



Marine Offshore Rescue Advisory Group: Good practice in offshore rescue

Prepared by **MaTSU**
for the Health and Safety Executive

**OFFSHORE TECHNOLOGY REPORT
2001/040**



Marine Offshore Rescue Advisory Group: Good practice in offshore rescue

MaTSU
154 Harwell
Didcot
Oxfordshire
OX11 0RA
United Kingdom

© Crown copyright 2001

Applications for reproduction should be made in writing to:
Copyright Unit, Her Majesty's Stationery Office,
St Clements House, 2-16 Colegate, Norwich NR3 1BQ

First published 2001

ISBN 0 7176 2068 9

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means (electronic, mechanical, photocopying, recording or otherwise) without the prior written permission of the copyright owner.

This report is made available by the Health and Safety Executive as part of a series of reports of work which has been supported by funds provided by the Executive. Neither the Executive, nor the contractors concerned assume any liability for the reports nor do they necessarily reflect the views or policy of the Executive.

CONTENTS

1	INTRODUCTION	1
	1.1 BACKGROUND	1
	1.2 OBJECTIVES	1
2	SCOPE OF THE REPORT	2
	2.1 SHIP AND BOAT OPERATIONS	2
	2.2 LOCATION, CARE AND TRANSFER OF THE CASUALTY	2
	2.3 HUMAN FACTORS ASPECTS OF RESCUERS	3
3	SHIP AND BOAT OPERATIONS	4
	3.1 OVERVIEW OF VESSELS AND CRAFT	4
	3.1.1 Equipment	4
	3.2 LAUNCH AND RECOVERY	5
	3.2.1 Fast Rescue Craft and Standby Vessel Interaction	6
	3.2.2 Launching Equipment	6
	3.2.3 Designs	7
	3.2.4 Operational Aspects and Limits	8
	3.2.5 Training Aspects	10
	3.3 BOAT OPERATION	10
	3.3.1 Fast Rescue Craft and Daughter Craft Driving Techniques	10
	3.3.2 Specific Rescue Operations	12
	3.3.3 Recovery Directly to the Standby Vessel	13
	3.3.4 Typical Maintenance Problems and Equipment Failures	14
	3.4 ENVIRONMENTAL FACTORS	15
	3.4.1 Overview of Typical Weather for UKCS	15
	3.4.2 Effect of Wind and Waves on Operations	17
	3.5 ADDITIONAL EQUIPMENT	18
	3.5.1 General	18
	3.5.2 Equipment Schedule	18
	3.5.3 Communications Equipment	19
	3.5.4 Navigational Equipment	19
	3.5.5 Rescuers' Personal Protective Equipment	20
	3.5.6 Specialist and Novel Equipment	23
4	LOCATION, CARE AND TRANSFER OF THE CASUALTY	25
	4.1 LOCATION	25
	4.1.1 Methods	25
	4.1.2 Competence and Training	28
	4.1.3 Conclusions	29
	4.2 CASUALTY CARE	30
	4.2.1 Immersion Injuries	30
	4.2.2 Other Injuries	31
	4.3 THE TREATMENT OF IMMERSION CASUALTIES	31
	4.3.1 Introduction	31
	4.3.2 Rescue	32
	4.3.3 Treatment on the FRC	32

4.3.4	Insulation	34
4.3.5	Treatment on the SBV	35
4.3.6	Competence and Training	37
4.4	TRANSFER	37
4.4.1	From FRC in Water	37
4.4.2	From FRC on Deck	37
5	HUMAN FACTORS ASPECTS OF RESCUERS	39
5.1	THE RESCUER	39
5.1.1	Self-Selection and Motivation	39
5.1.2	Rescue Vessel Officers	40
5.1.3	Coxswains and Boatmen	41
5.2	TRAINING	41
5.3	OUTSIDE INFLUENCES	42
5.3.1	Positive Influences	42
5.3.2	Negative Influences	42
5.3.3	Best Practice	43
5.4	RESCUE CRAFT OPERATIONS	43
5.4.1	Fast Rescue Craft	43
5.4.2	Daughter Craft	44
	GLOSSARY	45
	BIBLIOGRAPHY	46
	ACKNOWLEDGEMENTS	48

1 INTRODUCTION

1.1 BACKGROUND

In recent years a large number of research study reports, codes of practice and company based operations manuals have been produced attempting to lay down the preferred manner in which marine offshore rescue should be carried out. While much of this advice is still valid today, it is generally widely dispersed throughout many documents to the extent that it is unlikely that all relevant aspects have been considered by all those who may be involved in offshore rescue. Improved standards may be achieved by industry-wide dissemination of authoritative and comprehensive guidance. The workgroup also recognised that the success of many rescues often depends on the skill and professionalism of the rescue craft crews, who are often tasked with saving lives in difficult circumstances. It is hoped that the production of this document will help stimulate the dissemination of information about marine rescue to and from rescue craft crews so as to enable them to benefit from the experiences of others.

At an Evacuation, Escape and Rescue Technical Advisory Group (EERTAG) meeting in March 1998 it was decided to initiate the Marine Offshore Rescue Advisory Group (MORAG), with the remit of drawing together examples of best practice into an authoritative and single reference document. MORAG was further sub-divided into 3 groups, Ship and Boat Operations, Location, Care and Transfer of the Casualty, and Human Factors Aspects of Rescuers, with members of each sub-group tasked with identifying relevant best practice. In support of MORAG, a need was expressed to collate the results of the initial information gathering exercise into a tailored form which can be presented to EERTAG for their consideration prior to being disseminated to the target audience in industry. The Marine and Aviation Operations Team (OD5.5) of the Offshore Safety Division (OSD) of the Health and Safety Executive (HSE) subsequently contracted AEA Technology Environment to carry out a research project to produce an authoritative and seamless reference document on best practice in marine offshore rescue. This report constitutes that reference document.

1.2 OBJECTIVES

The detailed objectives of the project were to:

- Enhance the value of individual examples of best practice in marine offshore rescue by providing independent technical assessment of current best practice as adopted by the different operating companies, and by reviewing and collating this information into a single reference document.
- Disseminate the final approved report to industry as an example of current best practice with a view to improving awareness of the issues and generally raising standards in this field.

These objectives have been achieved by undertaking the Scope of Work described in Section 2. The detailed direction of the work was agreed with the client and members of MORAG.

2 SCOPE OF THE REPORT

In consultation with the client prior to starting the work it was decided that the report should consider the following issues. These have been addressed in Sections 3, 4 and 5, respectively.

2.1 SHIP AND BOAT OPERATIONS

- Overview of Vessels and Craft:
 - i) Equipment (including types of SBV, and FRC/daughter craft (DC)).
- Launch and Recovery:
 - i) Fast Rescue Craft (FRC) and Standby Vessel (SBV) interaction;
 - ii) Launching Equipment (including davit and launch and recovery systems);
 - iii) Designs (including important aspects of design, siting, power, human factor aspects);
 - iv) Operational aspects and limits;
 - v) Training aspects.
- Boat Operation:
 - i) FRC/DC driving techniques;
 - ii) FRC/DC and SBV operations during specific rescue operations (including operations with TEMPSC and liferafts);
 - iii) Recovery directly to the standby vessel (including use of the Dacon scoop);
 - iv) Typical maintenance problems and equipment failures;
 - v) SBV Scoop operation (including types, critical actions, limits, precautions and limits).
- Environmental Factors:
 - i) Overview of typical weather for UKCS;
 - ii) Effect of wind and waves on operations (including identification of key factors, separation of sea/swell).
- Additional Equipment:
 - i) Suggested additional FRC/DC general equipment;
 - ii) Communications gear (including the type and minimum levels of equipment, and any useful additional equipment);
 - iii) Navigational gear (including the type and minimum levels of equipment, and any useful additional equipment);
 - iv) Rescuers' Personal Protective Equipment (including headgear, gloves, immersion suits, lifejackets);
 - v) Specialist and novel equipment.

2.2 LOCATION, CARE AND TRANSFER OF THE CASUALTY

- Location:
 - i) Methods of location (including visual, electronic and a summary of the constraints);
 - ii) Competence and training (including visual, electronic and weaknesses).

- Casualty Care:
 - i) Survivors' condition on rescue (including immersion and other injuries);
 - ii) Care principles (including immersion and other injuries);
 - iii) Competence and training (including OPITO training and weaknesses).
- Transfer:
 - i) Methods of transfer (including from FRC/DC in the water and from FRC/DC on deck).

2.3 HUMAN FACTORS ASPECTS OF RESCUERS

- Command and Control:
 - i) Improving rescuers' psychological techniques;
 - ii) Use of hardware and 'live' ware.
- Personnel Issues:
 - i) Adapting to different degrees and layout of safety cover provision in different fields;
 - ii) Training and competence of rescuers in areas other than ship and boat operations and casualty location, care and transfer;
 - iii) Outside influences.
- Rescue Craft Operations:
 - i) Fast rescue craft;
 - ii) Daughter craft.

3 SHIP AND BOAT OPERATIONS

Provided that subsequent transfer to a larger vessel is also possible, in-water survivors or the occupants of a survival craft are provided with the best prospect of survival when they are recovered by a FRC or DC. The same is also true for survivors of other incidents, for example, individuals who are lost overboard from offshore oil and gas installations, or possibly the survivors of an aircraft ditching. Experience from simulated exercises as well as actual rescues has proved that direct recovery to a supply vessel or SBV should be attempted only as a means of last resort when a FRC/DC can not be launched.

For the purposes of this report, the focus of the study will remain with FRC or DC operations. For completeness, however, and to highlight the dangers involved, certain aspects of direct recovery will also be covered including a discussion on equipment and techniques.

3.1 OVERVIEW OF VESSELS AND CRAFT

3.1.1 Equipment

3.1.1.1 Standby Vessels

Standby vessels (SBV) can be defined as ships that contain the equipment and trained crew to carry out offshore rescue and are deployed to do so, while providing a safe haven for all persons aboard in case of full evacuation. These craft are the subject of SBV Industry Guidelines, published by UKOOA.

At present, there are approximately 115 SBV operating on the UKCS, with the majority owned by six companies. They are positioned at approximately 111 locations where they cover an estimated 220 installations, not all of which are manned on a permanent basis.

Up until the Piper Alpha disaster in 1989, SBV on the UKCS were usually converted fishing trawlers, with only a small percentage being purpose built (4%)¹. Today, only about 22% of the fleet are of the converted trawler type². The figure for purpose built SBV is still low (10%), with the majority of the fleet comprising of converted supply vessels (63%).

Table 1
SBV types on the UKCS

Vessel Description	Total Number	Percentage
Former Platform Supply Vessels	93	63.3%
Former Fishing Vessels	33	22.4%
Purpose Built Vessels	14	9.5%
'Other' Vessels	7	4.8%

3.1.1.2 Fast Rescue Craft

Most FRC's are of the so-called rigid inflatable boat (RIB) design, are self-righting, exhibit a high level of static stability and share many common features with inshore rescue craft as used by the Royal National Lifeboat Institute (RLNI). Smaller craft are often powered by outboard motors, modified to automatically cut out and be re-started following capsize and righting. Larger and more recent designs have tended to rely on compact high speed diesel engines, sometimes driving through water jets.

¹ Cullen vol. 2 para. 20.40

² Jacobs Offshore: January 1999

Their principal assets are high speed and manoeuvrability, even in relatively severe weather. However, it is their motions and stability characteristics at low speed that will dictate their effectiveness in retrieving survivors from the sea or assisting in the transfer of personnel.

A typical FRC (similar to the Avon Searider 6.0m) operates with a crew of 3 and a maximum passenger complement of 12. This type of FRC is approximately 6m overall length and 2.5m overall width; the dry weight of a fully equipped boat is in the region of 750kg. In still water these craft can achieve speeds of around 30 knots.

3.1.1.3 Daughter Craft

A relatively new and separate class of boat, termed daughter craft (DC), are carried by some SBV. These craft are generally longer than FRC's, are built with weather protection for the crew and are launched from the SBV 'mother' craft. This configuration allows the DC to loiter close to platforms or facilities in which over-side or other hazardous activities are taking place for extended periods. In some types of vessel their hull construction tends to be of fully welded profiles and plates of marine aluminium. In a number of designs some void spaces are filled with expanded polyurethane foam to ensure the craft will remain afloat under conditions of flooding. The superstructure is often made from either marine aluminium or glass reinforced plastic and has such stability to make the boat self-righting. These craft rely upon the superstructure remaining intact with restraining straps for personnel being fitted to maintain its self-righting capabilities.

The term daughter craft can cover craft with a displacement of between 2 - 15 tonnes and with a length of between 9 - 20 metres. The United Kingdom Maritime and Coastguard Agency (MCA) regulates the operation of daughter craft from UK registered vessels in the UKCS, usually by means of Loadline Exemption certificates. In deciding to issue a Load Line Exemption Certificate to this type of vessel, the MCA imposed a number of conditions. These are generic and not specific to any design or manufacturer/model of craft:

- The maximum distance a DC can be separate from its parent vessel;
- That the craft operates only in close proximity to offshore installations and only in weather conditions up to a specified maximum in terms of both wind speed and mean wave height;
- That no cargo is carried;
- That no more than 12 passengers are carried;
- The minimum manning requirement including the number of OPITO trained Coxswains together with the maximum continuous operation time;
- That all weathertight closing appliances are maintained in good condition;
- That the craft is surveyed annually.

So far as specific aspects of craft design are concerned, there may be slight differences in craft design and fitment depending on the specific operating environment in which it is intended to operate the craft. This may mean that craft intended for use in the Southern North Sea may be different from those intended for the area West of Shetlands.

A typical DC (e.g. the MP-1111) is designed for operation with a maximum crew of 4 and a maximum passenger complement of 12. This type of craft is approximately 11m overall length and 3.5m overall width whereas the dry weight of a fully equipped boat is in the region of 5500kg. In still water these craft can achieve speeds of approximately 35 knots.

3.2 LAUNCH AND RECOVERY

The ability to launch, and particularly to recover, a FRC or DC from its mother vessel is in most cases a limiting factor when attempting to rescue survivors from the water. The sub-sections below assess some of the factors that are important in this respect.

3.2.1 Fast Rescue Craft and Standby Vessel Interaction

As with all rescue and survival craft transfers, the major threat to the FRC and its occupants is the respective rolling motions and difference in deck heights when alongside a larger vessel. To a large extent this can be overcome if the FRC is hoisted clear of the water with the occupants still on board and either brought fully on board the rescue vessel, or bowsed in hard against its rails if the FRC has to be put to sea again.

3.2.2 Launching Equipment

To fully achieve an extended operational envelope, consideration needs to be given to a number of different aspects of equipment and operation:

World-wide, the launching and recovery of FRC and DC from SBV's is conducted in a number of different ways, often depending on the environmental conditions prevailing at particular locations. In coastal/sheltered waters and outside the UKCS, this may involve launching and recovering of smaller craft to and from the stern of the mother vessel. However, in offshore and exposed locations on the UKCS, as in other rough sea environments, launch/recovery is generally undertaken by the use of davits or cranes from, in most cases, the midships position of the SBV.

Locating davits and cranes amidships has the advantage that movement of the crane head due to the SBV pitching will be kept to a minimum. When launch/recovery is undertaken at the stern of the vessel the process will be affected by pitching. Though pitching can be reduced by conducting the operations at higher speeds, such higher speeds may not be achievable in rough sea conditions. Currently, stern launch/recovery FRC/DC operations are not commonly used in rough/open sea conditions.

Launch and recovery operations can be assisted by reducing the amount of movement of the SBV, especially its rolling motion. This can be achieved by design (changes to the hydrostatic parameters of the vessel, the use of skegs, a deeper draft, the use of flume tanks or active anti-rolling devices) or by operation (by conducting rescue craft launch/recovery at speed with the bow or stern to the sea or by turning the SBV while under way to provide a "flattened" area of sea) or by altering the stability of the vessel to reduce violent rolling motions (to reduce large GZ levers while ensuring that the range of stability is not reduced).

In current UKCS SBV operations, all launch/recovery operations are conducted using davits or cranes. Both offer advantages and disadvantages. Davits are generally simpler in design and operation, enabling consistent operation; the simplicity of design also results in less mechanical problems. Alternatively, cranes allow for more flexibility during operations and tend to be more powerful (especially more recent designs). Balanced against this can be the increased maintenance required of the more complex engineering involved in crane manufacture. Some of the more recent designs allow the tip of the boom to be positioned close to the water thereby reducing the amount of vertical wire between the boom tip and the FRC, this in turn reduces the pendulum effect during the launch/recovery process. Some davits offer the advantage of cradling the FRC during the lift, thereby limiting any movement and damage of the craft during the launch/recovery process. Most cranes offer the advantage of being able to bowse in the craft without the use of additional tackle.

The davits commonly in use on current UKCS SBV are the 'Schat Vest', 'Grampian' and 'Miranda' types. Cranes in use on current UKCS SBV include, 'Hydramaskin', 'Calley', 'Seamaster'.

The height that a davit/crane is positioned will mainly depend on the basic design of the SBV it is to be placed on. Notwithstanding this, there are advantages in placing such launch/recovery devices at the lowest possible position but clear of any seas that are likely to break over the vessel.

For many typical SBV designs, especially those converted from supply vessels, the optimum position is probably one deck above the main deck on the after end of the accommodation block. Such locations should have space for the stowage of the FRC nearby, enable maintenance to be conducted on the machinery, allow visibility of the launch/recovery sea area alongside the vessel and be visible from the bridge of the SBV. The location is also likely to be the main transfer point of casualties from the FRC/DC to the SBV's hospital and will therefore need to have sufficient deck space and access ways available to allow stretchers to be manoeuvred around such a location. There are advantages in positioning davits and cranes close to the SBV's side; this affords better access to the water and requires less travel, making the launch/recovery process quicker.

In addition to the above the launch/recovery system should be located at a position where there are no obstructions on the ships side.

Although both launch and recovery present different problems and tasks to the SBV crew, it is generally accepted that recovery is the more difficult task and the one that defines the overall extent or nature of operation over the range of environmental conditions to be experienced.

There is broad agreement across the industry that the davit/crane winch speed has a significant effect on the ability to launch and recover a FRC/DC. More crucially, the speed at which FRC can be recovered from the sea is a key determinant on the overall performance of the rescue facility. A part of that overall speed and efficiency in recovery will be the power and speed of the winch system. It is often stated that the speed of the lift from the water is more important than the use of any auto-tension or heave compensation devices.

In the UKCS at the moment, hoisting speeds of not less than 0.3 metre per second are required. However, higher hoisting speeds of up to 1.0 metre per second are considered to offer significant benefits, whilst still allowing sufficient control of the hoisting speed. Variable speed winch controls can be of benefit here.

The overall hoisting speed is dependant not just on the power of the davit/crane, but also on the weight of the FRC/DC, complete with its crew and passengers. Heavier craft (such as DC) are typically harder to hoist rapidly from a seaway during recovery operations.

As weather conditions deteriorate both the SBV and the FRC will move more; the SBV mainly subject to rolling movement and the FRC in a more complex way but of which heave is probably most significant. The movements of these craft will be periodic and during any given period of time will vary in frequency and amplitude. If the FRC is alongside the SBV there will also be the interaction between the vessels. The vessels' movements will be subject to periods of intense movement and to periods where there is less movement. A good launch/recovery system needs to take account of this periodic movement and significant advantage can be gained by being able to conduct the launch/recovery process within the lulls, where movement is at a minimum. Higher power/speed winches enable the crew to take opportunity of these periods. Slower winches can expose the FRC to periods of higher movement. Although only one of a number of factors which effect the recovery process, it is important and can make a significant difference to the rescue envelope.

3.2.3 Designs

The following is a summary of points to be considered when designing and positioning davit and cranes:

- The davit/crane operator should be able to see overside from the control position;
- The launch/recovery position should be visible from the SBV bridge;

- The davit/crane should be positioned as close to the centre of rotation of the SBV as possible;
- The davit/crane should be positioned as close as possible to the ship's side;
- The davit/crane should be located as close as possible to sea level notwithstanding the need to keep equipment clear of wave action;
- The embarkation location should allow access to the hospital area;
- There should be sufficient deck space around the davit/crane and FRC stowage area to allow maintenance;
- The launch/recovery area should be well lit;
- There should be good communication facilities available;
- The davit/crane should have sufficient power to lift a fully laden FRC (plus an extra allowance for entrapped water) preferably at a rate of 1 metre per second;
- The winch controls should allow variable speed control of the motor;
- Auto tension winch systems and shock absorbing devices within the davit/crane system are beneficial;
- There should be no obstructions on the ships side which could impede the launch/recovery process (such as tyre fenders, metal rubbing strakes or rails);
- The launch/recovery area should be clear of the rescue zones.

3.2.4 Operational Aspects and Limits

A number of studies have been undertaken recently in an attempt to quantify the operational limits for FRC/DC operations and to demonstrate the level of performance that should be achievable. Definitive levels are extremely difficult to determine and depend on several circumstances, the greatest of which are the significant wave height (H_s) and the wave steepness, both of which may be linked to the area of operation. In the North Sea operators have generally adopted the benchmark of 3.5³ metres H_s as the figure below which all FRC should be capable of being launched. While this figure should be achievable as a minimum value, the upper limit will depend on such factors as the competence and training of the FRC and launch crews, as well as the type of equipment in use.

Notwithstanding this, it is a widely held belief that SBV Operators and their crews would do their utmost to save life in an emergency situation regardless of prevailing sea conditions. The rescue of the Survivors of the Drilling Unit West Gamma in the Danish Sector was achieved by FRC in waves reported as 12 metres.

The limits of the operational envelope for launch and recovery are dependent on a number of factors, which include the following:

- The connection between the davit/crane wire and the FRC is the key area where attention to detail can make a real difference to the overall launch/recovery process. There are a number of connection systems currently in use in the North Sea outlined below. Notwithstanding the fact that the overall efficiency of a launch/recovery system is dependant on a number of factors including crew training, experience and practice; the following list of connection systems illustrates the variety in use:
 - * A handle operated latched hook on the fall wire of the crane connects to a 'D' ring atop of a rigid mono-pole lifting point on the FRC. The pole also has a handle for the crew member to steady himself;

³ The majority of Southern North Sea SBV use non-heave compensated davits. Although davits with compensation facilities tend to have a higher launch and recovery limit, the performance gain from their use in the Southern North Sea would be smaller than expected when compared to the Northern North Sea due to the differing sea conditions. In the Southern North Sea the significant wave height is composed mainly of wind driven waves whereas in the Northern North Sea it is likely to be swell waves. Heave compensation tends to work better on swell waves than on wind waves.

- * ‘Pull down system’. During rescue craft recovery with this system, a light line is first (manually) attached to the FRC/DC. This line is lead to the davit/crane and senses the motion of the craft and enables the heavier lifting line to be attached to the craft automatically;
- * ‘Off/On Load’ quick release hook mounted on the strengthened cabin top of a DC. This connects to a ring on the fall wire from the davit/crane;
- * ‘Off/On Load’ quick release hook on fall wire connects to single ring on four legged wire/rope/webbing strops attached to the FRC;
- * Single fall wire with simple (latched or unlatched) hook to single on four legged wire/rope/webbing strops attached to the FRC;
- * Twin fall wires with simple hooks to rings on soft wire strops attached to the FRC.

To expand upon this, there are a number of design details that can offer an advantage to the task of connecting the fall wire to the FRC/DC:

- * The connection point on the end of the fall wire should not be overly heavy. The use of rubber for the weight should be considered;
 - * A soft rope tail attached to the end of the fall wire enables it to be controlled well before the hook (or eye) presents a danger to the FRC crew;
 - * The fitting of handles to the connection point on the fall wire (hook or eye) should be considered to keep the crew members fingers away from the connection point, thus avoiding pinching or entrapment injuries;
 - * A steadying handhold near the connection point enables the crew member to remain in control and thus make precise efficient actions with the minimum of error.
- The use, or otherwise, of boat ropes, or how they are used, is for the consideration of the crews involved, however, it can be said that most standby vessel FRC crews use boat ropes in some way or another.

The most common use is during recovery of the FRC, where a boat rope of a measured length is picked up first and attached; the FRC then falls back on this and in so doing is positioned correctly for the davit/crane fall wire. Variations of this include having the boat rope attached to a small boom positioned at right angles to the SBV’s side - this arrangement keeps the FRC clear of the shearstrake and can reduce the chance of damage. Some operators dispense with the use of boat ropes, preferring instead to conduct the operation at speed; which if conducted well can reduce the number of tasks needed for safe recovery. In some operations boat ropes are only used to control the FRC whilst it is being manoeuvred from/to its stowed position to the SBV’s side; once the FRC is bowsed in to the ship’s side the boat ropes are then removed/attached (two boat ropes are used which comprise of two fixed length ropes attached via snaplinks). Boat ropes are mostly used during the recovery of FRC/DC, being less used during launch.

- The actions of the SBV prior to and during the rescue can make a significant impact on extending the FRC/DC launch and recovery envelope. By manoeuvring the SBV in such a way as to produce a lee, either in a very localised area on the side of the SBV away from wind, or in a slightly larger area by driving the SBV in a circle to produce a “swept lee”, there will be a better chance of successful launch/recovery. Suggested manoeuvres by the SBV are discussed further in Section 3.3.2.

While the provision of a lee by the actions of the SBV alone will extend the operational envelope, the possible use of third party vessels should not be overlooked. The lee afforded by the judicious actions of other vessels, especially large commercial vessels, can be extremely beneficial. If the SBV becomes aware of other vessels in the vicinity during a rescue the SBV Master should consider calling for their assistance and directing their activities. By international convention all vessels are obliged to offer all

possible support when they become aware that a vessel or persons are in distress. However, the decision to use other vessels should be carefully considered depending on the location of the rescue. Large commercial vessels are rarely as manoeuvrable, particularly at low speeds, as smaller SBV or other in-field support craft, and so their use may be limited to rescues that occur at some distance from fixed structures or other obstructions or navigational hazards.

- During both launch and recovery, but especially the latter, the operations can be conducted more efficiently and with less chance of damage by timing the connection or release to the sea and vessel motions. As mentioned earlier there are advantages in conducting launch/recovery in periods of relatively less movement, i.e. in lulls. Such lulls are a well recognised behaviour of waves. Although it should be noted that as conditions worsen, the period between the lulls lengthens and the motions within the lulls increases. Notwithstanding this, real benefit can be gained by conducting launch/recovery operations within these periods.

In addition to the above, the precise timing of the release/connection in relation to individual waves can improve the overall outcome. Where possible, release should be conducted just prior to the crest of a wave (as it is rising); allowing the immediate period after release to take the FRC clear of the wave or hook as appropriate. This provides a time gap to enable the coxswain of the FRC to manoeuvre the craft clear of the SBV's side. In the case of recovery, connection conducted just prior to the crest of a wave allows the final rise to assist the davit/crane in rapid recovery of the craft.

3.2.5 Training Aspects

Prior to being assigned to man a FRC or DC it is accepted practice in the UKCS for the crew and Coxswains to have undergone approved training. Such courses are administered by the Offshore Petroleum Industry Training Organisation (OPITO) and cover skills such as training of FRC boatman and FRC coxswains to participate in or take command of FRC and develop their handling skills.

While possession of a training certificate is a prerequisite for the duties on a FRC or DC, while on station it is imperative that all SBV crew are well practised. Frequent drills will:

- Enable crews to become familiar with their specific equipment and best methods of deployment;
- Engender confidence in being able to decide on the best recovery technique in a particular circumstance;
- Simulate stabilising and safely transporting a survivor to the SBV;
- Enable team working and development.

Drills should not only concentrate on the use of equipment with a full crew but should also be used to develop contingency plans. They should follow the Ongoing Onboard Training modules provided by the OPITO approved training provider contracted to provide this service or equivalent.

3.3 BOAT OPERATION

3.3.1 Fast Rescue Craft and Daughter Craft Driving Techniques

A large number of books have been published in recent years by learned practitioners of small craft handling. As with most other craft, the handling of FRC and DC is a skill which only comes with experience and practice of good seamanship; it is therefore difficult to prescribe hard and fast rules for manoeuvring and handling of these craft. Nonetheless, this section seeks to give some guidance.

So far as DC are concerned, their handling is not considered to differ significantly from conventional FRC's.

The sub-sections below seek to present the crew of FRC/DC with advice and factors to be considered when operating their craft. Generally, they refer to operations in adverse sea conditions and it should be remembered that the launch and recovery limits discussed in Section 3.2 may preclude FRC/DC being at sea in conditions that produce the risks described below. However, many of the techniques described can be used during 'normal' operations in less adverse sea conditions.

3.3.1.1 Speed

A FRC's speed should be adjusted as circumstances dictate. When searching for survivors the continuous use of maximum speed is futile, especially in moderate or rough seas, as the craft's motion is too severe and too much spray is created to keep an effective lookout. At best, excessive speed in bad weather will only result in a less effective search pattern and at worst in possible injury to the crew or damage to the craft. Where in-water survivors have been located it is better to proceed towards them at moderate speed rather than launching from the tops of waves and then re-entering the water with a violent impact; the passage will be as quick and the crew will reach their destination in a better physical condition and so be able to better offer assistance.

If it is necessary to stop whilst on passage the FRC should be placed head to sea with the engine(s) engaged and with ahead drive both to maintain position and to enable power to be applied instantly if circumstances warrant. Where survivors are being recovered from the water the drives should be in neutral to avoid possible injury to the survivor from the turning propellers.

3.3.1.2 Turning

FRC are highly manoeuvrable craft and can make extremely tight turns. Under normal circumstances this should not present a problem for the coxswain, however if the craft is held in a turn of increasing tightness a point will be reached where the propellers lose their grip on the water and the engines race. This is known as cavitation and occurs when the water in contact with the propeller becomes separated by air bubbles. A similar situation may also occur because the inward heel of the boat in a turn will cause the outboard propeller to come closer to the water's surface. In the breaking wave condition cavitation can occur because of the aeration of the sea surface due to broken water. The result will be a loss of propeller 'bite'.

The effects of cavitation can be prevented by turning less sharply or by throttling back on the engines.

3.3.1.3 Wave Direction and Speed

When heading into a large swell and high wind there will be a tendency for the bows to be blown off the wind when clearing the top of a wave. It is necessary to maintain constant throttle control when passing over a crest to ensure the craft has sufficient speed to pass over the crest; insufficient speed may result in the craft being thrown back and capsized by the wave. Once the bow has broken through the crest the throttles should be eased to prevent launching from the water and heavy impact into the succeeding trough.

With the craft running before a following sea care must be taken to prevent the bows driving into the back of the next wave ahead as this will reduce the craft's speed and may result in large quantities of water being shipped or cause the stern to swing with loss of directional stability leading to the possibility of broaching. Swamping or broaching from a following sea may also occur if insufficient speed is maintained to keep ahead of the waves.

The most expeditious progress to windward in heavy breaking seas can usually be achieved by driving in a 'zig-zag' fashion by steering the bows to square the wave crests and then steering off the waves. When doing so it is extremely important that the seas are not taken any further aft than the bow or there will be a very real danger of swamping or capsizing.

If the requirement is to make headway across a sea then this may only be possible by keeping the sea on the opposite bow and using the leeway to 'crab' in the required direction between successive waves.

3.3.2 Specific Rescue Operations

This section contains details of techniques that may be used in specific circumstances.

3.3.2.1 Use of the Standby Vessel During Rescue

There are a number of actions that can be taken by the SBV itself to assist the rescue craft launch and recovery operation both prior to and during the event. Typically, these will include the SBV conducting a number of manoeuvres designed to improve the local environment for launch/recovery; these are:

- a) Manoeuvre in a full 360° circle to dampen out the seas in a localised area prior to launch/recovery; which would then be conducted with the SBV stopped in the calmed water;
- b) Use the SBV to provide a lee; to protect the operation from the effects of the wind and waves;
- c) Conduct the launch/recovery operations at speed; this has the effect of reducing vessel movement;
- d) A combination of the above, where the SBV adjusts its speed to that of the seas and proceeds in a general downwind direction but with the wind coming over one quarter; the FRC is then launched or recovered on the lee side.

On a cautionary note, some points to consider regarding the preceding manoeuvres are worthy of note:

- * The first manoeuvre [(a) above], can take some time to conduct, though may have advantages when operations are conducted in close proximity to platforms and the turn is made only using a thruster;
- * When conducting launch/recovery at speed [(c) above], the SBV will need to reposition itself if a number of launch/recovery operations have to be conducted;
- * During the full circle manoeuvre [(a) above], difficulty can be experienced in maintaining visibility of survivors in the water;
- * The combined manoeuvre [(d) above] has been shown to be particularly useful in rough weather conditions.

Preparations for launch and recovery by the SBV crew assigned these duties should be well rehearsed and co-ordinated and should commence immediately the alarm has been raised. Similarly, crew assigned to the care and welfare of survivors when brought on board the SBV should start their preparations as soon as possible. Time spent in preparation is rarely wasted and may mean that survivors will stand a better chance of recovery.

3.3.2.2 Recovery of survivors from the water

The current preferred method of recovery is to a FRC/DC provided that subsequent recovery and transfer to a larger vessel is possible. The most basic method for recovery from the sea requires the crew of a FRC/DC to manually haul survivors into the boat, either by using a lifejacket lifting becket in conjunction with a crutch strap, if fitted, or by the FRC/DC crew lifting a survivor from under the arms. In some instances a survivor may be able to assist the rescuers by pulling and/or pushing himself over the FRC/DC sponson, provided that suitable hand and foot holds exist. However all FRC in the UK Sector are now required by the Industry Guidelines to be fitted with a net or cradle system for recovery of persons from the water (see Section 3.5.6.3).

The effectiveness of the manual recovery method can be somewhat compromised in situations where survivors are large or heavy, particularly when wearing a flooded immersion suit, or where they may be unconscious or injured. Additionally, several other factors need to be considered when deciding on the choice of recovery method. The prevailing weather conditions, the increased physical demands when recovering multiple casualties, or whether the FRC/DC is being operated with less than a full crew complement all affect the speed of rescue and physical effort required.

With the advent of the larger DC it has become common for some of the horizontal recovery devices described in Section 3.5.6.3 to be available to DC crews. These are generally fitted forward in the bow section of the DC and it then becomes necessary to man-handle the casualty back along the deck of craft to the cabin entrance. This is by no means an easy or safe task and may lead to either the casualty or the DC deck crew, or both, falling overboard. Proper and effective design of the DC deck access and layout, within the constraints of their operational function, may alleviate or minimise this problem.

3.3.2.3 Recovery of survivors from survival craft

The best method of transferring survivors from a survival craft to a rescue vessel is via an FRC. Rescue craft are much closer in size to survival craft so there is more likelihood that the motion of the two craft will be similar in both extent and period. The usual construction of RIB FRC, with large inflatable sponsons around the gunwales, also lends itself to bringing the FRC into contact with a survival craft with minimal chance of damaging either vessel. These factors are important when it is necessary to bring a rescue craft alongside a TEMPSC or liferaft to enable personnel transfer.

Depending on the capacity of the FRC/DC in relation to the survival craft it may be necessary to make a number of trips back to the SBV to offload survivors.

On occasions when rescue craft operations or transfer of survivors are impossible due to the prevailing weather conditions it has been suggested that survivors in an intact survival craft should be left to wait out their ordeal until weather conditions moderate. Conversely, numerous instances of sea-sickness have been documented, both in studies and in actual evacuations, to suggest that unless recovery occurs within 12 - 24 hours then the effects may be so debilitating as to prevent many of the occupants from contributing any assistance to their rescue. The decision on which course of action should be followed should be left to the judgement of those on the scene. If the former is chosen, consideration should be given to manoeuvring the SBV in such a way as to make conditions as comfortable as possible for those inside the survival craft. This can be facilitated by providing a lee for the survival craft until weather conditions improve or until a suitably equipped rescue vessel is available.

3.3.3 Recovery Directly to the Standby Vessel

Rescue direct to a SBV is attempted more by necessity than choice. It is almost certainly the case that such operations will be conducted in poor weather, which will reduce the chance of success and also increase the risk of injury to the casualty. Direct recovery to a SBV should be attempted only as a means of last resort when a FRC can not be launched.

Aside from the most basic manner of direct rescue via boarding ladders or scrambling net lowered over the rescue vessel's side, a number of other methods for direct recovery to a rescue vessel are available. These generally consist of baskets or scoops however it is essential that such devices are able to reach beyond the reflected waves of the rescue vessel and be constructed so as not to injure the survivor during the rescue attempt. A concern with some of these devices is that a survivor must be conscious and able to assist the rescuers to some extent although in recent years innovations such as the Dacon scoop have opened the possibility of passive in-water survivor rescue.

The successful operation of devices such as the Dacon scoop depends on careful siting of the equipment on a vessel specific basis. The following guidelines, which are specifically intended for the Dacon scoop, indicate the points that need to be considered:

- The scoop should be installed close to the tipping centre of the vessel;
- For optimum operation the scoop should be attached to the deck at a height of between 3.5 - 5 metres above the waterline;
- The scoop should be located at a position where both the Master and the crane operator can see its operation;
- The scoop should be located where there is enough deck space to handle casualties;
- The crane used for the operation of the scoop should have a good reach and sufficient power/speed to heave and lower (when loaded) at about 50 metres per minute.

If optimum scoop output performance is to be achieved it is also important for a 'whole crew' training regime to be adopted. Practise and training in scoop operation can significantly improve operational performance. To afford an in-water survivor the best chance of recovery via a scoop, the recommended procedure for its operations is:

- The SBV Master should aim to create a slight lee if possible;
- The pickup should be made whilst heading into the weather;
- The scoop should be kept out of the water and clear until the last moment;
- The speed of the SBV at the time of the pickup should be slow;
- The crane operator should slew the jib to create a 'mouth' or 'funnel' shape with the scoop;
- Once the casualty is caught, the scoop should be lifted so that the person is brought to the deck level;
- A line attached to the aft point of the outer boom can be heaved on to extend the reach of the scoop;
- Care should be taken to ensure that there is a minimal gap between the scoop and the ship's side.

It is likely that these methods will only be deployed when weather conditions are so severe as to preclude the launching and retrieval of FRC. Generally speaking, this situation coincides with the marked reduction in performance of such systems and practical limitations on the use of the scoop in extremely adverse sea conditions have been experienced on occasions. In some respects it remains the case that vessels that are fitted with scoop or basket equipment may have an operating limit only marginally better than that for FRC/DC.

3.3.4 Typical Maintenance Problems and Equipment Failures

The marine environment is harsh both for personnel and equipment, with the UKCS being noted for severe weather due to the frequent occurrence of high winds and rough seas. It has long been recognised by seafarers that the corrosive nature of the moisture-laden atmosphere together with large amounts of wind driven salt-water spray can cause rapid degradation of equipment. This is particularly true for SBV and FRC/DC which spend considerable periods of time in an environment of naturally occurring spray or generate spray through their own activities. Due to the size and speed of these craft, it is likely that when spray does develop it will envelope them and reach all parts of the craft.

Rescue craft equipment that is susceptible to malfunction include:

- Console and handheld radios or radio helmets suffering water ingress to connectors;
- Gas detection equipment;
- Electrical wiring loom problems on control console and on engines.

An important consideration in rescue craft reliability is the type of propulsion unit. Rescue craft can use petrol or diesel to drive either a waterjet, an outboard engine or an inboard engine. Historically, there have been a number of advantages and disadvantages in the various types. Though more expensive and difficult to maintain, diesel engines are generally more reliable than petrol. The choice of whether to use inboard or outboard usually depends on the maintenance philosophy of the SBV operating company. An outboard engine can be changed-out as a single unit for maintenance ashore, or replaced at sea if failure occurs and spare units are carried. An inboard engine can usually only be fully overhauled ashore when the rescue craft is landed.

Notwithstanding the need for improved resistance to the elements through design, it is imperative that the crews and operators of SBV and rescue craft undertake the necessary maintenance to ensure that their craft remain serviceable and ready for use. This can be achieved through a number of means. For simple on-board routine maintenance, such as ensuring that running gear turns freely and corrosion is minimised, this may be through a planned maintenance system that stipulates which items are checked, lubricated or overhauled at designated intervals. For more complex tasks, for example the overhaul of rescue craft engines or the whole craft, this may be through the scheduled change-out of the entire unit for maintenance ashore. To ensure success in this approach it is therefore necessary to have sufficient equipment redundancy to maintain full operational readiness.

3.4 ENVIRONMENTAL FACTORS

3.4.1 Overview of Typical Weather for UKCS

The weather conditions experienced on the UKCS can be among the most hostile in the world, with each region having different. The predominant wind direction on the UKCS is from the south-westerly quadrant with the winter season experiencing more severe weather conditions than the summer, although it is possible for adverse weather to be experienced at any time of year and from any direction.

So far as ship and boat operations are concerned, there are three main parameters that affect the ability to carry out rescue boat activities; wind speed, significant wave height and wave steepness. These factors, to one extent or another, offer a quantifiable measure of how 'bad' conditions are at a particular location and whether rescue operations ought to be possible. Having said that, the nature of the UKCS, with large areas to the north-west and south-west being exposed to oceanic wave spectra, with other areas to the east of the Britain and between Britain and Ireland being more sheltered and with wide variations in water depth causes profound differences in the type of sea conditions. This casts doubt on the possibility of using a single parameter to state with certainty whether boat operations should be possible in all areas.

3.4.1.1 Wind Speed

It is well known that the wind, whether local or at some distance away, is responsible for the generation of surface wind waves and swell. The factors that affect wave development are the wind speed, the distance over which the wind has blown, known as the fetch, the time that the wind has been blowing over the fetch, the water depth and the relative direction of tidal stream and current to the wind. The fetch in a particular location is also affected by storm track. Wind directions around a depression are anti-clockwise in the northern hemisphere and it follows that if storms pass more to the south then there will be limited fetch from the north. Storm track is less important to the west of the UKCS where there is large fetch from most directions but more important to the east, particularly in the North Sea, where the northerly fetch may be limited by storms taking a more southerly track.

3.4.1.2 Significant Wave Height

Significant wave height (H_s) is a popular parameter in attempting to determine the minimum operational limits for rescue craft activities. It is defined as the mean height of the highest one third of waves and is a measure of the total energy in the wave spectrum.

The factors that coincide to make up the total wave spectrum at any point are complex but can be considered to come from two sources, the wind waves and the swell. Wind waves are locally generated waves that can have a wide range of directions and can cause a highly irregular sea surface. They can have a wavelength of up to 100m and a period of between 0.2 and 9 seconds. Swell is formed as a result of wind elsewhere. It can have originated several hundred miles away and generally has a narrow directional range, a wavelength measured in hundreds of metres and a period of greater than 9 seconds. Swell wavelength and period generally increase with time and with the distance from their source.

Although the wind and wave components of the H_s will be a factor in all sea areas of the UKCS, the relative size of these components will differ from place to place. In the Southern North Sea for example, the wind waves are likely to produce most of the H_s because there is little fetch and hence swell (except possibly from the north), whereas to the West of Shetlands the H_s could be made up primarily of swell unless there are local storm conditions to produce wind waves.

3.4.1.3 Wave Steepness

Although H_s is the common performance measure when considering whether it ought to be possible to carry out rescue craft operations, a better indication may well be the wave steepness. While it is possible to represent this in a number of scientific ways such as relating it to the water depth, in simple terms this is the ratio between the wave height and the wavelength. It is the wave steepness that determines the force upon a fixed or floating structure, how floating structures will behave and when waves are likely to break.

As an indication of the likely wind and wave conditions on the UKCS, as well as the extremes, data from the North European Storm Study (NESS) has been used to produce Table 2. To provide a simplified interpretation of historic weather conditions the NESS data has been collated over a number of years and averaged.

Table 2
Wind and wave characteristics on the UKCS

Region	Most Likely Wind Direction	Peak Wind Speed (m/s)	Wind Direction Associated with Peak Wind Speed	Most Likely Wave Direction	Peak Wave Height (m)	Wave Direction Associated with Peak Wave Height
Northern North Sea	South to South-West	28.5 - 32.7	North-West to North	North	12.5 - 13.0	North
Central North Sea	South-West to West	28.5 - 32.7	North-West	North	10.0 - 10.5	North
Southern North Sea	South-West to West	28.5 - 32.7	West	North	7.0 - 7.5	North
English Channel	South-West to West	28.5 - 32.7	West	South-West	12.5 - 13.0	South-West
Celtic Sea	South-West to West	24.5 - 28.5	South to South-West to West	West	16.0 - 16.5	South-West
Irish Sea	South-West to West	28.5 - 32.7	West	West	6.0 - 6.5	West
Hebrides Shelf	South-West	32.7 - 51.5	South-West	South-West	15.0 - 15.5	South-West
West of Shetlands	South-West	32.7 - 51.5	South-West to West	West	15.0 - 15.5	West



Figure 1
Sea areas on the UKCS

3.4.2 Effect of Wind and Waves on Operations

Section 3.4.1 presents an overview of typical weather conditions on the UKCS as well as some of the factors that have to be included when considering ship and boat operations. This section details what some of the practical effects of these factors might be.

- Generally speaking, the operational activities of rescue craft are likely to be affected more by wind waves than by swell and it follows that some differences in the design and operating procedures may be necessary to cater for differences in their working environment;
- Wind speed alone, although easy to determine by rescue vessel crews, is not a reliable indicator of likely conditions to be experienced. Further, wind speed has less of an effect on the operation of rescue craft, especially FRC, than the effects of waves and swell;
- Wave steepness is likely to be more location specific than simply considering the wave height. Differences in wave steepness could enable a successful launch/recovery in one area whereas it could be prevented in another even though both have the same wave height. It is likely to be the factor uppermost in the mind of rescue craft crews when preparing to launch and manoeuvre their boat;
- Conflicting current and wind directions will cause a steepening of the seas.

3.5 ADDITIONAL EQUIPMENT

3.5.1 General

FRC and DC are designed for rescue use and as such should carry various pieces of additional equipment for communications, navigation, casualty recovery and treatment, casualty location and maintenance. The equipment used for the treatment, casualty location and recovery is discussed elsewhere in this document, however the remaining topics of additional equipment are considered in this section.

Equipment for navigation or communications should be constructed to a high standard and most importantly be:

- Totally waterproof – as the vessel will possibly be used in severe conditions the equipment should be capable of being fully submersible;
- Capable of withstanding high levels of shock, vibration and G-force.

3.5.2 Equipment Schedule

The following table provides a list of equipment that can be included with an FRC or DC's standard outfit.

Item	Quantity
Tool Kit	1
Boathooks (telescopic alloy)	1
Mooring line	2
Towing line	1
Searchlight	1
Fire extinguisher	1
Repair kit	1
First aid kit	1
Set of Flares	1
Thermal Blankets	6*
Bolt Cutters and Hacksaw	1
Spares Kit	1
Loadhailer	1
Assorted inflatable splints	1
Body recovery bags	2
Radar reflector	1
Steering compass	1
Hand held compass	1
Laminated chart of operational area	1
VHF radios	2
Buoyant oars or paddles	2
Buoyant bailer	1
Sea Anchor	1
Whistle	1
Buoyant rescue quoits	2
Bucket	1
Manually operated pump	1
Sponges	2
Fire Axe	1
Additional Items	
Lightsticks	6
Binoculars (waterproof)	1
Global Positioning System receiver	1
Grapple	1
Anchor and cable	1

*The current UKOOA SBV Guidelines require 20 thermal blankets per FRC and 30 per DC.

3.5.3 Communications Equipment

Good communications are vital for marine rescue and most FRC/DC operating in the UKCS use either fixed VHF units mounted to the console or portable hand held units carried by the crew members. It is not intended to discuss marine communication systems or VHF radios in general here, but to emphasise the need to ensure that such communication systems be reliable and 'fit for purpose'. At least two independent radios should always be carried to provide for back up.

The VHF radio carried by the FRC/DC is mainly for communication to and from the SBV. The advantage that console mounted units offer is that their typical power output (25 watts) enables communication with the FRC/DC at a much greater range than by hand held units; given that the communication range of FRC/DC is adversely effected by the low height of eye of their respective antenna.

Hand held radios have the advantage that they can be kept in a more protective environment and are generally of lower cost; maintenance is often far easier to conduct on hand held units and should a radio fail, it can be easily replaced or repaired without affecting the functionality of the FRC/DC.

3.5.4 Navigational Equipment

Most navigation conducted by FRC crews in the offshore oilfield environment will be approximate and by eye. However, in conditions of reduced visibility, darkness or when operating out of sight of the SBV or obvious navigational marks, the FRC crew will need navigational equipment to enable them to complete the voyage they wish to undertake.

3.5.4.1 Compasses

Although limited in its accuracy during use aboard a FRC, a compass is a vital piece of equipment whose use is often underrated. During helicopter operations, conditions of reduced visibility, bad weather, night operations, searching operations and when working with other craft; compasses enable the FRC to navigate in and around the area of operation. They enable a FRC to proceed in a given direction for the safety of the casualties and crew alike. Notwithstanding this, it has to be conceded that the accuracy of most compasses when used in typical offshore rescue FRC's is low and furthermore, the shocks and vibration common to most FRC operations make accurate use difficult.

Most offshore FRC are fitted with console mounted steering compasses which, if accurate at rest, can enable the craft to steer a course within an accuracy of about 20° in moderate weather conditions. As weather conditions deteriorate and/or the FRC's speed increases, the ability to accurately read the compass diminishes rapidly. Conversely, more accurate checks can often be conducted by slowing the craft. Hand held compasses can be carried in a FRC as a backup and are also useful to take bearings of objects for navigation. An alternative to the standard magnetic compass is the electronic or fluxgate compass. In several high quality versions of these compasses the sensor unit is separate from the display and can be mounted in a dry location close to the boat's roll and pitch axes, where there is minimum movement. If they are well mounted they offer some advantages over standard magnetic compasses; their resettling time is much reduced and in normal use there is only a limited amount of swing. Furthermore, the display can be configured in different ways to aid course keeping.

FRC compasses should be checked on a periodical basis after launch (and therefore away from the deviation caused by the steel structure of the SBV) by visually aligning the craft on the same heading as the SBV and comparing the compass heading with that of the SBV. Alternatively, bearings of two charted objects can be taken by heading towards them while they are in transit and then repeating the manoeuvre on the reciprocal heading. The compass heading is then compared to the true bearing as taken from the navigational chart, after

making allowance for variation. Unless this procedure is repeated on several headings in different quadrants, the compass deviation caused by the FRC's structure or equipment will be unknown. The accuracy of 20° stated above is partly due to this unknown factor.

3.5.4.2 Global Positioning System Receivers

Whereas a few years ago Global Positioning System (GPS) equipment would not be capable of withstanding the harsh environment of a FRC, today a number of different units are available that can operate satisfactorily in such conditions and this has made their use more widespread.

The publicly available GPS signal has its accuracy degraded to a nominal +/- 50m, which for most FRC applications is more than adequate. In certain specialist applications, however, to increase this level of accuracy, differential GPS (DGPS) was introduced with claimed accuracy distances of less than +/- 10m. DGPS works by receiving a correction signal and applying it to the normal GPS signal; the correction signals being transmitted by differential correction beacons at known terrestrial locations. GPS receivers can be of single or multi-channel types; multi-channel units being more accurate.

GPS units can be in the form of fixed units that are fitted to a console or hand held units that are transportable. Fixed units are often easier to use (especially in rough conditions) whereas handheld units can be kept in a more protective environment and are often of lower cost.

While most FRC activities are likely to take place within close proximity to a SBV, there may be times when DC are operating at ranges that take them beyond line of sight from their mother vessel. In these circumstances the use of a GPS receiver that is combined with a plotter may be beneficial. Essentially, this provides the DC crew with an electronic representation of a navigational chart with the GPS receiver's position superimposed upon it. Such a system would enable the DC to navigate back to the mother vessel or to some other point, for example to another installation or to a search point, without reference to external information.

3.5.5 Rescuers' Personal Protective Equipment

FRC are often expected to be able to operate in all but the more severe environmental conditions when performing tasks to rescue others. Such activity necessarily exposes the crew members to hazards that require the use of personnel protective equipment (PPE). The nature of the environment on the UKCS within which the crew are expected to operate means that they may need to be protected against a number of natural hazards; most notably, cold water immersion, vibration and impact.

To protect the FRC and DC crew, they should be issued with a wide range of PPE, both to maintain a comfortable and safe working environment while aboard the craft and to ensure the best possible chance of survival should they fall overboard.

3.5.5.1 Headgear

It is generally assumed that FRC crews should wear helmets and that the disadvantages of wearing them are outweighed by the numerous advantages, not least that the crew members are exposed to head injury from falls within the boat, impact during embarkation/disembarkation, from swinging objects and from thrown objects. The disadvantages arise from risks associated with wearing helmets, which include: neck injury from the 'scoop' effect, whiplash, vision impairment and thermal problems. Some helmets without lips are now available reducing the 'scoop' effect.

A helmet of the correct size for the individual protects the most vulnerable part of the body and additionally will reduce the rate of body heat loss. In choosing a helmet, crew members should ensure that it is closely fitting and should provide a wide range of vision. The chinstrap should be of adequate length to pass under the chin and be securely fastened. To maintain full efficiency wearers should not make any alterations to either the helmet, its chinstrap or its visor, if fitted. Nor should the helmet be painted or decorated in any manner as this may impair its performance due to harmful solvents interacting with the polycarbonate shell.

In many circumstances it is essential that continuous radio communications are maintained with the SBV and it has been found useful if the Coxswain's helmet is fitted with an integral VHF radio microphone and headset to permit hands free operation. In the event of a capsized it is important that any radio connection between the craft and the Coxswain's helmet would break free.

The design of these helmets should be such that they are fit for their purpose and weigh no more than 1.5kg complete (including communications links etc.). They should have an impact resistance at least as good as that of the standard industrial safety helmet (constructed to EN 397:1995), and ideally should be constructed so as to provide impact protection to the front, side, rear and crown of the helmet. In general, helmets with cut-outs should be avoided. If the helmet does suffer a severe blow there will be energy absorption through partial destruction of the shell and/or protective padding and although damage may not be visually apparent, any helmet which suffers an impact ought to be replaced by a new one.

If visors are fitted to helmets care should be taken to ensure that they do not become scratched or marked. After use any salt deposits should be washed off with clean soapy water and then the visors dried with a soft cloth. Salt or other dry dust deposits should not be brushed or wiped off with a dry cloth as faint scratches will occur which will greatly impair vision.

Recent work by the Royal National Lifeboat Institute (RNLI) has led to the production of a suitable helmet that meets the criteria suggested above and this is being issued to their Inshore Lifeboat crews.

3.5.5.2 Immersion Suits

It is clear when examining the work of a number of recent studies into the survivability of immersion victims, that the clothing a person is wearing when they enter the water can make a great deal of difference to their chances of survival. Many studies have shown that to afford the best prospect of survival for an in-water casualty, some form of thick, close fitting suit should be worn. There are broadly two groups of such protective suits: the so-called 'wet suits' and 'dry suits'. Wet suits are close fitting and usually constructed of cellular neoprene (similar to the type of suits worn by divers), however they do permit a small quantity of water to enter. Dry suits on the other hand, attempt to keep the wearer dry inside the suit (by the use of rubber seals). For a number of years there have basically been two types of 'dry suit' construction; those that have insulation and those that do not, whereas 'wet suits' have been uninsulated, relying instead on the thin layer of trapped water to provide some degree of insulation. More recently, new designs of 'wet suits' have also been available in both insulated and non-insulated forms.

It is not the purpose of this document to specify one type of suit over another, however, whatever type of protective clothing is chosen, it should be suitable for the activity that the wearer is engaged in. In the typical FRC environment such suits should be robust, be suitable for working in without hindering movement and not overheat the wearer. Such suits need to be regularly examined and maintained in a satisfactory condition.

3.5.5.3 Gloves and Boots

If the FRC/DC crew are fitted out with immersion suits it is probable that both gloves and boots will form an integral part of such suits. Notwithstanding this, both pieces of clothing should be suitable for the work envisaged in the craft. Gloves should not unduly restrict the dexterity of the wearer and boots should have non-slip soles and toe protectors. Crew members assigned swimming responsibilities will need to wear clothing that will enable them to readily perform that activity.

It is incumbent upon the SBV Masters to ensure that FRC/DC crew member are encouraged to wear protective gloves and boots in what is after all, the often harsh and cold environment of the North Sea.

3.5.5.4 Lifejackets

Numerous research projects have been undertaken into issues surrounding the use of lifejackets, which basically fall into one of two categories; inherently buoyant and inflatable. For reasons of freedom of movement and space, FRC/DC crew members generally use inflatable lifejackets. Activation can be achieved manually by the user or alternatively, by automatic inflation sensors that cause inflation on contact with salt water. It has been reported that this latter type can be prone to spurious activation during normal use on board a FRC due to the wet environment within which they work, although it has been shown that the occurrence of unexpected activation can be reduced if the lifejacket is tested in accordance with the relevant British Standard and SOLAS requirements.

The purpose of the lifejacket is to provide sufficient buoyancy to keep the wearer afloat in a head upwards attitude, even in an unconscious condition, until he can be recovered from the water. Provided that the lifejacket is of the automatically inflating type and is correctly worn prior to entering the water, there will be sufficient buoyancy to orientate an unconscious face down survivor to a face up position.

If life jackets are used with immersion suits they should be tested as being compatible. It has been found that immersion suits can adversely effect the floating aspect of a lifejacket wearer.

The point about correct donning of the lifejacket cannot be over stressed. A lifejacket which is incorrectly fastened or inadequately adjusted will not be able to perform with its expected efficiency. In this regard it is important that all straps are passed around the wearer's body in accordance with manufacturers' instructions and securely fastened. Loose fastenings will prevent correct orientation of an unconscious survivor and may well permit the wearer to float free from the lifejacket.

To assist in providing the best chance of survival of the wearer all inflatable lifejackets should be fitted with the following features:

- Reflective strips located on the front and around the lifejacket's collar. These are extremely useful when searching for in-water survivors at night and cause search light beams to be reflected back to the rescue craft. The minimum requirement is for 800mm of retro-reflective tape;
- A battery powered light fitted high up on the front of the lifejacket. These may either be manually operated high intensity battery powered devices or seawater activated;
- A whistle that can be used to summon the attention of a rescuer who is close by;
- A manoeuvring becket around the back of the collar to assist rescuers in manoeuvring the wearer while in the water and a lifting becket attached to the waist strap on the front of the lifejacket;
- An oral inflation tube to permit the buoyancy provided by the lifejacket's gas cartridge to be supplemented by breath;

- A lifeline/toggle and securing ring to permit multiple in-water survivors to secure themselves together;
- A crutch strap to enable wearers to be lifted from the water with minimum likelihood of the lifejacket slipping over the wearer's head;
- A spray shield is generally considered to be beneficial, however, the design should ensure that it does not collapse on the wearer's face nor cause water to become trapped inside.

3.5.6 Specialist and Novel Equipment

There have been a number of new and innovative products introduced to the offshore standby vessel industry in recent years. Some are entirely new designs whereas others can be considered as enhancements to existing equipment that have attempted to rectify deficiencies which have manifested themselves during rescue operations or in training. Types of equipment covered in this section include quoits and lines, flotation recovery aids and recovery devices.

Before mentioning some of this equipment it is worth considering the attributes that they should possess, as a minimum, if they are going to be successful:

- Equipment developed on the basis of one specific past incident is unlikely to be effective in future incidents where the conditions may be different;
- So far as possible all equipment should be capable of being used equally well in both light and when it is dark;
- Equipment should not rely on the survivor having to contribute to their own rescue. While it is inevitable that for most of this equipment some interaction with a survivor will be necessary, this should be kept to as minimum;
- Any device that requires perfect deployment to be successful is unlikely to be effective in the majority of rescue situations;
- Equipment that requires careful repacking or specialist maintenance before re-use will have limited use in situations involving multiple survivors;
- Equipment that does not lend itself to regular deployment or training exercises is unlikely to be effective. This is especially true for equipment that requires teamwork for its successful use.

3.5.6.1 Quoits and Lines

These are a low cost and low technology form of equipment requiring only that a rescuer can throw a weighted object that is attached to a line to a survivor and that the survivor can grasp it until the rescuer can pull the survivor towards him. When considering the use of this type of device there are a number of points to note:

- Lines are inherently buoyant and can be made in a highly visible colour;
- Casualties must be conscious to grasp or attach line to themselves;
- Lines and quoits could be useful if the survivor is close to obstructions that would prevent recovery by FRC/DC;
- Dragging a survivor to a rescue craft could be physically arduous in adverse weather conditions;
- Training is straightforward and inexpensive. It should be easy for personnel to become skilled in its use;
- Lines with a 'throwing head' containing the line suffer worse performance if the line is not coiled back into the head between throws;
- Accuracy of throw may be affected by wind and seas;
- The speed of recovery is governed by the need to keep the survivor's airway clear.

3.5.6.2 Flotation Recovery Aids

This type of aid consists of an inflatable device that is thrown into the water. The survivor subsequently boards the device and it is lifted (usually under power) on board a rescue craft. Points to note when considering the use of this equipment include:

- Rapid deployment;
- Survivors must be able to swim to and board the device. This requires them to be conscious and fit;
- The drift speed and direction of the device may be different from that of the survivor;
- Once released by the rescue vessel physical contact with the device is lost;
- The rescue vessel must be able to manoeuvre close enough to the device to enable it be connected to a davit/crane;
- Regular planned maintenance and testing of the inflation mechanism is required;
- Training in its use may not be possible in the normal operating environment unless sufficient spare devices were available to maintain capacity. After inflation it is likely that the device would need to be returned to an approved service station for repacking.

3.5.6.3 Recovery Devices

These generally fall into the category of buoyant slings or nets, horizontal recovery nets and ramps. Points to note when considering the use of these devices include:

Buoyant Slings

- Relative position of sling and survivor difficult to determine at night;
- Unsuitable for unconscious survivors in the water unless very close to rescue vessel;
- Possibility of survivor being ‘towed’ by rescue vessel when in the sling and airway becoming submerged;
- Vertical lifting of survivor from water using the sling is not recommended;
- Physically arduous for rescuers to manually haul survivors.

Buoyant Nets

- The need for survivors to ‘entangle’ themselves in some designs of net may be dangerous if they can not be lifted from the water immediately;
- Unsuitable for unconscious survivors in the water;
- High degree of crew training is required if deployment is to be successful;
- Nets that are also intended to be used as scoops should be weighted so they float just below the waterline while retaining their shape. The method of weighting should not cause injury to survivors if it should come into contact with them.

Horizontal Recovery Nets

- The casualty can be recovered in the preferred horizontal attitude;
- Recovery is only possible on the side of the rescue craft to which the device is fitted;
- It is possible for a survivor to become entangled in a net or to become turned face down into the water during a recovery operation;
- Recovery is generally less arduous for rescuers, if slower, than other methods described above.

Ramps

- The device can be rapidly deployed;
- Large numbers of able-bodied survivors ought to be able to use the device in a short time;
- Incapacitated or unconscious survivors would be unable to use the device without assistance from rescuers and even then it could be an arduous task.

4 LOCATION, CARE AND TRANSFER OF THE CASUALTY

4.1 LOCATION

4.1.1 Methods

Locating survivors in the sea is very difficult. Those who have experienced or exercised it will know how quickly the casualty or object used to represent him disappears from view. This is, of course, accentuated by bad weather.

To add to this difficulty, when there are several casualties, unless they take measures to prevent it, they will quickly drift apart. This, while in itself aggravating the problem, also highlights how difficult it is to predict the location of survivors after even quite a short period in the sea. One SBV operator reported in 1996 that during a rescue exercise in the Southern North Sea, out of six dummy survivors, three were quickly found and rescued to a FRC, one was found after a 20 minute search and the other 2 were never recovered.

This fundamental fact must be recognised and acted on when preparing arrangements for rescue of survivors from offshore installations. The arrangements must clearly include measures to ensure that survivors can be located in whatever environmental conditions pertain in time to be rescued and appropriately treated.

There are two fundamental media for location of survivors in the sea. These are:

- Visual systems;
- Electronic systems.

They are examined in the following paragraphs.

4.1.1.1 Visual Systems

There are several approaches which are available to aid the naked eye which can be summarised as:

Light Systems. These systems are in two parts, the source of light and the detector of that light. Sources include:

- Signalling lights;
- Mirrors;
- Fixed incandescent lights;
- Laser lights;
- Flashing lights;
- Photochemical lights;
- Electroluminescent lights;
- Pyrotechnics;
- Reflective equipment (not strictly a source but can be considered as such);
- Infrared beacons;
- Photochemical infrared light sticks.

Detectors include:

- Binoculars;
- Image intensifiers;
- Thermal imaging equipment.

In practice, most of the sources suffer from constraints that make their use in this role unsuitable. However, some offer advantages. These include:

Electroluminescent strips. Mounted on the head of immersion suits these offer some promise, particularly if flashing. They need a power pack and must be designed to ensure against water ingress at electrical connections. They also suffer from the possible disadvantage of being invisible to thermal imaging systems.

Strobe lights. There are several concerns over the use and effectiveness of xenon discharge strobe lights in this role. They vary from considerations of their effectiveness in waves and in their very short duration, to others about the safety of survivors on whom they operate. Many of these were found by the authors of the HSE publication (OTH 93 407) to be specious. In spite of the effects of those which had any truth in them they considered that, subject to incorporation of a longer pulse (say 0.1 to 0.2 seconds) and an increase in the flash rate from 50/60 per minute to 75/150 per minute, they offer the most effective light base method of detecting and locating a person or persons lost at sea at night.

Reflective equipment. Reflective tape, particularly using materials now available with significantly higher reflective properties than those now generally in use, offers a cost effective initial step to increasing the visibility of a person in the water. This is especially true if mounted in all possible orientations on the lifejacket, survival suit and hood and behind any light emitting device carried by the survivor. Naturally it is only of use if the searching vessel (preferably) shines a light for it to reflect. Light from a bright searchlight reflecting off reflective tape provides better visibility than a 0.75cd lifejacket light.

Normal incandescent lights, as currently fitted to lifejackets, were found by the HSE report to be outperformed by the systems referred to above.

Binoculars have been used at sea for very many years but need good instruction and some practical experience to ensure the best results. Furthermore at night and particularly in rough weather, they are hard to use effectively when searching for objects in the sea because of the difficulty of knowing where they are being directed. That said, they provide an important aid to the location of survivors in daylight and any light, strobe or reflective tape the survivors may have on them at night.

Image Intensifiers. The most appropriate form of image intensifier is that used in Night Vision Goggles (NVG). These are already widely used in the armed forces and, if used by those searching for survivors at sea, would, according to the HSE report, significantly increase their chances of detecting and locating survivors at night. They could also provide rescuers with greater freedom of action when actually rescuing survivors.

A limitation of NVG is that bright lights such as flares or searchlights can temporarily blind the equipment. However careful operation can reduce the risk of this happening and, if it does, the search can still be continued with the naked eye until the NVG regain efficiency.

It is expected that the use of NVG would significantly enhance the chances of detecting survivors at night, particularly if they are wearing strobe lights or reflective tape (with the search vessel using a searchlight screened from the NVG).

Thermal Imaging Equipment. So far the use of this type of equipment is limited. Some Coastguard helicopters carry it but the United Kingdom Ministry of Defence (MOD) claims no military requirement for it and not to be carrying out trials on it for search and rescue (SAR) helicopters.

It is unlikely that a survivor in close proximity to a burning installation could be individually identified by thermal imaging equipment.

It is possible that, within the limitations of burning installations, thermal imaging systems could offer an all weather survivor detection system but the cost could prove prohibitive.

4.1.1.2 Electronic Systems

There are three principal forms of radio based location systems for survivors in the sea and three radar based systems.

Electronic Position Indicating Radio Beacon (EPIRB). These are currently used by ships and aircraft world-wide but they provide insufficient accuracy (about 2.5 km radius) for use by survivors in the water. Though there are ways to overcome this, the resultant cost would probably be prohibitive.

Personal Radios. Very High Frequency (VHF) personal survival radios would, at present be of little use in the location of survivors because no suitable radio direction finding (RDF)/homing equipment is currently available although the RNLI is currently developing a handheld VHF/RDF for use by its Inshore Lifeboats. Furthermore, issuing of VHF personal survival radios would require considerable instruction, particularly in the application of effective voice-procedures.

Personal Locator Beacon (PLB). Until recently such equipment suffered from the disadvantages of requiring considerable experience to operate it and of being unsuitable for use by more than one survivor in a search area. However, these limitations have recently been overcome and the equipment, which is now available and is being used in the UKCS, offers a potentially effective location system for small and large numbers of survivors in the water. A system currently deployed in the UK Sector uses radio beacons attached to the PPE of people who are particularly at risk of falling into the sea which transmit at low power on 121.5 MHz. Low power is used because this is the frequency used by EPIRBs and it is important that the EPIRB satellites should not detect signals from the beacons. The transmissions are received by equipment onboard the installation and re-transmitted to be displayed on the radar screen on board the SBV and the DC radar display to enable the DC to home directly onto survivors. The receiver only displays the strongest signal being received which ensures that the display is not confused by several signals. On the other hand, because this may be from survivors in life-rafts or other relatively secure places, it may bias the attention of the rescuers away from survivors in the water who most need rescue. The system has significant potential and offers a considerable step towards minimising the time taken in locating survivors and so assisting achievement of required response times.

The use of radar for survivor location has been examined for several years but, so far, no suitable system has yet been designed. Three avenues have been considered. These are:

Radar Reflective Systems. Though differing types of radar reflector are used in several situations, it would not be feasible to design a system which could be deployed high enough above the survivor to work in anything but calm seas. The incorporation of radar reflective material into survivor's protective clothing may provide a feasible answer but has not yet been tried.

Search and Rescue Transponder (SART). These are active transmitters/receivers which, by transmitting a series of swept frequency pulses on being triggered by radar transmissions received on the same frequency, show up on the other radar screen as a series of dots leading away from the position of the SART. They are currently fitted to ships for use by survival

craft (though not yet necessarily on offshore installations) They are thoroughly effective when used from survival craft but are unlikely to be effective if operated from the waterline, as would be required if they were to be mounted in the PPE of survivors.

High Frequency (HF) Radar. This equipment is still only in the concept design stage. There is certainly room for further development of equipment and systems to aid the location of survivors. Some of the systems described above are starting to be used by SBV but no single one is likely to provide a complete solution.

4.1.2 Competence and Training

This subject can be considered in two parts which address overall approaches to location and the specific needs of particular location aids.

4.1.2.1 Search Competence and Training

Both SBV and FRC/DC will carry out the search for casualties in the sea. However the available aids will in some respects vary. It is essential that Masters and Mates of SBV and Coxswains of FRC/DC are able to prepare and undertake an effective search using those resources and aids available to them.

Masters and Mates of SBV must be ready to co-ordinate searches, using their own and other FRC/DC and other vessels which are on the scene. They may, particularly in the early stages of an incident before the arrival of other units, be required to act as On-Scene Commander (OSC).

To perform the functions required of them, Masters and Mates must be competent in:

- Search planning;
- Communications with search units;
- Monitoring the conduct of the search by their own and other units;
- Responding to changing situations, including controlling the actions of others.

These involve knowledge of:

- The use of relevant communications systems;
- The choice of appropriate search plans;
- Plotting and recording the movements/activities of own and other units;
- Communication with relevant other bodies (e.g. Coastguard, shore management, nearby installations, shipping, etc.);
- Use of available search aids.

In the UK SBV Masters and Mates are required to undertake training and demonstrate competence as set out in the OPITO Approved Standard for Command and Control for Standby Vessel Masters and Mates which address all these subjects.

DC Coxswains must be competent in:

- Search planning;
- Communication with their SBV;
- Plotting and recording the movements/activities of own units;
- Use of available search aids.

FRC Coxswains must be competent in:

- Search planning;
- Communication with their SBV;
- Use of available search aids.

FRC/DC Coxswains are required to undertake training and demonstrate competence as set out in the OPITO Approved Standard for Standby Vessel Crew Fast Rescue Craft and Daughter Craft Coxswain respectively, which address all these subjects.

Competence in the use of most location equipment is briefly examined below:

Light Systems. Except in the case of pyrotechnics it is only necessary to have some limited experience-based knowledge of the application of any of these aids to location. The use of pyrotechnics in the vicinity of offshore installations is normally not advisable in view of the possible presence of flammable hydrocarbon substances.

Electronic Position Indicating Radio Beacon (EPIRB). The operation of EPIRB equipment & the details of the various EPIRB operating frequencies form part of GMDSS training. Those ships which have equipment to detect the operating frequency 121.5 MHz should have people competent to use it.

Personal Radios. These forms of location device are not currently used in the offshore oil industry and, in view of their constraints, are unlikely to be used in future so competence in their use is not needed. If this situation changed, then some training of FRC/DC Coxswains in their use would be needed.

Personal Locator Beacons. Competence in the use of these location devices requires some limited explanation of the principles on which they work and demonstration and practice of their operation. This is currently carried out by those SBV companies which operate ships on fields where they are deployed and, unless they become generally used, this is enough, provided careful control is maintained over the instruction of all DC Coxswains (and FRC Coxswains if their use expands to these craft) who may use them.

Radar Reflective Systems. These systems are not currently used in the offshore oil industry and competence in their use is not therefore needed there. If they were deployed some training of DC Coxswains in their use would be needed.

Search and Rescue Transponders (SART). The recognition of SART traces on radar screens and understanding of their significance must be described, demonstrated and practised. This is done on the OPITO DC Coxswain Course but would not be relevant for FRC Coxswains because FRC do not carry radar.

HF Radar. Like Personal radios and Radar reflective systems, HF Radar is not used offshore now and is unlikely to be adopted soon. If it is some special training in its use will be needed.

4.1.3 Conclusions

From the above comments it is clear that the system offering the greatest assistance in locating casualties is the Personal Locator Beacon (PLB) system. It is therefore appropriate that this system should be used wherever possible and particularly where any delay in rescue (say over 20 minutes) is possible. Training in its use should initially be done on a crew by crew basis but, when its use becomes more widespread, it should be included in the OPITO DC and, if appropriate, FRC Coxswains' Courses.

Additionally it would be prudent to incorporate at least one visual location aid such as strobe lights or reflective tape on all survival suits which may be worn by casualties.

The use of image intensifiers and thermal imaging equipment, though attractive, is not at present considered a cost-effective addition to the aids set out above.

4.2 CASUALTY CARE

4.2.1 Immersion Injuries

Though casualties rescued from the sea may be suffering from any of a great many different physiological and psychological conditions, the only sure thing is that they have been immersed in water, and probably cold water. To give an indication of what may be expected in the waters off North West Europe, the mean temperature in summer (taken for the month of August) is 13°C north of Shetland and 16°C in the southern sector and in winter 8°C in the north and 5°C in the south. Accordingly it can be safely assumed that the most likely medical conditions to expect in them will be those associated with immersion in cold water. These are examined below.

Cold Shock. When a person falls into water (particularly in temperatures less than 10C) the sudden drop in skin temperature causes a reflex reaction which raises respiratory and cardiac responses. After an initial involuntary gasp on entering the water, breath-hold times will usually decrease to less than 10 seconds and breathing rates are likely to increase six to ten-fold. This will greatly increase the risk of inhaling water so that there is a significant risk of drowning within minutes of immersion. In addition, both heart rate and blood pressure increase significantly imposing severe demands on the work of the heart with the potential for cardiac arrest in susceptible individuals. It is reported that in as many as 50% of the annual UK water deaths, cold shock may be implicated.

Cold Shock and Aspiration of Water. The repetitive submersion of the face resulting from wave splash in turbulent water may result in the aspiration of a sufficient volume of water to damage the lungs or cause drowning. One purpose of personal protective equipment (PPE) worn when the risk of entering the water is deemed higher than usual (for example when travelling in helicopters or working over the side of an offshore installation) is to provide the necessary protection to overcome this. However this is easier said than done and trials have demonstrated the inadequacy of several types of PPE designed for this purpose, in particular when damaged or not worn correctly. Accordingly the risk of inhaling water in anything worse than calm sea conditions is significant. When this is happening and the victim is not treated properly in time, death is likely to occur by drowning, within minutes, or later from the damaging effects to the lungs.

Manual Dexterity. Immersion in cold water (5C – 10C) will quickly (less than 5 – 10 minutes) result in the cooling of the hand and arm muscles which can make even the most simple manual tasks (e.g. locating and activating a survival aid) extremely difficult, if not impossible. Training, procedures and equipment should make allowances for this eventuality. Such peripheral cooling occurs long before a fall in deep body temperature.

Decline in Core Temperature. The inevitable effect of immersion in cold water is for the core temperature to cool at a rate which will principally depend on water temperature, available insulation (including body fat) and levels of activity required. When body temperature falls by 2C a condition of hypothermia is said to exist. If cooling is allowed to continue unchecked, it will ultimately cause unconsciousness and eventual death. However before cooling to such a degree occurs the effects of local periphery cooling described above are far more likely to cause the casualty to become severely debilitated, lose motor function and to become physically and physiologically unable to make the necessary effort to maintain an airway clear of the water. He is most likely to drown due to inhalation of water either before or as he loses consciousness from hypothermia. Thus, in spite of a common perception that hypothermia is the main cause of death in water, it is usually the local peripheral effects of cold which lead to drowning before hypothermic death occurs.

Rescue Collapse. It has been postulated that around 10 – 20% of fatalities following cold water immersion have resulted from this condition. When a survivor is removed from the water the resulting loss in hydrostatic pressure assistance to circulation may lead to collapse of arterial blood pressure and a resulting reduction in cardiac output causing hypoxia in the vital organs of brain and heart. This, often aggravated by the extra physical effort involved with rescue, may cause death, either at the time or shortly after recovery from the water. The risk of this condition occurring can be reduced by lifting survivors horizontally from the water instead of by the more traditional vertical lift by strop or over the side of a boat. However, in sea conditions when the victim's airway is under threat from wave splash it is most important to rescue him in the speediest fashion possible.

Loss of Will to Survive. This psychological condition is still little understood. However there are many recorded cases of people dying just before, during or immediately after rescue. It is conceivable that, with the psychological relief of imminent rescue, or the removal of the threat following rescue, there is a sudden relaxation associated with a reduction in the amount of circulating adrenaline in the body, which may in turn result in cardiac arrest in some people.

Near Drowning. Many immersion fatalities are rescued alive. Some may even be conscious and breathing spontaneously at the time of rescue. However their condition may progressively deteriorate over the succeeding minutes or hours as a result of water damage to their lungs which impairs the transport of oxygen from the inspired air to the blood. The resulting progressive hypoxia will eventually lead to unconsciousness and death if the correct treatment is not followed.

Secondary Drowning. Salt water in the lungs can introduce an irritant effect to their lining which prevents their normal function. This in turn is likely to cause a build-up of fluid in the lung which, if not properly treated straight away, can result in death. The condition can occur between 15 minutes and 48 hours after immersion but is most often found after about 3 to 6 hours. Though it is rare, any survivor who has had salt water in the lungs is susceptible to the condition, which may occur to people who were apparently symptom free on rescue.

Re-warming Collapse. This condition can result from catastrophic fall in the blood pressure of cold survivors who are being subjected to superficial artificial re-warming, particularly if they are not lying horizontally.

4.2.2 Other Injuries

The preceding short explanations highlight conditions which can result from immersion in cold water. It is important to realise that, when survivors have been in the sea because of the results of an accident, they may well have suffered one or several other injuries from the accident itself. They may be cut, burned, suffering from head injuries, broken bones or internal haemorrhage. All of these are likely to have been aggravated by immersion in the sea and possibly by the very act of rescue. The danger is that poorly trained rescuers who might assume that the condition of the victim is due solely to the effects of immersion may overlook such injuries. In multi-casualty situations, where the initial priority is to rescue everybody as speedily as possible, secondary injuries may be overlooked at the time of rescue. For such casualties it is important therefore to conduct full, proper Triage when they arrive at the "place of safety".

4.3 THE TREATMENT OF IMMERSION CASUALTIES

4.3.1 Introduction

From the previous sections it can be concluded that the principal "medical" problems likely to be encountered in immersion victims are *Near Drowning*, *Hypothermia* and *Cardiovascular problems*. In addition, in those victims who have been involved in a helicopter ditching or accidental falls into the water, the possibility of co-incidental *traumatic injury* should not be overlooked. *Pulmonary infection*, if it occurs, is usually a late complication.

4.3.2 Rescue

Recovery of the victim from the water should be achieved speedily without compromising the safety of the rescuers or the victim. In general, the victim should be brought inboard as quickly as possible by whatever means are most appropriate to the situation; however, if the victim has been in the water for some time and is clearly able to breathe without having his airway compromised by wave splash, i.e. his lifejacket is maintaining his airway clear of the water, the speed of recovery is less important than exercising care in doing so. Such victims, who have survived prolonged immersion in cold water, are likely to be suffering from severe hypothermia and, provided circumstances permit, require care in handling as if they were critically ill. If however, the safety of their airway is under threat from wave splash, they should be removed from that threat as quickly as possible by whatever means.

Alternatively, if the risk of aspiration of water is considered to be low, then every effort should be made to recover the victim in as near a horizontal attitude as possible in order to assist their circulation, which may be compromised if kept in an upright posture for long on being returned to the full effects of gravity. Survivors should be required to do as little as possible to assist in their rescue.

Following prolonged immersion in water at any temperature, physiological adjustments are made to the circulation to compensate for the effect of the reduction of gravity on the body and the additional increase in hydrostatic pressure around it. As a consequence, circulating fluid volume is decreased. On returning to the full effects of gravity on being rescued from the water, there is a requirement for circulating fluid volume to be restored if an effective circulation to the brain is to be maintained. If the overall duration of immersion was short, this can be achieved physiologically, almost instantaneously, as no net loss of volume will have occurred. If, however, the duration of immersion was prolonged, the relative excess of circulating fluid – which is physiologically sensed while immersed – will be redistributed to the tissues and some will be excreted as urine. As a consequence, on leaving the water, there will be a time delay before the necessary adjustment to the circulation can be made, during which, if the victim is upright, the brain may be starved of blood resulting in fainting. Through the same mechanism, the blood supply to the coronary arteries to the heart may also be deprived of blood, especially in those who have underlying coronary artery disease (e.g. the middle aged or elderly), this can result in a “heart attack” (myocardial infarction - M.I.) or even sudden cardiac arrest. *The longer the duration of the lift (greater the height above water the victim is being lifted vertically), the greater the threat of this complication.* The risk is also significantly increased in those who are cold; there is evidence to suggest that the physiological mechanisms, which make the necessary adjustments to the circulation on leaving the water, are seriously compromised by cooling. For these reasons, recovery in a horizontal attitude is preferable to being lifted vertically and should be attempted *if time and circumstances permit* without compromising the safety of the victim or the rescuers.

Regardless, whatever attitude they are recovered in, it is important to lie the victim horizontally as soon as possible after rescue.

4.3.3 Treatment on the FRC

Despite much advice to the contrary many FRC/DC crews believe that their only real role is to return casualties to the SBV as fast as is possible and that survivor care in the FRC/DC is not practical. The sub-sections below present some of the issues that crews should be aware of after survivors have been taken on board their craft.

4.3.3.1 Airway Management

Once the victim is safely inboard and the risk of re-immersion is safeguarded against, a thorough examination of the victim must be conducted as soon as is practicable. A minute or two doing so is time well spent and may prove life-saving. General “First Aid” principles should be followed: first checking the airway and clearing it where necessary. Remember, *establishing and maintaining a clear airway is probably the most important First Aid action any rescuer can perform and is the first priority after the victim has been safely rescued.* Loosen any tight clothing around the neck and remove any obstruction from the mouth, such as vomit, loose denture, etc.; if the victim has well fitting dentures leave them in situ as they will help to preserve the firmness of the lips and shape of the mouth thus making it easier to make a better seal when carrying out Expired Air Resuscitation (EAR) should that be necessary subsequently.

With the victim lying on his back, extend the neck backwards by gently exerting some downwards pressure on the forehead with one hand while tilting the jaw forwards and slightly upwards with the other; this will clear a gap for air to flow between the tongue and the back of the throat and permit breathing to restart if such an obstruction was present – which is likely in an unconscious victim. The standard First Aid principles of “Look, Listen and Feel” for evidence of breathing are much more difficult to achieve in a boat in the open seas but nevertheless worth pursuing briefly. If breathing is absent then 10 breaths of EAR should be given immediately. Watch for the chest rising to ensure that the airway is patent and the EAR is effectively moving air into the lungs. After ensuring that the airway is clear and the victim is breathing freely, or having given the 10 breaths of EAR, check to see if the victim is breathing spontaneously. Be watchful for vomiting: approximately 60% of people who have aspirated seawater vomit after rescue, especially during resuscitation.

In some susceptible individuals, a condition known as “Vagal Inhibition” may result from immersion of the face in very cold water. This can produce a stoppage of both the heart and respiration, which may remain arrested even after the victim is rescued from the water. The condition may be immediately reversed, without any undue harm to the casualty, simply by inflating the lungs by EAR. This action will usually restore normal cardiac and respiratory function. Delay in reversing the condition may, however, result in brain damage or even death from hypoxia. It is important therefore to quickly check the rescued victim for signs of respiration and immediately commence EAR once it has been established that spontaneous breathing is absent in spite of there being a clear airway.

Airway clearance and the commencement of resuscitation will always take precedence over a speedy return to the SBV. A few minutes restoring a clear airway and re-oxygenating the lungs through EAR immediately on rescue could help prevent severe brain damage and may even prove lifesaving. The desire to rush back to the SBV should be resisted until a careful assessment of the casualty has been made. Making such an assessment when the FRC is underway, especially at speed, is extremely difficult, and in a rough sea, well nigh impossible. It is important therefore to remain calm and carry out practised routines slowly and deliberately rather than rushing back to the SBV. Once the FRC is underway it will be extremely difficult to carry out expired air resuscitation effectively; consequently, if indicated, EAR should be commenced immediately on rescue and then repeated intermittently (10 breaths once every minute) on the return journey to the SBV. It may be necessary for the FRC to be slowed or even stopped during these intervals. The delay incurred by such an interrupted journey will prove less damaging overall to the victim who is not breathing adequately, than the damage incurred from even a three or four minute period of oxygen starvation of the brain which may occur during a non stop rapid return to the SBV. Ideally, an airway with a flexible junction between the resuscitator and the victims mouth should be used as it enables resuscitation to be carried out continuously without the requirement to stop the boat.

4.3.3.2 Cardiac Arrest

Conventional First Aid teaching recommends that the next action, after establishing the airway is clear, is to check for a pulse in the neck and commence External Cardiac Massage (ECM) if it is absent. However, the diagnosis of cardiac arrest in these circumstances can be extremely difficult, given that the inability to detect a pulse in the neck could simply be due to factors such as: boat movement; cold (numb) fingers in the rescuers; severe vasoconstriction (blood vessels shut down); bradycardia (marked slowing of the heart rate) in the hypothermic victim. In addition, the possibility of conducting effective ECM in an FRC under way is highly improbable. For all of these reasons, it is considered inadvisable to commence ECM – in these circumstances – in the absence of a palpable pulse, even in the neck. Instead, it is better to wait until the victim has been returned to the more stable platform of the SBV where a thorough assessment of his condition can more easily, and efficiently, be made.

The rationale behind this unconventional advice is as follows: commencing ECM in a severely hypothermic victim may precipitate ventricular fibrillation and cardiac arrest. On rescue, even if a pulse cannot be detected there is still a possibility that the heart is still beating, albeit slowly, but at sufficient speed and efficiency to meet the circulatory demands of the hypothermic body. If ECM is commenced and cardiac arrest results, it is then mandatory to perform effective ECM, continuously, in order to maintain a viable circulation until electrical defibrillation can be carried out. But, as the chances of accurately diagnosing cardiac arrest in the first place and then carrying out effective ECM are remote, it is better to defer any such action until the victim is returned to the SBV where a better assessment can be made and the necessary technical aids may be available to assist in making a diagnosis. Additionally, as the requirement of the brain for oxygen in severe hypothermia is greatly reduced, a relatively short delay in commencing ECM is associated, overall, with less risk to the individual than commencing ECM and possibly inducing a cardiac arrest. Finally, in the absence of the necessary advanced medical therapeutic and biochemical support, the effectiveness of ECM as a life saving measure diminishes rapidly with time from the onset of cardiac arrest. The majority of cases where ECM has proved successful in saving life, are those incidents when cardiac arrest has been witnessed and ECM commenced almost immediately, with relatively rapid recourse to full critical care medical facilities.

4.3.4 Insulation

Thus, having established that the victim is breathing spontaneously, or commencing EAR if he is not, the next step is to insulate the victim against further heat loss as soon as is practicable. This can be achieved by enclosing in a wind-proof/water-proof material such as polythene. (“Space Blankets” are virtually useless in these conditions as the routes of heat loss are primarily through *evaporation* and forced *convection*, from wind chill, not *radiation* which the “Space Blankets” were designed to counteract). It is important to cover the head which is a major source of heat loss from the body in cold ambient environments. In such conditions, with wet hair and high levels of relative air movement, over 50% of body heat loss may occur through the head alone.

Good judgement will be called for when deciding the priority for this measure over that for general First Aid. Obviously, the requirement for airway maintenance is the first priority; thereafter, in the absence of any sign of injury, insulation against further heat loss usually becomes the next priority. However, should some other life threatening condition be evident, e.g. severe bleeding, then that will take precedence over the treatment for hypothermia, during the relatively short duration transit back to the SBV. Common sense will also provide some clues in helping to make a decision regarding the priority for the requirement for immediate insulation over that for carrying out a thorough general First Aid examination for other injuries e.g. survivors of a helicopter ditching should be handled with care as they are more likely to have some associated traumatic injury. Furthermore, if it is known that the victim has not been exposed to the elements for very long, then he is unlikely to be suffering from significant hypothermia and, although cold and continuing to lose body heat all the time he remains exposed to those conditions, it would be wise to check for further injuries before any, possibly damaging, additional movement of the victim is made. Alternatively, if

the victim has been immersed for some time, i.e. found after it was necessary to institute a search in order to locate him, he is more than likely to be suffering from near-drowning and/or hypothermia, in which case insulation will usually be the next priority to a clear airway and EAR.

4.3.5 Treatment on the SBV

On returning to the SBV, care should again be exercised in transferring the survivor to the Treatment Room where a thorough and detailed examination must be carried out. Again he should be transported in a horizontal attitude on a stretcher, or carrying sheet, if there is a likelihood of him suffering from a potential circulatory problem for the reasons outlined previously. Heart rate and respiratory frequency must be recorded together with the state of consciousness. Evidence of cyanosis (blueness of lips and nail beds) should be sought and noted if present. Blood Pressure (BP) should be recorded and a careful auscultation of the chest made to detect any extraneous sounds which might suggest aspiration of water into the lungs. Deep body (rectal) temperature should be measured by an electric thermometer and, if low, rechecked ensuring that the thermometer is inserted fully (at least 10 – 15cms) and for sufficient duration (>2 mins.). If unconscious, the state of the pupils and their reactivity to light should be noted and monitored frequently.

Even when the victim is breathing spontaneously, and regardless of his state of consciousness, if there is any evidence of *near drowning* (coughing, cyanosis, noisy chest, laboured breathing), oxygen should be administered and arrangements made to air-evac to hospital as soon as possible. Cyanosis alone should not be interpreted as evidence of near drowning as it may simply be due to a sluggish peripheral circulation in cold extremities. If respiration is laboured and the level of consciousness deteriorating, then intubation should be contemplated. If not, EAR should be commenced and continued during the transfer to hospital. If the patient is attempting to breathe spontaneously he must be continually advised to relax and not to fight the EAR. Providing additional oxygen to the inspired air of someone who is breathing spontaneously but who has inadequate ventilation of his lung from near drowning, although advisable, may be insufficient to oxygenate his blood adequately. Additional pressure may be required to force the air down into the terminal airways; this can only be achieved by external pressure. In ideal conditions relaxation and intubation can achieve this relatively easily by someone competent with the appropriate equipment and drugs. However, in the absence of such sophisticated equipment, EAR may supply the necessary life saving pressure which cannot be achieved through spontaneous breathing alone. If oxygenation of the blood remains inadequate, the level of consciousness will continue to deteriorate and the victim will eventually die.

4.3.5.1 Rewarming

Following a thorough examination, immersion victims who are suffering from uncomplicated hypothermia alone should be assessed with regard to their suitability for one of the following rewarming regimes: rapid external (*active rewarming*); slow spontaneous (*passive rewarming*), or *assisted passive* rewarming.

Active Rewarming. In general, victims who are moderately cold (rectal temperature =34°C) following a relatively short duration of immersion, shivering, and fully conscious, may be rapidly rewarmed without risk. This is best achieved in a bath of hot water (40°C), under supervision. Hot showers are less effective as a rewarming medium and have the added risk of possibly inducing fainting in these victims when the skin blood vessels re-open on rewarming. This will place an additional demand on the circulation of individuals standing upright who may already be having difficulty in maintaining an adequate circulation. If showers are being used for this purpose, the victim should be encouraged to sit down and constantly supervised. They should be warned that if they are feeling even slightly dizzy they should say so and be removed from the shower to continue rewarming by the slow passive method.

Active rewarming has the advantage that it rewarms the victim quickly and thus speedily restores the feeling of well-being and reduces the overall stress suffered by the victim. An added advantage is that it inhibits, or reduces the intensity of shivering and thereby reduces the workload of the heart in addition to having other biochemical and some circulatory benefits. The major danger associated with such treatment is that the victim may stay too long in the comfort of the bath and for the reasons given above, suffer a fainting attack on leaving the water. The victim should be advised that he should leave the bath when he feels he has rewarmed sufficiently, and certainly before he starts to sweat. An increase in heart rate will indicate rewarming should be terminated. On leaving the water he should always be assisted a supervised as he dries himself and dons dry clothes. He should then be advised to lie down on bunk for a period to continue recovery, during which he may be given some hot sweet drinks.

In a major disaster there may be many casualties requiring to be rewarmed at one time. In such situations there is no alternative to hot showers, other than passive rewarming. If it is deemed that in such a scenario, showers are indicated, then in the absence of individual supervision, victims should be advised to sit on the deck beneath the shower to reduce the risk of possibly fainting and suffering an additional traumatic injury. Again, care should be exercised to ensure that they do not overheat; following showering they should also lie down for a short period to complete their recovery and enable supervision to be continued. Before leaving the Treatment Room they should be re-examined to check especially for any evidence of "secondary drowning" the symptoms of which are identical to those given above for near drowning.

Passive Rewarming. This is achieved by gently removing the victim's wet garments with the minimum of disturbance. If necessary the clothes should be cut off, particularly in unconscious victims. The victim should then simply be insulated by placing him in a sleeping bag or blankets to prevent further heat loss. The head, excluding the face, should also be covered to prevent heat loss via this major route. Rewarming is then dependent on the body's own metabolism (shivering) which generates heat internally, thereby rewarms the body from inside out. It is the safest way to rewarm hypothermic casualties as it relies on the body's own internal mechanisms to regulate the rate of rewarming and other biochemical physiological demands. By so doing there is little danger of overheating, or placing undue demands on the circulation as skin blood flow will only be restored when the surface of the body has reached near normal temperatures. It is the method of choice in the 'out of hospital' management of all severely hypothermic cases (body temperature < 34°C), especially those who are semi-conscious or unconscious. The major disadvantage with passive rewarming is the time it takes to restore body temperature to normal levels; this prolongs the duration of discomfort and suffering experienced by the victim. It also prolongs the time the heart is required to operate at an increased work load, both to support the continued high blood flows to shivering muscle and to work against the back pressure of closed peripheral blood vessels. Nevertheless, it has been shown to be the safest method of rewarming profoundly hypothermic patients.

Assisted Passive Rewarming. As passive rewarming relies on the body's own ability to generate heat through shivering, there is little point in depending on this method if shivering is inhibited, for example by severe injury or intoxication. When shivering is absent some extraneous heating will be necessary, as evidenced by a continuing decline in rectal temperature 15 or more minutes after passive rewarming methods have been instituted. In such cases a moderately warm "hot water bottle" (or other method of controlled local application of heat e.g. small electrically heated blanket with good thermal control) applied to the stomach may help to reverse the fall in body temperature. Great care must be taken to ensure that the temperature of the heat source is not too hot; with the impaired circulation to the skin, burning can occur at temperatures perceived as comfortably warm by people providing the treatment who have normal body temperatures. If in doubt, the "bottle" should be wrapped in a towel or similar material to insulate it from coming into direct contact with the skin of the cold abdomen. As long as the temperature of the "bottle" is several degrees above that of the rectal temperature, heat will flow into the body and contribute to the

rewarming process. As only moderately warm “hot water bottles” are being used, they will require frequent replacement. Obviously, unconscious patients will require to be placed in the “unconscious position” throughout the rewarming procedure to ensure that a patent airway is maintained. Frequent monitoring of deep body temperature is also necessary to ensure that it is rising at a satisfactory rate; about 0.5 to 1.0°C per hour is the optimum. In a very cold casualty, rates in excess of these can precipitate rewarming collapse, and should therefore be controlled by judicious adjustment of the insulation around the body to control the level of heat loss from it.

On regaining consciousness, hot sweet drinks may be offered and the patient should be reassured. Ideally he should not be isolated from his fellow survivors but they should be encouraged to discuss their experiences freely if they so desire. When rewarming is complete, advice should be available from some medical authority regarding the disposal of the casualty and counselling if deemed necessary.

4.3.6 Competence and Training

Industry Guidelines require that all UK SBV crew should complete the OPITO Initial Shipboard Training Course and be assessed competent in the subjects it addresses. These include the handling and care of casualties.

The Guidelines also require that 1 (and for remote locations, 2) crew member undergo OPITO approved training in Advanced Medical Aid. Competence is also assessed in this course.

All SBV carry out ongoing, onboard training which includes practical exercises in casualty handling, care and treatment, supplemented by video-based training in these subjects which is designed to remind crew members of the knowledge of the subject needed to carry out practical measures effectively.

The effectiveness of this training is judged by periodical audits.

4.4 TRANSFER

4.4.1 From FRC in Water

When an FRC returns to the SBV the choice must be made as to whether to transfer casualties from the craft in the water or when hoisted.

The advantage of doing so from the water is that it saves time, making the FRC available again to return to the search area for more casualties. However, in anything but favourable sea conditions, it is more hazardous to the casualties and requires more action from them which may well be beyond them (see Section 4.2.1). Accordingly, it should only be used if casualties are reasonably unaffected by the incident (and certainly not if they are in stretchers) and if the weather is suitable.

When it is carried out, the FRC should be held alongside the Rescue Area by bow and stern lines. Casualties should be assisted from it to the deck by both the FRC crew and those in the Rescue Area. Safety lines should first be attached to them, which should be tended in the Rescue Area.

4.4.2 From FRC on Deck

Casualties can be transferred from the FRC either at deck level or once it has been fully recovered to the deck. The former is the most common and usually the most practical approach.

The advantages of using this method is that it can be done in any conditions in which the FRC can be recovered and casualties can be handled whatever their condition. The FRC should be recovered in the usual manner and the casualties should then be transferred to the deck by the FRC crew and deck crew.

Particular care must be exercised to avoid danger to the casualties, particularly if the SBV is rolling. A significant risk with normal davit systems is that the FRC may swing away from the ship's side. To prevent this, the FRC should be bowsed into the ship's side before transfer starts.

5 HUMAN FACTORS ASPECTS OF RESCUERS

This section specifically examines human factors in marine rescue. It summarises views obtained from discussions with vessel Masters, trainers, operators and academics involved in offshore rescue research and training. It sets out the factors in human behaviour that are believed to have a significant effect on the performance of the rescuer or the outcome of the rescue operation. From this evolves a consensus on best practice and hence competency.

The scope of this section is limited to human factors that relate to the rescuer, the value of training, the impact of outside influences and the specific human problems associated with rescue and daughter craft operations. The context is limited to rescue and recovery, emergency response, or SBV operations in the UKCS in support of the oil and gas industry. Nonetheless, the best practice is equally relevant to marine rescue operations elsewhere.

The issue of recruiting and retaining competent rescuers is not addressed, although it is probably the biggest challenge currently facing the industry. However, best practice leads to competency, the job being valued and hence to higher status.

5.1 THE RESCUER

This section examines what makes a good rescuer and looks at two specific groups: Officers of designated rescue and recovery (SBV) and Coxswains/Boatmen of rescue craft. Firstly, and common to both groups, is the underlying issue of self-selection and motivation of rescue personnel.

5.1.1 Self-Selection and Motivation

In the offshore rescue and recovery service, virtually all personnel are self-selected. No one is forced into being a full time rescuer although economics do influence some. Each person rapidly comes to understand the demands of the job and accepts them or leaves. The rescuer recognises that at greater or lesser frequencies, they will have to:

- Recover rapidly from a slow, boring and possibly uncomfortable existence;
- Respond instantly to an emergency in a manner that may pose significant hazards to himself;
- Undertake prolonged physically and mentally arduous work;
- Witness extremely unpleasant events.

The following are suggestions from professionals as to what motivates the rescuer. For convenience they are split into positive and negative aspects.

5.1.1.1 Positive Motivators

- Pride in their own seamanship skills;
- Professionalism;
- Recognition, feeling valued, being part of the 'field team', having successes recognised;
- Rescue as part of an otherwise interesting and satisfying occupation;
- Feel they are doing a worthwhile job, both the routine and the emergencies;
- Good living and working conditions.

5.1.1.2 Negative Motivators

- Default job (it's the best I can get with my qualifications/skills/background);
- Financial pressures;
- Avoiding social problems;
- Uncontrolled thrill seekers (adrenaline junkies).

5.1.1.3 Best Practice

From the above, it can be concluded that the best rescuer is motivated by a combination of the following influences:

- Pride in his own seamanship and as a professional rescuer;
- Having an interesting and satisfying job to do whilst remaining alert for emergencies;
- Being valued by his employers, peers and the client field/installation;
- Enjoys realistic compensation and good working/living conditions;
- Feels supported by his employers, Master and colleagues.

5.1.2 Rescue Vessel Officers

The rescue vessel Master and Mate lead the response. By their seamanship they provide the rescue platform and by their motivation and training of the crew establish the level and competence of the response to an emergency. They are the key personnel.

5.1.2.1 Physiology

Masters and Mates, in common with all crew, require a level of fitness to live and work on a vessel which moves violently in a seaway. They do not necessarily need the high levels of fitness of the rescue craft crew.

They do have to cope with vessel motion fatigue, often for several weeks in succession and establish sleep and recreation patterns to suit. Although not strictly physiological factors, they should be mature and be able to cope with both the stress of dealing with an emergency and the boredom of a humdrum existence.

5.1.2.2 Personality

All consultees agreed that personality of the rescue vessel Master is critical in motivating the crew and in running an efficient rescue operation. Listed below are some positive traits and some that are less positive.

5.1.2.3 Positive Personality Traits

- Mature (age not considered to be a critical factor);
- Assertive, strong personality, disciplined, self-confident, a decision taker;
- Excellent seamanship skills; “seawise”; the “small ships, big seas” background of fishing skippers is well suited to rescue vessels although seafarers from other backgrounds bring equal if different skills;
- Alert; reacts rapidly but doesn’t panic; prioritises the most important tasks; thinks through the problem; controls the pace of his and his crew’s response;
- Able to deal with conflicting demands and concentrate on the priority actions;
- Able to handle stress; calm in the face of trauma or panic (some consultees suggest limited imagination is a positive trait);
- A leader; a manager; a good communicator; good interpersonal skills; aware of his own and other’s abilities;
- Well organised; good team player, involves his crew;
- Supports and motivates his crew before, during and after a rescue.

5.1.2.4 Less Positive Personality Traits

- Responds to commercial pressures – real or imagined;
- A dictator;
- Freezes or panics;
- Refuses to accept or ignores the problem;
- “Must do something” regardless of priorities or the full picture;
- A thrill seeker.

5.1.3 Coxswains and Boatmen

Rescue craft crews are the first line of response in any marine rescue. Their skills, physical fitness, ability to deal with the elements and stamina will have a major impact on the outcome.

5.1.3.1 Physiology

- Must be physically fit, firstly to take the motion and pounding of a rescue craft underway and secondly to recover inert survivors from the water;
- Even with lifting aids, manoeuvring a 70-90kg inert body into a rescue craft requires skill and strength;
- For a multi person rescue endurance and stamina are essential;
- Technique and experience are essential;
- Although age is not critical, physical requirements will deselect boatmen progressively through their 50's;
- Able to remain alert despite boredom, fatigue and the various effects of sea motion, coldness (or alternatively heat in a DC);
- Ability to live, work and sleep in the violent motion of a rescue vessel are critical.

5.1.3.2 Personality

- Maturity;
- Experience;
- Seamanship skills;
- Common sense;
- *Not* a risk taker;
- Rapid reaction but remain calm;
- Many of the positive traits of a vessel Master apply equally to Coxswains, particularly Daughter Craft Coxswains;

5.1.3.3 Best Practice

To summarise the above, key rescue vessel and craft personnel need to be:

- Physically fit for the task;
- Mature;
- Good seamen;
- Organised;
- Able to prioritise and deal with these priorities in the face of stress, conflicting demands and a multitude of outside influences.

5.2 TRAINING

It almost goes without saying that training is essential for a good rescue service. Nonetheless, the comments below, taken from trainers and operators, relate.

- Training must be at the right level and above all relevant:
 - * If training is excessive or irrelevant, it leads to resentment, boredom and inefficiency;
 - * It must have value and *be perceived as having an end value*;
 - * Training in basic skills may be resented at first, but if handled correctly, gets a positive response;
- The most effective training involves the whole team;
- Integration of rescue vessels into Field training and Masters in platform Emergency Response training brings positive results;

- Command and Control/Bridge Team training is viewed as positive:
 - * Masters may be defensive among their peers until the first one makes a mistake;
 - * It gives status;
 - * This training cascades through the whole crew;
 - * Seen as positive in understanding relative roles and relationships;
- Military style repetitive training until response becomes second nature is generally positive, however civilian tolerance levels may be lower;
- Training to cope is essential;
- Coxswain and boatman training must include techniques for recovering casualties into rescue craft;
- Boatmen must also be trained to keep casualties alive – even though they appear dead;
- Phased regular training through each period of duty is viewed as a positive development.

5.3 OUTSIDE INFLUENCES

The ideal rescuer would be stimulated, supported, motivated and protected from negative influences – pampered even. Unfortunately the real world is different and they are subject to the same annoyances, interference's and frustrations as the rest of the population. These negatives are often amplified by distance from home, remoteness from their “customers” the installation personnel and limited control over their lives and work pattern.

Nonetheless, these outside influences can have a significant impact on overall motivation of rescuers. Conditions during an incident can also affect the rescuer’s concentration, response capability and endurance. Listed below are some positive and negative influences.

5.3.1 Positive Influences

- Recognised as part of a ‘field team’;
- Busy and varied work pattern, one operator states that the ships with lots of activity are the most popular;
- Well laid out work areas for routine and emergencies: bridge and engine room layout; communications systems; rescue system layout; handling and processing of survivors;
- Good relationships with and support from management and office staff;
- Skills and professionalism recognised – “valued”;
- Support and recognition by family and peers;
- Good living conditions, recreation facilities, food; realistic income; pension and medical schemes; good career structure, recruitment, development, opportunities for advancement
- Facilities for fitness training on board mother vessel; encouraging fitness training on leave.

5.3.2 Negative Influences

5.3.2.1 Background influences

- Social and family problems = pre-occupation;
- Lack of adequate communication, consultation by client platform;
- Poor management support and communication, failure to understand and resolve operating and/or human issues problems;
- Insufficient stimulating work resulting in boredom and lack of motivation; conversely excessive work demands resulting in fatigue and lack of alertness;
- Commercial pressure, real or perceived.

5.3.2.2 Outside influences during an incident

- Rescue craft (particularly daughter craft) crews fatigued by close standby shifts;
- Excessive communications demands which interfere with the rescue task, may be caused by:
 - * Demands for information by client platform, Coastguard, onshore management, onshore client;
 - * Too many radios and telephones;
 - * Responsibility for On-Scene Command as well as search and rescue;
- Other external influences which interfere with crew's ability to get on with the rescue task, may include:
 - * Military On-Scene command;
 - * Helicopter noise;
 - * Medical teams seeking information;
 - * Media enquiries;

5.3.3 Best Practice

When an incident occurs the rescue vessel crews need to be alert, motivated and not fatigued. To achieve this they need:

- Good working and living conditions, realistic compensation and career structure;
- Appropriate work patterns which maintain skills and alertness but do not fatigue the rescuer;
- Recognition by their client platform, peers and management;
- Support, good communications and consultation from their management and client platforms;
- Encouragement of and onboard facilities for fitness training;
- Reasonable assistance in dealing with social and family problems;
- Separation, if possible, of the SAR role from On-Scene Command;
- Understanding by Coastguard, military, clients and management of the pressures, particularly on communications, during an incident.

5.4 RESCUE CRAFT OPERATIONS

5.4.1 Fast Rescue Craft

In the UKCS, the operating philosophy centres on a three person crew. A divergent philosophy exists in the Danish Sector where the custom is a crew of two. A further element of the philosophy is that all crew change out at sea via FRC's between the mother vessel and a transportation vessel. The operators believe that this element of regular training allows smaller crews. This and other operating practices lead to a wider operating envelope.

However, in this section we deal principally with the UKCS. Relevant factors in best practice appear to be:

- Except in very calm conditions, FRC tasks are usually "out and back", they do not normally spend prolonged periods afloat;
- FRC's are an uncomfortable ride in all but calm sea states, they risk injuring unskilled or ill-trained crew;
- Hence, launch and recovery are frequent and critical events;
- The skill of the mother vessel Master in manoeuvring relative to the seaway and the skill of the coxswain in judging when to release from/hook on to the falls are critical for crew and survivor safety;
- The skill of the coxswain in judging his speed and aspect relative to the predominant wave field are equally critical to crew safety;

- When carrying survivors, the coxswain needs to be aware that a safe ride for his passengers is more important than speed of return;
- Because of the normally short missions each with a launch and recovery, the number and frequency of exercises needs to be balanced against the risk of fatiguing the crews before a genuine emergency;
- The mother vessel Master and rescue craft coxswain must have a keen sense of when it is safe to launch and recover, and when it is not.

5.4.2 Daughter Craft

Daughter craft are based on the same rigid or semi-rigid hulls with inherent flotation, as FRC's. They are generally greater than 11 metres in length and have enclosed cabins (which may or may not accommodate all survivors), basic navigation equipment, stretchers. Being slightly larger and a more comfortable ride they are often used as semi-autonomous Close Standby and Rescue vessels.

The use of DC's has increased greatly in recent years, and is likely to become more common. They often feature strongly in rescue and recovery arrangements shared between multiple installations. In such situations they may be working several miles from the mother vessel. Critical human factors in best practice appear to be:

- Enhanced skills in judging launch and recovery conditions because of the larger, heavier hulls;
- Judging when to abort an operation in deteriorating weather conditions, so as to regain the mother vessel safely;
- Self-reliance of the coxswain remote from the mother vessel; navigation skills sufficient to deal with the abnormal as well as normal operations;
- A boatman or assistant coxswain capable of taking over control and navigation in the event that the coxswain is incapacitated;
- Fitness of the crews and tolerance to the motion of such a vessel in an seaway;
- A maximum operating range relevant to the local situation in terms of physical facilities, exposure of the location, extreme weather and place of refuge in the event of rapid deterioration in conditions;
- Work shift lengths relevant to the task and typical operating conditions;
- Adequate crew rest periods between shifts;
- Appreciation by the field operator of the risks of fatigue from routine tasks in the event of an emergency.

GLOSSARY

BP	Blood Pressure
DC	Daughter Craft
DGPS	Differential Global Positioning System
EAR	Expired Air Resuscitation
ECM	External Cardiac Massage
EERTAG	Evacuation, Escape and Rescue Technical Advisory Group
EPIRB	Electronic Position Indicating Radio Beacon
FRC	Fast Rescue Craft
GPS	Global Positioning System
HF	High Frequency
H _s	Significant Wave Height – The mean height of the highest one third of waves
MCA	United Kingdom Maritime and Coastguard Agency
MI	Myocardial Infarction
MOD	United Kingdom Ministry of Defence
MORAG	Marine Offshore Rescue Advisory Group
NESS	North European Storm Study
NVG	Night Vision Goggles
OCES	Offshore Clean Seas and Emergency Services
OPITO	Offshore Petroleum Industry Training Organisation
OSC	On-Scene Commander
PLB	Personal Locator Beacon
PPE	Personnel Protective Equipment
RDF	Radio Direction Finder
RIB	Rigid Inflatable Boat
RNLI	Royal National Lifeboat Institute
SAR	Search and Rescue
SART	Search and Rescue Transponders
SBV	Standby Vessel
TEMPSC	Totally Enclosed Motor Propelled Survival Craft
UKCS	United Kingdom Continental Shelf
USCG	United States Coast Guard
VHF	Very High Frequency

BIBLIOGRAPHY

The following publications have been reviewed during the preparation of this document:

Title	Author	Report No.	Publication Date
An Assessment of the Technologies for the Location of Persons Lost at Sea in the UKCS	GEC-Marconi	OTH 93 407	1996
Dutch Experience with Fast RIBs	Ship and Boat International	-	October 1995
Review of Rescue and Immediate Post-Immersion Problems		OTO 591	1997
Effect of Weather on Performance and Response Times in Offshore Rescue	WS Atkins Science and Technology	AM3487-D02	July 1998
Evacuation, Escape and Rescue West of Shetlands	WS Atkins Science and Technology	OTO 98 085	May 1997
Fast Rescue Craft – Latest Developments	Safety at Sea International	-	July 1995
FRC Crews – Guidelines for the Treatment of Immersion Casualties	HSE (OSD)	-	April 1997
Handbook for 'B' Class Atlantic 21 & 75 Lifeboats	Royal National Lifeboat Institute	TRG/10	1996
Human Factor Analysis of Evacuation, Escape and Rescue from Offshore Installations	RM Consultants Ltd.	OTO 93 004	March 1993
Investigation of the Requirements for Standby Vessels in the Development of the West of Shetlands Oil Fields	Environment & Resource Technology Ltd.	ERT 95/071	January 1996
Launch and Recovery Systems	Safety at Sea International	-	January 1995
Ocean Odyssey Emergency Evacuation: Analysis of Survivor Experiences	MaTSU	MaTR 109	July 1992
Operating Fast Rescue Craft	Safety at Sea International	-	July 1994
Performance of Fast Rescue Craft		OTN 92 204	November 1994
Recovery of Personnel from Survival Craft		OTO 96 011	April 1997
Recovery of Personnel From TEMPSC and Rescue From the Sea	BP/MaTSU	HSQ 01.05.21	1996
Report on EESC Visit to Danish Offshore Rescue Service	MaTSU	MaTR 111	September 1992
The Code of Practice for the Safety of Small Workboats and Pilot Boats	Maritime and Coastguard Agency	ISBN 0 11 5520006 6	1998
The Operation of SBV FRC Used as 'Daughter Craft'	WS Atkins Science and Technology	AM2918-D03	January 1995

Title	Author	Report No.	Publication Date
Training for the Issue of Certificates of Proficiency in Fast Rescue Boats	Merchant Navy Training Board	-	April 1998
Training for the Issue of Certificates of Proficiency in Survival Craft and Rescue Boats (Other Than Fast Rescue Boats)	Merchant Navy Training Board	-	February 1998
Use of Planing Search and Rescue Units in Waterborne Emergency Response	Maritime Rescue International Ltd.	-	-
Wind and Wave Frequency Distributions for Sites Around the British Isles	Fugro Geos, Southampton	C50024	October 1996
Seaboat Seamanship	Seaways	-	August 1997
The Incidence of Head & Other Injuries among those using Small Fast Boats	Institute of Naval Medicine EHN Oakley & DF Grist	98034	July 1998
Head Protection for Occupants of Small Fast Boats: Final Report	Institute of Naval Medicine EHN Oakley & DF Grist	98042	August 1998
Rigid Inflatable Boats	C Jones		1995
Inflatables	Dag Pike		1994
Fast Boats & Rough Seas	Dag Pike		1989
Offshore Recovery & Rescue	Douglas Westwood Ltd	Report 66-97	April 1997
Guidelines for The Safe Management and Operation of Vessels Standing by Offshore Installations.	UKOOA	Issue 1	August 1999
Guidelines for Survey of Vessels Standing by Offshore Installations.	UKOOA	Issue 2	July 1999

ACKNOWLEDGEMENTS

The following organisations have offered support and advice during the preparation of this document:

United Kingdom Offshore Operators Association (UKOOA)
First Floor
30 Buckingham Gate
London, SW1E 6NN

British Rig Owners Association (BROA)
Carthusian Court
12 Carthusian Street
London, EC1M 6EB

International Association of Drilling Contractors (IADC)
Wood International Centre
Craigshaw Drive
West Tullos
Aberdeen, AB9 8GE

Emergency Response & Rescue Vessel Association (EERVA)
Chappetts Farm House
West Meon
Petersfield
Hampshire, GU32 1NB

Maritime & Coastguard Agency (MCA).
Spring Place
105 Commercial Road
Southampton, SO15 1EG

North Sea Training Services
South Wharf
Belvedere Road
Lowestoft
Suffolk, NR33 0PR

Maritime Rescue International Ltd.
The Old Pier
Stonehaven
Aberdeenshire, AB39 2JU

JCM Marine
33 Prospect Road
Oulton Broad
Lowestoft
Suffolk, NR32 3PT

Royal National Lifeboat Institution (RNLI)
West Quay Road
Poole
Dorset, BH15 1HZ

National Sea Rescue Institute (NSRI)

Deutsche Gesellschaft zur Rettung Schiffbrüchiger (German Sea-Rescue Service)
Werderstase 2
28199 Bremen
Germany

Health & Safety Executive, Offshore Safety Division (OSD)
Marine & Aviation Operations
Rose Court
2 Southwark Bridge
London, SE1 9HS



MAIL ORDER

HSE priced and free
publications are
available from:

HSE Books
PO Box 1999
Sudbury
Suffolk CO10 2WA
Tel: 01787 881165
Fax: 01787 313995
Website: www.hsebooks.co.uk

RETAIL

HSE priced publications
are available from booksellers

HEALTH AND SAFETY INFORMATION

HSE InfoLine
Tel: 08701 545500
Fax: 02920 859260
e-mail: hseinformationservices@natbrit.com

or write to:

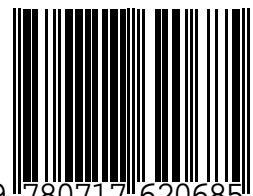
HSE Information Services
Caerphilly Business Park
Caerphilly CF83 3GG

HSE website: www.hse.gov.uk

OTO 2001/040

£10.00

ISBN 0-7176-2068-9



9 780717 620685