

# Assessing and managing risk in United Kingdom scientific diving at work operations

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## Key words

Risk assessment, risk management, scientific diving, diving at work

## Abstract

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In 1998 the United Kingdom (UK) Health and Safety Executive replaced a very prescriptive set of diving-at-work regulations with one that set minimum standards augmented through a series of risk-assessment procedures. These assessments match the potential severity of outcome resulting from a particular hazard against its likely occurrence in order to give a quantitative rating of risk. This account reviews methods of assessing risk within diving operations and discusses ways of implementing those assessments to either modify or inform diving operations as a consequence. It also details some of the generic risks assessed with the use of scuba and examines how the process of risk assessment in general is translated into effective methods for planning and executing diving operations. With a significant proportion of UK scientific diving projects being undertaken around the world, many of the aspects related to their planning will be common to operations undertaken by other diving sectors and nationalities.

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## Introduction

Until the early 1980s, diving at work in the United Kingdom (UK) was largely unregulated, but instead was undertaken in association with a series of industry sector codes.<sup>1,2</sup> The introduction of the 1981 Diving Operations at Work Regulations (DOWR 1981) as a statutory instrument of the 1974 Health and Safety at Work etc., Act (HSW 1974) was largely a consequence of high fatality levels in the offshore sector dominated by diving operations associated with oil exploration and exploitation in the North Sea.<sup>3</sup> DOWR 1981 was put in place through the UK Health and Safety Commission (HSC) and implemented through its Health and Safety Executive (HSE).

Because of their origins DOWR 1981 were largely targeted at the offshore sector and were necessarily prescriptive. However, the regulations were in place to cover all diving operations at work in the UK and the prescribed approach to offshore diving operations did not always fit easily with other industry sectors. Two revisions to DOWR 1981 were made in 1985 and 1992, but for significant numbers of diving contractors, specifically journalists, scientists, archaeologists and recreational instructors diving at work, operations could only continue through the issue of exemption certificates by the HSE.

In the mid-1990s the HSE recognised that, although there could be generic regulations in place to control diving operations, there were large differences in approach and the needs of various sectors within the diving-at-work industry. Therefore, the HSE set about creating a framework under which there would be a set of generic regulations for

implementing diving operations at work in the UK, complemented by sector-specific codes of practice. The codes of practice were written jointly by the HSE with bodies or groups that were representative of the respective sectors. Once accepted by the HSE these became the Approved Codes of Practice (ACoPs) for each sector.

There were five ACoPs recognised representing the Offshore, Inshore, Scientific and archaeological, Recreational and Media sectors. These codes were all much less prescriptive than the DOWR 1981 in a way that set minimum standards for each sector, and were largely self-regulated through processes of risk assessment and risk management.

Following extensive consultation the new HSE Diving at Work Regulations were formally accepted as a statutory instrument of the HSW 1974 Act in November 1997, and came into force in April 1998. The regulations were statutory instrument No. 2776 of the HSW 1974 Act and, although they came into force in 1998, are known by their 1997 acceptance date and are identified as the HSE Diving at Work Regulations 1997 (DWR 1997).<sup>4</sup>

The DWR 1997 are effectively goal-setting regulations. They set out, in generic terms, the roles of the diving client, the diving contractor, the diving supervisor and the diver. They outline the minimum qualification and medical requirements for a person to dive at work and describe minimum dive team numbers for specific types of diving operation. Because of their generic nature, the regulations do not give detailed or specific guidelines for how a particular operation should be conducted in practical terms

and state specifically that minimum standards are unlikely to be acceptable for most diving operations. However, there are specific requirements to produce and maintain written records of the appointment of the diving supervisor, a diving project plan and a diving operation record. Specific reference is also made to the diving project plans and operation records being based on a system of risk assessment.<sup>4</sup>

It is the requirement to assess the risks associated with the overall diving project, the site at which the operation is to take place and the tasks within each operation that presents a framework for planning the diving operations through a system of risk management. This ensures that operations that attract a higher than accepted level of risk either do not go ahead or attract additional safeguards.

The process is also one by which information about the diving operation and the diving team is collated by the diving supervisor and imparted to all members of the diving team, ensuring good communication of the diving operation plan. Because risk assessment works best as a dynamic procedure, the process of risk management allows both on-site adjustment to the assessed risks and a process of continual re-assessment based on information gathered through the diving operation.

The UK scientific and archaeological diving sector differs from most of the other diving industry sectors in that a significant proportion of diving operations are undertaken abroad, outside UK waters. The jurisdiction of the HSE in the UK is only to a limit of 12 nautical miles from the coast, unless the diving project is either launched or operated from a UK ship (Merchant Shipping (Diving Safety) Regulations 2002).<sup>5</sup> Although not tested in law, it has always been assumed that a UK employer has 'duty of care' for their employees irrespective of the country in which the work takes place.

With respect to diving operations it could be argued that because an industry standard is in place within the UK, adherence to that standard would be the minimum requirement for ensuring 'duty of care'. It is recognised that the nature of overseas operations, and the conditions under which they are undertaken, makes strict compliance difficult. However, employment of the minimum standards where reasonably practicable would probably be viewed as a realistic provision of 'duty of care'.

Where conditions vary considerably from those normally encountered, the principles of risk assessment and risk management allow diving operations to be planned and executed in line with industry standards without the requirement to produce new forms of operational guidance. This account reviews some approaches to undertaking risk assessment and risk management procedures within the context of the scientific and archaeological diving-at-work sector. In doing so, it discusses methods by which diving operations can be planned based on risk assessment in ways

that make allowance for potentially large-ranging differences in operational conditions.

### **Risk assessment and approaches to risk management in diving**

The principles of assessing and managing risk are influenced by the groups for which the analysis is targeted and the risk concerns of those groups.<sup>6</sup> For example, fully trained and experienced sub-aqua divers, by the very nature of their profession, should have minimal concerns about prolonged submersion below the surface of water with full dependence on the mechanical delivery of breathing gases compared with an untrained office worker. For this type of reason, attempting to compare quantitative assessments of risk has its problems.<sup>7</sup>

Adopting a standardised methodology for assessing risk through the multiplication of the severity of the outcome of a particular hazard against the likelihood of that hazard occurring will, in the case of diving operations, always produce a numerical outcome of medium risk. This is because every diving operation carries the potential outcome of death or serious disease, but the likelihood is usually very low.

However, the very fact that diving at work is a regulated industry in many countries already indicates an acceptance that it is perceived as having a risk higher than baseline attached to it. Management of additional risks has to accommodate the basic approaches to diving at work while assessing the cumulative modifiers to the baseline risk through the environment in which the operation is conducted and the tasks employed.

For a diving industry sector with no recorded fatalities and with a low incidence of significant accidents, it could be argued that the likely most severe outcome expected while diving at work would be a case of neurological decompression illness (DCI) rather than death, even though death remains the theoretical maximum severity of outcome.<sup>8,9</sup> However, subjecting risk assessment to a more realistic axis of outcomes presents a more informed format on which to base risk management. Therefore, by assuming that avoidance of death in work-related self-contained underwater breathing apparatus (scuba) diving is catered for during the basic training, the main targets for risk assessment and management come in the form of reducing the chances of non-life-threatening major or minor injury.

In designing a risk management process, there are scales of factors that make up the diving operation, from those that are well known to those that are less predictable. Most scientific diving is undertaken using scuba. The level of adoption of scuba varies with other diving sectors but, as an example, it is assumed here that scuba is the predominant form of diving. Therefore, the use of scuba as the method of diving is relatively predictable.

The majority of scientific diving involves some form of sampling at a relatively small number of locations, employing relatively few methods. So, although the location and task are more variable in the type of operations undertaken, the likelihood of either the location of the diving operation or the task being repeated a number of times during a year is relatively high. However, changes to either the conditions of the location, e.g., weather, tides, surface traffic, or how the task is affected by those conditions cannot be predicted.

Therefore, the overall risk management process can be divided into four distinct approaches. The first is a generic risk assessment for employing scuba as the standard approach for most diving operations. The assessment is undertaken on a temporal scale determined by the specific operators of the diving operation, although revision on an annual basis in order to accommodate any changes in legislation and/or guidance is recommended. Effectively, this becomes a standard operational procedure.

Secondly, the location of the dive operation is risk assessed separately from the task being employed, with the assumption that the task retains a uniform level of risk (the third assessment) irrespective of the dive location, and likewise with the location risk not being affected by the task. In this way there is no requirement to continually alter the location and task risk assessments when the combination changes.

However, the lack of alteration in risk associated with changes in location and/or task change cannot be assumed in reality. So a fourth level of risk assessment analyses whether the location affects the task risk and *vice versa*, with the addition of any unpredictable variations in factors such as weather, surface traffic and dive-team membership. There is a legal requirement in the DWR 1997 to ensure that on-site, daily risk-assessment changes are noted on the diving operation record.

### Generic risk assessment for scuba diving

The generic risk assessment examines the minimum requirements for undertaking a diving operation employing scuba equipment. The example of the risk assessment given below examines ten sections specific to potential risks associated with scuba:

1. Suitability of the individual diver;
  - i. minimum training/certification levels
  - ii. medical certification required
  - iii. day-by-day dive fitness of the individual.
2. Standard of equipment used and performance of that equipment;
  - i. maintenance and service requirements for equipment
  - ii. assessment of all equipment prior to a diving operation by a competent person to ensure that it is suitable, compatible and functional
- iii. guidelines under which to terminate a diving operation if there are any concerns over equipment performance
- iv. guidelines on the standards of breathing gases and recommended volumes and rates of supply.
3. Suitable size and make-up of the total dive team;
  - i. minimum dive team for scuba
  - ii. modification required to the basic dive team based on remoteness of location or specific tasks.
4. Standard of overall supervision of the diving operation;
  - i. requirements and duties of the diving supervisor.
5. Methods and suitability of communications over the whole operation;
  - i. suitability of communications between the diving supervisor and the dive team
  - ii. suitability of communications between the diving supervisor and third parties
  - iii. methods of indicating to other water users that a diving operation is underway, and more specific requirements if the diving operation is being undertaken in a port or harbour.
6. Adoption of safe decompression procedures;
  - i. method of calculating decompression
  - ii. any agreed limits or penalties on the chosen method of decompression calculation
  - iii. guidelines on the use of computers for deriving decompression schedules
  - iv. allowances for physical factors such as altitude and temperature.
7. Adoption of an evacuation plan in the event of an emergency;
  - i. provision of an agreed emergency plan for each diving operation
  - ii. standards of medical training and numbers/posts within the dive team that require medical training
  - iii. provision of sufficient oxygen supplies for any diving operation
  - iv. availability and content of a medical supply kit
  - v. availability of and transfer requirements to the recompression chamber nearest to the site of the diving operation.
8. Safety of diver ingress and egress from the water;
  - i. acceptability of the ingress/egress routes
  - ii. guidance on diving from boats.
9. Provision of suitable personal protective equipment;
  - i. types of protective equipment to prevent excessive environmental exposure
  - ii. additional care for areas of potential contamination risk.
10. Assessment of manual handling risks;
  - i. provision of specific manual handling risk assessment for scuba diving.

For each section the risk is identified and the actions taken to minimise the risk are outlined. Each action is qualified through reference to guidance material or, where

appropriate, the regulations. In some sections the minimum requirements will be prescribed by regulation, such as minimum levels of basic training, medical requirements and the structure of the dive team. However, it is typical within DWR 1997 to prescribe only minimum requirements thereby placing the responsibility of determining the optimum requirements for the diving operation to be undertaken safely onto the supervisor of that operation. The only method by which the optimum requirements can be identified through a structured approach to dive planning is through the process of risk assessment.

Because of the requirement to maintain the scuba risk assessment as generic to all diving operations, the content is also generic and outlines only the basic principles, guidelines and reference sources for diving at work for that specific institution. In order for specific diving operations to be planned and managed, the assessment of risk needs to be more precise.

#### **Location risk assessment**

The location of the diving operation will influence greatly the basic assessment of risk for scuba diving. The HSE approved Code of Practice for scientific and archaeological diving projects<sup>10</sup> defines benign location conditions simply as clear water, no excessive tide or current, no trapping hazard, easy entry and exit from the water, and where the task to be performed is not arduous. There is no more guidance, except that the Code defines the minimum diving team acceptable for benign diving conditions and then states that it would only rarely be acceptable to employ the minimum dive team.

By inference, therefore, it seems likely that diving at work in the UK would rarely be accepted as being undertaken in benign conditions. The accepted method of determining the diving conditions presented by the location of the diving operation is through assessment of the risks and then re-forming of the structure of the dive team based on the overall assessment of risk.

An assessment of risk at a specific location is broken down into the following divisions.

#### **LOCATION**

The assessment gives full details of where the diving operation is to be undertaken, making full reference to the ease of travelling to and from the site. Where the location is remote, or travelling times between the site of operation and a 'safe haven' are substantial, this will influence how management of the risks associated with the operation is approached, and the make-up and size of the dive team.

#### **TIDAL CONDITIONS**

The location is assessed on the likelihood *versus* the severity

of outcome of excessive water movements caused by tidal influences. A heavily tidal location will determine the times at which the diving operation can be undertaken in order to minimise risk. Again, the level of risk attached to the location because of tidal influences will determine the methodology of the diving operation as well as the membership of the diving team.

#### **AIR/WATER TEMPERATURES AND WEATHER EXPOSURE**

The assessment of risk has to include the conditions for the divers below water as well as the conditions for the divers and the rest of the dive team above water. Obviously, the temperature of the water in which the diver is operating will influence greatly the types of diving equipment used. However, in areas of both mild and extreme climatic change, the risk assessment should consider the additional influences of likely surface conditions and the potential consequences of change. The assessment should also consider the personnel on the surface who may be more likely to be affected. The severity of outcome may increase concomitantly with the remoteness of the location and the duration of transport between the diving location and safe areas.

#### **UNDERWATER HAZARDS**

The types of underwater hazard that could influence the risks associated with a diving operation could include underwater entrapment, no clear surface, water visibility, water depth, harmful biological life and pollution. Quantifying likelihood against severity of outcome with underwater hazards can influence greatly how a diving operation is managed.

#### **ACCESS TO THE WATER**

A number of considerations need to be made about how divers enter and leave the water. If the diving operation is shore based, there are associated issues of carrying relatively large weights of equipment over unstable or uneven ground. Shore diving also presents problems associated with retrieving divers who may be injured in some way. Diving from boats may allow the support team to be better placed to assist the divers in the water, but how the divers move into and out of the water requires assessment. Risk management associated with access can be further complicated where the route to the subsurface location of the operation site is restricted by surface objects, e.g., ice, fish-farm cages.

#### **SURFACE TRAFFIC**

Surface traffic adds to the assessment of safe access for diving operations, but also influences how safe passage to the surface can be conducted in the event of an emergency.

## RECOMPRESSION CONSIDERATIONS

At present, DWR 1997 is highly prescriptive in how a diving operation should be planned with respect to emergency recompression:

- For dives with no planned in-water decompression that are less than 10 metres water depth, the legal requirement is to identify the nearest suitable, operational, two-person, two-compartment chamber within six hours' travelling time from the dive site.
- For dives of between 10 and 50 metres water depth with either no planned decompression or up to 20 minutes planned in-water decompression, a suitable two-person, two-compartment chamber should be identified within two hours' travel time.
- Where in-water decompression of greater than 20 minutes is planned, there is a requirement to have a recompression chamber at the site of the operation.

Transport of a diver to a recompression facility within the above time frames is the main factor to be assessed, and will be influenced by the remoteness of the location and the methods of transport available.

On completion of the above sections of the location risk assessment an overall assessment of risk is made. There are a number of outcomes from that assessment. The location may influence the size and members of the dive team. The location may influence how or if the task of the diving operation can be conducted safely. The overall assessment should generate an emergency protocol that states clearly how, in an emergency, the diver would be retrieved, what the on-site treatment would be, how transfer for ongoing treatment would be achieved and what the contact details for the emergency services were.

### Task risk assessment

Although there is no specific requirement under DWR 1997 to assess the risk of performing a specific underwater task, it is obvious that the task will influence the overall management of the diving operation. Effectively, a risk assessment for task re-analyses the issues addressed under the risk assessment for location (location, tidal conditions, air/water temperatures and weather exposure, underwater hazards, access to the water, surface traffic, recompression considerations, etc) within the context of how the task to be carried out may alter that initial assessment.

Similar to the location risk assessment, the task assessment will inform the team size and the qualifications and experience of the team's membership. The task assessment should conclude with an overall task protocol that defines the stages within the planning and execution of the task, along with the specific personnel responsible for each stage.

### Operational diving risk assessment

A significant problem associated with the process of risk

assessment is that it can be viewed by operators as an administrative task rather than a dynamic tool for guiding the management of an operation. Although the DWR 1997 regulations state that every diving operation must be risk assessed, it was never the intention that this would result in numerous, repetitious and largely meaningless risk assessments. Conversely, there were concerns that the use of a single risk assessment to cover a large number of similar diving operations may result in diving supervisors overlooking day- or site-specific differences in the overall assessment.

There is a legal responsibility on the diving supervisor to review all relevant risk assessments prior to the diving operation taking place. This ensures that the person with ultimate responsibility for the safety management of the diving operation is fully aware of the risks associated with the type of diving employed, and the location and task of the operation. By providing summaries of the work to be carried out, any manpower or procedural limitations on the operation, and the protocols to employ in the event of an emergency, the site and task risk assessments provide the diving supervisor with easily accessible information covering the whole diving operation.

The DWR 1997 state that there should be an entry on the diving operation record to confirm that the diving supervisor has read the appropriate risk assessments. In order to allow for any on-site occurrences that may differ from the original risk assessment, there is also a legal requirement for the dive supervisor to note in the diving operation record any differences and how they affected the safety management of the diving operation.

At first, the level of detail required through the risk assessment procedures, coupled with the requirement to maintain the process as dynamic and useable, can appear to be imperious and, to significant sectors of the diving industry, unworkable. However, the diving operations undertaken by the diving-at-work industries tend to be predominantly repetitive either in the tasks employed and/or in the locations dived. Therefore, by dividing the risk assessments between location and task the diving supervisor can simply construct an overall risk assessment through simple combination complemented by an assessment of any temporal change.

Simply put, if a diving group carried out seven diving tasks at each of ten different diving locations per year, then performing individual task/location risk assessments for all the possible diving operations would generate 70 evaluations. Splitting task from location and then merging the two with the addition of a brief, legally required, on-site assessment, cuts the number of evaluations to be considered from, in this example, 70 down to 17. This approach has support with the HSE, with the proviso that individual risk assessments are time limited and are revised within 12 months.

## Discussion

The employment of risk assessment as the central tool for the safety management of diving-at-work operations has been operating in the UK for the past five years. During that period, the employment of risk assessment in numerous health-and-safety-at-work areas has become widespread in the UK, and it is now considered to be the main tool in the management of safety. Although there is provision in the law for revision as to how the DWR 1997 are implemented, it appears to be highly unlikely that any of the diving-at-work industry sectors within the UK will seek any change in the process of risk assessment.

The lack of prescription has permitted some sectors an added degree of flexibility to use a larger variety of diving techniques and equipment. However, the use of risk assessment, whereas presenting numerous alternatives to how a diving operation may be carried out, has increased the responsibility of those in charge of the diving operations to provide supporting qualification for the methods and approaches employed within any one diving operation.

There are many approaches to risk assessment employed in numerous different industries.<sup>7, 11-16</sup> The DWR 1997 do not specifically outline how risk assessment should be approached. Compared with other industries, where risk to an individual's health can be directly correlated with dose-response criteria<sup>17</sup>, there remains debate within the diving industry as to whether risk assessment in diving can ever be much more than largely qualitative. This notwithstanding, risk analysis does provide a method for active management of a large range of diving operations, some of which may fall outside any prescriptive legislation, while permitting change on localised or time-specific scales.

If employed properly, the record of the initial analyses, in addition to any changes, provides the diving supervisor with guidance on the methods of carrying out the diving operation, in addition to any actions to be employed in the event of an incident. The maintenance of the risk assessments in association with the daily operation records provides an auditable tool for internal, top-down management as well as aiding external investigation of any incidents.

When first introduced, the process of risk assessment for diving operations appeared to be an unnecessary paper exercise in stating the obvious. However, when approached constructively by the whole diving team, the risk assessments build into a dynamic form of outlining company policy and procedures, in addition to giving the supervisor and the divers clear, written guidance as to how the diving operation is to be completed.

As stated above, this approach to the safety management of diving operations is a legal requirement only for diving groups defined as 'at work' and for that work to be carried out within 12 miles of the UK coastline. Many UK scientific

diving operations occur outside this limit in addition to the hundreds of thousands of recreational dives that occur on an annual basis worldwide. The obvious question is whether or not a legal requirement for at-work divers has any relevance to working dives abroad or the leisure diving industry.

## WORKING ABROAD

The question of scientific divers from the UK working abroad has always presented the employers of those divers with a fairly basic choice. The first option is to effectively dismiss the relevance of UK legislation for diving operations not enforced by the UK HSE and to allow the scientists to adopt their own practices. The vast majority of UK scientific diving occurs within the 10–29 m depth range, is based on recreational qualifications and techniques, and is carried out predominantly using equipment intended primarily for use by the recreational sector.<sup>9</sup>

There will, therefore, be an element of the at-work sector who will simply adopt diving practices based on recreational approaches. There are notable exceptions to this. The employees of the UK Natural Environment Research Council, which include those of the British Antarctic Survey, have a policy of adhering to UK regulations for all diving operations worldwide where it is reasonably practical. The main reason for this is that the UK regulations are considered to be an accepted industry standard.

The UK employer of those who are employed and paid in the UK will have a duty of care to ensure that those employees are working to health and safety standards that adhere to an industry standard. Therefore, it could be argued that, by dismissing the relevance of UK legislation to an employee working abroad, the employer is open to litigation through their dereliction of duty of care.

Because the HSE regulations do not have legal status outside UK territorial waters, the HSE themselves cannot prosecute the employer. Any prosecution would have to be a civil action most probably brought by the diver themselves or the family of that diver. Until such a civil action is brought, a clear legal definition of the limits of duty of care as they relate to diving-at-work operations abroad remains lacking.

## RECREATIONAL DIVING

The application of risk management and risk assessment in the recreational sector is likely to depend on the level of organisation related to that diving operation. Theoretically, the application could be considered at three levels. Firstly, at the purest form of recreational diving where the divers entering the water are doing so under their own control, any assessment of risk is likely to be in the form of the application of common sense based on the divers' own knowledge of their own abilities. It is highly unlikely that any written assessment of risk will be carried out proactively, although comments written retrospectively in diving

records may inform future dives.

The second level of recreational diving is where there is an element of control and guidance coming through a recreational diving club that may be connected with a national or international association. In this case, it can be argued that payment of a membership fee by the individual to the club and/or association should guarantee a certain level of control associated with the organisation of a diving event. This could take the form of club members being allocated the task of supervising dives.

That supervision will require assessment of the diving site as appropriate for the qualifications and experience of the divers, or *vice versa*, and that the structure of the diving group in the water properly reflects the relative experience levels of those divers. The supervising person will also have to make decisions as to local changes in conditions in a similar way to a diving-at-work risk assessment being revised because of on-site and/or on-the-day changes.

Although this second level in the structure of recreational diving will carry a higher degree of organisation, it is still unlikely that written forms of risk assessment could be easily incorporated into an amateur club situation. The payment of membership fees and charges associated with the real costs of the diving operation will provide only a nominal level of guidance to the diver. It is unlikely that national inspectorates or legislators would wish to become involved significantly with a sector where individuals are not being paid and are thus assumed to have minimal professional knowledge.

The third level in recreational diving is where the diving is managed by people at work, and is controlled by commercial bodies that charge fees for these managed dives. In this case, the divers who are paying for the organised diving should expect a level of care and control above that assumed in unorganised or organised amateur diving. It is also possible that, because these operations are defined as commercial, there could be some form of statutory regulation attached to these diving operations.

Equally, because someone within the diving operation is being paid by customers, in the event of a serious incident, the operators of this level of recreational diving would be defined as professionals and could be liable to prosecution by statutory organisations. At this level, therefore, it would appear appropriate for commercial operators of recreational diving to adopt some form of risk assessment or management in order both to reduce the likelihood of incidents but also to provide evidence of a properly managed operation in the event of an incident occurring. In effect, this is already adopted worldwide by a number of professional organisations.<sup>18</sup>

Because of the trends in recreational diving, it is most likely that a company will have researched or have available to it a finite number of dive sites. Each dive site over the course

of a year or diving season, will probably be dived repeatedly by the same company and the same professionals. Therefore, there will be a high level of local knowledge already existing about the site in question. In addition, many dive operators will have visual representations of the dive site in order to aid the briefing of the dive groups. Some of these visual aids will clearly identify the area in which the dive will take place plus any underwater hazards.

Although there may not be a regular assessment of diver competence undertaken by recreational companies, there appears to be a trend of introducing the customer divers to dive sites with lower risk potentials at the beginning of a series of dives. Once the diving professional has had an opportunity to assess the overall competence of the divers under their control, this may inform decisions made later during the series of dives as to the appropriateness of future dive sites. However, in the commercial operation of recreational diving, it is often this assessment of customer competence that appears to be lacking in the written form.

If a professional diving instructor or guide were expected to make a written record of the divers' qualifications and assess their competence as individuals or the group as a whole, this would aid in making decisions for dives later in the series. It would also provide evidence of an assessment process. There is no requirement for this record to be particularly detailed. A simple printed diving slate could provide a *pro forma* approach whereby the most common diving qualifications are listed, and the diving professional only has to record the numbers of those qualifications present in the group. Following the initial dive of a series, the professional should be able to rate the group, or parts of the group, as very competent, competent, lacking competence in some areas, or incompetent. That assessment would inform either the locations of future dives in the series or the structure of the group itself.

The adoption of risk assessment for the management of safety in UK scientific diving-at-work operations has been a welcome development following the over-prescriptive regulations for UK professional diving in the past. It is believed that the approaches to risk assessment set out for diving operations in the present account are relatively straightforward and could be adopted by other nationalities and diving industry sectors, as well as UK-employed scientists diving for work outside UK waters. If implemented correctly, the process of risk assessment provides a clear record of the decisions made in the control of diving operations, while also improving safety through better guidance for the divers and increased responsibility being placed on the person supervising the operation.

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