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## **Sewage systems on ships: associated hazards, installation and maintenance**

Guidance to shipowners, charterers, ship builders and repairers, masters, fishing vessel owners, and skippers

*This Note supersedes Merchant Shipping Notice M1548, which is hereby cancelled*

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1. This Guidance Note draws attention to the hazards that can arise from unsatisfactory designs of sewage systems and from the maintenance and operation on board of all sewage systems.

### **Background**

2. Different systems for the disposal of sewage may be found on ships such as -

- (a) collecting system: discharge from the toilet bowls into drains collecting all such discharges which are led to the ship's side and overboard through storm valves;
- (b) collecting and storage tank system (with or without aeration facilities): sewage is collected as above but is led into storage tanks, where it is retained for disposal ashore or at sea;
- (c) sewage treatment systems: a combination of collecting and treatment tanks, with processes designed to break down the sewage into effluent suitable for discharge into the sea without harmful effects;
- (d) vacuum collecting systems: where the system is maintained at reduced pressure and operation of a valve at the toilet pan causes air, sewage and flush water to be drawn through piping to the holding tank. (Treatment tanks are generally at atmospheric pressure).

3. When sewage is flushed from toilet pans it enters the drainage pipelines and storage tanks where it is broken down by naturally occurring bacteria; this is an aerobic process which strips oxygen from the water, producing more water, carbon dioxide and new bacteria. If sufficient oxygen is not present, alternative bacteria become dominant and the process becomes anaerobic with the production of gases including hydrogen sulphide, methane, ammonia, etc. These gases have highly toxic and flammable properties, in particular, hydrogen sulphide is toxic to humans in concentrations as low as 10 parts per million and its flammable vapours are heavier than air so that potentially lethal pockets of gas may accumulate in enclosed spaces.

### **Safety Parameters**

4. The generation of toxic and explosive gases in the event of anaerobic conditions is present to different degrees in each system. It is evident from the foregoing that anaerobic conditions in sewage systems leading to the production of toxic and flammable gases is an unacceptable hazard within the confined boundaries of a ship.

5. Various safety features can be incorporated in the design and operation of a sewage system. These are described below, but in general barriers between the sewage gases such as the water traps of the toilet bowls, ventilation of the pipework and tanks, etc., should only be considered only as providing secondary measures of protection: the prime safety feature is to prevent the production of hazardous gasses within the system in the first place.

## Storage and Treatment Tanks

6. (a) Sewage may be collected in storage tanks, either for holding prior to transfer to a treatment unit, or for later discharge. Any tank used for holding sewage is a potential source of anaerobic activity, and the resultant production of toxic and flammable gas. The design of a tank may include features for maintaining an adequate oxygen level in the liquid so as to eliminate anaerobic conditions. These are based on direct air injection, or by air entrainment into the liquid whilst pumping through an injector nozzle.

(b) When not equipped with an active aeration feature the conditions within the storage tanks should be monitored. They should be completely emptied and flushed through at intervals not exceeding 24 hours unless some other treatment is used which maintains satisfactory conditions.

(c) Where treatment systems use the aerobic digestion process, or other means to purify the effluent the manufacturer's recommendations for operation and maintenance should be followed to ensure satisfactory operation at all times. All tanks and associated systems should be subjected to a thorough inspection when unsatisfactory conditions prevail, or at not less than annual intervals. Such inspections should include the -

- (i) removal of tank inspection covers and cleaning out any deposits, paying particular attention to areas behind internal tank division;
- (ii) inspection of tank structure, internal divisions, pipework and internal coatings to ensure they remain in satisfactory condition;
- (iii) checking of sensing instruments, level measuring devices and valves to ensure they are operating correctly;
- (iv) confirmation that air distribution systems are free from leaks and any nozzles or diffuser elements used to introduce air are in satisfactory condition;

(v) check that any systems used to transfer tank contents are operational;

(vi) inspection of any air blowers fitted including a check on whether the discharge pressure is within allowable limits and if any relief valve fitted they are not leaking;

It is recommended that any alarms fitted to air blower systems operate on sensing of air pressure rather than on the monitoring of electric motors, otherwise failure of fan belts between fans and electric motors may not be detected.

## Tank Ventilation Arrangements

7. Ventilation pipes to collection, storage and treatment tanks should be in good condition, clear from internal obstruction, and of an adequate size to minimise pressure drop and to ensure satisfactory clearance of gases. The size of the vent pipes should also be sufficient to vent any air from blowers, or from vacuum collection system discharge system.

The manufacturer's recommendations should be followed for treatment tanks.

Vent pipes should be arranged to be self draining at all angles of heel and trim, to eliminate any water traps that may otherwise form and cause back pressure. Any flame gauze or other fittings on the vent terminal should be checked for cleanliness.

## Toilets, Showers, Washbasins, etc.

8. Check all drain pipes for satisfactory water/gas tightness and adequate water seals and traps to prevent backflow of sewage gases into the toilet compartments. Check that all sanitary fittings are securely fastened to prevent relative movements at pipe points. Toilet pans incorporate a water trap and are often fitted with vacuum breaking arrangements at the back of the trap such as individual air pipes or patented backflow prevention valves. Check for satisfactory condition and operation. Ensure there is an adequate supply of flush water to clear toilet pan and to replenish the water seal.

## Drainage and Ventilation Pipe Systems

9. Check that drains and their air vents are clear of obstruction and are in sound water/gas tight

condition throughout their length and are self draining at all expected angles of heel or trim. Adequate air vents should be fitted to the piping network, paying special attention to the extremities of the system. These should ensure an adequate supply of air and obviate any tendency for plugs of water that may form within the system tending to syphon or create vacuums, thus removing water seals, when moving through the pipes especially under the action of violent rolling or pitching.

### **Accommodation Ventilation Arrangements**

**10.** Ventilation systems to all compartments of a ship should be designed, installed and balanced to ensure satisfactory distribution of air. They should be maintained in a clean and efficient condition to achieve the designed air changes throughout the service life of the vessel.

**11.** Particular attention should be paid to the exhaust or extraction systems in toilet or washing areas. In general, attention should be paid to the -

- (a) extraction grilles, louvres, ducts, etc. in order to ensure that they are clear and free of accumulations of dirt, fluff, etc;
- (b) adjustment of extraction louvres or cones to ensure an even extraction rate from all spaces. However, once satisfactorily adjusted, there should be no interference with these units as the adjustment of one unit can seriously affect the rate of extraction through other units. The design of these fittings should be such that they are not capable of manual adjustment without these of special tools or equipment;
- (c) extraction units to ensure they are not blocked off;
- (d) air extraction from alleyways to ensure it is operating efficiently and that essential airgaps under cabin doors, etc. have not been blocked off;
- (e) the forced ventilation of cabin spaces to ensure it is operating efficiently;
- (f) associated elements of ventilation systems, including -
  - (i) fans - to check direction of rotation, condition of impellers, etc;

(ii) flaps and dampers - to ensure that they have not become detached from the operating mechanisms and that they are actually open when indicating open;

(iii) goosenecks and vents - to ensure that they are clear of any obstructions, that grilles or meshes are not painted over, etc. They should be situated clear of decks to which personnel have general access and clear of sources of ignition;

(iv) piping or ducting - to ensure that these are intact and free from leaks throughout their length, especially where they pass through accommodation areas.

### **Operational Aspects**

**12.** The use of large quantities of disinfectant toilet cleaners may destroy the bacteria which are essential to the operation of aerobic sewage treatment plants. The makers of the treatment plant should be contacted for their recommendations, and only approved cleaners used at the correct concentration.

**13.** The officers and crew should be made aware of the possible generation of gases from sewage systems and the dangers of the gas finding its way into working and living spaces. There should be operational procedures for recording the inspections and maintenance of the sewage system and the action taken to deal with complaints of foul or musty smells due to toxic or oxygen-depleted gases.

### **Communications**

**14.** The contents of this Note should be brought to the attention of all shipboard personnel engaged in the day-to-day operation of the vessel to ensure it is fully understood, this is particularly important where multilingual crews are employed.

**15.** The attention of all personnel engaged in maintenance work on sewage systems should be drawn to the hazards of encountering oxygen-depleted, toxic and flammable gases when entering sewage tanks or working on the system. The precautions detailed in the Marine Safety Agency's Code of Safe Working Practices should be observed as appropriate.

16. The International Maritime Organization is currently considering whether international standards should be developed for the design and inspection/survey of ships' sewage systems. Until such time as international requirements are adopted the advice contained in this Note should be followed.

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August 1997

MS 7/12/0832

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