Cave Diving Group Risk Assessment

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Introduction
Cave diving is an activity that is growing globally, and the Cave Diving Group (CDG) of Great Britain is among many amateur and professional organisations engaged in educating new divers and conducting sporting and exploratory dives all over the world. Caving in England is recognised through Sport England which is accountable to Parliament through the Department for Culture, Media and Sport. Sport England recognises the British Caving Association (BCA) as the national representative body for caving. The BCA in turn recognises the Cave Diving Group as the sole representative body for British cave diving. As such, the CDG is committed to improving the safety of all British cave divers.

This document is primarily concerned with cave diving in the UK, which is the established roots of the organisation. However, it acknowledges that divers trained in British cave conditions may dive globally and whilst the document does not claim to have expertise in different global environments, it will seek to provide guidance and control measures in these circumstances. Members consist of cave explorers who carry out sport and exploratory cave diving in both the UK and abroad. Volunteer members assist new members through a mentorship programme, to safely use well established cave diving techniques to further their experience.

Cave diving members may be either Trainee Divers or Qualified Divers, Trainee Divers learn safe cave diving practices through the mentorship programme. Qualified Diver status is granted by a vote of the Qualified Divers of a regional Section based on the logbook of the Trainee Diver and an Examiner's report covering the Trainee Diver's completion of the theory and practical exams.

The organisation's main objects are:
a) To explore submerged caves and cave passages.
b) To lay down codes of practice for that purpose.
c) To review and publicise new diving techniques.
d) To provide education primarily, but not limited to, the area of side-mount techniques applicable to UK conditions.

This Risk Assessment is intended for use by cave divers with experience of caving. If cave divers do not have extensive caving experience, then the risks associated with cave diving are increased and additional control measures may be appropriate.

This Risk Assessment combines standard practices primarily associated with cave diving in the UK and seeks to control risk through the associated risk assessment. The document is not designed to exhaustively cover the risks incurred by general caving but will acknowledge the unique risks presented when caving beyond flooded cave passages (sumps) and transporting diving equipment underground. This Risk Assessment is not a set of rules that must be followed, but a statement of risks that should be considered and controlled as each diver sees fit. Not all control measures are appropriate for all dives. A wide range of potential control measures are suggested for the diver to think about to allow for a wide range of situations. There is no expectation that a diver must follow any specific control measure. All cave divers are recommended to view this document as a starting point and to develop their own personal Risk Assessments relevant to their background and their specific diving projects.

This document is compiled by volunteers to the best of their knowledge and experience and is reviewed regularly should any significant changes in cave diving techniques or incidents arise.

This document references the Cave Diving Group constitution and Cave Diving Group Manual but does not take precedence over any guidance therein.

Like many activities, cave diving has the potential to be a hazardous activity which can carry significant risk which includes personal injury or death.

Risk Assessment Procedure

Cave Diving topics are grouped into 'Tasks' and these are numbered for reference.

There are two risk scores for each component of the task.

The initial risk score is based around one or more of the following:

- Limited or no experience of the diver.
- Lack of or no training in relevant cave diving skills and procedures.
- No or not enough mitigating actions taken.
- When combined with one or more hazards, can result in the initial risk score.

Example: A flooded mask by itself is unlikely to lead to a fatality. But combined with lack of training, lack of experience, cold water and lack of understanding of suitable gas margins, it could be a contributing factor to a fatality.

The Risk Score (R) is achieved by combining the following factors, using the associated matrix for this risk assessment.

S = Severity
This identifies the actual or potential as a result of the hazard. This ranges from fatality to negligible injury or health implications.

L = Likelihood
This is based on a probability rating from A-E which ranges from very likely to very unlikely.

R = Risk Score
The resulting risk score is then calculated using the matrix. The Risk score results in:

1: High Risk
2: Medium Risk
3: Low Risk.

Owing to the nature of cave diving, the initial risk score, without control measures in place, is likely to be very high.

Once some or all control measure described are in place, where necessary, the residual risk score is likely to be much reduced, making undertaking the task tolerable.

Figure 1: Risk Assessment Matrix Cave Diving Group

Hazard Severity Category	Descriptive Words	Actual / Potential Consequences	Probability Rating				
		Personal Injury / Illness / Fatality	**A** Very Likely	**B** Likely	**C** Possible	**D** Unlikely	**E** Very Unlikely
I	Very High	Fatality(s), terminal condition, permanent disability.	**1**				
II	High	Serious injury, poisoning or requiring emergency hospital or hyperbaric treatment.					
III	Moderate	Injury/illness requiring assistance or medical treatment/rescue.			**2**		
IV	Slight	Minor injury or illness requiring first aid or that can be self-managed i.e. headache, nausea, minor abrasions.					
V	Negligible	Negligible injury or health implications.					**3**

PROBABILITY RATING	RISK PRIORITY CODE
A VERY LIKELY: Almost inevitable that an accident would result. **B LIKELY:** Not certain to happen, but an additional factor may result in an accident. **C POSSIBLE:** Could happen when additional factors are present but otherwise unlikely to occur. **D UNLIKELY:** A rare combination of factors would be required for an incident to result. **E VERY UNLIKELY:** A freak combination of factors would be required for an incident to result.	1. HIGH RISK: Must not proceed. Do not begin the dive, abort the dive in progress or put in place measures to reduce the risk. 2. MEDIUM RISK: Can only proceed when risk has been reduced as far as practically possible, given the experience and capabilities of the diver, taking into account training, knowledge of the site and conditions on the day. 3. LOW RISK: Permissible by those trained and competent but a dynamic assessment should always be undertaken to see if any risk can be reduced further.

TASK 1 - Dive Planning and Preparation

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
1.0	Serious harm including death by cave diving.	Fatality	I	C	1	1. It is recommended that potential cave divers are trained in all emergency procedures in open water first, rather than venturing into an overhead environment without the tools they need to survive. Only when they demonstrate competency in these procedures should they dive in an overhead environment. 2. Cave divers should have sufficient caving experience. Cave diving by its very nature is unforgiving. Diving underwater in an overhead environment with no direct access to air surface, whilst in dark poor visibility conditions is inherently dangerous if safe practices, guidelines, rules and thorough training are not adhered to. Even today, cave diving fatalities occur due to poor or lack of training, disregarding cave diving rules which have been built on many years of experience and are almost always due to human factors. Whilst the number of cave diving fatalities are thankfully relatively low, the outcome of a cave dive going badly wrong is usually fatal. It is rarely one single event that causes a fatality, rather a string of minor events leading the diver into the 'incident pit' which is extremely difficult to recover from.	I	D	2
1.1	Environmental: Underground/Underwater Flood pulse.	Injury Fatality Damage to equipment	I	C	1	1. Check weather forecast and river levels data locally prior to going underground. 2. Assess the impact on the cave in adverse weather such as flooding of dry passages or difficulty returning against (or with) a strong current underwater, in addition to visibility reduction and broken dive lines. 3. Utilise research and knowledge from cavers and divers who know the site well. 4. If cave conditions are not within the normal safe parameters for diving for a particular site, do not dive. Conduct a general site survey once at the dive site. If conditions cause any doubt or concern, do not dive.	I	E	3
1.2	Inadequate or incorrect pre-dive planning.	Injury Fatality	I	C	1	1. Research an unfamiliar site before diving 2. Plan the dive. 3. Treat the site with caution and keep gas margins conservative. 4. Plan for broken lines, unexpected line junctions or no line at all. 5. Build up a knowledge of the system over time and several dives. 6. Be prepared to end the dive early. 7. Plan manageable objectives, with only one unknown, e.g. if you are diving at a new site, only use familiar equipment. If you are trying a new piece of equipment, try it at a familiar site. Whilst it is unlikely that cave surveys will be inaccurate and cause an issue, the lack of a survey and reliance on another diver's memory or description may be the only information available. If available, it is likely that cave surveys will be reasonably accurate and unlikely to cause an issue, however for exploration dives there may be limited or no information available. Where possible it is prudent to consult dive logs and speak to divers who have previously dived at the site, but remember that this information may not be accurate. At previously undivided sites, it may be possible to anticipate some underwater conditions from the cave formation leading to the sump, conditions in other sumps in the cave, or at other nearby sites. Even in well documented sites, silt banks or boulders can move, altering the layout of the cave and potentially leaving a diver ill-prepared for the environment.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
1.3	Diver ill prepared to undertake the planned dive due to physical and mental factors i.e. Lack of sleep, poor fitness, alcohol, medications, poor mental fitness, stress.	Injury Fatality	I	C	1	1. Avoid diving when on any medication contraindicated for diving; excess alcohol prior to a dive can increase risk of decompression illness through dehydration and can affect cognitive ability. Likewise, stress and poor mental health can significantly affect a diver's ability to problem solve underwater. 2. Prior to the dive, moderate any alcohol consumption, ensure they are well rested and in good physical shape to conduct the dive. Do not dive under the influence of alcohol, while hung over, taking medications contraindicated for diving or in a state of poor mental health. 3. Ensure that you are physically fit enough to undertake the dive. 4. Ensure that you are well rested with adequate sleep prior to the intended dive. The severity of the dive is not subject to the amount of sleep or mental fitness, as an overhead environment is unforgiving regardless of depth and distance exposure. Poor physical fitness will add stressors to the dive, increase gas consumption and elevated CO_2 levels which will in turn, affect cognitive ability.	I	E	3
1.4	Nitrogen Narcosis, leading to poor decision making, lack of cognitive ability, potential for fatal mistakes.	Fatality	I	C	1	1. Beyond 30m depth consider how to mitigate narcosis risks. For example, by incorporating a gas that is easier to breathe into their gas mixture, such as helium. 2. Use a gas mix appropriate to the planned depth of dive. 3. Only use mixed gases (Nitrox or Helium based) after receiving training from an agency competent in the field of mixed gas diving and decompression. Dense gases such as air, oxygen and carbon dioxide carry a risk of narcosis, which affects the cognitive ability and thought processes of the diver. Physically, dense gases also decrease the efficiency of gas exchange in the lungs and can increase CO_2 levels which is extremely narcotic and increase the diver's breathing rate. Narcosis affects divers differently on any different dive and divers cannot be 'trained' to manage it. Narcosis is generally considered to become an issue at around 30m (4 atmospheres/ATA).	I	E	3
1.5	Diver breathing the wrong breathing gas for the intended dive.	Fatality	I	C	1	1. Select gases to stay within well-defined safe parameters to avoid narcosis, oxygen toxicity and hypoxia. 2. When diving with mixed gases, measure the oxygen content (and helium if used) using a calibrated analyser and the label the cylinder with: Date of analysis; oxygen/helium %; fill pressure in bar; divers' signature. 3. Analyses every diving cylinder prior to diving. 4. Label the cylinder with the analysis details and mark the cylinder with the maximum operating depth of the gas contents. Diving the wrong gas at the wrong depth has been identified as one of the leading causes of fatality in divers. The only certain way to ascertain what gas is in a diving cylinder is to analyse it.	I	E	3

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
1.6	Hypercapnia – CO_2 retention.	Fatality	I	C	1	1. Do not use skip breathing to reduce gas consumption if there is a risk of elevated CO_2 retention. 2. Ensure your breathing apparatus has a sufficiently low work of breathing for the planned dive. 3. To control the risks associated with hypercapnia caused by the increased density of gases at depth when using a rebreather, it seems prudent to recommend an ideal maximum gas density of 5.2 g/L (equivalent to air diving at 31 m) and an absolute maximum of 6.2 g/L (equivalent to air diving at 39 m) [Anthony et al, 2016]. 4. Consider measures to limit strenuous activity underwater such as mechanical aids for digging, or the use of DPVs in caves with strong flow. This is particularly important at depths greater than 30m. 5. Ensure CO_2 scrubbers are correctly maintained and pre-dive checks are correctly conducted. Diving can cause a retention of CO_2 or hypercapnia. An elevated $PaCO_2$ can cause unpleasant and dangerous symptoms, increase inert gas narcosis, and predispose to cerebral oxygen toxicity. Retention of CO_2 can be exacerbated by strenuous exercise underwater or by using dense gases such as air, nitrogen or oxygen at depth. Some rebreathers can have a higher work of breathing than open circuit regulators, which will increase the potential for CO_2 retention. It is possible to have a CO_2 'hit' on open circuit, examples are known due to diving dense gasses, stress and working hard into a strong current.	I	E	3
1.7	Contaminated breathing gas.	Fatality	I	C	1	1. Compressors should be kept in good condition, exhausts kept well away and downwind of the intakes. 2. Taking a few breaths from the cylinders before diving may indicate any bad tasting or smelling gas. 3. If contaminated breathing gas is suspected, do not dive. Empty the cylinder and get it inspected for oil and other contaminants. It may require internal inspection and cleaning. 4. If contaminated gas is first suspected during the dive swap regulators to see if the problem goes away and immediately return to the nearest safe surface area breathing from the least contaminated supply (probably dive base). Remember that narcosis can sometimes cause a metallic taste. If diving with another person, consider sharing gas and swapping a breathing set if needed.	I	D	2
1.8	Injury on approach or entry to dive site, such as slips, trips or falls.	Fatality Injury Rescue	I	C	1	1. Follow good caving practises when moving underground. 2. Conduct a site survey prior to moving equipment to the water. 3. Maintain awareness of muddy, slippery access, obstructions such as barbed wire, loose rocks or cliff edges. 4. Use appropriate footwear for slippery or wet paths. 5. Store diving equipment out of sight ideally and out of reach of the public where they cannot come to harm by falling over equipment or tampering with it.	I	E	3
1.9	Animal/Insect bites.	Injury Illness	I	C	1	1. Take precautions if there is a likelihood of local wildlife ingress into drysuits and wetsuits and use insect repellent suitable for the country you are diving in. 2. Take local advice on likely encounters with harmful wildlife. 3. Abort the dive if you are feeling unwell or local wildlife is posing a risk. 4. Be aware that allergic reactions due to insect or animal bites have the potential to cause issues during a dive.	I	E	3

TASK 2 - Gas Management for Cave Diving

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
2.1	Running out of breathing gas (open circuit).	Fatality	I	C	1	1. Carry a minimum of two independent breathing sets. 2. Follow gas margins as described in the CDG Manual; at a minimum respect the rule of thirds. 3. Carry an additional margin of gas to fix problems at the maximum expected depth. 4. Consider the performance of your specific regulators. Some regulators may not allow you to effectively access the last 10 to 20 bar of gas, so this last portion of gas should be excluded from your margin calculations. 5. Consider carrying additional gas if conditions, tasks or personal experience increase the risk. 6. Consider carrying a stage cylinder to increase equipment redundancy. 7. Calculate gas margins after cylinders have cooled to cave water temperature 8. Regularly monitor contents gauges; more frequently the smaller the gas volumes carried. 9. Ensure equipment is well serviced. 10. Regularly switch between breathing sets. 11. In previously explored and documented caves, familiarise yourself with any air bells or alternative exit points, including those off-route. 12. Where appropriate, train and dive with others to allow gas sharing in an emergency. 13. Adhere to your own turn point. Do not be led on by others. 14. Use a gauge reader to read SPGs in zero visibility conditions. 15. If appropriate to the site, the divers and their training then, when diving with another person, it may be appropriate to consider sharing gas. 16. Pay particular attention near the entrance in a low on gas situation. Most out of gas fatalities happen close to the entrance Factors which can cause a breach in the gas rules are: Low or zero visibility on the return dive; current; loss of dive line; broken line on return dive; entanglement in dive line; increased gas consumption for various reasons such as cold, fatigue, duress, loss of buoyancy, equipment failure; failure to observe pre-determined turn point etc. In most situations, the above factors can be managed through proper dive planning, training and personal discipline of the diver. In exceptional or unforeseeable circumstances, such as multiple equipment failure, severe line entanglement or personal injury, a diver may find themselves short of gas, despite adequate preparation, training and discipline. The options available to a diver in this situation will depend entirely on the cave environment, equipment configuration and presence, or otherwise, of other divers. Solo diving: In many UK sumps, it is not viable, or desirable to dive with others. In such situations, if a diver has less gas than planned, they may have a number of options depending on the cause of the shortage and the nature of the cave. In the event of equipment malfunction, control measures to make best use of available gas are covered later in	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
						this document. If there are available and usable air spaces, the diver may be able to surface and await rescue, or exit the cave via an alternative route. In the event of awaiting rescue, consideration should be given to both air quality and quantity, as well as the ability to exit the water to maintain body temperature. If an alternative exit exits, the diver should consider the route and equipment needed while planning the dive. Diving with others: In some situations, it may be viable to dive effectively with others. In such situations, if a diver has less gas than planned, in addition to the options discussed above they may also request gas from another diver if possible – this should be pre-discussed. This may mean giving them a cylinder if the cave is small. Most divers run out of gas close to the end of the dive or the surface, so it is entirely acceptable for another diver who remains within acceptable gas margins to offer spare gas. This goes much smoother if divers have trained for it. There are plenty of dive sites in the UK that would facilitate a gas sharing exit easily. If diving with others, consider the additional risks this may introduce, as covered later in this document. Any diver running out of gas in a sump will likely become a fatality.			
2.2	Gas contents gauge failure.	Fatality	I	C	1	1. Check SPG reads zero before it is pressurized. 2. Calibrate SPGs against other SPGs 3. Do not rely upon SPG when reading 50 bar or less. 4. Keep pressure gauges and hoses well serviced. 5. In the event of a hose rupture, turn off the affected cylinder and abort the dive, breathing from the working cylinder. 6. The option to feather the valve (using the cylinder tap to control air flow to the regulator) will cause a slowed exit and should only be used in the event of the working cylinder running out. 7. In the event of one or both contents gauge failure on the inward dive, abort the dive. 8. In the event of a both contents gauge failure on the return dive, keep breathing and switching regulators every few minutes so long as they continue to deliver gas.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
2.3	Single regulator failure.	Fatality Injury	I	C	1	1. Dive with two independent sets of breathing apparatus and be proficient in switching between regulators. 2. Test regulators on surface and also in water to check functionality and water ingress. Consider a split mouthpiece and/or a poorly sealed exhaust valve which may not be apparent in air. 3. Keep regulators well maintained and serviced. 4. Conduct a flow check when passing small cave passages and in situations that involve a lot of arm movement such as laying line or underwater digging in case a cylinder valve has rolled off. 5. Utilise rule of 3rds gas rule as a minimum. 6. In the event of a single regulator failure whilst diving, refer to training as to whether the failure is a fixable or non-fixable failure. Purging a regulator or feathering a cylinder valve may provide gas to get to safety. 7. In the event of a non-fixable failure, abort the dive. 8. Learn to breathe from a free-flowing regulator and a flooding second stage. This can allow access to otherwise unavailable gas should the need arise on the dive out. 9. Regulators may have specific failure modes in the cave environment that have not been considered by the manufacturer. 10. Use regulator designs with a proven track record for performing in a cave environment.	IV	C	3
2.4	Failure of all regulators.	Fatality	I	C	1	1. Test regulators on surface and also in water to check functionality and water ingress. 2. Test for a split mouthpiece and/or a poorly sealed exhaust valve which may not be apparent in air. 3. Keep regulators well maintained. 4. Conduct a flow check when passing small cave passages and in situations that involve a lot of arm movement such as laying line or underwater digging in case a cylinder valve has rolled off. 5. Utilise rule of 3rds gas rule as a minimum and carry two separate gas sources, adequate to reach safety. 6. Refer to training whereby purging a regulator may provide gas to get to safety or feathering a cylinder valve. 7. Check cylinder valves are fully open. 8. Consider carrying a third stage cylinder. 9. If appropriate to the site, the divers and their training then, when diving with another person, it may be appropriate to consider sharing gas.	I	D	2
2.5	Cylinder tap failure – gas leak.	Fatality	I	C	1	1. Check cylinder taps for leaks in water prior to the dive. 2. Keep cylinders in service. 3. Carry at least two independent sources of breathing gas and utilise the rule of 3rds as a minimum. 4. In the event of a cylinder neck leak, this will not be fixable during a dive so the dive must be aborted. 5. Consider using cylinder taps without a Pressure Release Device (burst disc). In the event of a cylinder neck leak, this will not be fixable during a dive so the dive must be aborted.	I	D	2
2.6	Cylinder tap failure – no gas delivered during dive.	Fatality	I	C	1	1. Conduct a flow check to test for roll off. 2. Check SPG; is the cylinder empty? 3. Carry at least two independent sources of breathing gas and utilise the rule of 3rds as a minimum.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
2.7	Using wrong breathing gas for the given depth when switching between two different mixtures of gases.	Fatality	I	C	1	1. Ensure the gas has been analysed and all cylinders are marked with the maximum operating depth for the gas in those cylinders. 2. Stop and stabilise and reference the dive line. 3. Check the MOD of the cylinder matches the depth on the diver's depth gauge/computer. 4. Pressurise the cylinder then turn the valve off. 5. Pick up the regulator expected to be attached to the cylinder and purge the regulator. Confirm that the pressure gauge on the confirmed bottle is attached to the regulator you want to switch to. 6. Open the cylinder valve fully. 7. If diving with another diver, they should confirm the cylinder MOD (maximum operating depth) for the gas, with their own depth gauge/computer before confirming to you that it is safe to switch. 8. Remove existing regulator and replace with new regulator. Be aware that switching from one cylinder to another is a regular expectation to 'balance' diving cylinder contents when diving independent sidemount cylinders. The risk is reduced when the generic gas is the same in both cylinders for the maximum bottom depth. The risk is increased when the diver switches to another cylinder containing a different gas mix, quite often containing decompression gas which is richer in oxygen. Specific steps should be taken during a gas switch to ensure the diver is switching to a safe gas. Risks include oxygen toxicity and hypoxia.	I	E	3

TASK 3 - Cave Diving Line

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
3.1	Line entanglement.	Fatality Injury	I	C	1	1. Use lines that are suitable for the cave environment. 2. Use thicker lines in areas prone to lower visibility, or colder water. 3. Use regular belays to optimise the line route which should be easy to follow in zero visibility. 4. When following pre-existing lines, remove any slack in lines if possible, tidy or re-lay line if required. 5. Divers should aim to be as streamlined as possible, reducing any entanglement hazards on their person such as dangling reels or straps and hoses sticking out. 6. Divers should be trained in line entanglement procedures in open water before entering an overhead environment. 7. Divers should carry a minimum of one, preferably two, line cutting tool, appropriate to the line in the cave environment. This should be easy to deploy in a small cave passage. Consider different types of line cutters if wire or cable is expected to be encountered. 8. If a diver cannot clear an entanglement then cutting the line may be necessary. Cutting and repairing lines should be well practised in open water before entering an overhead environment. 9. Every attempt should be made to repair a cut line. If there is another diver in the cave on the inward side of the cut line, then the line must be repaired to enable their safe exit. 10. Ensure that the exit line is referenced at all times. 11. In very constricted passage consider routing the line through a hose pipe to reduce entanglement risk	I	D	2
3.2	Broken line.	Fatality	I	B	1	1. Be aware that existing cave lines can be broken by floods, poor belays, other divers or deterioration due to age. 2. Expect to mend any broken lines during the inbound dive and consider an extra dive reel with line to patch any problem areas. 3. Cave divers should be well trained in repairing broken lines and not enter into an overhead until they are proficient. 4. Always take note prior to the dive of the compass direction that the cave trends – in and out. 5. Always carry a search reel which should have enough line to cover the longest distance between belays and to be able to conduct both vertical and circular searches of the cave passage dimensions. In larger caves this could be as much as 30 metres of line or more. 6. In the case of encountering a broken line on the homeward journey, follow lost line procedures as set out in training: Tie the search reel into the existing line and begin lost line search patterns until the continuing line is found.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
3.3	Lost line.	Fatality	I	C	1	1. In the case of losing the line, follow lost line procedures as set out in training: a. Stop. b. Make note of the direction of travel and compass bearing. c. Tie search reel to nearest suitable belay the diver can find. Maintain heading and tie in a secondary belay if available to assist with direction of travel. d. Use a search reel to begin a suitable search pattern for the cave shape. e. Continue the search until the line is relocated 2. Divers should not stray much more than an arm's length from cave line in UK caves in general and physically follow the line by hand in poor or zero visibility. 3. Always take note prior to the dive of the compass direction that the cave trends – in and out. 4. Always carry a search reel which should have enough line to cover the longest distance between belays and to be able to conduct both vertical and circular searches of the cave passage dimensions. In larger caves this could be as much as 30 metres of line or more. Losing the line can mean losing contact visually or physically.	I	D	2
3.4	Unexpected line junction.	Fatality	I	C	1	1. Plan and research dives and dive sites as much as possible. 2. Obtain descriptions and surveys where possible. 3. Carry personal line markers, to aid correct navigation and put a line marker per diver on the exit side of the line junction. 4. Make a note of compass bearings and any sharp turns on the inward journey. 5. In the instance of finding an unexpected line junction on the return journey, having not seen it on the way on, refer to outbound compass bearing before continuing.	I	D	2
3.5	Line belay failure.	Fatality	I	C	1	1. Avoid pulling on dive lines which can dislodge line belays. 2. Repair any line belays on the inward journey to enable safe navigation home. 3. Ensure that primary belays in air surface are backed up shortly afterwards with a secondary belay underwater, but still under or very close to airspace.	I	D	2
3.6	Line routing failure: Line pulls into a bedding or rift that is too small for the diver to follow.	Fatality	I	C	1	1. Use intermediate belays to make the line safe to follow both on the inward and outward journey. 2. If a diver cannot follow the line on the return journey, a search reel may be used to bypass the undercut or obstruction. This can be used to maintain contact with the line whilst moving forwards a distance away from it. 3. A line that is not visible or reachable on the way in should be fixed and made followable before continuing the dive.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
3.7	Multiple (fixed) lines.	Fatality	I	C	1	1. Be aware Multiple lines in the same cave passage can create an entanglement and navigation hazard. 2. Do not assume that all lines go to the same destination. 3. Do not 'jump' from one line to another without connecting the lines with a gap reel and marking the homeward line. 4. There should always be a personal marker per diver. 5. Consider removing redundant lines which head in the same direction as they are surplus to requirement and create a hazard. 6. When replacing dive lines, the new line should be laid before the old line is removed and divers warned about multiple lines in the sump while the work is ongoing.	I	D	2
3.8	Lack of line junction: Removal of a jump or gap line that created a junction.	Fatality	I	C	1	1. Ensure there is a single continuous guideline from/to air surface or open water. 2. A line junction that is intended to lead to safety i.e. the exit line or to air surface, should NEVER be removed by anyone until the last diver is confirmed as on the surface and safe. 3. Temporary junctions should always be marked with a personal marker placed by each diver passing the junction and only removed by that diver. Only when one remaining diver is left in the sump should the temporary line be removed. 4. Multiple divers or groups of divers diving at the same site must use their own temporary lines and mark them with their own personal markers. 5. If two divers or groups of divers are both laying line in the same place, then your line should be laid underneath theirs. Avoid sharing the same belays where possible. 6. Never interfere with another diver's line under any circumstances, even if you believe them to be out of the cave. 7. Lines from the surface should be shortly backed up by secondary belays underwater to help prevent the public tampering with lines. 8. If there is any doubt about a divers whereabouts then the primary line to safety should stay in situ. 9. Should a diver find themselves without a line to surface/safety they must immediately conduct a lost line search procedure to try to find the exit or the broken line. Bear in mind, the line they are looking for has been removed or broken and the chances of success in poor visibility are extremely limited. 10. Divers should be thoroughly trained in lost line search drills in open water before entering any overhead environment.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
3.9	Failure to follow the guideline.	Fatality	I	C	1	1. In the case of losing the line, follow lost line procedures as set out in training: a. Stop. b. Make note of the direction of travel and compass bearing. c. Tie search reel to nearest suitable belay the diver can find. d. Maintain heading and tie in a secondary belay if available to assist with direction of travel. e. Use a search reel to begin a suitable search pattern for the cave shape. 2. Pay close attention to following a single continuous line and be aware of any parallel lines, line gaps or line junctions. 3. Divers should not stray much more than an arm's length from cave line in UK caves in general and physically follow the line by hand in poor or zero visibility. 4. Always take note prior to the dive of the compass direction that the cave trends – in and out. 5. Always carry a search reel which should have enough line to cover the longest distance between belays and to be able to conduct vertical and circular searches of the cave passage dimensions. In larger caves this could be as much as 30 metres of line or more. Failing to follow a dive line correctly can lead to a lost line. Losing the line can mean losing contact visually or physically.	I	D	2
3.10	Unexpected removal of a dive line.	Fatality	I	C	1	1. Be aware that failure to maintain a single continuous guideline from/to air surface or open water is the primary cause of fatalities in the cave environment. It is the most common, direct reason for overhead fatalities. 2. Dive lines should NEVER be removed by anyone until the last diver is confirmed as on the surface and safe. 3. Temporary junctions should always be marked with an individual divers personal marker and only when the one remaining diver is left in the sump and markers removed, should they remove the temporary line. 4. Multiple divers or groups of divers diving at the same site must use their own temporary lines and mark them with their own personal markers. 5. If two divers or groups of divers are both laying line in the same place, then your line should be laid underneath theirs. Avoid sharing the same belays where possible. 6. Never interfere with another diver's line under any circumstances, even if you believe them to be out of the cave. 7. Should a diver find themselves without a line to surface/safety they must immediately conduct a lost line search procedure to try to find the exit or the broken line. Bear in mind, the line they are looking for has been removed or broken and the chances of success in poor visibility are extremely limited. 8. Divers should be thoroughly trained in lost line search drills in open water before entering any overhead environment.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
3.11	Route finding problems/unrecognised destinations.	Fatality	I	C	1	1. Maintain visual or physical contact with the intended guideline. 2. A diver finding themselves in cave they do not think they should be in may have missed a junction, lost the main line, followed an incorrect line or misunderstood a survey or description. So long as a line connected to safety is followed, and the return journey established with gas margins being safely followed, going into the wrong bit of cave should be a minor inconvenience. 3. In the case of missing a junction or jumping to a wrong line, a compass bearing for home should be taken immediately and the diver retrace their steps until the main line home is found.	I	D	2

TASK 4 - The Cave Environment

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
4.1	Physical changes to the cave during the dive.	Fatality Injury	I	C	1	1. Be aware that cave features can change during a dive as a result of diving activity(including exhaust bubbles), flood pulse and unstable areas. Particularly dangerous conditions can involve gravel slopes slumping and trapping a diver, likewise mud squeezes on slopes or small boulder chokes where physical contact may cause a collapse. 2. Consider each site according to the risk. 3. Avoid pushing through mobile slopes of mud/gravel without a clear exit behind; where possible consider stabilising. 4. Consider shoring up boulder chokes. 5. Take the time to dig open any cobble or gravel squeezes, on another dive with additional gas to ensure a clear exit. 6. If there is any doubt at all about the safety of a cave feature, do not attempt to pass it. 7. Be aware that diving with others may exacerbate problems, particularly as a second diver may be passing unstable features in reduced visibility.	I	D	2
4.2	Underwater – falling objects.	Fatality Injury	I	C	1	1. Be aware that objects can fall underwater and cause both harm and entrapment. 2. Consideration must be taken especially in boulder chokes or passing under them, as well as man-made environments such as mines, where exhalation bubbles can cause roof collapses or diver movement can dislodge roof props. 3. Work on boulder chokes from the exit side. 4. In mines, avoid touching roof props and stay away from known or potentially unstable areas. Avoid diving in areas where the roof condition is not either visible or known. Consider specific mine diving training if intending to dive in this environment, since the hazard profile is different to that of a cave. 5. Avoid lingering in one place in mines and creating large air bubbles in the roof. 6. Reinforce known unstable areas if safe to do so.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
4.3	Strong currents.	Fatality Injury	I	C	1	1. Dive planning should take into account caves prone to high flow, the effects on visibility and the changeability of conditions due to weather. 2. When beginning a dive downstream, the diver must use modified gas reserves and calculate likely gas consumption for the return journey against the current. 3. Give consideration to an increased breathing rate, causing elevated levels of CO_2 and resulting narcosis. Working hard on a CCR can result in elevated levels of CO_2, resulting in narcosis, hypercapnia (high levels of carbon dioxide in the blood) and the possibility of needing to bail out to open circuit. 4. Do not dive reactive sites in unstable weather. 5. Plan gas reserves for the likely conditions. 6. Plan for a reduction in visibility and broken lines and loose lines in a high flow cave. 7. Use 'pull and glide 'techniques, using the cave passage and not the line, to make progress if required. 8. If the environment does not feel safe, abort the dive. 9. On CCR, carry enough bailout gas to return to dive base from the furthest part of the planned dive, with an elevated breathing rate.	I	D	2
4.4	Becoming physically stuck underwater.	Fatality	I	C	1	1. Be aware that some sumps have been explored by extraordinarily thin divers using specialised techniques for "pushing" confined spaces. Also, some cave features change shape between dives or during a dive (e.g. gravel banks) and may become impassable very quickly. 2. Do not expect to always be able to follow any line or cave passage in existence and plan dives accordingly. 3. Gain experience of passing cave squeezes above water before attempting an underwater squeeze. 4. Practice techniques such as removing a cylinder in an open water environment before attempting this in a cave; be aware of how this will affect your buoyancy. 5. Critically examine your equipment configuration and your ability with respect to passing confined sections of sump before entering the water. 6. Research the dimensions of the passage for your planned dive before entering the water. 7. If you are concerned about becoming stuck, then do not proceed with the dive. In the case of becoming physically stuck; 1. Stop. Presence of mind will be of primary assistance in recovery from this hazard. 2. Recovery actions will depend on the nature of the obstacle, but the opportunities for external assistance will be limited. Options may involve taking a cylinder off to pass through a small space to retreat. 3. In the case of entrapment beyond a slumped gravel slope underwater and unable to make a space for exit, time for retreat is limited. If a known air space/air bell is nearby and accessible, retreat to this and wait for assistance.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
4.5	Becoming trapped by another diver.	Fatality	I	C	1	1. If diving with others, be aware of the risk of another diver blocking your way to safety. This may be because: they have caused an unstable feature to collapse; they have become physically stuck; there is not space for you to pass them. 2. When passing sumps with a known constriction, ensure sufficient time is left between divers to allow one diver to pass the sump before the next enters the water. 3. Consider if it necessary for two divers to conduct the dive at the same time. 4. Consider the physical size and experience of any other divers you plan to dive with.	I	D	2
4.6	Collision with physical objects.	Injury	IV	B	2	1. Wear a helmet. 2. Make every effort to maintain neutral buoyancy and look up and ahead when diving, not down at the floor. 3. In poor visibility, maintain one hand on the guideline and another outstretched in front to feel for roof projections or objects and slow the swim speed down.	IV	D	3
4.7	Interference to equipment/line by other people.	Fatality	I	C	1	1. When diving in popular/well-travelled caves abroad, be aware of the increased risk that your line or equipment may be removed by mistake. 2. Follow local line laying protocol when laying lines from the surface. 3. Consider hiding decompression/ stage cylinders off the beaten track, out of sight. It is prudent though to mark the line to find them again.	I	D	2
4.8	Anxiety, fear or panic due to cave environment.	Fatality	I	C	1	1. Ensure that you are familiar with, and comfortable in, the cave environment before diving in a cave. 2. As a novice, avoid constricted sites and sites with poor visibility. 3. Limit task-loading, by planning manageable objectives for the dive. 4. Build familiarity with a new site over multiple dives. 5. If you become out of practice either diving or caving, rebuild experience in familiar sites before undertaking a trip to a new site. 6. In the event of rising anxiety, stop and recover self-control before continuing, or turning the dive. Avoid making a rushed exit in an anxious state as this will increase gas consumption and increase the chances of another accident.	I	D	2
4.9	Disorientation.	Fatality	I	C	1	1. Note the general bearing of the sump before starting the dive and at any changes in direction. This could either be a mental note, or written on the diver's slate, or by regularly rotating the compass bezel to the direction of travel. 2. Wear a compass in a visible and accessible location (e.g. wrist). 3. Learn to recognise the features and formation of a cave above water before diving in a cave. 4. Where visibility allows, be observant of your surroundings and the features of the cave. Do not just follow the dive line. 5. Where possible, take care to preserve visibility. 6. Use directional line markers at junctions. 1. 7. When loading a line reel, mark dive lines with distance and out tags	I	D	2

TASK 5 - Hazards of the Dry Cave Environment in Relation to Cave Diving

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
5.1	Falling objects – above water.	Fatality Injury	I	C	1	1. Be aware of the risk of rock falls underground. 2. Be cautious of boulder chokes, loose pitch heads and other areas liable to falling objects. 3. Always wear a suitable helmet in dry cave passages; canoe helmets do not generally provide protection against falling objects. 4. Kit up away from areas likely to be at risk from falling objects. 5. Consider the likelihood of falling rocks at resurgences below cliffs.	I	D	2
5.2	Falling/injury underground when beyond a sump.	Fatality Injury	I	C	1	1. Avoid caving alone beyond a sump, where practicable. 2. Wear a suitable caving helmet when caving beyond a sump; canoe helmets may be comfortable for diving, but are not generally suitable for dry caving. 3. Wear suitable footwear when caving beyond sumps; avoid drysuit 'booties' which offer no grip or ankle support. 4. Consider additional aids to make access to dry cave beyond a sump safer, such as slings, hand lines, electron ladders, cowstails and jammers etc. 5. For project trips beyond a sump or frequently visited sites consider setting up a rescue dump in case of emergency. It is essential that you have sufficient caving experience when planning to cave beyond a sump. The risks owing to the remoteness and difficulty of rescue beyond sumps should not be underestimated. Caving alone beyond sumps carries higher risk if a diver is injured. There is nobody to provide assistance or exit the cave to raise the alarm. Hypothermia and injuries become serious very quickly.	I	D	2
5.3	Contaminated air i.e. low oxygen content, high CO_2 levels in air bells, or H_2S.	Fatality	I	C	1	1. Be aware that some caves and mines are particularly prone to high levels of CO_2 which can affect breathing rate and cognitive ability. Low oxygen in air bells can result in lack of cognitive ability and unconsciousness. H_2S (hydrogen sulphide) is extremely dangerous and high levels affect the central nervous system, leading to convulsions and death. 2. Avoid surfacing in places with known H_2S. 3. Avoid breathing ambient air in caves with known high levels of CO_2 or low levels of oxygen. 4. Divers should be alert to the signs and symptoms of hypoxia, especially in other divers as they may not be able to recognise symptoms in themselves. 5. If there is any doubt, no matter how small, leave the cave.	I	D	2
5.4	Damage of diving equipment during transportation.	Fatality	I	C	1	1. Expect that anything that can be broken, will be and make efforts to keep gear tidy and protected. 2. Check all equipment thoroughly for correct function prior to entering the water. 3. Use all available options such as separate drums, boxes, bags to protect equipment when carrying. 4. Take the time to educate any caving helpers in the moving of diving gear through the cave and more fragile parts to look out for. 5. Keep fragile items such as regulators, pressure gauges and masks packed and protected and not loose such as hanging off a harness, cylinder or loose in a fin pocket. 6. Use steel blanking plugs to protect DIN cylinder valves.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
5.5	Damage to/ loss of equipment at dive base.	Fatality Injury	I	C	1	1. Where possible, sort equipment and kit up away from deep or flowing water, particularly if regulators need dismantling to clean. 2. Where possible, avoid sorting equipment in muddy conditions and take particular care to avoid the ingress of mud into regulators. 3. Use a 'washing line' to secure equipment. 4. Always leave your regulator necklace attached to one regulator. 5. Avoid putting your mask down anywhere where anything could be put on top of it. 6. Consider the potential for rising water or flood pulses if leaving equipment to continue caving beyond a sump. 7. Carry a spare mask. 8. Carry an emergency tool kit, including hex key, spanner, spare O-rings and regulator blanking plugs. 9. Keep a separate back-up light on your person when removing your helmet during kitting up.	I	D	2
5.6	Loss of above ground communications (e.g. failure of telephones or radios) which may be required in an emergency.	Fatality Injury	I	C	1	1. Plan according to the limitations of surface communications when making diving plans such as surface coordination of support or contingency plans in the event of an emergency. 2. Plan your diving on the assumption that above ground communications are outside of your control. 3. Make contingency plans in regions with poor cell coverage, such as satellite phones. 4. Make an agreed plan of action if communications are poor. 5. Ensure everyone has appropriate access to all vehicles in an emergency.	I	D	2
5.7	Lack of or unexpected loss of underground to surface communications.	Fatality	I	C	1	1. Expect failure of underground to surface communications. 2. Do not plan your dive to rely on underground to surface communication for safety. 3. Make contingency plans and an agreed timeline with flexibility, with surface support in the event of surface to underground communications failure. 4. Ensure this plan is written down for both surface and underground parties to avoid confusion.	I	D	2
5.8	Failure of any artificial aid, e.g. ladder, bolt, belay, bridge, step, rope, stemple... etc.	Fatality Injury	I	C	1	1. Test all artificial aids before use. 2. Expect artificial aids to have been placed to assist the original user during original exploration and not to be suitable for subsequent usage. Be aware that Artificial aids in caves are designed to help prevent incidents but their failure can cause serious injury, especially from height.	I	D	2

TASK 6 - Diving Equipment Failures

Diving equipment, in the modern age, is rarely the cause of fatalities, which are most often human and procedural errors/lack of training.

Diving equipment is often blamed as it is more palatable to blame equipment than the deceased. Diving equipment if maintained properly and quality equipment sought, should offer no problems underwater to the diver that cannot be easily managed. Redundancy is important in the overhead environment and equipment can be easily damaged if handled incorrectly.

Divers should be well trained in equipment failure procedures but also follow clear cave diving protocols to mitigate one problem becoming life threatening. Divers should be trained well enough that the failure of any piece of equipment is no more than a minor inconvenience. The failure may be fixable and the dive safe to continue, or non-fixable in which case the dive must be aborted.

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
6.1	Total mask failure.	Fatality	I	C	1	1. Check the integrity of the mask prior to entering the water. 2. Carry a spare mask, especially if caving beyond a sump where the risk of breakage is much higher. 3. Divers should be trained in open water in following a line underwater without a mask, before going into an overhead environment. 4. If a mask fails underwater, replace it with a spare mask. 5. In the event of no spare mask available, abort the dive and follow the line home by hand. 6. If a mask fails beyond a sump, use a spare. 7. If you do not have a spare mask beyond a sump, weigh up the risk of diving out without a mask versus waiting for assistance.	I	D	2
6.2	Mask flooding.	Fatality	I	C	1	1. Ensure the mask fits well and is in good repair. 2. Be aware that mask flooding is a potential problem if the mask is knocked against rock, and in particular for dives in constricted cave passages. 3. Train divers in mask clearing drills. 4. Practice diving with no mask. 5. Consider carrying a second mask on a dive and ensure the diver is proficient in swapping masks when also diving with a helmet.	I	D	2
6.3	Single light source failure.	Fatality	I	C	1	1. Cave divers should carry a minimum of three light sources. 2. Check functionality of all lights prior to diving. 3. Follow manufacturer's guidance in charging and discharging battery. 4. Never start a dive with an insufficiently charged light. 5. Consider if the diver can tolerate a single light failure following the failure of one light source on the inward dive. If not, abort the dive. 6. Do not use high powered dive lights out of the water which require water for cooling as they can overheat. Take a suitable light for caving beyond sumps.	V	C	3

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
6.4	Failure of all lighting sources.	Fatality	I	C	1	1. Cave divers should carry a minimum of three light sources. 2. Check functionality of all lights prior to diving. 3. Follow manufacturer's guidance in charging and discharging battery cells. 4. Never start a dive with an insufficiently charged light. 5. Divers should be well trained in diving in darkness and this should be covered in open water training with a blacked out mask. 6. Consider if the diver can tolerate a second light failure following the failure of one light source on the inward dive. If not, turn the dive. 7. Pay close attention to gas reserves as a blacked-out dive home will be significantly slower than the inward dive. 8. Ensure divers are trained to follow lines and deal with junctions with no light. 9. Consider the burn time of your lights. 10. Consider carrying spare batteries. 11. If diving with another diver, the second diver may be able to offer a spare light to enable an efficient and quicker exit. The stricken diver should lead the way out of the cave, accompanied closely by the other. A diver with partial or complete light failure should not be abandoned by the other diver where practicable.	I	D	2
6.5	Drysuit failure.	Fatality	I	C	1	1. Be aware that drysuits are designed primarily as thermal protection devices and not buoyancy devices. Relying on a drysuit for buoyancy can result in several issues including; loss of all buoyancy, slowing the diver down, and uncontrolled ascents. 2. Ensure drysuits are suitable for the environment and use knee and elbow pads beyond sumps if required. 3. Maintain drysuits carefully. Keep zips in good repair and change out neck and wrist seals before they begin to deteriorate. 4. Avoid where possible unzipping drysuits beyond sumps – this is the greatest risk of zip failure. 5. Ensure dry suit inflation button is in good working order and clean of debris/grit as a jammed button may lead to unintended drysuit inflation and inadvertent positive buoyancy. 6. Divers should be proficient in removing/reinstating the dry suit hose. 7. Use a separate buoyancy device where possible in addition to a drysuit. 8. Do not depend on heating systems as failure can lead to hypothermia very quickly. 9. A snoopy loop or drysuit seal can be used over the top of a failed wrist seal to reduce the leaking of water through a failed seal. Depending on the length of the dive and water temperature, a leaking or catastrophically flooding drysuit can be anywhere from a minor inconvenience to life threatening. A hypothermic diver is at risk of decompression illness.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
6.6	Loss of buoyancy device.	Fatality	I	C	1	1. Divers should weight themselves to be neutrally buoyant with empty cylinders. Air has a weight of approximately 1.3Kg per 1,000L. Divers should be sufficiently weighted at the start of the dive such that they will be neutrally buoyant at the end of the dive, even if they suffer gas loss and have to use all their excess gas margins. The additional weight of breathing gas at the beginning of the dive should initially be offset by additional buoyancy that can be dumped during the dive. 2. Be aware that whilst weight is needed to 'sink' a wetsuit, compression at depth will then cause a diver to be overweighted. 3. Whilst the cave environment can be forgiving and progress along the floor is possible, it can disturb visibility and make for a slow exit, eating into gas reserves. 4. Avoid being incorrectly weighted. 5. Use pull and glide technique on rock if needed. 6. Do not pull on the cave guidelines unless absolutely necessary (example: High flow, clear cave in Florida with no hand holds in the floor and bombproof, thick, tight main lines).	I	D	2
6.7	Depth gauge/dive computer failure (open circuit).	Fatality	I	C	1	1. The diver should ideally abort the dive in the event of a depth gauge failure as a depth gauge can give an indicator of location within the system where visibility is too poor to identify cave features. However, a diver should be able to exit the cave safely with a malfunctioning or failed depth gauge. 2. Ensure sufficiently fresh batteries are used in devices such as depth gauges and computers and that devices are fully charged prior to diving. 3. Back up tables, back up computer and a diving watch are all sensible additions to be carried where appropriate. 4. On a long dive involving decompression, a spare computer and/or tables and a watch would be expected. 5. On a very short, shallow single or multi sump dive in a well-known cave, one depth gauge is acceptable. In known cave systems, surveys should indicate the depths at certain points of the cave and the inward journey will also allow the diver to identify key points of depth changes or the average depth for the given passage.	I	D	2
6.8	Loose material breaking diaphragm on exhaust of regulator second stage.	Fatality	I	C	1	1. Be aware of any design features of your breathing apparatus that may allow ingress of foreign material to the exhaust of regulator second stage. 2. Consider options for eliminating these features. Take steps to ensure loose material from the environment does not find its way into the second stage mouthpiece. Consideration should be given to how the second stage is carried during the dive when not in use. If a physical barrier is used, such as a gauze over the second stage, then ensure that the barrier does not interfere with the performance of the valve or access to the valve when swapping mouthpieces underwater. 3. Consider options to aid removal of foreign material from the exhaust of a regulator second stage whilst underwater. 4. Ensure training in changing mouthpieces whilst under stressful conditions. 5. Practice clearing foreign materials from a mouthpiece and reinstating the breathing apparatus to a functioning condition. 6. Carry at least two fully independent breathing supplies that are capable of sustaining life long enough to reach safety.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
6.9	Obstruction of alternative breathing supply, during switching of breathing supply.	Fatality	I	C	1	1. Ensure that gear configuration or the physical nature of the cave does not compromise access to the alternate breathing supply. 2. Keep alternate breathing supplies protected from gravel, mud or stone ingress and rigged so it is protected, for example, underneath the diver's chin. 3. When using stage or decompression cylinders, with regulators stowed on the cylinder, keep these cylinders turned off until required for use. 4. Any discharge of gas during the dive, especially a purge button pressed during scootering, can cause a cylinder to empty without the diver knowing. 5. Plan the gas management strategy on the assumption the diver may need to remain on the one working gas supply.	I	D	2
6.10	Diver propulsion vehicle (DPV) drive failure/buoyancy failure.	Fatality	I	C	1	1. Ensure that the DPV is serviced in accordance with the manufacturer's specification by appropriately qualified individuals. 2. Complete a thorough pre-dive check of the vehicle. 3. Charge battery in accordance with the manufactures recommendations. 4. Expect failure of a DPV's propulsion. 5. Plan your dive to allow for a retreat to safety by swimming, including adjustment of the thirds rule. 6. A back up scooter is advisable, and diver should be trained in towing a backup scooter, which should have the range to facilitate a safe exit including towing heavy equipment. 7. In the case of a dead scooter, DO NOT tow the dead scooter out of the cave during a swimming exit. It is advisable to leave the dead scooter behind in the case of a backup scooter exit also. The potential loss of money is negligible compared to the loss of life.	I	D	2
6.11	Decompression habitat failure.	Fatality	I	C	1	1. Put in place and rehearse emergency procedures for a flooding habitat. 2. Ensure backup breathing supplies are readily available at the correct mix for each stage of the decompression and adequate for all divers in the habitat. 3. Ensure any additional gas required to maintain the pressure in the habitat are available. 4. Ensure appropriate analysis of the habitat gas is conducted. 5. Support diver/s must be fully kitted and available to assist at all times during the decompression. 6. Consider the option of a communication system with the surface. Decompression habitats are often homemade or modified to suit the cave and the dive plan. A sudden catastrophic failure of a habitat can lead to fatality.	I	D	2

TASK 7 - Procedural Failures

This section refers to human error and failure to follow cave diving procedures as set out by the diver's qualifying body.

<table>
<tr><th rowspan="2">ID</th><th rowspan="2">Description</th><th rowspan="2">Consequences</th><th colspan="3">Initial</th><th rowspan="2">Potential Control Measures</th><th colspan="3">Residual</th></tr>
<tr><th>S</th><th>L</th><th>R</th><th>S</th><th>L</th><th>R</th></tr>
<tr><td>7.1</td><td>Failure to check equipment adequately prior to entering the water.</td><td>Fatality</td><td>I</td><td>C</td><td>1</td><td>1. From the inception of training, develop a sequence of pre dive checks that you conduct on every dive.
2. Laminated checklists or checklists written on a dive slate or wet notes should be considered, even for experienced divers.
3. When diving in a sump with another diver, go through the pre-dive check lists together. The divers will also know what equipment/options are available during the dive for example, spare mask or spare line reel.
4. When diving in a sump with other divers, avoid the temptation to rush to be first in the water to get the best visibility.

Human factors such as tiredness, rushing, complacency, stress, attitude, over confidence or lack of quality training can all contribute to a diver failing to conduct pre-dive checks prior to a cave dive. The consequences can be relatively minor such as discomfort and distraction owing to equipment being uncomfortable or malfunctioning i.e. a wet breathing or noisy regulator or leaking mask. This can begin the 'incident pit' whereby the diver lacks capacity to cope with a bigger issue during the dive. The consequences can be greater such as catastrophic loss of gas.</td><td>I</td><td>D</td><td>2</td></tr>
<tr><td>7.2</td><td>Lack of or limited emergency, rescue or medical personnel or equipment at the site of an accident.</td><td>Fatality</td><td>I</td><td>C</td><td>1</td><td>1. Make contingency plans in the event of a cave diving emergency based on the resources that you know will be available on site. Do not expect any additional emergency, rescue or medical personnel to be able to reach you in time to offer substantial assistance.
2. Make every attempt to plan well ahead and make sure that all divers and support personnel are aware of rescue options and medical provision.

Questions for everyone involved:
a. Where is the nearest recompression chamber?
b. Do you have the number?
c. Who is the local cave rescue?
d. Is there anyone capable of raising the alarm?
e. Is there any mobile signal near the cave entrance?
f. How well trained are the divers/cavers in dealing with an emergency?
g. What if something happens to me?</td><td>I</td><td>D</td><td>2</td></tr>
</table>

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
7.3	Failure to observe gas margins.	Fatality	I	C	1	1. Work to pre-planned gas margins based on the gas available at the start of the dive. 2. Use margins appropriate to the dive conditions, the size of the cylinders used and techniques adopted. 3. The rule of thirds is a guideline only and in many cases it is wise to plan gas more conservatively. 4. Carry at least two fully independent breathing supplies that are capable of sustaining life long enough to reach safety. 5. Where appropriate, switch regularly between breathing supplies to keep gas resources roughly aligned. 6. In the event that thirds have been exceeded, head out immediately or to the nearest sizeable airspace if diving solo. 7. If diving with another person, consider following previously established gas sharing procedures. 8. If diving with other divers, observe your own turn point; do not be led on by someone else.	I	D	2
7.4	Failure to observe correct ascent rates.	Fatality	I	C	1	1. At the beginning of a dive, check that dump valves are operating correctly. 2. Maintain a recommended ascent rate and ensure neutral buoyancy is established before initiating the next move in the ascent. 3. Ensure dump valves are easily reachable and operable. 4. Take the time to move gas up the drysuit towards the dump valve at regular stages throughout the ascent. 5. Ensure that dump valves are operable whilst maintaining physical contact with the guideline e.g. one handed. 6. Open water 'free' ascents should be practised before entering an overhead environment. Ascending too quickly can result in physical injury such as barotrauma. Rapid ascents make it harder to manage buoyancy in the buoyancy devices and drysuits.	I	D	2
7.5	Failure to observe correct descent rates.	Fatality	I	C	1	1. Maintain a steady descent rate and ensure neutral buoyancy is established before initiating the next move in the descent. 2. A drysuit squeeze can render a diver completely immobile and unable to help themselves. Ensure inflation valves are working, attached to a gas source and easily reachable and operable. 3. Ensure that drysuit inflator valves are connected and working during pre-dive checks and again once in the water. 4. Ensure that inflator valves are operable whilst maintaining physical contact with the guideline e.g. one handed. 5. Open water 'free' descents should be practised before entering an overhead environment, practising stopping at a pre-planned target depth. Descending too quickly and losing control of the descent can result in physical injury and overshooting the Maximum Operating Depth for the breathing gas.	I	D	2
7.6	Failure to interpret decompression tables correctly.	Fatality	I	C	1	1. Acquire proper training in decompression theory, use of tables and how decompression computers work. 2. Learn correct gasses for decompression and the benefits of increased oxygen for decompression. 3. Do not rely on dive computers. A simple mistake such as inputting the wrong gas can lead to DCI. 4. Obtain thorough education in decompression theory and utilise dive planning software as well as tables to support the dive.	I	E	3

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
7.7	Communication failure between divers underwater or confusion over the expected actions of other divers whilst underwater.	Fatality	I	C	1	1. Avoid diving with other people unless underwater communication methods have been established, agreed and practised. 2. It should be clear what line markers mean, what touch contact signals are and hand signals likewise. 3. Torch signals are also extremely valuable but only mostly useful with handheld torches. 4. Pay attention to passive light communication i.e. a dark space behind/loss of light contact is a signal that the diver is not there and may require assistance. Communication failure is most likely to occur due to lack of training in standard diving communications such as hand signals, touch contact and line markings.	I	D	2
7.8	Lack of judgement of personal capabilities to execute a planned dive safely.	Fatality	I	C	1	1. Build experience of cave diving gradually and incrementally. 2. Obtain feedback on your current abilities from a suitably experienced cave diver. 3. Dive within your limitations and experience. 4. Be aware of the dangers of over-estimating your own capabilities. 5. Plan manageable objectives for your dive to limit task loading. 6. Be aware that diving with others may provide a false sense of security. 7. Do not succumb to peer pressure if diving with others; know your own limits and respect your own gas margins.	I	D	2
7.9	Changes in buoyancy due to consumption or loss of breathing gas or other discharged/gained materials.	Fatality	I	C	1	1. Assess the likely change in your buoyancy that will occur during your dive. 2. Carry sufficient buoyancy control measures to allow you to maintain neutral buoyancy. 3. Be aware of the potential for empty cylinders to become more buoyant near the end of a dive. Air has a weight of approximately 1.3Kg per 1,000L. Divers should be sufficiently weighted at the start of the dive such that they will be neutrally buoyant at the end of the dive even if they suffer gas loss and have to use their excess gas margins. The additional weight of breathing gas at the beginning of the dive should initially be offset by additional buoyancy that can be dumped during the dive. 4. The diver should weight themselves to achieve neutral buoyancy with empty cylinders according to the equipment carried and any items which will be jettisoned during the dive. 5. Divers should plan for stage bottle drops/pick ups and adjust buoyancy prior to these procedures. 6. The use of heavy steel line reels also impacts significantly on the divers weighting system. 7. Drop weights for significant and planned changes in weighting during a dive can be considered. 8. Pay attention to any additional snag hazards when adding weight to your equipment.	I	D	2

TASK 8 - Medical problems

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
8.1	Hypothermia.	Fatality	I	C	1	1. Ensure suitable clothing and equipment for the temperature of the water and the duration and depth of the dive. 2. Typically wetsuits should be of the diving variety, consider layering and overlapping of wetsuit sections to reduce flushing. 3. Give consideration to using drysuits, especially the thickness and layering of undersuits and undergarments and quality materials. Ensure the drysuit is sufficiently robust and/or protected to cope with the physical nature of the cave. 4. Thickness of hoods and gloves or use of dry gloves are also to be considered. 5. Remember that altering suits, both dry, wet and undersuits can affect the buoyancy of the diver and should be weighted for accordingly. 6. Do not depend on heating systems and consider them a luxury rather than essential for the dive. A failed heating system can have immediate and dangerous consequences, especially during decompression. 7. If a diver becomes cold the dive should be aborted to prevent the situation worsening. 8. If it is a known cold water site consider re-warming measures on the surface. 9. Consider proper hydration and nutrition, fuelling properly prior to a dive.	I	E	3
8.2	Blocked sinus.	Fatality Injury	I	C	1	1. Avoid diving with a cold or too soon after a cold. 2. Ensure you can equalise easily in the first stages of the dive. If not, do not 'force' sinuses as the return profile may be worse. 3. Avoid medications such as Sudafed which can have a reverse effect when they wear off. 4. Proactive sprays containing oxymetazoline can be carried with the diver to aid a return to safety from beyond a sump, if required. 5. A well hydrated diver is less likely to have ear or sinus issues. A blocked sinus can cause difficulties in changing depth due to build up of pressure within sinus cavities. This results in pain, can rupture sinuses and whilst not lethal, can distract a diver significantly and cause medical problems further down the line.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
8.3	Unable to clear ears.	Fatality Injury	I	C	1	1. If there are signs of a 'sticky' ear early in the dive, abort it. It will not improve the more it is forced. 2. Keep descents and ascents slow and do not 'force' ears to clear. 3. Avoid diving with a cold or too soon after a cold. 4. Ensure you can equalise easily in the first stages of the dive. If not, do not 'force' ears to clear as the return profile may be worse. 5. Avoid medications such as Sudafed which can have a reverse effect when they wear off. 6. Proactive sprays containing oxymetazoline can be carried with the diver to aid a return to safety from beyond a sump, if required. 7. A well hydrated diver is less likely to have ear or sinus issues. 8. If dry passage/air bell is available use it to surface and blow out the sinuses. In some cases it may be possible to wait out of the water beyond a sump for a rescue party who can bring in a decongestant. This approach is site dependant, a diver should consider the effects of hypothermia while waiting. A ruptured ear drum is extremely painful and unpleasant.	I	D	2
8.4	Respiratory illness.	Fatality Injury	I	C	1	1. Do not dive if you are suffering from or have recently had any respiratory illness. Breathing difficulties underwater are almost impossible to rectify at the time. 2. If any breathing discomfort is felt, abort the dive and return slowly, keeping the breathing rate calm. 3. If a diver notices any shortness of breath, tight chest, wheezing, gurgling or any other sign that their breathing is abnormal, the dive should be aborted calmly. 4. If another diver is present, they should escort the diver back to safety and be ready to assist on the surface at least.	I	D	2
8.5	Physical or mental impairment due to alcohol or other substances.	Fatality	I	C	1	1. Cave divers should be physically and mentally fit to dive to reduce the likelihood of serious consequences. 2. It is recommended to avoid alcohol or drugs that conflict with diving, at least 24 hours prior to diving. 3. Medication, both prescription and non-prescription, is unlikely to list the side effects of a drug during a scuba dive. Either avoid diving while taking medication or consult a hyperbaric medic for information on side effects before deciding whether or not to dive. Cave diving is an inherently dangerous activity and this is magnified if the diver is suffering from substance abuse, through drugs or alcohol.	I	D	2
8.6	Medical, physical or mental impairment due to pre-existing condition.	Fatality	I	C	1	1. Cave divers should be medically, physically and mentally fit for the dive they wish to embark on. Some pre-existing physical conditions may manifest themselves in a negative way when under physiological or psychological pressure. 2. Obtain a medical certificate prior to starting to learn to dive. Update certification regularly in line with medical advice. 3. Divers should be physically capable of the dive they are about to undertake with any pre-existing conditions well managed and approved by a diving physician. Cave diving is not a cure for mental health problems nor should it be used as a tool for managing it. 4. Obtain advice on your ability to cope mentally with the demands of cave diving from a suitably qualified medical professional prior to entering the water, if you have ever suffered from a psychological condition.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
8.7	Mental impairment due to psychological condition emergent during diving, e.g. stress or panic.	Fatality	I	C	1	1. Ensure that you are familiar with, and comfortable in, the cave environment before diving in a cave. 2. Expect to suffer from an element of stress whilst diving and plan your dive accordingly. 3. Consider the nature of the "incident pit" before entering the water. 4. Plan the dive thoroughly before entering the water to minimise the number of unexpected situations faced and decisions taken underwater. 5. Build experience of cave diving gradually and incrementally. As a novice, avoid constricted sites and sites with poor visibility. 6. Do not over extend yourself mentally or allow others to encourage you into a situation that you are not comfortable with. 7. Think through the compounding of problems that can occur when decisions are made in an impaired state. 8. Thorough training and dive planning contributes significantly to reducing stress during a cave dive. Limit task-loading, by planning manageable objectives for the dive. 9. Abort the dive if the diver is feeling overwhelmed or stressed. Avoid making a rushed exit in an anxious state as this will increase gas consumption and increase the chances of another accident. 10. If you become out of practice either diving or caving, rebuild experience in familiar sites before undertaking a trip to a new site. Entering an overhead environment in the dark, underwater puts the brain and body under stress even if the diver feels normal. Lack of training and planning can be catastrophic as panic is far more likely when a diver does not know what to do in the situation presented.	I	D	2
8.8	Sudden medical emergency, e.g. anaphylactic shock, asthma attack, heart attack, immersion pulmonary oedema and hypoglycaemia.	Fatality	I	C	1	1. Cave divers should be medically and physically fit to dive. 2. Plan your diving in accordance with any professional medical advice you receive regarding pre-existing medical conditions. 3. Medical emergencies such as a heart attack, stroke, asthma attack, pulmonary embolism or immersion pulmonary oedema may be fatal underwater. If a diver feels unwell, abort the dive to the closest safety. 4. Do not ignore any shortness of breath or unusual or unfamiliar pain. 5. Remain calm, do not overexert yourself and make your way to safety. 6. If you witness a diver go unconscious underwater and it is possible to assist them to air space/the surface without compromising your own safety – do so. With the benefit of hindsight, which is often too late, many underwater medical incidents could have been avoided.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
8.9	Barotrauma.	Fatality Injury	I	C	1	1. Conduct recommended ascent rates 2. Avoid breath holding. 3. Breath normally in the middle of the lungs. 4. Maintain neutral buoyancy using buoyancy devices if passage size allows and avoid using the lungs for buoyancy when using a buoyancy device. Barotrauma covers expansion of the air spaces in the body. This includes, lungs, sinuses, air spaces in the mouth and ears etc. Pulmonary barotrauma is lung overexpansion injury and can be fatal.	I	D	2
8.10	Dental emergency.	Fatality Injury	I	C	1	1. Maintain good oral health and ensure that your dentist understands the issues surrounding dental work and diving under pressure. 2. Ascending can cause severe pain if gas behind the tooth expands. Ascend slowly back to safety, aborting the dive.	I	D	2
8.11	Hyperthermia/ Dehydration.	Fatality	I	C	1	1. Divers should be properly hydrated, giving thought to ongoing hydration during the trip and any prolonged decompression. 2. Divers should give thought to how to pass urine 1. i.e. pee valves/she-p in drysuits and cave conservation considerations. 2. Maintain proper hydration and start hydrating the night before the dive. 3. Wear appropriate clothing for the carry to the sump and considering changing into a diving suit at the dive site. 4. Consider adding electrolytes to drinks to maintain hydration. Hyperthermia is rarely a consideration in UK cave diving, but overheating or excessive sweating during a carry of equipment can contribute. Dehydration is a significant factor in decompression illness.	I	D	2
8.12	Lack of nutrition.	Illness	I	C	1	1. Make a conscious effort to balance nutrition with expected effort of the trip and dedicate a water/depth proof container for it. Some items such as energy gels will survive in drysuit pockets and can be consumed underwater. Others can be packed in small dry tubes or added to tackle bags for the carry. 2. Do not underestimate the requirement for energy before, during and after a dive. 3. Consider common food allergies such as nut allergies when selecting food to take underground when caving with other people. Nutrition is often overlooked in cave diving as eating underwater is difficult and there often isn't enough capacity within the equipment to carry food that will survive a sump. Lack of nutrition can cause low blood sugar, affect decision making and reduce the amount of energy and physical and mental capacity the diver has, especially in a cold environment.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
8.13	Vomiting underwater.	Fatality	I	C	1	1. Avoid diving when feeling nauseous. 2. Be aware of the capacity of your breathing apparatus to pass vomit into the surrounding water without malfunction. 3. Be aware of the difficulties associated with vomiting underwater without a mouthpiece. 4. Practice changing mouthpieces whilst under stressful conditions. 5. Practice clearing foreign materials from a mouthpiece and reinstating the breathing apparatus to a functioning condition. 6. Avoid alcohol before diving. 7. Carry at least two fully independent breathing supplies that are each capable of sustaining life long enough to reach safety.	I	D	2
8.14	Stress and trauma in the instance of being present with a deceased diver.	Fatality	I	C	1	1. Be aware that coming across a deceased diver or witnessing a fatality can be extremely stressful. 2. If trained to do so and without compromising your own safety, assistance should be offered to a diver in distress, who may have witnessed an incident. 3. In the instance of a fatality, abort the dive calmly and once on the surface, raise the alarm according to local protocol. 4. If abroad, it is wise to keep a checklist in your vehicle with emergency numbers, fire and cave rescue and translate any key messages into text if you are not fluent in the local language. 5. Consider professional counselling after being present at any accident involving a fellow diver. Seek medical advice if necessary	I	D	2

TASK 9 - Underwater Digging

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
9.1	Sudden loss of visibility.	Fatality	I	C	1	1. Ensure you are familiar with your surroundings before commencing any digging activities. 2. Ensure the dive line is firmly belayed and will not be disturbed by digging. 3. Consider how to maintain contact with the dive line while digging, without increasing the risk of entanglement. 4. Consider the direction of flow; will digging reduce visibility ahead, or for the return dive? 5. Expect to lose visibility immediately any sediments re disturbed.	I	D	2
9.2	Collapse/ slumping of fill material entrapping the diver.	Fatality	I	C	1	1. Where visibility allows, carefully inspect the area before commencing digging to identify potentially loose or unstable material that could lead to entrapment. 2. Support unstable boulders with scaffolding before digging around, or under them. 3. Consider working remotely when collapse is possible. For example: a. use a winch that can be operated at a safe distance from a boulder being pulled; b. use a long bar to probe ahead; c. use remotely operated explosives. 4. Where possible, keep a selection of digging tools within reach while digging to help get free in the event of entrapment. 5. Consider allowing additional gas reserves to provide more time to deal with entrapment. 6. Consider diving with a support diver at a safe distance (at the dive base if appropriate), with a pre-determined call-out time, beyond which the support diver should assume that you are in trouble. 7. Gain digging experience above water; although fill material behaves differently underwater, familiarity with cave digging above water will improve awareness of particular risks and aid decision making	I	D	2
9.3	Change in buoyancy due to carrying tools/ dug material.	Fatality	I	C	1	1. Use a buoyancy compensator where appropriate. 2. Ensure that you are in a stable/secure position before putting down tools that have formed part of the buoyancy control system on the approach. 3. Consider using a lift-bag for removing heavy items from a dig. 4. Consider using a fixed ‘shot-line’ or hauling line to control ascent/ descent. 5. Consider leaving drop-weights at the dig which can be attached when tools are put down.	I	D	2
9.4	Physical stress due to frequent ascents/ descents.	Fatality	I	C	1	1. Avoid ascending and descending more than necessary. 2. Consider digging with a support team (above or below water), with the means to haul dug material away without the need to ascend/ descend with each load dug. 3. Consider stacking dug material at a similar depth to the working depth. 4. Avoid diving with any signs of a cold, if frequent ascents/ descents are likely to be required. 5. Consider the profile of your return dive.	I	D	2
9.5	Physical stress due to excessive physical activity at depth.	Fatality	I	C	1	1. Avoid excessive physical activity underwater at any depth. 2. Where possible, use mechanical aids, such as winches to reduce physical activity. 3. Work slowly to avoid raising breathing and heart rate. 4. Take regular breaks to minimise accumulation of CO_2.	I	D	2

ID	Description	Consequences	Initial			Potential Control Measures	Residual		
			S	L	R		S	L	R
9.6	Injuries resulting from the use of explosives.	Fatality	I	C	1	1. Do not detonate explosives when a diver is in the same body of water. 2. Be aware of where any fumes will surface from an underwater detonation. 3. Be aware that the use of explosives underwater may destabilise material some distance from the site of the detonation, potentially including above water. Always approach with caution after using explosives underwater. 4. Ensure that a safe location out of the water is chosen to detonate the explosives.	I	D	2

Glossary of terms

Barotrauma: Barotrauma is a term used to describe pressure-related tissue injuries to the human body. A person may experience barotrauma when pressure changes in the surrounding environment cause air in the body to expand or contract in a manner that damages the surrounding tissue. Scuba divers must be particularly mindful of the risk of barotrauma because of the high pressures they are exposed to when diving.
Bedding / bedding plane: The horizon between two beds of rock. In caving, this normally indicates such a weakness between two beds of limestone which has been enlarged by erosion and solution to give a wide, low cave passage.
Belay: (noun) A point used for anchoring a diving line, rope or ladder. (verb) In climbing, to safeguard one's companion with a rope in case of a fall. In diving, to secure the line to anchor points to ensure that it remains in position.
Boulder choke: A mass of boulders which fills a cave passage.
Cave Diving: An activity, whether recreational or exploratory, which involves diving in flooded cave passages. The term can also be used to cover flooded man-made mines. Cave diving requires specialist training owing to the overhead diving environment and the lack of opportunity to be able to retreat to air surface as with open water diving.
Chamber: A part of a cave which is large in relation to nearby passage.
Closed Circuit Rebreather (CCR): A device which enables the diver's breathing gas to be recirculated and used multiple times by removing the harmful carbon dioxide from the diver's exhaled gas using an absorbent of soda lime. Modern devices are computer controlled and add oxygen to the "breathing loop" as required to maintain a safe breathing mixture. Rebreathers are rarely used in UK cave diving but are more commonly used in open water and in larger cave passages overseas.
Decompression Illness (DCI): Also referred to as decompression sickness or "the bends", a collective name for the harmful consequences of bubbles in the body that are not managed. Causes can be a diver ascending too quickly or otherwise having failed to complete the decompression process. Can also be caused by physiological factors such as hypothermia, dehydration, Patent Foramen Ovale (PFO), Obesity etc.
Decompression: The process whereby the diver allows inert gases, which have been absorbed into the blood and tissues during the dive, to disperse safely during the ascent, usually by making a series of "stops" at various depths and by using oxygen rich gasses to 'flush' out the inert gasses more efficiently.
Diver Propulsion Vehicles (DPVs) or 'Scooters': Battery powered vehicles, designed to tow divers along underwater, increasing the speed and range of a dive. Normally torpedo shaped with a rear propellor, the DPV is clipped via a lanyard to the diver's waist to tow them along.
Jump Line/Gap Line: Cave side passages that are lined may not have a permanent connection to the main line. This can be for conservation reasons and in some countries, gaps or jumps are marked with arrows on the main line. Thus it is necessary to maintain a continuous guideline to surface and to do so, the diver must bridge the 'jump' between the main line and the side passage by installing their own section of line to link the two. Likewise, a 'gap' in the main line must be bridged using an extra spool of line. This is a temporary installation and the last diver to exit must remove the jump or gap line. Any diver navigating a jump/gap must leave their own personal marker, as they would a junction, to indicate they are still in the cave and remove it upon their exit. The term 'jump' is used when jumping from one line to another. Gap is used to indicate a gap in the main, continuing line. A connecting line and personal markers must always be used.
Junction: A permanent intersection in the cave line, where splitting the permanent line forms a 'T' or a 'Y'. The split often indicates another cave passage and to pass a junction, divers must each leave a personal marker on the exit side of the line junction to clearly mark the correct route home.
Line: Navigational aid to enable the diver to retreat to safety and air surface. Dive lines are made from various materials and the diver follows them to navigate the underwater cave. The lines are also used to survey underwater caves. Lines are designed and laid to be followed by hand in the case of loss of lights or visibility.
Maximum Operating Depth (MOD): The maximum depth that a diving gas can safely be breathed, with regard to the partial pressure of oxygen. Oxygen can become toxic at depth, hence different gas mixes will have a mandated maximum operating depth.
Narcosis: Narcosis can be caused by breathing any gas under increased pressure (Meyer-Overton rule). Dense gasses such as oxygen or nitrogen lend themselves more readily to narcosis. Narcosis can cause a decrease in reaction time, mental capacity, motor skills and can impact on the ability to make wise decisions. It is often compared to being intoxicated and impaired by drugs or alcohol. It is not possible to build up a tolerance to narcosis (Fowler et al., 1985).
Nitrox: A breathing mixture of air enriched with additional oxygen, also removing some nitrogen, generally used at mid-range depths to reduce the amount of time required for the diver to complete decompression. With less nitrogen in a breathing mix, the diver can conduct longer bottom times and/or a reduced decompression time.

Open Circuit (OC): Open circuit diving is a type of diving where the diver uses a breathing apparatus that is not connected to the surface. The diver exhales into the apparatus, and the used breathing gas is then vented into the environment. The diver then inhales fresh breathing gas from the apparatus. Open-circuit diving involves the use of a traditional breathing apparatus, known as a regulator and pressurised scuba cylinder from which no gas is recycled.
Oxygen Toxicity: Central Nervous System Oxygen Toxicity (CNS toxicity) can be a complication of too much oxygen at pressure. Excessive use of richer oxygen mixes can damage the pulmonary system. Exceeding guidelines for the partial pressure of oxygen can cause seizures, which can be fatal underwater.
Pitch: A vertical descent or ascent, usually requiring a rope or ladder.
Qualified Diver (QD): In the context of the Cave Diving Group, a Qualified Diver is one who has built several years of cave diving experience under the guidance of a mentor and has successfully passed both theory and practical Cave Diving Group examinations. A qualified diver, post qualification, may mentor trainee divers and vote on qualification matters at Cave Diving Group meetings.
Regulator: Piece of diving equipment, which adjusts the flow of breathing gas from the diver's supply tank to meet the demands of the diver. A regulator consists of a demand valve which delivers breathing gas on 'demand' from the diver, whilst being held in their mouth by a soft rubber mouthpiece. It also contains an exhaust valve which allows exhaled gas to escape into the water.
Resurgence: Also known as a 'Rising' The point where cave water re-joins the surface from underground, normally from a known source.
Rift: A term generally used to describe passage elongated in the vertical plane.
Search Reel: A compact reel of line which the diver carries for use if he loses and needs to relocate the main line through the cave.
Sidemount: This is the normal equipment configuration for UK cave diving, with cylinders mounted at the diver's sides to (a) present a more streamlined profile and enable the diver to pass through lower passages, and (b) offer protection to the cylinder valves from damage against the cave walls by keeping them under the diver's armpits.
Skip Breathing: An irregular pattern of breathing where the diver holds the inhaled breath for an extended period before breathing out.
Squeeze: A narrow part of a cave requiring extra care and effort to pass.
Sump: A section of completely flooded cave passage.
Thirds Rule: A gas management method whereby the diver uses a maximum of one third of the air for the way in, one third for the way out and keeps one third for emergencies. A diver using the normal configuration of two cylinders of equal gas volume will use breathing gas from one or both cylinders until one third of the breathing gas volume remains in each cylinder, meaning that should either regulator fail there will be enough air in the other cylinder to exit the cave. In the event that the cylinders are unequal, it requires careful calculations to apply this rule safely. The rule of thirds is a guide only and can be adapted, usually conservatively, to consider poor visibility, high flow or other cave features which may slow a diver down on the return to surface, to add a working phase, or where an additional safety margin is considered appropriate, such as on a diver's early training dives.
Trainee (TD): Term used by the Cave Diving Group for a diver who has yet to demonstrate full competency and experience in cave diving. Trainees are mentored, sometimes over several years, by experienced and Qualified divers as they progress towards a qualifying cave diving exam. Trainees joining the group are given 5 years to obtain Qualified Diver Status. If they fail to reach qualified diver status within this period, they will be transferred to non-diver status. Any member wishing to maintain trainee diver status past the five-year limit must reapply annually. Continued trainee diver status will be awarded at the discretion of the section qualified divers.
Trimix: A breathing mixture of oxygen, nitrogen and helium, used to avoid the toxic effects of oxygen and the narcotic effects of nitrogen for deeper dives. Reduces the work of breathing and can help eliminate the harmful effects of CO_2 build up.
Washing Line: A length of rope or dive line, installed close to a sump and secured either end to allow equipment to be safely clipped on and stored, while not in use

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