SEAHEALTH

DRINKING WATER – ON BOARD SHIPS

A guidance about how to provide clean drinking water

Thank you to the observer group:

- Danish Maritime Authority
- Danish Health and Medicine Authority, Medical Office by Henrik Hansen, The Region of Southern Denmark
- DHI
- The Danish Shipowners' Association
- The Shipowners' Association of 2010
- CO-SEA, Danish Metal Workers
- Danish Engineering Association
- Danish Seamen's Union (3F)
- 3F (United Federation of Danish Workers)
- DFDS
- DS Norden
- J. Lauritzen
- Maersk Line
- Maersk Supply Service
- Maersk Tankers
- Nordic Tankers
- Royal Arctic Line
- Scandlines
- Svitzer
- Torm
- Uni-tankers

Thanks to suppliers and other players for their contribution to this guidance.

Sources:

Order No. 593 of 7 June 2013 on Danish Maritime Authority Notices B – construction and equipment of ships (Notices B 2013). Rule 20.

European Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption, as amended 18 June 2009

Guide to Ship Sanitation, third edition, WHO, 2011

European Manual for Hygiene Standards and Communicable Diseases Surveillance on Passenger Ships, European Commission, Directorate General for Health and Consumers, Work Package 5, Deliverable: 9 Dec. 2010

About threshold limit values:

The guidance uses the European threshold limit values. Some parameters lack a European threshold limit value. In these cases there is chosen a Danish threshold limit value instead of a threshold limit value from WHO. The Danish threshold limit values are the lowest, after them come the European threshold limit values and at last the threshold limit values from WHO. WHO have however far more threshold limit values; for instance threshold limit values for many pesticides.

Contents

Publisher: Seahealth Denmark
Responsible Editor: Connie S. Gehrt
Written & edited by: Anne Ries & Bo Jacobsen, Seahealth Denmark
Eva Thoft, TeamArbejdsliv
Graphic design: martinsonnedesign
Printed by: Grefta Tryk A/S

ISBN: 978-87-92084-30-9

1. Clean drinking water - a necessity for life

Clean drinking water is a special challenge on board a ship. It either has to be made from seawater or loaded on board when in port. So it is absolutely essential that the water produced or loaded on board is clean and that tanks and pipe systems are also clean.

This is why there are rules for the quality of drinking water on board.

This guidance tells you how to do so in practice, i.e. how the captain, chief engineer and the rest of the crew can ensure that the quality of drinking water is satisfactory and complies with applicable requirements.

"It shall be ensured that drinking water on board (used for human beings) is of satisfactory quality and suitable for the purpose. It shall be possible to document this by means of regular analasys held up against international standards"

Danish Maritime Authority Notices B of 7/6-2013 Ch. 11-3 Rule 20.2 (The Danish authority implementing MLC – Maritime Labour Convention)

What is drinking water?

All water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers.

EU Directive 98/83/EC of 3 November 1998 on the quality of drinking water

Note that this definition also covers water for other domestic purposes, such as personal hygiene – tooth-brushing, showering, etc.

This guidance has been drawn up on the basis of current experience at the time of production. Seahealth will regularly monitor feedback on the guidance and revise and amend it as and when required.

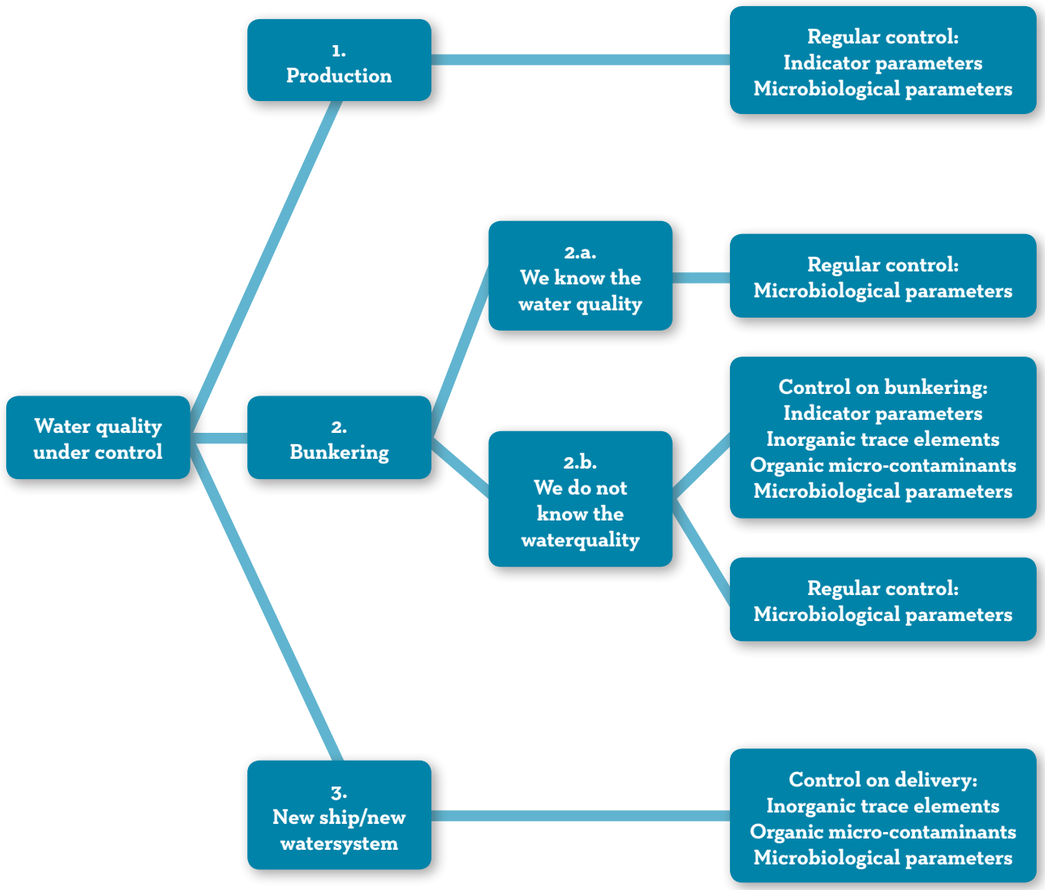
Clean drinking water demands awareness

There are four aspects to clean drinking water on board that require special attention:

- What is the quality of the water produced or loaded on board?
- What are the risks of water being contaminated and how should the water be treated?
- How should you routinely monitor that water is clean?
- What should you do if it is not clean?

There are differences between what you should do, also depending on how you have loaded water on board. The figure below gives an overview.

Overview of what should be checked in different situations.



2. Control and sampling

To prevent anyone from drinking or using contaminated water, drinking water must be regularly analysed.

The schedule below shows the drinking water analyses you should undertake in various situations. It is also necessary to analyse drinking water if work has been done on the freshwater tanks.

Annex 1 lists the specific substances/micro-organisms for which water should be tested and the threshold limit values for these substances/ micro-organisms. You can compare your own results with these threshold limit values.

Parameter **What should be meassured?**	**1.** **Production from seawater**	**2.a** **Bunkering** Water quality is known and acceptable. You are able to get documentation for water quality	**2.b** **Bunkering** Water quality is unknown	**3** **New vessels or if work has been done on the drinking water system**
Indicator parameters e.g. salt, pH, iron	Annual control		Control	
Inorganic trace elements e.g. lead, copper, zinc			Control	Control of metals, especially for new buildings
Organic micro-contaminants e.g. pesticides, organic compounds			Control	Control of organic compounds from coating
Microbiological parameters Determination of bacteria count, coliform bacteria, E. coli	Annual control	Annual control	Control - and annual control	Control on delivery and after repairs
Additives for further treatment Chlorine/silver salts or other additives	Annual control	Annual control	Annual control	

Periodic tests

Water quality must be checked at least once a year.

1. **If water is produced on board,** it must be analysed to see that it has the normal physical /chemical properties for drinking water (indicator parameters) and microorganisms such as bacteria like E. coli.

2a. **If you have bunkered good quality water,** you can make do by analysing it once a year for the development of microorganisms.

2b. **If you bunker water of unknown quality,** it must be analysed thoroughly - i.e. for indicator parameters, inorganic trace elements, organic micro-contaminants and microorganisms. This should be done everytime. If topping up a tank with bunkered water, treat it as for bunkered water.

3. **If freshwater tanks have been coated** while in dock, be aware that in some cases coatings can contaminate drinking water by way of organic micro-contaminants.

However, this is rarely a problem now because nowadays products are available that are approved for use in drinking water tanks. This means they do not release harmful substances in high concentrations into the water, provided that the shipyard complies with curing times and the requirements for degassing before delivery.

The company must basically require products used for coating to be approved for the purpose.

These may be products approved for instance by one of the organisations below:

- US National Sanitation Federation
- Norwegian Institute of Public Health
- UK Water Regulations Advisory Scheme
- American Water Works Association
- Australian Water Quality Centre
- Empresa Portuguesa das Aguas

If an unapproved product has been used or if you are doubtful about the shipyard's quality standards, you should analyse the water. See Annex 1. 1.C.

On many ships, chemicals are added to water to prevent the growth of microorganisms. If you do so, it is also important to check for these chemicals and their derivatives (what they can be converted to). So at least once a year, there must be an analysis and their concentration must not be either too high or too low.

If something is suspected

There is actually no guarantee that contamination will not have occurred between the periodic tests. This is why it is important to be aware and react if anyone suspects that the water might be contaminated. This can be a reason for having an analysis done between the periodic checks.

3. Sampling and testing

When it comes to periodic testing which involves complex chemical and microbiological tests, samples should be taken and analysed by an accredited laboratory. They have the right equipment and qualifications. It is also possible to buy test kits so that crew can take samples and analyse water samples on board.

It is a good idea to be completely aware of the advantages and disadvantages of doing your own tests and analyses. Check what equipment and qualifications are required to achieve reliable results. For example, microbiological analytical samples require an incubator, special sterile glass, and special bottles of PE must be used for chemical testing. It is also a requirement for crew to have been instructed in the correct way to carry out tests and to use disposable gloves to prevent samples from being contaminated. Futhermore samples should be kept at 2-10°C for transport and examined within 24 hours.

If sampling is done by an accredited analytical institute, it will often be done in port and the results usually sent on after departure. Results should possibly be retested in the next port.

It can be a good idea between periodic testing to do occasional analyses to determine whether the water is contaminated. Checking such indicator parameters as pH and conductivity does not require advanced equipment. Both parameters generally reflect the quality of water.

How to take samples
At least one water sample is to be taken from a tap in the galley. If you have the option of doing several analyses, it is a good idea also to take samples at water tank outlets if this is feasible. This enables you then to check whether any contamination of the water has occurred in production, storage or in the distribution system.

The safety committee may also have proposals for relevant places to take samples from.

Taking samples
If you take samples yourself, it is important to be very careful and follow the sampling kit directions exactly. Use sterile flasks, sterilise the tap from which the water is to be taken (alcohol cleaning) and use gloves so that water is not contaminated by dirty fingers. Otherwise it is not the quality of the water you are measuring but the contamination on your fingers, on the tap or flask.

4. When you get results

Water analysis must comply with a range of threshold limit values. The laboratory will write a report to say so or that threshold limit values have been exceeded. You will probably find that threshold limit values get exceeded once in a while. Be aware that threshold limit values vary from country to country. The threshold limit values you should use for comparison are given in Annex 1.

If the test shows that water is contaminated
The greatest risk in drinking water is microbial contamination from human or animal waste. Other high readings need not be an urgent problem.

The threshold limit value of E. coli is exceeded:

- **Immediately provide clean drinking water**
  Acquire clean drinking water – this also applies to water used in the galley and for personal hygiene. The options are for drinking water to be boiled or bottled.
- **Drain and disinfect the system**
  See Annex 2 on cleaning/chlorination, Rule 20.1.11 in Notices B – Danish Health and *Medicines Authority Guidance. Be aware that it is only a cleaning procedure, not a chlorination maintenance procedure.*
  If this fails to help, please contact Seahealth.
  The cleaning procedure must also be followed for new ships and after a stay in dock, and also if work has been done on the tank or there has been an inspection.
- **Identify the source**
  Inspect the water supply system to identify the source of contamination. In the chapter Sources of contamination and prevention p. 11 you can see possible sources.
- **Take additional water samples:**
  - Of water ashore
  - From the bunkering hose
  - In the tanks before the filter(s)
  - In the tanks after the filter(s)
  - After hydrophore, water softener equipment if using this
  - After UV system if using this
  - From the most remote taps
- **Remove the source of contamination**
  For instance maintain the water system, bunker water from somewhere else, depending on the source of contamination.
- **Contact Seahealth if the above do not help**

Other microbial contamination and contamination by organic and inorganic substances and if threshold limit values for indicator parameters are exceeded

In such instances, exceeding the threshold limit value may not necessarily be an urgent problem. Some threshold limit values reflect the long-term effects. So for shorter periods, slightly exceeding the threshold limit values value can be acceptable.

An excessive bacteria (Aerobic colony) count at 22° C may also be due to the water tanks not being drained and cleaned sufficiently. If may also be due to work having been done on the system recently. Finally, it may be due to contamination from surface water.

Unfortunately, it is not possible to give any simple rules here.

So if threshold limit values are exceeded for anything other than E. coli, proceed as follows:

- Contact Seahealth for advice
- Consider bunkering water from somewhere else with better quality water next time
- See whether you can dilute yourselves out of the problem.

The results from your own samples and the laboratory should be kept on board and also sent to the company. Results should be kept for three years.

5. Sources of contamination and prevention – for different production systems

Sources of contamination differ, depending on the production system used on board.

Drinking water produced on board

There are various processes for producing drinking water on board, such as reverse osmosis or distillation of seawater.

The following may be sources of contamination for ships that make their own drinking water:

- The water you load on board
- Additives
- Leaks and contaminants in the production and storage system.
- Tanks, if they are new or have been maintained.

Seawater can contain microorganisms that are damaging to health such as algae and cyanobacteria and organic micro-contaminants, for example from industrial effluent.

You therefore need to be aware of where you take seawater from. Only use seawater from the open sea – i.e. more than 20 nautical miles offshore. If there is a risk of estuarial pollution you may need more than 20 nautical miles. The makers of the water system often recommend where seawater should be taken from.

When using reverse osmosis or if water is distilled at low temperatures, that is at less than 80° C (176° F) in a fresh water generator, you cannot be certain that the water is free of disease-causing microorganisms. This is why further treatment is required – see section “Further treatment of water” on page 14.

The stars show where contamination can arise

Bunkered water

Insofar as possible, try to bunker drinking water direct from shore and not from a supply ship or bunker barge, which increases the risk of contamination.

The following may be sources of contamination for ships that bunker drinking water:

- Water from ashore
- Shore-based distribution system
- Transfer and delivery system
- Additives
- Leaks and contaminants in the production and storage system
- Tanks, if they are new or have been maintained.

Bunkering in regular ports with known (good) water quality

Get documentation from the shore authority or supplier. Possibly leave this to the agent. Documentation must show compliance at the very least with the threshold limit values in Annex 1.

If you bunker from a waterworks subject to standardised controls, you do not need to get documentation every time. This means that you will be alerted if the water at the works is contaminated.

Check whether contamination could come to the ship from ashore by being transferred, for example by hoses and on board via storage tanks or the piping to taps.

The stars indicate where you should do a risk assessment

Bunkering at places with unknown water quality

Endeavour to obtain documentation and compare it with the threshold limit values in Annex 1.

If you are in doubt or cannot get the necessary documentation, test the quality of the drinking water, meaning that you must have laboratory documentation for the water's:

- Indicator parameters, e.g. cloudiness (turbidity), pH and disinfectant residues
- Inorganic and organic micro-contaminants
- Microbiological parameters.

Samples must be taken before (see the recommendation below on bunkering) or otherwise after bunkering. It takes at least 18-24 hours to get results from the laboratory.

If water quality is unknown, only take it on board if absolutely necessary. You risk contaminating the entire water system and falling ill. Do not use the water until you have received documentation for its quality so that you can see whether the water complies with the threshold limit values. If this is not possible, try to assess the risk of using the water, also on the basis of how confident you are about the place where you bunkered the water.

RECOMMENDATION

Action before bunkering from a fresh water hydrant (tap) on the quay:

- Clean the hydrant on the quay. Make sure all the connectors are clean and there is nothing in the discharge hose. Consider flushing the hydrant for 10 minutes before connecting the fresh water line.
- Clean the fresh water hose coupler and the hose coupler on the ships inlet manifold before connecting.
- Take samples of the water on the quay after running it for 10 minutes.
- Flush the freshwater hose before connecting to the ships inlet manifold.
- Connect the fresh water hose to the inlet manifold.
- Ensure that the fresh water hose runs directly to the inlet manifold and that it does not touch seawater or anything else on the way (although touching the ground or side of the ship cannot be prevented).
- Only use the ship's own fresh water hoses, do not accept other types of hose. Consider using a blue or other coloured hose to stand out from the other hoses on board.
- When bunkering is complete, do not use the tank(s) concerned before getting the test results.
- Remember to replace the caps on the inlet manifold connectors.
- Drain hoses of water and store them properly and dry without contact with contaminated materials.

Further treatment of water

Removing microorganisms
You will need to disinfect the water if you are not certain that the production system is free of disease-causing microorganisms.

There are several methods: UV radiation or membrane filtration, or chemical disinfection with chlorine or silver salts for example.

UV light
UV light is an effective way of disinfecting water. It has the advantage that it does not leave chemical residues such as chlorine or silver behind in the water. Care must be taken to ensure that all water passes directly under the ultraviolet light. The method is not effective for water that does not pass through the ultraviolet light. If water is re-circulated through the UV unit, you can be sure that all water does pass through the ultraviolet and is disinfected. This method is vulnerable if water is very cloudy. It is therefore recommended that an ultraviolet unit should also have integral filtration before the water passes to actual UV radiation.

Chemical disinfection
If chemicals are added to water to be disinfected, such as silver salts or chlorine, the concentration in the water must meet applicable threshold limit values, cf. Annex 1.

Chlorine concentration should be 0.1–0.3 mg/l. If adding chlorine to seawater, a dose of 0.5–1 mg/l should be sufficient, although it may not, depending on the amount of chlorine absorbed by the water and tank. The residual chlorine in the water should therefore be monitored to learn how much is required to achieve a level of 0.3 mg/l after a few hours in the tank. In hotter climates, chlorine degrades faster and it may be necessary to check chlorine levels regularly and more often (3-4 times daily).

When it comes to adding silver, there are two different methods: Dosing silver directly in the water in liquid form, or using a silver anode, which releases silver ions into the water passing through the anode housing.

Removing solvents and chlorine

Charcoal filters
An activated charcoal filter can remove solvents from drinking water. This may be relevant if bunker in drinking water at places where the water may be contaminated with pesticides.
Activated charcoal can also remove the chlorine you have added as a disinfectant. This lets you remove the taste of chlorine before use as drinking water.

Treatments with other chemicals
If you add other chemicals to the water, only use suppliers you trust and who provide safety data sheets. Then you have information about how the chemicals should be used, the health hazards and threshold limit values.

This refers to additives used to regulate pH, hardness and prevent corrosion.

> Insofar as possible, avoid using additives in drinking water. They can be avoided if you are certain that the water loaded on board is good quality and that the system and tanks are monitored and regularly maintained.

New ships and after a stay in dock

The water system must be disinfected if the ship is new or it has been repaired or maintenance has been done on the water tanks and system.
See Annex 2 on cleaning/chlorination, Rule 20.1.11 in Notices B – Danish Health and Medicines Authority Guidance.

Significant health and safety issues

Chemicals and additives for cleaning and disinfection can be harmful to health, some for example are corrosive.

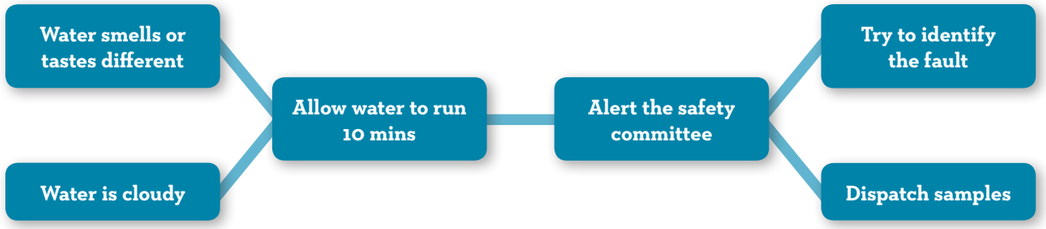
Observe the ordinary rules for handling chemicals and use safety data sheets and workplace instructions for the individual chemicals. Only use chemicals from suppliers you trust.

Be especially aware if working with chlorine. Chlorine can develop dangerous vapours so crew must not be alone when using chlorine or chlorine products.

6. Day-to-day awareness

Everyone on board should be alert to water tasting or smelling different or becoming cloudy. The cook especially should be alert as the person who regularly uses water for cooking.

When should we check the water – apart from regular checks?



So be alert to the following:

- Water should generally be colourless. Sometimes a slight reddish tinge can be seen in water. This is often due to iron, for example from rust flaking from inside the water pipes.
  If it does not disappear after the water has been running for about 10 minutes, investigate where the contamination is coming from.
- Water must be clear and transparent. If the water is not clear, this can often be due to the presence of iron or manganese. If there has been no flow through that part of the pipe system for some time, there may also be biofilm. This means that the water contains microorganisms that in the worst case could make you ill.
- Water must not smell. Since water is stored in tanks the water may acquire taste from the tanks. This can be a sign of chemical contamination from coatings.
- If you detect a smell of “rotten eggs” (hydrogen sulphide) when using the hot tap, it may be due to the lack of maintenance on the hot water system.

The above will alert most crew and get them asking questions. If someone on board is concerned about water quality, they should contact the ship’s safety committee who will then assess whether water should be checked or whether other precautions should be taken.

Most of the health hazards from metals come from leaking from pipes and taps. These problems can be minimized by always letting the water run for a while before using it for drinking, making coffee etc. This is especially relevant if a tap has not been used for some time, but also for instance when using a tap first thing in the morning.

If you do not feel the water is OK:

Allow the water to run for 10 minutes and flush the pipe system. This is also a good idea if you get a cabin, which has not been used for some time.

If this does not solve the problem, contact the safety committee. They will try to identify the source of the problem.

If you cannot immediately identify the problem do or order a water analysis to identify what is causing discoloration or smell, and possibly contact the company and Seahealth for further assistance.

7. Especially about Legionella in hot water system

Preventing Legionnaires disease
It is important to be aware of the hot water where Legionella pneumophila bacteria can develop. This can cause Legionnaires' disease, which is a serious lung infection. Infection is caused by inhaling small droplets (aerosols) of water containing Legionella bacteria. This might for example be in the shower. The bacteria reproduce best in a temperature range of 25-50° C (77–122° oF). So cold water should insofar as possible always be kept at less than 25° C and hot water at over 55° C.

It is never possible to be totally certain that water maintains the right temperature on board a ship. So you should set up a system to monitor and register the temperature in the hot water system. The hot water system should also be regularly flushed (once a year) with water at more than 50° C.

The ship must also have a plan to ensure that pipes, taps and showerheads that are used rarely are flushed every month with water at a temperature of at least 55° C for a minimum of one minute.

Also maintain the heat exchanger outlet temperature at 60° C.

Finally, it is important to ensure there is no backflow from pipes, taps and showerheads that are used seldom, such as in the hospital, Suez room and passenger cabins. This is where Legionella and other microorganisms thrive.

If it is difficult to maintain the right temperature for a lengthy time, you can test to see whether Legionella bacteria have developed.
It is **always** a good idea to let the hot water in the shower run for a couple of minutes before showering.

Legionella in the hot water system

- **Warn the crew**
  Alert them to the danger and ask everyone to let the hot water in the shower run for at least a couple of minutes before showering.
- **Drain, flush and disinfect the system**
  See Annex 2 on cleaning/chlorination, Rule 20.1.11 in Notices B – Danish Health and Medicines Authority Guidance. Be aware that it is only a cleaning procedure, not a maintenance procedure for chlorination.
  If this fails to help, please contact Seahealth.
- **Adjust the hot water system**
  The outlet temperature must be at least 60° C.

8. Guide to prevention

To ensure crew have clean drinking water, the ship should have a plan, meaning:

- How you do a risk assessment on the whole drinking water supply system by identifying risks, critical control points and assessment?
- How you provide routine operational monitoring?
- Which actions must you take if the water quality or the water system is not in order?

Next page is a guide for just such a plan. The points can be included in the system and routines you already have. You do not need to have a separate plan.

GUIDE TO PREVENTION

System

1. Take a copy of the drinking water system from the ship's manual.
2. On the drawing, circle where contamination can occur, such as filters or tank breather vents. That is places where the system can be or is open.
3. Decide how you will prevent water from being contaminated by the various sources of contamination. This might for example be ensuring that the filter is clean before insertion, that the breather vent has a finely meshed screen, that the fresh water generator has been cleaned and other programmed maintenance has been undertaken.
4. Decide whether some of these places should be regularly controlled or whether after routine maintenance. Include the points in the maintenance system and check/inspection lists that you already have.
5. When possible water storage tanks should be opened up, emptied, ventilated and inspected at intervals not exceeding 12 months.

Additional water treatment

1. Register the additives you use in the water and determine the correct amounts of additives to be used. Do so on the basis of the manufacturer's directions in the safety data sheet and enter on the inspection list.
2. Decide and write down where you will take on seawater for fresh water production - or are there special criteria you will establish on board? Get this included in standing orders or the company's SMS.
3. When bunkering, consider which ports of call where you feel the water quality is satisfactory and how you can check the quality subsequently.

Operations

1. Check the taste, smell and clarity of water at the dinner table.
2. Describe what to do if it is felt that taste, smell or clarity are not right, and consider inclusion in the company's SMS.
3. Check that hot water is maintained at 60° C at the heat exchanger outlet and include on the inspection list.
4. On the ship's maintenance system or the company's SMS, enter the tests that are to be taken on drinking water in accordance with the guidance.
5. If you have cabins on board that you rarely use, be aware of the potential for Legionella. So establish a routine requiring showers and water taps to be flushed before use.
6. When you get results from drinking water analyses, keep them on board. Scan them or keep them on file. Check the values and compare them with the values in Annex 1.

If water is contaminated

Make a plan for what to do with water, which is contaminated. Should water be boiled? Will you use bottled water? Do you for example have chlorine on board to decontaminate the system? Get it included in the company's SMS.

Annex 1: Threshold limit values
When is drinking water clean enough?

1.A. Check monitoring and threshold limit values (TLV) for production and bunkering in general
If water is analysed, it must comply with a range of values. The scheme shows the values recommended in the EU Directive 1998/83 EC of 3 November 1998 on the quality of drinking water. The crosses indicate which values you minimum should analyse for.

Indicator parameter

	Production from seawater	Bunkering Water quality is;		Comments	Threshold limit value	Significance
		known and acceptable	unknown			
pH	X	X	X		Between 6.5 and 9.5	pH expresses the acidity of the water. If pH is less than 7, it can corrode tanks and pipework and lead to metals in the water. If it is above 8.5, the chalk in the water starts to separate out in the pipework
Conductivity	X	X	X	For water produced on board, this is an indicator for whether the system is working properly	2500 µS pr. cm^3	Conductivity shows how much salt there is in the water
Ammonium (NH_4)	X	X	X	For water produced on board, this is an indicator for whether the system is working properly	0.5 mg/l	A high reading is an indication of contamination
Chloride (Cl)	X		X	For water produced on board, this is an indicator for whether the system is working properly	250 mg/l	A raised level gives taste problems and has a corrosive effect
Fluoride	X		X	Only applicable in special instances	1.5 ml/l	Too much can cause poisoning. The initial symptoms of poisoning include white patches on tooth enamel
Iron (Fe)	X	X	X	Raised levels of iron may come from the bottom of tanks and from installations	200 µg/l	Too much iron discolours the water and makes it taste metallic
Manganese (Mn)	X		X	For water produced on board, this is an indicator for whether the system is working properly	50 µg/l	Causes the same problems as iron
Nitrate (NO_3)	X		X	For water produced on board, this is an indicator for whether the system is working properly	50 mg/l	Sign of contamination. Bacteria can convert nitrate to nitrite, which is toxic
Nitrite (NO_2)	X		X		0.5 mg/l	Indicative of contamination and microbiological activity. Nitrite restricts blood oxygen uptake and can be a carcinogen
Oxygen (O_2)	X	X	X		>5.0 mg/l	Oxygen is important for the taste of water. Too little oxygen provides ideal conditions for the growth of bacteria that live in a low oxygen environment. Makes water smell and taste rotten
Sodium (Na)	X		X	For water produced on board, this is an indicator for whether the system is working properly	200 mg/l	Too much sodium in the water makes it taste salty. Risk of raised blood pressure
Sulphate (SO_4)	X		X	For water produced on board, this is an indicator for whether the system is working properly	250 mg/l	Makes water taste bitter and is corrosive

Inorganic trace elements

	Production from seawater	Bunkering Water quality is;		Comments	Threshold limit value	Significance
		known and acceptable	unknown[1)]			
Aluminium (Al)			X	Only applicable in special instances	200 µg/l	
Antimony (Sb)			X	Only applicable in special instances	5 µg/l	
Arsenic (As)			X	Occurrence varies very widely geographically, with special problems in parts of Asia and the whole of South and Central America	10 µg/l	Inorganic arsenic is very toxic and can cause long-term damage to various organs
Boron (B)			X	Only applicable in special instances	1 mg/l	
Bromate (BrO_3)			X	Only applicable in special instances	10 µg/l	
Cadmium (Cd)			X	Only applicable in special instances	5 µg/l	
Chromium (Cr)			X	Only applicable in special instances	50 µg/l	
Copper (Cu)	(X)	(X)	X	Copper may come from pipes, joints and taps and so it may be appropriate to test for it in all ships, e.g. every 5 years	2 mg/l	Relatively non-toxic but large quantities can cause health problems

[1)] Usually only necessary to analyse for inorganic trace substances if planning to bunker from somewhere more than once. This is because there is not and acute effect but only a long time effect

Inorganic trace substances	Production from seawater	Bunkering Water quality is; known and acceptable	Bunkering Water quality is; unknown[1)]	Comments	Threshold limit value	Significance
Cyanide (Cn)			X	Only applicable in special instances	50 µg/l	Toxic
Lead (Pb)	(X)	(X)	X	Lead may come from pipes, joints and taps and so it may be appropriate to test for it in all ships, e.g. every 5 years [2)]	10 µg/l	Toxic
Mercury (Hg)			X		1 µg/l	Toxic
Nickel (Ni)	(X)	(X)	X	Nickel may come from pipes, joints and taps and so it may be appropriate to test for it in all ships, e.g. every 5 years [2)]	20 µg/l	Relatively non-toxic but it can lead to allergy and be a serious problem for individuals already allergic to nickel
Selenium (Se)			X	Only applicable in special instances	10 µg/l	
Total indicative dose			X	Only applicable in special instances	0.10 mSv/year	
Tritium			X	Only applicable in special instances	100 Bq/l	Radioactive

[1)] Usually only necessary to analyse for inorganic trace substances if planning to bunker from somewhere more than once. This is because there is not and acute effect but only a long time effect

Organic micro-contaminants

	Production from seawater	Bunkering Water quality is; known and acceptable	Bunkering Water quality is; unknown[2)]	Comments	Threshold limit value	Significance
Benzene			X	Usable as an indicator of oil/fuel contamination of drinking water	1 µg/l	Carcinogen
Benzo(a) pyrene			X	Only in special instances	0.01 µg/l	
Pesticides			X	Agricultural spray residues – of which there are many different types. Arrange tests as necessary depending on the circumstances	0.1 µg/l	Long-term ingestion of spray-residues can be harmful to health
Total of all Pesticides			X		0.5 µg/l	
Tetra- and trichloroethene			X	Also called tetrachlorethylene (PCE) and trichloroethylene (TCE)	10 µg/l	Chlorine solvents
Total of trihalomethanes			(X)	Only in special instances	100 µg/l	
Vinyl chloride	(X)	(X)	X	May be especially relevant if chlorinating the water on board or if bunkered water is chlorinated	0.5 µg/l	Can be formed when water is treated with chlorine

[2)] Usually only necessary to analyse for organic micro-contaminants if planning to bunker from somewhere more than once. This is because there is not and acute effect but only a long time effect

Microbiological parameters

	Production from seawater	Bunkering Water quality is; known and acceptable	Bunkering Water quality is; unknown[3)]	Comments	Threshold limit value	Significance
Clostridium perfringens, incl. spores	(X)	(X)	(X)	Only used when contamination detected. Seek further advice on interpreting results	0/50 ml	Clostridium perfringens is always present in normal intestinal and soil flora. The bacteria form spores and may therefore be associated with previous contamination
Coliform bacteria	X	X	X	Low levels of coliform bacteria (up to 20/100 ml). Does not usually require special precautions on board but the cause should be established and eliminated. For higher levels, water should be boiled before drinking and should not be used for cooking unless food is subsequently boiled/cooked. Seek further advice	0/100 ml	Coliform bacteria occur naturally in soil, surface water and decaying plants but not in drinking water. The presence of coliform bacteria in drinking water is therefore an indication of contamination, typically from surface water. This group does not generally cause illnesses by itself but thrives in the same places as bacteria that do cause illness
Colont count (at 37 °C)	X	X	X	Many places abroad do not use this analysis in the way it is used in Denmark. At levels of >2000/ml, water should be boiled before drinking. Instead, there should, be an overall assessment of excess levels reported in microbiological analyses and the possible reasons. Seek further advice [1)]	20/ml	An indicator for the bacteria that can grow at 37 °C (human body temperature) including bacteria that can cause disease. Often caused by reproduction in the pipework or in sludge at the bottom of tanks
Colony count (at 22 °C)	X	X	X	Many places abroad do not use this analysis in the way it is used in Denmark. At levels of >2000/ml, water should be boiled before drinking. Instead, there should, be an overall assessment of excess levels reported in microbiological analyses and the possible reasons. Seek further advice [1)]	100/ml	An indicator for the bacteria that can grow at 22 °C. These are soil and water bacteria that live on organic matter in the water. The reason for a raised colony count at 22 °C may be due to growth in filters and tank bottom sludge, hydrophores, etc. A sign of bacteria getting in from outside or reproducing in the water
Enterococcer	(X)	(X)	(X)	Checking for enterococcus is usually only required when contamination has been detected	0/100 ml	Comes from the intestinal flora but can survive and reproduce outside the intestines. These thus indicate faecal contamination some time in the past. Water should be boiled and the reason identified

[3)] In the case of excess levels of E. coli and coliform bacteria, it is these parameters that are typically used to determine what restrictions on use should be introduced to cut the risk of illness breaking out on board

	Production from seawater	Bunkering Water quality is; known and acceptable	Bunkering Water quality is; unknown[3)]	Comments	Threshold limit value	Significance
Escherichia coli (E. coli)	X	X	X	The water cannot be used for drinking or cookery or other galley purposes when in direct contact with food or cutlery/crockery. Dishwashers with final temperatures of more than 80 °C can be used. Seek further advice	0/100 ml	E. coli belong to the group of thermo-tolerant coliform bacteria and are found solely in animal and human intestines. Thermo-tolerant coliform bacteria do not in themselves cause illness but contamination with these bacteria indicates recent contamination of drinking water coming from domestic wastewater, animal dung or the like. Water should be boiled and the reason identified

[3)] In the case of excess levels of E. coli and coliform bacteria, it is these parameters that are typically used to determine what restrictions on use should be introduced to cut the risk of illness breaking out on board

1.B. Check monitoring and threshold limit values when using additives for further treatment

Chlorine and Silver

Only applicable if the water has been disinfected with chlorine and silver compounds	Threshold limit value	Remarks
Chlorine	5000 µg/l	WHO threshold limit value
Silver	10 µg/l	Danish threshold limit value

1.C. Check monitoring and threshold limit values when the tank has been coated

Solvents etc

Only applicable if tanks have been coated	Threshold limit value	Remarks
Alkyl benzenes	1 µg/l	Danish threshold limit value
Benzene	1 µg/l	EU threshold limit value
Bisphenol A (relevant for epoxy coating)	0.5 µg/l	Danish threshold limit value
Bromodichloromethane	60 µg/l	WHO threshold limit value
Chloroform	10 µg/l	Danish threshold limit value
Dibromochloromethane	100 µg/l	WHO threshold limit value
1.2-dibromethane	0.01 µg/l	Danish threshold limit value
Mixed Xylenes	500 µg/l	WHO threshold limit value
Silver	10 µg/l	Danish threshold limit value
Tribromomethane	100 µg/l	EU threshold limit value
Vinyl chloride	0.5 µg/l	EU threshold limit value

1.D. Other check monitoring and threshold limit values

Other microorganisms

	Threshold limit value	Remarks
Legionella pneumophila Only applicable for the hot water system	1000 bacteria/l Recommendation	Recommendation from the Danish SSI (Statens Seruminstitut) Can cause serious lung inflammation

Annex 2: Cleaning procedures

This is a transcript of:
Danish Health and Medicines Authority guidance of 31/5/1968 on disinfection when cleaning drinking water tanks and drinking water piping in ships.[1)]

1. Water in the drinking water tanks and pipes should be drained and the tanks scrubbed internally. Tanks and piping should then be flushed with drinking water.

2. Calculate how much water is needed to fill the drinking water tanks and pipes and then use the tables below to decide on the quantity of chlorine product to be added to the drinking water system to achieve the necessary chlorine concentration for disinfection (50 g/m³).

a. Use of sodium hypochlorite solution

Volume of tanks and pipes	Sodium hypochlorite solution containing		
	5% chlorine	10% chlorine	15% chlorine
1,000 litres	1 litres	0,5 litres	0,35 litres
10,000 litres	10 litres	5 litres	3,5 litres
20,000 litres	20 litres	10 litres	7 litres
40,000 litres	40 litres	20 litres	14 litres

b. Use of solid chlorine product

Volume of tanks and pipes	Solid chlorine product	
	25% chlorine	70% chlorine
1,000 litres	0,2 kg	0,08 kg
10,000 litres	2,0 kg	0,8 kg
20,000 litres	4,0 kg	1,6 kg
40,000 litres	8,0 kg	3,2 kg

Before use, the solid chlorine product must be dissolved.
25% chlorine (calcium hypochlorite). Place the quantity of product found in the table in a clean, dry bucket and add a little water. Mix to a thick paste. Then dilute with water while stirring constantly until there are 4-8 litres of solution (hot water is better than cold for this purpose). Then stand the solution for 1/2 hour to allow undissolved particles to sink to the bottom. Pour off the clear (chlorine) solution and possibly filter it through cheesecloth or the like.

70% calcium hypochlorite. Place the quantity of product found in the table in a bucket nearly filled with water and stir until the powder is dissolved. Slight turbidity (cloudiness) of the solution is of no concern.

3. Then pour the sodium hydrochloride solution or the chlorine solution made from the solid product into the drinking water tanks and immediately fill with drinking water.

4. Open the taps on the part of the piping nearest the drinking water tanks until they have been flushed with chlorinated water. Then open all the other taps in order from the tanks until all the taps have been flushed with chlorinated water. Then refill the drinking water tanks with water and add the required quantity of chlorine solution.

5. Allow the chlorinated water to stand in the drinking water tanks and pipes for four hours before draining.

6. After draining the chlorinated water, the tanks and pipe work should be flushed with drinking water until the water no longer has an unpleasant taste of chlorine.

7. The tanks and pipes can then be filled with drinking water.

[1)] This guidance is good practice although it is not legally in force anymore.

Visit www.seahealth.dk

Clean drinking water is a special challenge on board a ship.
This guidance tells you how to ensure that the quality of drinking water is satisfactory and complies with applicable requirements.

The guidance has been drawn up on the basis of current experience at the time of production.

August 2013

SEAHEALTH

Seahealth Denmark
Amaliegade 33B, 2
DK-1256 Copenhagen K
www.seahealth.dk