IMCA

Guidance on
Diving in Contaminated Waters

International Marine
Contractors Association

www.imca-int.com

IMCA D 021 Rev. 1
July 2016

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 by other appropriate means.

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 by their clients.

There are two core activities that relate to all members:

- Competence & Training
- Safety, Environment & Legislation

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

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

IMCA D 021 Rev. 1

This guidance document was prepared for IMCA, under the direction of its Diving Division Management Committee, by a workgroup chaired by Crawford Logan, who also acted as the author.

This guidance supersedes IMCA D 021 dated November 1999, which has now been withdrawn.

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Date	Reason	Revision
November 1999	Initial publication	
November 2004	To expand upon earlier guidance	Rev. 1
July 2016	Minor updates made during review process	Rev. 1

Guidance on Diving in Contaminated Waters

IMCA D 021 Rev. 1 – July 2016

Appendices

1 Introduction

Commercial divers working offshore are sometimes required to dive in situations where there may be contamination in the water or on the seabed. This contamination can be due to the presence of drill mud and cuttings or can be due to the work the diver is required to carry out, such as recovering drums of chemicals, breaking of flanges, working on pipelines, etc. It may also be due to general contamination by heavy metals, chemicals, radioactivity, biological material or similar in the area that the work has to be carried out.

The hazards that need to be considered are:

- direct contamination of the diver while working in the water;
- contamination of the diver's equipment causing hazards to the surface personnel or others that are required to handle it;
- contamination of the atmosphere of the diving bell or deck decompression chamber (DDC) either by the contaminant entering directly or else on the equipment of the diver after he returns.

One of the problems faced by diving contractors is that the operator, owner of the area or client may not be able to provide any detailed information to the diving contractor about the exact composition of the suspected contaminants.

IMCA assembled a workgroup to consider the evidence available and to develop this comprehensive guidance, addressing issues such as decontamination procedures, etc., which need to be addressed when diving in potentially contaminated waters.

The most obvious advice that can be given is the application of the following by the diving contractor prior to any work commencing:

- an adequate safety management system;
- hazard identification and a detailed risk assessment. This assessment should result in the selection of suitable protective equipment and procedures in order to carry the operation out safely;
- adequate briefings of all involved personnel.

All reasonably foreseeable emergencies should also be considered.

1.1 Application

This guidance is intended to apply internationally, 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 this guidance.

2 Routes of Entry of Contaminants into the Body

The principal routes of entry into the body are inhalation (breathing in), skin contact and ingestion (swallowing). Two other situations that need to be considered are aspiration (swallowing directly in to the lung) and ionising radiation. There can also be a combination of these methods of ingress.

2.1 Inhalation

The lung is the most vulnerable part of the body, as it can readily absorb gases, soluble dusts and fumes. Even small concentrations of a toxic agent in the atmosphere being inhaled can, after a period, develop a build-up of toxicant in the body. This is another problem to be considered in connection with the identification of chronic toxicity and the need for ongoing health monitoring. The lung also provides an extremely large surface area for the absorption process to occur.

When considering the risk of material in terms of inhalation, the questions to be asked are:

- *"Is it a gas?"*
- *"Is it a liquid that will easily give off vapours?"*

If it is a solid:

- *"Can respirable dust be generated, or vapours?"*

If any of the answers are 'yes', then you may be dealing with conditions that provide a major risk of entry of toxicants into the body.

2.2 Skin/Body Contact

The skin is the next vulnerable area, as it can be in contact with toxic substances that may be solid, liquid or gaseous, and in very high concentrations (i.e. in terms of quantity of substance to skin area). Fortunately unbroken skin has many layers of protection and does not allow solid or gaseous substances to be absorbed (in general), so only liquids normally provide a hazard. Skin which is in prolonged contact with water (as in diving) however may become softened and provide less protection than normal. In the diving situation it must be recognised that many hazardous materials can be suspended within the water being dived in including water borne parasites and small marine animals. In normal circumstances, if contact between the skin and a toxic substance does occur, a considerable amount of contaminant can usually be removed before excessive absorption has taken place. However, in diving it is unlikely that the diver will be aware of the contamination or have the ability to remove the contaminant before absorption takes place. Where normal suits etc. do reduce the available skin contact area available for exposure to a toxic agent the protection afforded is only as good as the sealing mechanisms provided by the suit, glove, boots, etc.

Where divers have skin injuries or skin breaks on hands, arms, legs, etc., entry into the body 'by injection' is always a possibility. This can also be the case if the diver is suffering from certain skin conditions such as eczema. Entry of parasites and small marine animals into bodily orifices has also been recorded.

2.3 Ingestion

In terms of occupational hazards from toxins, the gastrointestinal tract is possibly the least vulnerable area of the body. The possibility of solid or liquid toxicants being ingested is limited and the diver would normally be aware of having swallowed water that could contain toxic substances that may be soluble or suspended in the water.

2.4 Aspiration

Aspiration is a term used to describe a route of entry that concerns the direct entry of solid or liquid into the lungs. In a diving situation there are two ways in which this can happen. Firstly, when substances that have been ingested are expelled in vomit and run down the respiratory tract. Secondly, when substances are sucked directly into the lungs. A typical situation can be created by means of the hat being partially flooded with contaminated water in combination with the need to breathe using the demand system.

Aspiration can have serious consequences: toxic substances could exhibit an increase in their relative hazard potential, e.g. if a hydrocarbon solvent has been ingested, it is not likely to be lethal; but if aspiration occurs during vomiting, entry into the respiratory system could produce a lethal situation.

2.5 Ionising radiation

When ionising radiation is present, two concepts must be considered. These are exposure and contamination. Exposure deals with the damage that has been done to the body having subjected it to harm by energy imparted from a source or dose of ionising radiation. Contamination describes the situation where a person has radioactive material attached to his or her body.

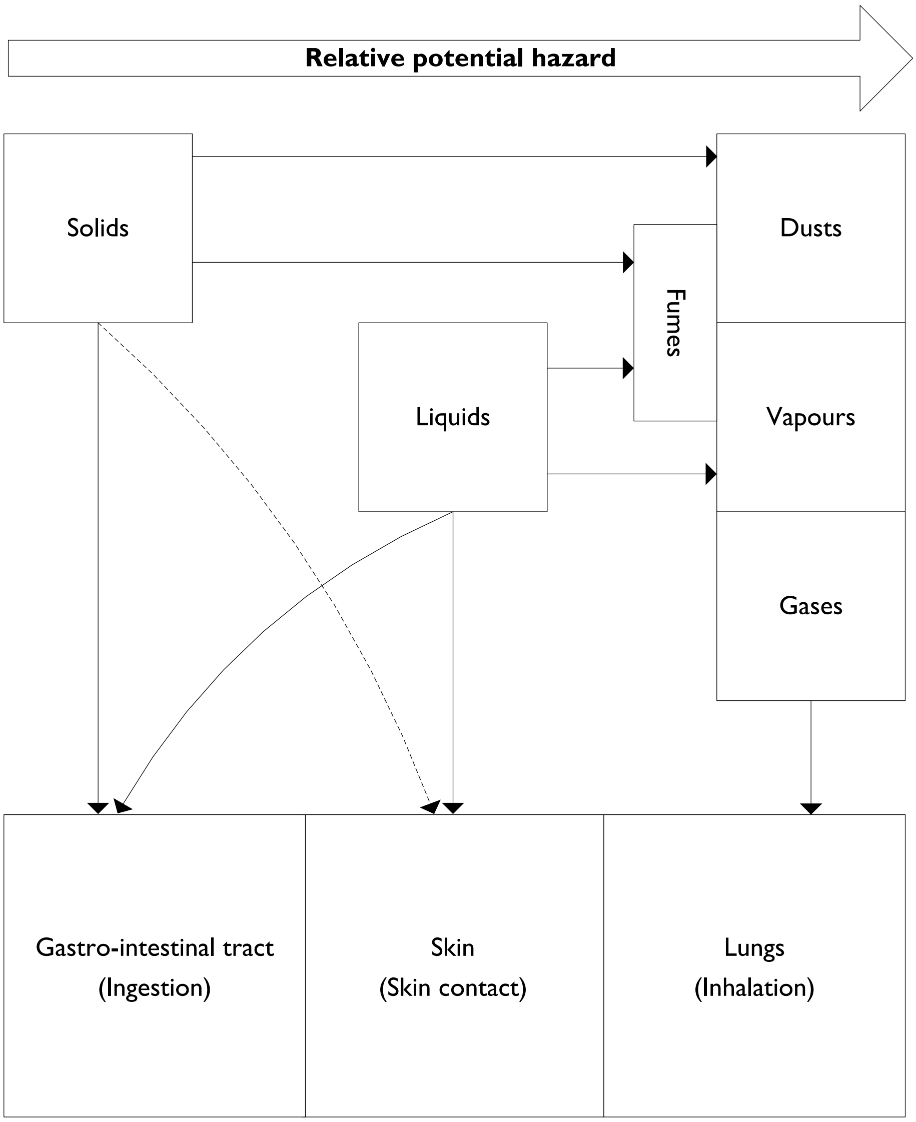

Figure 1 – Routes of entry model

Note: The above model may not necessarily be suitable for use in assessment of all ionising radiation or biological hazards.

3 Types of Contamination, Associated Hazards

The types of contaminant can be split up in to a number of distinct groups:

3.1 Ionising Radiation

As stated earlier, when ionising radiation is present, two concepts must be considered and these are contamination and exposure. Exposure deals with the damage that has been done to the body having subjected it to a source or dose of ionising radiation. Contamination describes the situation where a person has radioactive material attached to his or her body.

Radioactive material can exist in all states, i.e. solid, liquid and gas. As an example consideration should be given to:

- quantifiable hazard (such as in a power station); and
- unquantifiable hazard (such as searching for a lost non-destructive examination (NDE) source).

The hazards associated with these could be either contamination or exposure; and will depend on the circumstances, but may include respiration (dust), ingestion (liquid borne) and ionising radiation exposure (whole body).

In the specific situation where any seabed equipment through which oil or gas production has passed is recovered to the surface, such equipment may be contaminated with low specific activity (LSA) scale deposits.

LSA (also known as naturally occurring radioactive material (NORM)) provides little hazard to divers but once recovered to deck is slightly radioactive and, once dried out into a respirable dust, is a serious hazard if ingested or inhaled. Any work involving the recovery of used pipework or equipment through which any produced fluids have passed needs to be checked for LSA scale and suitable precautions taken.

3.2 Biological

Possible biological hazards include exposure to bacteria, viruses, fungi, water borne parasites or marine animals. These can come from a number of likely sources:

- predictable hazard (sewage farm, animal waste etc.);
- less predictable hazard (waterways into which contamination can flow);
- water borne parasites or small marine animals indigenous to certain areas of the world.

The hazards associated with biological contamination will normally involve protecting the skin of the individuals plus protection against ingestion. It is also known that the action of biological microbes can produce gases such as H_2S that can lead to contamination of breathing gas supplies and can even enter umbilical hoses.

3.3 Heavy Metals

Heavy metal contamination is normally encountered as a result of past industrial activity. Examples of such substances that may be encountered are mercury, cadmium and arsenic although other substances may also be found.

Heavy metals do not normally have acute (that is sudden) effects but tend toward chronic (that is long term) health effects. Skin contact will normally have to be repeated and prolonged to become a serious hazard and there will usually be little or no toxic vapours given off that may contaminate, for example, the inside of a bell. The main risk is if the heavy metals are ingested which means that the risk to divers from heavy metals on their own is often relatively small.

3.4 Chemical

Chemical hazards can be subdivided into the following groups:

- corrosive (typically a very acidic or alkaline environment); and
- toxic/poisonous (often associated with industrial chemicals).

The hazards associated with chemicals may involve all three routes of entry although the degree of risk will vary from one type to another. Protection against skin contact is obviously the most important for corrosive substances while ingestion and respiration may be more important with toxic substances.

Some chemical hazards will fall in to more than one category, e.g. corrosive and toxic.

3.5 Hydrocarbons and Condensate

Hydrocarbons are normally encountered in association with the oil and gas industries. Hydrocarbons often contain condensates, which is a loose term covering the light end of the crude oil spectrum. Condensates are extremely volatile and will evaporate into almost any gaseous atmosphere instantaneously. For this reason ventilation such as flushing a bell atmosphere will be of very limited use due to the ongoing evaporation.

The following hazards are associated with condensate or hydrocarbon contamination:

- in liquid form will burn and penetrate skin;
- in gaseous form will have hypnotic, soporific and toxic effects.

One specific hazard that needs to be considered in almost all cases of hydrocarbon contamination is the possibility of the contaminant giving off hydrogen sulphide gas (H_2S). This is a particularly hazardous substance, even in small quantities.

3.6 Multiple Hazards

It must be realised that many contaminated waters may well contain more than one hazard and that all possible hazards will need to be assessed and appropriate measures introduced.

3.7 Ergonomic Hazards

Ergonomic hazards cover the possible effects that any personal protective equipment (PPE) may have on the diver's interface with the tasks that are to be undertaken. The diver may require so much protection that the task he is required to carry out is impossible to do. Equally the PPE may introduce a hazard such as making rapid access to an unconscious diver for resuscitation more difficult.

4 Risk Assessment

When requested to dive in a possibly polluted environment, a responsible employer will have to assess the risks his personnel are exposed to, or may be expected to be exposed to.

The following step by step assessment simply provides a number of logical questions that should allow progress from an uncertain level of knowledge to a better defined one. This in turn will assist in decision making regarding:

- levels of risks;
- types of risks;
- ways and methods to overcome these risks;
- precautions;
- detection;
- monitoring;
- emergency procedures should accidental contact occur.

Attached to this document are a number of appendices intended to assist in carrying out risk assessments for work in possibly contaminated waters:

- Appendix 1 is a flowchart for surface supplied diving that allows personnel carrying out a risk assessment to consider all of the likely steps in the operation where risks of contamination need to be considered;
- Appendix 2 is a similar chart for bell diving;
- Appendix 3 looks at each of these areas and gives a small number of points to consider as the most likely prompts needed for that particular section. The prompts are expanded upon below the list;
- Appendix 4 contains information previously published by IMCA and directly relevant to this subject.

It needs to be remembered that most of the information available about the health effects of various contaminants refers to personnel exposed on the surface at normal atmospheric pressure. Relatively little information is available about any effects while the individual is under pressure where the effects could be worse. Special consideration therefore needs to be given to any possible risk to personnel inside bells or chambers. Threshold limit values (TLV) which can be found in specialised tables may require to be 'corrected' according to the pressure involved.

4.1 Hazard Identification

Historical or up-to-date data (such as analysis of samples from the site) are two possible methods of identifying substances. Unfortunately known substance information may be limited and in many cases not available. Also the number of constituents in certain substances, e.g. drill mud, can be large and varied. Equipment that is available for monitoring chemical hazards subsea is also limited. Another factor to consider is that the hazard may vary due to temperature, concentration level, and reaction with other chemicals.

Issues to consider regarding the situation and nature of pollution:

- Is polluting material/substance:
  - in the water?
  - on the seabed?
  - contained but containment requires to be broken?
- Is polluting material/substance:
  - water soluble or not?
  - toxic:
    - on contact?
    - on ingestion?
    - on inhalation?

        - by proximity (i.e. ionising radiation)?
    - are the effects likely to be:
        - acute?
        - chronic?
        - very long term?

The answer to the above questions may or may not be known.

- If known, is the knowledge:
    - precise? (e.g. samples taken/analysed)
    - generic? (e.g. crude oil or condensate or heavy metals)
    - specific? (e.g. data sheet provided or result of previous analysis);
- If not known:
    - can generic information be obtained?
    - alternatively, can a sample be obtained and analysed?
        - method of collection, mechanism, ROV?
        - using divers?
            - total protection may be prohibitive
            - partial protection may not be reasonably safe.

If the process of hazard identification does not result in a satisfactory conclusion then the 'worst case' should be assumed and the risk assessment carried out accordingly.

4.2 Assessment of Risk

When assessing the risk, the diving contractor should consider:

- a health hazard is something with the potential to cause occupational ill health or disease;
- risk is a measure of the likelihood that the harm from a substance or agent will occur.
- severity of harm is a function of the level of concentration of the agent to which a person is exposed, and the duration of the exposure.

Once the nature of the substance(s) is known, as well as an indication of the concentration, or the 'worst case' has been assumed, an evaluation of the possible exposure has to be made.

- Risks on contact:
    - nuisance risk such as a compound that clings to equipment but has little toxicity, or
    - significant risk on contact, possibly exacerbated by wet skin;
- Risks on ingestion:
    - although accidental ingestion is less likely, some water can leak past the mushroom exhaust valve. This risk is much reduced with gas reclaim equipment;
- Risks on inhalation:
    - highly unlikely while in the water, as the diver is breathing gas supplied under pressure from the surface and unlikely to become contaminated
    - could become a problem if chemical is 'imported' into the bell or living chambers – the more volatile it is then the quicker it will vaporise into the atmosphere
    - if inhaled, will the effect be acute, chronic or very long term?
    - toxic concentrations combined with exposure levels such as those provided in threshold limit value (TLV) tables may require to be 'corrected' according to the pressure at depth;

- Risks by ionising radiation:
  - water does provide a very effective 'natural' protection, and control measures will have to concentrate on establishing and respecting safe paths and safe areas
  - if radioactive materials, such as LSA scale, are allowed to dry out, dusts could be inhaled. This surface problem can usually be controlled by keeping any suspected materials damp and sealed.

Managing and controlling the hazards and risks from diving in contaminated waters will include the requirement, if practicable and equipment is available, to monitor the exposure of substances. The likely components/constituents of that substance need to be known to enable accurate monitoring to take place.

It is important that safe systems of work to reduce the risk of exposure and contamination from substances are put in place prior to a hazard becoming obvious. Pro-active measures such as engineering or design of equipment may be needed. Generally what will be required is the maximum level of protection available.

Planning and management of risk of exposure to contamination is dependent upon the 'hierarchy of control' (see section 5.1) of protective and preventative measures.

4.3 Control Measures

Having established the above, an outline strategy can be defined that will provide adequate levels of control for those who may be exposed to possible contamination:

- Ionising radiation:
  - normal diving equipment
  - procedural measures;
- Biological:
  - any significant level of risk will normally require a completely enclosed diving suit and a helmet fitted to the suit
  - decontamination by washing down with appropriate medium on return to surface
  - collection/disposal of products from washing down
  - ensuring that only divers and surface personnel are used that do not have open wounds or other skin conditions
  - provision of vaccination or immunisation of personnel against common diseases that may be encountered such as hepatitis A, typhoid and polio
  - use of a very high standard of personal hygiene, such as hand washing, etc., with separate 'clean' and 'dirty' areas. Eating and drinking facilities to be particularly considered;
- Heavy metals:
  - levels of risks should normally be considered low/medium
  - for lowest level risks, normal diving equipment with precautions such as those for drilling muds
  - for medium level risks, closed suits with fitted helmet may need to be used
  - particular care is needed that divers are not exposed to risk of ingestion
  - surface teams with adequate PPE disinfecting/rinsing by washing down, showers, etc.;
- Chemical (corrosive/toxic):
  - low risk levels – normal diving equipment with precautions such as those for drilling muds
  - higher risk levels – may have to involve completely enclosed suit with helmet fitted. The material of the suit, diaphragms, etc., will have to be compatible, i.e. not damaged by the chemical pollutant. Further information on this can be found in ref. 2 or from equipment manufacturers

- problems of contact or inhalation can be controlled by:
  - keeping suit/gloves on
  - breathing from the built-in breathing system (BIBS) in the bell
  - surface teams with adequate PPE disinfecting/rinsing by washing down, showers, etc.;

♦ Hydrocarbons and condensate:

- low levels, heavy components:
  - protective aprons, disposable coveralls for equipment protection from heavy components
  - cleaning periodically of equipment/bell/suits with rubber compatible cleaning agents. Such agents should not themselves be toxic or harmful within a closed environment
  - transfer from bell to DDC involving an over-pressured DDC and bleeding off the bell to create a gas flow from the DDC to the bell;
- high levels, volatile components:
  - ongoing automatic monitoring
  - alternative breathing supplies
  - systematic decontamination of equipment after each exposure.

In reality, it is likely to be very difficult in advance of diving operations, to know exactly what hazardous agents may be present in hydrocarbon contamination, or indeed the levels of concentration that the diver is likely to be exposed to. Without these key pieces of information it is likely to be very difficult to conduct a meaningful assessment of either the hazard or severity which would allow the development of an appropriate control measure.

When exact identification cannot be established, reasonable assumptions erring on the 'worst case' side of safety can be made:

♦ bell atmosphere may be polluted so divers should breathe on BIBS;

♦ skin contact may take place, so barrier creams, washing chemicals, protective suits, gloves, etc. should be used;

♦ hyperbaric hydrocarbon monitors are available for fitting inside diving bells, although they may not detect the full range of hydrocarbons that may be present in polluted water. These units are normally set to alarm at 10% of the amount of hydrocarbons required to induce anaesthesia. The use of hyperbaric hydrocarbon monitors does not obviate the need for diving contractors to carry out suitable and sufficient contaminated water risk assessments and identify suitable controls when they are requested to dive in possibly polluted environments;

♦ although colorimetric monitoring tubes are available, they cannot always be relied upon to give warning when dangerous levels occur, and the use of conservative assumptions may be safer;

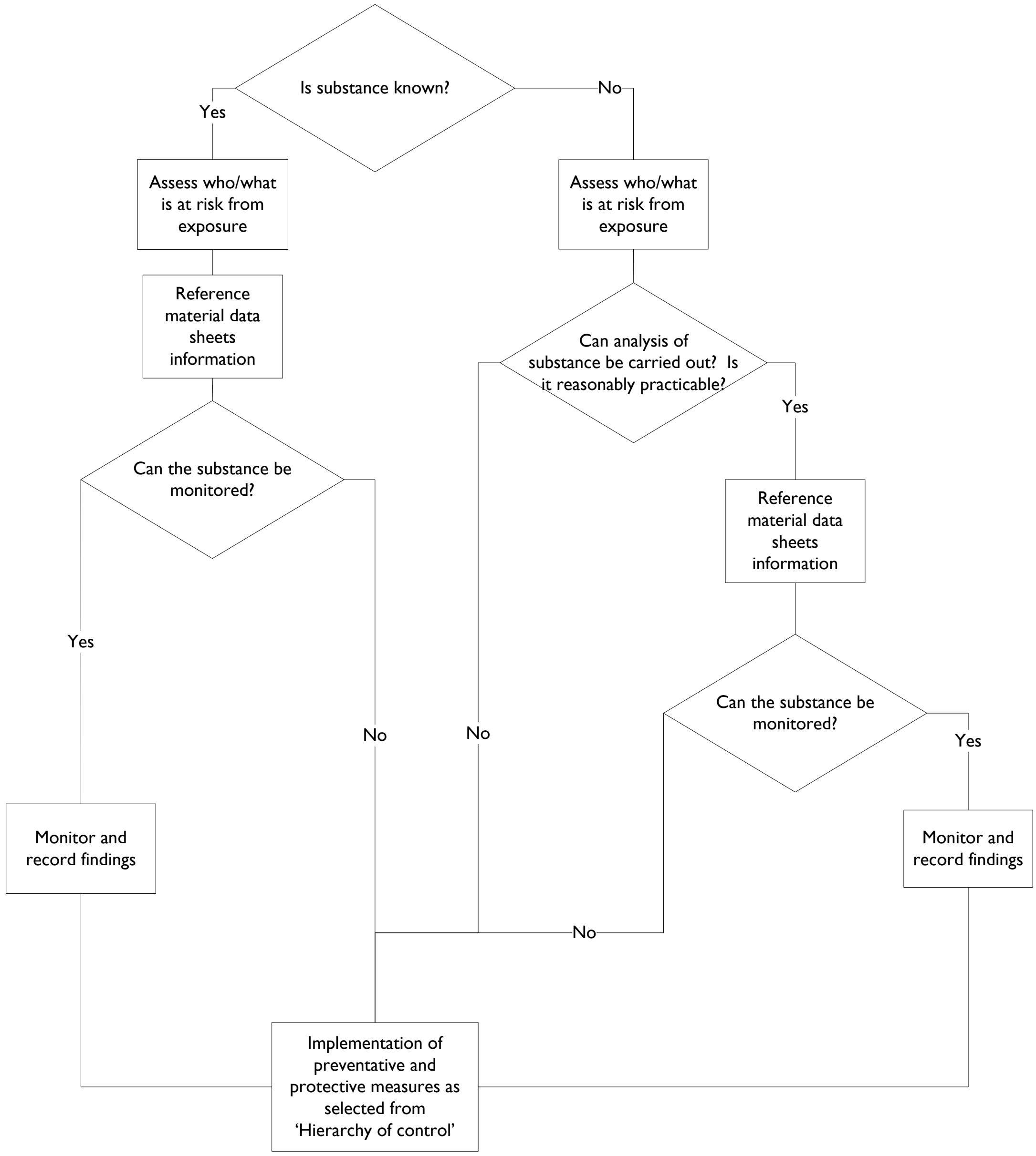

Figure 2 – Flowchart for risk assessment

5 Practical Aspects – Lessons Learnt

Much of what follows is intended to provide protection to a diver or the deck crew carrying out their normal work in the presence of possible contamination. Care needs to be exercised however that the precautions taken to protect them from the contaminant do not result in an increased risk in an emergency situation.

- If the standby diver has to be deployed, will they have the same level of protection from the contamination as the diver?
- If protection against inhalation or ingestion relies on the breathing apparatus, will the emergency supply arrangements (bail-out) be sufficient to protect the diver until he is recovered. For example: if the diver is using free flow, is the bail-out adequate; or, if the protection is provided by gas recovery, will the emergency supply provide the same protection?
- If the diver is recovered to the surface (or in to a bell) unconscious or injured, can the rescuers obtain easy access to him for cardiopulmonary resuscitation (CPR) or emergency first aid?
- If the diver is recovered to the surface/in to a bell unconscious or injured – might he require extensive decontamination before it is safe for rescuers to help him?
- Is the equipment worn by the diver such that it creates a hazard because he cannot move freely or is likely to become entangled?
- If he is acting as standby diver, will the protective equipment allow him to provide assistance in an emergency?
- Have any barrier creams or cleaning agents themselves been risk assessed for use in a closed environment?

5.1 Hierarchy of Control

There are a number of options available for control purposes and sometimes it will be necessary to use a combination of these options in order to reduce risk. The hierarchy and types of control measures are:

- elimination;
- substitution;
- engineering controls:
  - isolation
  - enclosure
  - containment
  - limitation;
- administrative controls – examples are:
  - policies
  - procedures;
- personal protective equipment.

5.1.1 Elimination

The ultimate control measure for any hazardous activity is to eliminate it. For example, *elimination* of an activity, process or use of a substance might be:

- In the diving context, the only practical way to use elimination as a means of control is not to dive. This option will of course not be available in most situations since diving will normally only have been considered in the first place if it is the only way of carrying out the work.

5.1.2 Substitution

If the hazard cannot be controlled by elimination, which is likely to be the case for many diving tasks, then the next best option is *substitution*. Can the potential hazard be substituted for something potentially less hazardous? An example might be:

- Substituting the need for a diver by using a remotely operated vehicle (ROV) to do the work. This removes the hazard to a diver but substitutes a hazard to the deck crew handling the ROV after recovery. The hazard to the deck crew may be easier or safer to deal with.

5.1.3 Engineering Controls

Engineering control is where the hazard is controlled or limited, generally by a mechanical or physical means. Examples might be:

- Covering over the possibly contaminated area such that the diver is physically separated from the contaminant.
- Creating a gas flow by over pressurising a transfer lock while bleeding gas out of a bell would ensure that contaminant cannot enter the living area.
- Orientating a ship such that the prevailing wind blows any possible gaseous contamination away from the accommodation area.
- Fitting covers (similar to a hot water shroud) to the second stage of the helmet to help prevent ingress of mud through the demand valve.
- As most of the drill mud will be brought back into the bell on the diver's umbilical, mainly in the twisted lay of the hoses, some form of cleaning brush could be fitted to the bell clump weight. This could be a brush that surrounds the umbilical such that the umbilical can be dragged back and forward through the bristles and thus cleaned properly (not a hand scrubbing brush).
- Protecting the first (say) 40 metres of umbilical with some form of rubber (latex) sock. This would be easier to clean or remove by the divers in the water prior to entering the bell.
- Special care should be taken when working with habitats in a known area of drill mud. Prior to landing the habitat a large plastic sheet could be laid out to cover the area of the habitat to prevent any mud giving off gas that could rise into the habitat.
- All doors to safe havens to be kept shut at all times. When the habitat is in position and blown dry the diver should wash the deck plates and walls with correct detergent (not in itself hazardous) to get rid of any residual mud. After entering the habitat the diver should wash the hats and any umbilical, close the reclaim and bag the hat. Disposable protective suits to be bagged. If hot water suits are contaminated then when dry these could start to give off gas so these are also to be bagged until the diver is to return to the bell.
- Fitting extra or specialised filtration to breathing gas supplies.

5.1.4 Administrative Controls

Administrative controls involve laying down policies and managing workplace procedures. Examples might be:

- Limiting the number of personnel on deck who require to handle potentially contaminated equipment.
- Ensuring that only divers and surface personnel that do not have open wounds or skin conditions are used.
- Preparing a detailed procedure to follow and providing copies to the diving supervisor plus any other relevant parties.
- Monitoring for ionising radiation levels on deck such that personnel can be withdrawn to a safe distance if levels rise too high.
- Proper scrub down procedures for the diver when returning to the system.
- Regular change-out of helmets for cleaning and inspection.
- Prior to locking on the bell should be totally drained of excess water, to prevent contaminated water entering the system.

- All equipment that can be left in the bell should be, i.e. hot water suits (if the bell is to be surfaced).
- If back-to-back diving, all equipment should be locked out, including wellington boots, neck dams, gloves, all personal gear (not left in the system to give off gas) and washed in the correct decontamination liquid.
- Any contaminated equipment that can be left outside the bell, i.e. bail-outs, should be left on the clump weight.
- When the bellman has all the umbilical back in the bell with both divers on the clump weight, the umbilical should be sprayed with detergent and washed off with the bellman's hot water hose (bellman on BIBS mask at all times). BIBS masks fitted in the bell should all be fitted with communications, not just the bellman's.

5.1.5 Personal Protective Equipment

Personal protective equipment (PPE) is the last of the control measures to be considered once the potential for the other methods has been thoroughly considered. PPE will limit the effect of any hazard but it must be remembered that the hazard is not removed by the use of PPE – it is still there.

PPE has a distinct role as a control measure however its use as a control measure should not be confused with its more widespread role as a last line of defence should an unplanned incident occur.

PPE is important as a means of hazard control in situations where the exact level of hazard may not be readily quantifiable.

In diving situations, PPE may be the only control measure readily available to the diving contractor. Examples might be:

- Limit points of entry – proper gloves and boots that seal to the suit, neck protection (possibly some form of protective neck and shoulder latex top to be worn next to the skin).
- Properly fitting disposable oversuits are recommended. These must be discarded and left outside the bell before full re-entry of the diver(s).
- The wearing of two pairs of gloves, use of double cuff and neck seals, etc.
- Use of thin undersuits or similar in case outer suit is punctured.

6 References

1. Diving in Waters Contaminated by Drill Mud/Cuttings, Information Note IMCA D 16/02 published in July 2002 (attached as Appendix 4).

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3. Code of Practice for the Safe Handling of Drilling Fluids © 1992 The Institute of Petroleum, London, UK. ISBN 0 471 93461 5.

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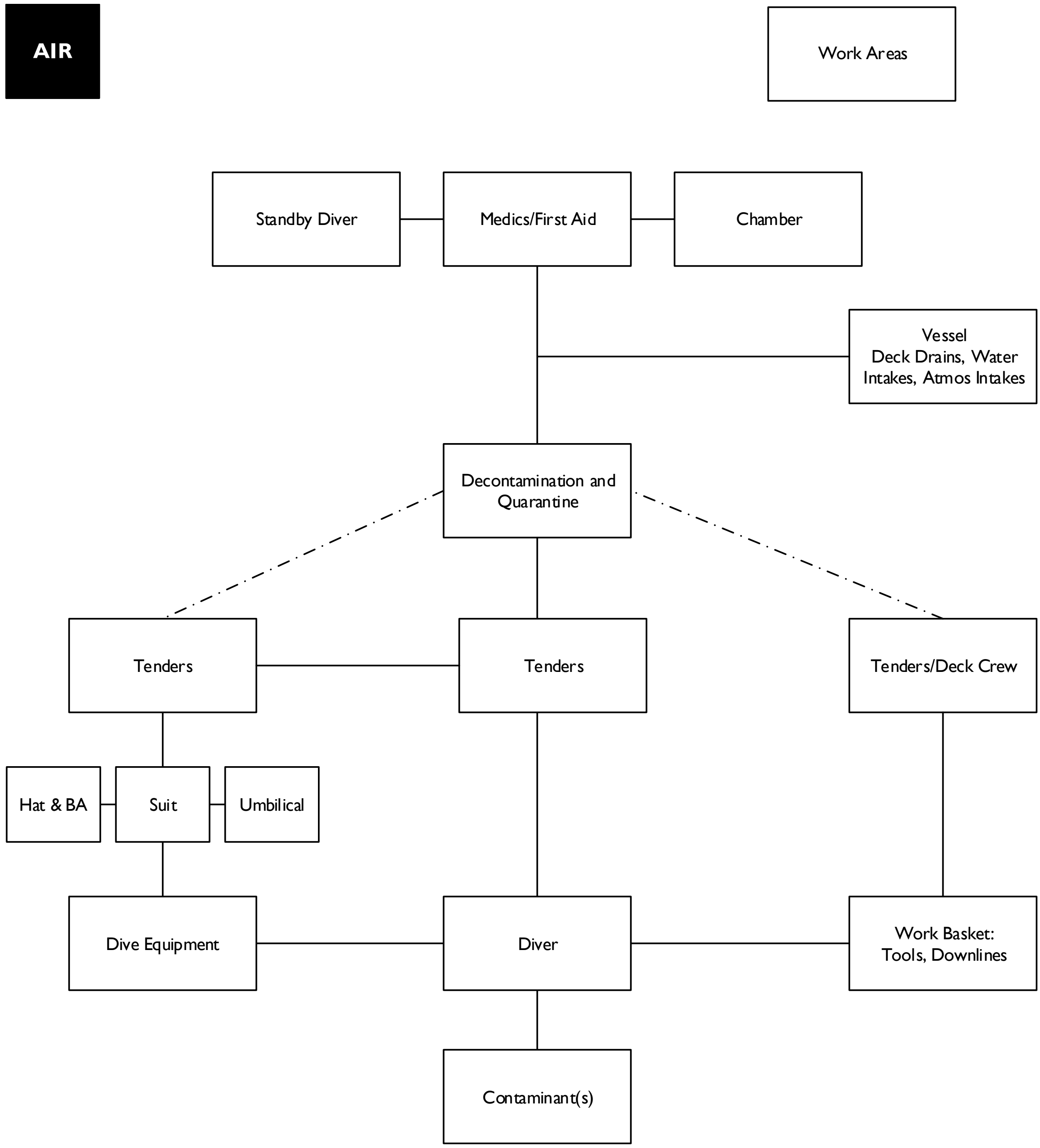
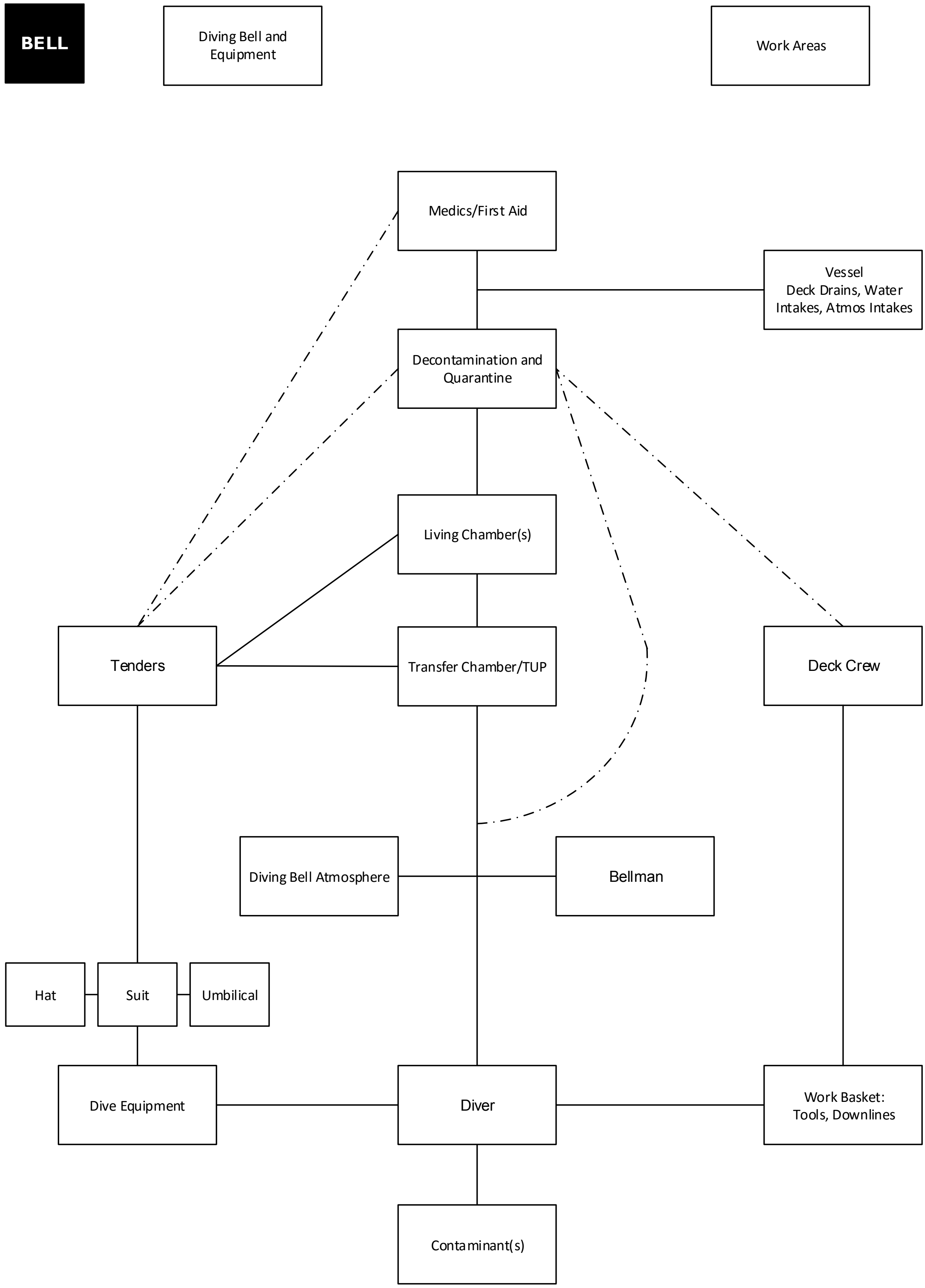
8. Protection of Recreational Divers Against Water Borne Microbiological Hazards: Masterson, BF (1991): Undersea Biomedical Research, Vol 18, No 3, pages 197-203.

Flowchart for Risk Assessment – Surface Diving



Flowchart for Risk Assessment – Bell Diving



Bullet Points for Risk Assessment

Element	Prompts
Contaminant	♦ Access to data on expected contaminants ♦ Response level (applicable to substance category)
Diver	♦ Suitability of personal protective equipment (PPE) ♦ Monitoring ♦ Minimise contact ♦ Method of decontamination ♦ Emergency plan ♦ No skin openings
Dive equipment	♦ Reaction of material to contaminant ♦ Suitability ♦ Method of decontamination
Tenders/LSTs	♦ Handling and containment of contaminated items ♦ Method of decontamination ♦ Suitability of PPE ♦ Emergency plan ♦ No skin openings
Diving bell atmosphere	♦ Bell positioning ♦ Ingress of contaminant ♦ Monitoring ♦ Action if contaminant ingress
Bellman	♦ Exposure to dive equipment contamination ♦ Action if contaminant ingress ♦ Suitability of PPE ♦ Monitoring ♦ Diver decontamination ♦ Emergency plan
Transfer chamber	♦ Ingress of contaminant ♦ Contaminated clothing and equipment ♦ Action if contaminant ingress ♦ Monitoring ♦ Handling and containment of contaminated items
Living chamber	♦ Ingress of contaminant ♦ Contaminated clothing and equipment ♦ Action if contaminant ingress ♦ Monitoring ♦ Health surveillance ♦ Handling and containment of contaminated items
Work basket, tools, downlines	♦ Method of decontamination ♦ Minimise contact ♦ Reaction of material to contaminant ♦ Handling and containment of contaminated items
Deck crew	♦ Handling and containment of contaminated items ♦ Suitability of PPE ♦ Method of decontamination ♦ Minimise contact ♦ Emergency plan ♦ No skin openings
Decontamination and quarantine	♦ Suitability of decontamination equipment ♦ Minimise contact ♦ Handling and containment of contaminated items ♦ Suitability of PPE ♦ Emergency plan
Vessel deck drains, water intakes	♦ Ingress of contaminant ♦ Action if contaminant ingress
Medics/First Aid Personnel	♦ Appropriate treatment ♦ Appropriate medical supplies ♦ Access to data on expected contaminants ♦ Emergency plan
Work areas	♦ External/unplanned incident
Diving bell and handling equipment	♦ Reaction of material to contaminants ♦ Method of decontamination ♦ Minimise contact with contaminants ♦ Emergency plan

Explanation

For ease of understanding, any of the short references above that are not self-explanatory are expanded below:

Suitability of PPE – This refers to checking that the PPE that will be used gives adequate protection to skin etc.; that the material it is made of will not react with the possible contaminant; that it does not restrict the diver or surface personnel in carrying out their task; that the PPE itself does not introduce an extra hazard.

Emergency Plan – This refers to having a plan that has been prepared in advance to consider what actions are necessary in the event of any foreseeable emergency. Typical emergencies would include an unconscious or injured diver, damaged equipment, loss of breathing gas, contamination of personnel etc. The plan must also be available to and understood by all personnel involved in the operation.

Method of Decontamination – This refers to consideration of what actions are required once the actual dive is over. For example how to stop the diver bringing any contaminant in to the bell, how the deck crew will decontaminate the diver, his equipment and tools on the surface, how any contaminated equipment or clothing will be handled and disposed of etc.

Reaction of Material to Contaminant – This indicates that many contaminants are likely to react with materials commonly used in diving. Various rubbers and plastics will deteriorate rapidly if exposed to some chemicals and careful consideration needs to be given to the material of gloves, suits, O rings, diaphragms etc. Solid materials such as steels, coppers etc. may also react badly if exposed to certain contaminants.

Minimise Contact – It may seem obvious but the less contact there will be with the contaminant then the lower the risks. Simple methods for minimising contact can be to keep the diver away from the contaminated area as much as possible or to cover over the contaminated area if possible. Such measures as limiting the number of deck personnel handling possibly contaminated equipment also reduce the likelihood of a problem.

Monitoring – This means more than the normal monitoring of a diver by a supervisor. While the diver is in the water, the supervisor must pay particular attention to the diver's breathing and to his conversation. Mental confusion, slurred speech etc. can be an early sign of problems. Similarly the bellman should be monitored and if possible the bell environment should be monitored for contaminants. Once the divers have returned to the chambers, monitoring of both atmosphere (if possible) and behaviour should be continued.

Action if Contaminant Ingress – This indicates that a plan should exist and be well understood by all as to what actions are required if it is found (or suspected) that a contaminant has actually got in to the atmosphere of the bell or chambers. These actions may be simple for the bell (such as all occupants breathing only on BIBS and the atmosphere being flushed) but in the case of the living chamber the contamination may last for a long period and the plan needs to recognise this possibility. In the case of the vessel's drains, or more seriously the water intakes, plans need to consider both long and short term measures.

Handling and Containment of Contaminated Items – It needs to be recognised that contaminated items such as tools, dive baskets, clothing, breathing apparatus etc. may need to be handled. In order to limit the further spread of contaminant, arrangements need to be in place to handle these items safely (that is minimising the risk to those handling them) and to then either decontaminate them at once or else to securely store them for future decontamination or disposal.

Ingress of Contaminant – This identifies the possible hazard if any of the contaminant is allowed to enter the gaseous environment of the bell or chambers. It is obviously best to keep contaminant outside and measures should be considered to ensure this happens. Measures to minimise the risk might be; flushing of the TUP and bell by slightly pressurising the TUP and exhausting through the bell while the divers are actually transferring from the bell in to the TUP; thorough flushing of the bell atmosphere after it is sealed on completion of the dive and before TUP starts; surfacing the bell for cleaning after TUP and before the next dive starts etc.

Bell Positioning – This refers to two specific points to consider. Firstly the need to ensure that the bell is positioned so that the diver travels the shortest distance possible to the work site and preferably avoids transiting through contaminated areas. Secondly consideration of possible vapours or other contaminants entering the bell through the open bottom door. Towards this end, bells should normally be positioned upstream of any suspected contaminant, remembering that current direction may change with time.

External/Unplanned Incident – This refers to the need to consider what would happen if an incident took place which was not directly related to the work in the contaminated area. Examples might be loss of electrical power, dropping of a load on deck, DP incident or similar. The effect of each of these on the work and the plans made to minimise risks of contamination would need to be considered.

No Skin Openings – This refers to the need to consider whether a diver or member of the surface personnel with an open wound, abrasion or skin condition resulting in broken skin would be at greater risk than a person with whole skin. This will be of most relevance in relation to biological hazards but may also be a factor in other types of contamination.

Diving in Waters Contaminated by Drill Mud or Cuttings

Diving Division

Information Note IMCA D 16/02 **July 2002**

In November 1999, IMCA published guidance note IMCA D 021 – *Diving in potentially contaminated locations.* While that note gives general advice on the problem, this information note has been produced in order to provide more precise guidance on one particular hazard.

1 Introduction

Commercial divers working offshore are sometimes required to dive in situations where there may be contamination in the water. This contamination can be due to the presence of oil-based drill mud and cuttings or can be due to the work the diver is required to carry out, such as the recovery of drums of chemicals, breaking of flanges, working on pipelines, etc.

IMCA has assembled a workgroup to consider all of the evidence available and to develop comprehensive guidance, which will be published in due course. This will address issues such as decontamination procedures.

This brief information note is intended as a 'short term fix' to give practical advice to diving contractors on ways in which they can minimise the risk to divers of exposure to contaminated waters.

One of the most common problems is where divers have to work in areas that are contaminated with drill mud or cuttings. The operator or owner of this area may not be able to provide any detailed information to the diving contractor about the exact chemical composition of the fluids discharged.

This has in the past resulted in localised skin irritations (often called 'burns'), particularly around the neck, wrists and ankles. It is felt that interim advice can be given now on a number of basic precautions that can be taken to protect the diver from such contamination.

2 Risk Assessment

The best advice is for such contamination to be considered as part of the risk assessment carried out before each dive. By considering the risk, a judgement can be made as to the requirements for the dive and any precautions that are needed to protect the diver.

The main perceived risk to the diver from contact with such fluids is skin problems.

One of the difficult problems, however, is that the presence of contamination may not be obvious to those concerned prior to the dive. This is particularly the case in relation to drill mud or cuttings that may be in the vicinity, but their presence or their exact content could well be unknown to those planning the dive.

3 Drill Mud/Cuttings

Over the years many different chemicals have been used in drill mud and stimulation fluids. Their presence may not have been noted in detail, particularly in years past. Known constituents of such fluids that have been used in the past include acids, hydrocarbons, various chemical compounds, etc. Wells drilled in more recent times may be less problematical since more environmentally (and diver) friendly constituents will probably have been used.

Similarly it is impossible to know what may be contained in cuttings that have returned back up the drill hole but it is reasonable to assume some may contain hydrocarbons.

4 Atmosphere Contamination

If the divers are working from a diving bell, there is a risk that contaminants which give off vapours may be introduced in to the diving bell when the divers return to it after their dive. Suitable precautions (such as removing contaminated oversuits before entering the bell) should be considered during the risk assessment in order to minimise this risk.

When considering possible atmospheric contamination of the diving bell, the 5-10 metres of excursion umbilical closest to the diver should be considered as this is the portion most likely to have come in to contact with any contaminants.

If contamination of the bell atmosphere is even suspected, all occupants should breathe from BIBS until such time as the situation has been corrected.

5 Body Protection

In colder waters, such as the North Sea, and in deeper saturation diving, it is normal for divers to wear hot water suits. These provide good protection to the divers body but they do expose the skin at the ankles, wrists and neck where they terminate.

In warmer waters, where divers may be wearing wet suits or even fabric coveralls, the suit may give much less protection to the skin. In such cases, the use of dry suits or other means of protecting the diver's body will need to be considered, although this may introduce possible overheating problems.

In all cases the 'fit' of the suit to the individual diver is important. A well-fitting and well-maintained suit will provide better protection than a suit that is meant for a different size of diver or has been modified in order to fit.

Disposable overalls are sometimes provided to divers if they are working in areas of contamination. It must be realised that the purpose of such overalls is normally not to protect the diver but rather to protect his equipment from heavy soiling and to reduce the risk of contaminants being carried back in to the diving bell.

6 Foot and Ankle Protection

In most diving suits, other than dry suits, the suit stops at ankle level, meaning that the diver has to wear other protection for his feet and ankles. This can take the form of neoprene bootees, wellington boots, lace-up boots, etc. What is important, in the presence of drill mud, is to ensure that the diver's skin is protected.

Simple methods can be used to provide additional protection such as:

- ensuring neoprene bootees are long enough to overlap the leg of the suit;
- covering the joint between bootee and suit with tape or similar;
- using wellington boots with a draw-cord seal at the top;
- wearing waterproof socks of the type used by motorcyclists or climbers.

7 Hand and Wrist Protection

Many divers wear gloves while working. Some of these, such as neoprene gauntlets, provide good protection to the skin of the hands and wrists. Other types, such as canvas work gloves provide less protection.

Simple methods can be used to provide protection such as:

- using gloves that overlap the suit and not ones which expose part of the wrist;
- using gloves made of a material that is resistant to the expected contaminants;
- ensuring gauntlet type gloves are long enough to overlap the arms of the suit;
- covering the joint between gloves and suit with tape or similar;
- wearing thin rubber under-gloves such as domestic, kitchen or surgical gloves under normal diving gloves.

8 Neck, Chest and Shoulder Protection

The gap between the neck of the diving suit and the seal of the diving helmet or mask can be exposed to contaminants. Some manufacturers are currently looking at ways of solving this problem, such as connecting the neck of the suit directly to the helmet. However, the following simple methods are currently available:

- Minimise the area exposed. A 'turtle neck' of neoprene or similar can be used;
- For many diving helmets, a 'cold water' neck seal is available which fits inside the diving suit.

9 Equipment Damage

Divers will frequently 'modify' equipment to suit their individual working styles. In many cases this has in the past involved them cutting parts out of their equipment. Typical examples are divers who cut small holes in boots so that the water drains out of them more quickly when they go back to the bell; divers who cut fingers out of gloves to improve their manual dexterity; cutting back of suit legs, necks and sleeves if they are felt to be the wrong size.

Any such modifications to equipment will reduce the ability of that equipment to provide protection against contaminants and many of these modifications will expose the diver, or those using the equipment after him, to increased risk.

10 Barrier Creams

On the surface, barrier creams are often used to provide protection to skin from irritant materials. The disadvantage of most creams for diving use is that they are normally designed such that they can be relatively easily removed by washing. Such water-soluble creams are thus fairly ineffective in protecting a diver, although water resistant barrier creams are available. Any barrier cream used should be checked regarding its suitability for diving use.

11 Isolation from Problem

One solution which has proved very effective is to cover any known concentrations of contaminated drill cuttings on the seabed such that the activities of the divers does not agitate them and raise contaminants from the seabed.

Covering such access areas for the divers with a plastic membrane, temporary flooring system, removable trackway, portable roadway or similar can therefore provide significantly increased protection to divers working in the vicinity.

12 Conclusion

This guidance is the best available at the moment. Solutions to this problem are, however, constantly evolving and IMCA invites any suggestions for improvement in this advice.

A checklist is attached at Annex 1. This is split in to two parts – one for those planning the work (often onshore) and the second for those at the work site actually carrying out the work.

Diving in Waters Contaminated by Drill Mud/Cuttings: Checklist

Company	Worksite
♦ Has the operator provided details of the composition of the mud?	♦ Do you have details of the composition of the mud?
♦ Has a risk assessment been carried out?	♦ Do you have a copy of the risk assessment? ♦ Have tool box talks taken place?
♦ Has bell atmosphere contamination been considered?	♦ Are suitable precautions in place?
♦ Are enough diving suits of the correct type and size provided?	♦ Does each diver have the correct type and size of diving suit?
♦ Have disposable overalls been provided?	♦ Do you have enough disposable overalls of the correct size?
♦ Have enough boots/socks been provided in a range of sizes?	♦ Has each diver got suitable socks/boots to protect his feet and ankles?
♦ Have enough gloves of a suitable type been provided in a range of sizes?	♦ Has each diver got suitable gloves to protect his hands and wrists?
♦ Are there suitable arrangements to protect the diver's neck/shoulders?	♦ Are there suitable arrangements to protect the diver's neck/shoulders? ♦ Check that none of the divers have 'modified' their protective equipment.
♦ Has suitable barrier cream been provided?	♦ Are the divers using the barrier cream? ♦ Is the barrier cream effective/suitable?
♦ Can the mud/cuttings be covered over to minimise the exposure of the divers?	♦ Has the mud/cuttings been covered over as much as possible?