IMCA

The International Marine Contractors Association

# Code of Practice for
# The Operation of Manned Submersible Craft

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# Recognition

This Code:

- has been "Accepted by the United Kingdom Department of Transport for Submersible Operations".
- is "Recognised by the Norwegian Petroleum Directorate for Submersible Operations".
- is "Acceptable to the Canada Oil and Gas Lands Administration. Any person operating under this Code within Canadian Jurisdiction must ensure that they comply with specific requirements of the Canadian Diving Regulations".

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## PREFACE

Submersibles began to be used commercially in support of offshore activities in the late 1960s Since then, various types have been successfully developed ranging from tethered, one man vehicles to untethered vehicles having a pilot and crew an sometimes a diver lockout capability. There are now over 10 manned submersibles on the commercial market and they are being successfully and safely operated in many parts of the world.

As the industry developed and technical standards evolved, some of the International Classification Societies and other organisations produced Guidance Notes and Rules or Standards. In the main these were directed at design, construction, test and certification aspects. More recently, the UK Department of Transport issued Regulations (Merchant Shipping [Submersible Craft Construction and Survey] Regulations 1981) and other governments have either issued drafts or are in the process of preparing them. Most of these documents, however, are aimed a design and related matters and not with operational aspects.

In 1979 the Marine Technology Society (MTS) published a book entitled 'The International Safety Standard Guidelines for the Operation of Undersea Vehicles'. This has been widely use across the industry by designers, manufacturers and operators of submersibles as well as by client companies, government departments and others. Much technical progress has been made however since 1979 with new technology and operating practices particularly with one man submersibles.

As the organisation representing the interests of Manned Submersible Operators, AODC decided that an up to date 'Code of Practice' should be produced for the 'Operation of all types of manned submersible craft'. The Code would help to harmonise safe operating practices throughout the industry, not only for existing operators but also for new companies in the field.

The Code has been produced by the AODC's Submersible Committee with the support of manufacturers, clients, government departments and other agencies. In particular the support of the relevant UK and Norwegian government departments has been significant.

Work on the Code started in 1981, through a small drafting group but has been monitored throughout by the Submersible Committee. Many drafts have been produced, with the objective of reaching agreement on common safe operating practices and taking into account the varying requirements of the different types of submersible craft now available.

In order to take account of views and advice from interested and experienced organisations not directly represented on the AODC Submersible Committee it was agreed that the UK Department of Transport should circulate copies of the draft code for third party comment. In June 1983 they sent copies to a large number of organisations covering a wide cross-section of interested parties on a world-wide basis. A substantial number of helpful comments were received and these have been incorporated into the Code.

It is not geographically limited in its scope and should be applicable in all areas of the world where commercial submersible operations are carried out, particularly in support of offshore hydrocarbon exploration and production. The Code will be updated to take account of operating experience as well as technical developments and positive suggestions will be welcome.

# Index

## DEFINITIONS

Set out in this section are definitions for a number of technical terms used in this Code. Some of these are specific to the submersible industry whilst others are in more general usage.

**ADS**

Abbreviation for ATMOSPHERIC DIVING SUIT, i.e. a tethered one man submersible in which the operator's arms or arms and legs move inside articulated joints to provide the effort to carry out the underwater task.

**Client's Representative**

The person appointed by the client to be the representative offshore of the client's interests in matters relating to the performance of the work.

**Contractor**

The company responsible for the safe and efficient operation of the submersible.

**DDG**

Abbreviation for Digital Depth Gauge.

**DES**

Abbreviation for Digital Echo Sounder.

**Diver**

A person who works underwater and whose body is subject to a pressure greater than atmospheric.

**DP**

Abbreviation for Dynamic Positioning, i.e. a system whereby a surface vessel maintains position automatically at any predetermined location.

**Drop Weights**

A safety system carried by some submersibles whereby heavy weights attached to the submersible during normal operations may be jettisoned whilst underwater in order that the submersible may become positively buoyant and rise to the surface.

**Eject Systems**

Safety systems fitted to all submersibles whereby parts of the submersible may be jettisoned underwater in an emergency to release the submersible from entanglement and/or to increase positive buoyancy.

**GRP**

Abbreviation for Glass Reinforced Plastic which is a material commonly- used in submersible construction.

**Handling System**

The equipment used to deploy and recover the submersible.

**Hard Tank**

A type of bouyancy and trim adjusting system (normally mounted internally) in which sea water can be flooded into or pumped out of tanks enabling fine control of the submersible.

**Launch**

The procedure whereby the submersible is deployed from the surface support vessel into the water.

**Life Support**

The systems provided within the submersible to maintain the occupants in thermal balance and with a suitable breathing atmosphere.

**Lockout Submersible**

A type of submersible having a compartment from which divers may exit whilst underwater in order to carry out tasks.

**Passenger**

Any occupant of a submersible who takes no part in the operation of the craft.

**Payload**

The weight which the submersible is capable of carrying in addition to its permanently fitted equipment which may include jettisonable weights

**Pilot**

The person in control of the submersible whilst it is in the water.

**Pinger**

A device emitting a regular acoustic signal which can be used either for emergency location or routine tracking purposes.

**Recovery**

The procedure whereby the submersible is recovered to the surface support vessel from the water.

**Saturation Diving**

A technique in which divers remain pressurised for a period of hours or days to approximately the equivalent pressure of their working depth and are conveyed to and from the underwater worksite inside a pressurised compartment.

**Scrubber**

Equipment used to remove unwanted contaminants from the atmosphere. Normally refers to a $C0_2$ removal device.

**Sector Club**

An arrangement whereby various Concession Owners and Operators in the North Sea have joined together with one of them nominated to provide emergency services for a particular area of the North Sea.

**Shot Weight**

A weight with rope attached which is lowered to the seabed from the surface support vessel to provide a reference path for the submersible during its travel from the surface to the work site and return.

**Soft Tank**

A buoyancy adjusting system (see HARD TANK) where the bottom of the tank is open to the sea and to ambient pressure. Positive buoyancy is increased by using compressed air to pump out some of the water in these tanks.

**Submersible**

A craft designed to operate underwater which is mobile and is designed to maintain some or all of its occupants at or near atmospheric pressure.

**Submiss**

The term used to describe the emergency situation where a submersible loses communication with the surface support vessel and communication is not re-established within pre-established timescale (normally thirty minutes). At this stage the surface support vessel has no knowledge of any problem being suffered by the submersible.

**Subsunk**

The term used to describe the emergency situation where a submersible is known to be suffering a problem underwater which prevents it surfacing or where a submersible has been out of communication for an agreed time, i.e. if SUBMISS exists then it becomes SUBSUNK after a further period with no communications.

**Support Vessel**

The vessel on the surface which provides the launch and recovery facilities for the submersible and from which the submersible operation is controlled

**Tracking**

The procedure by which a submersible whilst underwater is monitored from the surface support vessel in order to establish its underwater position.

**Transponder**

A location device which operates underwater returning a signal sent to it at a predetermine frequency such that range and bearing can be measured.

**UKOOA**

Abbreviation for United Kingdom Offshore Operators Association.

**Umbilical**

The connection between a submersible and the surface support vessel along which necessary supplies pass.

**UWT**

Abbreviation for Underwater Telephone meaning an apparatus designed for acoustic through water communications underwater in the absence of a hand wire link.

**Vehicle**

Term commonly used to describe a submersible.

**VHF**

Abbreviation for Very High Frequency which is a type of surface radio communication.

## SECTION A : PERSONNEL

### 1.0 INTRODUCTION

1.1 This section gives guidance on minimum standards of competence for personnel, on individual responsibilities and organisational matters.

1.2 It should be studied in conjunction with any relevant National Regulations.

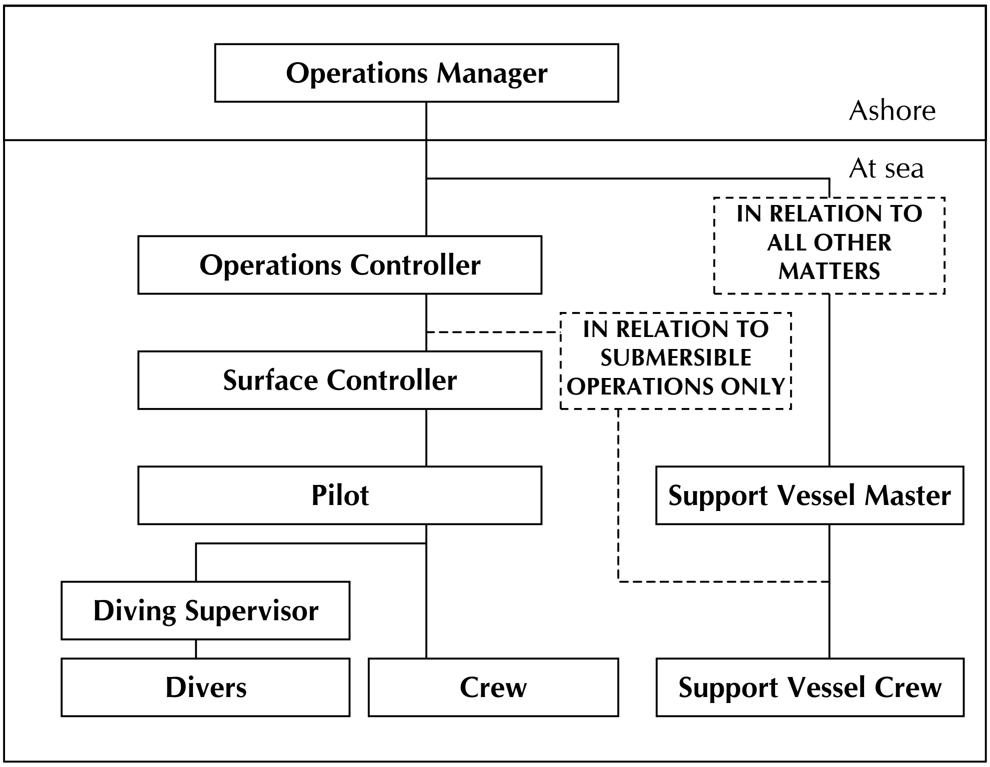
1.3 The requirements for a submersible operating team vary considerably, depending on the type of vehicle, the type of work and the area of operation. This section establishes an outline standard which should be met for all operations and against which additional requirements can be determined.

1.4 Personnel should work to an established set of procedures. These should include an established Chain of Command, defining who is in charge at each stage of an operation and the duties and responsibilities of all key members of the team. The qualifications and training required of individuals in key positions should be defined.

## 2.0 CHAIN OF COMMAND

2.1 A clear chain of command and level of responsibilities is essential for the conduct of safe submersible operations. It should include the relationships between those ashore, those at sea, the submersible team, the support vessel, the contractor and those with immediate responsibility for the work site or area in which the submersible is operated.

2.2 A suggested outline of a Chain of Command for a submersible craft operation is as follows:




### 2.3 Operations Manager

He will normally be situated ashore. He is in overall charge of submersible operations on behalf of the Submersible Owner and will maintain close links with the Operations Controller.

### 2.4 Operations Controller

He is in charge of the operation and is directly responsible to the Operations Manager. He has authority to request the Master of the Support Vessel to proceed to the required area for the launch, recovery and safe operation of the submersible.

The Master however retains his statutory responsibility for the safety of his vessel.

## 2.5 Support Vessel Master

He has overall authority for the safety of his vessel and all personnel on board. He would normally however carry out all requests by the Operations Controller with regard to submersible operations.

It must be emphasised that although the Operations Controller and the Master have particular responsibilities, they should have a complete understanding of each other's duties and a close rapport must be established between them.

## 2.6 Surface Controller

Whilst the Operations Controller is in charge of the operation he may partially delegate his responsibility for a particular period to a Surface Controller.

## 2.7 Pilots

The Pilot assigned by the Operations Controller to be in charge of the submersible for a dive has authority over all persons onboard the submersible.

# 3.0 RESPONSIBILITIES, AUTHORITY AND DUTIES

## 3.1 Operations Controller

Is the person in overall charge of the submersible operation offshore. He will be appointed in writing by the Submersible Owner or Contractor.

### 3.1.1 Responsibility

The Operations Controller is responsible to the Operations Manager for the safe and efficient conduct of the operation.

### 3.1.2 Authority

The Operations Controller has authority over all personnel involved in the submersible operation.

### 3.1.3 Duties

The Operations Controller will:

A. Ensure that all submersible operations for which he has been appointed comply with all relevant regulations and are carried out in accordance with the Operations Manual issued by the owners. Any deviation from the Operations Manual should be authorised by him in writing.

B. Co-ordinate all aspects of the submersible operation to achieve the operational aims.

C. Monitor the continued effectiveness of contingency plans for foreseeable emergencies.

D. Co-ordinate all activities in the event of an emergency.

E. Carry out additional duties which may be assigned to him by the Operations Manager.

## 3.2 Surface Controller

Is the person responsible for the launch, recovery, tracking, communications and conduct of a specific dive. He will often be the Operations Controller, but if he is not, then he will be in possession of written authority to act as Surface Controller, issued by the Operations Manager.

### 3.2.1 Responsibility

The Surface Controller is responsible to the Operations Controller for the safe and efficient conduct of the submersible operation for which he has been nominated.

### 3.2.2 Authority

The Surface Controller has authority over all personnel taking part in the submersible operation.

### 3.2.3 Duties

The Surface Controller will:

A. Ensure that the dive is carried out in accordance with the aims specified during the Pre-Dive Briefing, by the Operations Controller. He will also ensure that all relevant regulations and procedures are observed.

B. Be in charge of the operation during launch, dive and recovery of the submersible, ensuring that safety precautions are properly observed and liaising as necessary with the Master of the Support Vessel.

C. Ensure that all support personnel are properly briefed and at their stations during launch and recovery and as required during the dive.

D. Direct the submersible pilot to abort the dive if conditions so dictate.

E. Keep the Operations Controller and Master of the Support Vessel informed of any unusual conditions or occurrences which may affect the operation.

## 3.3 Submersible Pilot

### 3.3.1 Responsibility

The Pilot is responsible to the Operations Controller, through the Surface Controller, for the safe and efficient conduct of the dive.

### 3.3.2 Authority

The Pilot has authority over all persons onboard the submersible. He may abort the dive or refuse to dive at any time should he consider that the submersible or personnel are at risk.

### 3.3.3 Duties

The Pilot should:

A. Take all possible steps to ensure the safety of the submersible and all personnel onboard.

B. Carry out pre-dive and post-dive checks and hand signed copies of these check lists to the Surface Controller.

C. Ensure that all submersible personnel are properly briefed on safety and emergency procedures, the purpose of the dive and procedures to be carried out during it.

D. Conduct the dive in accordance with the Operations Manual for the submersible.

E. Perform any other duties which may be assigned to him by the Operations Controller through the Surface Controller.

## 3.4 Submersible Occupants

In this context, occupants include all personnel in the submersible other than the pilot.

### 3.4.1 Responsibility

All occupants are responsible to the Pilot for the performance of assigned functions.

### 3.4.2 Authority

All occupants, other than the Diving Supervisor, have no authority except as may be specifically delegated by the Pilot.

### 3.4.3 Duties

All occupants should:

A. Carry out all assigned functions.

B. Observe all safety precautions.

C. Be familiar with emergency systems and procedures.

## 3.5 Submersible Maintenance Personnel

Those persons assigned to the submersible operations team for the purpose of repair and maintenance of the submersible and support equipment.

### 3.5.1 Responsibility

Responsible to the Operations Controller, through the Surface Controller.

If a Maintenance Supervisor is appointed, the Maintenance Personnel will be responsible to him.

### 3.5.2 Authority

They may have authority delegated to them by Company Procedures, the Operations Controller, or the Surface Controller.

### 3.5.3 Duties

They should:

A. Maintain the submersible and support equipment in accordance with the manufacturer's and owners maintenance manuals.

   *NB:* No major modifications should be undertaken without prior approval from base.

B. Immediately report any defective equipment.

C. Complete and sign all pre- and post-dive check lists requiring their input, in addition to that of the submersible pilot.

### 3.6 Other Support Personnel

Other support personnel may include:

- Project Engineer
- Boat Operator
- Handling System Operator
- Swimmer/Standby Swimmer
- Communications Operator
- Log Keeper/Data Recorder
- Sonar Operator
- Stores or Logistics Co-ordinator

These positions should be defined and the duties, responsibilities and authority of each set out in the company Operations Manual.

### 3.7 Divers And Support Personnel

Lock-out diving from a submersible has a number of special features, even though much of the equipment, techniques and physiological factors are similar or identical to conventional surface or bell diving.

3.7.1 For diver lock-out operations special consideration should be given to the selection and training of personnel, including:

A. Operations Controller;
B. Pilot;
C. Diving Supervisor;
D. Lock-Out Divers.

They each require a detailed knowledge of the particular submersible and the diving system.

3.7.2 The Operations Controller should ensure that Diving Supervisors are appointed to be responsible for the divers and diving equipment on the Support Vessel and in the submersible. The diving personnel may be employed by a different company from the submersible operator. The Operations Controller cannot override the Diving Supervisor's decisions but he does have the authority to instruct the Diving Supervisor not to start or to abort a dive on grounds of safety.

The Operations Controller should conduct a pre-operations briefing in conjunction with the Pilot, Diving Supervisors Master, client's representative, and other personnel concerned. He should ensure that clear and adequate arrangements exist to co-ordinate submersible and diving operations and that good liaison exists between senior personnel.

#### 3.7.3 Pilot

In addition to his normal responsibilities, the pilot has additional responsibilities for the safety of diving personnel. He cannot override the Diving Supervisor's decisions, but he does have the authority to instruct the Diving Supervisor not to start or to abort a dive on grounds of safety.

The Pilot has an additional responsibility to acquaint himself with the saturation diving equipment and procedures.

### 3.7.4 Diving Supervisor

The Diving Supervisor is responsible to his own employer and to the Operations Controller for:

A. Carrying out diver lock-out operations in accordance with statutory requirements.

B. Running the onboard diving complex in accordance with statutory requirements.

The Diving Supervisor in the submersible craft has direct authority over the lock-out divers. He has the authority to terminate a lock-out dive or decline to perform a task if he considers it necessary for reasons of safety.

His responsibilities include:

A. Conducting a pre-operation briefing in conjunction with the Operations Controller to ensure that all personnel are fully briefed on the tasks to be undertaken, operating and emergency procedures and the identities of key personnel.

B. During actual lock out operations he must obtain the permission of the pilot before requesting the divers to carry out an) operation which will affect the buoyancy, trim or pressure integrity of the submersible. This would include but may not be limited to opening the lock-out hatches, blowing down the diver lock-out chamber and filling the after trim tanks in the diver lock-out chamber.

C. Ensuring that all diving personnel are certified medically fit and fully qualified for the depth and type of dive to be undertaken.

D. Ensuring that all diving equipment is suitable for the tasks to be undertaken, in good working order, and in accordance with relevant statutory requirements.

E. Ensuring that members of his team are familiar with relevant operating practices.

F. Ensuring the diving operations log book divers' log books and equipment maintenance records are updated.

### 3.7.5 Lock-Out Divers

It is the diver's responsibility to ensure:

A. That he is medically fit to dive in accordance with statutory requirements and that he is in possession of a valid and up-to-date medical certificate.

B. That all equipment used by him is in good working order.

C. That he complies with any other requirements , imposed on him by relevant National Regulations.

The diver's responsibilities include:

A. Carrying out tasks and duties assigned to him by the Diving Supervisor.
B. Ensuring that he is fully conversant with the submersible diving system and the consequences of any action taken by him on the submersible craft.
C. Ensuring that he is fully conversant with the shipboard decompression facility and the procedures to be adopted for transferring to and from the submersible.
D. Carrying out pre- and post-dive checks of the diving system in conjunction with the Diving Supervisor and the submersible Pilot.
E. Ensuring that he is fully conversant with the Company Diving Manual.

# 4.0 TRAINING AND QUALIFICATION

## 4.1 Degrees Of Knowledge

Safe and efficient submersible operations are dependent on personnel having adequate training, knowledge and experience to carry out their tasks in a competent manner and to reasonably foresee and contain any problems which at inherent in them or any emergencies which may be encountered.

All personnel who are required to dive in a submersible should be medically fit (see Section 5.0) and should be familiar with emergency procedures.

## 4.2 Training Of Submersible Pilots

The syllabus which follows should form the basis for training all submersible pilots, modified, as necessary, for particular types of submersible craft.

It assumes that:

A. Trainees have no previous submersible operating experience.
B. Trainees have a basic technical capability/background.
C. Trainees have no previous offshore experience, although this is desirable.

### 4.2.1 Training Syllabus

The syllabus has been broken down into distinct subjects. The order in which they are taught is largely immaterial, provided that training is progressive. Preferably theoretical, practical and operational training should be interspersed. Oral, written and practical examinations should be held and the practical work should include the satisfactory completion of a number of tasks and operations.

### 4.2.2 Theory

This should include the following subjects:

A. Life Support
Thermal protection. $O_2$, $C0_2$, CO. Partial pressures. Gas mixtures. Effects of high/low $O_2$ The body's requirements - food and water. Atmosphere monitoring. Cleanliness in gas systems, particularly in relation to $O_2$ systems. Colour coding and marking of gas cylinders. $C0_2$ removal. Material compatibility with $O_2$

B. Buoyancy and Trim/Ballast Systems
Hard and soft tanks, reserves of buoyancy, trim, drop weights, payload, stability on the surface, submerged and in emergency conditions. Water density, layering, pressure effects, ballast systems.

C. Navigation
Compasses, gyro and magnetic, including compass errors. Log, depth gauge, echo sounder, currents and tides, velocity triangles, doppler log principles, acoustics, visibility and midwater problems. Chart reading and general seamanship. Transponders, pingers and sonars .

D. Communications
Hard line, acoustic and radio.

E. Power Sources and Electrical Systems
Batteries and other relevant primary sources. Umbilical systems. Circuit protection electrical faults and their effects, fault detection and elimination. Emergency power sources .

F. Hydraulic and Pneumatic Systems
Pumps, accumulators, valves, compensated systems, HP air and vent valves.

G. Movement
Propulsion systems, rudders, thrusters. Control of vertical, athwartship and forward movement.

H. Emergencies
Fire(s) and fire extinguishing methods. Flooding. Entanglement. Life-support, toxic hazards Loss of communications, loss of power an sensors. Emergency communications. Emergency planning. Physical and mental effects of prolonged period underwater when subject to sensory, perceptory and thermal deprivation.

I. Personnel Responsibilities
Chain of command, liaison.

J. Statutory Requirements
Familiarisation with codes of practice, Certification requirements and relevant government regulations.

K. Work Procedures
Operational planning. Interface with other underwater activities/operations.

L. Submersible Design and Construction
Hull shapes, depth rating, materials, safety factors, collapse depth, displacement, and hydrodynamics.

M. Diving theory
Only required if operating a diver lockout submersible an outline of diving theory.

### 4.2.3 Practical Instruction

This should include study of the systems of the submersible on which training is being undertaken and its support equipment. The trainee should acquire a thorough knowledge of the use, capability, limitations and alternatives for all systems provided, including the handling system. He should have a thorough knowledge of all operating procedures. He should be familiar with the need for ant the correct keeping of maintenance, communication, and submersible dive logs, defects lists, and pre and post-dive check lists.

### 4.2.4 Operational Training

Training should be progressive. In multi-man submersibles it should include a period as second pilot followed by subsequent dives as first pilot under the direct supervision of an experienced pilot. Training should culminate in tests where emergencies should be simulated .

Consideration should be given to subjecting the trainee, under supervision, to an extended period underwater in order to obtain first-hand experience of some of the effects of sensory, perceptory and thermal deprivation.

With one-man systems early dives should be carried out in tanks or sheltered waters and NOT offshore, unless the trainee is an experienced pilot and is simply transferring from one system to another in which case a short familiarisation offshore would be acceptable.

After initial training, operational dives should not be carried out until the trainee has some experience offshore as part of an operating team Even then, experience should progress from simple to more complex work under experienced supervision.

### 4.2.5 Certification

Each pilot should be awarded a certificate of competence after successfully completing the training specified in Section 4.2, specifying the type submersible on which he has been trained and the extent of his training. This should be signed by the Examining Supervisors and countersigned by the Operations Manager of the company that carried out the training. The certificate should only be awarded following the successful completion of properly organised course and examinations. A standard format for this certificate attached to this code in Appendix 2.

Every pilot must maintain a log book of a suitable format. This should include details of his training and operational experience. It must be counter- signed by the Operations Controller or Surface Controller after each dive.

It is recognised that the introduction of such scheme for certification would result in a large number of existing and experienced personnel requiring to be certified during an interim period and it is proposed that this situation be overcome by each Contractor issuing certificates of competence to suitable experienced pilots after satisfying themselves of the individuals background training and experience of particular types of submersibles.

## 5.0 MEDICAL STANDARDS FOR ADS PILOTS, SUBMERSIBLE PILOTS AND CREW, AND PASSENGERS

### 5.1 Introduction

Underwater vehicles in commercial use range from submarines large enough to require several crew members to one-man vehicles and atmospheric diving suits (ADS). Both for administrative convenience and because of the high probability that personnel will move from one vehicle to another between examinations, it is desirable that one medical examination should cover all personnel other than passengers. As these examinations may be made by doctors approved to examine commercial divers, it is convenient that the form of the examination should be as for commercial diving, without the radiography of the long bones and taking into consideration the paragraphs below.

### 5.2 ADS Pilots

A distinction must be made between ADS pilots and submersible crew, because the physical demands made on the occupant of an atmospheric diving suit require his general standard of fitness to be in some respects the same as that applied to commercial divers. Examining physicians are referred to the UK Health & Safety Executive's recommendations on the medical examination of divers. Among relaxations allowable are conditions which are pressure dependent and somewhat less stringent requirements generally, while bearing in mind the conditions which must disqualify.

### 5.3 Submersible Pilots And Crew

Candidates should be physically and mentally healthy. Particular attention should be paid to the exclusion, as far as is practicable, of conditions having the potential of sudden disablement or of causing inability to cope with an emergency situation. Consideration should be given to such conditions as skin diseases, which might be exacerbated by the environment within the vehicle. Pulmonary function should be checked because breathing apparatus may be necessary for long periods in an emergency. Speech and hearing should be able to cope with the variable quality of underwater communications.

#### 5.3.1 Age

There is no upper age limit provided that all the medical standards can be met. Serious consideration should be given, however, to the need for adequate reserves of pulmonary and cardiovascular fitness for use in emergency.

#### 5.3.2 Obesity

Obesity causes particular problems in the confine spaces of ADS and submersibles and may also imply lack of physical fitness. Any candidate over 20 in excess of his recommended weight based on recognised height/age/weight tables should be disqualified. In general, the aim should be a figure of less than 15% in excess of the recommended weight.

### 5.3.3 Respiratory System

Particular attention should be paid to any condition that might impair life-saving use of emergency breathing apparatus. The presence or history of bronchial asthma, spontaneous pneumothorax or other lung disease or injury of sufficient severity to have caused permanent functional impairment should disqualify. A large-plate postero-anterior chest X-ray should confirm the absence of these conditions. The results of pulmonary function test should be considered in relation to other factors including age, but absolute numerical limits are felt to be inappropriate.

### 5.3.4 Central Nervous System

A full examination of the central nervous system should show normal function, but localised minor abnormalities such as patches of anaesthesia are allowable, provided that generalised nervous system disease can be excluded. Any history of fits or severe head injury should be cause for further investigation. Any past or present evidence of psychiatric illness should be cause for rejection unless the examining doctor can be confident that it is of a minor nature and unlikely to recur.

### 5.3.5 Musculo-skeletal

Any impairment of musculo-skeletal function should be carefully assessed against the general requirements of the operation of underwater vehicles.

### 5.3.6 Ears

Any evidence of chronic middle ear disease or a history of middle ear surgery (including tympanoplastry) and residual symptoms should be referred for specialist opinion before deciding upon fitness. Any evidence of deafness must be considered against the vital need for good communication.

### 5.3.7 Alimentary System

Any evidence of active peptic ulceration or of other chronic gastrointestinal disease should disqualify.

### 5.3.8 Skin

There should be no evidence of acute or chronic skin disorders likely to be affected adversely by the working environment.

### 5.3.9 Cardio-Vascular System

There should be no evidence of serious abnormality including either high or low blood pressure.

### 5.3.10 Vision

The following visual acuity standard should be the minimum acceptable:

Uncorrected distance: R 6/36 L 6/36 both 6/24 Uncorrected near : R J16(N24) L J16(N24) both J15(N18)

Visual fields should be normal on simple tests and fundi should be normal. (Colour vision show be tested at first examination and any abnormality noted on the certificate of fitness.)

### 5.3.11 General

The urine should be tested at each examination. Glycosuria must be investigated as diabetes is cause for rejection. Hb of less than 12.0 g/dl a PCV of less than 40% indicates further investigation before a decision. Similarly Haemophilia other serious blood abnormality would be a case for rejection.

Consideration must be given to any long term drug treatment being undertaken by a candidate for such ailments as Hypertension, Asthma, Hayfever, Anxiety. Similarly any candidate who has undergone major surgery must be carefully consider before acceptance.

### 5.3.12 Special Tests

<u>5.3.12.1 ECG Examinations</u>
All candidates should have a resting standard twelve lead ECG at initial examination and annually after the age of 35 years, with post-exercise or stress ECGs at the discretion of the examining doctor.

<u>5.3.12.2 Pulmonary Function Tests</u>
All examinees should have annual pulmonary function tests to establish Forced Expiratory Volume at 1 second (FEV1) and Forced Vital Capacity (FVC). An FVC of less than 3.5 litres and an FEV1/FVC ratio of less than 75% initially and 70% subsequently should be considered only as possible indications for further pulmonary function testing, not as defining the threshold of respiratory fitness.

5.3.12.3 <u>Audiometry</u>
Annual audiometric examination should be performed, when a hearing loss in either ear of 35 dB or more at frequencies up to 3 kHz and 50 dB or more at frequencies above 3 kHz should be considered as a possible indication for referral to a specialist.

## 5.4 Certification

All ADS pilots, submersible pilots and crew, should be medically examined at a maximum interval of one year. The examining doctor should issue a certificate of fitness which should include any restriction upon the type of vehicle or limitation of duration of the certificate imposed by factors emerging from the examination. (In the UK the Appeal procedure in the case of failure of an applicant by the examining doctor would be as per paragraph 11(7) of the "Diving Operations at Work Regulations 1981".)

## 5.5 Passengers

Passengers in this context are defined as persons who make occasional excursions in submersibles and who take no part in the operation of the craft.

No form of medical examination is normally required but prospective passengers should be screened to exclude, as far as is reasonably practicable, sudden disabling conditions or conditions requiring regular medication. Any evidence of overt or latent claustrophobia must disqualify.

## SECTION B: OPERATIONAL PLANNING

### 1.0 INTRODUCTION

Operational planning should be in a standard format. The resulting written operations plan will however be different for each mission or submersible activity, and should be additional to the standard Operations Manual for each type of vehicle.

The general questions that should be asked and answered before operational planning can be carried out include:

- Where are you going?
- What conditions can be expected when you get there?
- What are you going to do?
- How long are you going to be there?
- Are any special mission requirements identified from the above questions?
- For normal operations and in the light of the specific mission activity, are there any special safety actions that should be taken?

You need to know where you are and the shore base needs to know where you can be contacted.

It is essential that all concerned know who is in charge of what function, and what the chain of command is.

### 2.0 OPERATIONAL ENVIRONMENT

The following parameters should be documented prior to undertaking submersible operations.

- The long and short range weather forecasts over the expected duration of the mission.
- The surface, mid-water and bottom tidal current conditions.
- The water depth and general bathymetry, that is the bottom area topography
- Known obstacles or hazards in the area of operation.
- Water temperature and salinity.
- Environmental conditions which will have a significant impact on the safe execution of the mission.

## 3.0 MISSION PLANNING

The operations plan should describe the geographic location of the mission in sufficient detail for it to be readily found by another vessel.

### 3.1 Mission/Dive Activity

It is important that the objective of the mission, or charter and of each dive be defined, including what results are expected and how they are to be achieved.

Since the activities undertaken by modern submersibles are varied and often complex, a concise clear statement of the objective and extent of each mission should be prepared to avoid any misunderstanding or confusion during the dive.

### 3.2 Mission/Dive Duration And Schedules

The following information should be included in the operations plan:

- The date and time required on site.
- The expected duration of the mission or charter in days.
- The expected number and duration of dives and the approximate dive schedule.
- The date by which the dive site must be vacated.

Additional factors to be taken into account should include, battery charging, pilot fatigue, diver fatigue in lock-out submersibles, weather and bottom conditions.

### 3.3 Dive Duration Schedule And Lock-Out Diver Schedule

The question of how long the submersible should be in the water before a lockout is conducted should be addressed. In some instances, the submersible is required to sit on the bottom for four or five hours before the diver actually locks out. Six hours should normally be regarded as the maximum time that a diver should remain in the dive chamber before he locks out. The diver should have sufficient rest before carrying out subsequent lock-outs.

# 4.0 SAFETY PLANNING

This section covers broad categories, including General Safety requirements, Safety Equipment Status and Hazard Identification associated with the particular mission.

Safety requirements and equipment status refer to the information and checks which should be up-to-date before starting an operation. These should be certified by the appropriate personnel in charge of the support vessel or submersible. The safety contingency plans should be included in the Operations Manual.

## 4.1 Operating Rules

Observance of the following rules should ensure overall safety during a submersible operation:

### 4.1.1 UWT/VHF

Voice contact should be established at least every 15 minutes. This need not be specifically to establish a reporting time and, for example, conversation between occupants of a multi-person vehicle overheard from the surface may be an acceptable contact.

### 4.1.2 Logs

Must be kept fully up-to-date by relevant personnel. The Surface Controller and Pilot should have compatible up-to-date record sheets.

### 4.1.3 Navigation

The Support Vessel is under the control of the Master. Requests for positioning the vessel should be made through the Surface Controller. The submersible is under the direct control of the Pilot who reports to the Surface Controller.

### 4.1.4 Designation

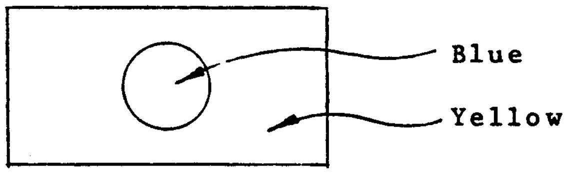
Necessary signals on the support vessel should be shown at all times.

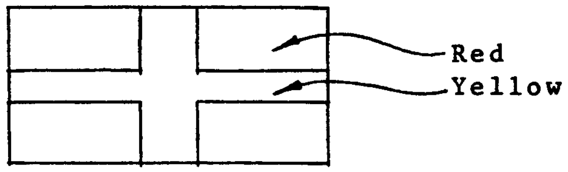
Under THE INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA (1972) and THE INTERNATIONAL CODE OF SIGNALS (1969), the following are the required signals for vessels over 20 metres in length:

A vessel engaged in underwater operations when from the nature of her work she is unable to get out of the way of approaching vessels shall carry three lights in a vertical line one over the other so that the upper and lower lights shall be the same distance from and not less than two metres above or below the middle light which shall be at least four metres above the hull. The highest and lowest of these lights shall be red and the middle lights shall be white, and they shall be of such character as to be visible all round the horizon a distance of at least two nautical miles or three nautical miles if the vessel is over 50 metres in length.

By day, she shall carry in a vertical line on over the other not less than 1.5 metres apart where they can best be seen, three shapes each no less than 0.6 metres in diameter, of which the highest and lowest shall be balls and the middle one diamond in shape. The colour of the shape shall be black.

The corresponding flag signal is INDIA, ROMEO, made as follows:




NB: Other lights, shapes and flags may be required as a result of the position of the support vessel and detailed investigation of the relevant regulations is recommended.

### 4.1.5 Collision

If collision is anticipated due to non-recognition of signals or any other reason, the support vessel must take such action as is necessary to avoid collision, at the same time ordering the submersible whether to surface or not. The Ship's Master is in charge. The International Regulations for Prevention of Collision at Sea must be observed.

### 4.1.6 Unauthorised Vessels

If another vessel approaches despite signals, it should be warned by all possible means including:

- Whistles
- Aldis lamp
- Searchlight
- R/T
- VHF
- Flares
- Foghorn/Siren

### 4.1.7 Use of Buoys

Buoys may be used if no other reliable means of surface tracking is available. The buoyline should have jettison capability at the submersible and be of minimal breaking strain. If required a boat may be despatched to highlight the position of the buoy.

## 4.2 Operating Restrictions

Observation of the following restrictions should ensure that the Operation is carried out within accepted safety limits.

### 4.2.1 Area Limitations

The water depth should not exceed the submersible's maximum depth capability. Fullest information on

sea state, weather, tides, currents(surface/subsurface) should be obtained before the commencement of the dive and at regular intervals during it.

### 4.2.2 Sea State

Launching of the submersible craft should not be undertaken in sea states in excess of that states in the Operations Manual.

### 4.2.3 Weather Conditions

The submersible should not normally be launched if visibility is less than one nautical mile, or if the visibility is likely to reduce to less than one nautical mile during the operation.

### 4.2.4 Range

The submersible should be kept in UWT contact (UWT maximum range varies between 0.5 and 2 nautical miles dependent upon water conditions and other relevant parameters).

### 4.2.5 Positioning Support Vessel

Due consideration should be taken of other vessels operating in the area when positioning the support vessel. Any other vessel connected with the Operation should be under the overall control of the Support Vessel.

### 4.2.6 Duration

Dive duration should be limited by a number of factors, including pilot fatigue and comfort. Whereas 8 hours may be uncomfortable in an ADS, longer times are tolerable in a larger vehicle.

### 4.2.7 Speed

The maximum speed of the submersible underwater should be within its visibility limitations.

### 4.2.8 Minimum Battery Reserves

To be consistent with the envisaged requirements for the mission.

#### 4.2.9 Authorisation

Permission to dive should only be issued by the Surface Controller after all systems and prevailing conditions have been checked.

#### 4.2.10 Overall Control (On Site)

Ultimate authority offshore rests with the Operations Controller, except that the Pilot should use his discretion about emergency surfacing of the submersible. The Master has ultimate responsibility for the safety of his ship.

### 4.3 System Safety Considerations

All necessary equipment on the submersible and the support ship should have been checked and in good working order.

4.3.1 The submersible must undergo a post-dive check after the last dive and be pre-dive checked in accordance with the pre/post-dive log. The submersible and its support equipment must be capable of the planned task and have adequate reserve buoyancy.

4.3.2 The appropriate authorities, such as the Offshore Installation Manager, port officials, and in some areas the military or coastguards, should be informed before diving operations are started.

4.3.3 The whereabouts and status of other submersibles or dive support vessels having similar depth capability should be ascertained, before the diving operations are started.

4.3.4 Team planning must allow for all personnel, particularly pilots, to have sufficient rest between missions.

4.3.5 For lock-out dives the particular safety aspects of the vehicle and divers should be considered.

4.3.6 All personnel should be informed of their individual duties and their relationship to other members of the team.

4.3.7 The Support Vessel's crew should be to the required standards of the flag state and the vessel must hold relevant statutory certificates, be seaworthy, and stable, have adequate stores, spares and general logistic support for the anticipated period of operation.

4.3.8 The submersible(s) and support system certification should be valid for the anticipated duration of the operation.

4.3.9 Pre-operational briefings should be attended by the client's representative, the Ship's Master, Offshore Installation Manager, the Masters of any other involved ships, the Operations Controller, the Surface Controller, the submersible Pilot the Diving Supervisor if applicable, and any other senior personnel who may be involved in aspects of the operation.

4.3.10 The minimum equipment condition on the submersible before and during the dive should be checked against checklists and faulty equipment replaced or brought up to standard before the start of a dive.

Although these checks may also be included under the standard operational procedures, it is important that they are included in the safety planning stage as they define inherently safe levels of operation.

## 4.4 Support Ship Safety Equipment

1. An emergency recovery line and winch, crane or other suitable lifting device, in a readily available location, of adequate length and strength to recover the submersible to the surface from its maximum operating depth, in its worst anticipated disabled condition, should be provided.
2. An emergency lift hook capable of being attached to the submersible's lift point should be available.
3. An echo sounder with a range of operation at least equal to the submersible's operational depth and/or ocean bottom should be available.

   Dependant on the circumstances of the operation and the type of submersible being used, the following items may be advisable.
4. A tracking system, capable of locating the submersible, installed in or on the support vessel.
5. Two boats, which could be inflatables, complete with motors and support equipment, should be available for immediate use, along with experienced crew.
6. A means of shore communications should be available.
7. A radio direction finder should be installed and maintained if a non-tethered submersible is being used.
8. A transponder location device should be installed and maintained.
9. A suitable Deck Compression Chamber if diver lock-out operations are envisaged.

## 4.5 Mission Hazard Identification

Hazard identification is a relative subject, since entanglement risk, tidal current, temperature and salinity, debris and local visibility may not be definable prior to a dive. However charted objects such as wrecks, pipelines, cables and dumping sites can be identified in advance of an operation. The intent should be to list and establish the risk associated with known and probable hazards which would endanger the vessel, submersible or diver. This will enable the Operations Controller to anticipate problems likely to be encountered and prepare accordingly. An example is the requirement for cable cutters and propeller guards to be fitted to vehicles operating in areas beneath structures where cable and line debris may exist.

When operating in Hazardous Areas (wrecks, submerged cables, known dumping areas, etc), the following additional points should be taken into account during detailed planning:

Pre-Mission Planning

1. Gather information:
   - Area charts
   - Fathometer or echo sounder traces
   - Side scan sonar traces
   - Water temperature at depth
   - Current and tidal data
   - Weather forecasts.
   - Talk with local fishermen if charts are old or unreliable
2. Study information gathered
3. Plan for locking-out at maximum depth
4. Review decompression tables
5. Review lock-out procedures
6. Discuss emergency procedures, especially communications, with all mission personnel.
7. When working on or with hazardous materials or equipment special considerations and precautions should be taken.

## 5.0 MOVEMENT AND POSITION REPORTING, POSITION INDICATION

5.1 Movement and position may be reported in four ways:

A. To the Company headquarters or shore base, either direct or through an appointed agent.

B. To the local Maritime Authority to avoid interference with military submarines or autonomous submersibles or other commercial subsea activity of the same or some other nationality.

C. To a shipping movement control - for shipping lanes such as in the English Channel, for entering and leaving harbour, and for movement around structures in oil and gas fields, which have a number of structures, sea bed production systems, pipelines/flowlines, loading buoys, etc.

D. To the rescue organiser or co-ordinator.

5.2 To whom, in what manner, and with what frequency these reports are made will depend upon any local rules or regulations covering the area of operations and the company policy,

5.3 There will be occasions when timing or other considerations will not allow an effective declaration or warning in accordance with paragraph 5.1.B. In these circumstances submersibles may still dive provided that all reasonable safety precautions are taken.

## SECTION C: OPERATIONAL PROCEDURES

## 1.0 INTRODUCTION

Because of the large number of different types of vehicles in operation and the wide variety of operational situations, it is impossible to lay down procedures to suit all eventualities. These procedures therefore serve as guidelines only, and should be adapted to suit individual vehicles and operational conditions.

## 2.0 PLANNED MAINTENANCE

2.1 By definition, planned maintenance implies a schedule of maintenance to be carried out over a period of time, so that all systems and sub-systems, including support equipment, are thoroughly examined and maintained, and the results of such examinations and maintenance recorded.

2.2 As most underwater vehicles are subject to annual survey by the appropriate statutory authority and/or classification society, planned maintenance should be scheduled over a 12 month period.

2.3 In conjunction with planned maintenance, pre- and post-dive checks should be carried out by a competent person and entered in the maintenance record.

2.4 All modifications and defects requiring remedial action should be recorded with a report of remedial action taken. A separate log should be maintained for vehicle support equipment.

## 3.0 CHECKLISTS AND LOGS

3.1 Submersible operating companies should maintain good records of all aspects of their operations. The special logs and checklists specified in Appendix 2 are included for information only, but could act as the basis for minimum checklists for an operating company.

3.2 Logs and checklists should normally be completed in triplicate and are typically distributed as follows:

COPY NO 1: To the operating company's head office for information, processing and record-keeping.

COPY NO 2: To the client's representative (discretionary)

COPY NO 3: Retained with the submersible or. support equipment for information and record-keeping.

## 4.0 BRIEFINGS AND CALCULATIONS

4.1 A pre-dive briefing should always be carried out with the client's representative, the Ship's Master, Offshore Installation manager, the Operations Controller, the Surface Controller, the Submersible Pilot, the Diving Supervisor if applicable, and any other senior personnel involved, so that all concerned are familiar with the purpose of the dive, proposed method of achieving its completion and the responsibilities of key personnel.

4.2 The client's representative should be kept fully aware of the operational limitations of the submersible and its associated equipment.

4.3 Before a dive is undertaken, any equipment added to, or removed from the submersible, should be recorded, proved capable of successful jettisoning, if applicable, and its effect on the trim, surface and submerged stability checked and approved. If required, calculations should be carried out to verify that the submersible will be able to achieve and maintain positive buoyancy.

4.4 The flammability and/or toxicity of any substance, item or clothing taken inside the craft should be known before the dive commences.

## 5.0 VEHICLE COMMUNICATIONS PROCEDURES

### 5.1 Surface Communications

The working channel selected should be compatible with other onboard users (eg bridge, DP room), the area standby vessel (if available) and submersible tender craft. Prior to launch, a communications check should be carried out between all parties concerned with the dive programme, including the standby vessel. A listening watch should be kept on the working channel throughout the course of the dive.

### 5.2 Underwater Communications

All submersibles should be provided with two independent means of underwater communication. (This may be A and B below or two sets of B).

A. Hardline communications, allowing continuous two-way communications between surface control and submersible (if the submersible is provided with an umbilical link).

B. Through-water communications, normally only used if the hardline communication system fails, or is not available as with a free-swimming submersible.

### 5.3 Hardline And Through-Water Communications

A. An underwater communications watch should be constantly maintained between the surface and submersible while it is submerged.

B. Communications should be kept to a minimum to allow the pilot to devote his full attention to the task in hand.

C. Standard words and abbreviations as laid down in Appendix 3 should be used whenever possible.

D. In the absence of other communications, a check should be initiated by the Surface Controller every 15 minutes. A life support report should normally be obtained at the same time.

E. In the event of loss of communications or failure to respond to a communications check, the Pilot or Surface Controller should initiate emergency action in accordance with the procedures in E6.

F. Hardline communications systems are normally extremely sensitive and experienced Surface Communications Controllers can often monitor dives without the need for continuous verbal exchanges, except at specified check times. Surface Communications Controllers should therefore listen out at all times for any changes in circumstances, ie alarms sounding, change in Pilot's respiration rate, unusual noises, etc.

G. If the Surface Communications Controller has any reason to doubt the safety or well being of the Pilot due to conditions as in paragraph F above, he should immediately inform the Surface Controller, who will, if necessary, take appropriate action.

H. All communications between submersible and support vessel should be adequately recorded.

## 5.4 Emergency Through-Water Communications

A. A serviceable portable underwater communications set complete with batteries and transducer, should be kept at the dive control location at all times.

B. The surface transducer should be deployed, and a through-water communications check should normally be carried out when the submersible reaches a depth of about 30 m. Normally the transducer should be kept in the water as long as the submersible is submerged.

C. Should it be necessary to abandon the surface control station whilst the submersible is in the water, the emergency communications equipment should be taken to a lifeboat, complete with the surface transducer. The submersible should be informed as soon as possible.

In this respect it is important that:

i. The installation of emergency communications equipment at the dive control station is such as to allow its removal with the shortest delay.

ii. The batteries are always fully charged and in good condition.

iii. The surface transducer can be recovered quickly from the normal dive position.

iv. If an installation has two emergency communications sets onboard, it is recommended that one set be permanently installed in one of the lifeboats designated to the shipborne submersible operations crew, or stored in close proximity to that lifeboat.

## 6.0 SUPPORT VESSEL POSITION

6.1 If a free swimming or tethered submersible is being operated from a support vessel, the Master is responsible to the Operations Controller for:

A. Manoeuvering the vessel into position for launch and recovery of the submersible as required by the Operations Controller/Surface Controller.

B. Maintaining station on the submersible for the duration of the dive as required by the Operations Controller/Surface Controller.

C. Maintaining a safe area for the submersible by monitoring and if necessary warning other shipping traffic in the area.

6.2 If a submersible is being operated from, or close to, a drilling rig or platform, then the standby vessel attending the rig or platform should maintain station as requested by the Submersible Operations Controller in agreement with the Offshore Installation Manager.

6.3 One of the two rubber inflatable or other similar boats should always be ready for launching, with the correct equipment to hand.

## 7.0 SUPPORT VESSEL EXTERNAL COMMUNICATIONS PROCEDURES

Whilst diving operations are being carried out, the support vessel, rig or platform should maintain a listening watch on an appropriate local frequency (HF/VHF) in order to monitor other traffic. It is imperative that other radio communications should be kept to an absolute minimum during submersible operations in order to avoid interference.

## SECTION D: EMERGENCY PLANNING

### 1.0 INTRODUCTION

The guidance on emergency planning presented in this Section is progressive in that it starts with minor problems which can be dealt with on the spot, and carries on through to emergencies that require outside assistance. It gives guidance on when the Company base should be informed, and actions requiring outside assistance. Reference should be made to the safety contingency plans included in individual Company Operating Manuals. A written Emergency Plan should be drawn up for each operation.

Emergency plans and procedures are a guide and an assistance to the person in charge, on the spot, at the time of the incident and should not inhibit him from making other decisions which he may consider correct at the time.

## 2.0 PROBLEM IDENTIFICATION

2.1 In an emergency situation with the submersible underwater, there are two fundamental questions that must be answered.

2.1.1 When should the submersible surface?

Occurrences which require emergency action include communications failure, equipment failure, hazardous bottom or current conditions and personnel sickness or accident.

2.1.2 When should the submersible stay submerged?

Reasons include temporary surface traffic in the recovery area, temporary recovery system failure, temporary support ship failure, and temporary bad weather. The prefix 'temporary' should be noted, the time being measured in minutes rather than days.

2.1.3 The hazard should be identified and isolated so that appropriate remedial action can be taken.

2.1.4 With certain major hazards in the submersible itself, such as fire, flooding, abnormal atmosphere, crew casualty or inadequate life support reserve, the submersible must surface, if possible.

Should a submersible wish to surface but cannot because it is partially flooded, stuck in a soft bottom, or entangled in debris, the situation should be regarded as critical.

2.1.5 Other critical problems can be identified as:

- The submersible is lost on the surface
- The submersible is lost below the surface
- The support ship is unable to recover the submersible
- There is personnel sickness or injury that cannot be dealt with onboard.

2.1.6 At this stage, emergency procedures for deploying . rescue craft should be actively considered. The submersible crew should decide on a course of action, and as soon as possible inform the Surface Controller. Similarly, the support ship, and any other vessels in the immediate area, should be warned if the vehicle is likely to surface in al emergency situation.

2.1.7 Problems arising with the support ship which can hazard the operation include:

- Weather effects
- Collision
- Major loss of propulsion, electrical power steering, dynamic positioning, etc
- Fire
- Major fault on the submersible handling gear when the submersible is in the water.

Guidance must be given in the Emergency Plan to assist the Operations Controller and the Ship's Master to decide on the best course of action to take, depending on all the circumstances, including the weather forecast, severity of the hazard and self-help facilities available. Guidance must be included in the Emergency Plan on when to call for outside assistance.

## 3.0 STATUS OF EQUIPMENT AND SUPPORT SERVICES

3.1 In the event of outside help being required, any rescue vehicle listed as available for use by the Company should have a realistic mobilisation time to the operations area.

3.2 In areas where outside assistance is not readily available, on site back-up should be provided for immediate assistance. This system should have the same basic operating capability and maximum operating depth.

## 4.0 SELF-HELP PLAN

4.1 The self-help plan should be clear and comprehensive. The extent of the plan should at least include sections covering procedures for the recovery of lost or disable vehicles, and for providing medical assistance.

4.2 All self-help plans should be prepared with the most likely incidents in mind in relation to the equipment being operated by the Company. The plan should be co-ordinated where possible with those of other operators, to ensure the compatibility of systems when outside assistance is required.

4.3 To avoid misunderstandings or ambiguities, the timing of key parts of the rescue plan should be detailed.

4.4 From the earliest sign of an emergency, the local and geographical reference positions of the submersible should be clearly noted and marked.

4.5 Within the self-help plan, the situations requiring the use of special equipment, such as submersible lift buoys, remotely operated vehicles, manned vehicles, or divers, should be clearly defined and the availability and status of this equipment listed in the Emergency Plan. The extent medical assistance available should also be included.

## 5.0 SPECIAL REQUIREMENTS FOR LOCK-OUT SUBMERSIBLES

### 5.1 Unique Features

A lock-out submersible can normally rescue itself if it is operated in a diving mode, i.e. mixed gas onboard for dive depth, diving gear aboard, at least two qualified divers in the dive chamber and rescue tools stored aboard.

### 5.2 Medical Treatment

A recompression facility is provided onboard all lock-out submersible support vessels for treatment of diving accidents and decompression sickness.

### 5.3 Emergency Plan

The dive compartment of a lock-out submersible is a self-contained diving bell. Normally it differs from a conventional bell in that no umbilical exists between the submersible and the surface support ship. Onboard power and gas supplies are therefore limited. Pre-dive planning needs to take this into account. Possible emergencies which must be considered include:

- Loss of onboard power.
- Leak in any gas system.
- Loss of communication to the diver compartment, lock-out diver or surface.
- Inability to seal internal pressure hatch following a lock-out dive.
- Operations in areas of strong bottom currents.
- Disabled diver(s) in the lock-out compartment or in the water.
- Fire or flooding
- Inability to recover the submersible
- Entrapment. Evacuation of divers under pressure on ship abandonment.
- Diver unable to re-enter lockout compartment due to trunking being fouled on sea-bed.

## 6.0 OUTSIDE HELP PLAN

Availability of outside help should be detailed in the Emergency Plan. This should include equipment available from outside sources and the following:

6.1 Copies of the AODC's quarterly Emergency Contact List and Submersible Locations .

6.2 The relevant or appropriate outside bodies to be contacted, including the name and address of the relevant UKOOA Sector Club co-ordinator (if working in the North Sea).

6.3 Statements such as:

What has happened?
What is needed?
Where is it required?
When is it required?
When can it arrive on site?

6.4 The outside help plan should be co-ordinated in the overall search and rescue plan to ensure that a co-ordinated approach to the problem is directed from a central control point.

6.5 The responsibility for who should initiate and take charge of the rescue operations should be clearly laid down in the Emergency Plan. The initial responsibility for the rescue on site will rest with the Operations Controller, but he may be relieved of this responsibility by the Operations Manager or another senior member of the Company, depending on the severity and location of the accident. The most important aspect is that the Emergency Plan makes it quite clear who should be in charge in the event of an emergency occurring, and that there should be no deviation from this.

6.6 The location of the nearest diving activity capable of helping with a rescue should be included. Some drilling vessels have diving systems onboard but they might not be able to be used for rescue, due to the location of the rig and for other technical or operational reasons.

## 7.0 DIVING MEDICAL EMERGENCIES

The need for medical aid should at no point be overlooked, especially the specialist care required for divers in saturation. It is important to include this emergency service in the Emergency Plan, and to brief the Emergency Doctor in advance of the operation.

## SECTION E: EMERGENCY PROCEDURES

### 1.0 INTRODUCTION

A set of definite procedures should be included in the Operations Manual to cover emergency events, so that all members of the operations team know what each of them should do if an emergency arises.

Emergency plans and procedures are a guide and an assistance to the person in charge, on the spot, at the time of the incident and should not inhibit him from making other decisions which he may consider correct at the time.

## 2.0 POSITION MARKING

2.1 If communications with the submersible are lost, or if the submersible is damaged while submerged, the support ship should have an established procedure for marking the last known position of the submersible. The procedure should list the equipment required, such as buoy and line, anchor, pinger, light and radar reflector and their means of deployment (see Section F7.2). The procedure should include sufficient detail so that the equipment is always ready for deployment. The combinations of lights, radar reflectors, pingers and transponders should be clearly indicated for day or night operation, as should the normal method of deployment.

2.2 The method of geographically fixing the position of the submersible should also be detailed in the procedures. A list of the available surface navigation aids and their mode of operation should be clearly given. At least one of the surface navigation aids on board the support ship should be used to fix an accurate geographical position. If an underwater navigation array is deployed, the position from its subsurface plot should be noted in addition to the ship's own estimate. Consideration should be given to laying a transponder array in the area of the submersible's last known position, if one is not already deployed.

2.3 The geographic position of the support vessel should be fixed at regular intervals, using the best navigation aids available. If the support ship has to leave the area for any reason, this position will be crucial for subsequent rescue operations.

2.4 If the submersible was unmarked with a surface buoy when the emergency arose, a marker buoy should be dropped from the support ship in the vicinity of the last known position of the submersible.

2.5 If the submersible becomes entangled or is unable to surface, the pilot should switch on the emergency pinger or switch the UWT to the pinger mode. If a submersible transponder is fitted, the pilot should ensure that it is activated.

2.6 Location on the surface is difficult because the low profile of a submersible makes for a poor radar target. Storm conditions will reduce this profile even more and may involve loss of daylight for visual contact. Addition of a radar reflector, dayglow paint, Scotchlight strips, strobe lights, radar transponder, or a combination of these items will increase the chances of locating a submersible on the surface.

2.7 Communication in storm conditions can also be difficult, especially underwater, where wave action degrades the quality of the acoustic signals due to background noise and scattering

## 3.0 SEARCH PROCEDURES FOR LOST VEHICLES

If the submersible is lost, it should first be determined whether it is on the surface or submerged.

### 3.1 If Submersible Is Surfaced

Radio contact should be established if possible. In certain circumstances a hand held DF could be available to provide a bearing of any radio transmission. In rough weather the submersible may well see the support ship first and, if in radio contact, the crew can direct the ship towards the submersible.

Visual contact will be aided if the submersible is equipped with flares, smoke generators, lights and reflective strips. By day, and particularly in sunlight, a smoke generator will probably be most effective. At night the use of a strobe light is desirable.

Even with such visual aids there is a danger of the submersible being run down by the support vessel and great care should be taken.

### 3.2 IF THE SUBMERSIBLE IS SUBMERGED

#### 3.2.1 Support Ship Search

Search is normally by acoustic means, ie:

- UWT speech or morse code
- Emergency pinger (independent)
- UWT in pinger mode
- Transponders
- Active sonar
- Echo sounder(s)

#### 3.2.2 Search by Submersible

A rescue submersible launched to search for another submersible known to be on the bottom will rely on:

- UWT
- Pinger receiver
- Sonar
- Lost vehicle lights
- Transponder(s)
- Directed courses from the surface ship
- A box pattern search at the discretion of the Pilot

## 4.0 RECOVERY

4.1 The Operations Controller or Surface Controller should assess the weather conditions and decide whether it is better to recover or to tow. Relevant procedures learned from the experience of operating systems in foul weather should be included in the Operations Manual wherever possible.

4.2 An assessment should be made of the situation:

- Is reliable meteorological information available?
- Is recovery during storm conditions justified?
- Can the submersible wait on the bottom until the storm has passed?
- Is the submersible life support adequate for the predicted wait with a reasonable safety margin?
- Can the support ship hold station throughout the storm?
- Has the submersible been warned of the approach of the storm and its likely duration?
- Is an agreed procedure for waiting on the bottom fully worked out and understood?
- Is the precise position of the submersible known?
- Is there likely to be a break in UWT use due to wave effects on the ships transducer(s)?
- How far is it to the nearest sheltered water?
- In the event of deciding to recover the craft in adverse weather conditions, is there a possibility of failure of the recovery line or handling system due to the increased loadings imposed on the system?
- How long will it take for the submersible to be recovered?
- Is the weather expected to improve or deteriorate during this time?
- Is the submersible designed for towing?
- Will towing in rough seas cause loss of air from open bottomed buoyancy tanks due to rolling?
- Will the direction of tow to sheltered water be compatible with the best or an acceptable course relative to the direction of the weather?
- Is the submersible fully serviceable, i.e. is there a low level emergency situation in the submersible? If there is an emergency requiring immediate surfacing and recovery is impossible, is it essential to evacuate the crew from the surfaced submersible?
- Is the sea state too high to risk opening the hatch (ie risk of sinking before crew have left?)
- If a crew rescue from the surface submersible is essential, has the marker buoy been deployed?
- Is additional equipment such as support boat available?

### 4.3 Rescue Of Crew

Crew rescue from a surfaced submersible in storm conditions will be hazardous and should only be attempted as a last resort, due for instance to an uncontrollable fire, noxious gases, flooding in the crew compartment, loss of buoyancy, or loss of emergency breathing system.

After escape from the submersible, exposure or drowning are major risks. Life jackets are therefore essential for free-swimming submersibles.

### 4.4 Tow

Once a free-swimming submersible has surfaced, a tow should be undertaken. The major risk is damage due to wave action. Under tow in rough seas, pitching and rolling may cause loss of air from buoyancy tanks due to spillage from the open lower parts.

## 5.0 DAMAGED VEHICLE RECOVERY

5.1 The emergency lift gear on the support ship and emergency flotation devices should be itemised in the Operation Manual, and should be kept in a state of readiness at all times. The method of operation of this emergency equipment should be clearly indicated in the Emergency Procedures, and relevant personnel should be thoroughly familiarise with its use.

5.2 An assessment should be made of the situation and the Operations Controller will have to consider several factors when undertaking damaged vehicle recovery, for example:

- Is the vehicle adrift or on the bottom?
- Is the vehicle entangled? If so, by what?
- Is there an on site back-up vehicle able to effect the rescue?
- Is there a lift point available?
- Is there a significant bottom current which may hinder rescue operations?
- Are there any hazardous substances, such as oil, gas, explosives, in the vicinity of the vehicle?

As with all emergencies, these situations are unpredictable and experience should form part of their analysis.

### 5.3 Lift Point Damaged/Fouled

As emergency lift points are fitted to the submersible, one of them should be accessible for attaching a lift rope. If the vehicle is on the seabed, one or more lift lines should be attached, using different lift points for each line where possible.

If the vehicle surfaces normally and the main lift point is damaged or fouled, an emergency "harness" should be rigged and fitted to as many of the emergency lift points as possible.

### 5.4 Vehicle Adrift

If the vehicle's main propulsion is inoperative or the batteries are exhausted, it may be necessary to try to tow it out of danger. This should be carried out using the support ship, if possible, or with an inflatable craft or similar boat if the support ship is unable to close the vehicle sufficiently. Once clear of danger, the submersible should be recovered normally, if possible.

### 5.5 Hazardous Substances

These may be slicks of inflammable low specific gravity liquids, such as oil on the surface of the sea, which have contaminated the vehicle, or through which the vehicle must be recovered. The vehicle should be towed clear, or if possible told to submerge again and to manoeuvre clear of the hazard.

Alternatively, it could be ordered to submerge again and to remain stationary whilst the hazard moves, if this is thought likely. It should be remembered that the hazard may be more dangerous to the support vessel than to the submersible.

The hazardous substance may be a high specific gravity liquid on the seabed (toxic chemical, explosive liquid or solid, etc) which is carried up to the surface in pockets of the vehicle. If this is suspected, the vehicle should be examined, if possible, whilst on tow or on the hook before being brought inboard. It should be washed down with a seawater jet to remove the substance and then thoroughly washed down with water and detergent.

The substance should be identified as soon as possible to ensure that it will not damage the vehicle or vehicle systems, e.g. some solvents may damage acrylic materials, such as viewports, seals such as O-rings, washers, etc, GRP, paint insulation, solid buoyancy or even metals.

## 6.0 INITIATION RESPONSIBILITY

If the submersible misses a communication check, then a continuous attempt should be made to establish contact. After 30 minutes from the last communication, emergency procedures should be initiated.

### 6.1 Submersible Pilot

If able, the vehicle Pilot should initiate emergency status or action. If unable, the normal procedure requires emergency action by the Surface Controller after an agreed loss of communication time between the vessel and the submersible.

If able, the submersible Pilot should broadcast an emergency signal on UWT and surface independently.

The support vessel should stand clear and prepare to recover under the preplanned emergency conditions.

### 6.2 Operations Controller

Upon declaring 'Submiss' the Operations Controller either:

- Informs the master and requests that the parent vessel be moved clear of the operational area.
- Prepares the on site back-up vehicle and divers.
- Notifies the Operations Manager only.

OR

- Declares 'Subsunk' to the Operations Manager, giving all possible details.
- Informs the master and requests that the parent vessel be moved clear of the operational area.
- Initiates recovery plans using the on site back-up vehicle if applicable.

AND

- Remains in complete charge of search and rescue operations unless relieved by the Operations Manager.
- Maintains a complete written record of the proceedings.
- Cancels Submiss/Subsunk alert on recovery of the vehicle.

### 6.3 Operations Manager

Upon receipt of 'Submiss' alert, the Operations Manager:

- Acknowledges 'Submiss' and notifies all personnel concerned.
- Prepares all relevant information details of on sit back-up facilities and available assistance.
- Notifies the company officers and key personnel to 'Stand-by'.
- Maintains an 'open line' to the operational base.
- Provides support to the operation as required.

- Liaises with the media - all requests for information are to be referred to him.
- Maintains a 24-hour office support facility.

Upon receipt of 'Subsunk' confirmation, or else after the time elapsed since 'Submiss' alert to assume 'Subsunk', the Operations Manager:

- Acknowledges 'Subsunk'.
- Notifies all the company officers and key personnel.

### 6.4 Master Of The Support Vessel

- Acts as requested by the Operations Controller, including positioning the vessel. (Unless in his judgement this would hazard the vessel itself or its crew.)
- Arranges constant radar and radio watch and logs all traffic.
- Ensures that the launch and recovery system is ready for instant use.
- Maintains open channels to assistance facilities.
- Alerts other shipping in the vicinity.
- Monitors the weather.

## 7.0 VEHICLE EMERGENCY PROCEDURES

Emergency procedures should be generated to cover the following situations which may occur in or to the submersible.

- Fire
- Flooding
- Leaking of gas or liquid into or out of any space in the vehicle
- Entanglement
- Loss of electrical power
- Loss of a key system, such as hydraulics, air or life support
- The methods, sequence and result of jettisoning weight
- Establishing stability on the surface
- Loss of surface communications
- Loss of underwater communications
- Sickness or injury to the submersible crew or divers
- Tow and recovery under abnormal conditions
- Lock-out vehicle emergency procedures and surface exiting and abandoning procedures
- Procedures specific to one-man submersibles.
- Procedures relating to the instigation of on site vehicle back-up.

## SECTION F: EQUIPMENT

## 1.0 INTRODUCTION

1.1 This section is concerned with the equipment and individual systems associated with the operation of manned submersibles. These are categorised as:

**Essential -** To ensure safe operational practice

**Recommended -** Within the constraints of the particular submersible design or operational requirements envisaged.

1.2 It is arranged to cover the basic submersible types and outline their specific requirements. It should be noted, however, that individual submersibles may not be capable of carrying all the equipment and systems included in this section.

1.3 The Operations Manual for each type of submersible should be complemented by adequate drawings, details and construction schematics for its equipment.

## 2.0 ONE-ATMOSPHERE SUBMERSIBLE VEHICLES

### 2.1 General Considerations

Structural and system design criteria are fully covered in the UR by the Department of Trade Construction and Survey Regulations, and compliance with these should ensure a safe operational submersible.

Submersible operators should however give consideration to general design parameters when considering particular operations, and the attachment of specialised tooling and instrument packages. The following are examples:

No tool or system which causes an obstruction should be fitted externally unless it can be ejected by the Pilot.

Instruments or other items fitted internally should no obstruct the Pilot or essential systems and should be sited to reduce fatigue.

The vehicle design should include adequate emergency lift attachments or a permanently fitted lift strop.

Vehicle trim and stability in submerged and surface conditions should be considered in the event of equipment release. Pilots and other personnel should be aware of possible changes in vehicle trim underwater or on the surface.

Fire prevention - Every effort should be made to avoid using flammable materials, especially those which emit toxic gases.

All large volume atmospheric pressure compartments should be fitted with water ingress alarms.

It will be appreciated that some of the points which follow can only apply to multi-man systems and are not relevant or practical for one-man submersibles.

### 2.2 Life Support Systems

#### 2.2.1 Essential

- Sufficient $O_2$ should be available for the anticipated dive duration plus the reserve for emergency requirements.
- Sufficient $C0_2$ absorbent for the anticipated dive duration should be available plus the reserve for emergency requirements.
- Main and reserve power supply for the $C0_2$ scrubber.
- One spare scrubber unit motor, or a dual redundancy system or manual alternative.
- A self-contained $O_2$ rebreather system with a minimum duration equivalent to maximum ascent time from depth in an emergency, or an air BIBS system.
- Adequate drinking water, concentrated food, and waste disposal arrangements.

- Exposure suits - one per man or equivalent thermal blankets. (Multi-man systems.)
- For one-man submersibles suitable means to maintain the pilot in thermal balance for the period specified in paragraph *B. 15* of Form *B*.
- Inflatable life jackets - one per man. (Multi-man systems.)
- First aid kit.
- Tool kit.
- Emergency lighting system (flash light).
- Life support instrumentation.
- Clock.

#### 2.2.2 Recommended

- Cabin humidity gauge.
- Crew compartment hull insulation. (Multi-man systems.)

### 2.3 Communications Systems

#### 2.3.1 Essential

- Two independent communications systems for underwater use.

#### 2.3.2 Recommended

- Multi-channel VHF surface transceiver with emergency channel 16 and at least one designated working frequency to the support vessel.

- Acoustic communications fitted with 'up' directed transducer and 'down' directed transducer, the latter to be fitted below on surface water line to increase effectiveness at or near the surface range of the unit.

### 2.4 Emergency Location Equipment (Submersible)

#### 2.4.1 Essential

- 27 kHz pinger (or integral pinger mode on acoustic communications unit).
- Strobe light permanently fitted, to be visible on the surface.
- Reflective or bright contrast colour scheme.

#### 2:4.2 Recommended

- 37.5 kHz transponder as standard common emergency location device. (AODC. specification.)
- Built-in pinger location system.
- Releasable surface buoy where depth limitations permit (multi-man systems).

### 2.5 Navigation Systems

### 2.5.1 Essential

- Good all round visual observation.
- One independent depth indicator.
- Pre-set gyro or magnetic compass.
- A chart of the area, or an outline diagram o the area or structure, for navigational purposes. (Multi-man systems.)

### 2.5.2 Recommended for Multi-Man Systems

(As required for specific tasks)

- High resolution search/location and inspection sonar.
- High resolution chart recording, echo-sounder.
- Precision digital depth indicator.
- Tracking transponder system:
  - i) Ultra short base line system for support vessel tracking
  - ii) Long base line array for survey/local are navigation.
- Doppler log system.
- Auto-pilot.
- Inertial navigation system.
- Current indicator - direction and speed.

## 2.6 Fire Prevention Systems

### 2.6.1 Essential

Careful attention should be paid to the selection of materials for use in submersible during initial construction and refits avoiding the use of those which are flammable, particularly if they emit toxic gases on combustion.

Careful attention should be paid to electrical system circuit breakers and circuit protection devices.

Care should be taken to avoid interference with electrical circuit protection systems when fitting special equipment for particular operational missions.

Careful selection of fire extinction agents in relation to the compartment's volume, contents and personnel - for example $C0_2$ or dry powder extinguisher systems should not normally be used.

Oils or greases which are incompatible with breathing systems and $O_2$ make-up systems should not be used.

## 2.7 External Equipment And Tooling

The selection of external equipment and tools will depend on task requirements. This section therefore only offers general advice.

### 2.7.1 Essential

Adequate lighting for mission requirements.

All manipulators should be jettisonable by the Pilot in case of entanglement.

All temporary or permanent systems should be sited or adequately protected to avoid entanglement, eg cameras, wire cutters, thrusters.

Hydraulic hoses and penetrators should be pressure tested before use, and penetrators should always be fitted with stop valves.

Careful consideration should be given to the protection of exposed electrical cables and penetrators against damage by impact.

If external buoyancy floats are fitted the) should be suitable for the operating depth.

### 2.7.2 Recommended

It may be beneficial to protect front ports, especially large ports or hemispherical units with bars or outer covers.

## 2.8 Systems Status - Instrumentation

### 2.8.1 Essential

A contents gauge for every gas supply system whether for life support or air buoyancy.

Main and Emergency battery state indication.

Individual trip breakers or fuses as protection and indication of overload situations for all electrical systems.

### 2.8.2 Recommended

Where possible a permanent main electrical system 'insulation resistance' check system should be fitted, in particular on main supply and heavy load 'through-hull' circuits.

Hydraulic units should, where possible, be fitted with oil level indicators and pressure gauges. This would particularly apply to s central main unit supplying multiple functions.

# 3.0 DIVER LOCK-OUT SUBMERSIBLE VEHICLES

## 3.1 General Considerations

For general purposes a diver lock-out submersible can be considered to be a manned one-atmosphere unit, the lock-out compartment being capable of use during a normal one-atmosphere dive mission. The diver lock-out compartment should be fitted out to support the submersible crew at one-atmosphere when used in this mode. (See Section F-2)

When used in a diver lock-out mode the diver lock-out compartment becomes in effect a diving bell and the equipment/system requirements and operational procedures for the divers are similar to those used for normal bell diving operations.

## 3.2 Life Support Systems

### 3.2.1 Essential

Separate mixed gas supply system for the divers which can be controlled from the Pilot's compartment by the Diving Supervisor. Dive duration and a safety margin should be calculated prior to the pre- dive briefing.

Separate $O_2$ supply system which can be controlled from the Pilot's compartment by the Diving Supervisor.

Thermal insulation of the diver lock-out compartment and heating for the divers to normal diving standards.

All diver lock-out compartment instrumentation, including depth gauges, should be duplicated in the Pilot's compartment and at the Diving Supervisor's station.

All breathing mixture analysis and control instrumentation for the diver lock-out compartment should be monitored by the Diving Supervisor.

Life support equipment in accordance wit accepted standards for bell diving.

### 3.2.2 Recommended

Mixed gas re-breather system.
Humidifier

## 3.3 Communications

### 3.3.1 Essential

Hardline communications (with a helium void unscrambler) from (a) diver to diver, (E Diving Supervisor to the diver lockout compartment, (c) Diving Supervisor to locked out diver.

Visual contact between the Diving Supervisor in the Pilot's compartment and the diver lock-out compartment.

## 3.4 Diving Equipment

### 3.4.1 Essential

Adequate lighting externally around the dive lock-out compartment hatch.

Submersible has sufficient ballast control to counteract two divers exiting from diver lockout compartment (to cater for standby diver going to the assistance of the locked-out diver).

Stout support legs with flat feet to support submersible at a sufficient height above the sea-bed to allow easy diver entrance and exit taking account of a possible soft sea-bed.

### 3.4.2 Recommended

A latching system for mid-water diver lock-out on structures (if this method of operation is envisaged).

Provision of a short emergency umbilical to supply hot water, breathing gas and hardline communications to the lock-out compartment in an emergency.

# 4.0 ONE-ATMOSPHERE DRY TRANSFER VEHICLES

## 4.1 General Considerations

Equipment for these vehicles is similar to that used in the diver lock-out compartment of a lock-out submersible or in a diving bell. The equipment is however designed to be operated at atmospheric pressure for locking on to another unit (such as a seabed habitat) and transferring personnel. Equipment criteria should include the following:

## 4.2 Life Support

### 4.2.1 Essential

Suitable breathing apparatus independent of the transfer vehicle atmosphere.

$CO_2$ and $O_2$ monitoring to be duplicated in the Pilot's compartment (if a separate compartment).

## 4.3 Fire Control

### 4.3.1 Essential

Fire extinction system capable of being directed into the entrance of the unit being transferred to and designed to be compatible with the environment of the unit being transferred to.

## 4.4 Communications

Hardline communications between all compartments and transferred personnel.

## 4.5 Environmental Testing Equipment

Suitable equipment to test and monitor the chamber environment of the unit being transferred to.

# 5.0 TETHERED ONE-ATMOSPHERE SUBMERSIBLE (MOBILE BELL)

## 5.1 General Considerations

This type of submersible is a mobile one-atmosphere vehicle attached to the surface support vessel by a tether or umbilical and which is capable of lateral movement. The definition does not include a diving bell operated at one atmosphere for observation purposes. The notes contained in Section F-2 generally apply to this type of submersible.

5.1.1 Special consideration should be given to unarmoured umbilicals and to separate launching arrangements, docking devices and lifting wires. Care should be taken in arranging the handling of the umbilical, and in particular any spooling or heave compensation devices should not inadvertently cause damage to the umbilical.

5.1.2 Care should be taken to avoid "snatch loads" being applied to unarmoured umbilicals which may lead to breaking loads being exceeded. This is particularly important where no permanent strain member or lifting wire is attached during the dive.

5.1.3 All umbilical and lifting wire attachments should be capable of being jettisoned in case of entanglement.

5.1.4 Vehicles that derive their main power source through the umbilical should be equipped with adequate emergency batteries to provide for emergency lighting and limited motive power for manoeuvering purposes, and life support.

## 5.2 Communications

### 5.2.1 Essential

- Hardline communications to the surface control station.
- Acoustic communications back-up on 27 kHz.

### 5.2.2 Recommended

- VHF for on surface use as Section 2.3.2.
- Video system to the surface control station.

# 6.0 ONE-MAN TETHERED SUBMERSIBLES

## 6.1 General Considerations

A one-man tethered submersible is a one-atmosphere vehicle that receives its normal power through an umbilical to operate thruster units.

An exception is the one-man vehicle type with articulated legs which is operated by the person inside and which does not rely on an electrical power source. Notwithstanding this difference, both these types of submersible or atmospheric diving suits are considered as one-atmosphere submersibles for the purposes of this Code.

These vehicles are generally lowered to a specific location and rarely move large distances from their initial point of deployment.

## 6.2 Life Support

### 6.2.1 Essential

- $O_2$ supply and $C0_2$ removal.
- $CO_2$ scrubber system to be provided with a back-up emergency power supply or with a manual alternative.
- Protective thermal clothing and/or equivalent thermal blanket.
- $O_2$ monitor.
- Cabin barometric pressure gauge.
- $O_2$ flow control meter.

### 6.2.2 Recommended

- Cabin temperature gauge.
- Food and water rations.
- $CO_2$ monitor.

## 6.3 Communications

### 6.3.1 Essential

- Hardline communication to surface control vi. the umbilical tether.
- Acoustic through-water communications at 27 kH: with back-up power supply.

### 6.3.2 Recommended

- VHF surface radio.
- 9 kHz acoustic frequency with a bandwidth of or - 2 kHz.
- Video system to the surface control via the umbilical tether.

## 6.4 Navigation

### 6.4.1 Essential

- Depth gauge.
- Gyro or correctly compensated magnetic compass.

### 6.4.2 Recommended

- Sonar (if possible) given size/power limitations.

## 6.5 Emergency Location Devices

### 6.5.1 Essential

- 27 kHz pinger.
- Strobe light.

### 6.5.2 Recommended

- 37.5 kHz transponder AODC specification).

# 7.0 SURFACE SUPPORT EQUIPMENT

## 7.1 General Considerations

The surface support equipment will be dependent on the type of submersible vehicle and its intended method of operation. The equipment may be permanent on a dedicated support vessel, or transportable for temporary installation. The section therefore only gives a general outline of the system requirements but where necessary draws attention to major differences between systems.

## 7.2 Permanent Installation On A Support Vessel

### 7.2.1 Essential

- Launch/recovery systems should have prime move power sources, with back-up or cross-over capability for use in the event of failure of the primary system.
- An emergency lift line plus relevant winch crane, or other lifting device capable of s least reaching to the maximum operating depth and fitted with a suitable attachment device.
- General systems for air charging, $O_2$ charging, battery charging, ventilation, lift support consumables, systems consumables, maintenance facilities.
- Personnel requirements, including foul weather survival suits, life jackets, wet or dry suit for on-surface assistance to submersible, including surface diving equipment as necessary
- Spare tow line ready for use (where appropriate)
- Two boats (preferably inflatable) for on-surface assistance.
  NB In the case of drilling rigs or fixed structures, the location of these boats on the rig stand-by vessel is acceptable.
- Operations control room fitted with VHF with sufficient channels to reach all working and emergency stations, acoustic communications set compatible with submersible system, communications taping facility.
  NB Deck communications or telephone contact from the control room to a properly outfitted radio room is acceptable for VHF communications.

### 7.2.2 Recommended

- Secondary lift capability utilising stern 'A' frame or a second davit. This could also be used for emergency recovery from the seabed.
- Standby portable acoustic communications set ready for use in an emergency.
- Standby portable VHF set ready for use in an emergency.
- Position location marking system ready for use in an emergency to consist of: Dan buoy with two flashing lights, surface buoy, sufficient line for the depth and anchor or weight system fitted with pinger for bottom reference.

## 7.3 Temporary Installations (including Tethered Systems)

These are essentially the same as for permanent installations, but special attention should be given to equipment layout, and in particular to deck loadings, distribution of load bearing equipment, and the proximity of the installation to hazardous zones.

### 7.3.1 Essential

- Prime mover power source for tether winch and deployment system.
- Back-up power source for tether winch and deployment system.
- Back-up winch fitted with either a spare umbilical or a lifting wire as a separate secondary recovery system and rigged for immediate use however if the primary lifting winch is of the "man carrying" type and has a back-up drive mechanism, then a separate back-up winch is not necessary.
- Secondary lifting position, either as part of the system or utilising part of the surface vessel's equipment. To be rigged for immediate use.

### 7.3.2 Recommended

- Guide wire system for launch and recovery through the air and air/water interface where cursor system is not used.

**SECTION G: APPENDICES**

# Appendix 1
# Specimen Maintenance Procedures

It must be stressed that this section is provided as a specimen only and that in practice there will be wide variations in the amount and frequency of maintenance required.

Clearly the extent of maintenance requirements and the various checks are dependent on the type of submersible.

Each operating company will have its own maintenance procedures included in its company manuals or else should use the maintenance procedures provided in the equipment makers handbook.

## A. Daily Checks

These are necessary only if the vehicle is involved in diving operations.

Normally if checks by both technician and pilot are required the vehicle would be checked daily by the technician only, unless it is called upon to dive, when the pilot would also carry out his pre-dive checks immediately prior to the dive.

Immediately on completion of diving operations. the vehicle should be prepared for its next operation with the following checks:

- ♦ Pilot's post-dive checks, including inspection for external damage
- ♦ Rectification of all defects
- ♦ Charging main and emergency batteries, including through water communications, VHF batteries etc
- ♦ Charging air, $O_2$ and other breathing gas systems
- ♦ Clean out vehicle.

## B. Routine Maintenance Submersibles

Many routine maintenance checks will be carried out daily if the vehicle is involved in continuous diving operations. However, the routine maintenance log should be completed for the required interval. Examples of routine maintenance checks are:

1. Charging batteries (as applicable) – weekly
    - ♦ Main
    - ♦ Emergency
    - ♦ Through-water communications - surface/sub-surface
    - ♦ Hardline communications - emergency backup
    - ♦ Control functions, ie video focus, stills camera trigger
    - ♦ Support equipment batteries - oil pumps etc VHF sets

    Note: Separate logs for main and emergency batteries should be maintained. If submersibles are not involved in diving operations for extended periods, then discharge and recharge cycles should be undertaken to keep batteries in good condition.

2. Thruster/Propulsion Motors – weekly

- Signs of damage to body, propellers, propeller guards, nozzles etc, and for security of attachment.
- Signs of damage to compensation units, especially perishing of rubber components.
- Check for water ingress and top up with oil as necessary.
- Damage to electrical or mechanical connections an electrical penetrator cable.

3. Eject Systems - two weekly

a. Hydraulic:

- Top up with correct grade oil.
- Mechanically isolate eject units and remove electrical cables from guillotine. Operate system to check for full range of eject movement.
- If eject system includes severing of electric cable a piece of cable similar to that normally used should be inserted in guillotine to ensure a clean cut.
- Before reassembly of system, check all electrical cables, especially those near cutting blades, for damage to outer sheath. If necessary, this area of cable should be protected by thin brass shimming materials, insulation tape etc.
- Dress any damage to the cutting edge of the blade.
- Check for corrosion, clean and re-grease.
- After re-assembly, ensure that all locking devices are fitted.

b. Mechanical:

- Back-off ejects two or three turns to check ease of movement.
- Check for corrosion, clean and re-grease.
- Re-tighten, ensuring that no cables are trapped.
- Check all ejectable items to ensure that they are not fouled by cables, tywraps etc.
  Note: This item should be carried out on all vehicles before every dive.
- On completion of eject checks, ensure eject handles or other tools are correctly stored inside the vehicle.
- Ensure that all necessary locking devices are fitted.

c. Explosive:

- Ensure that the explosive medium is in date and free from damage or deterioration.
- Check the electrical system for continuity of circuit.
- Ensure that all components are securely attached and locking devices are in place.
- Check for signs of corrosion, clean and re-grease.

4. Main Lights – weekly

- Remove and clean glasses.
- Dry out any condensation or water.
- Invert filaments if necessary.
  Note: Do not handle filaments with bare hands. Use clean, dry cloth or paper.
- Ensure filament holders are undamaged and free from corrosion.
- Clean O-ring grooves. Clean and grease O-rings and replace in position.
- Replace glasses securely.
- Check position and attachment of lights.

5. Manipulators – weekly

- Check all functions for signs of damage, corrosion etc. Remove any damaged or corroded pins and clean, grease or replace as necessary.
- Check around claw area particularly for signs of damage or wear.
- Check that all hoses, cables etc show no signs of damage or kinking, are securely attached and clear of moving joints.
- Check that all fittings are tight and that all locking, retaining or limiting devices are fitted.
- Check and refill hydraulic reservoirs.
- Check electric motor housings for water ingress, and top up or replace as necessary any fluid used to immerse the motor.
- Check operation of eject functions in accordance with paragraph B.3 of this section.
- Adjust all drive belts or chains to recommended limits.
- Check complete manipulator for security of attachment.
- Check that all compensation systems are filled to correct pressure/ level.
- In extremely cold conditions, sea water hydraulic systems should be drained and filled with antifreeze when not in use.

6. Air Systems – weekly

- The complete system should be checked for security of attachment and unrestricted hose or hard pipe runs. Particular attention should be given to flexible hoses, especially when fitted with 'push- on' connectors. Check for kinks in hoses which could offer resistance to air flow.
- Do NOT secure ends of ejectable hoses.
- Check that air bottles are undamaged and securely attached. Remove any corrosion and repair any damaged paintwork immediately.
- Check complete system for leaks.
- Check that electrical and mechanical vent and blow valves operate freely and that valves do not by-pass in the fully closed position.

- If external pressure reducing valves are fitted with a rubber boot anti-freeze reservoir, top up the antifreeze.
- In cold weather, ensure that the air system is fully bled down with air buoyancy tanks fully blown. If it is not possible to remove all water, anti-freeze should be added.
  Note: Use anti-freeze which is compatible with metal components. Aluminium is readily attacked by some types of anti-freeze.

7. $O_2$ Systems – weekly
   - The complete system should be checked for security of attachment and unrestricted hose or hard pipe runs.
   - Check that bottles are securely attached and undamaged. Remove any corrosion and repair any damaged paintwork immediately.
   - Check complete system for leaks.
   - Check that all hull stops and control valves operate freely and that valves do not by-pass in fully closed position.
   - If any part of the system is dismantled for maintenance during the above checks, $O_2$ cleanliness standards must be maintained during re-assembly of the system. Particular care should be taken to ensure that no oil or grease is introduced into $O_2$ systems. Care should also be taken in the use of PTFE tape in $O_2$ systems.

8. Electrical Connectors - 3 monthly

   Follow manufacturer's recommendations and in addition:
   - Disconnect.
   - Clean.
   - Using cleaning brush, clean female electrical connectors.
   - Check for damage, signs of arcing and wear. Carry out insulation checks/continuity checks on suspect connectors and cables.
   - Change any suspect connectors.
   - Grease with recommended lubricant.
   - Reconnect.
     Note: Connectors should be checked before every dive for signs of damage, burning etc. All cables are checked for signs of cuts, cracking, burning etc, and that they are laid out clear of possible obstructions. All ejectable electrical connectors are checked clear to eject.

9. Buoyancy Blocks - weekly/3 monthly
   - Check for signs of damage, cracking etc.
   - Remove any damaged area and repair and re-seal immediately with recommended repair material. Temporary repairs may be effected with Araldite or plastic filler material, sealed with a gel coat on completion.
   - Check for security of attachment.
   - (3 monthly) Remove and weigh blocks to check against water ingress. Record the results in the defect an maintenance log or other dedicated log.

10. Life Support Equipment – weekly

- Remove all emergency life support equipment an pilot's tool kit and check that it is in a satisfactory condition and in date.

11. Electrical Insulation Checks - 3 monthly (as applicable)

- Carry out insulation checks on the umbilical an other electrical circuits and record the results in the defect and maintenance log or other dedicate log.
- Insulation checks should also be carried out on an standby winch.

12. General Damage and Security Checks – weekly

- Lighting transformers.
- DDG and DES transducers.
- Through-water communications and pinger receive transducer.
- Ballast/trim weights.
- Crash bars/badge bars.
- Access covers.

13. Cleanliness - weekly

a. External:

- Wash complete vehicle with fresh water if available. Salt water may be used if necessary, but surplus water should be dried off. Protect metal parts as necessary with oil, grease, metal sprays etc as recommended.
- Any chipped or damaged anodizing should be cleaned, dressed and protected with the recommended agent. Temporary repairs may be effected with Araldite or paint.
- Clean acrylic windows with warm soapy water or a recommended polish. Remove protective covers as necessary. Check all acrylic windows for signs of deep scratches, chipping, cracking or crazing. Any such defects should be fully evaluated against manufacturer's recommendations, and repaired as necessary.

b. Internal:

- Remove, as far as possible, internal benches, control panels etc.
- Clean out all moisture and dirt, especially around batteries, printed circuit boards etc.
- Renew any silica gel or other moisture absorbing material.
- Clean and spray electrical components with a protective coat.
- Clean internal acrylic faces.

14. Instrumentation - 6 monthly

- Check and re-calibrate gauges and control instrumentation.

15. Gas Cylinders - annually/bi-annually

- Check test certificates and arrange pressure testing of HP air, $O_2$ and gas cylinders as necessary.
- Check $O_2$ cylinders in emergency rebreather and arrange re-test as necessary.

16. Re-Certification

- Arrange for regular re-certification through the appropriate Classification Society or Authority and Government Department, as necessary.

## C. ROUTINE MAINTENANCE - SUPPORT EQUIPMENT

1. Crane/'A' Frame

a. Weekly:

- Clean thoroughly to remove all drilling mud etc.
- Inspect all hydraulic lines for damage, cuts and chaffing. Check all end fittings and quick connects for cleanliness, corrosion and damage, and change, clean and spray with protective medium as necessary. Apply antifreeze grease to protect against corrosion.

Check hydraulic oil levels and top up as necessary.

b. Two monthly:

- Inspect oil filters and clean or replace as necessary.
- Clean and grease all lubrication points and moving joints.
- Operate all functions. Check for oil leaks.
- Check any anti-slew arrangements for security of attachment and damage.
- Check holding down bolts for damage or corrosion. Check for tightness. Grease threads with anti-seize compound.
- General damage check. Remove corrosion and paint as necessary.

c. Six monthly:

- Remove about 10% of the holding down bolts an examine thoroughly for signs of damage, stretching or corrosion. If any bolts appear suspect, a further 10% should be removed. Should this further inspection show similar defects, <u>all</u> holding down bolts should be replaced.
- Upon replacing holding down bolts, ensure that they are torque loaded to the recommended figure.

- Check all welds as far as possible for cracking. An suspect areas should be inspected by magnetic particle or dye-penetrant methods.

2. Docking Mechanism - weekly

- Check for damage. Remove corrosion, clean and pain as necessary.
- Grease all points. Check that all moving parts move freely.
- Exposed areas of cylinders, springs and the space between sheave and cheek plates should be cleaned an lightly sprayed with oil.
- Check hydraulic hoses and connectors.
- Check that hand pump is full of oil.
- Inspect docking dogs and springs and ensure freedom of movement. If corrosion is present, remove dogs clean and check. Check dog springs for corrosion an change as necessary. Any scuffing marks or burrs i dogs should be filed smooth. With dogs reassembled spray dogs internally and externally with a suitable anti-corrosion substance.
- Check that mating neck on umbilical bullet is smooth and free from burrs or scuffing marks. Dress as necessary.

3. Winches and Control Station - weekly

- Inspect all hydraulic lines for damage, cuts, abrasions etc. Clean quick connects or end fittings and spray with oil or apply anti-seize grease to protect against corrosion.
  - i. Grease all lubrication points
  - ii. Clean and grease spooling gear
  - iii. Clean and grease drive chains
  - iv. Check gear box and hand pump oil levers and top up as necessary.
- Clean off all corrosion and paint as necessary.
- Check holding down bolts in accordance with paragraph C.1(c) above.
- Grease control station operating handles.
- Check control station gauges for damage.
- Full function check:
  - i. Spool out/in slow speed
  - ii. Spool in fast speed
  - iii. Check all hydraulic connections for leaks
  - iv. Check operating pressure by lifting submersible off deck
  - v. Ensure winch brake holds, with power off, without 'creeping'.
- Check umbilicals as far as possible for signs of damage and kinking. Check for correct spooling.
- Grease shot weight winch controls.
- Check shot weight winch gauge pressure.
- Lubricate winch umbilicals, particularly standby winch and shot line cable, with oil.

4. Emergency Air Motor - weekly

- Ensure holding down bolts clean and free from corrosion. Clean and grease as necessary.
- Check external paint work for corrosion and damage, and clean and paint as necessary.
- Ensure that lubricator is full of oil.
- Top up motor pump to correct level.
- Open drip lubricator and run air motor. Lift submersible clear of deck and check brake action. Close drip lubricator on completion of this action.
- Ensure bolts for coupling motor to winch stub shaft are:
  - i. Clean and greased with anti-seize.
  - ii. Stowed correctly.
- Ensure winch and stub shaft end floats freely to meet air motor drive flange.
- Run motor.

5. Air Compressor - weekly

- Check oil level.
- Clean and repair damaged paintwork.
- Run for five minutes.
- Change air purification medium every thirty running hours. A log book should be maintained for this action, and results also recorded in the Defect and Maintenance Log.

6. $O_2$ Booster Pump - weekly

- Clean and repair damaged paintwork.
- Thoroughly check for cleanliness to approved standard.
- Run for five minutes.
- Record details in the Defect and Maintenance log.

7. Umbilical - weekly

- Check umbilical for earth continuity including continuity through any sliprings provided.
- Check any protective devices provided.

8. Re-Certification

- Arrange for regular re-certification through the appropriate Classification Society or Authority and Government Departments, as necessary.

# Appendix 2
# Examples

It must be stressed that this appendix is provided as a specimen ONLY and indicates the type of information which is required on the various forms. Individual layout and content of these forms will vary from Company to Company.

## Submersible Dive Sheet

**SUBMERSIBLE DIVE SHEET**

DIVE NO:

DATE:

| | |
|---|---|
| JOB LOCATION | CLIENT |
| SUBMERSIBLE CREW AND POSITIONS | DIVE DEPTH |
| OPERATIONS SUPERVISOR | |
| PILOT | |
| WINCH OPERATOR | |
| COMMUNICATIONS OPERATOR | |
| CRANE/'A' FRAME OPERATOR | |
| | |
| | |
| | |

| | | |
|---|---|---|
| HATCH SHUT | | EQUIPMENT USED |
| SUBMERSIBLE IN WATER | | |
| AT WORKSITE | | |
| DEPART WORKSITE | | |
| SUBMERSIBLE ON DECK | | |
| HATCH OPEN | | |
| | | EQUIPMENT DAMAGED |
| | | EQUIPMENT LOST |

| | |
|---|---|
| TASKS TO PERFORM | |
| | |
| | |
| TASKS COMPLETED | |
| | |
| | |
| SIGNATURE (CLIENTS REP) | SIGNATURE (OPERATIONS SUPERVISOR) |
| | |

# Maintenance or Defect Report

## MAINTENANCE OR DEFECT REPORT    SUBMERSIBLE NO:

| DATE | DEFECT/MAINTENANCE | REMEDIAL ACTION TAKEN | STORES/EQUIPMENT USED | TIME TAKEN | MAINTAINERS SIGNATURE | CONTROLLERS SIGNATURE |
|---|---|---|---|---|---|---|
| | | | | | | |

NOTE: Rule off page after each defect cleared.

DATE RETURNED TO OFFICE:

## Weekly Consumables List

Submarine: ....................................................................................................

Operating Location: .........................................................................................

| Date | Item | Number Used | Supplier (for office use) |
|---|---|---|---|
| | | | |

Representative:

# Communications Log

## COMMUNICATIONS LOG

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | DATE | | DIVE NO. | |
| PILOT | | CONTROLLER | | WINCH OP. | | COMMS. OP. | |
| SUB NO. | | | | | | | |
| CHARTERER | | LOCATION | | WIND SPEED | | SEA STATE | |
| DIVE OBJECTIVE | | EXPECTED CURRENT-RATE & HD'G | | EXPECTED DEPTH | | | |
| EXPECTED BOTTOM CONDITIONS | | ALL PRE-DIVE CHECK LISTS COMPLETE | | | | | |

| TIME | COMMUNICATION | TIME | COMMUNICATION | TIME | COMMUNICATION |
|---|---|---|---|---|---|
| | DOME SECURE | | | | |
| | O2 ON | | | | |
| | SCRUBBER ON | | | | |
| | GYRO FINAL CHECK | | | | |
| | LAUNCHING | | | | |
| | IN WATER | | | | |
| | WATER TIGHT INTEGRITY | | | | |
| | LEFT SURFACE | | | | |
| | ACOUSTIC COMMS. CHECK | | | | |
| | ON BOTTOM | | | | |
| | BOTTOM REPORT | | | | |
| | | | | | |
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| | | | | | |

| | | |
|---|---|---|
| SIGNED | COMMS. OP | |
| | CONTROLLER | |

# Engineer's Daily Checklist

11

ENGINEERS NAME

ENGINEERS DAILY CHECK LIST SUB. NO. DATE LOCATION CHARTERER

| | | | |
|---|---|---|---|
| EXTERNAL CHECKS | SPIDER PINS | EJECT MECHANISM (UMBILICAL) | HI-LOW ALARMS TEST & CANCELS |
| STBD: | SPIDER | BULLET | O2 GAUGES |
| MANIPULATOR | REAR DOME O RINGS | SECONDARY LIFT | EXTERNAL LIGHTS |
| MANIPULATOR JAWS | DOME HANDLE | STROBE | INTERNAL LIGHTS |
| MANIP HOSES & FILTER | D.E.S. TRANDUCERS | TRANSPONDER | ALL THRUSTER FUNCTIONS |
| MANIPULATOR CIRCLIPS | BATTERY VENTS | GENERAL: | ALL MANIPULATOR FUNCTIONS |
| MANIPULATOR ROTATE MOTOR | LOWER JETTISON CAM | ALL CABLES SECURE & STOWED | D.D.G. &CALIBRATE |
| CAMERA ASSEMBLIES | PORT | ALL THRUSTERS SECURE | D.E.S. |
| LOWER EJECT MECHANISM | MANIPULATOR | ALL THRUSTERS OIL FILLED | GYRO COMPASS |
| D.D.G. TRANSDUCER | MANIPULATOR JAWS | RELAY PODS OIL FILLED | VIDEO SYSTEMS |
| DOWN COMMS TRANSDUCER | MANIP HOSES & FILTER | INTERNAL CHECKS | %O2 GUAGE |
| EXTERNAL LIGHT & FILAMENT | MANIPULATOR CIRCLIPS | TOP PANEL PLUGS | CABIN PRESSURE GUAGE |
| FRONT SPIDER | MANIPULATOR ROTATE MOTOR | TOP PANEL SECURE | BLOW VALVES FUNCTION |
| PROTECTIVE DOME | EXTERNAL LIGHT & FILAMENT | CABLES UNDER AFT RING | VENT VALVES FUNCTION |
| DOME | FRONT SPIDER | RAILS SECURE | ALL EJECTS |
| DOME O RING | PROTECTIVE DOME | UDI EQUIPMENT | ACOUSTIC COMMS BATTERIES |
| FRONT HULL E.O.s | DOME | O2 SYSTEM | ACOUSTIC COMMS FUNCTION |
| FRONT HULL BREAKTHROUGHS | DOME O RING | SCRUBBER CANISTER BRACKET SECURE | SURFACE EQUIPMENT: |
| SIDE POD EJECT MECHANISM | FRONT HULL E.O.s | Fire Extinguishers | UMBILICAL |
| AIR CONTENTS GAUGE | FRONT HULL BREAKTHROUGHS | Emergency Batteries | WINCH |
| AIR & O2 PIPING | SIDE POD EJECT MECHANISM | BATTERY CHECKS: | LIFTING GEAR |
| AIR BOTTLE | AIR CONTENTS GAUGE | VOLTAGES PORT & STBD. | HYDRAULIC GENERATOR |
| LIGHTING TRANSFORMER | AIR & O2 PIPING | SCRUBBERS PORT & STBD. | POWER SUPPLY UNITS PLUS BREAKERS |
| CRASH GUARD | AIR BOTTLE | GYRO COMPASS | COMMS UNITS (HARDLINE) |
| REAR HULL E.O.s | LIGHTING TRANSFORMER | HI-LOW PRESSURE ALARM | COMMS UNITS (THRU' WATER) |
| REAR HULL BREAKTHROUGHS | CRASH GUARD | 30v EXTERNAL LIGHT | VIDEO EQUIPMENT |
| REAR HULL JETTISON CAM | REAR HULL E.O.s | INTERNAL LIGHT | SURFACE COMMUNICATIONS |
| RELAY POD | REAR HULL BREAKTHROUGHS | 1 THRUSTER FUNCTION | |
| | RELAY POD | 1 MANIP FUNCTION PORT & STBD. | |
| | | COMMS SATISFACTORY | ENGINEERS |
| | | MAIN POWER: | SIGNATURE: |
| AFT: | | VOLTAGES PORT & STBD | CONTROLLER |
| DOME LATCHES | UPPER | SCRUBBERS PORT & STBD | SIGNATURE |
| DOME CAMS | BOUYANCY PACK | | |
| | UPPER TRANSDUCER | | |

# Pilot's Pre- & Post-Dive Checklist

| PILOTS PRE & POST DIVE CHECK LIST | | | | | | DATE | | DIVE NO. | |
|---|---|---|---|---|---|---|---|---|---|
| PILOT | | CHARTERER | | LOCATION | | EXPECTED DEPTH | | SUB. NO. | |

| PRE-DIVE CHECKS | | | | | | POST DIVE CHECKS | |
|---|---|---|---|---|---|---|---|
| EXTERNAL<br>ALL DEFECTS FROM LAST DIVE CLEAR | | BATTERY | | MAINS & SYSTEMS CHECKS (CONTD) | | INTERNAL | |
| FORWARD DOME CLEAR | | PORT BATTERY VOLTS | | PORT & STB'D SCRUBBER | | PORT BATTERY VOLTS | |
| AFT DOME "O" RINGS | | STB'D BATTERY VOLTS | | HIGH LOW ALARMS | | STB'D BATTERY VOLTS | |
| AFT DOME LATCHES | | PT. & ST. SCRUBBER MOTORS | | INTERNAL LIGHTS | | COMMS. BATTERY NO. 1 VOLTS | |
| PT. & ST. EJECT CLEAR | | HARDLINE COMMS. | | EXTERNAL LIGHTS | | COMMS. BATTERY NO. 2 VOLTS | |
| LOWER EJECT CLEAR | | HIGH LOW ALARMS | | PORT & STB'D MANIPS. | | PORT O2 PRESSURE | |
| PORT & STB'D O2 OPEN | | INTERNAL LIGHTS | | ALL THRUSTER FUNCTIONS | | STB'D O2 PRESSURE | |
| PORT & STB'D AIR OPEN | | EXT. 24V LIGHT | | DIGITAL DEPTH GAUGE | | PORT AIR PRESSURE | |
| BALLAST REQD. FITTED | | MANIPS-ONE FUNCTION | | DIGITAL ECHO SOUNDER | | STB'D AIR PRESSURE | |
| BATTERY VENTS SECURE | | ACOUSTIC COMMS. | | GYRO SET HEADING | | O2 SYSTEM OFF | |
| ALL CABLES & HOSES SECURE | | BATTERY NO. 1 VOLTS | | VIDEO MONITOR | | VENT VALVES SHUT | |
| BULLET SECURE | | BATTERY NO. 2 VOLTS | | CAMERAS | | BLOW VALVES SHUT | |
| BULLET EJECT SECURE | | UP & DOWN TRANSDUCERS | | O2% GAUGE | | SCRUBBERS OFF | |
| THRUSTER COMP'S CHECKED | | PINGER RECEIVER | | CABIN PRESSURE GAUGE | | GYRO HEADING | |
| POD COMP'S CHECKED | | EMERGENCY EJECTS | | PT. & STB'D BLOW VALVES | | ALL SYSTEMS OFF | |
| THRUSTERS SECURE | | PORT EJECT | | PT. & STB'D VENT VALVES | | MAIN BREAKERS OFF | |
| LIGHTS SECURE | | STB'D EJECT | | PT. & STB'D O2 BLEED SET | | SUB. CLEANED OUT | |
| MANIPULATORS SECURE | | LOWER EJECT | | SODA SORB-FILLED-FITTED | | EXTERNAL | |
| CAMERAS SECURE | | BULLET EJECT | | ORAL NASAL | | O2 BOTTLES OFF | |
| LIGHT TRANS'S SECURE | | MAINS & SYSTEMS CHECKS | | DRAEGER KIT | | CHECK CABLES-HOSES | |
| | | ALL MAINS BREAKERS ON | | SPACE BLANKET | | CHECK ALL FITTINGS | |
| | | PORT VOLTS | | EMERGENCY RATIONS | | POD COMPENSATION | |
| | | STB'D VOLTS | | TOOL KIT | | THRUSTER COMPENSATION | |
| | | PORT AIR PRESSURE | | SANITARY BOTTLE | | LIGHT FILAMENTS | |
| | | STB'D AIR PRESSURE | | POLY. BAGS | | EXTERNAL DAMAGE | |
| | | PORT O2 PRESSURE | | FOOD & DRINK | | DEFECTS TO MAINT. LOG | |
| | | STB'D O2 PRESSURE | | TORCH | | | |
| | | SIGNED | | PILOT | | PILOT | |
| | | | | CONTROLLER | | CONTROLLER | |

| EQUIPMENT FITTED OR REMOVED | | | |
|---|---|---|---|
| ITEM | WEIGHT | FIT | REM. |
| | | | |

| Stability Check | Reserve of Buoyancy |
|---|---|
| | |

**Association of Offshore Diving Contractors**

This is to certify that ......................................................................................(name) has successfully completed a course of training as specified in the AODC 'Code of Practice for the Operation of Manned Submersible Craft' and has passed all relevant examinations and tests.

This certificate applies to the following type(s) of craft only:

.................................................................................................................... (type)

.................................................... Signed
Examining Supervisor

Name..........................................
Title ............................................ Print
Company ....................................

Company stamp:

.................................................... Signed
Operations Manager

Name..........................................
Title ............................................ Print
Company ....................................

Company stamp:

**Details of Training:**

# Appendix 3

## Standard Words And Abbreviations Used During Communications with The Submersible

| Word | Meaning |
|---|---|
| Affirmative | You are correct - Yes |
| All after - word | Refers to that part of the message after word |
| All before - word | Refers to that part of the message before word |
| Bounce - bounce - bounce | Pilot to surface. Indicates inadvertent lift off bottom, possible chance of breaking surface - keep clear. |
| Confirm | Verify, repeat last message and transmit correct version. |
| Figures | Numerals or numbers follow. |
| Go ahead | Transmit reply. |
| I spell | I shall spell next word phonetically. |
| Out | End of message - I do not expect reply. |
| Over | End of message - I require a reply. |
| Read back | Repeat message exactly as received. |
| Roger | Message received and understood. |
| Say again | Repeat all of last message. |
| Negative | Your last message incorrect, normally followed by correct version. |
| Wait (wait one) | Maintain listening watch. I will call you when ready. |
| X-Ray, X-Ray, X-Ray | Emergency given if possible - X-Ray procedure instigated - keep clear and watch for me (if applicable). Initiated by submersible only. |
| Wilco | I understand your message and will comply (Roger and Wilco are never to be used together). |

# Call Signs

The following abbreviations are normally used. Variation may occur due to a difference in terminology in different operating companies.

| | | |
|---|---|---|
| Deck | | VHF callsign for Operations Controller. |
| Control | | VHF and UWT callsign for Communications Controller in operation control room. |
| Bridge | | VHF callsign for officer on watch on bridge/rig. |
| Safety Boat | (Name) | VHF callsign for safety boat. |
| | (Number) | VHF and UWT callsign for submersible. |
| Ship's Name | | VHF callsign for ships or officer of the watch (normally from outside source, i.e. safety boat) |
| Winch Operator | | VHF or hardline callsign for winch/handling gear operator |

## Emergency Tapping Code Communications

(For use between the occupants of a lost craft and rescue divers)

| Code | Situation |
| --- | --- |
| 3.3.3 | Communication opening procedure (inside and outside) |
| 1 | Yes OR Affirmative OR Agreed |
| 3 | No OR Negative OR Disagreed |
| 2.2 | Repeat Please |
| 2 | Stop |
| 5 | Have you got a seal? |
| 6 | Standby to be pulled up |
| 1.2.1.2 | Get ready for through-water transfer (open your hatch) |
| 2.3.2.3 | You will NOT release your ballasts |
| 4.4 | Do release your ballast in 30 minutes from now |
| 1.2.3 | Do increase your pressure |
| 3.3.3 | Communications closing procedure (inside and outside) |

# Appendix 4

## Back-up recommendations for One-Atmosphere Diving systems

This Appendix specifically assesses the requirements and suitability of backup systems to assist in the rescue of one-atmosphere diving systems.

A study of underwater accidents has led to the conclusion that the majority result from several contributing factors which coincide to produce a situation which cannot be overcome by the individuals involved at the time. For this reason, all contingency plans should take account of "worst case conditions". The plan should also assume that more than one of these "worst case conditions" may occur simultaneously and the effects should be considered additive.

The attached forms (A and B) are for guidance only and should be used with the notes for assessment of the back-up requirements.

Each company's own contingency plans however will be based on the specific factors affecting the submersible type in use, the geographical location, and the likely hazards involved which will ultimately determine what means of back-up is required.

## One-Atmosphere Diving System Back-Up Mobilisation Assessment

(Form A)

This form will help in assessing the suitability of different back-up systems and the possible time which may be required for their complete mobilisation.

| | |
|---|---|
| A1 | Describe the system which is proposed for back-up. This should include a brief description of the vehicle, its handling system, electrical and other requirements and operating personnel required. |
| A2 | Show specific location of the back-up system. |
| A3 | Show whether or not the equipment is dedicated for back- up purposes or may be used on other projects, when its availability might be delayed or prevented. |
| A4 | List relevant information for emergency contact of a primary individual who would initiate mobilisation of the back-up system. Also provide information for at least 2(two) alternatives in the event that the primary individual is not available. Be sure to list any answering services or paging services which might be available. |
| A5 | Show the maximum depth capability of the back-up system. |
| A6 | Show the maximum operating duration of the back-up system at the maximum depth. |
| A7 | Note all weather conditions or other factors which might prevent or delay onshore mobilisation of the back-up equipment. Onshore mobilisation includes the preparation of the equipment at its home base and transport to the point of embarkation (airport, dock, etc.). |
| A8 | Show the time required to prepare the back-up system for mobilisation from its base location. |
| A9 | Show the time required to transport the back-up system onshore and to load it for transportation offshore. Specify the methods, suppliers, key operating personnel, etc, which would be used. |
| A10 | Note all weather conditions, daylight and other factors which might prevent or delay transport of the system from shore to the offshore work site. This should include any factors which would prevent safe navigation, landing of equipment, etc. |
| A11 | Show the maximum time required to transport the rescue system from the shore base to the offshore work site. In the case of transport methods which can only be operated during daylight hours, this time should include the total travel time required, plus the maximum number of hours of darkness which might occur during the time of year when operations are being conducted. Specify methods which would be used, including the names of suppliers, key operating personnel, etc. |

A12 Note all weather conditions or other factors which might prevent or delay the unloading of the equipment at the work site and subsequent set up of the equipment for launch. This should include any delays which might occur due to weather or lack of availability of suitable lifting facilities at the work site.

A13 Show the time required to set up the system on the work site and conduct adequate pre-dive checks to ensure the safety of the rescue personnel. Include details of hook-up facilities required, methods for handling the rescue system on site (to place it in a suitable launch position), utilities which may be required to operate the rescue system, provisions for obtaining these utilities, etc. It should be ensured that the available power supplies are compatible with those required by the back-up system.

A14 Specify any weather conditions which might prevent the safe launch and operation of the rescue vehicle. These would include sea state, currents, wind, etc.

A15 Show the time required to reach the maximum depth of the operation after pre-dive checks have been conducted.

A16 Show the total time which might be required to mobilise the back-up equipment, including allowances for darkness, and maximum times to accomplish each step of the mobilisation process. (A8 + A9 + All + A13 + A15)

A17 Show whether there is a suitable area at the work site for the launch and recovery of the back-up system.

**One-Atmosphere System Back-Up Mobilisation Assessment**
(Form A)

A1 METHOD: ...........................................................................

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A2 LOCATION: ...........................................................................

A3 DEDICATED? Yes ............ No ............

A4 CONTACT FOR MOBILISATION:

| | Primary | Alternate #1 | Alternate #2 |
|---|---|---|---|
| Name | ........................... | .......................... | ............................ |
| Address | ........................... | .......................... | ............................ |
| City | ........................... | .......................... | ............................ |
| Telephone | ........................... | .......................... | ............................ |
| Alt. Telephone | ........................... | .......................... | ............................ |

A5 DEPTH CAPABILITY: ...........................................................................

A6 DURATION: ...........................................................................

A7 WEATHER and other factors which may prevent or delay onshore mobilisation.

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A8 ONSHORE PREPARATION TIME
for mobilisation at base: .......... Hrs

A9 ONSHORE TRANSPORT AND LOADING TIME: .......... Hrs

Method: ..........................................................................................

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A10 WEATHER AND DAYLIGHT FACTORS which may prevent or delay transport offshore:

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A11 OFFSHORE TRANSPORT - en route time: .......... Hrs

Method: ..........................................................................................

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A12 WEATHER AND OTHER FACTORS which may prevent unloading and set up on site:

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A13 SET UP ON JOB SITE
Hook-Up facilities and pre-dive checks: .......... Hrs

Details of handling on site, utilities required, etc

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A14 WEATHER FACTORS which prevent safe launch and dive of rescue vehicle:

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A15 TIME TO REACH MAXIMUM OPERATING DEPTH

after pre-dive checks: ........... Hrs

A16 TOTAL TIME (A8 + A9 + A11 + A13 + A15) ........... Hrs

## One-Atmosphere Diving System Life Support Assessment

(Form B)

This form will help to provide an assessment of the maximum expected survival capability of the system and therefore indicates when a rescue capability must be requested.

| | |
|---|---|
| B1 | Show the maximum time which an operator will be allowed to work (deck to deck). |
| B2 | Show the total amount of oxygen available at the beginning of the dive. |
| B3 | Show the maximum amount of oxygen likely to be consumed during the maximum work period (B1). |
| B4 | Show the oxygen reserve (B2-B3). |
| B5 | Show the expected duration of the oxygen reserve with the operator remaining at rest (B4 divided by 2). This calculation is based on a minimum consumption of 0.33 litres per minute. |
| B6 | Show the total carbon dioxide absorbent supply available at the beginning of the dive. |
| B7 | Show the approximate amount of carbon dioxide absorbent used during the maximum working period. |
| B8 | Show the $C0_2$ absorbent which constitutes a reserve (B6 minus B7). |
| B9 | Show the expected duration of the reserve carbon dioxide absorbent based upon the type used. |
| B10 | Show the expected survival time of the operator based on the supply of food and water carried at the beginning of the dive. |
| B11 | Show the expected survival time based on heat loss, taking into consideration insulating garments, ambient water temperature, etc. |
| B12 | Show the minimum expected water temperature at the work site. |
| B13 | Show the expected survival time with the umbilical intact and all systems operational. |
| B14 | Show the expected survival time assuming that the umbilical has been severed or has been otherwise rendered inoperable. In this case the life support is dependent on power supplies and other capabilities which are a part of the one-atmosphere diving system and are not dependent on surface support. |
| B15 | Show the maximum allowable time before a rescue must be performed at the work site. This is based on the assumption that the back-up system should be able to make a dive before $^1/_3$ of the |

estimated remaining survival time has elapsed up to a maximum of 24 hours. This is necessary in order to provide sufficient time to evaluate the situation, devise appropriate rigging, or take other corrective actions as necessary to recover the primary system.

B16 Show the total time which may elapse from the first indication of entanglement or entrapment until a call is made for immediate mobilisation of the back-up system. This is calculated by subtracting the total mobilisation time indicated on Form A (A16) from rescue commencement span indicated on Form B (B15). If this results in a negative number, the proposed back-up system is unsuitable and an alternative system must be arranged before operations can begin.

## One-Atmosphere Diving System Life Support Assessment

(Form B)

| | | | |
|---|---|---|---|
| B1 | Maximum allowable work period: | .......... | Hrs |
| B2 | Oxygen supply (Total): | .......... | Litres |
| B3 | Oxygen allowance for maximum work period: | .......... | Hrs |
| B4 | Oxygen reserve: | .......... | Litres |
| B5 | Expected duration of oxygen reserve (survival time): | .......... | Hrs |
| B6 | $C0_2$ absorbent supply (Total): | .......... | Kilograms |
| B7 | $CO_2$ absorbent using during maximum work period: | .......... | Kilograms |
| B8 | $C0_2$ absorbent reserve: | .......... | Kilograms |
| B9 | Expected duration of $C0_2$ absorbent reserve (survival time): | .......... | Hrs |
| B10 | Expected survival time based upon food and water: | .......... | Hrs |
| B11 | Expected survival time based upon heat loss: | .......... | Hrs |
| B12 | Minimum expected water temperature | .......... | °C |
| B13 | Total expected survival time with umbilical intact and all systems operational | .......... | Hrs |
| B14 | Total expected survival time without umbilical: | .......... | Hrs |
| B15 | Rescue commencement span (B14 divided by three): | .......... | Hrs |
| B16 | Deadline to call for rescue back-up (B15 minus A16): | .......... | Hrs |

## One-Atmosphere Back-Up Requirements - Additional Notes

If a conventional diving system is to be used as a back-up in place of another submersible, then all life support systems which will be necessary to conduct a minimum of 8(eight) hours work at the maximum depth at which the one-atmosphere diving system will be used, must be available at all times.

All back-up systems must have the manipulative capability to:

- Cut lines and wire rope
- Attach lifting hooks and shackles
- Move an umbilical in order to clear fouled sections.

Back-up systems must be capable of working in any sea conditions (waves and current) in which the primary system is capable of operating.

Back-up systems must have appropriate equipment to locate a lost primary system without having to follow the umbilical.

All operations must be limited to the lesser of the performance capabilities of the primary system or the back-up system. Operations must not be conducted when environmental conditions exceed the capability of the back-up system, or are predicted to exceed the capability of the primary system. These factors include any conditions which could prevent or delay mobilisation, launch, or operation of the back-up system (such as wind, wave heights, currents, fog, etc).

When back-up is to be provided by a system which is not totally dedicated to rescue operations, confirmation of its availability must be obtained prior to starting any dive and must be reconfirmed daily while operations continue.