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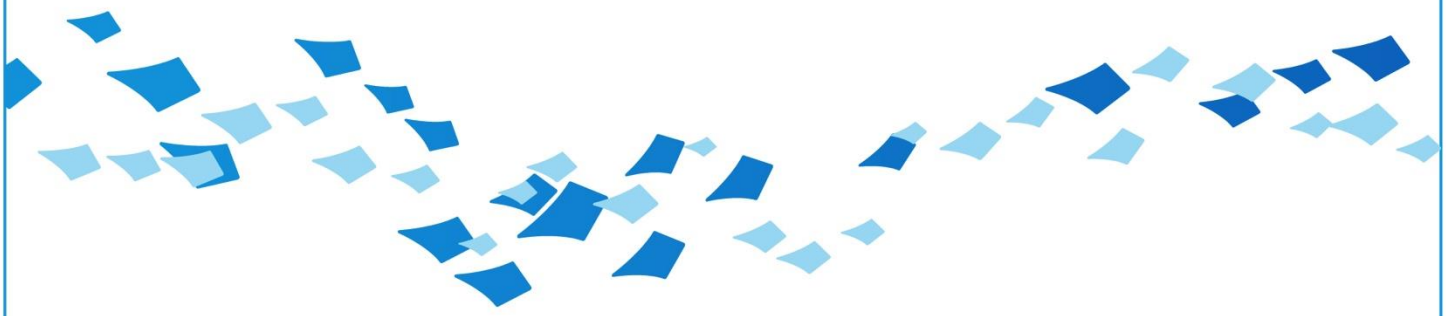
How to Build a Shellfish Purification Centre



About this Guidance

This document is intended to provide concise and practical advice in relation to constructing a shellfish purification centre. It offers details on four key project stages, namely, planning, site selection and permissions, design and build, and approval. It also touches on relevant training.

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Contents

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Disclaimer:

The use of this guidance is not compulsory. It is the responsibility of the individual Food Business Operation to make sure all appropriate and necessary steps are taken, and all pertinent regulations are adhered to, when building a shellfish purification centre.

Why Purify Shellfish

The classification of a shellfish production area determines the treatment required before Live Bivalve Molluscs (LBMs) may be marketed for human consumption[1]. These production areas (and relay areas[2]) are classified according to the levels of the bacteria *Escherichia coli* (*E. coli*), an indicator of faecal contamination detected in the flesh of shellfish. Details on the permitted levels of E. coli, and the subsequent level of treatment required for each classification, are provided by the Food Standards Agency (FSA) and Food Standards Scotland (FSS)[1].

In the UK, there is a long history of using purification to overcome the problems caused by sewage-derived microbial contamination of shellfish harvesting areas due to the large numbers of people living, and/or livestock being extensively reared, in catchment areas that drain into coastal waters.

Whilst the ideal situation is to have good water quality in production areas, rather than remove contamination after the event, commercial purification is widely used across the UK (and Europe) to treat harvested LBMs ensuring shellfish is fit for human consumption. Purification is only one of the supply chain activities from harvesting LBMs, preparation for market and onto our plates[3].

What is Shellfish Purification?

Shellfish purification can also be referred to as ‘depuration’. The two terms are interchangeable, but for the purposes of this document ‘purification’ is used. The term relates to the use of a controlled, aquatic environment to reduce low-level contamination by bacteria in live bivalve shellfish to a safe, acceptable level for human consumption. Purification is a natural biological process whereby bivalve shellfish purge themselves of microbial contamination by filtering sterilised seawater.

It must be noted that whilst purification has been shown to be effective at removing bacterial pathogens, it has only a limited impact on levels of human enteric viruses such as Norovirus within bivalve shellfish. For the purposes of this guidance, the focus is on reducing *E. coli* counts via purification.

LBMs destined to undergo purification must be in good condition. They are sensitive animals that are susceptible to stress through exposure to temperature extremes and physical shock. It is therefore vital to ensure that good harvesting and general handling practices are

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[1] Various elements of, and official guidance in relation to, shellfish classification, including current lists of English, Welsh and NI production areas for LBM, can be found on the FSA’s ‘Shellfish Classification’ page here. For Scotland, visit the FSS ‘Shellfish Safety and Sanitation’ page here.
[2] Relaying – shellfish harvested from contaminated areas can be placed in clean ‘relay’ areas (free from microbiological contamination) to allow them to cleanse themselves by a continuation of their normal filtering and digestive processes (WHO, 2010 – ‘Safe Management of Shellfish and Harvest Waters’
[3] Seafish ‘Good manufacturing practice guidelines Live bivalves workbook’ 2019

followed so that the animals are not unduly stressed, and to ensure end product quality is not unduly affected.

Building a Purification Centre – Key Stages and Considerations

A Purification Centre is an establishment with tanks fed by clean seawater in which live bivalve molluscs are placed for the time necessary to reduce contamination to make them fit for human consumption. A 'Dispatch Centre' on the other hand is any on-shore or off-shore area that processes shellfish fit for human consumption. Dispatch centres often incorporate a purification centre / system.

The construction of an LBM purification plant includes four main stages which are detailed below:

1. Planning
2. Site Selection and Permissions
3. Design and Build
4. System Approval

In relation to the four stages, a developer needs to take on-board, and keep in mind, the following two over-arching recommendations:

A. It is important, from the outset, that contact is made with the appropriate Local Authority (LA) departments (i.e. Planning, Building Standards and Environmental Health). Facilities have the best chance of being approved when good working relationships are established, and regular communications maintained between the developer and all relevant parties throughout the process.

B. Engaging expert and professional assistance – whether to help with securing consents and permissions; designing and/or building the actual system; or undertaking operator training – could make the process much smoother, efficient, and effective. Whilst costs may be increased by using consultants and/or turnkey system suppliers, ultimately the less problematic the process, the greater the likelihood that the desired outcome of a safe and reliable LBM purification system will be on-stream quicker.

Stage 1 – Planning

Planning is the process of articulating the vision and defining the goals of a project. It sees the collection / collation of all pertinent information relating to the requirements of the build. A purification centre developer needs to identify and engage with the relevant stakeholders such as LA representatives, consultants, construction mangers, etc., and instigate discussions as early as possible. In doing so, these collaborative conversations will, amongst others, ensure the project and system is feasible and approvable; the build is considered in relation to the necessary structural and operation regulations / parameters; and the various permission and licences required are understood and are attainable.

The duration of this initial stage, whilst still envisaged to take months, may be shortened, if all relevant stakeholders are on-board straightaway; it will also help minimise delays in subsequent stages.

- Structural and operational parameters that must be adhered to for purification (and dispatch) centres are found in Regulation (EC) No 853/2004, which specifies hygiene rules for food of animal origin[4].
- Resources such as the 'Aquaculture Regulatory Toolbox for England', and its Welsh equivalent[5], provide Cefas guidance on the permissions needed to establish a marine shellfish purification centre.

Stage 2 – Site Selection and Permissions

Carried out by the developer and/or consultant(s), a suitable site needs to be selected and secured for the development, and in relation to the discussions and research carried out in Stage 1. There are several important considerations to take into account in relation to site requirements:

- Planning regulations – LA planning regulations may be the deciding factor as to where a purification centre can be sited, its size and exterior design. It may be that in a particular shore-side or rural location it is difficult to site a new development due to LA restrictions in place. Alternatively, in other LAs it may be that similar areas have been earmarked for new development, and/or certain new and pre-existing structures, such as small agricultural buildings or industrial estate units, may be exempt from some planning requirements. Again, establishing a good working relationship with the appropriate LA department(s) is recommended.
- Access to the necessary infrastructure and services – any prospective site needs to consider its seawater supply (whether raw or artificial – see below); municipal services, power and communications; transport logistics / connections for raw product(s) (shellfish and other consumables) and finished product(s); disposal of wastes (liquid and solid); and labour to operate the centre.
- Seawater:
    - A consistent source of good quality, clean seawater is a necessity for proper purification, and is vital to avoid contaminating the shellfish in the system. The operator of the purification centre, i.e. the Food Business Operator (FBO) is responsible for the quality of the seawater being used. The various factors affecting the suitability of seawater, as well as the technical practicalities, dis/advantages of using natural and artificial seawater are explored in various documents[6].
    - Using artificial seawater can widen potential locations for siting a purification centre as it would not need to be tied to a coastal location with access to natural seawater.

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[4] REGULATION (EC) No 853/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 29 April 2004 laying down specific hygiene rules for food of animal origin
- Annex III, Section VII, Chapter III - structural requirements for purification (and dispatch) centres
- Annex III, Section VII, Chapter IV - hygiene requirements for purification (and dispatch) centres

[5] Aquaculture Regulatory Toolbox for England – see 'Marine Shellfish Purification' PDF; Aquaculture Regulatory Toolbox for Wales – see 'Marine Land based – Shellfish Purification (RAS)' PDF

[6] See: Water Quality in Purification (Depuration) Systems Guidance for Purification Plant Operators – Cefas, 2012; Bivalve depuration: fundamental and practical aspects – FAO Fisheries Technical Paper, No. 511

- The flow of water may be via flow-through or a recirculating system (natural seawater or artificial seawater respectively). In a recirculating system, the water is sterilised as it is circulated, generally by ultra-violet light (UV), although other methods such as the use of ozone are becoming more common. In a flow-through or single-pass system, the seawater requires a much higher and more intense initial sterilisation process as it is not recirculated back through the UV system.

Stage 3 – Design and Build

Whist not compulsory, engaging professional assistance in relation to the design and build of a purification centre, could be advantageous for a number of reasons – provision of expert advice and guidance; designs reflecting current building standards; engagement of qualified trades (e.g. mechanical and electrical installation), with guarantees for any work carried out.

Conceptual Design

Initially a conceptual design will be created (usually by a design engineer) which will often consist of the following elements: draft site layouts / plans / 3D-design of the entire operation and the purification system; a schedule of operations; a mechanical 'Bill of Quantities' (e.g. outlining what equipment will be needed); an 'Electrical Bill of Quantities' (e.g. list of electrical equipment ; outline the system's power usage); and a budgeted price for the full construction and commissioning of the system.

The overall cost of the conceptual design will be a relatively low cost compared to the total build cost. The scale, complexity and location of the project, as well as the amount of information available to the design engineer from the outset, will all influence conceptual design and ultimately build costs. It's reasonable to assume conceptual design costs alone could range from a few thousand pounds upwards, again depending on scale, complexity and location of the project.

The Building

A purification system must be housed in a suitably robust and secure building - something along the lines of an industrial unit. General requirements of the building would include:

- Openings
  - Windows and doors must be constructed to prevent the build-up of dirt and be easy to clean / maintain.
  - Access to the buildings and site should be suitable for the management of biosecurity.
    - They must also stop pests / vermin being able access the building's interior.
    - External openings may need to be fitted with insect-proof screens which are removable to allow for cleaning.
- Internal surfaces
  - Floors and walls are easy to clean and maintain. Floors and walls should be smooth, hard-wearing, washable, and well-maintained.
  - Flooring should be non-slip.

    - Ceilings which prevent the build-up of dirt, reduce condensation, mould growth and shedding of particles. They too should be smooth, easy to clean and well-maintained.
- Fittings, surfaces, and equipment
    - All fittings, surfaces and any used for bivalve handling or purification equipment must be in good order and in a condition that allows effective and frequent cleaning, and when required, disinfection.
    - Dedicated sinks and/or equipment provided for cleaning / disinfecting live bivalve handling equipment.
- Storage and waste
    - Adequate and appropriate space for the reception and storage of live bivalves pre-purification.
    - Adequate and appropriate space for post-purified bivalves awaiting dispatch.
    - Adequate space for storing deliveries, consumables, utensils, equipment and cleaning materials.
    - Dedicated liquid and solid waste containment / disposal area(s) which are accessible to waste collection services.
- Staff Facilities
    - Changing and/or mess facilities which are clean, dry and warm.
    - Enough handwashing facilities and toilets appropriate to the number of staff.
        - These need to be maintained in good order, be clean and have hot and cold potable running water plus materials for hygienically cleaning / drying hands.
    - Toilets must not lead directly off / into food handling areas or areas where LBMs may be handled, stored or purified.
- Ventilation, lighting, and drainage in all areas of the building is appropriate / adequate.

The Purification System

It's recommended that a shellfish purification system is based on Seafish's design standards. These fall into the following six categories, each with its own accompanying operating manual[7]:

- Medium scale multi-layer stack
- Large scale multi-layer stack
- Small scale shallow tank
- Bulk bin system (mussels only)
- Vertical stack system
- Non-standard design (based on elements of the other five standard system designs)

[7] Links to the six Seafish bivalve shellfish purification system manuals:

- Seafish Standard Design Purification Systems: Operating Manual for the Small Scale Shallow Tank Purification System
- Seafish Standard Design Purification Systems: Operating Manual for the Medium Scale Multi-Layer System
- Seafish Standard Design Purification Systems: Operating Manual for the Large Scale Multi-Layer System
- Seafish Standard Design Purification Systems: Operating Manual for the Vertical Stack System
- Seafish Standard Design Purification Systems: Operating Manual for the Bulk Bin System for Mussels
- Seafish Non-Standard Design Purification Systems: Generalised Operating Manual for Purification Systems of Non-Standard Design

Originally developed in the 1990's, these manuals were updated in March 2018 to reflect current good practice and latest legislation at that time. They continue to be a trusted and frequently referenced resource, valuable not only for individual businesses and LAs, but official Regulating Bodies such as FSA and FSS, as well as international bodies and research programmes (e.g. the FAO). They provide technical information including specifications of materials, system testing, operating, monitoring, cleaning, and problem solving.

There is no legal obligation for a purification centre system to follow Seafish's standard design. However, these six standard models have been extensively tested, are frequently used by industry, and are represent proven technology. The level of evidence required in validating and officially approving a system that is not based on the principles of a Seafish design may well be increased, together with associated costs.

Again, whilst not compulsory, engaging professional services / suppliers in constructing the actual purification system may be advantageous, as would using 'plug and play' or 'turnkey' units (based on Seafish standard designs). Such equipment comes guaranteed, will speed-up installation and overall system build, and their ability to 'do the job' is proven. It instils confidence that the system will gain its official approval and be effective and reliable.

An advantage of a system consisting of turnkey components is that it can be relatively easily dismantled, with its units having a 'resale' value. As such, plug and play systems could be eligible for credit agreements; helping developers spread costs over time. Also, adding turnkey units to a system over time will allow capacity to be increased as and when the FBO needs it.

There are only a very small number of UK-based manufacturers of turnkey purification units, including 'Laity tanks' (believed to be part of Sailors Creek Shellfish[8]), Menai Oysters and Mussels[9], Todd Fish Tech Ltd.[10] and the Tropical Marine Centre (TMC)[11].

Box 1 provides further background information on turnkey purification equipment from two of these suppliers, namely Todd Fish Tech, and TMC.

[8] https://www.sailorscreekshellfish.co.uk/
[9] https://www.menaioysters.co.uk/purification-systems/
[10] http://www.toddfishtech.com/bivalve-depuration/
[11] https://www.tropicalmarinecentre.com/en/products/drygoods/equipment/tmc-systems/tmc-shellfish-depuration-system

Box 1 – Bivalve Purification: Turnkey Units 2021

Todd Fish Tech Ltd. (information from the company web site, and via pers. comm.)

Todd Fish Tech Ltd. is a Scotland-based consultancy, designer and manufacturer of equipment and systems related to shellfish storage, transportation, including LBM depuration. It is the biggest of the limited number of UK manufacturers and suppliers of this type of equipment and offers the largest range of turn-key purification units (six in total).

Todd Fish Tech bivalve purification unit components - each turnkey system includes:

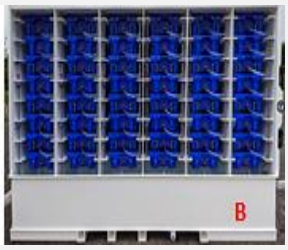
- Either a tank (Insulated fibreglass tank with self-cleaning base) or polypropylene pod
- Recirculation pump (energy efficient pump)
- Ultraviolet steriliser (a 55watt UV - larger than the minimum 35watt required)
- Flowmeter
- Pipework (plastic ABS industrial quality; impact resistant and less brittle at lower temperatures)
- Fittings (all A4 stainless steel)
- Stacking trays

Specifications of Todd Fish Tech Turnkey Bivalve Purification System Units (Feb. 2021)

Description	Dimensions	Water volume	Price	Capacity Oysters	Capacity Mussels	Capacity clams	Capacity Cockles	Capacity Razor clams
Small-scale Purification tank – fibreglass tank, submerged baskets, inc. chiller (Image A)	1.2m x 1m x 0.7m	600 litres	£3,200	750	90kg	84kg-108kg	90kg	40kg
Large Purification tank – fibreglass tank, submerged baskets, inc. chiller	2.4m x 1.4m x 0.6m	1,400 litres	£6,250	2,500	350kg	350kg	300kg	160kg
Oyster Pod Stacking System – 8 trays, inc. chiller	0.62m x 1m x 2.2m	300 litres	£4,000	1,000	n/a	168kg	120kg	48kg
Oyster Pod Stacking System – 16 trays, 2 stacks of 8 inc. chiller	1.2m x 1m x 2.2m	600 litres	£8,000	2,000	n/a	336kg	240kg	96kg
Oyster Pod Stacking System – 32 trays, 4 stacks of 8 inc. chiller	2.4m x 1m x 2.2m	1,200 litres	£16,000	4,000	n/a	672kg	480kg	192kg
Oyster Pod Stacking System – 48 trays, 6 stacks of 8 inc. chiller (Image B)	3.6m x 1m x 2.2m	1,500 litres	£24,000	6,000	n/a	1,008kg	720kg	288kg

Costs of using Todd Fish Tech turnkey components in two purification system examples:

- A small shellfish trader dealing with various species requiring a flexible system consisting of two small-scale tanks, and one 8 tray oyster pod = £10,400
- A significant oyster producer needing a large system consisting of six 48 tray oyster pods = £144,000



Tropical Marine Centre (TMC) (information from the company web site, and via pers. comm.)

Tropical Marine Centre is a leading, UK-based, international supplier to the ornamental aquatics trade. They are also manufacturers and distributers of commercial filtration equipment and aquatic products; suppling biosystems to both the ornamental and aquaculture sectors. TMC build and supply a plug and play small-scale commercial depuration unit – specifications below. The unit's price is available on request from the company. TMC also manufacture UV sterilisers, protein skimmers and can supply filtration equipment such as pumps, filters, chillers, pipework and fittings for fully customised systems.

TMC purification unit components – the turnkey unit includes:

- Insulated food grade container (double walled, HDPE foam filled)
- Drainage port with sump in each corner
- Can be filled via the UV steriliser using the multi-stage hosetail
- 100% waterproof pump (up to 30 litres/minute), flow meter and a ball valve
- Holds six stackable baskets, each with open mesh sides and bottoms

Specifications of TMC Commercial Purification Unit (Mar. 2021)

Description	Dimensions (mm)	Shipping Weight	Water volume	Flow Rate	Total Stocking Density			
					Oysters	Mussels	Clams	Cockles
TMC Small-scale Depuration Unit (Image C)	1375 x 1120 x 750	60 kg	628 litres	28 litres/hr	750	90kg	84kg	90kg

Build

Assuming the contents of the designs are satisfactory, the price is acceptable, and the developer is happy, then the project will proceed. Often the following elements will make up this final sub-stage: finalised designs approved; equipment purchased and delivered to site; all building and site works carried out, the system is tested, and any snags addressed. The duration of this sub-stage could be in the order of weeks to months, depending on the scale, complexity, and location of the project.

Test

Once built the system needs to be filled and tested, e.g. to makes sure there are no leaks, the water flow is balanced (i.e. circulates correctly and tanks and bins fill and drain at the desired rate), and the sterilisation system / UV lamps operate correctly, etc. 'Snagging' the system will list all issues that need to be addressed.

Stage 4 – System Approval

- Approval will be decided by an LA Authorised Officer (AO) (i.e. a suitably trained Environmental Health Officer or 'EHO'). In England, Wales and NI they will follow the guidance provided by the FSA[12]. There is similar guidance for Scottish AOs from FSS[13].
- The FBO should prepare for the approval process:
    - Have a Food Safety Management Plan (FSMP) in place based on Hazard Analysis and Critical Control Points (HACCP) Plan[14], plus all other documentation which would apply to any food business in order to comply with food safety and hygiene law[15].
    - Provide evidence to the AO to demonstrate compliance, i.e. bacteriological challenge tests using sufficiently contaminated bivalve shellfish (such tests are the responsibility of the FBO and can prove time consuming / costly, particularly if repeated).
- The AO will approve a system only if satisfied that it is designed and operated in accordance with basic rules, that there is sufficient evidence to demonstrate that the system will satisfactorily purify LBMs, and that staff operating the system are trained commensurate with their responsibilities. The approval process should only take a few days.
- If an FBO is considering modifying their existing purification system, including the potential to reduce purification times[16], they will need to notify and engage with the LA before any changes are made. A modified system will need to be re-approved.
- If a business changes ownership, then there is a requirement for the system to be re-approved.

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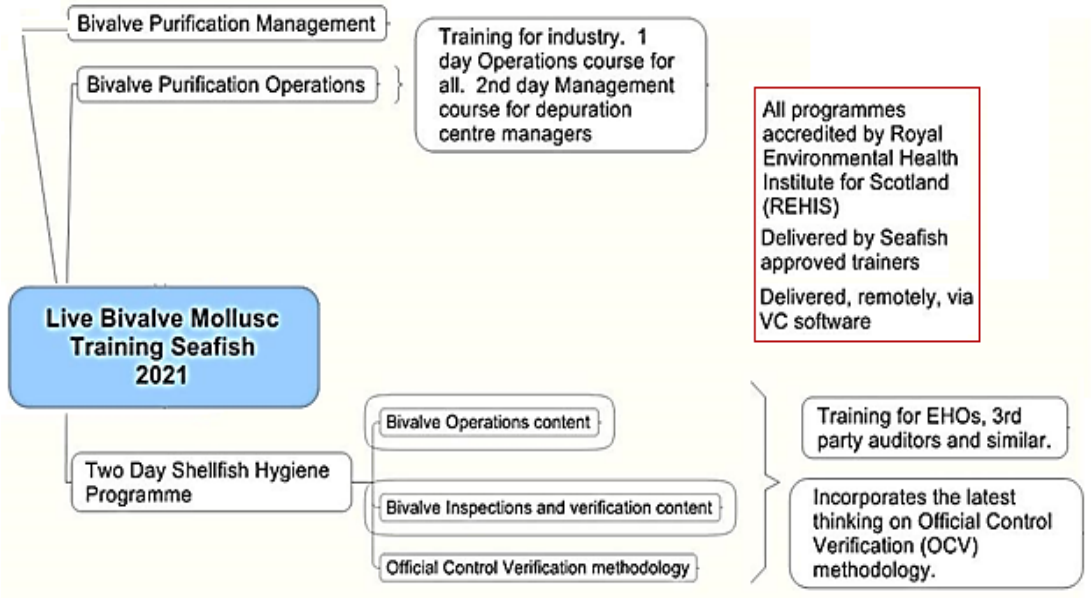
[12] FSA – 'Guidance for Local Authority Authorised Officers on the Inspection of Purification Systems for Live Bivalve Molluscs in England Wales and Northern Ireland', 2016
[13] FSS – 'OFFICIAL CONTROLS OF SHELLFISH PURIFICATION SYSTEMS GUIDANCE FOR LOCAL AUTHORITY OFFICERS' 2018
[14] Seafish – Guidance on HACCP Plans for Bivalve Purification Operations 2021
[15] See FSA 'Business Guidance', and FSS 'FOR BUSINESS & INDUSTRY' online resources
[16] Seafish – Assessing Risk Based Reduction in Purification Times for Bivalve Molluscs 2021

LBM Purification – Training

Whether for a new and recently approved purification centre, a well-established FBO seeking to modify its system or a LA that finds itself increasingly called upon to appraise and approve purification systems, these all need adequately trained individuals, to ensure the necessary procedures and processes are safe, effective and efficient.

Figure 1 – Seafish LBM Training Programme, 2021



Seafish offers a range of LBM training courses, pertinent to both FBOs and EHOs. Figure 1 shows the 2021 Seafish LBM Training Programme; the courses and who they are targeted towards / pertinent to. For further information, visit the Seafish website[17] and/or email the Onshore Training team (onshore@seafish.co.uk).

[17] Seafish Onshore Training pages - https://www.seafish.org/safety-and-training/onshore-training/

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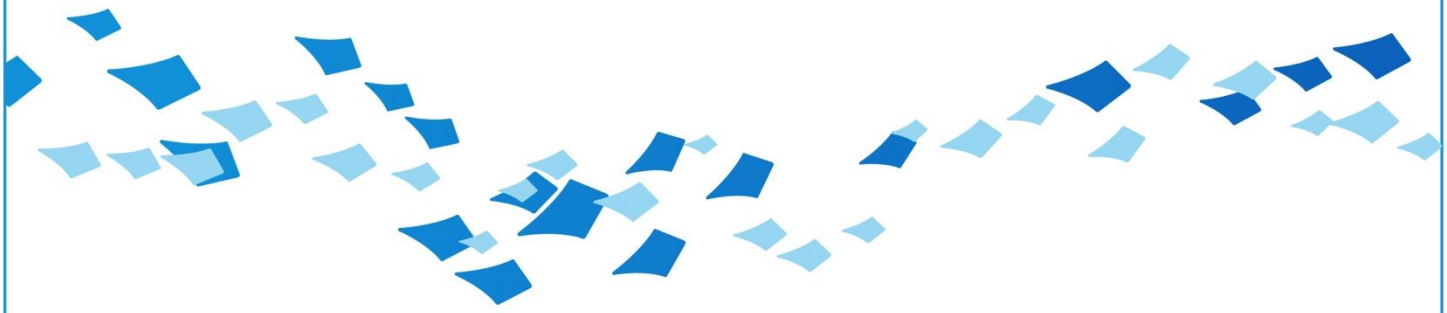

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