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# “SALMON FEEDER BARGE”

## H<sub>2</sub>S GAS PURGING



**Portree, Scotland**

**For**



**CONTENTS**

**1. INTRODUCTION** ..... ERROR! BOOKMARK NOT DEFINED.

    1.1. BACKGROUND ..... 3

    1.2. PURPOSE AND SCOPE ..... 4

**2. METHODS**..... 5

    2.1. TASK LIST..... 5

**OIL AND GAS REMOVAL**..... 5

**3. BRIEFING RECORD**..... ERROR! BOOKMARK NOT DEFINED.

Abbreviation	Definition
CTV	Crew Transfer Vessel
CH <sub>4</sub>	Methane (gases)
DS	Dive supervisor
DSV	Dive Support Vessel
H2S	Hydrogen Sulfide (gases)
IBC	Intermediate Bulk Container
VTS	Vessel Traffic service
NOK	Next of Kin
PAX	Passengers
PID	Photoionization device
PLB	Personal Locator Beacon
POB	Persons on board
PM	Project Manager
PPE	Personal Protective Equipment
SMB	Surface Marker Buoy
SOLAS	Safety of Life at Sea



## 1 INTRODUCTION

### 1.1. Background

The Seamate 450 fish feed barge supplying pellet food to the salmon farm in Portree Harbour, Isle of Skye sank during Storm Arwen in Q4 2021 with approximately 400t of feed on board. Owners, Scottish Salmon Company (SSC), instructed Briggs Marine Contractors (BMC) shortly thereafter to secure the feed silos with temporary hatch covers to control and prevent the emission of feed oils that are part of the feed pellets from being emitted to the environment. In May 2022 BMC was awarded the contract to recover the barge. An ROV survey was conducted in June 2022 to aid the preparation of the salvage plan. Preliminary diving work started on site July 2022 with the aim of preparing the barge for recovery August 2022. During these works it was noticed that gas bubbles were escaping from the temporary hatch covers and from previously unidentified cracks in the concrete wall of the accommodation block on the starboard stern. These gas bubbles had not been identified during the ROV survey or during the early preparatory works.

Hoses, pumps, and two IBCs were supplied to allow the relief of the unknown pressure within the silos as there was concern over the possibility of an uncontrolled release of the pent up gases and oils or structural harm to the barge as cracks were identified by the emission of the gases. During the relief of the gas and oils from the silos it became apparent that the gases were toxic in composition with Hydrogen Sulphide (H<sub>2</sub>S) and Methane (CH<sub>4</sub>) detected.

During diving operations, a gas sample was collected directly from the sunken barge itself, and analysed by a Marine Chemist which provided the results of the presence of H<sub>2</sub>S in concentrations of 55,000 ppm which puts the gas into explosive range but only when oxygen is introduced as levels in the silos for O<sub>2</sub> are very low at 2.4% volume.

Actual readings from silo test below -

O <sub>2</sub>	:2,4 %vol
CO	:1580 PPM
H <sub>2</sub> S	:5,5 % vol (55000 PPM)
LEL	: 100 % (not accurate O <sub>2</sub> <8 % vol)
VOC	: 231 PPM (PID)

Please note the lower explosion limit of H2S is 4,3 % vol

At August 26 BMC was released of their duties and a different contractor was brought in to assist SSC with the gas purging works.

## 1.2. Purpose and Scope

The purpose of this methodology document is to provide a clearly defined process for the removal of any further oils and gas within the silos of the barge.

## 1.3 Roles and Responsibilities

The site Dive supervisor has the authority to supervise the Dive team and operations in accordance with procedures, legislation, ACOP and guidance.

- Responsible for safety of all personnel at the work site
- To confirm that all personnel have sufficient training and competence to carry out works
- To confirm all equipment is certified against industry standards
- To confirm that risk assessments relevant to work scopes have been completed
- Responsible for efficient operations of the project and to ensure all personnel employed to carry out works are competent to do so.
- Reports to Salvage Master.
- Ensure that equipment maintenance activities are carried out in accordance with industry standards.
- Must initiate Emergency Response if an incident/medical emergency takes place at site

2. METHODS

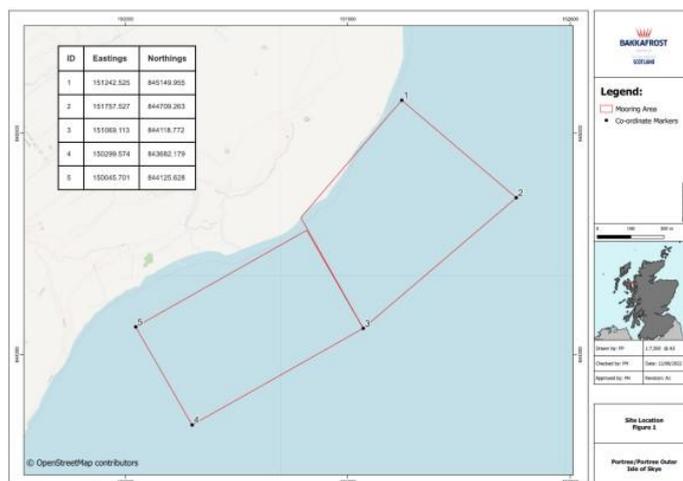
2.1. Task list

- Oil/Gas removal and site gas monitoring

2 OIL AND GAS REMOVAL

The following steps describe the procedure for venting and removing the oil from the silos subsea and the monitoring of gases around the casualty area

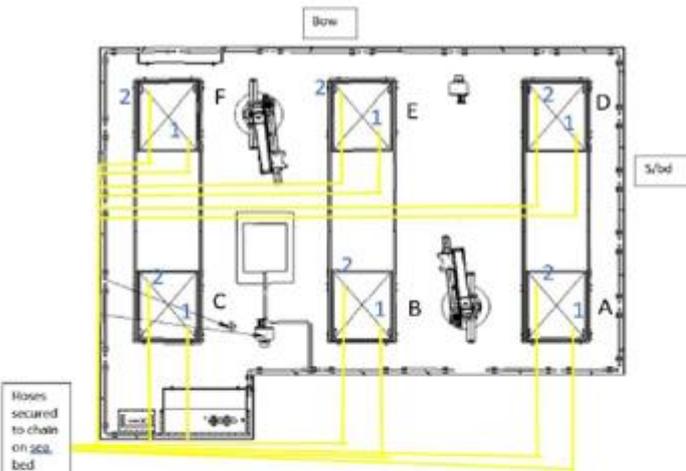
Method of Work		
Item	Task	Persons responsible
	<b>NO SMOKING ALLOWED!</b>	
	<p><b>Note: Project team and Vessel Master assess weather conditions and sea state are within parameters to carry out tasks.</b></p> <p>Maximum operational limits:</p> <p>Water current: 0.8 knots</p> <p>Surface visibility: ≤1km</p> <p>Lightning Risk: Lightning forecast within 4hrs</p> <p>Wind speed: 20 knots</p> <p>Significant wave height: 1m</p>	
	<b>Notice to mariner's exclusion zone for operation</b>	





Area gas monitors to be positioned at below locations for continuous readings of H2s to the North, East, South and West from casualty location.

<p>1.</p> 	<p>Dive supervisor holds TBT with team.</p> <p>Reviews risk assessments and emergency procedures</p> <p>Dive Supervisor obtain permit to work from vessel and harbour authority</p>	<p>Dive supervisor and Duty officer</p>
<p>1.</p>	<p>Dive supervisor holds toolbox talk – ensuring that all personnel are aware of the escape plan, safe use of the escape set and familiarisation with the risks at hand, including irritation of skin at wrists and neck if H2S concentrated in water</p>	<p>DS</p>
<p>2.</p>	<p>Personal gas monitors to be bump tested and recorded daily</p> <p>Static monitors to be checked for functionality during all plant checks</p> <p>BA sets to be checked over for readiness, charged if necessary and placed into locations for immediate access by the dive team.</p>	<p>All crew</p>
<p>3.</p> 	<p>Only personnel immediately needed to perform the task are to be present on deck e.g. Crane operator, slinger banksman</p> <p>Escape sets to be worn by all personnel on the vessels – ready for use!</p> <p><b>NO SMOKING ALLOWED!</b></p>	<p>All Crew</p>
<p>4.</p>	<p>Gas monitor readings to be obtained in all areas</p> <p>CH<sub>4</sub> =</p> <p>O<sub>2</sub> =</p> <p>C<sub>0</sub> =</p> <p>H<sub>2</sub>S =</p>	<p>All crew</p>
<p>5.</p>	<p>Dive team to set up the dive spread and plant for the scheduled tasks ahead</p>	<p>Dive team</p>
<p>6.</p>	<p>Nitrogen spread to be set-up on the Forth Warrior with sufficient length of hoses and connections to reach and connect to the valves on the silos on the sunken barge.</p>	<p>DS Dive team</p>
<p>7.</p>	<p>DS and Vessel Master confirm vessel and working Forth Warrior are in suitable positions for diving</p> <ul style="list-style-type: none"> <li>• Forth Warrior to be within the 4-point mooring grid</li> <li>• MV Forth Drummer to be attached to the 4-point mooring grid, but on the outside, on 2-points of mooring just, up wind from the venting gases</li> </ul>	<p>DS Vessel Master</p>
<p>8.</p>	<p>Function test equipment, Standby and diver cross checks complete.</p>	<p>Dive team</p>
<p>9.</p>	<p>Dive team and deck crew ensure all hoses and tools are ready to be lowered to the diver down the job line using a messenger line</p>	<p>Dive team Deck Crew</p>

10.	Diver enters the water via the dive ladder	Diver Tender
11.	Diver places hat and hoses under the surface to check for leaks, Topside tenders to confirm to DS that there are / are not leaks.	Diver Tenders DS
12.	When satisfied there are no leaks DS instructs diver to leave surface. (In the event of leaks dive is aborted and diver recovered to deck to check leaks and repair)	DS Diver Tenders
13.	Diver makes way down the job line taking the first length of hose from Nitrogen spread Topside paying out the hose as diver descends	DS Diver Deck crew
14.	Diver takes hose to first location as listed in the table below  	Diver
15.	 Prior to connecting the crows' feet fittings, diver is to make sure umbilical is clear	Diver
16.	Diver connects fittings in order of the table, confirms with DS before securing with R-clip and whip checks	Diver DS

17.	Diver connects remaining Nitrogen hoses in sequence and confirms each are securely connected.	Diver DS
18.	Diver now connects each of the venting hoses in a similar manner as per the diagram above, Point 14, ensuring each hose is securely fastened	Diver DS

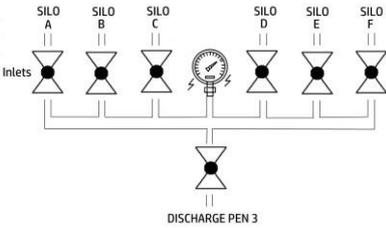
19.	Diver uses zip ties to secure the hose running along to the Aft Portside quarter railings ensuring the hoses will be clear of lifting ops to take place	Diver DS
20.	Diver requests next hose is sent down the job line on the weighted messenger	Diver DS Topside
21.	Diver recovers hose and instructs topside to recover messenger	Diver DS Topside
22.	Diver installs hose on next position. Repeat steps 13 – 19 until all hoses are in place.	Diver
23.	Diver to secure all hoses to each other at the Aft Portside quarter and then secure to the Chain on the seabed that runs towards the pens from the Port side of the vessel	Diver
24.	Diver will secure an SMB to themselves and make way along the chain securing the hoses to the chain on the bed.	Diver
25.	Once the SMB is at distance safe enough for the MV Forth Drummer to move in and out of moorings the diver make way back to the barge	Diver DS Vessel master
26.	Diver leaves bottom and makes way to the job line for ascent to surface, adhering to ascent rate stipulated by the DS in accordance with tables	Diver DS Tenders
27.	Diver leaves the water at the splash zone ladders	Diver DS Tenders
28.	Tenders will use PID meter to ensure the PPM levels from the divers clothing are at a safe level prior to making contact with the diver to undress	Tenders
29.	Once the diver is on deck, the FRC will be used to place a weighted 27mm polypropylene line down the SMB a second line is to be secured for recovering the pipes to the surface	FRC skipper Crew

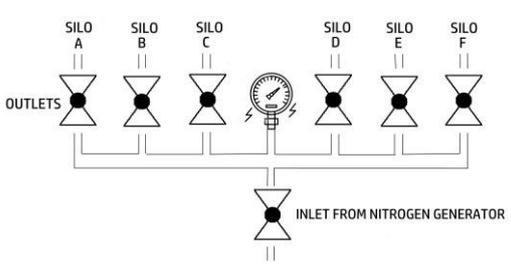
30.	When the FRC is back alongside the next diver can enter the water	DS Diver FRC Skipper Vessel
31.	Diver places hat and hoses under the surface to check for leaks, Topside tenders to confirm to DS that there are/are not leaks.	Diver Tenders DS
32.	When satisfied there are no leaks DS instructs diver to leave surface. (In the event of leaks dive is aborted and diver recovered to deck to check leaks and repair)	DS Diver Tenders
33.	Diver leaves surface and descends along the job line	DS Diver Tenders
34.	Diver makes it to the top of the barge, moves along secured hoses to the seabed and makes way along the chain and hose to the SMB.	Diver Tenders
35.	Diver removes the polypropylene line from the SMB and secures to the chain on the seabed Diver secures hose ends to the recovery line secured to the polypropylene line for recovery to surface	Diver
36.	Diver removes the SMB marker buoy reel from the chain and releases for recovery by the FRC	Diver

<p>37.</p>	<p>Dependant on bottom time</p> <ul style="list-style-type: none"> <li>- Diver will make way back to the barge and leave bottom</li> <li>- Diver will leave bottom at the marker buoy just installed</li> </ul> <p>Diver leaves bottom and adheres to ascent rate stipulated by the DS in accordance with tables</p>	<p>Diver DS Tenders</p>
<p>38.</p>	<p>Diver leaves the water via the splash zone ladders</p> <p>Tenders will use PID meter to ensure the PPM levels from the divers clothing are at a safe level prior to making contact with the diver to undress</p>	<p>Diver DS Tenders</p>
<p>39.</p>	<p>Once the diver is on deck the FRC can make way to the buoy recover hoses and secure at the surface on the marker buoy</p> <p>If possible, dive team will utilise one of the marker buoys in location</p>	<p>Diver DS Tenders FRC Skipper Crew</p>
<p>40.</p>	<p>Hoses are now installed sub surface ready for connections on the surface</p>	<p>All crew</p>
<p>41.</p>	<p>Hoses recovered with the FRC and run to the 1<sup>st</sup> of the Northern pens on the inshore side to the manifold for venting, and discharge of oils into the boomed off area in the 3<sup>rd</sup> pen North inshore side.</p>  <p><b>Figure 1 Proposed boomed off area (image for reference only)</b></p> <p>From the manifold at pen 11 the discharge pipe will continue onto pen 3 for discharge into the boomed off area.</p> <p>The discharge pipe is tethered to the pen using ropes, there will be 4 pellet buoys placed between pens 1 and 2, then 4 pellet buoys placed between 2 and 3.</p>	<p>FRC Skipper Crew</p>



42.	<p>When all pipes have been connected and confirmed secure dive team will prepare to dive and open the valves on tanks as specified by the dive supervisor and operations supervisor.</p> <p>Gases will be dispersed slowly into the atmosphere – any oils that are recovered in the boomed off area will be recovered using the skimmer and dealt with according to instructions to follow!</p>	All crew
43.	Function test equipment, Standby and diver cross checks complete.	Dive team
44.	Diver enters the water via the splash zone ladders	Diver
45.	Diver places hat and hoses under the surface to check for leaks, Topside tenders to confirm to DS that there are / are not leaks.	DS Diver
46.	<p>When satisfied there are no leaks DS instructs diver to leave surface.</p> <p>(In the event of leaks dive is aborted and diver recovered to deck to check leaks and repair)</p>	DS Diver Tenders
47.	Diver makes way down the job line to the barge, then makes way to tank A	Diver DS
48.	Surface operator to connect N2 hose to Nitrogen generator	Forth Warrior
49.	start compressor and N2 generator open by pass and allow the N2 generator to settle to 97% purity	Forth Warrior
50.	With surface manifold valves all closed diver will be instructed to open Valve A on the venting manifold	DS Diver Tenders

	<p style="text-align: center;"><b>VENTING MANIFOLD</b></p> 	
51.	Surface operator opens valve A1 on venting Manifold and records pressure reading before opening discharge valve to containment boom in pen 3.	
52.	<p>Pressure reading and sample gas to be taken.</p> <ul style="list-style-type: none"> <li>• Pressure reading =</li> <li>• Sample gas H<sub>2</sub>S =</li> </ul> <p>Marine Chemist to be on station to provide direction / confirmation</p>	Diver DS Chemist
53.	<p><b>Nitrogen to be very slowly, continually trickle fed, into the silos with constant monitoring of the pressure readings, to dilute the H<sub>2</sub>S until limit is achieved &lt;20 % lower explosive limit or 8600ppm H<sub>2</sub>s</b></p> <p>Marine Chemist to be on station to provide direction</p>	DS Chemist
54.	Diver exits water at splash zone ladders whilst waiting for H <sub>2</sub> S dilution	DS Diver
55.	When safe to do so again and on advice from Marine Chemist, DS to recommence diving ops., Points 1 – 13 to be stepped through for the venting hoses, where applicable.	DS Chemist
56.	The maximum allowed flow rate from each silo during venting, will be advised by marine chemist	Chemist
57.	Once Silo “A” has been discharged of gas / oil all valves on manifold will be closed ready to repeat previous operation on remaining silos hatches, each time recording pressures for each silo.	DS Diver
58.	When all silos have been depressurised Diver will be instructed to open all 12 valves so control of the venting can be achieved from surface manifolds and to allow low pressure flushing/de-gassing of silos.	DS Diver
59.	Surface operator will open Valve “A1” on venting manifold and “A2” on purging Manifold.	

		<p style="text-align: center;"><b>PURGING MANIFOLD</b></p> 		
60.		<p>Surface operator opens valve to nitrogen generator allowing low pressure inert gas to transverse pipework to the lower valve “A2” which in turn will push any remaining gases and oil up to venting manifold then onwards to pen 3 containment booms.</p>	Forth warrior	
61.		<p>Once operation on silo “A” LEL is below limits of &lt;20 % LEL or 8600ppm H2s the previous operation 61 will be repeated on remaining silos one by one until all 6 silos are venting to pen 3</p>	Forth Warrior	
62.		<p>Nitrogen venting to be carried out 24hrs a day to ensure no build-up of noxious gases.</p>	Forth Warrior	
63.		<p>Gases will be monitored on a 24/7 basis by use of monitors situated at discharge pen 3 which will send information back to the marine chemist direct.</p>	Marine Chemist	
64.		<p>Once Hazardous gases are at an acceptable level fish feed removal will commence.</p>	All	
65.		<p><b><u>Overview of operation</u></b></p> 		
66.		<p><b><u>Overview of equipment set up</u></b></p>		

