

Seafish Standard Design Purification Systems



Operating Manual for the Vertical Stack System

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1. The Development of the Seafish Vertical Stack Purification System

Vertical stack purification systems were developed during the 1960's and had the advantages over traditional shallow tank systems of a reduced floor area requirement and ready access to individual containers of molluscs. However, the capital cost of such systems was generally high compared to shallow tanks and consequently their use was usually limited to the purification and subsequent storage of high value molluscs such as oysters and clams.

Although the concept of the vertical stack system was good Seafish were concerned with the apparent poor seawater flow characteristics and the methods of draining down of most systems. There was a need to ensure sufficient water flow to maintain adequate dissolved oxygen levels whilst not disturbing the molluscs, and the methods of draining down must minimise the possibility of recontamination. The original drainage methods were partly a result of such systems also being intended for crustacean storage.

Seafish built prototype systems and after extensive development work and trials this became the basis for a standard design with a nominal capacity of 2000 oysters.

2. How does the Seafish Vertical Stack System work?

The molluscs are held in purpose designed solid sided containers which are supported in a stainless steel frame over a plastic pallet box (650 litres) used as a sump tank. The framework supports a total of sixteen containers in two vertical columns. Seawater is drawn from the sump up to one end of the top container of each stack. It flows along the container and then cascades down from the other end into the container below, and so on until it returns eventually to the sump. The cascades provide re-oxygenation between containers.



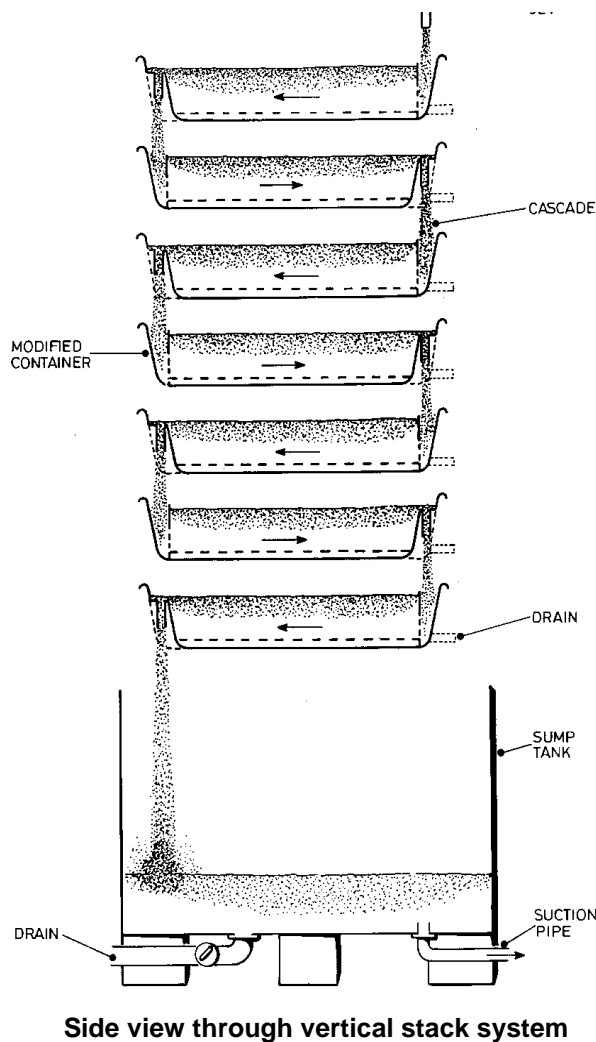
Modified container



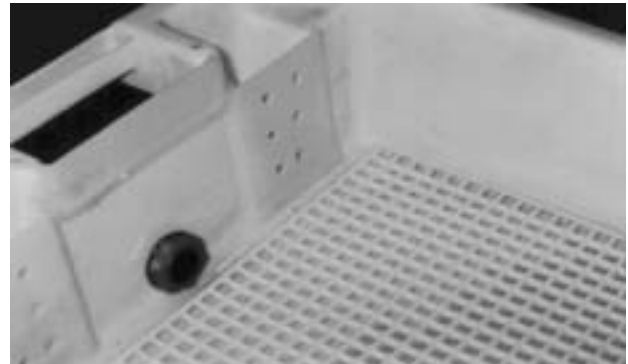
Containers supported on stainless steel frame

The mollusc containers used are a specially modified Allibert Type 12030 which has external dimensions of 800 mm x 450 mm x 150 mm.

The modifications ensure a uniform flow of seawater through the molluscs and that the cascade is not directed onto the molluscs in the container below. This involves the partitioning of the recesses at one end of the container with small plastic flowscreens to contain the initial turbulence of the water cascading into them. At the other end of the container plastic overflow pipes are fitted to maintain the required water level and direct the water into the recesses of the container below.



A drain tap is fitted to each container to provide independent drainage of seawater directly to the sump via a central drainage pipe mounted between the columns of the boxes. This enables the removal of individual containers without draining down the whole system. The drain tap is fitted such that not all of the seawater drains out and 10% of the seawater is retained. This is to prevent the sediment that settles out on the container bottom being returned to the sump.



Partitioned recesses, drain and mesh floor mat

Each container is fitted with removal mesh plastic mat. This holds molluscs clear of the bottom of the container and accumulated sediment.

Seawater is re-circulated via pump and the flow rate is controlled by a valve and flowmeter. This control is essential if the system is to operate effectively. The seawater receives microbiological treatment by passing through an enclosed ultraviolet light (UV) sterilisation unit.

The molluscs function naturally in the clean seawater and purge themselves of bacteriological contamination.

Detritus settles on the base of the container.

3. The Approval of Purification Systems

Strict controls under the Food Safety (Live Bivalve Molluscs) Regulations govern the handling of live bivalve molluscs from harvesting through to retail sale. It is essential that before any purification system is set in operation, the local Food Authority is contacted and approval granted.

Premises where purification systems are operated must be issued with an approval number which is given by the Food Authority only if the requirements of the Regulations are complied with. In addition, a "conditions of approval" document is issued for each purification system. This document is obtained by the Food Authority and specifies conditions of usage. In England and Wales this is obtained from the Ministry of Agriculture, Fisheries and Food (MAFF), in Scotland from the Scottish Office Agriculture and Fisheries Department (SOAFD) and in Northern Ireland from the Department of Health and Social Security (DHSS). Other local requirements must be considered including planning, water discharge and waste disposal. Animal Health Regulations may also apply controls over the re-immersion of shellfish if premises are located in coastal sites and shellfish are not caught locally.

Seafish have no statutory responsibility for the approval of purification systems but are able to give advice on their design and operation to Industry, to Food Authorities and Government Departments, and to assist in any testing of systems.

4. The Standard Design Concept

Government Departments are responsible for ensuring that technical requirements for purification systems are met. They will issue “conditions of approval” for a system only if satisfied that it is designed and operated in accordance with basic rules and that there is sufficient evidence to demonstrate that the system will purify bivalve molluscs satisfactorily. This requires them to make a site visit before approval, to carry out a technical inspection, and for a bacteriological test to be carried out. The bacteriological test is the responsibility of the operator of the purification system and can prove time consuming and costly, particularly if repeat testing is required.

The range of standard design purification systems developed by Seafish are built to specified designs that meet the technical requirements and which have been tested extensively in a wide range of conditions. Being proven designs, bacteriological testing is less stringent and consequently they have a more predictable, simplified, less time consuming and less expensive approval procedure.

5. Seawater Supply

The seawater must be free from contamination in quantities that may adversely effect the molluscs or be subsequently harmful to the consumer. Either natural or artificial seawater can be used. Where natural seawater is to be used, advice should be sought as to the suitability of the local water from the relevant Government Department (MAFF, SOAFD or DHSS), either directly or via the local Food Authority.

Factors effecting the suitability of seawater are:

- **Turbidity.** The seawater should be clear in appearance as turbidity reduces the efficiency of UV sterilization. Turbidity can be removed by the use of a sand filter or a seawater settling tank. A sand filter should be used for new incoming water only and not be installed as part of the seawater re-circulation system.
- **Salinity.** This must suit the particular species of bivalve mollusc being held and should ideally be similar to the area from which they were harvested.

Minimum levels of salinity are given in the table below (“conditions of approval” may require higher levels).

Minimum Seawater Salinity	
Species	Salinity ‰ (parts per thousand)
Native Oysters	25.0‰
Pacific Oysters	20.5‰
Hard Shell Clam	20.5‰
Mussels	19.0‰
Cockles	20.0‰

- **Microbiological Treatment.** Initial low levels of microbiological contamination are reduced by UV treatment of the water before it enters the tank.
- **Position of seawater intake.** This must not draw in waste from other discharges, it should be sufficiently below the water surface to avoid poor quality surface water and be above the seabed where mud or fine sand are present. The times when suitable seawater may be drawn may be limited by tide and this may require the provision of water storage tanks ashore.

Artificial seawater has higher initial cost but can offer considerable advantages where systems are to be operated inland or local supplies of natural seawater are considered unsuitable. Advice on the production and use of artificial seawater is given in Seafish Technical Information Service Sheet No.1994/25/FT.

6. System Installation



Panel and equipment at back of system

seawater into the top container of each stack. An electrical control box is also mounted on the rear panel and contains the switches. If a seawater heater is provided the thermostatic controller (Digistat) will also be mounted in the control box, the temperature display being visible through the clear panel in the control box door. The temperature controller must be set up in accordance with the manufacturers instructions. The thermostat cable and one or two titanium heater units sit in the sump. The heaters must not be located adjacent to the thermostat and must be held clear of the plastic tank surface by the collars provided.

Although the equipment is designed to be splashproof care should be taken to keep it dry by avoiding areas used for washing molluscs, etc. Clear plastic sidepanels are fitted to the container support frame to contain any splashing.

The controls must be accessible and the flowmeter and U.V. clearly visible. Pipework and equipment should be installed such that they drain when the system is emptied to avoid leaving areas of stagnant water when not in use. If this is not practical then means of draining specific pipework or equipment should be included. Access for maintenance is important, particularly to the UV sterilization unit which will require periodic cleaning and tube replacement.

Tank location should avoid direct sunlight. The system must be installed such that it sits level, and the frame must be secured to the sump tank by the four pinch bolts. This is to ensure that there is a uniform depth of water maintained in the containers.

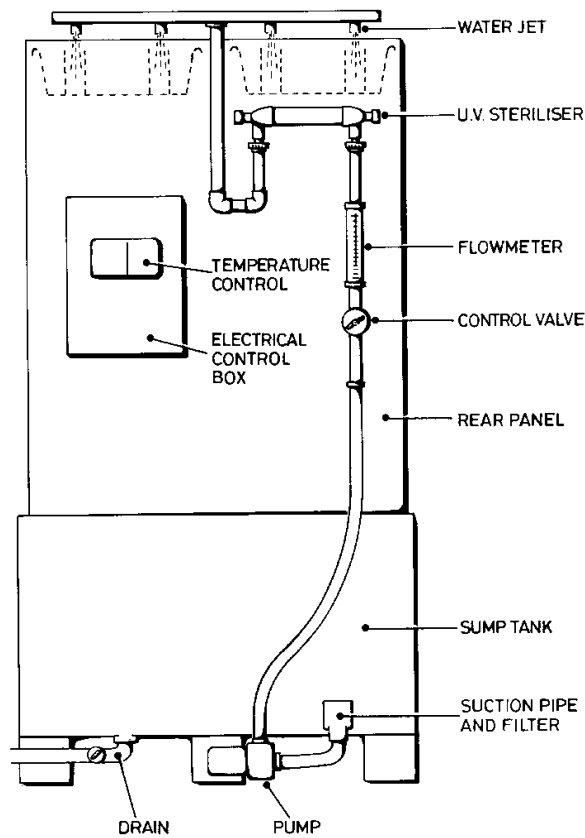
A final check on levels is made when running the initial test, as described in Section 7.

The seawater re-circulation equipment is usually installed by the manufacturer but may be self assembled provided the manufacturers instructions are followed.

The seawater re-circulation equipment consists of a waterproof pump attached externally to the bottom of the sump with a flow control valve, flowmeter, UV steriliser and inter-connecting pipework mounted on the panel which forms the back wall of the system.



Seawater pump



Seawater circulation system

and the water jets and cascades must be even and be directed into the partitioned recesses of the containers. Adjustments to level can be made by placing shims between the frame and the sump tank. These should be provided by the supplier of the system.



Even water flow from overflow pipes

8. System Operation

When used for purification, the operating requirements specified in the “conditions of approval” must be followed. Although the instructions given in this manual are in line with established practices, the “conditions of approval” apply to each individual system and may incorporate special conditions depending on the particular circumstances of operation.

If artificial seawater is to be used or the seawater re-used the sump can act as a reservoir. The seawater feed pipe to the pump is clear of the base to avoid circulating solid material. However, the sump must not be used as a settlement tank for turbid raw seawater supply and if this is required then a separate tank should be installed for that purpose.

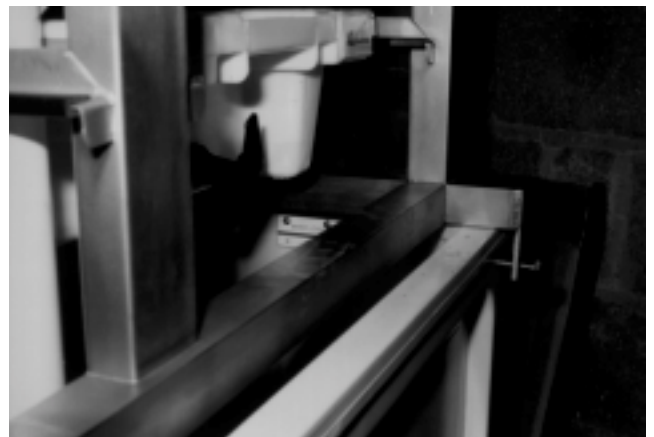
A single phase electrical supply is usually adequate. All connections and switches used within the working area where the system is installed must be hoseproof. IP66 classification is recommended. Cables must not be left trailing on the floor.

7. Initial Testing

A new system must be run firstly filled with seawater only, to check that the water circulation system will operate correctly and that there are no leaking joints, and then be left to run overnight. The container positioning and water filling procedures are given in Section 8.3 and 8.4. Leaks will probably be a result of joints being inadequately tightened. The system must be able to operate at the required water flow of 15 litres/minute. The UV lamp must operate correctly. Check the water levels and the operation of the water spray jets and cascades.

The water depth in the containers must be uniform

After draining down the tank should be cleaned as described in Section 9.3.



Level adjustment between frame and sump

Purification is a batch process. Firstly the containers are loaded with molluscs and positioned in the frame, then water circulation commenced and the containers fill with seawater from the sump. After the requisite period the circulation is stopped and the seawater is drained from the containers back to the sump. The purified molluscs can then be removed. The system must not be disturbed (i.e. trays moved or molluscs added or removed) during the requisite period of immersion.

Batches of molluscs from different sources must be kept separate for documentation purposes, enabling the tracing of molluscs back to source, but different batches from the same category of harvesting area can be held in the same purification system. The Regulations prohibit the mixing of species in a purification system. The mixing of species would be harmful if the conditions did not suit all the species concerned. Although the vertical stack system has two columns of boxes they share the same water and still form part of a single system.

8.1 Mollusc Supply

It is often forgotten when handling live bivalve molluscs that they are a live animal and even though encased in a hard shell they are easily damaged and physically or thermally shocked. Molluscs must be in good intrinsic condition if they are to be active when re-immersed and it is advisable, therefore, that the handling history between harvesting and arrival at the purification or dispatch centre is known and acceptable.

Depending upon species and harvesting techniques, damage to a few molluscs may be inevitable. However, if more than a few molluscs are dead, gaping or showing signs of excessive shell damage then the batch should be rejected. The time from harvesting should be known as molluscs should not be out of seawater for more than a few days before re-immersion. For some species, such as those grown in sub-littoral areas and not used to being out of water, this time period must be short. For cockles a maximum of 6 hours is recommended. When out of seawater a raw material storage temperature of between 2 °C and 10 °C is generally recommended although native oysters which should not be held at less than 4 °C and mussels can be iced.

When approaching their spawning season bivalve molluscs are more susceptible to shock, and great care needs to be taken if spawning in the tank is to be avoided. Molluscs are weakened by spawning, and often they are not harvested until they have sufficiently recovered.

8.2 Loading the Containers with Molluscs

The molluscs must have been thoroughly washed with clean water to remove silt, sand and weed before being put into the containers, and care taken not to roughly handle them. Any dead or damaged molluscs should be removed.

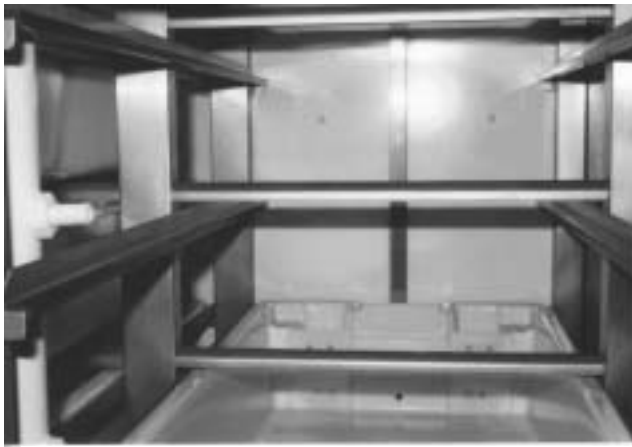
Container Loading

Species	Depth	Nominal Amount
Mussels	80 mm	15 kg
Pacific Oysters	Double Layer	125 oysters
Native Oysters	Single Over-lapping Layer	125 oysters (100 gm)
Clams	80 mm	21 kg
Cockles	80 mm	15 kg

The mesh matting must first be placed in the bottom of the containers and then the molluscs can be loaded to depths no greater than those specified in the table above. The nominal weight (or number in the case of oysters) is only a guide and will vary with season, harvesting area and size.

8.3 Loading the Containers into the Frame

Because of the alternating flow direction through the stack the containers are 'handed' and each must be loaded such that the jets or cascades from above are directed into the partitioned recesses of the container below, and the drain taps are to the front. The containers may be marked or numbered to assist in this.



Vertical stop bar, frame runners and support

If the system is to be only part loaded all the containers should still be installed to aid water circulation and reduce splashing.

The containers are slid into the frame, supported on their rims, to position against the stop at the back of the frame. The drain taps are then connected into the flexible pipes leading to the central drainage pipe to the sump, although the bottom pair of boxes drain directly into the sump. The drain taps must be closed.



Flexible drain tubes and central drain

8.4 Filling and Recirculating the Seawater

The sump is usually filled prior to loading the containers (if the water is being re-used it will already be in the sump). Filling from an external source requires a gravity or separate pumped feed via a hose directly into the sump. Before filling the coarse suction filter on the sump suction pipe should be unscrewed, cleaned and replaced. The sump must be filled with sufficient seawater to fill the containers which is usually indicated by a water level mark inside the tank. This is 50mm from the top of the tank. If there is not enough seawater in the tank the pump can be damaged by running dry.

Before switching on the circulation pump, the UV unit must be switched on and care taken to ensure that the tube is functioning correctly. This is usually indicated by an annular ring of green/blue light at the end caps of each unit. If the light flickers, is dull or is not on refer to Section 10.4. The water then must pass through the UV before reaching the molluscs.

If a seawater heater is to be used the thermostat unit in the control box should be set to the required seawater temperature (Section 8.6) and heater switched on.

**In line
flowmeter and
control valve**

**Picture not
available**

The pump can now be switched on and the seawater will start to fill the containers. The flow valve can be turned fully open but must be turned down to the required flow rate of 15 litres/minute once the containers are full.

The flowmeter is of the in-line flow-through type and is read from the widest part of the indicator.

A check must be made to ensure that all the containers have been correctly orientated and that the water cascades are even. All molluscs must be immersed and should initially be well covered by about 30mm of seawater. Once respiratory/filter feeding activity begins there is a tendency for molluscs to move up within the container, reducing the depth of water above them. During the first few hours of operation the

water level in the sump may fall slightly if the molluscs have lost intervalvular fluid during storage and replenish it as their shell halves open.

8.5 Seawater Salinity

Seawater salinity should be checked whilst the sump is being filled.

The seawater salinity must be within the range required for the species as given in Section 5, and can be measured using a hydrometer as described in Section 12.2. If the reading shows the salinity to be too low or high it should be re-checked and if still incorrect the water must not be used.

Salinity that is too low can result from an incorrect artificial seawater mix or, in the case of natural seawater, too much dilution from a natural freshwater source. For natural seawater supply it may be possible to wait for a change in tidal condition.

The salinity of artificial seawater can be adjusted by dilution with tap water or adding extra salt. Care must be taken to maintain the correct mixture of salts.

8.6 Seawater Temperature

Mollusc activity is dependent upon seawater temperature and adequate dissolved oxygen levels. Minimum seawater temperatures are stipulated for the purification of each species to ensure adequate mollusc filtration activity. A maximum seawater temperature is stipulated for mussels which have a high oxygen demand. In addition, if seawater temperature is too high all molluscs will weaken, spawn or die and so maximum temperatures are recommended for all species. These depend upon species, growing conditions and season. The temperatures normally required for purification are shown below.

Species	Seawater Temperatures	
	Minimum	Maximum
Mussels	5°C	15°C
Native Oysters	5°C	15°C
Pacific Oysters	8°C	18°C
Clams	12°C	20°C
Cockles	7°C	16°C

Large temperature differentials between molluscs and seawater when filling the purification system should be avoided as they may reduce mollusc activity, induce spawning or even cause mortality. To avoid this, molluscs should be allowed to reach the required temperature slowly.

If suitable seawater temperatures cannot be maintained the system must not be used for purification.

A seawater chiller can be fitted as well as a heater but must be installed and operated such that the water flow is not disrupted. Further information should be obtained from the tank manufacturer or from Seafish and approval sought from the local Food Authority before use (Section 11).

8.7 Mollusc Activity

When the molluscs are immersed in seawater they should exhibit signs of activity by slightly opening their shell halves. Often air bubbles will be seen rising to the water surface as entrapped air is released. After a few hours the shell halves should be more open and, depending upon species, mantles or syphons should be visible. Some species are more active than others. Mussels are often active within minutes whereas hard shell clams exhibit intermittent activity. After the first overnight period the molluscs should be active and the seawater clear (tank bottom visible). If not, the system should be drained down and the reason sought. Inactive molluscs will not purify satisfactorily.

Foaming on the water surface is created as a result of the build up of dissolved waste excreted by molluscs. The amount of foam will depend upon species, level of activity and the extent of re-use of seawater. It is not normally a problem with a vertical stack system as any overflow will return to the sump.

8.8 Immersion Time

For purification the “conditions of approval” will specify the minimum immersion time required, which will usually be 42 hours. The immersion period can be extended prior to draining down if it is desired to store the full load of molluscs in the system, but extended storage of cockles is not recommended as they become exhausted and die.

If during a purification cycle the system should stop operating, the time lost must be made up to ensure the required purification time has been achieved. If the system has been stopped or operating at a reduced flow for more than a few hours the molluscs may have been weakened. If they show signs of weakness such as gaping, or even mortality, the molluscs must not be consigned for human consumption.

8.9 Draining and Unloading the Containers

At no time whilst they are immersed must molluscs be disturbed or removed as this can cause re-suspension and ingestion of settled out material. Containers must be drained before removing the molluscs.

To drain the containers turn off the circulation pump and UV, then, checking that the flexible tubes are connected to the central drain pipe, open the drain taps to allow the seawater to return to the sump. Once drainage has stopped, close the drain taps and separate the flexible pipes. Some water and the detritus will be left in the bottom of the containers but this will be below the molluscs.

The containers can then be slid out of the frame and the molluscs removed from the container. The molluscs must then be washed with clean water and the required sorting and packing operations carried out. As the finished product must be alive, this should be done with care to minimise shock and damage. Packaging must be clean and labels attached as instructed by the local Food Authority. A product storage temperature of 2°C to 5°C is generally recommended although native oysters should not be held at less than 4°C and mussels can be iced.

The seawater left in the bottom of the container cannot be re-used and must be tipped to waste with the detritus. The containers and floor mats should be washed whilst wet before sediment dries on.

If only some of the molluscs are to be packed after purification and the system is to be used for immersed storage of the remainder, all the containers must still be emptied and washed out and then be re-loaded. Instructions on part loading the system given in section 8.3 should be followed.

If the seawater is to be re-used, that lost to waste will have to be replenished with new seawater as necessary. Also in warm weather there may be a need to make up evaporative losses.

If the seawater is to be totally replenished the sump is emptied via the drain valve situated under the front of the pallet box and any sediment flushed out.



Sump drain

8.10 Monitoring the System Operation

For a purification centre details of molluscs received, start and finish times of purification and details of subsequent consignment must be recorded and checks of seawater salinity, temperature and UV lamp life made. These details are best recorded in tabular form using a log sheet such as that shown at the end of the manual. The source column could include movement document number. It is recommended that seawater temperature is measured at the start, middle and end of purification. If a time recorder is not fitted to the UV sterilization unit then hours switched on should be recorded cumulatively to give an indication as to when the lamps need replacement (Section 9.2). The comment column can be used to note anything that occurred during purification such as a power cut or pump failure and subsequent action taken. The dates also allow a check on seawater re-usage.

If more than one purification system is used each should have its own log sheet to avoid confusion.

Log sheets must be filled in legibly and be kept somewhere dry, such as an office, and not be left lying around in the purification or dispatch centre. It is a good idea to keep basic system details of start and finish time, salinity and temperature on a chalk or pen board mounted on a wall. This serves as a daily reminder of status and can be transferred to the log book on a weekly basis.

8.11 Seawater Re-Use

The “conditions of approval” prescribe conditions under which seawater can be re-used for each purification system, and generally permit re-use over a specified period of time. However, this period is prescribed as the

maximum limit of water usage and the operator of a purification system must satisfy himself at each successive re-use within the period that the water quality is adequate. If molluscs appear inactive when immersed (see section 10.6) and water quality is suspected, new seawater should be used. If seawater quality is the cause, molluscs will usually become active when re-immersed in the new seawater.

The re-use of seawater for successive purification cycles can result in dissolved waste from the molluscs accumulating in the seawater to a level which may inhibit purification. This depends upon the species of molluscs, their intrinsic condition, the loading of the purification system and the seawater temperature. The Seafish vertical stack system was originally developed for oyster purification using artificial seawater, and for this usage the re-use of seawater over a period of one month would normally be permitted. However, for more active molluscs, such as mussels, this would not be advisable.

When re-using seawater the salinity will increase as a result of evaporation, particularly when temperatures are high, and care must be taken to ensure it does not go beyond the prescribed level.

Further advice on the re-use of seawater should be sought from Seafish.

8.12 Microbiological Sampling

Operators of purification systems are required to carry out microbiological testing on samples of molluscs. Guidance on the frequency of sampling and on competent laboratories to which samples can be taken should be sought from the local Food Authority. Sampling frequency will be based upon the standards of operation at the purification centre including the degree of supervision and control and adherence to industry good practice guidelines (13.1). The laboratory must carry out a prescribed microbiological analysis procedure.

A sample of molluscs must contain sufficient shellfish flesh for a test to be carried out. 10-15 molluscs would normally be taken as a sample. With large molluscs it may be possible to use less (although never less than 6). Dead or gaping molluscs should not be used. The laboratory will advise if sample size is inadequate and sometimes will not accept samples below a certain number, so it is advisable to check.

The sample molluscs should be put into a clean plastic bag and be kept in cool conditions, ideally at 4°C (an insulated picnic box containing freezer packs is the method normally used) and be delivered to the laboratory within 24 hours. Molluscs must not be frozen. The samples must be labelled to enable identification.

The microbiological results must show that the purified molluscs contain less than 300 faecal coliforms or 230 *E.coli*/100gm to meet the product standard requirements. Samples must not contain Salmonella in 25 gm mollusc flesh. If these standards are not met then local the Food Authority must be contacted for further advice.

9. Cleaning and Maintenance

9.1 Pump Filter

A coarse filter is fitted within the sump on the suction pipe to the pump to prevent any large shell pieces from entering the pump and causing damage. This requires occasional cleaning and is removed (with the pump switched off) by unscrewing the filter assembly from the suction pipe. The filter element is then removed and rinsed with clean tap water. The assembly can then be replaced.

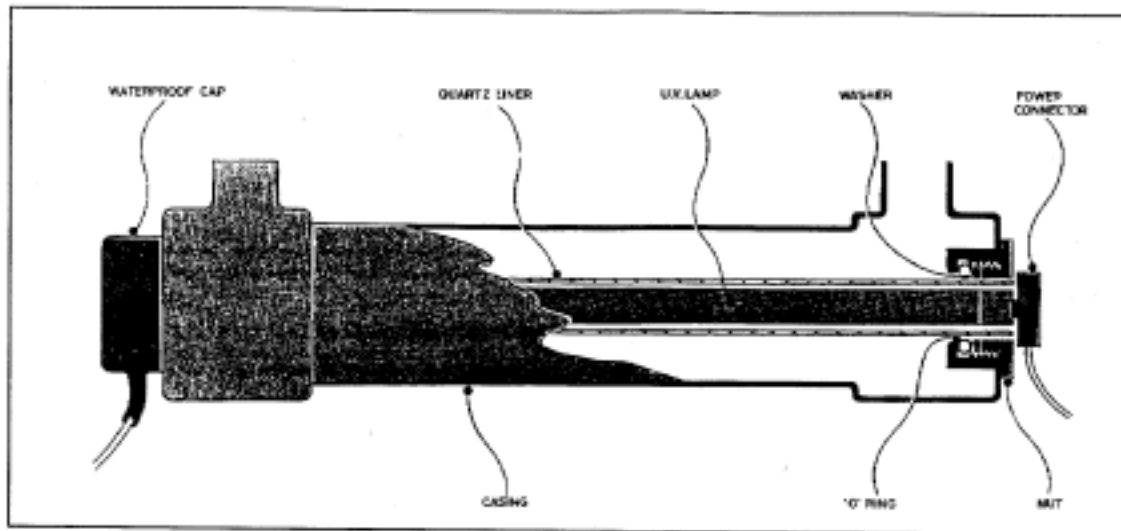
9.2 Ultra Violet Light (UV) Sterilization Unit

A single 25 watt lamp UV unit is fitted.

Safety: UV light is dangerous to the eyes and skin and the lamp must never be operated outside its housing. A green/blue glow can be seen at the ends of the unit to indicate that it is on in normal use. Before any cleaning or maintenance is carried out the electrical power must be switched off.



25 watt UV lamp unit



UV steriliser unit

Lamp Replacement: The lamps gradually deteriorate in use and must be changed as specified in the “conditions of approval”. This may be based upon the intervals specified by the lamp manufacturer in terms of hours of use although a calendar time interval may be given instead .

To replace a lamp:

- switch off the power
- carefully pull off the lamp connectors and covers from either end, supporting the tube if mounted vertically
- gently slide the lamp out of the quartz sleeve
- fit the new lamp in the reverse procedure.

Cleaning: The quartz sleeve may need cleaning occasionally as a result of sediment building up on its outer surface. The accumulation up of sediment will depend upon the clarity of the water supply and it is recommended that the sleeve is checked after a few weeks to give a guide to the frequency of cleaning required.

To remove the quartz sleeve:

- switch off the power and remove the UV lamp as described above
- make sure the water has been drained out of the unit
- unscrew the end nuts and remove the “O” ring seals and washers (this is sometimes difficult). The tube will need support at the bottom of the unit if mounted vertically to prevent it falling out
- withdraw the quartz sleeve, taking care to handle it at the ends only, and inspect it carefully. If cracked the sleeve must be replaced. The sleeve should be cleaned with soapy water and gentle brushing if necessary. The sleeves discolour after many years of use and if badly stained should be replaced
- rinse and dry the sleeve and replace it in the unit. Inserting a clean wooden dowel into the sleeve can assist in this and reduce the chance of breakage
- replace “O” rings and washers and tighten the nuts with hand pressure only and, if necessary, re-connect to the plumbing system
- turn on the water and check for leaks
- replace the lamp.

If access to the UV unit for servicing is difficult it may be easier to first remove it from the purification system.

9.3 Purification System Cleaning

After each purification cycle the containers and floor mats must be thoroughly flushed out with clean water to remove silt and shell debris. The sump tank should also be cleaned out on a regular basis.

To prevent accumulation of slime and dirt the tank and pipework should periodically be cleaned with a suitable cleaning agent. Hypochlorite solution (as found in household bleach) is recommended. The empty containers

should be loaded into the frame, the system filled with tap water and the hypochlorite added (with care, following manufacturers instructions). It should then be switched on and left for a few hours, preferably overnight. After cleaning the system must be thoroughly flushed through with clean water to remove any traces of residual chlorine which will harm molluscs.

Cleaning agents must be stored in a safe place away from the mollusc handling and purification areas.

9.4 Sand Filter

If a sand filter is used for seawater supply (it must not be fitted such that it forms part of seawater re-circulation), care must be taken to follow the manufacturers operating instructions. In particular the pressure gauge should be checked as excess pressure indicates the filter is becoming saturated and requires back flushing.

10. Possible Problems and Answers

Occasionally things can go wrong due to equipment failure, poor handling, poor seawater quality or poor intrinsic quality of the molluscs, or simply incorrect operating procedure. The following gives some of the more likely problems and answers but by no means covers every possibility. If the cause of a problem cannot be found, further advice should be sought by contacting Seafish.

10.1 Difficulty in Filling Containers with Seawater

- Air lock in supply pipework.
- Valve incorrectly set.
- Pump filter partly blocked.
- Containers incorrectly positioned.

10.2 Water Flow Stopped

- Power supply off (if circuit trip in control box will not re-set, contact electrician).
- Pump failure.
- Control valve turned off .
- Pump filter blocked.
- Water level in tank below suction pipe.

10.3 Water will not Flow at Required Rate

- Pump filter partly blocked.
- Pipework fouled with marine growth
- Air leak on pump suction. When this occurs air can be seen passing through the sight tube of the flowmeter.
- Valve partly blocked or incorrectly set.
- Worn pump.

10.4 UV Lamp Unit not on or Flickering

If the green/blue light does not appear at the ends of the unit when switched on, or the lamp flickers, the unit is not operating correctly.

- UV lamp faulty and requires replacement.
- Starter unit in control box faulty.
- Corrosion on terminal ends.

10.5 Excessive Foaming

- Water flow greater than that prescribed.
- Water re-use. With seawater re-use there can be a gradual build up of the dissolved waste that causes foaming, particularly with mussels and at higher seawater temperatures. More frequent water replacement may be necessary.

10.6 Molluscs appear Inactive whilst Immersed

- Incorrect salinity.
- Seawater temperatures too low or too high.

- Seawater quality poor (re-used too often).
- Molluscs in weakened condition as a result of poor handling and/or delays between harvesting and re-immersion.
- Molluscs in seasonally weak condition (post spawning).
- Thermal shock. Molluscs subjected to too great a temperature change when re-immersed.

10.7 Seawater becomes Cloudy

If during purification or immersed storage the seawater becomes clouded (usually a milky colour) the molluscs have probably spawned and if held in the system will die. Spawning does occur naturally but can be precipitated by shock and high water temperatures. The clouding of the water should not be confused with the slight turbidity that can sometimes occur when molluscs are initially immersed. This can be caused by mud and silt not removed completely by washing and should disappear within a few hours.

10.8 Molluscs Die or Appear Weak

Molluscs generally gape when dead or are in a weakened condition, and will not close their shell halves at all or only close them slowly when disturbed.

- Molluscs have spawned.
- Molluscs in a weakened condition (see 10.6).
- Water temperature too high.
- Too long a period of immersion.
- Molluscs stressed following a period with no water flow.

11. Modifications to Purification System

Modifications to the system or its method of operation should not be made without first contacting Seafish. The design flow conditions in the system must be maintained if it is to operate effectively and modification may disrupt this. The local Food Authority must approve of any changes made.

12. Measurement of Seawater Salinity and Temperature

12.1 Temperature

A hand held digital electronic probe thermometer is recommended. A robust and water resistant type should be used and its calibration checked at intervals (for example in a container of clean, iced, fresh water). Glass thermometers are prone to breakage and if used to measure seawater temperature this should not be directly in the purification system but in a suitable container (as used for salinity measurement) filled from the tank.

The continuous monitoring of seawater temperature is possible using special sealed units that can be positioned in the purification system. Further information can be obtained from Seafish.

12.2 Salinity

Seawater salinity should be checked using an hydrometer. These are usually made of glass so care must be taken and measurement made in a suitable container filled from the tank. The container must be clean and be deep and wide enough to allow the hydrometer to float without touching the sides or bottom (a soft drink bottle with the top cut off can be used).

The hydrometer will usually give a reading of specific gravity (SG). From this and seawater temperature the conversion chart is used to obtain a salinity reading.

Some hydrometers can give a direct reading of salinity with built in temperature compensation. For this type the salinity conversion chart is not required.

Using the traditional type hydrometer:

1. Fill the container with seawater, place on a bench at eye level and let any air settle out.
2. Insert the hydrometer (ensuring it is clean) and let it settle making sure it is afloat and not touching the container sides.

3. Read the hydrometer scale level with the water surface ignoring the surface tension meniscus around the hydrometer stem. The scale is usually between 1.000 and 1.050 and is a reading of specific gravity (SG).
4. After use, wash the hydrometer and container with tap water.

13. Further Information

13.1 Industry Guidelines

Seafish, in collaboration with the Trade, Local Food Authorities and relevant Government Departments are publishing comprehensive Guidelines covering the harvesting, handling and distribution of bivalve molluscs. Recommendations are based upon good practice but include legal requirements. The current document deals with facilities and equipment and includes purification and the use of purification facilities for conditioning and immersed storage.

13.2 Other Operating Manuals

Seafish are producing a series of these operating manuals for the range of standard design purification systems available. These include shallow tank, multi-layer and bulk bin systems. There is also a manual for those who wish to operate a system constructed to their own design.

Manual

Ref No Title

95/31/FT	Operating Manual for the Medium Scale Multi-Layer System
95/32/FT	Operating Manual for the Vertical Stack System
95/33/FT	Operating Manual for the Large Scale Multi-Layer System
95/34/FT	Operating Manual for the Small Scale Shallow Tank System
95/35/FT	Operating Manual for the Bulk Bin System for Mussels
95/36/FT	General Operating Manual for Purification Systems of Non-Standard Design.

13.3 Seafish Advisory and Consultancy Service

Seafish offer a general advisory role to Industry, Local Food Authorities and Government Departments. General advice, usually given by post or telephone, is provided free of charge. More detailed involvement on behalf of a particular business is charged for. Further details are given in Seafish Technical Information Service Sheet No. L94/27/FT.

13.4 Artificial Seawater

Advice on the production and use of artificial seawater is given in Seafish Technical Information Service Sheet No. 1994/25/FT.

13.5 Seafish Technical Reports

Technical Reports describing much of the work upon which the Vertical Stack Systems have been developed can be obtained from Seafish.

Report

No. Title

433	Biological Criteria for the Depuration of the Pacific Oyster (<i>Crassostrea gigas</i>) and the Design of Prototype Small Scale Depuration Plant.
459	Repeated re-use of Artificial Seawater in a Small Scale Vertical Stack Oyster Purification Plant Under Development by Seafish.

Further information on the operation of the Vertical Stack Purification System or any of the above mentioned publications can be obtained from:

The Fish Technology Department
 Sea Fish Industry Authority
 St Andrew's Dock
 HULL
 HU3 4QE
 Telephone: (01482) 327837
 Fax: (01482) 223310

Purification System Log Sheet

Species	Amount	Source	Start		Finish		Seawater				UV Hours	Consignment	Comment
			Date	Time	Date	Time	Sal	Temp	Temp	Temp			