Remotely Operated Vehicle Intervention During Diving Operations

International Marine Contractors Association

www.imca-int.com

IMCA D 054, IMCA R 020 Rev. 0.1
January 2020

The International Marine Contractors Association (IMCA) is the international trade association representing offshore, marine and underwater engineering companies.

IMCA promotes improvements in quality, health, safety, environmental and technical standards through the publication of information notes, codes of practice and other documentation.

Members are self-regulating through the adoption of IMCA guidelines as appropriate. They commit to act as responsible members by following relevant guidelines and being willing to be audited against compliance with them.

There are five core committees that relate to all members:

- Competence & Training
- Contracts & Insurance
- Health, Safety, Security & Environment
- Lifting & Rigging
- Marine Policy & Regulatory Affairs

The Association is organised through four distinct divisions, each covering a specific area of members' interests – Diving, Marine, Offshore Survey and Remote Systems & ROV.

There are also five regions which facilitate work on issues affecting members in their local geographic area – Asia-Pacific, Europe & Africa, Middle East & India, North America and South America.

IMCA D 054, IMCA R 020 Rev. 0.1

www.imca-int.com/diving
www.imca-int.com/rov

If you have any comments on this document, please click the feedback button below:

feedback@imca-int.com

Date	Reason	Revision
February 2020	Initial publication	
January 2020	Minor amendments to the terminology used	Rev. 0.1

The information contained herein is given for guidance only and endeavours to reflect best industry practice. For the avoidance of doubt no legal liability shall attach to any guidance and/or recommendation and/or statement herein contained.

© 2020 IMCA – International Marine Contractors Association

Remotely Operated Vehicle Intervention During Diving Operations

IMCA D 054, IMCA R 020 Rev. 0.1 – January 2020

1 Foreword

This guidance document has been produced by IMCA (the International Marine Contractors Association) to provide guidelines for the safe and efficient offshore operation of remotely operated vehicles (ROVs), in combined operations with divers in the same underwater space. This document now replaces the earlier guidance in AODC 032 which was first published in 1992 and revised in 1996.

Designed for use by both contractors and clients, the guidance purposely avoids subjects of minority interest. It contains guidelines and recommendations for the maintenance of a high level of safety and efficiency across the ROV sector. However, it does not attempt to replace the need for contractors to maintain their own, ROV specific, comprehensive operations manuals and procedures.

The advice given in the guidance is intended to apply anywhere in the world, but it is recognised that some countries will have regulations that require different standards or practices to be followed. Where local or national regulations are more stringent than those contained herein, they will always take precedence over any provision in this document.

In line with IMCA's strategy goal of '*providing tools, documentation and frameworks to promote, encourage and facilitate consistency across the sector*', it is intended that adoption of this guidance, and adherence to it, will help to enable common industry standards to be widely accepted.

This is a 'dynamic document' and the advice given in it will change with the development of the industry. It is intended to review it on a regular basis and any necessary improvements made. Any suggested improvements should be forwarded to IMCA (e-mail imca@imca-int.com).

2 Glossary

ALARP	As low as reasonably practicable
AODC	Association of Offshore Diving Contractors
DP	Dynamic positioning
HiPAP	High precision acoustic positioning
HP	High pressure
LIM	Line insulation monitor
MOC	Management of change
OIM	Offshore installation manager
PPE	Personal protective equipment
ROV	Remotely operated vehicle
RA	Risk assessment
TBT	Toolbox talk
TMS	Tether management system
UHF	Ultra high frequency
VHF	Very high frequency
WROV	Work class remotely operated vehicle

3 Scope

This guidance deals with the hazards which may arise from the combined use of divers and ROV in the same underwater space. The most obvious of these are entanglement, entrapment, obstruction of and collision with divers by the ROV and the prevention of these is the primary intent of the guidance.

Other hazards can also be present in such operations including electrocution, degradation of underwater visibility, injury from manipulators and equipment fitted to ROVs, high noise levels and disorientation. Information on the prevention of these hazards is included.

The guidance covers combined diving and ROV operations, where the ROVs range from small 'observation' role systems to large 'work class' ROVs (WROV) and towed and bottom crawlers. It is designed to provide general guidance for such operations in order that they might be conducted effectively and efficiently and with minimum operating safety risk. This risk includes that to the divers but also to surface support teams involved in the operation from both the diving and ROV element aspects. However, it is not intended to replace the requirement for a targeted risk assessment process for the particular circumstances of these projects and operations.

The guidance considers the risks arising from the various environments encountered. It makes recommendations for the procedures to be followed for combined diving and ROV operations but does not address the specific requirements of water space management for adjacent activity situations where ROV and diving operations are being conducted simultaneously but in different but adjacent areas underwater.

The guidance does not address general diving, ROV or electrical safety issues in particular, as these are covered in other documents.

4 Introduction

The combined use of ROV and divers for underwater tasks is relatively common practice. The option of divers working close to or being monitored by an ROV can improve effectiveness, efficiency and safety. Every scenario is different; there are potential problems which can arise when ROVs are used; such as the entanglement with divers' umbilicals, injury to a diver through collision or electrical shock or his obstruction by the ROV and/or its umbilicals, fittings and ancillary equipment, as well as other technical or environmental hazards.

The guidance in this document has been derived from the experience gained by IMCA members[1] familiar with the operation of ROVs and divers in a combined project or task. Where possible, in order to prevent or minimise these potential problems, it is recommended that the guidance provided be applied.

Further guidance for ROV and diving operations is available in other publications and should be read in conjunction with this document.

5 Issue

The development and technical advances in the capability of ROVs has expanded their utility in underwater operations. ROVs range in size from very small 'observation' role systems weighing a few kilogrammes, to very large class III and IV ROVs weighing many tonnes, designed for complex underwater engineering tasks. The opportunities afforded by the combined employment of divers either supporting or being supported by ROVs, to maximise efficiency and increase the effectiveness of the underwater operation being conducted, clearly makes practical and financial sense. Equally the potential contribution to the operating safety of divers is to the advantage and benefit of all concerned. However the use of ROVs in the same underwater location as a diver or divers needs to be robustly and effectively controlled to avoid the obvious hazards from causing harm to the diver.

The following list, though not exhaustive, comprises the key hazards posed to divers operating in very close proximity to ROVs:

a) Snagging/entanglement/entrapment of or with umbilicals;

b) Entrapment/crushing by large ROV;

[1] IMCA Remote Systems & ROV and Diving Divisional Management Committees

c) Collision or strike by a moving ROV causing injury/loss of consciousness/damage to diving equipment;

d) Injury caused by ROV manipulator/thruster operation or movement;

e) Electrocution from ROV insulation failure;

f) Disturbance of silt/sediment by the ROV causing reduced visibility;

g) Obstructed route to safety/bell access;

h) Damage to eyesight by ROV lighting outfit;

i) Obstruction/entanglement/entrapment of diving bell;

j) High noise levels underwater;

k) ROV colliding with or damaging underwater structures, cables and pipework creating a hazard to divers;

l) Potential risk of injury if the ROV is used as a means of diver transport (an unacceptable practice).

6 Risk Assessment

As with any other diving or ROV operation, the completion of an effective risk assessment process is fundamental to good safety and business practice. Whenever it is considered necessary to use an ROV in close proximity to divers, a risk assessment should be used to identify the associated hazards and corresponding mitigation required, with the aim of ensuring that any remaining risk is reduced to a level that is as low as reasonably practicable (ALARP). Ideally this should always be part of the project preparation phase and be included in the project plan with details of procedures to be adopted.

A risk assessment is a 'live' process and any change to the original circumstances and conditions should prompt a revision of the risk assessment in accordance with the operating company's management of change (MOC) process, to confirm that assumptions and risk levels remain ALARP. At the very least a 'dynamic' risk assessment (toolbox talk (TBT) or risk assessment (RA)) should be conducted to assess the implications of the changed circumstances and the potential increased risk to everyone involved in the project.

Notwithstanding the paragraph above, it is strongly recommended that 'ad hoc' adjustment of diving project plans are not initiated during combined diving and ROV operations, unless any change to the plan would be considered to be a standard operating procedure in accordance with the MOC. The mantra of 'plan the dive and dive the plan' is particularly appropriate to these operations.

7 ROV Team Requirements

Guidance on manning levels for ROVs is contained in IMCA R 004 – *Code of practice for the safe and efficient operation of remotely operated vehicles*. The overriding criterion is that manning levels should be such as to enable the safe operation of the ROV in a combination with divers in close proximity. Industry standard minimum team sizes are specified for the safe and efficient operation of each ROV type. For single class III or IV ROV deployment, 6 or 8 crew (dependent on ROV class) are required for 24-hour operations (3-4 per 12-hour shift). On dual WROV deployments, a minimum 13-man crew is required for 24-hour operations. An observation ROV crew is 4 (2 per shift) for 24-hour operations.

Trainees should not to be allowed to pilot WROVs near divers. Training using the smaller observation type ROVs working with divers is acceptable with appropriate mentoring and instruction.

The ROV team should be fully integrated into the operation and any relevant briefing, 'management of change' meeting and 'time out for safety' pauses should be attended by all ROV team members deemed necessary by the ROV supervisor or duty holder.

Consideration needs to be given to the ROV crew structure with respect to shift changes and meal times. When there are only two personnel in the ROV control, the least skilled person should not be piloting the ROV.

8 Physical Protection of Personnel

All ROV thrusters should be fitted with securely fixed guards to prevent the accidental entry of a diver's fingers, umbilical or equipment into the thruster blades.

Consideration for the protection of all personnel involved in ROV and dive operations including support teams should be covered in the project risk assessment. Issues such as provisions for working in exposed areas, availability and wearing of appropriate PPE are amongst the subjects that should be taken into account.

9 Familiarisation

As part of the project plan, diver/ROV familiarisation sessions should be held onboard prior to the divers entering the water or saturation and should involve the ROV and diving personnel and include a 'hands-on' review of the tasks and tooling to be used. This is preferably undertaken at the ROV with a walk-around and discussion of the work to be undertaken by the divers and the ROV crew.

All members of the diving and ROV teams should be made aware of the potential hazards and operational constraints of working with an ROV. The diving and ROV personnel should be familiar with each others' job functions.

Post-project, a follow-up meeting should be held to discuss the work and obtain feedback. Relevant points should be noted and included in 'end of trip' reports.

10 Vessel/Platform Interface

Where practicable the ROV deployment system should be sited an appropriate distance from a diving bell, basket or taut wire launch positions, in order to minimise the chances of umbilical entanglement.

If the ROV is fitted with a tracking device it should not be used as a primary reference for the surface vessel's dynamic positioning (DP) system whilst divers are in the water.

The vessel's master or OIM and management team should be fully informed of the intended operations and any special emergency response requirements such as the operation of the vessel or platform's small boat or emergency or standby craft.

11 ROV Configuration

It is recommended that WROVs are ballasted negatively buoyant to eliminate the risk of a diver being moved out of their excursion range. The ROV should be trimmed in such a way that it does not require excessive thrust to maintain position or manoeuvre in the water column.

Thruster guards should be fitted to prevent injury or entrapment of diving personnel or their equipment should they come into contact with the ROV. The pre/post-dive checks should include inspection of the guards to ensure they are securely attached and in good repair.

All cables and hoses should be securely tied – this is standard practice on ROVs, but needs to be reiterated here to minimise the chance of a loose hose or cable snagging or fouling a diver should physical contact be made.

All hydraulic/HP lines that are used in support of diver operated tooling should have certified whip checks fitted.

12 Responsibilities

A chain of command should be clearly established, included in the project plan and understood by all concerned for both aspects of the operation. Recommended formal responsibilities for these operations are as follows:

The **overall responsibility** for authorising the project or operation to commence should be clearly defined and will usually be the vessel's **Master** or **Offshore Installation Manager (OIM)**.

Accepted industry practice is that the **diving supervisor** always has authority over the ROV supervisor (or pilot) when combined operations are being carried out and divers are in the water with ROVs. The diving supervisor with responsibility for the operation is the only person who can order the start of a manned dive, subject to appropriate work permits etc.

The **ROV supervisor** is responsible for ensuring that the ROV is configured in a state which is as safe to the diver(s) as reasonably practicable and for the completion of the ROV element of the project risk assessment.

The **ROV supervisor** is responsible for ensuring that any known defect or weakness in the ROV's operating capacity is to be brought to the attention of the diving supervisor prior to operations commencing.

The **ROV supervisor** is responsible for ensuring that the pilots employed on the project are suitably qualified and experienced to be able to safely control the ROV in combination with divers for the project or task concerned.

ROV pilots should immediately bring to the attention of the ROV supervisor any doubt or concern that they have with regard to their ability to conduct the task they have been given; they should not be inexperienced in combined ROV/diver operations and less experienced pilots should be actively monitored by a suitably experienced ROV supervisor or nominated qualified instructor.

ROV pilots should immediately inform the diving supervisor/control of any fault, alarm or other ROV system defect which occurs when the ROV is in operation and divers are in the water.

The **ROV supervisor** or **pilot** should immediately inform the diving supervisor/control if the location of the ROV becomes unknown or uncertain.

The **diving supervisor** is responsible for ensuring that all divers are aware of the potential hazards of the ROV(s) in use. All members of the diving and ROV teams should be made aware of the potential hazards and operational constraints of working with an ROV.

The **diving supervisor** is responsible for ensuring that: the ROV supervisor (or pilot) understands the emergency procedures for recovering the diving bell and the implications of these; and emergency procedures for recovery of the ROV are agreed with the ROV supervisor (or pilot) and are understood by diving personnel.

The **diving supervisor** is responsible for authorising the ROV to be dived, recovered, and leave the tethered management system (TMS). The ROV should only be deployed or recovered with the authority of the diving supervisor and vessel master or OIM while diving is in progress and precautions should always be taken to avoid the possibility of umbilical fouling.

The **diving supervisor** is responsible for co-ordinating all diver and ROV movement. If not co-located with the pilot, he should have direct working communications with the ROV supervisor (or pilot). The diving supervisor should report via an agreed means to the person in overall authority for combined diving/ROV operations, on at least the following occasions:

a) On commencement of operations;

b) On any change to the project plan;

c) If the ROV develops a significant defect;

d) If any defect occurs in diving equipment/spread;

e) If environmental conditions change;

f) In the event of a safety incident;

g) On completion of the task/safe recovery of diver(s).

13 Operational Procedures

When a TMS/garage is used it will be untended when the ROV is at the worksite and generally cannot be seen by either the ROV supervisor (pilot) or diving supervisor. Its exact (referenced) position should, therefore, be established and promulgated to all control stations involved in the operation. In areas where tidal stream or current may affect both the TMS/garage and the ROV, their positions should be regularly monitored to assess the danger of entanglement with the bell and/or its umbilical, the diver's umbilical or the DP vessel's taut wire.

Similar measures should be taken to minimise the risk of entanglement with loads and rigging during subsea lifting operations and amongst any working lines that may be established to facilitate the work of the divers.

The ROV may be used to survey the worksite to assess potential hazards, and provide operational information, in which case it may then be used to guide the diver.

In the event of the ROV umbilical becoming entangled, the diver may, if the situation allows, take instructions for remedial action from the diving supervisor who should liaise with the ROV supervisor (or pilot). It needs to be remembered that the ROV umbilical will be carrying electrical power and should be electrically isolated before any such operation. Such circumstances should be taken into account in the task risk assessment and required mitigation applied accordingly.

If the ROV supervisor (or pilot) is unable to determine the relative position of the ROV due to poor visibility, high currents or for any technical reason, they should immediately inform the diving supervisor.

'On-site' operational procedures should be established in advance and recorded in the project plan. Any subsequent changes should be properly authorised and made clear to all concerned before they are implemented. The following procedures are provided for guidance but should not be considered as exhaustive:

a) Depending on underwater visibility conditions, the lights of an ROV may be used to help divers find their way from the dive basket or bell to underwater work sites. However, owing to the risk of injury, under no circumstances should the ROV be used to transport the diver from one underwater location to another.

b) If the ROV supervisor (or pilot) is unable to determine or maintain the position of the ROV due to poor visibility, high currents, disorientation or technical reasons, the diving supervisor should immediately be informed;

c) If disoriented the best course of action for the pilot is to attempt to maintain position with minimum thrust and make a calm reassessment of the situation;

d) All moves of the ROV should be planned prior to execution. Positions of all hazards in the water (diving bells, taut wires, hoses, etc.) should be ascertained by the pilot before moving;

e) Whenever possible keep all divers in view. Consider dimming the ROV lights to allow the divers' hat lights to be seen from a distance or request the dive supervisor to flash the hat lights if required;

f) Consideration needs to be given in the positioning of the ROV at the worksite. The pilot should plan for the effects of loss of propulsion in his current or intended position;

g) Taking up an observation position down current is preferable to up current in the event of a power failure;

h) Always try to locate the ROV such that there is a clear path back to the TMS/garage and that the path is down current if at all possible;

i) Placing the ROV between the divers and bell should be avoided if at all possible;

j) Positioning the ROV or its tether below the bell during a bell run is not acceptable;

k) Divers should not cross over an ROV tether. If the situation arises where a diver has to do so, i.e. tether is on the seabed, the dive supervisor should make all aware that this has occurred and as soon as possible afterwards, the diver should retrace their steps and clear the umbilical from the tether;

l) During bell runs, if not required to monitor the bell during ascent/decent, a WROV should be returned to the TMS/garage or moved to a safe location.

14 Communications

There should be a formal communication plan (included in the project plan) to ensure that all relevant personnel are able to communicate operational and safety matters required for the project. This communication plan should include the following as a minimum:

a) Procedures for lost/failed communications. Loss of communications would necessitate a 'STOP' call to be made and rectification of any shortcomings prior to recommencement;

b) Provision of dedicated hardwire voice communications between key stations (bridge/OIM control room/ ROV and dive control);

c) Provision of an emergency back-up communications system (UHF/VHF/general telephone system);

d) Provision for video distribution (preferably at least 2 video signal/channels) to key stations (as a minimum ROV video to dive control/diver video to ROV control and visible to ROV pilot). Where practicable, the provision of a repeater monitor displaying the ROV video on the bridge should also be considered;

e) Communication checks to be conducted pre-dive and at regular intervals during 'working' dive;

The communication plan needs to be distributed to all relevant personnel.

In addition, the diving supervisor should be supplied with a repeater monitor showing the same picture seen by the ROV pilot.

It is vitally important to consider the practical aspects of language commonality and cultural nuances when working with teams made up from multi-national resources. Common 'emergency terminology and phrases' need to be agreed and understood by all those involved to avoid confusion.

15 Navigation

ROV crew need to be familiar with the operation of the navigation screens in ROV control and able to set them up for the most relevant display of information.

Where a vessel HIPAP/positioning system has the capacity, it is strongly recommended that an additional transponder is to be fitted on the TMS/garage as a standard for diving support. (The issue to avoid on older positioning systems is to not introduce excessive update delays to the primary transponders.)

TMS/garage and ROV positions should be continuously monitored to minimise the potential of entanglement with the bell, the bell umbilical, the diver's umbilical or the DP vessel's taut wire. This position (of bell, TMS, etc.) information should be displayed on the navigation screens where possible.

The ROV tracking device should NOT be used as a primary reference for the surface vessel's DP system whilst divers are in the water.

ROV navigation displays should be located in all key stations.

16 Location and Positioning

When planning deployment of the ROV, consideration should be given to the use and positioning of the ROV and particularly the TMS/garage in relation to divers and the bells. This is especially so when working in strong currents and/or at shallow depths.

A WROV should remain in the TMS/garage for shallow diving support and make best use of the zoom capacity of the fitted cameras if visibility allows.

If a WROV is required to work in close proximity to a diver, the work task should be risk assessed and a safe distance maintained at all times. If this is an otherwise unplanned but essential requirement, a dynamic risk assessment/RA or TBT should be conducted by the ROV and dive supervisors prior to carrying out the task. (It is accepted that in an emergency situation, assistance to a diver in distress may need to be done without any RAs and TBTs.)

Subject to visibility conditions, a 4 metre minimum safe working distance around the active WROV into which the diver should not enter is recommended for normal diving/ROV operations.

The WROV location should be known and the vehicle should be static prior to the diver entering the worksite. Equally, the diver should move clear of the WROV before it moves. Wherever possible the diver should always remain in full camera view and maintain a safe position with respect to the WROV.

Launch and recovery of any ROV should be considered as a suspended load and normal procedures for this operation applied.

Where practicable the ROV deployment system should be sited an appropriate distance from the diving bell, basket or taut wire launch positions in order to minimise the chances of umbilical entanglement.

The location of the TMS/garage (i.e. higher or lower than the bell) is dependent on the work to be carried out and the distance to the bell. Best practice is for the TMS/garage to be located within the limits of excursion of the diver such that a diver would not be carried beyond his excursion limit should he become entangled with the ROV tether.

ROV supervisors and pilots should be aware that the vehicle's umbilical/tether could have become entangled with the diver's umbilical through the effects of current/tidal stream or diver activity even when the ROV itself has not been moved. Subsequent manoeuvring of the ROV may then have a serious impact on the safety of the diver even when it appears that the ROV is some distance away from the diver. Umbilical management by the dive team is equally important and all concerned should remain alert to the risk of entanglement occurring in apparently benign conditions. The risk of entanglement will obviously be increased in low/poor visibility conditions and should always be fully considered in the risk assessment process.

17 Electrical Considerations

Electrical safety relating to divers and ROVs is fully addressed in section 8.8 of IMCA D 045/R 015 – *Code of practice for the safe use of electricity under water* – which should be applied. Any insulation fault detected by the ROV operator/pilot should immediately be brought to the attention of the diving supervisor. All such key areas on the ROV should be identified during a pre-dive brief as part of the risk mitigation process for any divers nominated to be involved in diving operations with the ROV.

Regular testing of all ROV line insulation monitor (LIM) systems should be undertaken and logged. When supporting diving operations, LIMs should be physically tested and recorded as part of the pre and post dive checks and repeated on a 24 hourly basis during long dives.

High voltage warnings should be attached to the ROV and TMS/garage in clearly visible locations. The markings should conform to those already in use to indicate electrical danger.

During dive operations, LIMs need to be continuously monitored by the ROV crew. Normal readings should be noted and combined operations should be terminated if LIM readings deviate from an acceptable level.

18 Emergency Procedures

All ROV and diving team personnel should be familiar with the emergency procedures for recovery of the ROV and ensure that they are understood by diving personnel. If the personnel/teams conducting combined diving and ROV operations are inexperienced it is strongly recommended that key emergency procedures are drilled/ exercised at the start of the project to ensure that the procedures are effective and understood by all concerned.

The dive supervisor should ensure that the ROV supervisor and crew understand the emergency procedures for recovering the diving bell and the implications of these.

The ROV operators, especially the pilots involved in diver support, should be familiar with the actions to take in the event of a failure with any of the ROV's systems (loss of power, loss of control, etc.). The ROV crew should also be familiar with the procedures and equipment required in a diving emergency.

During diving operations, should there be entanglement between the diver/diver umbilical and the ROV, switching power off to the ROV is to be avoided. The ROV instrumentation and monitoring system should give any indication of potential electrical failure and priority to keeping control of the ROV – without power the ROV could be swept into the diver and cause injury.

Every effort should be made to maintain the ROV in a static position while the diver clears the entanglement. Thrusters should be isolated where the conditions or situation allows.

19 Simultaneous Adjacent Operations

In respect to ROV and diving operations, a simultaneous operation (SIMOP) is defined as two or more separate work tasks being undertaken in different areas at the same time.

SIMOPS can be described as the potential clash of activities which could bring about an undesired event or set of circumstances. It is important that SIMOPS are identified at an early stage before the work commences.

There is a distinction between SIMOPS and the activities described in this document. These activities are not considered as SIMOPS but as combined or close proximity diving and ROV operations.

For simultaneous diving and ROV operations, all of the guidelines described above could be applied with special emphasis to be placed on:

a) The overall authority of the dive supervisor for all operations being undertaken;

b) Communication between the ROV superintendents/supervisors and the dive supervisor in charge;

c) The positioning of the TMS/garage and the routing of the ROV tethers and ROV to the worksite;

d) Specific worksite procedures to be in place during bell runs and vessel moves.

20 Conclusion

ROVs and divers are integral elements of the offshore industry and can be usefully, effectively and efficiently employed together on a range of underwater tasks. The ability to visually monitor divers using ROVs has been shown to be a positive safety benefit. Through good planning and consideration of the potential hazards the combined use of divers with ROVs can be conducted in a safe manner. The nature of the environment and equipment means that hazards will always be present and while it is impossible to cater for every situation, it is believed that the application of the measures in this guidance should assist in preventing them from becoming safety incidents during such operations.