Guidance on the Use of Underwater Air Lift Bags

1 SCOPE

1.1 This guidance addresses the initial and periodic examination, testing, certification and maintenance of underwater type bags (cylindrical totally enclosed, closed and open parachute) used to lift submerged objects.

1.2 This guidance also addresses the operational use of open parachute type lift bags and the safety precautions that should be taken during their use.

1.3 This guidance does not apply to water-filled bags used as water weights for testing of other equipment.

2 OBJECTIVES

The objectives of this document are to provide clear guidance on:

i) Fitness for purpose;

ii) Examination and testing criteria;

iii) Maintenance, which should be carried out to ensure the continuing integrity of each bag, as far as is possible, between its periodic tests;

v) Operational guidance;

vi) Safety precautions to be taken into consideration during their use.

3 DEFINITIONS

DMA – dead man anchor or independent anchor point which, after assessment, is a suitable point from which to restrain the load.

Dump Line – this is attached to the dump valve inside the lift bag and is used for fine control and deflation of the bag buoyancy by the diver.

Inverter Line – this is attached to the top of an open parachute bag. Its purpose is to invert the bag if it becomes detached from the load being lifted.

Restraining or *Hold-back Line* – this is provided to restrain or hold back the positive buoyancy of the lift bag. It should be attached in such a way as to prevent an uncontrolled ascent of the load being lifted. It should be fitted between the load being lifted and a fixed point.

4 BACKGROUND

4.1 In some countries, national regulations require the initial and periodic examination, testing and certification of all items of lifting equipment. In 1993 IMCA published guidance note AODC 063 – *Underwater Air Lift Bags*. Until AODC 063 was published, there was no guidance available specific to the air lift bags used in the underwater industry. This guidance document has

subsequently been updated three times, with the last update IMCA D 016 Rev.2 – *Underwater Air Lift Bags* – being published in May 2003.

4.2 IMCA D 016 Rev. 2 (and the previous updated documents) based the testing of the rigging used the underwater air lift bags on the criteria defined in IMCA D 018 – *Code of Practice on the Initial and Periodic Examination, Testing and Certification of Diving Plant and Equipment* (Ref.1), with additional information included specific to underwater air lift bags.

4.3 The normal criteria for testing of lifting equipment is to subject it to an overload test greater than its safe working load (SWL), but in the case of underwater air lift bags this is not currently considered to be reasonably practicable. However, this overload test should be taken into consideration in the design calculations.

5 NEW EQUIPMENT

5.1 Whilst this guidance does not address design and manufacturing standards, generally the onus is on the manufacturer and/or supplier of equipment to ensure that their product is fit for the purpose for which it is to be used and can be used safely.

5.2 The manufacturer/supplier should provide the purchaser with the following information and certification:

i) The factor of safety to which the underwater air lift bag is designed. Usually the minimum factor of safety is 5:1 of its safe working load (SWL). (The test criteria for webbing strops is 7:1);

ii) The design has been type tested to the stated SWL (using the factor of safety in (i) above);

iii) The bag supplied conforms to the type test;

iv) Adequate information about the use for which the underwater air lift bag has been designed;

v) Details of maintenance requirements;

vi) The capacity stated for the size should be plus 0% / minus 5% in fresh water.

5.3 The bag and its individual detachable lifting components, e.g. strops, rings and shackles, should each be suitably marked or labeled with a unique serial number and it's SWL. The lift bag should be supplied with a certificate stating the unique serial number, the manufacturing standard, its SWL and listing the component parts supplied with the bag.

5.4 Open parachute type bags must be fitted with a suitable attachment point at or near the crown to allow an inverter line to be attached to the top of the bag. Since bags up to 50kg SWL are not normally manufactured with an inverter line, in such cases they should be used in conjunction with a restraining line.

5.5 Totally enclosed lift bags should be fitted with relief valves. These should be tested before use and set to maintain an internal pressure sufficient to fully inflate the bag to which they are fitted.

5.6 A historical record for each bag should be established and become part of the planned maintenance system (PMS).

6 INITIAL & PERIOD EXAMINATION, TESTING & CERTIFICATION

The categories of competent person appropriate to carry out examination, test and certification of equipment are defined in Appendix 1. Examination and test criteria are defined in Appendix 2.

7 OPERATIONAL CONSIDERATIONS

7.1 Underwater air lift bags are not just a handy tool, but also a major piece of lifting equipment and must be treated as such. They differ from conventional lifting equipment in that the loading comes from the up thrust generated by the volume of water displaced when the bags are filled with air.

7.2 As they cannot be over inflated, lift bags will not normally lift loads which are significantly greater than their designed safe working load. (The parachute type has an open bottom and when full the air spills out. The enclosed type has a relief valve that releases air when the internal pressure is approximately 13.8 kPa (2 PSI) over ambient pressure). However, it is possible for the rigging to be subjected to additional snatch loads. These can be imposed in various ways, some examples are given below:

i) When the bag is used in water depths shallow enough for wave action to cause snatching and rapid changes in the dynamic loading;

ii) When the bag has lifted up the load and the top of the bag is on the surface and therefore exposed to wave action;

iii) When the lift bag is incorrectly rigged;

iv) When the lift bag becomes snagged, breaks free and induces a snatch load on the webbing strops or attachment points;

v) When the lift is assisted by a crane and there is movement on the vessel causing changes in the dynamic loading.

These additional loads should be provided for in the 5:1 safety factor, discussed in paragraph 5.2 (i)

7.3 Allowance should be made for the fact that sometimes more than one lift bag is attached to the same lift point and, therefore, there will be contact between the bags.

7.4 Incorrect rigging can also cause the SWL to be exceeded on attachment points due to the uneven distribution of the load. For example, where strops of different length are used, the load imposed on the shortest strop may be in excess of the design factor and could result in failure. It is essential that no lift bag be used that has modified or replacement components which are not approved by the manufacturer.

7.5 A suitable inverter line must be fitted to parachute type bags and attached to a point on the top of the bag. This inverter line should be long enough to attach to the load being lifted, to permit the bag to invert and release the air should there be a failure of any part of the securing rigging of the bag. It should be strong

enough to resist the snatch load caused by a rapidly ascending bag, bearing in mind that a longer inverter line will allow the bag to achieve a greater upwards velocity and, hence, will create a larger snatch load. Since bags up to 50 kg SWL are not normally manufactured with an inverter line, in such cases they should be used in conjunction with a restraining line.

7.6 A suitable restraining line should be fitted between the load being lifted and DMA or other subsea structure that is not part of the load being lifted (see 8.7). This line should be arranged in such a way to resist a snatch load caused by a rapidly ascending load and to stop an uncontrolled ascent. The restraining line should not be attached to other adjacent subsea equipment or structures which could themselves be damaged or cause hazard in the event of a failure. Consideration should be given to the material selected for use as the restraining line as it may be subjected to snatch loading. Consideration should be given to the length of the restraining line to avoid unnecessary slack.

OPERATIONAL GUIDANCE

A sketch illustrating a typical example of subsea rigging of parachute bags is shown at Appendix IV.

8.1 Before lift bags are used in underwater engineering tasks, a proper assessment of the task to be performed should be made. This assessment should include:

(i) Calculations of the weight to be lifted or moved;

(ii) Calculations of the size of the lift bag and type (enclosed or open) required:

(iii) Calculations, where possible, to determine the centre of buoyancy and centre of gravity should be made so that steps can be taken to prevent the object being lifted spinning or turning over;

(iv) The number of lift bags required;

(v) The positioning and attachment of the lift bag;

(vi) Calculated safety factors for all of the above.

(vii) Determining the category of lift to be carried out as this will determine the need for a restraining line and also the identification of a suitable point for the inverter line.

Note 1 If the weight of the object to be lifted or moved is unknown, or the object is buried in the mud, the load can only be estimated. Precautions should be taken before the lift bags are attached to ensure that when they are inflated control of the load is not lost. The restraining line from the top of the bag, if secured to the load itself would perform its function should the lift bag attachment fail. It would not however prevent the load from going up in an uncontrolled fashion if the bag was accidentally over inflated. For this reason, the restraining line should normally be connected to an independent anchor point (see 8.7).

Note 2 Extreme care should be taken when using lift bags to overcome seabed suction or free mechanically locked or snagged equipment. A hold back strop and anchor should be available which is heavier than the up thrust created by the lift bag. This can be achieved by placing Dead Man Anchors (DMA) in the vicinity of the object and attaching slings from the object to the DMA.

Note 3 Only open bottom bags should be used where any form of ascent is planned or possible, such as vessel salvage or raising objects from the seabed. Fully enclosed bags should not be used for this purpose.

Note 4 Historically, there have been cases where the significant variations between the stated and actual capacities have been found, in some cases up to 20%.

8.2 Once the size/type and number of lift bags has been determined by the task specific assessment, then the bag(s) will need to be inspected before use for the following:

(i) A check of the serial numbers on all of the components with the number of the certificate.

(ii) A check of the test date on the certificate.

(iii) Visual inspection of all components, even if the lift bags are new.

(iv) Visual inspection of the webbing strops and the stitching on the bags.

(v) The "dump valve" at the top of the parachute bags should be checked to ensure that it is clean and can operate freely. The line attached to the "dump valve" should be checked to ensure that it is attached correctly and will operate the valve when pulled.

Note 5 It is recommended that these lines are made of different materials and of different sizes so as to be readily distinguishable from other lines that may be present

(vi) With parachute type bags, the restraining line should be checked to ensure that it is attached to the specified inverter line attachment point of the bag so that the bag will invert should there be a failure of any part of the attached rigging.

(vii) With enclosed lift bags, the relief valve should be checked to ensure that it is free and clean.

8.3 When closed lift bags are used care should be taken to ensure that they are never attached in the vertical position or can rotate into the vertical position. The manufacturer's instructions, where available, should be followed.

8.4 If it is found, during the task specific assessment, that the lift points cannot be distributed evenly along the load, a spreader bar should be used with pad eyes at equal distances on top for the lift bag slings to be attached. There should also be pad eyes on the bottom of the spreader bar to enable slings to be attached to the load.

Note 6 If spreader bars are used, test certificates will be required and the safe working load marked on the bar.

8.5 If the load capacity has been estimated, it may be necessary to provide residual lift capacity. In such cases, it may be preferable to use a series of small lift bags, rather that large ones.

8.6 The use of dead man anchors (DMAs) should be included in the task-specific assessment prior to commencing operations that involve air lift bags. The in-water weight of any DMA should be sufficient so that the combined weight of the load and any DMA is greater than the total lift force applied by the lift bag, thus preventing the possibility of an uncontrolled ascent of the load to the surface.

8.7 In normal circumstances the restraining line should be attached to an independent anchor point. However, there will be circumstances when the restraining line may be attached to the load, e.g. to reduce the in water weight of a trencher on a soft seabed, when the use of an independent anchorage is impracticable. This latter arrangement can only be applied when there is no possibility of the added buoyancy overcoming the weight of the load, and thereby creating a hazardous situation.

8.8 The air hose used to inflate the air bag should not be tied off to the air bag during inflation.

8.9 The selection of bags and inflation sequence should ensure that, during sub sea inflation prior to lift, the number of bags which are partially filled at any one time is minimised. In practical terms this means that each bag should be inflated to full capacity before commencing the inflation of the next.

8.10 The dump valve should be fitted with a dump line to enable it to be operated by the diver from a safe location. In some cases it may be necessary to extend the line to allow the diver to be in a safe position. This aspect should be taken into consideration when planning the work. Both the dump line and any extension should be of an easily identifiable colour and distinguishable from any other nearby line.

8.11 Weather conditions should be taken into consideration prior to the deployment of lift bags. Current and visibility as well as the water depth should also be considered.

8.12 When deploying two divers at one time on a project, the visibility in the area the divers are to work should be taken into consideration. Poor visibility could be an additional hazard for the divers and should be taken into account when doing the risk assessments.

8.13 The procedures should reflect the number of divers working on the same job. Strict controls should be in place to ensure that lift bags are not inflated or deflated until both divers have been informed and each knows where the other and their umbilicals are in relation to the work area. The supervisor must not give the order to inflate or deflate the bags until the divers are ready.

8 MAINTENANCE

9.1 Before use, all bags should be examined by a competent person. If any defects or out-of-date certification are found, the bag should not be used until repaired ad/or re-tested.

9.2 Lift bags should be washed after use with fresh water and any grease or oil removed.

9.3 The dump valve on parachute type bags should be cleaned and dried and lightly powdered with French chalk.

9.4 The relief valve on enclosed lift bags should be cleaned and lightly powdered with French chalk.

9.5 Once cleaned, the bag should be laid out so that it is fully extended. Fully enclosed bags should be fully inflated for inspection by a competent person.

9.6 The competent person should mark and record any defects in the historical log for that particular bag.

9.7 Any repairs should be carried out in accordance with the manufacturer's instructions. When repairs are completed, they must be entered into the log for that bag.

9.8 When repaired or ready for storage the lift bags should be checked to confirm they are dry, rolled up (not folded) and stored in a clean dry place.

9.9 An example checklist for use prior to using a lift bag and after maintenance is provided at Appendix3.

10 TRAINING

10.1 Personnel involved in the use of underwater lift bags should have a basic knowledge of the following:

(i) Archimedes Principle
(ii) Hydrostatic Pressure
(iii) Absolute Pressure
(iv) Boyles Law

With an understanding of these four aspects, personnel should be more aware of what can be accomplished by the use of lifting bags, the dangers that are present and the need for caution and strict controls.

10.2 Training should take place to make sure that personnel have a basic knowledge of the four subjects listed above.

10.3 Training should be given in accordance with the manufacturer's instructions, where appropriate, and should include but not be limited to:

(i) Storage, examination and testing if lift bags.
(ii) The deployment and rigging of lift bags.
(iii) The correct way to attach the inverter line used to invert the bag.
(iv) The correct way to use the dump valve and the precautions to be taken before using it.
(v) Cleaning and maintenance of lift bags after use.

11 REFERENCES

1. IMCA D018` Code of Practice on the Initial and Periodic Examination, Testing and certification of Diving Plant and Equipment`

APPENDIX 1

CATEGORIES OF COMPETENT PERSONS*

Category 1

a diving or lift support supervisor duly appointed by the diving contractor.

Category 2 a technician, certified Class 1 Chief Engineer, or other person, all specialising in such work who may be an employee of an independent company, or an employee of the owner of the equipment (unless specific legal restrictions apply), in which case his responsibilities should enable him to act independently and in a professional manner

Catergory 3 normally a classification society or insurance company surveyor, but who maybe an 'in-house' Chartered Engineer (unless legal restrictions apply), or a person of similar standing

Category 4 manufacturer or supplier of the equipment, or a company specialising in such work which has, or has access to, all the necessary testing facilities.

* as defined in IMCA DO18 'Code of Practice for the Initial and Periodic Examination, Testing and Certification of Diving Plant and Equipment'

APPENDIX III

Sample Check List – For use prior to using a lifting bag and after maintenance.

LIFTING BAG CHECK LIST

Customer:	**Serial No:**	**Date:**
Certification No:	**Work Load Limit (SWL):**	**Manufacturer:**

for ROV use

for Diver use

				Accepted	**Not Accepted**	**Comments**
Web Sling	Tag					
	Break in Seam					
	Break in Bearing Threads					
	General Condition.					
Lifting Bag Leak Test	Master Line					
	Shackle					
	Ball Valve ROV use					
	Dump Valve Diver use					
	Fabric					
	Restraining Line					
	Attachment Point					
	Dump Valve Line Colour					
	Air	2.0	P.S.I.			
Preservation	Dry & talc					

		Completed	**New Test**	**Comments**
Repair Conducted	Web Sling		Water Test	
	Bag Fabric		Leak Test	
	Bag Valve		Leak Test	

Check Conducted By:…… Authorised Technician.