Mollusc Purification Plant Fastnet Mussels

Consultancy Services Report No.22

November 1990

SEA FISH INDUSTRY AUTHORITY

Seafish Technology

MOLLUSC PURIFICATION PLANT

FASTNET MUSSELS

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M. Boulter/P. Wilson

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SUMMARY

A new mussel purification plant has been constructed by Fastnet Mussels, at Bantry Bay in Southern Ireland. Under contract to B.I.M. (The Irish Sea Fisheries Board) Seafish visited the plant to comment on its design and operation on the basis of their experience and current U.K. design criteria.

This report describes the plant, which is not yet complete, and comments on its intended design and operation. Seafish criticise the use of long, shallow, outdoor tanks on the basis of no water temperature control and potentially inadequate dissolved oxygen levels. Recommendations are made on the loading and operation of the plant on the basis of monitoring of dissolved oxygen levels.

In its present form the plant's seven purification channels could only be operated as a single tank under U.K. criteria. Seafish recommend remedial action to create a two tank system of three and four channels.

Comment is also made in light of the current, but not yet final, E.C. proposals for Bivalve Molluscs and the proposed construction of a building for handling and storage is supported.

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1. INTRODUCTION

Under contract to B.I.M. (The Irish Sea Fisheries Board) a visit was made to Fastnet Mussels at Bantry Bay in Southern Ireland to inspect their new purification tanks and to advise on any changes or requirements that would be necessary on the basis of the United Kingdom's established criteria for mussel purification.

In England and Wales all purification plants have to be licenced by the Department of Health. This licence is issued on the basis that the tanks meet the design criteria specified by MAFF (Ministry of Agriculture, Fisheries and Food) and the purification tanks can be shown to cleanse shellfish to below a specified level of 230 E. coli per 100 gm of flesh in a 42 hour purification cycle.

The Fastnet Mussels purification tanks hold a single layer of shellfish in large outdoor tanks. It must be emphasised that had Seafish been consulted prior to this plant's construction, we would have advised against such a design of outdoor type tanks, due to a lack of environmental and temperature control from which this design of tank suffers.

2. SITE DESCRIPTION

The purification plant is at Gearhies in Southern Ireland which is in a remote area five miles down the East coast of Bantry Bay from Bantry. The plant is situated here for purpose of clean seawater supply and is built on the side of a hill to allow the seawater to gravity flow through the purification system.

The purification tanks are of a large, concrete channel design, situated in the open. Facilities for washing, grading, packing and storage are planned but not yet under construction. (The layout of the site is shown in Figure No. 1).

3. PRESENT OPERATION

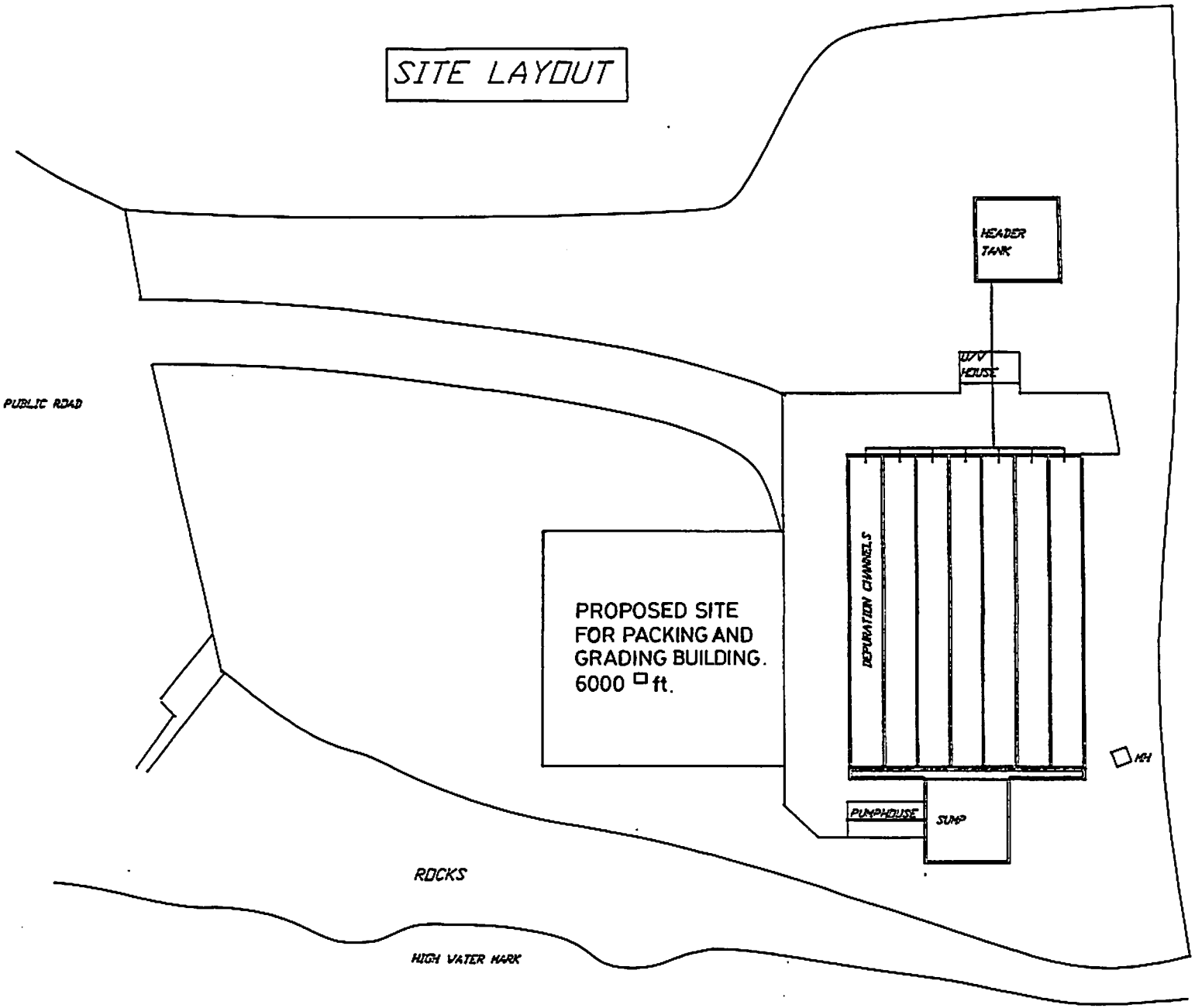
The purification plant is to be used exclusively for mussels. These are currently rope grown and harvested by Fastnet Mussels further north in Bantry Bay. They are capable of harvesting approximately 15 tonnes per day. The grading and washing operations are presently being conducted on the harvesting vessel in the north of the Bay. The harvesting, grading, washing and handling of the mussels is very well organised and showed little sign of damage or physical shock being caused to the mussels. This is important especially when they are to be purified as physical shocks impair the mussels ability to function.

The mussels are placed into bags after being graded and are then transported by an open top lorry from Bantry to the purification plant, a journey of approximately five miles. The mussels are placed into trays on an area of concrete hard standing alongside the purification tanks. Some of the mussels are placed loose into trays and others into trays in the mesh bags. There are no facilities for washing, packing or storage of the mussels after purification. The mussels being left in the tank until dispatch.

4. INTENDED OPERATION

Fastnet mussels has plans to instal a 550 square metre building alongside the purification tanks. This would be used for grading, washing and placing the mussels into trays before purification instead of on the harvesting vessel and also for washing, packing and cold storage of the mussels prior to dispatch.

SITE LAYOUT



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DEPURATION PLANT

AT GEARHIES, BANTRY, CO CORK

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Fig.1

5. SEAWATER SUPPLY

The water is pumped up from a pipe leading into the inlet by the harbour entrance. Enquiries revealed that the location of the site had been chosen due to advice on water quality from the Department of the Marine. It is assumed that water quality should be acceptable, although no test results were seen to substantiate this.

The plant is to discharge waste water from the tanks and wash down directly into the the sea and consideration must also be given to toilet facilities, yet to be installed. Care must be taken to ensure that discharge water, even when diluted, cannot circulate back into the plant. This must take into account any tidal flows that will no doubt exist. A buried inlet pipe utilising a sand filter may assist.

6. PURIFICATION TANKS

There are seven identical concrete tanks of internal dimensions 30.45 metres x 3.0 metres x 0.45 metres depth. All seven tanks are fed by a common header tank and feed into a common sump tank, thus in essence it is one purification tank split into seven separate channels.

A description of the individual elements of the tank(s) is given below. Action required to satisfy U.K. criteria for purification plant operation and design is included.

6.1 Purification Tank Design

Seafish has doubts about the effectiveness of this type of open air purification tank. Being open there is no environmental control over conditions within the tanks and water temperatures may fluctuate considerably.

In any purification system it is important that conditions present in the tanks do not unduly stress the shellfish. To maintain optimum filtration activity (and hence purification) the dissolved oxygen levels within the tank should not fall below 50% air saturation value. The oxygen holding capacity of the seawater falls with rising temperature whilst the mussels

activity and hence consumption increases. Our work in the U.K. with mussels has shown that once water temperature rises above 15°C it is increasingly difficult to maintain adequate dissolved oxygen levels. Water temperatures rising above this also increase the risk of mortality within the tanks and sometines premature spawning. The open nature of the tanks, with the dark mussel layer, creates a solar panel which is very susceptable to heating. In the U.K. the operation of such tanks can be restricted as a result. The open tanks are equally susceptible to cooling. Mussel activity reduces at lower water temperatures and in the U.K. a minimum operating temperature of 5°C is recommended.

The water flow along the length of these long channels is also of concern as in the theoretical loading situation there will be a considerable reduction in dissolved oxygen as the water passes along the tank. This could be offset by increasing the water flow (in the U.K. a minimum of one tank change per hour is recommended) or by reducing the tank loading but we consider neither to be practical in a commercial sense. Ideally the water flow should be across the narrow part of the channels, but would be difficult to achieve over a 30 metre length and would necessitate the splitting of each channel into 3 x 10 metre long tanks. This would create considerable plumbing problems and difficult access to some tanks.

A solution would be to install air diffusers at intervals along the channels to provide supplementary airation. If this is done the trays of shellfish must not be placed over them as the turbulence may reduce or even prevent filtration activity and resuspend detritus in the water.

Limited oxygen measurements in one channel that was two-thirds loaded with a water temperature at 12.1°C showed 98% saturation at the cascade but dropped to 65% in some areas. The water flow rate was not known. We recommended that dissolved oxygen levels be monitored to establish the extent of oxygen defficiency at known flow rates and temperatures. The required number and position of air diffusers could then be established.

It was these concerns, together with the generally labour intensive nature of this type of system that led Seafish to develop their high density tank systems. These require much less floor area and can be housed in a building, thereby allowing for environmental control and more mechanised handling.

6.2 Purification Tank Layout

This system uses header and sump tanks that are common to all seven purification channels. In the U.K., current criteria requires purification tanks to operate independently of one another and would mean in this case that all seven channels are in effect a single tank.

This means that all seven channels would be filled together to alleviate any risks of recontamination of the mussels in one channel by the mussels in another. This could happen if a channel was filled with polluted mussels shortly before another channel of mussels was drained down at the end of its purification cycle. The water can cross from one channel into another through the common sump and header tank. With the flows used the u.v. lights are not able to kill 100% of bacteria in one pass thus polluted water could pass into a channel just before it is drained down, recontaminating the mussels.

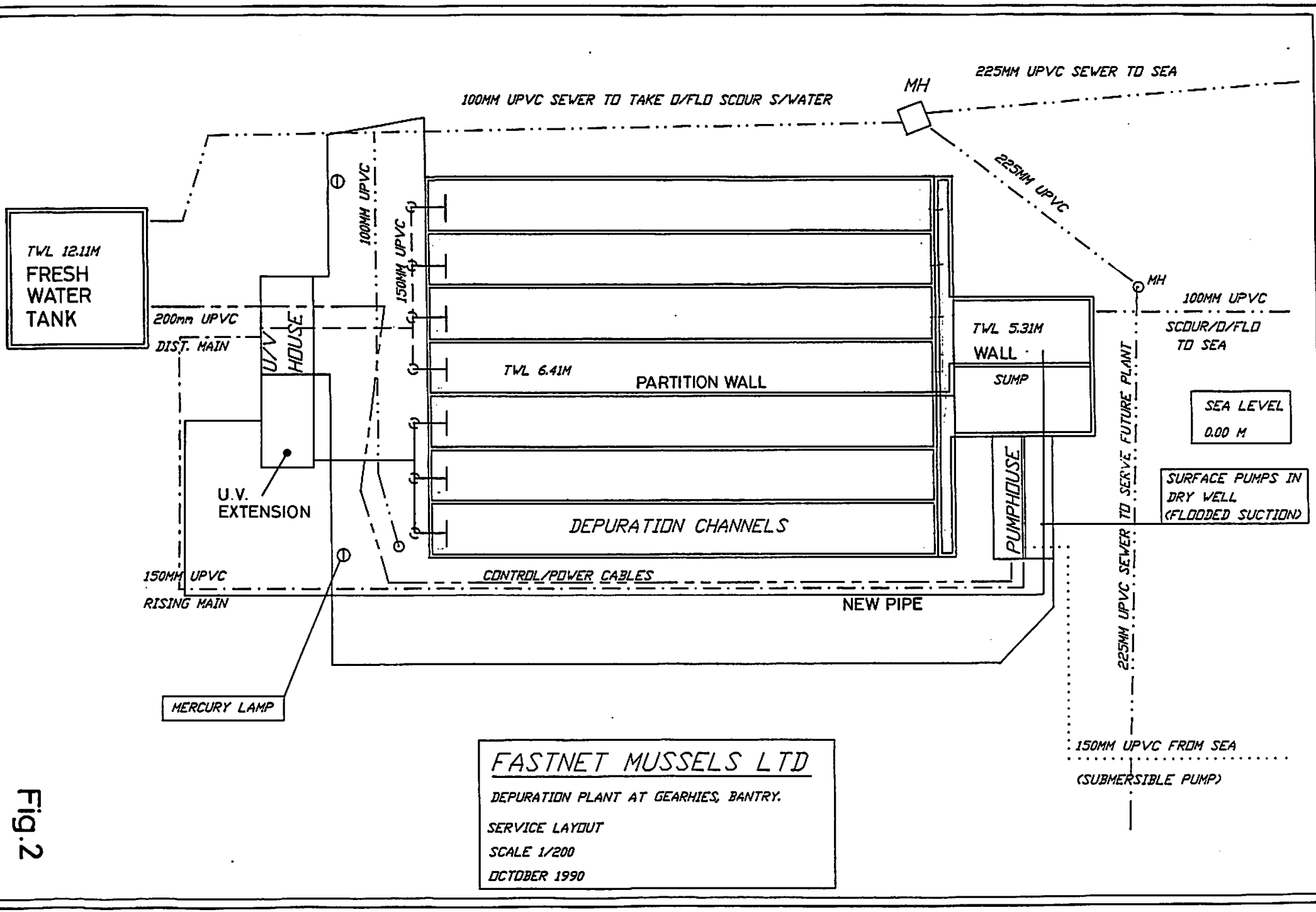
Once a purification cycle begins no shellfish can be removed or added to the tank until the required time has elapsed (42 hours in the U.K.). If this happens then the cycle must start again.

It is unlikely that all seven channels would be filled together thus we recommend that the seven channels are divided into two purification tanks. This can be done by building a partition wall across the wier and sump tank with a low dividing wall between channels three and four. This would create one tank of four channels and one tank of three channels (Figure 2).

Due to reasons of flow considerations the header tank should not be used (see Section 6.3).

6.3 Water Circulation

The reason for the header tank is not clear as its capacity is insufficient to give anything other than very short term back up in case of pump or power failure. As we are recommending that the plant be modified to run as two independent purification tanks, it is much more



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SERVICE LAYOUT

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Fig.2

straightforward to pump direct to the channels via the u.v. sterilisers. The header tank could serve a purpose as a settling tank in case the fresh seawater is turbid (this would reduce the efficiency of the u.v. sterilisers) but otherwise we suggest it is disconnected from the purification tanks. It could instead be used as a freshwater storage tank, which the site lacks at the present time. This would have to satisfy any local health requirements.

We suggest that for the four channel system one of the pumps is used together with the existing pipework and six u.v. steriliser units. The pipework would require modification to connect directly to the u.v. units and by-pass the header tank. The feed to the channels would need to be split to feed the four channels only. The horizontal water spraybars should be used at the head of each channel.

For the three channel system the remaining pump should be used and connected to a new circuit directed to five additional u.v. sterilisers. These in turn being connected to the three channel feed. The pump will have to draw water from the other half of the partitioned sump but the existing pump house should be adequate for both systems. The additional u.v. units will require installing in an extension to the existing u.v. house. Normally we would advise that the pump suctions be taken directly from the end of the channels through a horizontal suction pipe. As the weir and sump are in place, we see no reason to change them other than partitioning to form two tanks. The weirs aid re-oxygenation of the waters but because of the sump the pump flow is reduced by having to pump water through a greater height.

The pumps installed are Halberg and each rated at $136m^3/hr$. To maintain a flow of at least one water change per hour will require some $32m^3/hr$ for each channel. This will no doubt be adequate for three channels at once but possibly not four. Ultimately dissolved oxygen levels will test each system.

The spraybars themselves aid re-oxygenation by jetting the water onto the tank surface. Care must be taken with the jet hole sizes not to reduce flow with to little or reduce the effectiveness with too much. This can only be achieved by trial and error. It is important to maintain a

balanced flow to each channel. In practice with all channels in a system turned on the strength of the jets in each channel are a guide to a balanced flow.

6.4 U.V. Sterilisers

The MAFF requirements for shellfish purification requires one 30 watt u.v. tube for each 2.2m^3 of seawater and that the water in each raceway should be passed through the u.v. at least once per hour. Thus the u.v. capacity should be at least 130m^3/hr in the four channel system and 98m^3/hr in the three channel system. The present u.v. capacity of six 630/8P UVAQ sterilisers would only be 79m^3/hr for the whole system. Under MAFF criteria another twelve 630/8P UVAQ u.v. sterilisers would be needed.

This is a lot of additional u.v. capacity which we feel we could not justify as the plant has such excess water depth and hence capacity. Normally the shellfish in a single layer require 200mm depth of water. At this level of water the required u.v. would be six 630/8P units for the four channel system and five 630/8P units for the three channel system. We do not recommend reducing water level as this would exacerbate the problem of maintaining oxygen levels.

Clearly the six units on site at present can easily be plumbed into the four channel system and another five would need to be fitted to run the three channel system.

It must be noted that the water passing through the u.v.'s must not be turbid as this reduces the u.v.'s efficiency.

6.5 Boxes

The boxes used are an Allibert type 11031 of stack - nest design, with external dimensions of 600mm x 800mm x 180mm. These boxes are suitable for the purpose of shellfish purification.

6.6 Box Layout

The boxes can be laid out in either of two ways in each channel with either five or six boxes across the tank depending upon orientation. Boxes should not be placed in the first metre of the tank, due to turbulence caused by the spraybar or in the last 1.5 metres of the tanks as this is the area in which the drain pipe is situated and on draining down mussels may become recontaminated if placed too close to the drain due to the sudden change in water flow.

This leaves a working length of 28 metres which will allow 276 boxes to be used in each channel. The boxes must be in a single layer only. A double layer is physically possible in the tank but this would require the higher level of u.v. lights specified in Section 6.3 and would create a very large increase in dissolved oxygen demand.

6.7 Drainage

The tanks drain through a 230mm hole in the base of the raceways approximately one metre from the weir. The drain plugs are 0.5 metre lengths of 230mm pipe which slot into the drain when the tanks are in use. The drains lead directly back into the bay.

6.8 Power Supply

The power at present is supplied by an on site generator which is to be replaced by mains power in the future. It is recommended that mains power is introduced as soon as is feasible, as the generator power has proved to be unreliable leaving the mussels starved of oxygen for an extended period. The switchboard for all power is situated in the pumphouse on the ground floor, this is acceptable as it is well away from any water. The generator would be used as a standby in case of mains power failure.

6.9 Fresh Water

The site at present has no usable fresh water supply, however there is supposed to be fresh water plumbed into the site. The supply evidently requires a header tank to be of use and we have recommended the use of the header tank, once lined and covered, as a reservoir for fresh water supplies.

7. PURIFICATION TANK OPERATION

7.1 Purification in Bags

Mussels should not be purified in bags as the mussels expand when open and can be restricted from doing so if the bags are too tightly fasteneed thus potentially inhibiting purification.

7.2 Filling the Tank

Under MAFF requirements of 50kg/m^3 each raceway would be allowed to hold just over 4 tonnes (4140kg) of mussels and equates to 15kg per box. However, due to the amount of water in this system and the use of a single layer of boxes only, we consider that in practice this could be increased up to 20kg per tray provided adequate dissolved oxygen levels are maintained. This would give a capacity of 5.5 tonnes (5.520 kgs), with a depth of approximately 100mm in each box.

With this higher loading the water to mussel ratio is 5.9/1 and is still well within expected limits. Nevertheless boxes must not be filled any deeper than this. If the mussel layer is too deep it will inhibit mussels at the bottom of the layer from functioning efficiently.

We recommend that dissolved oxygen levels be monitored during the season, particularly if the higher tray loadings were to be used. Even with supplementary aeration it may be found that defined box loading will be required, dependent upon temperature. Initially the 15kg loading must be used.

A total of 1932 boxes will be needed to fill the whole system. The boxes must be placed into the tank before it is filled with water from the sump. Water passing into the tank must go through the u.v. lights which must be turned on.

7.3 Draining the Tank

After purification is complete the water must be drained to waste through the drains described in Section 6.7 before any mussels are moved.

After the tank has drained the shellfish can be removed for washing and packing. The building within which these operations will be carried out is at present not built and as such the washing of the mussels should occur by hosing in the tank after draining down. The mussels should be washed with either fresh water or clean seawater (u.v. sterilised) prior to packing. It is important not to risk mixing of cleansed and uncleansed shellfish. A method of handling whereby these both follow separate paths to and from the tanks must be set.

7.4 Packing Shellfish

At present there is no suitable site where packing of the mussels can be carried out. The building for packing the mussels in a clean area should be a priority to ensure no recontamination or cross-contamination of the product occurs. There is also no chill store in which the mussels can be placed prior to dispatch to markets.

7.5 Operating Instructions

In the U.K. a set of operating instructions are issued to the plant operator when a licence is given. We suggest similar instructions be drafted for Fastnet Mussels. Disciplined operation is essential in order to protect public health.

8. PROPOSED E.C. REGULATION COM (89) 648

At the present time this regulation for the 'Production and placing on the market of live bivalve molluscs" is stil under review by the Member States although it is now well developed. We cannot yet be sure of its final detail and full effect on the Industry and requirements for a purification plant such as that owned by Fastnet Mussels. Requirements are laid down at all stages of production including harvesting, handling, storage, transport and distribution. A 'Competent Authority' will define harvesting areas and licence and monitor areas were molluscs are subsequently handled and stored.

8.1 Harvesting Area

Molluscs will only be allowed to be taken for human consumption from designated harvesting areas. These areas will be put into one of three categories of clean, treatment required, or relaying (and possibly a fourth "no go" area). The area must be defined by means of shellfish quality and it is important therefore to start this work if not already in hand. In the U.K. with no 'Competent Authority' as yet defined, groups of local interested authorities are in some areas already carrying out joint monitoring programmes.

8.2 Establishment

Areas in which molluscs are handled and stored must be approved by the 'Competent Authority' as meeting set conditions for both premises and equipment. 'Buildings or facilities' are required for the handling and storage of purified and unpurified molluscs, which are easy to clean and protected from contamination. In our view this can only be satisfactorily achieved by housing the operation in a building with defined and partitioned areas for specific operations. In addition there is a requirement for changing rooms, toilets and washing facilities.

8.3 Purification Plant

This applies additinal conditions to those already given for an establishment and calls for "sufficient seawater or flow of seawater per hour and per tonnes of molluscs teated". Other than this the method of

purification is not defined but relies instead on the "Competant Authority" to give instructions, and the molluscs meeting a defined product standard following purification. The regulations do not appear to say that the purification tanks have to be housed in a building, but by inference they should at least be covered and fenced. The "facility" must "prevent contamination of live bivalve molluscs with any type of waste, dirty water, fumes, dirt or by the presence of rodents or other animals". Seabirds are a potential problem with an open system.

The purification plant must also have access to a laboratory for microbiological testing. The operator will have to have mollusc samples tested both pre and post purification although the frequency of testing is not defined.

8.4 Labelling

A system of labelling and documentation will be necessary such that molluscs can be traced back to source. This may already exist.

8.5 Storage and Transport

Temperature control is called for but not specified. Our work has shown that mussels are best kept at temperatures of $0^{\circ}C$ ideally with ice. Conditions for storage and transport are given and in addition require molluscs to be protected from possible contamination. The movement of purified mussels in onion sacks on the back of an open, wooden flat bed lorry would not comply in our view.

9. CONCLUSIONS AND RECOMMENDATIONS

1. Under current U.K. criteria for puriciation plant design the seven channels could not be used as independent purification tanks with the existing water flow system. We recommend that they be made into two separate systems of three and four raceways each.

2. To create two independent purification tanks from the existing layout will involve :

   5.1 Partition walls in the weir and sump

   5.2 Disconnection of the header tank from the system

   5.3 The four channel tank will use existing pipework and u.,v. sterilser units with one pump

   5.4 The three channel tank will require new pipework and resiting of the second pump

   5.5 The three channel tank will also require five new UVAQ 630/8P u,v. sterilsers

3. We anticipate that it may not be possible to maintain adequate dissolved oxygen levels in the tanks without supplementary aeration. A monitoring exercise will be required to establish the number and positions of air diffusers.

4. Under U.K. criteria trays should be filled with up to 15kg of mussels. We consider that this could be increased to 20kg provided dissolved oxygen is monitored. Ultimately it may be possible to define tray loading by water temperature. Bags must not be used for purification.

5. The tanks should not be operated when the water temperature is consistently below $5^{o}C$. We would advise great caution at water temperatures above $15^{o}C$.

6. Horizontal spraybars should be used at the head of each raceway.

7. The existing header tank could be converted into a fresh water storage tank for the plant.

8. Mains power should be installed as soon as possible. The existing generator can be used as a standby.

9. The present E.C. proposals may require a building for handling and storage of mussels and some cover for the purification tanks.

10. When finally modified and tested detailed instructions should be drafted for the operation of the plant.

11. Seafish could assist further in the testing of the plant and the drafting of instructions.