and handled as required in article 6–6(2) and article 6–22(6). Sufficient number of lengths of hose shall be provided to cover most connection situations.

(2) Hoses and fittings will be handled as discussed in article 6–11(3).

(3) During tank disinfection procedures as outlined in article 6–14 (6) and (7), contaminated hoses shall be placed in the circuit to accomplish disinfection of the entire polluted system.

(4) Hoses used for loading or transferring water shall be flushed to waste for 15–30 seconds prior to making final connection. If for any reason contamination of hoses is suspected, either because of careless handling, dropping in the harbor water, or not capped or plugged during stowage, the hoses shall be disinfected first by a thorough flushing with potable water and then subjecting interior to a minimum of 100.0 p.p.m. chlorine and held in the hose for at least 2 minutes. A contaminated hose must not be used for loading potable water. Fittings and connections shall be immersed in a chlorine solution of at least 100.0 p.p.m. prior to being connected. These apparently minor details must not be neglected.

(5) After taking on water from an unapproved source, the hoses used shall be disinfected as prescribed in article 6–15(4).

APPENDIX A

PROCEDURE FOR DISINFECTING A WATER SYSTEM

(1) Thoroughly scrub all of the storage tanks and flush the entire system with potable water. The interior of the tanks should be scrubbed with a soft brush to prevent chipping of the coating. Hard instruments should only be employed when removing the coating or rust.

(2) Determine the volume of the storage tanks, pressure tank, and all the water distribution system. Determine the amount of chlorine compound that will be needed in proportion to the total capacity of the system. The amounts of any of several chlorine-bearing products for different volumes of water are given in table 1. Any one of the chlorine compounds listed may be used. No matter which one is selected for the disinfection, the quality indicated in the table will give a dosage of 100.0 parts per million (p.p.m).

Table 1.—Amount of chlorine compound for disinfection of a water system with a solution containing 100 parts per million of chlorine

Tank capacity		25 percent chloride of lime	70 percent high test hypochlorite	Liquid sodium hypochlorite	
Gallons	Tons			5 percent solution	10 percent solution
				(Gallons)	(Gallons)
1,000	4	3 pounds, 4 ounces	1 pound, 4 ounces	2	1
2,000	8	6 pounds, 4 ounces	2 pounds, 6 ounces	4	2
5,000	21	16 pounds	6 pounds	10	5
10,000	42	32 pounds	12 pounds	20	10

NOTE: *See* top of page 6-10.

A heaping tablespoon holds approximately one-half ounce; a measuring cup approximately 6 ounces. One pound equals 16 ounces.

(3) Prepare the chlorine solution:

(a) CHLORIDE OF LIME. Place the proper amount of chlorine compound in a clean bucket containing no water; then add a small amount of water and mix to a thick paste. Dilute the paste by adding water gradually and stirring constantly until a gallon or two of solution is obtained. Warm water is better than cold for this purpose. Allow the solution to stand for 30 minutes so the undissolved particles may settle to the bottom. Pour off the clear liquid and if necessary filter it through muslin or several layers of cheesecloth.

(b) HTH, PERCHLORON ®, PITTCHLOR, etc. Place the proper amount in a bucket, fill with water to within a few inches of the top, and stir until the powder is dissolved. Disregard any slight turbidity. The dry powder may be added directly to the tank at the beginning of the filling operation.

(c) LIQUID SODIUM HYPOCHLORITE. This type of solution requires no preparation.

(4) Introduce the chlorine solution into the tank. If there is more than one storage tank, each one should be treated with the correct amount of chlorine compound.

(5) Immediately after introducing the chlorine solution into the tank, the tank should be filled with potable water. Sufficient mixing will usually be obtained by the whirling action of the incoming water.

(6) Open the taps and outlets nearest the supply tank and permit them to flow until the chlorinated water appears. After opening the nearest faucets the process should be continued outward from the tank until all taps and other outlets have been flushed with the chlorinated water. Care should be taken that the pressure tank is filled with the chlorinated water.

(7) After the storage tanks and the piping system are filled, the chlorinated water shall be circulated and shall be discharged after 4 hours' contact time. Prior to discharging the water, the free chlorine residual shall not be less than 50.0 p.p.m., which is the minimum that is considered safe to disinfect a water supply system. In an emergency the contact time may be shortened to 1 hour by increasing the dosage to allow for a minimum residual of 100.0 p.p.m. free chlorine at the end of 1 hour.

(8) After this contact time, the tanks and pipes shall be flushed with water of known potable quality until the chlorine taste has disappeared.

(9) Fill the storage tank with potable water.

CHLORINE COMPOUNDS FOR DISINFECTION OF A WATER SYSTEM

Calcium Hypochlorite, Technical, 70-Percent Chlorine Minimum (HTH, Pittchlor, Perchloron ®)

6-ounce plastic jar	9Y 6810–255–0471
3¾-pound can	9Y 6810–242–4770

Chlorinated Lime, Technical (Bleaching Powder), 30-Percent Chlorine Minimum

5-pound can	9Y 6810–255–0474
20-pound pail	9Y 6810–255–0476

Bleaching Chemicals, Liquid Form, Sodium Hypochlorite, 10-Percent Chlorine Minimum

1-quart bottle	9Y 6810–251–7979
1-gallon bottle	9Y 6810–290–3835

NOTE: No other chlorine compound shall be used for the disinfection of a water system; particularly the organic bleaching compounds.

APPENDIX B

PROCEDURE FOR PREPARING FUEL CARGO TANKS TO CARRY POTABLE WATER CARGO

The following procedure is recommended for preparing saran and other plastic-coated tanks for the emergency transportation of water intended for human consumption:

(a) Butterworth tanks with warm (60°–70° F.) sea water according to the methods described in "Cargo Tank Cleaning Manual" NAVSHIPS 250–341.

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

(c) Ventilate tanks until a gas-free condition exists.

(d) Strip tanks of all remaining water.

(e) Muck tanks (all personnel who enter tanks must wear protective clothing, acid-resistant rubber boots, and acid-resistant rubber gloves).

(f) Hose inside surfaces of tanks with potable water.

(g) Fill the tanks to capacity with potable water adding 2 ounces of 70-percent dry calcium hypochlorite for each 1,000 gallons of capacity.

(h) Check for chlorine residual at destination. If it is below 2.0 p.p.m., add sufficient chlorine compound to bring it to that residual or advise recipients to adjust chlorine residual if the water is pumped through their treatment plant.

Section V. MISCELLANEOUS FACTORS IN POTABLE WATER SUPPLIES

6–16. Alternate Use of Sea (Overboard) Water

(1) The various installations in which alternate use is permissible present problems which differ in type and degree of hazard and in precautionary measures required. The purposes for which either sea or fresh water may sometimes be used are:

(a) LAUNDRIES. If sea water is used in the laundries it must only be sea water that has been taken aboard after the ship is under way and outside the 10-mile limit. It must also be relatively clear and free of marine growths and other substances that might cause staining. If clothes are bleached or ironed, any water that is clear enough to give a satisfactory wash will probably be safe to use in the laundry. Sea water from polluted harbors or alongside piers shall not be used in laundry operations.

(b) COOLING JACKETS OR OTHER ENGINE ROOM EQUIPMENT. When it is necessary to admit fresh water to engine cooling circuits or other systems which normally carry nonpotable water, the airgap principle shall be used to protect the potable water system.

(c) FLUSHING DECKS. Good sanitary practice prohibits the use of sea water on the decks of naval ships in harbors or within 10 miles of entrances to harbors, rivers, ports, etc. Outside the 10-mile limit it may be used only on the weather decks.

(2) Precautions and safety factors:

(a) Sea water outlets shall not be permitted in any of the food service spaces. The medical officer or other medical department representative should determine whether or not all sea water lines entering these spaces have been removed in accordance with the Bureau of Ships Manual, article 48–282 (ch. 9) excepting those to be used for garbage disposal units with corrected construction which eliminates the aerosol. A report shall be made to the commanding officer listing any specific violations and emphasizing the health hazards involved.

(b) A water system that has been contaminated in port may continue to discharge impure water long after the ship is well at sea. The possibility of drawing contaminated water into the intake of a lone ship under way in the open sea is relatively remote. As the number of ships in an area increases, however, or as their motion relative to the water decreases, the chances of drawing contaminated sea water become greater and approach by degrees the condition that prevails in a congested harbor. The water around a large aggregation of ships receives the fresh fecal discharge from a population as large as that of a medium-sized city and entirely without the benefit of any form of sewage treatment processes.

(c) It is essential for the above reasons that chlorination of water distilled at sea be routinely accomplished as directed in article 6–13.

6–17. Control of the Water Supply

(1) Ships may receive water from sources listed in the U.S. Public Health Service publication entitled "Vessel Watering Points," or under the surveillance of U.S. Military Unit, or under the American-British-Canadian Tripartite Agreement. (See ONM INST 5711.9.) If it is necessary to obtain shore water from other than the above sources, the medical officer or medical department representative shall investigate to the best of his ability the source, method of treatment and storage, and local distribution practices. He shall then inform the commanding officer and recommend such additional protective measures as may be indicated. In every instance where water is taken aboard a naval ship, it shall be chlorinated, as outlined in section IV of this chapter.

6–18. Emergency Supplies

(1) *Battle Dressing Stations.* The battle dressing stations should each be equipped with a potable water tank of capacity as follows: 200 gallons for ships with total ship and troop complement over 500; 100 gallons for ships with total ship and troop complement less than 500, except on destroyers and ships of a similar type which should be provided with tanks of 50-gallon capacity. On ships having a midship's battle dressing station, this station should be equipped with a tank of 100-gallon capacity. Prior to action, buckets and tubs, if convenient, should be filled and placed at the battle dressing stations for use if the connections with gravity tanks should be damaged or destroyed. The water in these tanks should be changed every three

months and a residual of at least 0.2 p.p.m. free chlorine after a 30 minute contact time.

(2) *Boats and Rafts.* Emergency drinking water supplies should be made available at battle stations to provide for the crew in case the potable water system is damaged during action. Life rafts and other lifesaving facilities that are normally provisioned must at all times carry supplies of potable water.

(3) *Inspection.* Emergency supplies must be checked routinely to insure that the water is safe for drinking purposes. When the ship is operating in active or hostile area, such inspections should be made at least weekly, and any undesirable conditions found should be corrected immediately.

6–19. Sanitary Precautions in the Manufacture and Handling of Ice

(1) Observations in the field have pointed out the need for uniform guidance in the health aspects of the manufacture and handling of ice. This information is particularly important when ice is purchased from commercial concerns because laws in many State and local governments do not consider ice a food or food product until such time as it reaches the food service establishment or consumer. Consequently, ice may not come under regulatory control of the local or State health departments until such time as it enters the food service establishment. It is important, therefore, to insure that ice manufactured and utilized for food and drink purposes must be afforded the same sanitary protection as potable water. The belief that bacteria are destroyed by freezing is disproved by the fact that many bacteriologists have found in their research that disease-producing bacteria can survive for long periods in ice. In fact, freezing is now a common method of preserving cultures of some microorganisms in many laboratories.

(2) Because of the special vulnerability of ice to contamination, the precautions outlined in article 1–59 of chapter 1 of this manual must be followed. Careless practices, such as rinsing swabs in the thaw tanks, must not be tolerated. Filling lines or hoses for ice trays must not be carelessly handled by throwing or storage on the deck or otherwise unprotected when not in use. Thaw tanks must not overflow into the ice trays during thawing and removal of the ice. Overflow drains must be equipped with nonfloodable air gaps. Above all, the ice must not be contaminated by carelessness during handling, storage, or service. Sea water must not be used in the thaw tanks.

(3) Ice cube making machines must be kept clean at all times. The storage bins must be kept covered and must be routinely cleaned and disinfected. It is essential that the cubes be handled in such a manner that they do not become contaminated. The cubes must not be handled by the hands but by scoops or similar utensils. See chapter 1, article 1–59 of this manual.

6–20. Cross-Connections

(1) A cross-connection is any connection, complete or incomplete, direct or indirect, that will permit, or possibly permit, the flow of a nonpotable fluid into a conduit or receptacle containing, or intended to contain, potable water. Cross-connections between potable and sea water systems are prohibited by article 48–282, BUSHIPS Manual.

(2) Valves and blind flanges are not dependable as a means of separating the potable water distribution system from other systems and must therefore be eliminated. Potable water should be delivered or discharged through nonfloodable air gaps to all pipes, tanks, or water-using facilities. Facilities which must be provided air-gap protection are fresh water inlets and boiler feed tanks, engine-cooling systems, galley and pantry sinks, steam kettles and tables, dishwashing machines and other scullery equipment, vegetable peelers, laundry machines, lavatories, hospital sterilizers, and other similar fixtures. Air-gap spacing must be at least twice the diameter of the fresh water inlet pipe. All drainage outlets in the fresh water system, whether to sewers, drains, or the bilge, should be protected from flooding by the use of air gaps. Location of the fresh water inlets above the rims of lavatories, sinks, and other open-receiving vessels constitutes an adequate air gap. Delivery of potable water to closed containers or systems or its discharge to drains and sewers should be through a free opening located above the rim of a receiving funnel.

(3) Some examples of sanitary defects of potable water systems that have been noted aboard ship are as follows:

(a) Laundry trays, wash basins, service sinks, and deep sinks with faucets below the high water line or with hose extending into the receptacle.

(b) Drinking fountain orifice below the high water line, vertical jet, or orifice supply line surrounded by waste drain line.

(c) Bath tubs, therapeutic tubs, or steam tables with inlets below the high water line.

(d) Water operated waste ejectors: dental units, potato peelers, or garbage grinders.

(e) Drains to food preparation machinery that do not have air gaps.

(f) Industrial vats with water inlets below high water level.

(g) Rubber hoses attached to potable water lines that are allowed to remain in scuppers, sinks, etc.

(h) Combination faucets to potable and nonpotable water: showers, used for fresh and sea water, fresh and sea water lines to laundry machines.

(i) Leaky water lines close to drains, scuppers, etc.

(j) In general, any type of water supply connection that permits the return of used or contaminated water into potable water supply systems by drainage, back-siphonage, or higher pressure is not permissible.

6–21. Potable Water Usage Requirements

(1) While it is necessary to economize in the use of potable water, the rules for engineering performances, U.S. Navy, do not contemplate an insufficient allowance of potable water to meet all hygienic needs. Proper indoctrination of the crew and attention to leaks and waste should limit potable water consumption to reasonable amounts. Arbitrary limitation of hours during which washrooms are open for use, or restriction of members of the crew to definite small quantities of water for bathing, tends to result in breaches of hygiene. Water hours are necessary, however, on many ships, particularly transports loaded beyond their capacity for living comfort and convenience, and it will be found that men may keep clean and live under sanitary conditions even with a limited water supply if proper supervision by division officers and other responsible persons is maintained. If unusual conditions require drastic restrictions in the use of potable water, the allowances should not be less than 2 gallons per man per day to be used only for drinking and cooking purposes.

(2) The use of sea water in the laundry when at sea will effect material savings in the quantities of potable water consumed. Due to the danger of using polluted water for these purposes and the danger of cross-connection, however, judgment and careful supervision must be exercised when using sea water in laundries or other facilities.

(3) The tables below give a general breakdown of the quantities of potable water required aboard ship. Actual consumption will vary widely depending on the type of the ship, the area in which it is operating, and on the evaporator and tank capacity. When potable water serves all uses, the consumption rate may fall between 12 and 35 gallons per man per day, although the higher figure should be considered far too wasteful. When sea water is substituted for potable water in laundries, consumption should be less than 12 but rarely as low as 4 gallons per man per day.

Recommended Amounts of Potable Water Aboard Ship

Type of use:	*Gallons per man per day*
Drinking water	0.5– 1.0
Galley and scullery	1.5– 4.0
Personal hygiene	5.0–20.0
Laundry	5.0–10.0
Total	12.0–35.0

Consumption of Potable Water When Sea Water Is Used in Laundries

Type of use:	*Gallons per man per day*
Drinking water	0.5– 1.0
Galley and scullery	1.5– 4.0
Personal hygiene	5.0–20.0
Laundry	1.0– 3.0
Total	8.0–28.0

6–22. Water Sanitation Bill

Presented herewith is a sample water sanitation bill that may be used as a guide for all ships. It may be added to or altered to fit local circumstances but the general requirements as outlined are basic and essential to properly safeguard the health of the crew.

"WATER SANITATION BILL"

(1) All water distributed aboard naval ships shall be chlorinated and have a measurable free chlorine residual at all points in the system under constant circulation.

(2) All water received from sources other than under military surveillance shall be from approved sources, such as those listed in the United States Public Health Service publication entitled "Vessel Watering Points," military shore activities, or those under ABC Navy Agreement (see ONM Instruction 5711.9), and shall be chlorinated to 0.2 p.p.m. free chlorine residual after a 30-minute contact time at the point of delivery or aboard the ships.

(3) All water obtained in foreign ports (not under item 2), in areas where amebiasis is endemic, and from sources of unknown or doubtful origin shall be chlorinated to 2.0 p.p.m. free chlorine residual after a 30-minute contact time at the point of delivery or aboard ship, except when the source has been inspected and certified as satisfactory by the medical officer or his representative.

(4) Water from the evaporators shall be chlorinated and have a free residual chlorine content of 0.2 p.p.m. after a 30-minute contact time. Potable water ordinarily will not be evaporated in rivers, harbors, or within 10 miles of shore unless so dictated by necessity. Procedure for evaporation as outlined in Chapter 58 of BUSHIPS Technical Manual shall be followed. Instructions contained in articles 58–27 and 58–42 shall be scrupulously carried out.

(5) Filling hose used for potable water shall not be used for any other purpose.

(6) Personnel assigned to handle hose shall be properly instructed in necessary procedures to prevent contamination of hose line.

(7) Hose lines shall be stowed in a separate locked vermin proof locker, marked "POTABLE WATER HOSE ONLY." If this is not practical, hose ends shall be coupled before rolling or stowing, or otherwise protected from contamination by use

of screw-type caps or plugs (secured with keeper chains) and stowed separately from all other type hose when not in use. Inside the doors of the lockers there shall be posted instructions and precautions relative to the loading of fresh water and care of the hose.

(8) Hose lines shall be suitably marked "POTABLE WATER ONLY."

(9) Shore-to-ship water connections shall be in compliance with the current OPNAV Instructions (9930 Series).

(10) The hose line shall be flushed out at the source with potable water prior to connecting to the ship's tank.

(11) The hose line shall be kept in good condition at all times. Discard all hose lengths when cracks begin to develop.

(12) The filling line connections to potable water tanks shall be marked "POTABLE WATER ONLY." It is recommended that the inlet shall be no less than 18 inches above the deck and be fitted with a screw cap with keeper chain when not in use.

(13) Potable water tanks shall be marked "POTABLE WATER ONLY."

(14) Potable water lines shall not be piped through nonpotable liquids unless protected by a sleeve or tunnel.

(15) Nonpotable liquids should not be piped through potable water tanks. If this must be done, it shall be in accordance with General Specifications for Ships of the U.S. Navy.

(16) Sounding lines or rods used to measure potable water, in tanks not provided with sounding tubes and self-contained sounding rod, shall be disinfected before use by wiping with cloth soaked in chlorine solution.

(17) Potable water lines shall be stenciled "POTABLE WATER ONLY" in accordance with current BUSHIPS Instruction.

(18) All potable water tanks shall be disinfected if entered. For disinfection procedures refer to section IV of this chapter.

(19) Potable water pipelines shall not be used for nonpotable liquids.

(20) Potable water tanks shall not be filled with ballast water unless necessary to insure survival of the ship; in which case the tanks, pipes, fittings, and pumps utilized shall be disinfected in accordance with procedures outlined in section IV prior to refilling with potable water to prevent any possibility of contaminating any portion of the potable water system. The medical officer or his representative shall be notified if it is necessary to fill potable water tanks with ballast water. (See article 6–8.)

(21) If any break occurs in the potable water system, accidental or otherwise, the parts concerned shall be disinfected after reassembly and prior to placing that part of the system back in service. The medical officer or his representative shall be notified concerning the break.

(22) Potable water systems shall be absolutely free of interconnections with all nonpotable water systems.

(23) A routine bacteriological analysis of water shall be performed, when practicable, once each month, but not less than once every 3 months. Ships with laboratory facilities shall have analyses performed weekly.

(24) Potable water shall be used in the manufacture of ice to be used in connection with food or drink. Ice must be afforded the same conditions of cleanliness that are given to foods. Care shall be taken to insure the absence of submerged potable water inlets; provide air gaps in drains from potable water tanks; provide overflow pipes for defrosting tanks to prevent the ice being contaminated with water used for defrosting; provide sanitary rack or stowage for hose or line used to fill freezing trays; and provide rules of sanitary conduct of personnel manufacturing or handling ice.

(25) The drinking orifice of drinking fountains shall be above the overflow rim of other water contact surfaces, and all such surfaces must be kept clean and will be of the angle-jet type with the protective mouthpiece.

(26) Insure that potable water connections between ship and shore are undisturbed by unauthorized personnel during loading.

(27) Each ship shall maintain the following records:

(a) Each source of shore water supply: date, place, amount, and which tanks are filled.

(b) Laboratory analyses.

(c) Chlorination data: time, tanks, water temperature, pH of water, type chlorine agent, amount of agent used, time agent added, and chlorine residual after 30 minutes.

(d) Record of routine residual chlorinating checks.

(e) Record of routine salinity tests of potable water tanks when applicable.

EMERGENCY DISINFECTION OF WATER FOR DRINKING AND COOKING PURPOSES

If during an emergency potable water is not available, it may be necessary to obtain nonpotable water and use it for drinking and cooking purposes. Before it can be used for these purposes, it must be treated to make it safe. While a small quantity of water may be made safe by boiling it 15 to 20 minutes, it would be inconvenient to boil large quantities of water. It is more desirable to treat a large quantity of water chemically to make it safe for human consumption. Chlorine is the chemical that is used universally for this purpose. This emergency treatment with chlorine is known as batch chlorination. In the absence of other methods of treatment on board, batch chlorination may be used when it is necessary to load water of questionable quality for drinking and cooking purposes, and also for the routine treatment of nonpotable wash water. The water that is to be treated must be clean and free of turibidity. Batch chlorination should not be depended upon to make turbid (muddy) or heavily contaminated waters safe for drinking and cooking purposes.

Chlorine compounds which are most suitable to disinfect nonpotable water are chloride of lime, high test hypochlorites ("HTH," "Perchloron ®," "Pittchlor," and similar preparations), or commercially prepared liquid sodium hypochlorites ("Clorox," "Zonite," and similar preparations). Chloride of lime, or liquid sodium hypochlorite ("Clorox") can be purchased at most grocery or drug stores.

High test hypochlorite contains 70 percent available chlorine and should be a product of choice because smaller quantities are needed to disinfect water. The percentage of chlorine in these compounds is reduced once the containers have been opened and exposed to air. These compounds should be requisitioned in small containers so that the contents will be used as quickly as possible—within 6 days. The top of the container must be replaced tightly after each use in order to reduce the chlorine loss to a minimum. All the products should be stored in a cool, dry, dark place at all times, and these products should not be used for the disinfection of water if kept over 6 months but may be used for other purposes.

The procedure for disinfecting water for drinking and cooking purposes with a dosage of 2.0 p.p.m. chlorine is as follows:

(1) Select and thoroughly clean a water tank, one in a potable water system.

(2) Determine the volume (capacity) of this tank. Determine the amount of chlorine compound that will be needed for this tank when filled with water. The amounts of any of the several chlorine-bearing products for different volumes of water to be disinfected are given in table 2.

Table 2.—Dosage for treatment of water with 2.0 p.p.m. chlorine

Tank capacity		Amount of chlorine compound			
				Liquid sodium hypochlorite	
Gals.	Tons	25 percent chloride of lime	70 percent high test hypochlorite	1 percent solution	5 percent solution
250	1	⅜ oz	⅛ oz	½ pt	3 tbs.
500	2	¾ oz	¼ oz	1 pt	5 tbs.
1,000	4	1½ oz	½ oz	1 qt	12 tbs.
1,500	6	2¼ oz	¾ oz	1½ qt	1¼ cups
2,000	8	3 oz	1 oz	2 qt	1½ cups
2,500	10	3¾ oz	1¼ oz	2½ qt	1 pt.
3,000	12½	4½ oz	1½ oz	3 qt	1¼ pt.
4,000	17	6 oz	2 oz	1 gal	1½ pt.
5,000	21	7½ oz	2½ oz	1¼ gal	1 qt.
10,000	42	15 oz	5 oz	2½ gal	2 qt.
15,000	62½	1 lb., 8 oz	7½ oz	3¾ gal	3 qt.
20,000	84	1 lb., 14 oz	10 oz	5 gal	1 gal.
25,000	104	2 lb., 4 oz	12½ oz	6¼ gal	1¼ gal.
50,000	209	4 lb., 8 oz	1 lb., 9 oz	12½ gal	2½ gal.

A heaping tablespoon holds approximately one-half ounce; a measuring cup approximately 6 ounces. Standard measuring devices are preferable—1 pound equals 16 ounces.

(3) Prepare the chlorine solution:

(a) CHLORIDE OF LIME. Place the proper amount of chloride of lime in a clean enameled or glass container containing no water; then, add a small amount of water and mix to a thick paste. Dilute the paste by adding water gradually and stirring constantly until a gallon or two of solution is obtained. Warm water is better than cold for this purpose. Allow the solution to stand for 30 minutes so the undissolved particles may settle to the bottom. Pour off the clear liquid and introduce it into the tank of water to be disinfected or into the solution container of the chlorinator. If necessary, filter it through muslin or several layers of cheesecloth.

(b) HTH, PERCHLORON ®, OR PITTCHLOR. Place the proper amount in a bucket, fill with water to within a few inches of the top, and stir until the powder is dissolved. Disregard any slight turbidity, unless to be used in a chlorinator, then follow procedure in paragraph (a). The proper amount of the dry powder may be added directly to the tank and mixed.

(c) LIQUID SODIUM HYPOCHLORITE. These solutions require no preparation.

(4) Introduce the chlorine solution into the tank and fill it immediately with the water to be disinfected. Sufficient mixing usually will take place by the whirling action of the incoming water.

(5) Allow the water to stand in the tank for 30 minutes to permit the chlorine to purify the water. After this contact time the water must be tested to determine whether sufficient chlorine has been added to complete the disinfection process and produce a slight excess residual. If a standard test kit is not available, one of the following tests may be employed as a temporary substitute:

(a) If orthotolidine testing solution can be obtained, add about 20 drops of it to a quarter glass of the treated water. A yellowish color should appear in the water if any chlorine remains in it.

(b) A testing solution may not be procurable in an emergency, but there is a rough test that can be made. Draw a half glass of treated water, cover it tightly with the palm of the hand, shake the water back and forth two or three times, and smell. A faint but distinct odor of chlorine should be noticeable. (NOTE: Water for testing should be drawn from all taps which are or can be supplied with water from the tank. The water should be run long enough from each tap to assure that the treated water has reached the taps.)

(c) If either test shows the presence of chlorine, it means that a little more chlorine was added than was needed to disinfect the water and that the water has been made safe to drink. It must be assume that the amount of chlorine that was added destroyed all of the microorganisms of disease and united with all of the matter for which it had an affinity, and still there was a slight amount of chlorine remaining in the water. The presence of this excess of chlorine is the assurance that the water has been made safe to drink. This excess of chlorine is referred to as residual chlorine and should be maintained throughout the potable water system at all times at 0.2 p.p.m.

(d) If the test does not show the presence of chlorine, it means that an insufficient amount of chlorine was added and that the water still contains contamination. More chlorine compound must be added; the disinfection procedure described above must be repeated. It must be repeated until chlorine remains in the treated water after the contact time.

(Important: Care must be taken to make sure that chlorine can be detected in the treated water 30 minutes after the compound has been added to it; otherwise, effective disinfection will not have been accomplished.)

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MANUAL OF NAVAL PREVENTIVE MEDICINE

CHAPTER 7

SEWAGE DISPOSAL ASHORE AND AFLOAT

DEPARTMENT OF THE NAVY
BUREAU OF MEDICINE AND SURGERY
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CONTENTS

Illustrations—Continued

Chapter 7

SEWAGE DISPOSAL ASHORE

Section I. INTRODUCTION

7–1. Introduction

(1) This chapter discusses some of the methods of sewage disposal selected by the Bureau of Yards and Docks for use on shore-based naval establishments coming under the sanitary control of the Medical Department and comments upon disposal of toilet wastes on board ships under similar control. Underlying engineering theory is limited primarily to operating principles and efficiency, with emphasis on the limitations of each system.

(2) This chapter will be of greatest value as a reference and guide for naval personnel concerned with the various aspects of preventive medicine relating to sewage collection, treatment, and disposal.

7–2. Definition

(1) Sewage is the liquid wastes of a community, consisting of water, fecal materials, food wastes, laundry and bath water, and other liquid or water-transported wastes.

7–3. Historical Data

(1) Since man discontinued his nomadic way of living and settled in a permanent community, the disposal of human waste has presented a problem. Ancient civilizations of the East have left ruins of comprehensive sewer systems that date back to 4000 B. C. In the western world, sewage-disposal systems were constructed in both the Greek and Roman empires that are engineering marvels, parts of which are still operable today.

(2) With the fall of the Roman Empire the civilization of Europe retrogressed into the "Dark Ages," and excreta and household wastes were disposed of by throwing them from the doorstep or window into the courtyard or street. It was during this period of history that Europe was swept by great epidemics of typhoid fever, cholera, plague, and typhus fever. Whole populations were decimated by disease.

(3) No obvious advance was made in the field of environmental sanitation until the advent of the miasmic theory of disease transmission. Since there was no scientific knowledge the people could hold accountable for the origination of disease, shrewd observers associated disease with filth. These theories led to the enactment of laws pertaining to waste and refuse disposal, improving the environment in urban areas. These measures were effective to some degree.

(4) With the determination that any disease was caused by its specific micro-organism and the discoveries of the modes of transmission of such diseases at the end of the nineteenth century, rapid and effective advances in disease prevention were made possible. By the end of the first decade of the twentieth century the basic methods of adequate sewage treatment and disposal had been perfected.

7–4. Purpose of Disposal

(1) The proper disposal of waste materials is one of the important measures for the control of water-borne diseases. It must accomplish the following:

(a) Destruction or disposal of material which may contain pathogenic organisms, and destruction of such organisms.

(b) Destruction or prevention of breeding places of insects and rodents that can spread disease.

(c) Removal or prevention of conditions offensive to the senses.

7–5. Scope

(1) The sewage treatment methods are selected to meet the demands of the individual stations. The field worker may find one method or combinations of treatment methods in use, depending on

many factors. Population, type of waste, volume of sewage, climatic conditions, and so on must all be considered. The sequence that follows is not related to their efficiency, desirability, or recommended use.

7–6. Responsibility

(1) The medical representative's official interest in the sewerage system is limited to such inspection and examination as may be required to assure his commanding officer that the collection, treatment, and disposal of the sewage do not create nuisances or conditions hazardous to the health of military or civilian personnel.

(2) Reports of suspected discrepancies in sewerage systems and recommendations for necessary corrective action should properly be discussed and evaluated with the public works officer or his representative prior to submission to the commanding officer, if circumstances permit.

(3) The policies and practices of the Bureau of Yards and Docks with respect to the collection, treatment, and disposal of sewage are coordinated with the standards and directives of the Bureau of Medicine and Surgery. Inasmuch as the Bureau of Medicine and Surgery, under authority of Navy Regulations, is responsible for safeguarding the health of all naval personnel and for establishing and controlling the standards of quality and performance of sewerage systems and appurtenant facilities, the policies and practices of the Bureau of Yards and Docks conform closely with the standards and directives of that Bureau. The choice of methods to effect sanitary measures and control is the responsibility of the Bureau of Yards and Docks.

7–7. Composition of Sewage

(1) Sewage contains suspended solid materials as well as dissolved substances. The solids include fecal matter, paper, sticks, rags, garbage, and other floating materials, as well as sand and gravel. The objectionable materials in sewage are principally organic, such as fats, carbohydrates, and proteins of fecal or food origin. Such organic matter decomposes rapidly with the production of sewage odors from indole, skatole, hydrogen sulfide, and other noxious materials. In addition to the need of controlling the unaesthetic or nuisance factor by adequate disposal methods, the more obvious problem of controlling disease requires alteration of the sewage so that it will be less dangerous to human life.

(2) Treated and untreated sewage is disposed of on land or discharged into a body of water, river, or stream. In urban areas the population density creates such concentration of wastes that it is necessary to provide some form of sewage treatment. If untreated sewage is emptied into a stream or lake where the dilution factor is not adequate to accommodate it, the receiving body of water is rendered not only unfit for drinking purposes but also unsuitable for recreational or even industrial purposes.

(3) When untreated sewage is emptied into a body of water, the decomposition of the organic matter depletes the oxygen normally present in water. In addition, bacteria of human diseases, such as typhoid or cholera, may survive for several weeks.

(4) Nature has provided a very efficient process of nuisance removal by providing oxygen, aerobic bacteria, and other organisms capable of "digesting" decaying organic matter. These organisms are present in the soil, water, and even in sewage. Their multiplication depends on an adequate supply of atmospheric oxygen dissolved in the water. This requirement (or demand) for a specific amount of oxygen necessary to render a given amount of organic matter stable and inoffensive is called the biochemical oxygen demand or "B. O. D." The B. O. D. is dependent upon the volume of sewage and the amount of organic matter it contains. This oxygen requirement can be determined by appropriate laboratory tests, and the B. O. D. is used to determine the dilution factor necessary for satisfactory disposal of sewage effluent.

(5) When raw sewage is emptied into a stream in proportions greater than 1 part sewage to 40 parts water, the oxygen content of the stream may be reduced to the degree that it will not support marine life. Fish life requires at least 4.0 p. p. m. of dissolved oxygen. Any reduction in oxygen content either drives fish away, or, if they cannot escape, causes them to die. Shellfish beds become polluted, and the oysters or clams are no longer fit for human consumption.

(6) The processes used to treat sewage are designed to alter the objectionable suspended or dissolved solid substances in the liquid or to remove them so that the remaining liquid can be disposed of without harmful effect. In the water-carriage system of sewage disposal the liquid waste contains solid material that is seldom more than 0.2 percent of the total volume; the remaining 99.8 percent is water.

7–8. Disposal of Chemical, Radioactive, and Other Industrial Wastes

(1) Industrial-waste-disposal procedures necessarily vary from plant to plant depending basically upon the types, amounts, and concentration of the chemicals or other materials involved.

(2) The disposal of liquid wastes containing radioactive materials will be in accordance with local directives. Consultation with the radioactive safety officer is advised in each case.

(3) Problems concerning the disposal of any industrial liquid waste capable of adverse affect on domestic sewage treatment facilities or of contaminating ground- or surface-water supplies or

suspected of otherwise significantly affecting the health or safety of naval or civilian personnel should, properly, be brought to the attention of the commanding officer.

(4) It is of interest to note that, generally, the investigation and evaluation of industrial-waste-disposal problems are the responsibility of the several district public works officers.

Section II. METHODS OF TREATMENT

7–11. Classification of Treatment

(1) Sewage is treated in cesspools, septic tanks, modifications of these simple methods, or, for large Navy bases or municipalities, by treatment methods referred to as:

(a) Primary treatment (with or without chemicals)

(b) Secondary or complete treatment

(c) Chemical sterilizing

(2) Primary treatment consists of methods designed to remove a considerable portion of the suspended solids and the colloidal substance (solids apparently in solution). The secondary treatment oxidizes the suspended solids and the organic solids in solution that remain after primary treatment. Sterilization, usually applied after the secondary treatment, is used to destroy any pathogenic bacteria which may have passed through the secondary treatment.

7–12. Cesspools

(1) Cesspools (fig. 7–1) are seldom, if ever, found on Navy stations. They are never used for disposal of large quantities of sewage but in rare instances may be used for single, isolated buildings, such as houses utilized as quarters or dispersed shops, as at an ammunition depot. A cesspool is simply a covered pit into which raw sewage is emptied. The liquids leach into the soil and the solids remain in the pit where they decompose. Such a system is basically wrong in principle and may lead to groundwater pollution and usually to unsanitary surface conditions. The usual household wastes containing grease, oil, soaps, and other insoluble substances all too quickly line the walls and bottom of the cesspool and impede the leaching process. Soon it reverts to a septic tank, and, because there are no provisions for the subsurface distribution of the liquid effluent, the cesspool then overflows, discharging on the surface. To prevent this unpleasant eventuality, a cesspool must be cleaned frequently. A grease trap installed between the dwelling and the cesspool prolongs the time between cleanings.

7–13. Septic Tanks

(1) Septic tanks (fig. 7–2) are watertight tanks, placed underground, into which the raw sewage

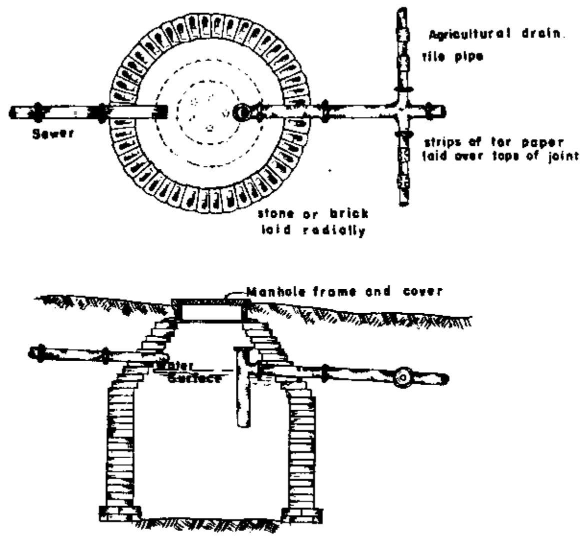

Figure 7–1.—Leaching cesspool. (Rarely used.)

flows by gravity. A series of baffles are usually placed within the tank to slow the flow, allowing the solids to settle and be retained. The solids are reduced in volume by the biological action of anaerobic bacteria. The liquid effluent is discharged from the end of the septic tank through an opening near the top, placed at the end opposite the influent. It may be disposed of by a network of subsurface tile drains. The effluent may be emptied into a stream only when ample dilution is available. Ordinarily, not more than 50 percent of the suspended matter, and 25 percent of the biochemical oxygen demand are removed in a septic tank. The effluent is but slightly less contaminated with bacteria than the raw sewage. Such systems should never be used for populations of over 500.

7–14. Imhoff Tank

(1) The purpose of the Imhoff tank (fig. 7–3) is to remove the settleable suspended solids in an upper sedimentation compartment and to liquefy and digest the settleable solids in a lower sludge compartment by anaerobic bacterial action. This is a

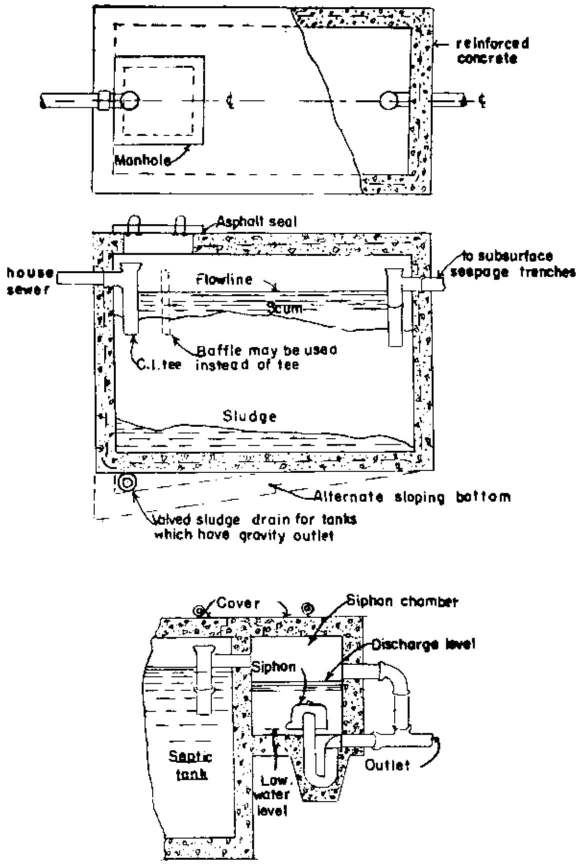

Figure 7–2.—Typical septic tank.

combined process of sedimentation and digestion accomplished in the same two-story tank.

(2) The Imhoff tank obtained its name from its inventor, Dr. Karl Imhoff, of Germany. It is a variation of a septic tank in which two chambers are provided, one above the other. The upper sedimentation or flow chamber is for the settling of the solids from the sewage, and the lower chamber is for the anaerobic digestion of the sludge. The solids settle to the bottom of the flow chamber, guided by sloping sides, and pass through a slot at the bottom into the lower chamber. The slot is baffled by one of several methods in such a manner that the gases rising from the lower chamber do not interfere with the sedimentation process in the upper chamber. A gas vent, known as the scum chamber, extends from the lower compartment up to the tank surface between the outside wall of the sedimentation chamber and the Imhoff tank enclosing wall.

(3) The main advantage of this type of tank over the septic tank is the separation of the digesting sludge from the effluent, which allows a more complete settling out of the solids and a more complete digestion of the sludge.

(4) These tanks remove from 30 to 60 percent of the suspended matter, and from 25 to 40 percent of the B. O. D.

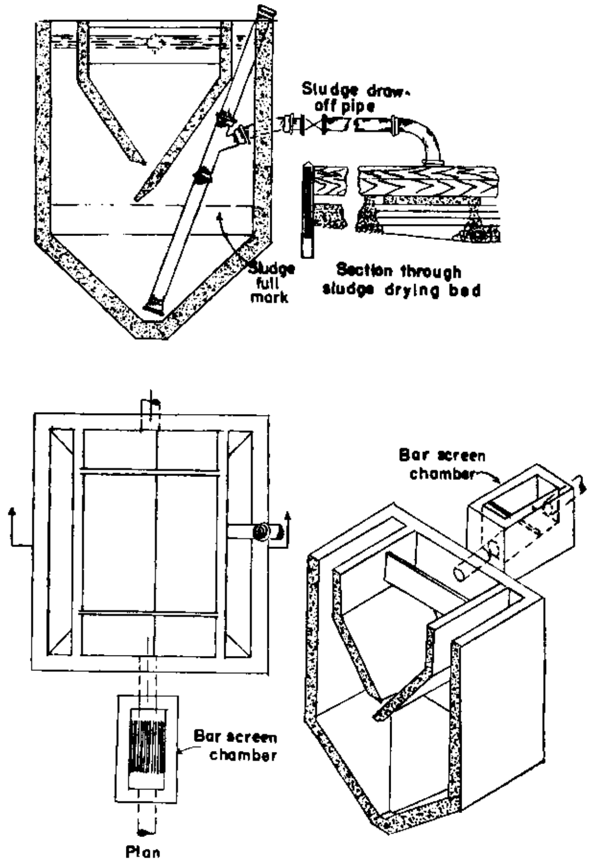

Figure 7–3.—Typical Imhoff tank.

(5) *Records of operation.*—Such records as established by the district public works officer are important, and as a general rule they should be reviewed by medical department personnel.

(6) *Foaming of Imhoff tanks.*—This is a condition which may be encountered where gas, froth, and scum rise in the gas vents and overflow the wall into the sedimentation chamber or on the ground. It sometimes occurs after cold weather has retarded the sludge digestion and the anaerobic decomposition resumes after warm weather. It may occur when a new tank is first put into operation, but is most likely to occur if too much sludge is removed from the sedimentation compartment. Besides being disagreeable from the esthetic standpoint, it interferes with the processes in the sedimentation tank. This often results in an overload and inter-

ference with the subsequent steps in the treatment plant. Relief from this situation may sometimes be obtained by recirculating a portion of the sludge from the bottom to the top of the digestion chamber, by hosing the gas vents with a high pressure hose, or by raising the pH of the digestion chamber high in the alkaline range by the addition of large amounts of lime to the gas chambers.

Section III. PRIMARY TREATMENT UNITS

7–21. Purpose

(1) Primary treatment is designed to remove only the suspended solids from the liquid sewage (fig. 7–4). This is done by screening, or by sedimentation. It may be preceded by chlorination to minimize odors, or it may be followed by chlorination.

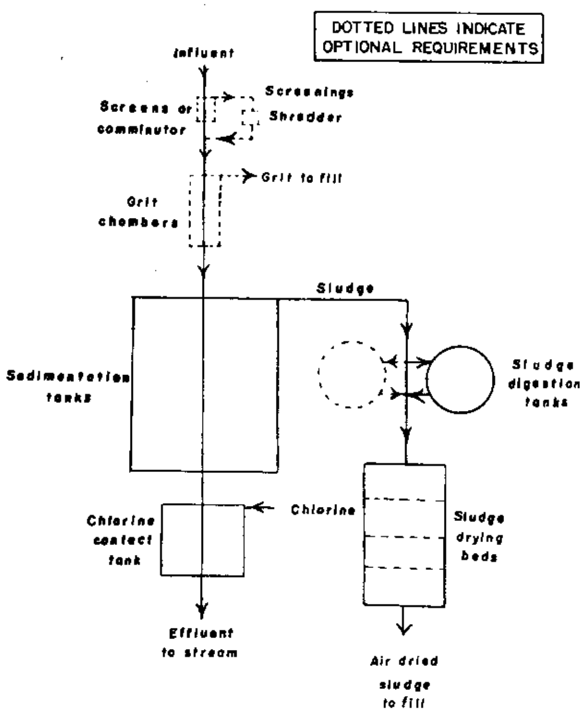

Figure 7–4.—Schematic diagram of primary sewage treatment.

7–22. Screens

(1) Screens (fig. 7–5) are used to remove large solid materials that clog or damage pumps or otherwise hinder the flow of sewage through the plant. They are placed in the path of the incoming raw sewage and are of two general types—course or fine, mechanically or manually cleaned.

(2) The amount of screening necessary is dependent upon existing conditions in each locality.

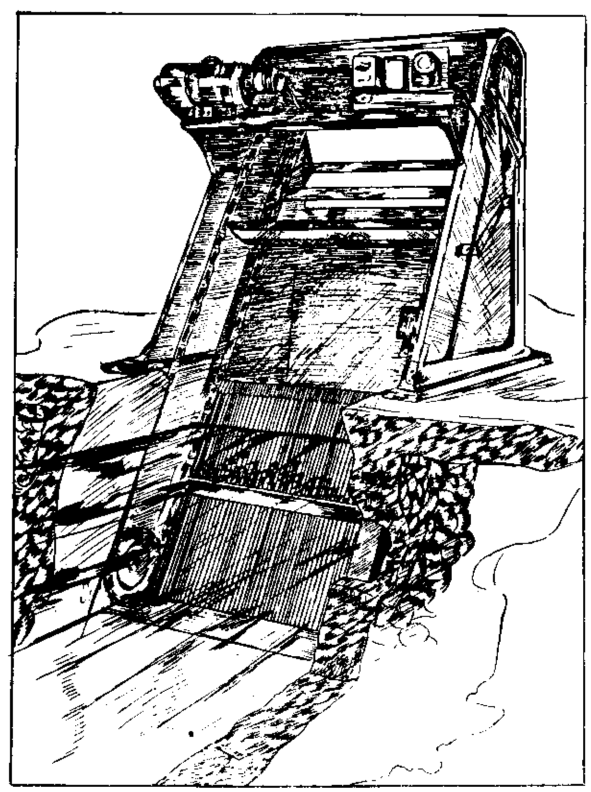

Figure 7–5.—A mechanically cleaned bar screen, with some of the cover plates removed. It is set in an open channel through which the sewage is flowing from left to right. The cleaning rake travels upward. This would probably discharge the screenings into a grinder. After being ground, the screenings would be returned to the stream of sewage.

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7–23. Comminutors

(1) These are grinders or revolving cutting screens (fig. 7–6) designed to reduce the size of the solid matter that passes through the coarse screens and to prevent damage to pumps. Comminutors (fig. 7–7) of a heavy-duty type are sometimes utilized, thereby eliminating the need for bar screens.

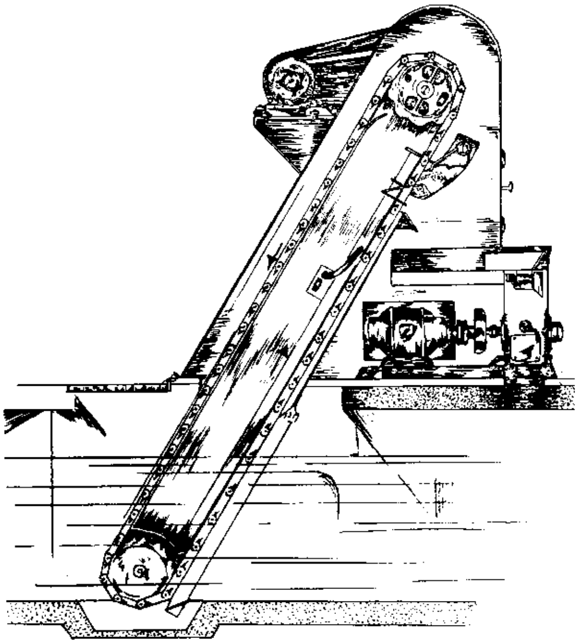

Figure 7–6.—Screen and shredder.

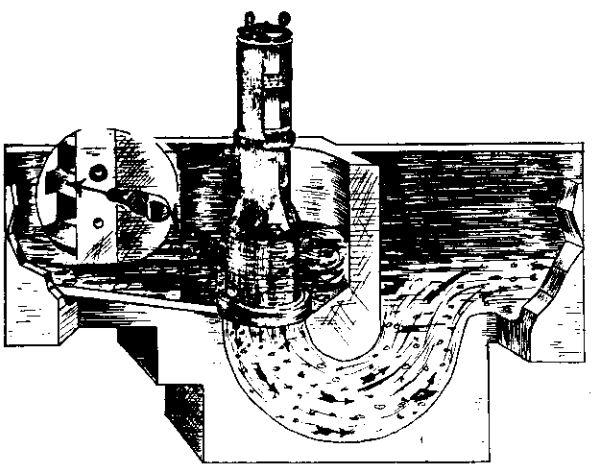

Figure 7–7.—Comminutor.

7–24. Wet Wells

(1) The influent sometimes flows into wet wells, or receiving reservoirs, from which it is lifted by pumps to continue its processing through the disposal plant. There is a great fluctuation in the rate of flow of sewage into a treatment plant at various hours of the day, dependent upon demands of the public and industry. While these wet wells may in some degree reduce the fluctuation in the rate of flow, their primary purpose is that of pump pits.

7–25. Grit Chambers

(1) These are designed to remove gritty material that might damage pumps, valves, etc., or occupy inert space in the sludge digestion tanks, if such materials were to pass through the plant. This is especially necessary in plants that combine storm water with the sewage, since the influent under such conditions has a high grit and gravel content.

(2) The grit is removed from the chamber, either manually or mechanically. Some mechanical-type scrapers are provided with a washing device that washes out, along with the grit, any organic material that might have settled. This washed grit is relatively inoffensive and can be used in land fills. In some localities the residual of the grit chamber is sold as "washed sand."

7–26. Sedimentation Basin

(1) The purpose of this step is the removal of a large part of the settleable solids from raw sewage. Sedimentation is utilized in both primary and secondary treatment processes (fig. 7–8, A and B), so the sedimentation basin employed in raw sewage treatment is designated as the "primary sedimentation basin." These settling basins may be rectangular or circular.

(2) Where increased capacity is necessary, an additional basin or basins are constructed parallel. It is advisable to have more than one basin to ensure continuous treatment in case a basin needs to be secured for repairs.

(3) The influent enters the basin at one end, and by a system of baffles, weirs, and multiple inlets the flow is evenly distributed across its width. This slow, even flow allows the solids to collect on the bottom of the basin, from where they are moved to a hopper by mechanical scrapers that may run intermittently or continuously. These solids are called "sludge" and are removed from the hopper to a digester tank, flowing through pipes by water pressure, hydrostatic pressure from the basin, or by suction pump.

(4) If sludge is allowed to remain in the basin and accumulate, decomposition starts and gas-lifted solids appear on the surface. This reduces the rate of settling and gives rise to odors. The surface of the basin should be kept free of scum and floating material by frequent skimming. This accumulation of scum can be disposed of by flushing it to a sump or trough, and withdrawing it with the sludge.

(5) The outlet weir of the sedimentation basin extends across the full width of the basin to ensure a smooth, even flow, and the effluent continues on to secondary treatment, or to final disposition.

(6) The circular-type sedimentation basin works on the same principle as the rectangular, and uses the same retaining time. The influent enters in the center, and flow is to the periphery of the tank where the effluent flows under a baffle and over a weir.

(7) Primary treatment removes only that portion of the pollution that is in the suspended state, leaving the colloidal and dissolved substances in the liquid effluent. Between 40 and 60 percent of the suspended matter is removed, depending upon the concentration of suspended matter, the retaining time in the sedimentation basin, and the evenness of distribution of the flow in the tank. This results in the reduction of the biochemical oxygen demand to from 25 to 40 percent.

7–27. Sludge Digestion

(1) Sludge is the organic byproduct of any polluted water. In sewage-treatment plants it accumulates in both the primary and secondary sedimentation basins. This bulky, semifluid mass is putrescible organic matter and is composed of about 95 percent moisture.

(2) The sludge is pumped from the sedimentation basins into tanks where it undergoes digestion under anaerobic conditions—that is, in the practical absence of oxygen. This process renders the sludge much more inoffensive by liquefaction and gasification of the organic matter. A great reduction in volume of sludge results. The excess liquid portion from the digestion tank (called supernatant liquor) may be returned to the sewage influent at the beginning of the treatment process and recirculated through the plant, or it may be separately treated, for example, on sand beds.

(3) The gasification process produces about one-cubic foot of gas per capita per day. The gases contain about ⅔ methane, ⅓ carbon dioxide, and traces of nitrogen and hydrogen. The gas may be collected in either fixed or floating domes on the top of the digestion tank (fig. 7–9) and can be utilized to generate heat for plant operation, or even to operate gas engines for power. The fuel has a heating efficiency of about 600 British thermal units (B. T. U.) per cubic foot. The optimal temperature for efficient digestion is 85° to 90° F., and a system of hot-water pipes, using water heated by the sludge gas, can be arranged within the tank to maintain this temperature, or the incoming sludge can be preheated for the same purpose.

(4) Depending upon temperature and certain characteristics of the sludge, a period of from 20 to 60 days is required to digest the sludge. After that time it is reduced to a black, tarry, inoffensive, semiliquid mass that may be either spread on beds for drying, or dehydration by means of vacuum filters sufficiently to form a moist cake, which can be further dried by applied heat.

(5) Sludge, if properly dried and ground to a coarse powder, is a good soil conditioner with a slight fertilizer value. It can be used on lawns and gardens at shore stations to promote plant growth.

ference with the subsequent steps in the treatment plant. Relief from this situation may sometimes be obtained by recirculating a portion of the sludge from the bottom to the top of the digestion chamber, by hosing the gas vents with a high pressure hose, or by raising the pH of the digestion chamber high in the alkaline range by the addition of large amounts of lime to the gas chambers.

Section III. PRIMARY TREATMENT UNITS

7–21. Purpose

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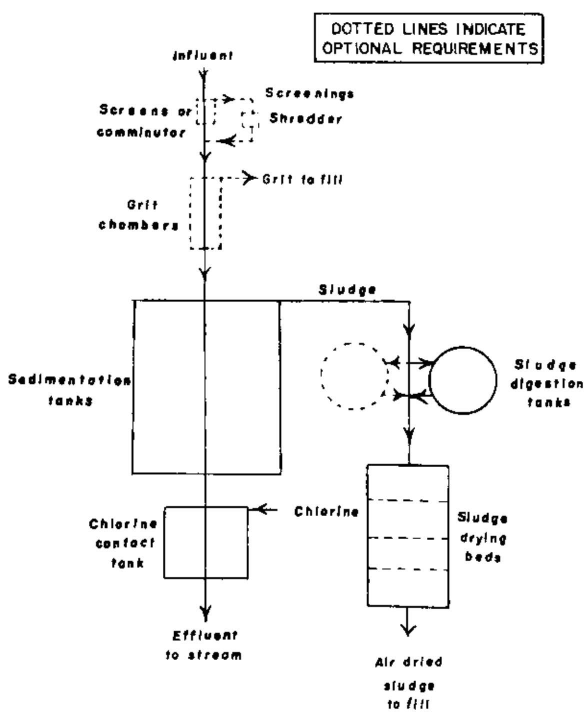

Figure 7–4.—Schematic diagram of primary sewage treatment.

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(2) The amount of screening necessary is dependent upon existing conditions in each locality.

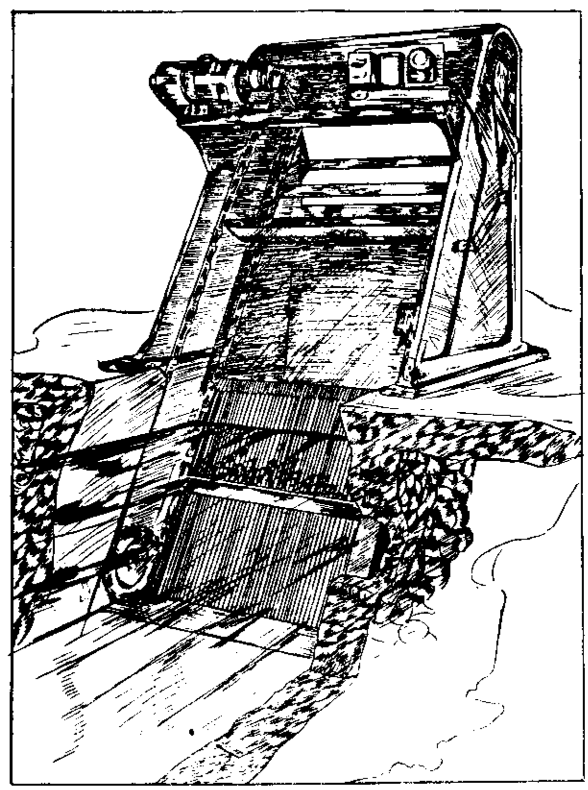

Figure 7–5.—A mechanically cleaned bar screen, with some of the cover plates removed. It is set in an open channel through which the sewage is flowing from left to right. The cleaning rake travels upward. This would probably discharge the screenings into a grinder. After being ground, the screenings would be returned to the stream of sewage.

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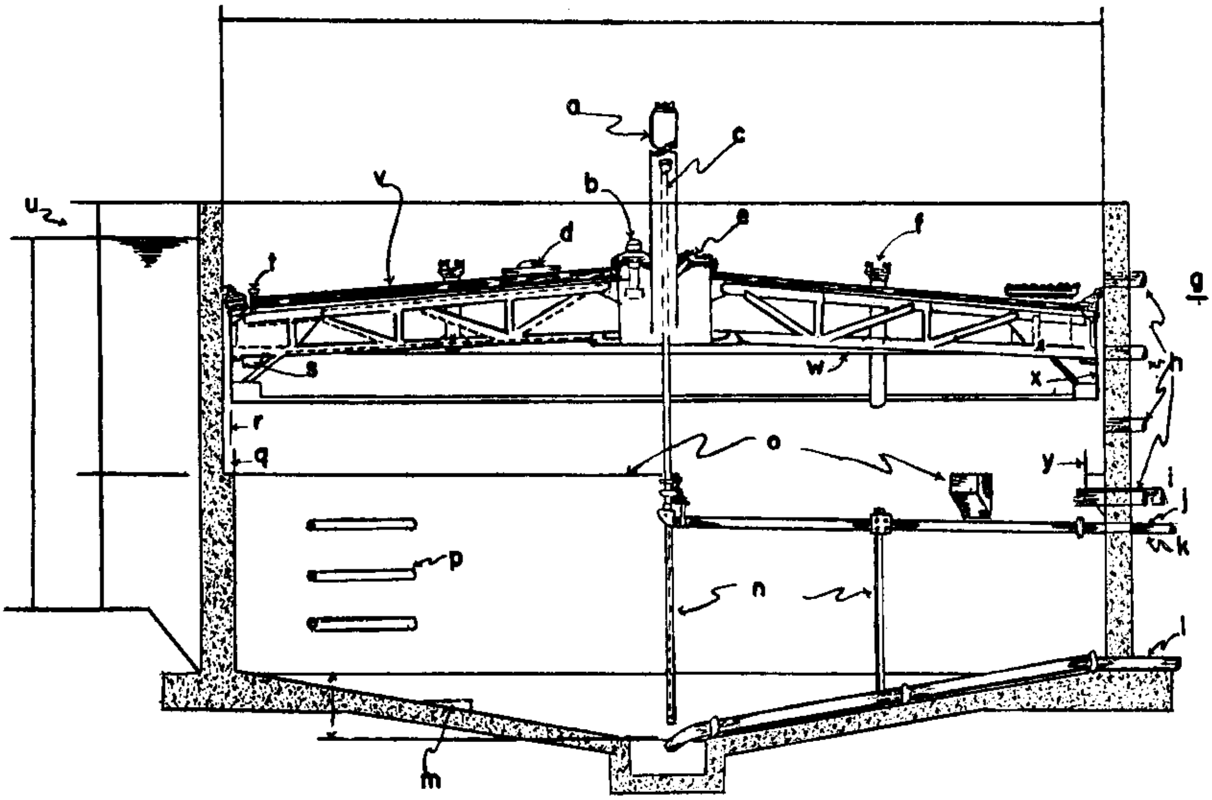

Figure 7–9.—Section of a floating-cover digestion tank.

a. Gas pipe housing
b. Pressure and vacuum relief
c. Gas pipe must be accurately and securely centered in tank
d. Entrance hatch
e. Hand hole
f. Sampling well
g. Control chamber should be ventilated
h. Supernatant drawoffs and overflows
i. Sludge inlet
j. Gas takeoff
k. Provide drip trays at low point. Provide flame trap and pressure relief.
l. Sludge drawoff
m. Button slope, about 1 in 6 suggested
n. Gas-piping support
o. Landing ledge on brackets
p. Heating coils
q. 6'' min.
r. 3'' clearance
s. Drain sump
t. Sump well
u. Freeboard
v. Composition roofing, sheathing and rafters furnished by others
w. Ceiling plate
x. Rim plate
y. 9'' min.

Section IV. SECONDARY TREATMENT

7–31. Processes of Secondary Treatment

(1) In systems including secondary treatment, the sewage is further purified by passage through trickling filters (fig. 7–10), or the activated sludge process (fig. 7–11), followed by secondary sedimentation, and in some cases with chlorination of the final effluent for practically complete bacterial elimination.

7–32. Trickling Filter

(1) The trickling filter (fig. 7–12) is a device designed to remove most of the colloidal and finely divided solids remaining in the liquid effluent after primary treatment, and also to greatly reduce the number of bacteria. The filter bed is usually of circular construction. The liquid sewage is distributed evenly over the upper surface of the bed

by means of rotating arms that revolve over the circular filters, spraying from nozzles about 12 inches above the surface of the stone. A row of spray nozzles are spaced along one side of each spray arm, closer together toward the periphery, to ensure the even distribution of the liquid over the bed. The pipe arms revolve on their central axis in the same manner as a rotating lawn sprinkler. They are driven by the reaction force of the flowing sewage.

(2) The filter bed should be constructed with an underdrain system that not only removes the effluent to the secondary sedimentation basin but allows a free circulation of air throughout the bed to support the aerobic bacteria and other organisms upon which the process depends. The depth of the bed ranges from 3 to 8 feet. It is filled with a coarse material (broken stone, tile, slag, etc.) that is usually not less than 2½ inches in diameter.

(3) After construction, a filter requires a period of several weeks of "aging" to allow the surfaces of the material in the filter bed to become covered with a film of biological growth, called zoogloea, which is primarily responsible for the efficiency of the filter. As the sewage flows down through the bed, the suspended and colloidal organic solids remaining after

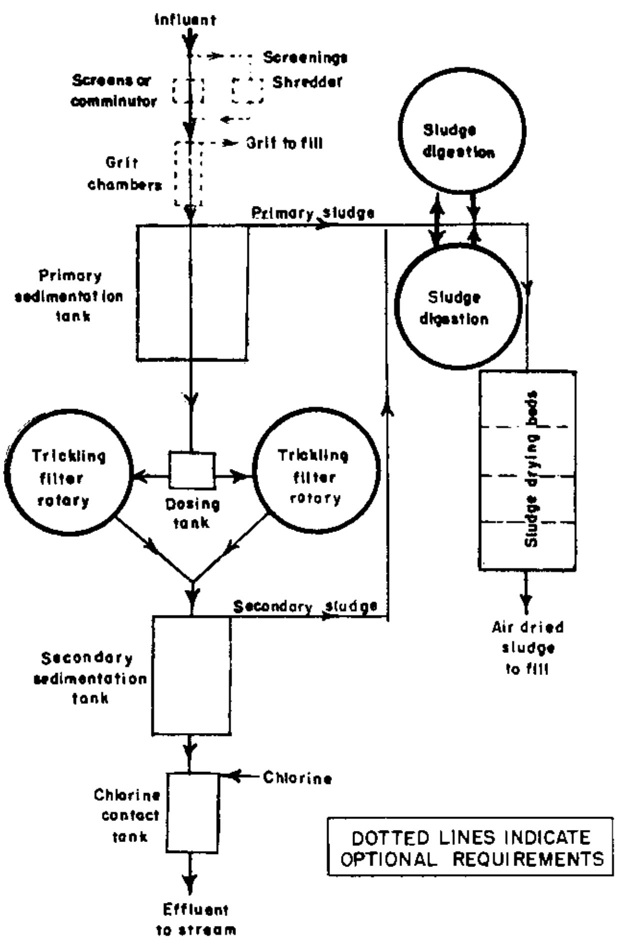

Figure 7–10.—Schematic flow diagram of secondary treatment with trickling filter.

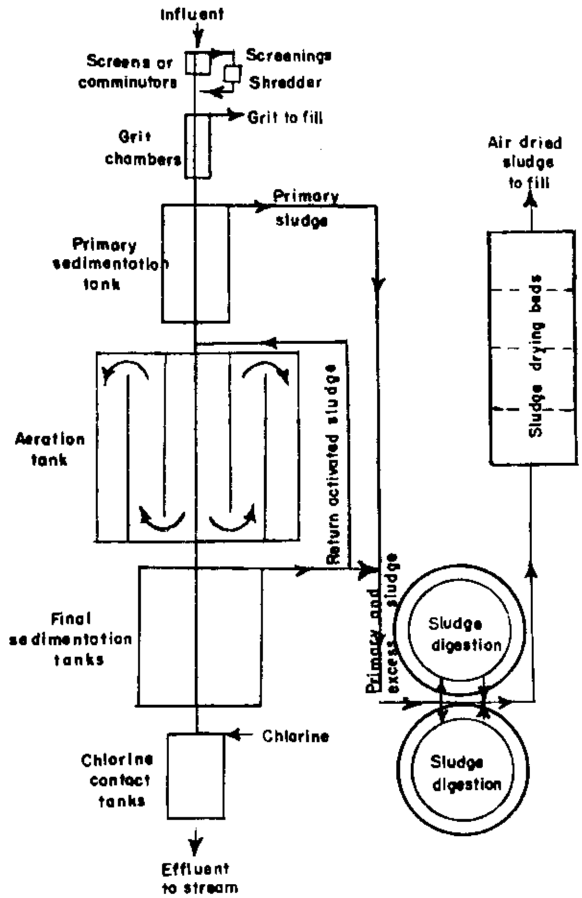

Figure 7–11.—Cross section of a secondary treatment plant, utilizing activated sludge treatment.

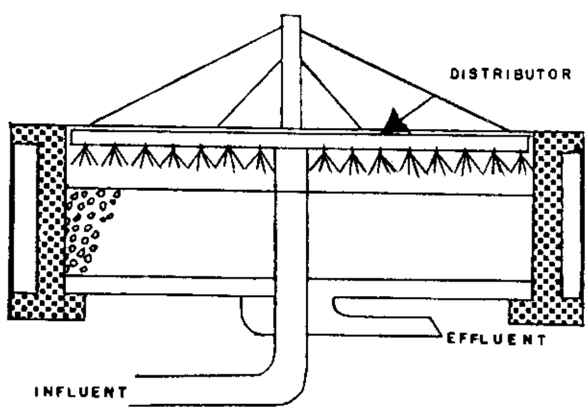

Figure 7–12.—Cross section of trickling filter.

primary treatment are either digested or oxidized as they come into contact with the jellylike layer of living organisms. As the layer of zoogloea builds up, air is not able to penetrate its thickness. Consequently, anaerobic bacteria develop between the film and the stone, creating gas which loosens the zoogloea so that it falls free to flow on to the secondary sedimentation basin. The aerobic bacteria then develop again on the stone surface to continue their oxidative process. As a result, the filter unloads an organic sludge, much like a humus.

(4) This self-cleaning process makes the trickling filter a very economical and efficient form of treatment. It can reduce both the suspended solids and the biochemical oxygen demand by from 50 to 90 percent. The efficiency of the process is reduced by lessening the contact time or by increasing the volume of the flow.

(5) There are two types of trickling filters, the standard rate (intermittent) and the high rate (continuous). The name is indicative of the rate of flow through the filter bed. The standard rate trickling filter is the most common type found in use, the sewage volume ranging between 2 and 3 million gallons per acre of filter surface per day. The high rate trickling filter is capable of carrying up to 10 times that volume. To maintain a constant flow of such large amounts the plant is arranged so that a portion of the liquid effluent from the secondary sedimentation basin can be returned to the influent line of the trickling filter; this also "seeds" the incoming sewage, and dilutes it with water containing an appreciable amount of oxygen.

(6) The high rate (continuous) filters operating with recirculation may be operated in either one or two stages. Two-stage filters will normally give a higher rate of purification than single-stage filters. In some sewages, preaeration of the primary sedimentation effluent before discharge to the filters may increase the efficiency of the process.

(7) Filter flies (*Psychoda* flies) may become a nuisance but can be controlled by closing the effluent drain and flooding the filter bed to a depth of about 4 inches above the surface of the stones. If the liquid is held at this level for 12 hours the fly larvae drown and are soon decomposed. Insecticides such as DDT also have been used with some success.

7–33. Activated Sludge

(1) In the activated sludge process (fig. 7–13) of sewage treatment the effluent from the primary sedimentation basin flows into an aeration chamber. The aeration chamber in some systems is so constructed that compressed air is forced up through the bottom and passes through the sewage; in other systems, mechanical stirring devices agitate the sewage to ensure air contact and movement adequate for supporting the aerobic bacteria and other organisms upon which the process depends.

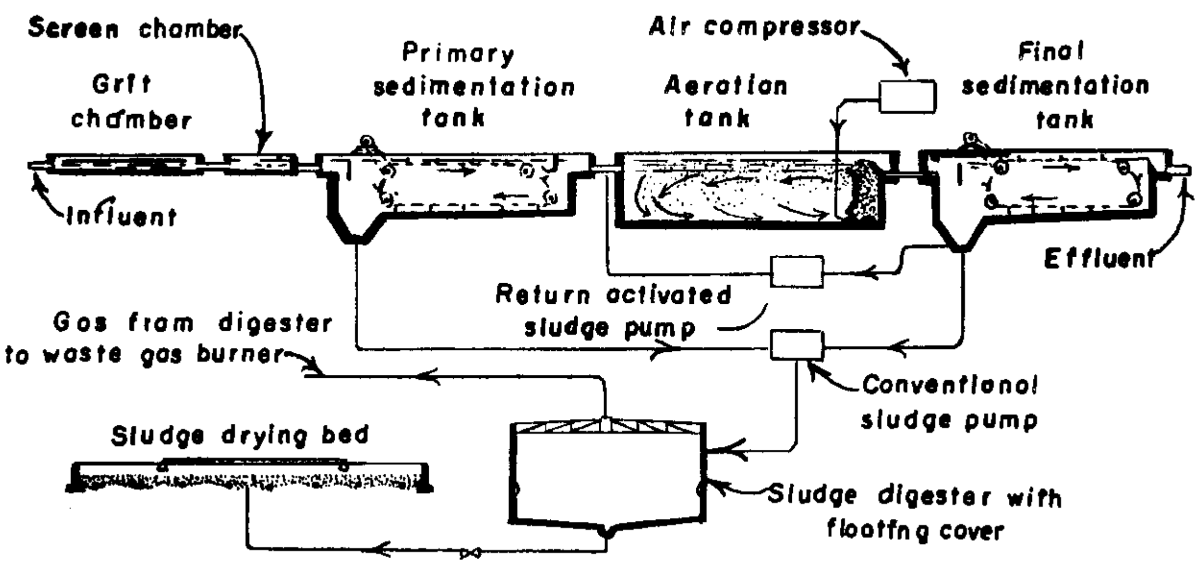

Figure 7–13.—Schematic flow diagram of secondary treatment, utilizing activated sludge.

(2) As the sewage enters the aeration chamber, it is mixed with fresh activated sludge, the volume of this sludge being about 25 percent of that of the sewage. Activated sludge is biologically active and is recovered from the secondary sedimentation basin. It contains organisms that are capable of oxidizing the solids that are suspended or dissolved in the liquid sewage. Its action is similar to that performed by the zoogloea of the trickling filter.

(3) The process, under proper conditions, is very efficient, removing 90 to 95 percent of the solids and reducing the biochemical oxygen demand the same amount. It also removes from 90 to 98 percent of the bacteria. However, it is dependent to a degree upon climatic and other conditions. Industrial wastes sometimes interfere with the biological action of the bacteria also. The aeration and agitation may give rise to excessive frothing in sewage containing appreciable amounts of soaps or detergents and so present an esthetic or nuisance problem. The method of disposal of the large volumes of sludge recovered also presents a problem.

(4) Successful results depend upon competent supervision.

7–34. Final Sedimentation

(1) The operation of this process is similar to that of primary sedimentation. The retention time in the final sedimentation basin may be less than for primary sedimentation.

(2) When sedimentation follows the complete processes of trickling filters, or activated sludge, it is referred to as "final sedimentation."

(3) As in the primary sedimentation, the efficiency of the process is dependent upon many physical factors. The characteristics of the sewage, the retention time in the sedimentation basin, and the ratio of the rate of sewage flow to the surface area of the sedimentation basin, all influence the percentage of solids removed. At the end of the trickling filters process about 90 percent of the settleable solids have been removed and after the activated sludge process, about 95 percent.

(4) Sludge from final sedimentation units is usually transferred by pumps back to the primary process, either direct to the sludge digestion tanks, after the excess water has been decanted, or to the primary sedimentation tank.

7–35. Sand Filters (Intermittent)

(1) Sewage can be rendered inoffensive, and the bacteria content and biochemical oxygen demand can be very efficiently reduced by sand filtration (fig. 14). Filter beds are constructed in the same manner as used in slow sand filtration for water purification. The bottom of the bed is laid with a system of tile drains, covered with coarse gravel. On top of the gravel is placed a layer of coarse sand and the finer sand comprises the top layers. The total depth of the filter bed is about 30 to 36 inches.

(2) These filters can operate with no other treatment except coarse screening to remove large particles of organic matter. They are usually not practical for large populations, because of the extensive area required. The primary essential of this process is the intermittent application of sewage, with resting periods between floodings to allow the filter to drain and reaerate itself, and so permit the removal of excess solids from the filter surface.

(3) Two or three separate filters must be constructed to permit drying and cleaning operations while one bed is available for flooding. The sewage is brought to the filter through a system of baffled inlets to ensure even distribution of the liquid over the bed without disturbance of the fine filter sand. The bed is filled to a depth of about 4 inches above the sand surface, and the sewage flow into the bed is stopped. As the liquid flows down through the sand interstices, it draws in air which supports the oxidative processes of the aerobic bacteria and other organisms in the sand.

(4) After the filter has drained, it is allowed to dry and the surface is cleaned by sweeping or by removal of a thin layer with shovel or scraper. The fine sand must be replaced periodically to maintain the filter depth.

(5) These filters are seldom used in modern practice, but are very efficient and in some cases can be used effectively in small installations.

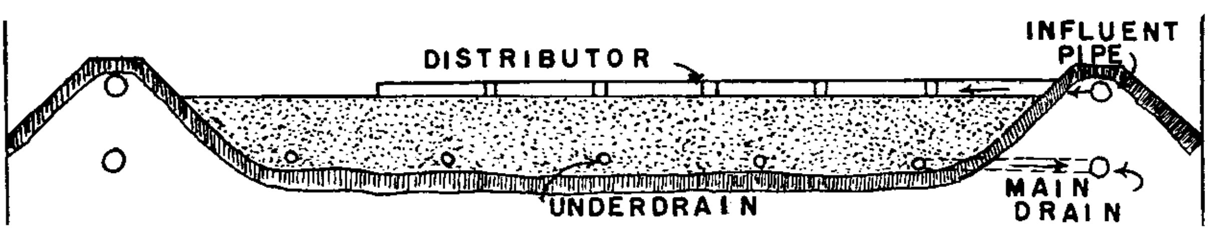

Figure 7–14.—Cross section of intermittent sand filter.

Section V. CHLORINATION OF SEWAGE

7-41. Methods of Application

(1) Chlorine is normally applied to sewage for one of two reasons: prechlorination for the control of the hydrogen sulfide normally found in sewage; and final (or post) chlorination for disinfecting purposes—to destroy pathogenic bacteria and other undesirable biological life in the plant effluent.

(2) The hydrogen sulfide which develops in stale sewage, in the presence of water produces sulfurous acid. Being a very corrosive acid it may cause rapid deterioration of metal and concrete structures in the plant, and may cause prohibitive maintenance costs. Chlorine is sufficiently active as an oxidizing agent to break down the hydrogen sulfide and liberate free, insoluble sulfur.

(3) In addition to corrosion prevention, the odor of hydrogen sulfide and associated organic mercaptans (sewage stink) is controlled by the addition of chlorine. Thus, the use of chlorine in prechlorination serves two purposes—prevention of corrosion and odor control. When prechlorination is employed, it is important not to use excessive amounts so as to leave a residual of free chlorine, since its bacteriostatic action will interfere with the biological processes of the secondary treatment system.

(4) None of the mechanical or biological methods of sewage treatment removes all of the pathogenic organisms even though referred to as "completed treatment." If bathing beaches, shellfish beds, or water supply inlets are located near the sewer outfall, disinfection of the treated effluent is mandatory.

(5) Postchlorination provides an effective disinfection of sewage effluents, which do not contain excessive amounts of organic matter. Chlorine does not have the penetrating ability to disinfect semisolid masses. For effective disinfection, the rate of chlorine feed should be high enough to establish a residual of 0.5 to 0.7 p. p. m. at the end of a 30-minute contact time. The amount of chlorine required to maintain this residual varies greatly, being dependent upon the composition of the treated effluent.

(6) The character of sewage effluent from any type of treatment is subject to wide variation, and frequent adjustment of the chlorine dosage is required to maintain uniform results.

Section VI. SANITARY CONTROL

7-51. Stream Pollution

(1) The Federal policy for control of stream and harbor pollution is established as follows:

(a) The Water Pollution Control Act, 62 Stat. 1155; 33 U. S. C. 466-466j, provides for pollution control activities through the Department of HEW, Public Health Service and is applicable to municipalities, industries, and others that may contribute to the pollution of surface and underground waters in the United States.

(b) Executive Order 10014, promulgated 3 November 1948, implements The Water Pollution Control Act by directing the heads of departments, agencies, and independent establishments of the executive branch of the Government to cooperate with State and local authorities concerned with control of water pollution resulting from Federal activities.

(2) In compliance with Executive Order 10014, the Department of the Navy has established the following policies:

(a) The general program of pollution abatement shall be in accord with the Navy's overall program for developing shore activities.

(b) The Navy shall proceed as rapidly as adjacent communities to stop pollution, paralleling any substantial active corrective effort made by local and/or State authorities.

(c) Full cooperation will be given State and local authorities in regard to pollution abatement, without permitting State control over installations at naval activities, final decision on any action being reserved for the Navy. State and local authorities may be contacted for information or comment on drawings and specifications, but here again the final action or approval is reserved for the Navy.

(d) State and local authorities are permitted individual visits to naval sewerage and disposal facilities when accompanied by a responsible technical representative of the command involved. Verbal or written comments of visitors will be considered as advisory only, but they are to be reviewed for appropriate action.

(e) Operating and analytical data on sewerage systems may be provided State authorities for information purposes, but no authorization will be given for publication of such material.

(f) Personnel in charge of sewerage systems should be thoroughly familiar with the above-listed policies and other regulations to prevent or control stream pollution.

7-52. Laboratory Control

(1) Laboratory control of sewage-treatment-plant operation includes determination for suspended solids, B. O. D., and residual chlorine. Plants which serve populations of less than 1,000 do not generally require daily analysis unless the effluent affects public drinking water, shellfish areas, or recreational waters. At large plants using complicated treatments, the routine analysis should be fairly complete. In cases where public drinking water, shellfish areas, or recreational waters are affected by small plants, or at plants using complicated treatment methods, routine and special analysis must be conducted on a schedule of reasonable time intervals.

(a) Chlorination of sewage is required for a number of reasons as listed in Section V, Chlorination of Sewage.

(b) B. O. D. or biochemical oxygen demand examinations are conducted to determine the quantity of dissolved oxygen required during stabilization of the decomposable organic matter by aerobic biochemical action.

(c) Laboratory examinations for suspended solids are conducted to determine the remaining solids in the effluent.

(2) The above-listed laboratory tests must be conducted as scheduled by the appropriate district public works officer. Reports are made to his office as required or as necessary to assure proper operating results. These tests may be conducted by the plant operator, but services of the sanitary engineer who is assigned to the District Public Works Office may be required.

(3) All laboratory analysis and tests are to be performed in accordance with methods described in reference 1.

7-53. Cross-Connections

(1) All cross-connections between potable water supplies and sewerage systems are hazardous. The standards contained in this article are abstracted from those published by the Bureau of Yards and Docks, and are designed to eliminate or prevent cross-connections, thereby eliminating the necessity of backflow prevention devices. Cross-connections with or without such devices may still be found occasionally at naval activities. These should be reported immediately to the proper authority for correction.

(2) When fresh water must be supplied to sewerage lines or appurtenances, an over-the-rim type of supply must be provided. This type of construction prevents any possibility of flow reversal due to siphonage, pressure, or flood.

(3) When necessary, water pressure may be produced by means of a pump so applied that it takes suction from the over-rim supply and discharges it directly into the contaminated system, rather than by means of cross-connections to the pressurized fresh-water system. The reason for this precaution is that when check valves are used to prevent the backward flow of sewage, they have been found to be unreliable.

(4) The following are the most common cross-connections found at sewage-treatment plants and pumping stations:

(a) Flushing connections for Imhoff tanks, sludge hoppers, or digesters.

(b) Priming connections for pumps or water seals.

(c) Makeup water connections to digester heating coils and systems.

(d) Water ejectors for draining sewage from pits.

(e) Flushing nozzles for screening bins and grit chambers.

(f) Scum-spraying or break-up nozzles at digester roofs.

(g) Sewer-flush tanks.

(h) Water hoses for flushing and clean-up purposes, which may be left with the nozzles submerged in sewage that could permit backflow of sewage into potable waterlines.

Section VII. METHODS AND PROBLEMS OF SEWAGE DISPOSAL ON NAVY VESSELS

7-61. Methods of Disposal

(1) Ships, in most cases, discharge their sewage over the side without treatment. Disposal by this method presents no problem when a ship is underway, except that of providing adequate sea water to ensure flushing of the troughs and the effluent line. Since sewage requires only a 1 to 40 dilution ratio. large bodies of water adequately handle any sewage discharge from shipboard.

(2) The discharge of sewage from vessels in port, or in closed waterways, must conform to port regulations, and such regulations should be made available to the command of the vessel from the office of the port director, the senior officer present afloat, or other competent authority.

7–62. Transfer of Sewage Overboard

(1) Lines that handle the sewage must be of sufficient diameter to carry the maximum load, and of sufficient slope to prevent settling out of the solids from the sewage and consequent clogging of the lines if the effluent is not forced by pumps.

(2) On some vessels the construction is such that drainage from the plumbing fixtures cannot be discharged overboard by gravity flow because they are below the level of the waterline or because openings would weaken the armor of the ship. In these instances, a means of storing the wastes and lifting them up and out of the tanks must be provided. The arrangement is usually one in which the toilet wastes flow into a sump tank equipped with a float device which, when the sewage rises to a certain level, automatically starts a pump that lifts the sewage up and over the side. Inspections must be made to ensure good working order, and that there is no leakage or overflow. These tanks should be cleaned, scraped, and painted when the ship is in port for regular overhaul periods.

(3) Deck drainage and flushing water is sometimes collected in bilge wells and lifted out periodically with pumps. The bilge wells are vented and, unless cleaned and flushed frequently, might give off undesirable odors. Some standard deck drains used in Navy ships are equipped with traps to prevent such odors from returning to the compartments in which they are installed. It is necessary to keep the traps filled with water to prevent the return of such odors.

(4) There are three methods of lifting the wastes from below the waterline and over the side:

(a) Motor driven pumps.

(b) Eductor system.

(c) Air blow system.

In the Eductor system the waste is lifted by the suction created by the flow of the salt (sea) water through the flushing system or the fire-fighting system of the ship. Care should be taken to avoid clogging or fouling of the Eductor valves or the salt-water system. Discharge lines from sewage tanks must be designed and installed so as to be entirely separate from and independent of any other piping system on the ship to avoid contamination of lines.

7–63. Cross-Connections and Back Siphonage

(1) Any cross-connection aboard ship presents a special problem due to the frequent variation of the water pressure and the subsequent back siphonage created, especially in the fresh-water system. Because of necessity, fresh-water, salt-water, and flushing-system lines are located in close proximity to one another. This condition requires that special attention be given to prevent any accidental contamination of the fresh-water supply by polluted harbor water or sewage wastes.

(2) Due to the problems involved in ship construction, it is often difficult or impossible to prevent sewage and other waste lines from passing through food-service or food-storage areas. When this condition does exist, the lines must be marked distinctly, and frequent inspections should be made to determine their freedom from leaks that might contaminate food.

7–64. Special Problems

(1) Sewage disposal from submarines presents a special problem. When operating underwater it is necessary to force the waste out by use of compressed air. This requires special equipment and indoctrination of personnel in its use to avoid blowing the waste back into the ship's compartment. In some type submarines the waste is collected in a tank and ejected from the submarine by air at specified intervals. Such tanks require periodic cleaning, scraping, and testing during Navy yard overhaul periods to prevent fouling and leaking.

REFERENCE

1. *Standard Methods for the Examination of Water, Sewage, and Industrial Wastes.* 10th edition. Prepared and published jointly by American Public Health Association, American Water Works Association, and Federation of Sewage and Industrial Wastes Associations. New York, N. Y.

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MANUAL OF NAVAL PREVENTIVE MEDICINE

CHAPTER 8

GARBAGE AND REFUSE DISPOSAL

DEPARTMENT OF THE NAVY

BUREAU OF MEDICINE AND SURGERY

JUNE 1957

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ILLUSTRATIONS

Chapter 8

GARBAGE AND REFUSE DISPOSAL

Section I. INTRODUCTION

8–1. Sources of Garbage and Refuse

(1) Tremendous amounts of materials enter a naval activity each day in widely varied forms—foodstuffs, clothing, textiles, office and household furnishings, packing cases of paper and wood, office supplies, lubricating oils and greases, building materials, medical supplies, and countless others. With a few exceptions, each of these materials, in its own way, serves its purpose, briefly or for long periods of time, then moves on as a waste material in the original or changed form. A relatively small amount of the resulting waste is carried off as sewage, and the rest constitutes what we think of as garbage and/or refuse.

8–2. Responsibility

(1) *Responsibility of the medical department*

(a) The medical department, to carry out its staff responsibility, must know the preventive medicine requirements of proper refuse disposal, disposal methods used within the command and in adjoining areas, and hazards to health resulting from improper practices. This information must be current so that any change in these factors may be dealt with by appropriate recommendations to the commanding officer. Therefore, the medical officer must be alert to deficiencies which threaten health, and to occurrence of disease or injury that may be associated with refuse disposal; as circumstances warrant, he must require periodic surveys of the insect and rodent populations.

(b) The medical officer also must be acquainted with the preventive medicine aspects of laws, regulations, official recommendations, and local practices relating to refuse disposal and must advise the commanding officer accordingly. In the absence of specific instructions, the medical officer should recommend disposal methods based upon accepted principles of sanitation.

(c) In military experience, the hazards to health associated with refuse disposal are frequently of greater importance than is the case in the civilian community. In the average municipal program of refuse disposal in the United States, economy, convenience, and general cleanliness are of greater concern than is hygiene. In contrast, in the military establishment—due to operations in less sanitated areas, frequent changes in personnel, and disruptions resulting from combat—the hazards to health arising from refuse may become much greater. The various factors of disease transmission assume significance in relation to each other. Transmitting agents become more important when infective persons or animals are present and under conditions favoring vector activity. For example, an open-face dump is less likely to be a factor in disease transmission in the United States than in some other areas of the world. Such a dump may be a source of plague in Naples, pappataci fever and trachoma in North Africa, or malaria and filariasis in the islands of the South Pacific.

(d) The medical department, in recommending the degree of technical refinement to be used in refuse disposal, must take into consideration the presence of infectious agents in the area, the life cycle of the disease organisms and their vectors, and the susceptibility of that portion of the population which is at risk. Under combat conditions, careful evaluation of these factors is particularly essential to finding the proper balance between disease prevalence, combat effectiveness, and esthetic considerations bearing on morale.

(e) Economic feasibility should be considered in the development of refuse collection and disposal procedures.

(2) *Responsibility of the Bureau of Yards and Docks.*—The Bureau of Yards and Docks is responsible for the planning, design, construction, and maintenance of refuse disposal systems at naval shore establishments, except Marine Corps managed installations. The public works officer, or other officer detailed to this duty, is responsible to the commanding officer of a naval establishment for efficient and economic refuse collection and disposal.

8-3. Definition of Terms

(1) Terms used in this chapter are based on these contained in reference 1, which provides detailed information for the organization of an efficient collection, segregation, and disposal system at a naval establishment. A review of current literature on the subject discloses considerable variance in definition of terms casually thought of as garbage, refuse, rubbish, or waste. The terms appear to have an approximately synonymous usage as well as a distinctive usage, and actual definition rests with the writer. Generally, the inclusion of garbage as a putrescible constituent of refuse seems to be acceptable to many authorities.

(2) The various kinds of wastes are classified and defined as follows:

(a) *Garbage.*—Garbage is defined as including those materials of organic substance which are directly significant to the public health in that they are capable of supporting bacterial life and/or are attractive to predatory animals and vectors or pests. This classification would include such materials as meat, fish, fowl, vegetables, fruits, and edible oils.

(b) *Combustible rubbish.*—This term comprises such unusable, unsalvageable materials (not disintegrated) as can be destroyed by burning. It includes cardboard, wooden cartons and crates, food cartons, wood scraps, rags, paper, books, and medical wastes.

(c) *Noncombustible rubbish.*—This form of waste includes unsalvageable materials that cannot be destroyed by burning such as glass, cans, metal, and pottery.

(d) *Trash.*—Trash consists of disintegrated combustible rubbish such as paper, sawdust, and leaves.

(e) *Ashes.*—This is the solid inert remains of burnt materials.

(f) *Dead animals.*

(g) *Liquid and semiliquid combustible wastes.*—This term is applied to petroleum sludge, crank case oils, greases, and tars.

8-4. Navy Housekeeping Practices

(1) Housekeeping practices in the Navy are, by long custom, stringent. Years of association with seagoing vessels have instilled a strong tendency to avoid accumulations of materials which might, under certain adverse weather or battle conditions, present hazards to other useful materials, structures, vessels, or personnel. Early observance of a possible correlation between overcrowding, uncleanliness, and generally poor housekeeping with occasional loss of life or limb is probably partially responsible for such opinionated expressions as "A clean ship is a happy ship." An acute awareness of the frequent incidence of communicable disease in the less sanitary parts of the world has further served to make naval personnel, as a whole, public health conscious.

(2) In the naval service, practical demonstration of this attitude is apparent in "field day" and the weekly commanding officers' materiel inspection. Though these inspections were adopted long before their significance in the control of sanitary environment was fully appreciated, they contribute greatly to the end result in which preventive medicine authorities are interested.

Section II. MEDICAL SIGNIFICANCE

8-11. Hazards to Health

(1) Disposal of refuse—trash and garbage—is of medical importance because of the associated hazards to health. Refuse, by improper collection and disposal, becomes an indirect but important factor in the spread of disease. It also becomes a hazard to safety and gives rise to nuisances.

(2) Refuse helps to spread disease, chiefly, by means of the numerous insects and rodents which it attracts. Accumulations of trash and garbage provide them with food, shelter, and places for breeding. Flies, particularly, are attracted to garbage. They transmit from their bodies, and possibly in their droppings, many infections such as typhoid fever, bacillary dysentery, conjunctivitis, yaws, and certain parasitic diseases. Several types of mosquitoes breed in the water, which collects in empty cans and other containers found in refuse. One of these is the *Aedes aegypti*, which transmits dengue and yellow fever. Mosquitoes also spread malaria, filariasis, and other diseases. Rats spread plague, murine typhus, Weil's disease, and salmonella infections.

(3) Uncooked garbage, when used as hog feed, transmits trichinosis to hogs, and the infected pork transmits it to man.

(4) Refuse from hospitals, laboratories, and animal colonies produces disease by means of the infectious agents, radioactive materials, and toxic chemicals which it may contain. Streptococcal and enteric infections, tuberculosis, and smallpox are among the diseases which may be spread by this means. Rivers, lakes, and other sources of water may be so heavily polluted by refuse that treatment of the water to make it safe for drinking becomes difficult and costly. Pollution destroys fish and shellfish, or makes them unfit for food. It also spoils recreational areas. Fires and accidental injuries which arise from improper disposal of refuse are additional hazards to health. Pest insects, odors, and other nuisances from refuse can result in undesirable living conditions.

8–12. Methods of Control

(1) Both preventive and corrective methods are used in controlling the hazards to health which are associated with refuse.

(a) *Preventive methods*.—Proper collection and disposal of trash and garbage is a method of prevention, and the use of insecticides, rodenticides, water purification, quarantine, and clean-up programs are corrective methods.

(b) *Corrective methods*.—Sanitary techniques of refuse collection and disposal are designed to prevent the development of conditions which result in disease, accidental injury, and nuisances. Corrective measures are merely temporary and remedial, but must be used when the hazards already exist in the area. Experience has proved that, when corrective methods are used to take the place of proper refuse disposal, they are less effective and more expensive than is the preventive method.

8–13. Insects and Rodents

(1) Elimination of attractants, breeding sites, harborage, and food sources is essential to insect and rodent control. The following factors of refuse disposal systems tend to reduce the insect and rodent populations:

(a) Containers that are properly constructed and maintained reduce the attraction of insects and rodents and prevent their entrance. Containers should be designed specifically for refuse and garbage. To be effective, they must be constructed of rustproof metal and must have watertight bottoms and tight-fitting lids. In handling, care must be taken to prevent damage to lids and watertight seams, and any damage must be repaired.

(b) Frequent collection of refuse is normally required to reduce organic decomposition and odors, thereby, the attraction of insects and rodents is lessened. The deposit of insect eggs, the hatching of larvae, and the emergence of adults requires a span of time, which can be interrupted by proper collection frequency.

(c) Keeping refuse as dry as is practicable helps to prevent organic decomposition, decreases odor nuisance, and makes the refuse less attractive to insects. Refuse with high liquid content interferes with efficient incineration and complicates burial. Separation of wet refuse from dry before collection, or drainage of wet refuse, is often desirable. Water must not be allowed to accumulate in bottles, cans, tires, or similar receptacles in which mosquitoes lay eggs.

(d) Burning is a common method of removing food and nesting material, and it also reduces the amount of residue requiring final disposal.

(e) Final disposal must prevent access of insects and rodents. The ideal solution is either complete destruction or burial, in soil or water, at a depth beyond the range of insects and rodents. Under approved conditions, disposal by composting, garbage grinders, or sale of garbage for hog feed are acceptable substitutes for complete destruction.

8–14. Trichinosis

(1) Trichinosis, which is a disease transmitted from infected hogs to man, affects as much as 27 percent of the population of the United States. This disease, often unrecognized, is frequently serious. Hogs are rarely infected unless they have been fed uncooked garbage containing infected scraps of pork, although it is considered probable that they may become infected by eating diseased rats. Vesicular exanthema is another disease transmittible by uncooked garbage. Vesicular exanthema is not known to infect man, but is of serious economic importance to hog growers. Trichinosis is medically important (fig. 8–1) to man because he becomes an accidental host to the parasites (trichinae) when he eats pork products which have not been cooked at temperatures high enough (140° F. in all portions of the meat) to kill the organisms. The actual incidence of clinical trichinosis is not known, but fatal cases are uncommon. Inspection of meat for evidence of trichinae is not effective. Recent reports indicate that no more than 60 percent of all processed pork sold for public consumption receives even cursory inspection. Various Federal and State regulations and other regulations have been developed in efforts to assure safety of pork products such as freezing at very low temperatures. These measures cannot be relied upon to resolve the problem. Therefore, all pork or meat products containing pork must be considered potentially infectious unless proved otherwise or adequately cooked.

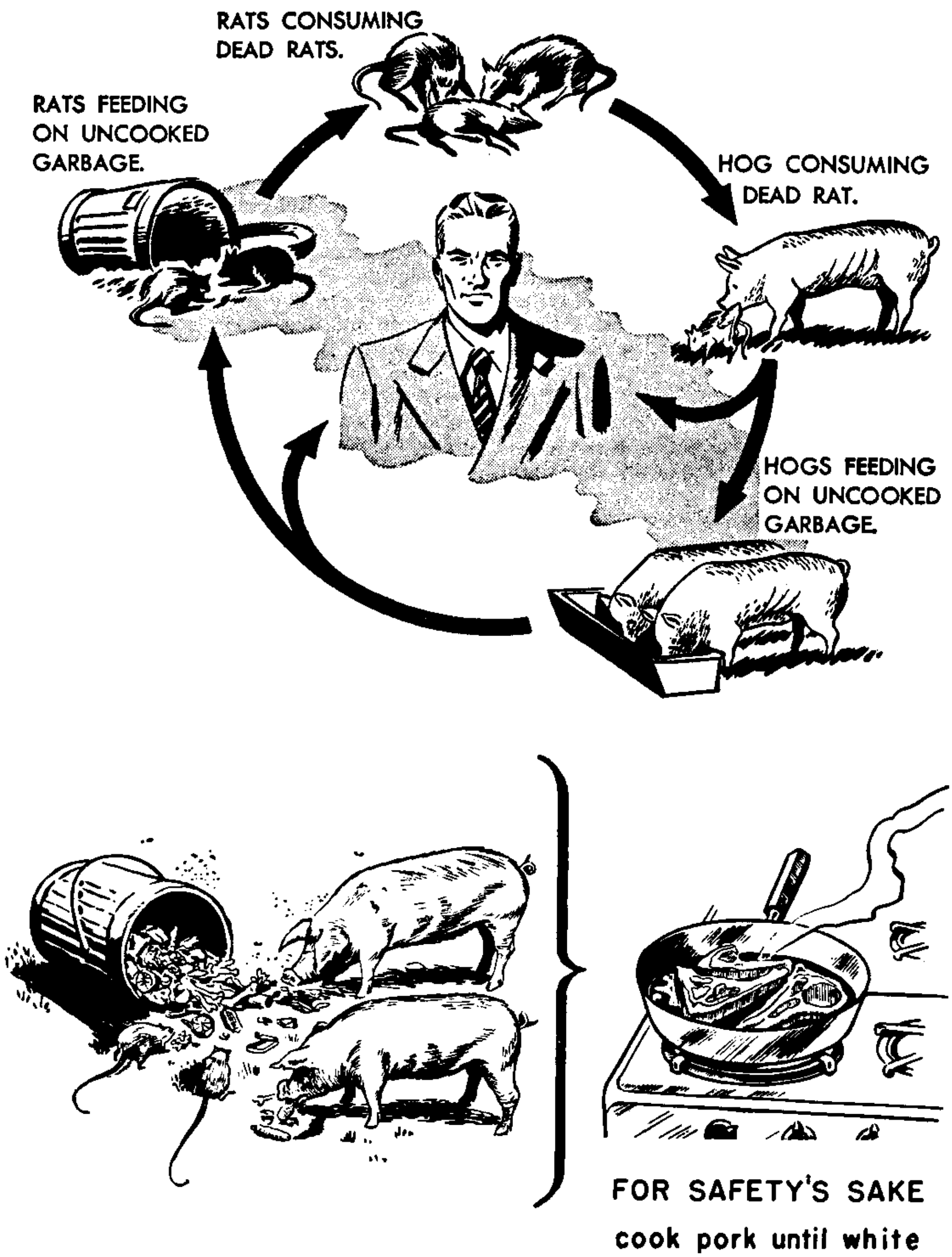

Figure 8-1.—Cycle of transmission of trichinosis from host to host.

8–15. Water Pollution

(1) Disposal of refuse into rivers, lakes, harbors, and their watersheds overloads water-purification systems and destroys sources of fish and shellfish, or makes the fish unfit for food. In recreational areas, this practice may introduce pollution and safety hazards and decrease the esthetic appeal.

(2) Most of the laws and regulations pertaining to control of water pollution are directed toward regulating the disposal of raw sewage into natural waters. However, the organic component of refuse—garbage—also contributes to water pollution, primarily, by increased biological oxygen demand (B. O. D.) of the water rather than by introduction of infectious agents. The addition of organic material not only causes a drain on available oxygen but perpetuates the condition by destruction of plant and animal life, which, in turn, increases pollution and B. O. D. Progression of this cycle tends to produce foul anaerobic conditions, the correction of which is much more difficult than is their prevention. Refuse, in any form, should not be disposed of where it may pollute surface or underground waters which are eventually to be used as drinking water. Garbage grinders have made it possible to dispose of garbage into the sewerage system, where it can be treated and reduced as sewage provided the capacity of the system permits. The sanitary landfill is an excellent substitute for the open dump, which spoils land for future use. Since refuse dumped into water may spoil bathing and other types of recreational areas, this practice is usually restricted by law. In disposal at sea, both dilution and natural biological reduction of the organic component counteract contamination of the water.

8–16. Safety

(1) Accumulation of refuse in living spaces and passages, particularly aboard ship, is conducive to fire and accidental injury. Control of these hazards requires proper containers and proper methods of collection, removal, and burning or burial. Ashore, open-face dumps and other improper methods of disposal also increase safety hazards.

8–17. Special Military Problems

(1) Aboard ship and on submarines, where space is limited, insect and rodent problems and safety hazards become acute. Garbage grinders become dangerous when flushed with contaminated sea water from harbors and areas of ship concentration because contamination may be spread by aerosols from the garbage grinder. Obviously, the flushing of garbage grinders with sea water so contaminated is especially hazardous when the grinder is in a food-handling space. In port, care must be taken that the overboard discharge of refuse—the disposal method commonly used at sea—does not violate laws, regulations, and quarantines. In the absence of restrictions, disposal of refuse should be governed by decent sanitary practice with respect to water pollution. Garbage from food procured in an overseas area may contain infectious organisms of insect, plant, and animal diseases not prevalent in other areas. When the ship's refuse is disposed of these infectious agents may enter the United States and other countries.

(2) Inflight dumping of refuse from aircraft also may spread insects and the infectious agents of human and animal diseases from one area to another; however, this does not preclude the dumping of refuse over the open ocean.

(3) Radioactive and toxic chemical wastes should be disposed of in a manner and by such procedures as will present the minimum necessary hazard to the inhabitants of the environment into which such materials are introduced. Guidance to local commands is available through the Bureau of Yards and Docks and its district and local representatives.

Section III. NAVY SALVAGE PROGRAM

8–21. Justification

(1) Economy of operation requires extensive salvage and/or reclamation of certain valuable materials in the Navy as it does in industry. Paper, scraps, and remnants of sheet metal, metal castings, wire, certain rubber goods, and many other materials which result from various construction, repair, or survey operations performed in the naval service carry certain values when collected and sold. Almost every naval activity produces a certain amount of such scrap material which is salvageable, and efforts are constantly exerted to avoid the destruction of such valuable waste material along with refuse which carries no value.

(2) The salvage program in the Navy varies from time to time in its demands, depending to a great extent upon the production capacity of the nation's industries, in relation to demand. For instance, waste paper which normally carries little salvage value may, during national emergency or during periods when the paper industry experiences difficulty in producing sufficient paper from raw

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materials, assume considerable value and be stringently collected and controlled.

8-22. Responsibility

(1) The Navy Salvage Program is governed and regulated by the Bureau of Supplies and Accounts, and at local activities is directed by a member of the Supply Department. Instructions for the accomplishment of the program are contained in "Navy Property Redistribution and Disposal Directives, Numbers 1 through 4, inclusive," and these manuals are usually maintained by the Supply Department.

8-23. Scavenging

(1) Considerable difference exists between methodical salvaging which usually occurs at the point of production of waste products and scavenging which occurs immediately prior to their destruction or their otherwise being made inaccessible. This scavenging usually consists of permitting various individuals to rummage through the collected refuse in an effort to find anything which may appear to them to have some resale value. Needless to say, permitting this operation usually creates confusion and disorder and frequently is prohibited by local directive.

Section IV. COLLECTION

8-31. Methods of Storing

(1) There are two general methods of collecting garbage and refuse, the *mixed* method in which all waste materials are placed together in collection containers, and the *separate* method in which garbage and refuse are placed in different containers. Occasionally, even further separation for ashes, broken glass, ceramics, and metal products such as tin cans is required. The degree of separation required is usually dependent upon the system of ultimate disposal for the various types of waste materials. If garbage is sold for hog feeding, it should be free of broken glass, steel wool, coffee grounds, and other inedible or dangerous materials. When all garbage and refuse is incinerated, it frequently must be drained and wrapped in paper before being deposited in the container. Occasionally, wrapping of garbage is required to permit the use of uncovered trucks.

(2) Wastes from hospitals, laboratories, and animal colonies must be collected, stored, and disposed of separately unless thoroughly sterilized or neutralized to make harmless the infectious, toxic, or radioactive materials. Personnel responsible for disposing of these wastes should be under orders which insure safe handling and effective sterilizing and neutralizing of the material. When incineration is recommended, care must be taken to insure that the materials are not placed with other wastes and that a practical incineration routine is set up.

(3) *Containers*

(a) To meet the minimum requirements, refuse containers should be of galvanized metal, should be large enough to prevent overflow of waste material, and should be covered with a tight-fitting lid. The cover must be tight enough to keep out insects, rodents, dogs, and other animals.

(b) The 30-gallon *G. I. can* frequently is used at small activities and Government quarters. Another container in widespread use throughout the Navy is the *Dempster-Dumpster type*, which is a closed, detachable, dump truck body of heavy-gage steel. The dump truck body, in which waste materials have been placed, is hoisted onto the chasis of the truck and hauled to the point of final disposal. Maintenance and operation costs are reported to be less than when individual collection containers and collection vehicles are used. Also, cleaning is relatively easy. When some of the refuse is wet, the container should be of the sump type, that is, with a bottom opening constructed to prevent leakage.

(c) When separation of wastes is considered necessary, it is advisable to have containers clearly marked to indicate the type of material that is to be deposited therein.

(4) *Platforms.*—Platforms provided for garbage or trash containers should be conveniently located, adequate in size, accessible to collection vehicles, and easily cleaned and drained. A solid block with smooth concrete surfaces is most easily kept in sanitary condition and is recommended for permanent installations. The cracks and crevices often found in asphalt and wooden platforms collect fragments of refuse and may even harbor insect larvae. Wooden platforms are satisfactory if properly constructed. Space must be left between the floor boards so that fragments of refuse will fall through the floor grid, water will drain off easily, and the space under the stand will have air and sunshine. The platforms also should be light enough in weight so that they can be moved, since the ground and surrounding area must be cleaned periodically. Routine policing of the area surrounding platforms of any type is essential so that spillage will be cleaned

up. Fly screens around platforms are recommended only as a supplementary means of insect control. Proper containers still must be used and the area must be kept clean.

(5) *Refrigeration of garbage.*—Storage of garbage under refrigeration is not a justifiable substitute for frequent collection and disposal.

8-32. Frequency of Collection

(1) The ideal removal of refuse provides immediate destruction of the waste material where it is produced, thereby eliminating storage and exposure to rodents or flies. Garbage grinders do this, since most food scraps and the resulting semiliquid wastes are discharged directly into the sewerage system. The possibility of overloading sewage-treatment plants may limit the widespread use of garbage grinders. Where garbage grinders are not used, adequate collection, removal, and disposal must be arranged.

(2) Garbage produced in large volume—at messes, commissaries, and clubs—should be collected at least once a day. At places such as Government quarters, it is recommended that collection be two or three times a week, as the volume of garbage and prevailing temperatures require. Rubbish should be removed often enough to maintain cleanliness and prevent hazards.

Where individual *G. I. cans* are used, cleaning and maintenance are best done at a central point where proper facilities can be provided.

8-33. Collection Vehicles

(1) Collection vehicles should be designed and equipped to eliminate spillage and odors and must be closed in order to keep out flies. Specialized vehicles of various design—including those fitted with mechanical loading, unloading, and compacting apparatus—are in use throughout the Navy. Although specialized collection vehicles for refuse are preferable, dump trucks may be used if they have watertight bodies.

(2) Collection vehicles at naval activities should at least meet the standards observed by adjacent communities.

(3) The distance which garbage and refuse must be hauled, and, more particularly, the time required for hauling, are of prime importance in the cost of garbage and refuse collection. The topography of the area, population distribution, and the layout of streets will all affect the type of vehicles used and the collection routes chosen.

(4) Cleaning of trucks and containers which collect mixed refuse and garbage should be performed daily and at the time they are emptied, if practical. Containers and trucks for trash only—as in separated disposal systems—should be cleaned as often as necessary. Cleaning of individual *G. I. cans*, vehicles, and other equipment should be performed at a central point where facilities designed for the purpose are provided and, preferably, where the refuse is unloaded. Hot water and steam should be available for cleaning containers and vehicles inside and out, floors should be of concrete, and adequate drainage for runoff water should be provided. The drain connecting with the sewer should be equipped with a grease trap. Fittings that allow the introduction of liquid soap or detergent into the hose streams may be desirable.

Section V. METHODS OF DISPOSAL

8-41. Disposal Afloat

(1) While underway at sea, the principles and standards of garbage collection and disposal are the same as when ashore. Except in harbors and in areas of ship concentration, disposal is usually made by overboard discharge. Special surveillance is necessary to prevent excessive collection of refuse on the fantail, storage of garbage in the reefer, and spillage in galleys, sculleries, and passageways. Garbage grinders have, for the most part, eliminated the problem of telltale surface debris in combat areas.

(2) In port, quarantine and sanitary regulations, article 8-2, applicable to disposal of refuse must be strictly complied with. Specific instructions usually are issued by the port authority.

(3) Hazards of contamination from garbage grinders on board ship arise from the use of contaminated sea water for flushing. This practice introduces aerosols of more or less diluted sewage into the food-handling spaces.

8-42. Disposal Ashore

(1) Disposal problems at shore activities increase and become more complex as the population of the activity served increases in size. The importance here lies in the expeditious consumption as in hog feeding, destruction as in incineration, modification as in composting, or concealment as in landfills of the organic portion of garbage and refuse, which otherwise would attract and serve to support bacterial, insect, and/or rodent life and thereby

promote a threat to the public health. Thorough consideration of collection and disposal problems emphasizes the advantage of selecting a method of disposal which can be located close to centers of population. Alternate costs of using one or several points of disposal may be considered for population groups covering large land areas. Among the more common methods for the disposal of one or more types of garbage and refuse, which may deserve consideration in the light of local conditions, are the following, which are listed in order of receding sanitary acceptability and effectiveness.

(2) *Sanitary landfill.*—Sanitary landfill, also known as "cut and cover" in this country and as "controlled tipping" in England, was developed in an effort to overcome the objections to the insanitary land dump.

(a) *Operation.*—The operation consists of dumping refuse into a prepared trench, or along a low embankment, and covering it promptly with a thick layer of earth. Refuse hauled to the site of final disposal is dumped either along the face of a low embankment or into a prepared trench (figs. 8-2, 8-3, and 8-4). Up to this time, salvage operations may be permitted. Under proper supervision, combustible matter may be burned out, thereby reducing volume. To minimize later settling, the dumped refuse is compacted with heavy mechanical equipment similar to a caterpillar tractor or bulldozer. Before the end of each working day, the compacted refuse, which should not exceed 6 to 8 feet in depth, is covered with at least 2 feet of dirt, which is adequate to insure the exclusion of rodents and insect larvae, and to prevent fires and the escape of odors. The rows, or trenches, of compacted refuse are broken up into compartments, which are separated by 2-foot walls of dirt. These compartments help to reduce gross settling of the surface, act as fire walls, and discourage the practice of allowing accumulations of refuse to lie uncovered too long.

(b) *Maintenance.*—Maintenance—as necessary to the success of the sanitary landfill as is proper burial, compaction, and cover—consists of trimming and filling cracks, erosions, and burrows. Erosion of the soil by wind and water may require additional fill in order to maintain the thickness of the cover (figs. 8-2, 8-3, and 8-4).

(c) *Chemical, biological, and physical changes.*—Relatively little is known regarding the chemical, biological, and physical changes which take place in the material deposited in landfills. Garbage buried deeply has been uncovered many years later almost unchanged by the passage of time, while the same type of material deposited near the surface apparently is decomposed rather completely in as short a time as 30 months. However, it should be remembered that the amount of garbage contained in mixed refuse is less than 15 percent by weight during a considerable portion of the year. The experience with buried refuse will therefore not be strictly analogous to that with garbage.

(3) *Incineration.*—Incineration of garbage and combustible refuse, in properly operated incinerators, is an effective sanitation practice, but plants may be costly, compared to other methods of disposal, and large quantities of fuel may be required. Occasionally there are compensating advantages from production of heat or power when the combustible portion of refuse is high. Noncombustible materials which interfere with incineration may require separation prior to stoking.

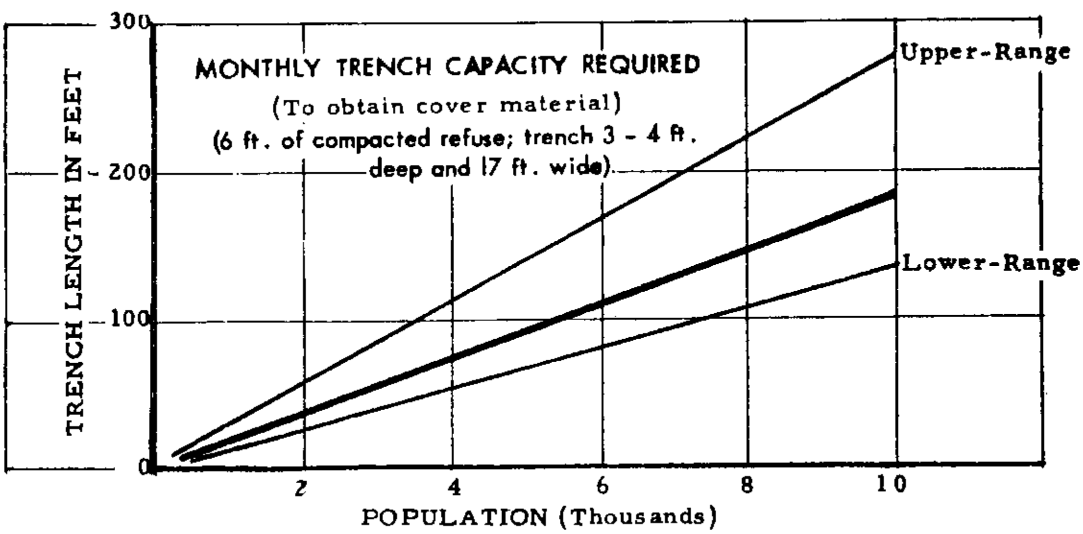

Figure 8-2.—Monthly trench capacity required by sanitary landfill.

(a) Information on incinerators is found in reference 1.

(b) Incinerators operate at maximum efficiency when continuously and uniformly stoked. In planning the capacity of the incinerator in relation to expected volume of refuse, facilities for storage of refuse at the plant and the qualifications of personnel in attendance must be taken into consideration.

(c) To prevent odor and smoke nuisance from an incinerator, all combustion gases should be passed through a furnace at a minimum temperature of 1100° F. and maximum of 1700° F.; 1300° F. is considered optimum. The 15 to 50 percent ash residue after incineration may become an additional disposal problem. Ashes often contain incompletely burned material which may supply food and shelter for rodents.

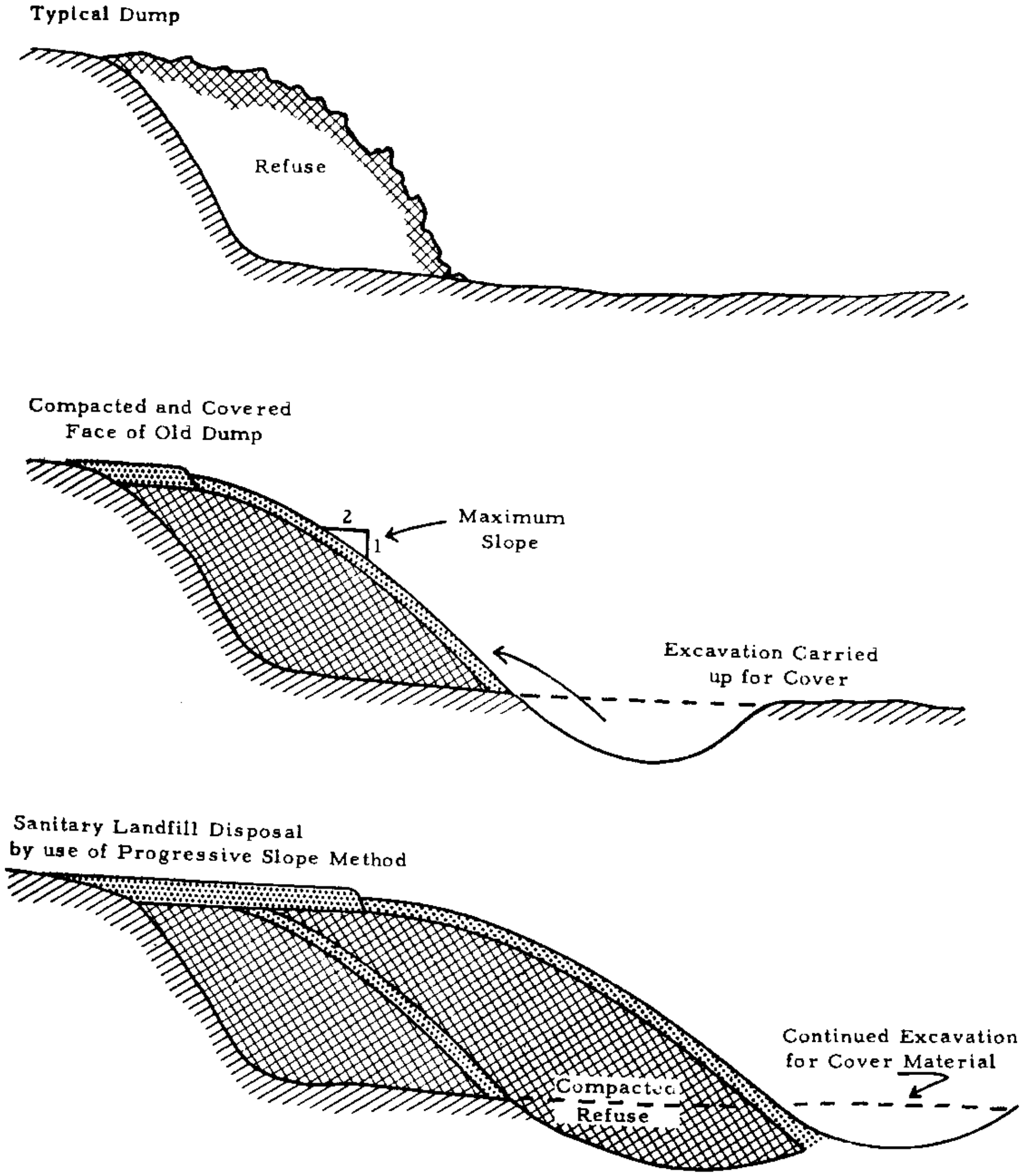

Figure 8-3.—Conversion of bank-type dump.

(4) *Garbage grinders.*—Garbage grinders are effective for disposing of refuse, but care must be taken to avoid placing in the garbage metals and other materials damaging to the machinery.

(5) *Composting.*—Composting by modern methods consists of grinding, stacking, turning for aeration, and regrinding the refuse. The compost product is produced by aerobic thermophilic microorganisms. Parasitic ova probably do not survive the temperature recorded in the center of the compost pile, and the constant agitation prevents breeding of flies. The results of current studies indicate that usable compost may be produced in 10 to 20 days. The possible commercial value of the compost product for soil fertilization may popularize this method.

(6) *Biological digestion.*—The Beccari process of biological digestion was originated in Italy and is infrequently seen in the United States. It consists of the construction of airtight cells containing several tiers of wooden shelves upon which the garbage is spread. Anaerobic action for about 10 days followed by aerobic action for 20 to 30 days results in a humus containing nitrogen, phosphoric acid,

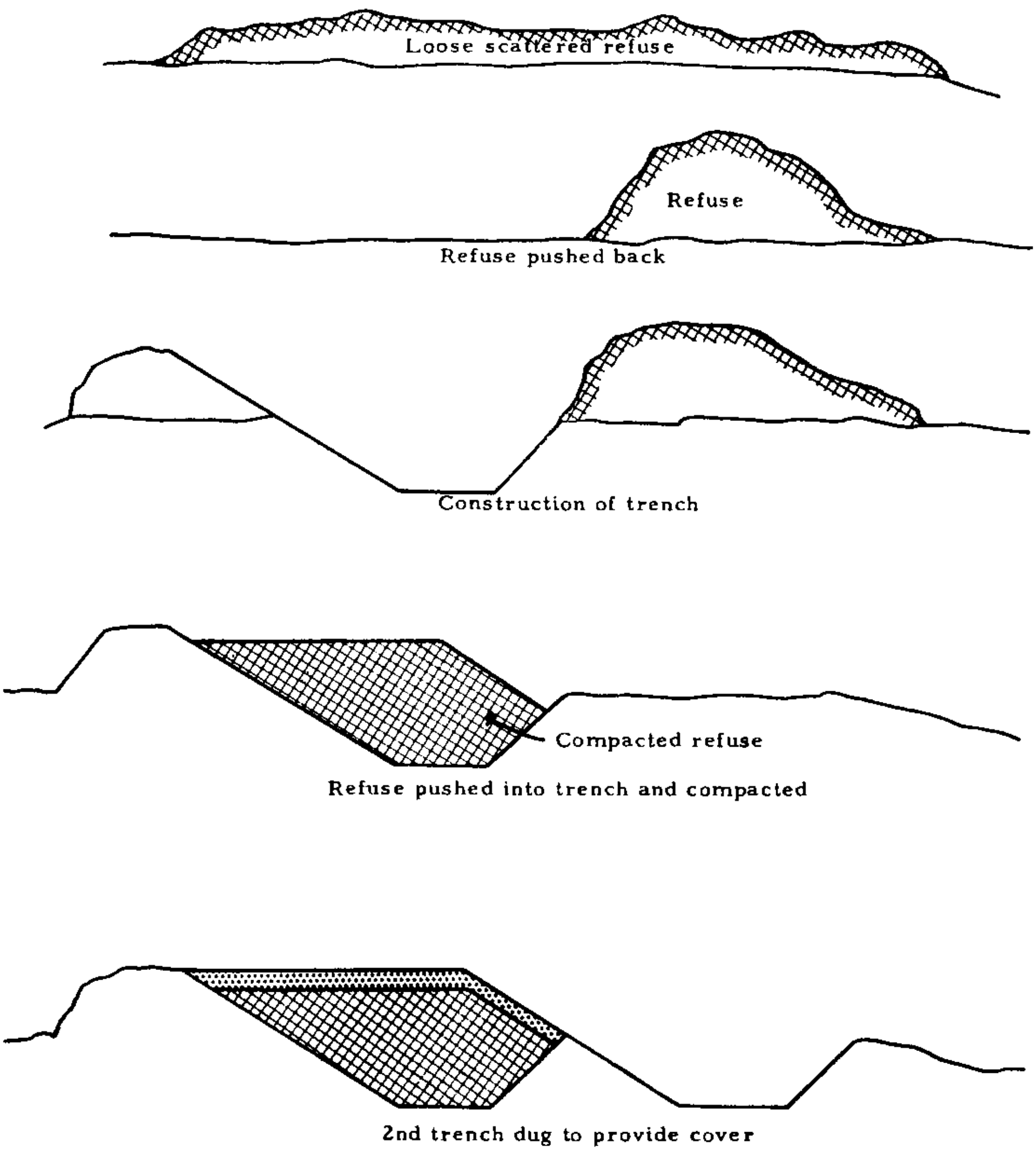

Figure 8–4.—Cleaning up an area dump.

and potash. When pulverized, it serves as a useful fertilizer. A Beccari plant will be as expensive in construction as an incinerator, but maintenance and operating costs will probably be considerably less.

(7) *Reduction.*—The process of reduction consists of cooking garbage under steam pressure for the recovery of grease and tankage. Solvents may or may not be used. Separate collection is required.

(a) Plant construction is costly and the process has generally been used only in cities over 100,000 population. For many years the low-market value of the salvaged materials and the high cost of operation have discouraged the use of this method.

(b) This process is partially characterized by the accompaniment of noxious odors with the steam escaping from the cookers. Several plants have been destroyed by fire which was supposed to have resulted from the injudicious handling of solvents.

(8) *Dumping into water.*—In the past many large cities have practiced dumping refuse and garbage into the ocean, large rivers, or other large bodies of water on which they are situated. In sea dumping, the refuse and garbage is first carried out from 5 to 20 miles from shore. This requires considerable equipment—barges, cranes, etc. The practice is falling into disuse generally because refuse is frequently washed back onto beaches where it becomes a nuisance. When disposal is delayed because of unfavorable weather, additional problems arise owing to limited facilities for storing refuse for an excessive length of time.

(9) *Hog feeding.*—Garbage has, perhaps, its greatest economic value as hog feed. Recent surveys by the Public Health Service indicate that more than 50 percent of the cities questioned dispose of all or a part of their garbage by hog feeding. The survey also showed a surprisingly high incidence of trichinosis among hogs which had been fed uncooked garbage.

(a) Swine are subject to many diseases, some of which are readily communicable and may cause loss from high mortality and morbidity rates. They are susceptible, also, to infestation with different kinds of parasites, most of which live in various passages and organs within the body. Young pigs are most easily injured by such parasites, which take part of the nourishment that would otherwise be used by the pig in putting on flesh.

(b) It is estimated that one million head of swine in the United States are fed raw garbage as all or part of their regular diet. Raw pork scraps may, and often do, contain the causative agents of various diseases in swine. Other garbage materials are also capable of carrying disease organisms. It is generally considered that feeding untreated garbage to hogs is a common method of spreading hog cholera, foot-and-mouth disease, vesicular exanthema, trichinosis, and in some instances, tuberculosis, swine erysipelas, and stomatitis. The disinfection of garbage in a manner sufficient to destroy viruses and bacteria, which are contained in parts thereof, offers a solution to the control of these diseases.

(c) Unfortunately, the practice of feeding untreated garbage to swine helps to perpetuate one of the most important parasitic diseases of man in the United States. It has been stated by some authorities that trichinosis is more prevalent in this country than anywhere else in the world. Its occurrence is associated to a considerable extent with the above-mentioned practice.

(d) Recently, the United States has experienced an outbreak of vesicular exanthema which is believed to have spread from California (where it had been endemic for 20 years) to 25 other states. Although this disease is considered nonpathogenic for man, and the mortality rate is not high, it is causing grave concern to the livestock industry because of financial loss resulting from decreased weight, retarded growth, abortions, and secondary infections among swine. Although it is recognized that heat treatment of garbage is not the only element important to control or eradication of this and other diseases of swine, it is believed to be an essential element of such a program.

(e) *Laws controlling garbage as hog feed.*—Several of the States—Florida, Kentucky, Louisiana, Nebraska, New York, Oregon, Washington, and Wyoming—have laws or regulations controlling the use of garbage as hog feed; the Territories of Alaska and Hawaii have regulations. Each State has expressed its requirements in different terms, but a review of these laws reveals the maximum requirement to be disinfection by heating the garbage to 212° F, and maintaining that temperature for at least 30 minutes. The Territory of Hawaii further requires that garbage so "boiled" shall afterwards be "cooled slowly so that every part thereof shall have been at the boiling point of water for at least 30 minutes." Actually, the time required for cooling to a satisfactory temperature for feeding is further insurance of adequate heat-penetration of all garbage particles, and the practice of permitting slow cooling is endorsed by the Department of Agriculture and the Public Health Service.

(f) *Garbage in interstate traffic.*—The attention of naval activities planning the sale of garbage for hog feed should be directed particularly to the requirement of the Public Health Service that such garbage be "cooked" prior to entering interstate traffic. Regulation 72–25 of the Interstate Regulations of February 1948, provides, in part,

A person shall not transport, receive or cause to be transported or received, garbage in interstate traffic (cross a State line) and feed any such garbage to hogs, unless, prior to feeding, such garbage has received minimum heat treatment, which is defined in the Regulations as "causing of all particles of garbage to be treated to a boiling temperature and held at that temperature for a period of not less than 30 minutes."

(g) *Hog farm sanitation.*—Frequently, contracts for the sale of garbage to farmers for use as hog feed include a clause requiring inspection and approval of the hog farm by the medical officer. There are certain principles covering the operation of a hog farm which should be observed if the requirements of good sanitation are to be met. Briefly, these are:

(*1*) Swine should not be given garbage or similar food on the ground. Suitable feeding floors or platforms, preferably of concrete, and troughs of nonabsorbent material that can be cleaned, washed, and disinfected frequently should be used.

(*2*) A supply of clean drinking water should be available at all times. Some type of automatic drinking fountain which does not overflow is preferable.

(*3*) The solid wastes and manure should be removed daily from hog pens. Disposal of the wastes should be by burial, incineration, or composting for fertilizer.

(*4*) The liquid wastes, including wash water and urine, should be disposed of in such a manner as to avoid their polluting the receiving waters, and their becoming a nuisance or health hazard when disposed of on land.

(*5*) The hog-raising operation should be maintained rodent-free by the provision of ratproof construction for the various structures on the hog farm, the elimination of rat harborages, the removal of sources of rodents' food, and eradication procedures.

(*6*) The hog-raising operation should be maintained free of flies. This is achieved basically by good sanitation, but may be supplemented by the use of insecticides.

(*7*) The farrowing houses and sleeping quarters should be located on well-drained ground, should be kept thoroughly clean, and should be supplied with fresh bedding at frequent intervals. In addition, they should have tight roofs and good ventilation without drafts. The floors should be thoroughly cleaned and disinfected at least once every 2 weeks.

(*8*) Hog pens should be hosed down or dry cleaned daily, to remove any accumulation of waste food, manure, or other matter that would tend to make the area insanitary.

(*9*) Hog wallows should be constructed of such material, and should be so designed, as to permit easy and frequent cleaning.

(*10*) All barnyards and lots on which hogs are kept should be plowed at least twice a year, as an aid in the disinfection of the premises. It is desirable that yards which are much used by hogs be so arranged that a change can be made every year or two to fresh ground.

(10) *Open dumps.*—The dumping of mixed refuse containing garbage in isolated spots has been practiced widely. As long as sufficient low-cost land is available within a reasonable distance, the practice will have many advocates for reasons of economy. The objections to it are so numerous that most cities are realizing the necessity for finding other methods of disposal. The gradual urbanization of the country is making it increasingly difficult to find acceptable dumping grounds without excessive hauls.

(a) Open dumps are not satisfactory to health authorities since they provide ideal breeding places for rats and other vermin, and usually constitute both a fire hazard and a smoke and odor nuisance. In addition, the nuisance afforded by an open dump may be expected to reduce property values in the vicinity.

(b) The Bureau of Yards and Docks does not advise the practice of open dumping at naval activities. Open burning of garbage and rubbish, as in an open pit or trench, is undesirable because it is a fire hazard, creates smoke and odors, and encourages the breeding of flies, mosquitoes, and rodents when the unburned residue is not promptly compacted and covered with inert material.

8–43. Field Disposal

(1) Refuse disposal in combat or maneuvers

(a) Garbage disposal in the field is usually a difficult problem. Separate collections of garbage, combustible rubbish, and noncombustible rubbish are preferable, so that when military conditions permit, combustible rubbish can be burned. Noncombustible refuse consists primarily of tin cans which must be flattened or otherwise treated before being placed in containers, so that they will not hold water in which mosquitoes may breed. The most practical method for disposing of large volumes of garbage is the sanitary landfill, in which other types of refuse may also be buried. Small amounts of garbage are buried in a trench and immediately covered with at least 2 feet of earth, the surface of which is then sprayed with an insecticide, usually 5 percent DDT in diesel oil. Garbage dumps should be situated at least 1,000 yards distant from living areas. Garbage—even in small quantities—may attract birds, insects, and animals, thereby revealing the location to the enemy. Care must be taken that careless operators do not scatter even small fragments, and that they bury all portions.

(b) When conditions permit, disposal by dumping in the ocean is satisfactory.

(c) Incineration, by means of facilities especially designed for the field, frequently is satisfactory if fuel is available and if the operation can be supervised to insure complete reduction of the garbage to ashes.

(d) Before departure from a camp site, all sanitary installations must be closed and left in a condition that will not foster insects and rodents. These installations should be filled, covered with earth, and treated with larvicides and rodenticides. Where military security is not violated, such areas should be marked with signs to indicate the nature of the sanitary installation and the date of closure. In the posting of the date, a number should not be used to indicate the month. The sign should read, "Dump closed 3 September 1954," not "Dump closed 9–3–54." To some people, the latter expression means March 9 instead of September 3.

REFERENCE

1. Refuse Disposal. *NAVDOCKS TP–Pu–1.*

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MANUAL OF NAVAL PREVENTIVE MEDICINE

CHAPTER 9

VECTOR CONTROL

DEPARTMENT OF THE NAVY

BUREAU OF MEDICINE AND SURGERY

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CONTENTS

Chapter 9

VECTOR CONTROL

Section I. NAVY ORGANIZATION FOR VECTOR CONTROL

9–1. Definition of Vector

(1) The term vector is used to refer to all insects, rodents, and related organisms which play a significant role in the transmission of disease to man, act as intermediate hosts or reservoirs of disease, present problems of sanitary or hygiene significance, or otherwise affect the health and efficiency of personnel. Included are such organisms as mosquitoes, biting flies, filth and flesh flies, lice, bed bugs, fleas, mites, ticks, reduviid bugs, rodents, and bats. Noxious organisms not ordinarily associated with specific diseases, such as cockroaches, ants, wasps, spiders, scorpions, and food-infesting insects, may be considered as vectors wherever the medical department finds that they present problems of sanitary or morale-affecting significance.

(2) Organisms destructive to structures, stored products, grounds, and other material properties are classified as "economic pests." Unless their presence has a public health significance, as detailed above, organisms important to man simply because their presence is objectionable are included in this classification. For information on economic pests, as well as additional vector species information, refer to the publication, NAVDOCKS TP–MO–310, *Pest Control.*

9–2. Command Responsibility

(1) Department of Defense Directive 4150.7 of 7 June 1955 outlines standards for insect and rodent control and related fields. These standards require that military departments maintain safe and economical pest control procedures supervised by trained and certified personnel. SECNAV Instruction 5430.54 of 27 December 1961 outlines the responsibilities and functions of the various offices, bureaus, and commands of the Department of the Navy, and establishes policies for the maximum effectiveness, efficiency, and safety in pest control operations.

(2) The commanding officer of each activity of the Department of the Navy bears basic responsibility for the maintenance of an adequate vector and economic pest control program. Normally, these responsibilities may be delegated to the medical and public works departments.

(3) The public works department is responsible to the commanding officer for all operational phases of the activity vector and economic pest control program.

(4) The medical department is responsible to the commanding officer for the determination, through appropriate surveillance techniques, of the extent that vector organisms may affect the health and efficiency of command personnel.

9–3. Specific Responsibilities of the Medical Department

(1) Specifically, the medical department is responsible to the commanding officer for:

(a) Inspections and surveys to determine the species, source, location, and density of vectors.

(b) Recommendations relating to sanitation standards and practices affecting the presence and abundance of vectors and to vector control methods.

(c) Evaluation of the effectiveness of vector control measures.

(d) Inspections and instructions to assure that pesticides are used safely in accordance with current directives.

(e) Utilization of all appropriate personal protective measures against vectors.

(f) Coordination with civilian and other governmental agencies having vector control problems that may affect naval personnel on or in the vicinity of a command.

(g) Compliance as required with all appropriate public health quarantine measures.

(2) The medical department may be additionally charged by the commanding officer with responsibility for all operational phases of the vector control program, as follows:

(a) In the event of a vector-borne disease outbreak.

(b) In the absence of a public works type department, such as at certain shore installations, on board ships, and with troops in the field.

(c) In the control of vectors actually existing on humans (lice, scabies, mites, etc.).

(d) In disasters.

(3) Vector control centers and preventive medicine units, when authorized by proper authority, may conduct vector control operations for the purpose of training personnel; field testing new methods, materials and equipment; or providing area-wide vector control services that involve the use of specialized equipment.

The Disease Vector Control Center, U.S. Naval Air Station, Jacksonville, Florida, is assigned responsibilities in the Eastern Sea Frontier, the Caribbean Sea Frontier, Naval Districts 1 through 9, and the river commands.

The Disease Vector Control Center, U.S. Naval Air Station, Alameda, California, is assigned responsibilities in the Western Sea Frontier, Naval Districts 11 through 14, and Naval District 17.

Medical entomologists are also located in each of the preventive medicine units and in certain of the research units.

(a) Functions of the Disease Vector Control Centers:

(1) Provide technical assistance with problems relating to vector prevention and control.

(2) Accomplish surveys of ships, stations, and other pertinent operational areas for the purpose of recognizing, defining, and preventing or abating vector problems of naval importance.

(3) Conduct special studies where required to facilitate vector prevention and control.

(4) Provide specialized area-wide operational services for the control of vectors where accomplishment is normally beyond the scope of individual commands.

(5) Prepare and provide locally adapted written guides on the survey, identification, biology, and control of vectors and pests.

(6) Provide basic, advanced, and refresher training in vector and economic pest prevention and control for military and civilian personnel. Certification of vector control personnel engaged in vector or pest control will be done in accordance with DOD Directive 4150.7 and SECNAV Instruction 5430.54, and may be coordinated with the public works certification training. Training concerning economic pest control will be coordinated with the Bureau of Yards and Docks or its designated representative.

(7) Provide aid, consistent with their mission and when authorized by appropriate higher authority, in the event of emergencies or disasters.

(8) Identify suspected entomological vector agents of biological warfare.

(9) Provide review of requisitions for nonstandard and controlled issue economic pest and vector control items as established by current directives.

(10) Provide specialized vector survey and control items, including appropriate maintenance service thereof, where such are not normally available.

(11) Conduct field and laboratory research, development, and testing studies in vector prevention and control as practicable and when authorized by the Bureau of Medicine and Surgery.

(12) Maintain such liaison with governmental and civil agencies as necessary for the accomplishment of their mission.

(b) Functions of Entomologists Attached to Preventive Medicine Units:

(1) Within the primary mission the entomologist has the same functions as those given for Disease Vector Control Centers in paragraph (a) above, subject to the limitations imposed by laboratory facilities and availability of funds.

9–4. Public Works Entomologists

(1) Entomologists are on the staffs of District Public Works Officers in various Naval Districts. These personnel are available for consultation, and in the absence of a medical entomologist will be utilized for both vector and economic pest control as necessary. The Directors of Bureau of Yards and Docks Overseas Divisions may be contacted for technical assistance on problems outside the continental limits of the United States.

9–5. Additional Personnel and Training

(1) Sanitation officers (NOBC–0811, or equivalent MEDSERVWRNT) and Environmental Sanitation Technicians (ENJC–8432) are specially trained to assist the medical officer with the accomplishment of the vector control responsibilities of the medical department. When utilized in this connection, these personnel are required to obtain certification in pest control operations in accordance with current Bureau of Yards and Docks directives. Specialized vector and pest control training leading to certification is available at the two Disease Vector Control Centers and at district and area level headquarters. In the same manner, refresher courses may be obtained for recertification.

9–6. Special Operating Units

(1) *Advanced base functional components.* Trained supervisory personnel and materials are provided in the Navy advanced base organization by the following components:

(a) *G–17 Vector Control Component.* The G–17 Component, headed by a medical entomologist, is designed to provide survey, coordination, and overall direction of vector control in an area.

(b) *G–19 Vector Control Material Component.* The G–19 Component supplements the G–17 with additional supplies, equipment, and technicians where required for more expanded control operations. The required number and type of components or portions of components must be determined, according to anticipated operations, by staff medical officers responsible for advanced base planning. Equivalent vector control components are included in Fleet Marine Force preventive medicine units.

(2) *Disaster Control Vector Survey Team (Code ML).* Within the medical element of the disaster control structure of the United States Navy (see *U.S. Navy Disaster Control Manual*), provision is made for a Vector Survey Team (Code ML). By this means, the early detection of vector problems resulting from the occurrence of enemy-caused catastrophes is made possible. Additionally, this team may be activated for service in connection with the occurrence of natural disasters.

9–7. Control Items and Methods

(1) *Materials and equipment.*—Department of Defense policy requires that only standard issue pesticides and dispersal equipment normally will be used in vector and economic pest control operations by the military services. These items are all listed in the *Federal Supply Catalogue.* Where nonstandard items must be used, approval of higher authority is required. Details for obtaining approval are set forth in the *Bureau of Supplies and Accounts Manual* under the heading "Pesticides and Pest Control Equipment" and in current Department of the Navy directives of the 6250 series. United States Navy standard materials and equipment and their uses are treated in chapter 10 of this manual.

(2) *Dispersal methods.*—The dispersal of insecticides is fully discussed in chapter 10. It must be borne in mind, however, that local conditions will vary widely in the Naval Establishment and that modification of methods frequently may be necessary.

9–8. Proper Handling of Pesticides

(1) With very few exceptions, pesticides are toxic to warm-blooded animals; thus their use shall be attended with care and foresight. A full treatment of safe and proper use of pesticides is presented in chapter 11 of this manual and constant reference shall be made to it when pesticides are applied.

(2) The development of resistance to insecticides by insects of medical importance continues to be a problem, and from time to time it becomes necessary to recommend the use of new materials. Standardization and central stocking of such items are accomplished as rapidly as possible. However, it may at times be necessary to recommend the use of nonstandard materials. Where the use of such insecticides is believed to be required, the assistance or advice of specialist personnel shall be obtained first.

Section II. VECTOR CONTROL AT SHORE INSTALLATIONS

9–11. Shore Installations

(1) Insect and rodent control at shore installations is fully treated in NAVDOCKS TP–MO–310, *Pest Control,* and will not be further discussed in this manual. The two manuals should be used at all times as companion publications since much of the information presented in the former manual will apply to situations other than at shore installations.