GOM Diving Safety Work Group

COMMITTEE WORK GROUP

Underwater Lift bags

July 15, 2014

DISCLAIMER

This US GOM DSWG document is not meant to be all inclusive, and not every rule and regulation is contained herein. The US GOM DSWG does not issue policy or create regulations. The reader should consult additional resources and subject matter experts for more detailed information as required.

Underwater Lift bags

The GOM Diving Safety Workgroup is a US GOM focused, non-competitive and non-commercial group of oil and gas operators, transmission companies, commercial diving companies, supporting sub-contractors, organizations and industry stake holders. The group will provide a unified voice to promote and improve diving safety, through the following:

- identification and sharing of best practices
- identify and seek solutions to industry challenges and issues
- review and comment of existing and proposed standards and guidelines
- provide input to the regulators and industry associations

Purpose of Committee

This document has been prepared by the US GOM DSWG as guidance for:

The Use of Lift Bags Underwater

Committee Chairman	Gary Kane
Executive Sponsor	Ted Roche

Committee Members (Names Only)	
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The document is divided into seven sections:

- **Part 1: Executive Summary**

- **Part 2: Definition**
  Defines the activity that is being evaluated and provides definitions from regulatory or industry groups that are associated with the activity

- **Part 3: Regulatory and Industry Gap Analysis**
  Identifies regulatory and industry association requirements to perform the activity or operation and provides a visual aid to determine the consistencies between these groups as it relates to the activity

- **Part 4: Past Incidents**
  Identifies past near misses, incidents, and fatalities and provides causal factors and the root cause of the incident in order to provide supporting documentation for the hazard analysis in Part 5

- **Part 5: Hazard Analysis**
  Identifies the hazards of the activity or operation, Identifies the risks associated with the hazards, and provides specific mitigation considerations for each hazard to reduce or eliminate risk

- **Part 6: Drills and Preparation**
  Provide a list of drills that should be performed to prepare the crew members for possible emergency situations

- **Part 7: Appendix**
  Please do not alter the template in order to maintain the consistency of the documents as it relates to other committees; but please add additional

documentation, reports, drawings, etc. in this section that may provide more depth or relevant information to the report.

Part 1: Executive Summary of Committee

Lift bags are commonly used in subsea activities to make lifts independent of surface support. When used in a safe controlled manner they can be a valuable tool on any subsea project. However, when used in an uncontrolled manner lift bags can be a dangerous tool and are directly responsible for numerous past fatalities (see section #4). The decision to use lift bags should be looked at in great detail and not taken lightly.

This document focuses on lift bag use in the Gulf of Mexico offshore oil industry. The primary type of lift bag used offshore is the open parachute bag. This document does not go into detail about enclosed bags which are used more in the salvage industry. The committee felt strongly that lift bags are used to assist the diver and they should not be used to make up for inadequate topside lifting capabilities or poor project planning.

As in any lifting activity a good lift plan should be developed and followed. The first step is to evaluate what is being lifted:

- Is the lift Dynamic or Static? Dynamic lift is when the object is being lifted off bottom and relocated. Static lift is when the object being lifted straight off bottom and is restrained to the bottom. Even though during a dynamic lift the object is being relocated if at all possible there should always be some type of hold back rigging to prevent uncontrolled ascent of the load and the bag.
- Confirm the weight of what is being lifted. Construction drawings should be used if possible. If buried take into consideration mud suction.

Once it is determined what is being lifted then the next step is to develop the lift plan:

- Determine the safety factor to be used for rigging, (See Appendix #3 for recommendations)
- Calculate the size of the lift bags and rigging. A lift bag that has a buoyancy capacity much larger than the planned lift should be avoided.
- Determine center of gravity on the object being lifted
- Calculate the number of bags to be used and their spacing. Spacing must be enough to allow the lift bags to completely fill and not interfere with each other.
- Determine rigging points
- Determine hold back rigging points
- Determine where inverter line should be secured.
- Determine a lift bag deflation plan.
- Consideration should be given to the location of the diving bell, down line, tool umbilical and diver's umbilical.

The lift plan should specifically address the main safety components on a parachute lift bag, the inverter line, dump valve / dump Line and hold back line. These three components play an integral part in mitigating any hazards:

- Inverter line; - Will be secured on the object being lifted or an alternate point on the bottom. The sole purpose of the inverter line is to invert the bag if there is a failure on any part of the rigging and the bag breaks free from the load and starts an uncontrolled ascent. For all dynamic lifts the inverter line should always be attached to a suitable manufactured attachment point at or near the crown of the bag and to the load itself. For static lifts the inverter line may be attached to the load being lifted or to a suitable fixed point. Slack in the inverter line should be minimised to avoid excessive shock-loading.
  During dynamic lifts inverter lines should never be attached to fixed point such as a Dead Man Anchor (DMA). An inverter line attached to a DMA cannot (and should not) be expected to act as a secondary means to ground a buoyant lift bag and load that is heading for the surface. In such circumstances the tension on the lift bag exerted by the load will make it very difficult or impossible for the inverter line to invert and empty the bag from the crown. The most likely scenario is that the inverter line will come under great tension and simply part, allowing the bag and load to ascend to surface.
- Dump valve and dump line; - Used by the diver to dump the contents of the lift bag in a controlled manner. The line should be easy to identify and access by the diver.
- Hold-back line; - The purpose of the hold-back rigging is to resist a snatch load caused by a rapidly ascending load and to stop an uncontrolled ascent of lift bag and load together to the surface. Suitable hold-back rigging should be fitted between the load being lifted and a dead man anchor or other suitable fixed point that is not part of the load being lifted. Engineering consideration should be given to the material selected for use as hold-back rigging as it may be subjected to snatch loading. Consideration should be given to the length of the hold-back rigging to avoid unnecessary slack.

Once the lift plan is developed select the rigging and the lift bags that are going to be used:

- Confirm the lift bags and rigging have recent test certifications, (See Appendix item #3 for recommendations). Each part of the lift bag should have a load certification. All straps, shackles, and lifting rings should have serial numbers and be certified.
- Perform a visual inspection of all lift bags and all rigging.

Once the plan is in place then the divers that are executing the plan are selected:

- Confirm the divers are trained to safely carry out the plan (See part #6 for drills and competency assessment).
- Confirm the divers understand the plan and have input into the plan.
- If possible a trial run can be performed in a diving tank to confirm the diver has proper working knowledge and operating experience.

Performing a HAZID (Hazard Identification) or "What If Scenario" is the next step in the planning phase. This HAZID will show what safety processes should be in place to mitigate the identified risks. The key to making a lift safely is to always have control of the object being lifted. The majority of incidents happen when either a lift bag makes an uncontrolled ascent or the object being lifted makes an uncontrolled ascent. To safely execute and control the lift consider the following mitigations:

- Installation of Inverter line – This line will be secured to a stationary object on the bottom or to the load being lifted. The inverter line is designed to invert the bag should the rigging fail and the bag begins a free ascent. The inverter line can be tied to the object being lifted or another suitable point on the bottom. The object it is tied to must weigh more than the lifting capacity of the bag. The inverter line should be long enough so there is slack in it, but not too long to cause a shock load. The inverter line should not be considered as a secondary hold back line.
- Dump Valve & Line – The line will normally be hanging below the lift bag. The dump valve is on top of the lift bag. The purpose is for the diver to be able to dump the contents of the bag in a controlled manner.
- Hold back Line is tied from the object being lifted to a stationary object on the bottom. The purpose of the hold back line is to restrain the object being lifted to the bottom to avoid an uncontrolled ascent. This line should be kept shorter than the inverter line and the length should be kept to a minimum to avoid a shock load on the rigging in case of an uncontrolled lift. The object that the hold back rigging is secured to must weigh more than the capacity of the lift bags. To mitigate any chance of an uncontrolled ascent the object being lifted or moved should always be restrained by a hold back line.
- Consideration must be given to where the contents of the bag will go if the bag is dumped in one of the above scenarios, or when the bag is being deflated. The location of the diving bell, if one is being used and the location of the diver need to be taken into consideration.
- Prior to inflation of the lift bag, a final check should be done of all rigging. When working in low or no visibility it is easy for the diver to make a mistake in the rigging. This final check should be documented. This documentation should be prepared during the pre-job planning
- During the inflation process the diver must maintain good body position. There should be an awareness of the load direction, vessel location, current and hose direction. Careful consideration should be given to the way the bag will be inflated so that the diver can remain clear of the lift at all times. Bags should all be partially inflated to confirm integrity and to ensure the load does not shift during inflation.

Once the object is lifted and moved to its desired location the deflation and de-rigging phase will begin;

- During deflation careful consideration should be given to where the contents of the bags will go.
- If an object is being lowered back to the seabed, the deflation process needs to be controlled.
- If there are multiple lifts bags suspending the load they need to be methodically deflated to ensure the load does not shift?

The last in-water phase is the de-rigging of the lift bag and retrieval back to surface.

- There have been incidents where the diver has been tangled in a bag or the bag has come to the surface because not all of the contents have been evacuated. This phase sometimes does not get as much attention as the rigging and inflation phase because the feeling is that the lift is completed and all you need to do is de-rig. Ensure bags are 100% deflated prior to de rigging.

The final phase is maintenance. Once the lift has been completed and the bags are recovered back to the surface the following should be completed:

- Bags should be examined by a competent person. If any defects or out of date certifications are found the bag should be taken out of service until it is repaired and re tested.
- Lift bags should be washed with fresh water and any oil or grease removed.
- The dump valve on the parachute bag should be cleaned and air dried.
- Once cleaned, the bags should be fully extended to dry out.
- Any repairs should be carried out in accordance with the manufacturer's recommendations.
- When the bag is ready for storage it should be checked to ensure that it is fully dried, rolled (not folded) and stored in a clean dry place.

To utilize lift bags safely the lift bag and object needs to be controlled. Control the lift bag; do not let the lift bag control you.

Part 2: Definition

Underwater lift bags are a means of lifting an object underwater independent of surface support. The lift bag utilizes buoyancy created by displacing sea water with air. Lift bags come in various shapes and size. Once in place the bag is filled with air creating a buoyant sphere that is greater than the weight of the object being moved.

There are two types of lift bags, Parachute, which is open on the bottom and Sphere which is closed. The most commonly used lift bag in the offshore oil industry is the Parachute bag. This type of bag can be rigged to empty its contents in the case of an uncontrolled ascent. This document focuses on the use of parachute lift bags in the Gulf of Mexico Offshore Oil industry.

Part 3: Regulatory and Industry GAP Analysis

In the table below, list the different requirements or guidelines from regulatory and industry work groups and complete the GAP analysis by inserting Yes or No to indicate which of the agencies or groups require or allow the action or process.

Item	Description of Item	IMCA	ADCI	USCG	OSHA	Comments
1	Inverter Line	Yes	Yes	No	No	Extremely critical as a failsafe / Should be double checked prior to filling bag
2	Dump Valve / Dump Line	Yes	Yes	No	No	Extremely critical as a failsafe / Should be double checked prior to filling bag
3	Hold Back Line	Yes	Yes	No	No	Extremely critical as a failsafe / Should be double checked prior to filling bag
4	Weight Calculations	Yes	Yes	No	No	Extremely important to know the weight of what is being lifted
5	Suitable Lift Bag Size	Yes	Yes	No	No	Ensure enough consideration is given to choosing the right size bag
6	Center of Gravity	Yes	Yes	No	No	Critical to address so the lift acts as expected
7	Lift Design	Yes	Yes	No	No	Lift design should be very detailed and take into consideration the hold back rigging, inverter line and dump line
8	Safety Factors to be Applied	Yes	No	No	No	Safety factor should be stated
9	Snatch Loading	Yes	No	No	No	Snatch Loading requires specific attention
10	Burial of item	Yes	No	No	No	Requires specific attention
11	Seabed Suction	Yes	No	No	No	Requires Specific Attention

12	Inspection and Certification	Yes	Yes	No	No	Needs attention especially if bags are stored and not used regularly

Item	Description of Item	IMCA	ADCI	USCG	OSHA	Comments
12	Inspection and Certification	Yes	Yes	No	No	Needs attention especially if bags are stored and not used regularly
13	Variation in actual to stated Lift bag capacity	Yes	No	No	No	
14	Use of Hold Back Point and Dead man Anchor	Yes	Yes	No	No	Include precaution when diving form DP vessel / Consideration must be given to current and escaping air
15	Environmental considerations	Yes	Yes	No	No	Attention to location of bell, current direction, umbilical etc.
16	Umbilical Management	Yes	Yes	No	No	There should be specific mention of umbilical management / This risk should be highlighted
17	Multiple Divers	Yes	No	No	No	Multiple divers would be an issue in terms of umbilical management / All divers need to be aware of lift bag operations and its impact to umbilical management
18	Maintenance	Yes	Yes Not Specific	No	No	A Written Lift bag maintenance regime needs to be in place
19	Training	Yes	Yes	No	No	Should be a High visibility item / Lack of training and competence is a big issue in incidents
20	Filling Precautions	Yes	No	No	No	Should be written in the procedures and on a check list
21	Specific list of potential hazards	No	Yes	No	No	This is site specific and gives input into JSA
22	Taut Wires Transponders etc.	No	No	No	No	An awareness of location needs to be addressed

23	Check List prior to inflation	Yes	No	No	No	Supervisor to check on rigging, divers umbilical, etc. / Specific check list to be recorded by supervisor
Item	**Description of Item**	**IMCA**	**ADCI**	**USCG**	**OSHA**	**Comments**
24	Risk Assessment	Yes	Yes	No	No	Should be very detailed orientated
25	High Hazard PTW	Yes	No	No	No	Must be included, draws attention to high risk task
26	De Rigging of Lift Bag	No	No	No	No	Rarely considered, should be confirmed all air is out of bag

Part 4: Past Incidents

List some past known incident types such as Near misses, incidents, or fatalities and include a root cause if one was determined. This is a representative sample of past incidents and it will aid the committee in Part 5 of this document which identifies hazards with the task or operation associate with this document.

Item	Incident Type (Near Miss / Incident / Fatality)	Description of Event	Root Cause	Comments
1	Fatality	Diver hauled from bottom in bags uncontrolled ascent	No hold back Poor umbilical management Lack of training No Pre inflation check list	
2	Fatality	Diver hauled from bottom in bags uncontrolled ascent during the de rigging phase	Bag was not fully deflated and while de rigging the bag the bag and diver were dragged to the surface	
3	Near Miss	Uncontrolled ascent of lay down head and pipeline when third bag was inflated.	No hold back Incorrect lift calculations No lift plan No pre inflation ck list Good Umbilical management	There have been numerous cases of uncontrolled pipeline ascents
4	Black Ship	Uncontrolled ascent of lift bag causes air to enter sea chest shutting in generator	Poor Rigging. No Inverter / dump lines Poor training and competency	
5	Diver Injury	Diver hauled from bottom in bags uncontrolled ascent	No hold back Poor umbilical management Lack of training No Pre inflation check list	

Item	Incident Type (Near Miss / Incident / Fatality)	Description of Event	Root Cause	Comments
6	Pipeline Damage	Added lift bags to pipeline per engineering resulting in too much lift and buckling pipeline	Incorrect lift calculations No hold back	
7	Near Miss / Injury/ Property Damage	Uncontrolled ascent of object being lifted	No hold back, No Inverter line / Dump line. Poor lift calculation No lift plan.	There have been numerous incidents where the object being lifted has made an uncontrolled ascent.
8	Injury	Unbolt Pig Receiver with lift bag attached	Lift bag rose to full extent of hold back rigging trapping divers leg and fracturing it	No visibility lack of competence
9	Injury / Embolism	Scientist moving steel on bottom used dry suit as lift bag and shot to surface	Lack of Competency and using the wrong tool for the job.	

Part 5: Hazard Analysis

Identify some known and possible hazards to the operation, describe the risk associated with each hazard and provide specific mitigation considerations that could be implemented to reduce or eliminate each risk.

Item	Hazard Identified	Risk Associated with Hazard	Mitigation Considerations (Be Specific)
1	Improper inspection of Lift Bag	Lift Bag Failure / Rigging failure	Properly inspect lift bag, rigging, dump valves and rigging going to DMA Prior to and after every dive References: ADCI Consensus Standards 5.33.6 & IMCA D016 Section 6, Section 9, App 2 & App 3
2	Uncontrolled Ascent of Lift Bag	Lifting the diver or material to surface.	Utilize Inverter line, Dump valve and additional tie back rigging to remove risk of lift bag entering uncontrolled ascent / Confirm weight of object and size lift bags accordingly / Proper calculation of seabed suction
3	Uncontrolled Ascent of Lift Bag	Material coming back down on diver and injuring diver.	Utilize Inverter line, Dump valve and additional tie back rigging to remove risk of lift bag entering uncontrolled ascent / Confirm weight of object and size lift bags accordingly / Proper calculation of seabed suction
4	Rigging Failure	Injury to diver or material	Ensure proper weight calculations / Ensure all rigging has certifications and visual inspection / Ensure correct safety factors are being used
5	Rigging Failure	Lift Bag / Diver / Equipment ascending uncontrollably to the surface.	Check Lift bag rigging, lifting rigging and rigging going to DMA prior to use

6	Air from lift bag entering bell	Injury to diver in the bell	Ensure bell is properly positioned away from lift bags
Item	**Hazard Identified**	**Risk Associated with Hazard**	**Mitigation Considerations (Be Specific)**
7	Lift bag and or material foul diver hose	Injury to diver	Practice good hose management / Pre inflation check list / If 2 divers are on the work site ensure good communications
8	Shock load of rigging during lifting of buried item	Rigging failure causing injury to diver	Ensure proper calculations of seabed suction. If possible, use the crane to break seabed suction before using lift bags.
9	Load shifts during inflation	Injury to diver	Bags should be partially filled during the inflation process to confirm their integrity and to ensure the object is brought up level
10	Diver tangled in bags during inflation.	Injury to diver	Proper planning on how the inflation line will be inserted into the lift bag and held in place
11	Over inflation of Lift bag	Damage to equipment, injury to diver	Ensure that diver is able to control air flow while filling bags. Try and maintain radio silence during operation in case of emergency.
12	Diver crushed by load during deflation of lift bags.	Injury to diver	Practice good hose management and body position / Bags should be deflated in the opposite order that they were filled
13	Lift bag was not fully deflated before removing inverter line and additional tie back rigging	Lifting of diver to surface	Ensure that inverter line, hold back line and DMA remain attached until bag is ready to be recovered to surface

Part 6: Drills and Preparation

Provide a list of drills that should be performed to familiarize the crew with possible risks and hazards and provide specific preparations that can be made to reduce risk. Attach the drills if provided in the Appendix.

Item	Drill Name	Describe Drill
1	Trapped Diver Recovery	Diver's hose is trapped after bag deflated and load went to bottom. Diver is conscious and has air. Standby diver will dress in, follow divers hose to bottom and determine best course of action to free diver. Diver has no physical injuries.
2	Trapped Diver Recovery	Diver is trapped after bag deflated and load went to bottom. Diver is conscious but has physical injuries which will prevent him from ascending on his own. Standby diver will dress in and follow divers hose to bottom and determine best course of action to free diver. Standby diver will have to assist diver to the surface and into DDC if decompression is required.
3	Trapped / Unconscious Diver	Diver is trapped after bag deflated and load went to bottom. Diver is unconscious and has physical injuries which will prevent him from ascending on his own. Standby diver will dress in and follow divers hose to bottom and determine best course of action to free diver. Standby diver will have to retrieve diver to the surface and into DDC if decompression is required.
4	Contaminated Bell Atmosphere	Lift bag inverted and contaminated bell atmosphere. Drill has bellman don BIB mask and retrieve diver back to bell.
5	Competency Drill	To confirm competency diver can be shown several drawings of lift bag set up. Some of the drawings will be correct and several will have missing items, such as the inverter line not secured. Diver will evaluate the drawings and make the necessary changes. Diver will then be given a scenario using lift bags to make a lift and will design the lifting arrangement and identify the hazards.
6	Pre Inflation Check List	Prior to the inflation of the bag the Supervisor and diver will complete a Pre Inflation Check List. The diver should

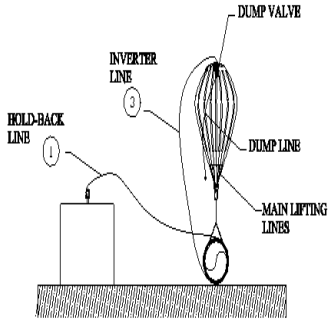
		have reviewed this check list prior to getting in the water (see appendix #4 for sample check list)

Part 7: Appendix

Insert additional documentation, reports, drawings, etc. in this section that may provide more depth or relevant information to the report. List additional material in table and attach original to the back of this report.

Item	Appendix Item	Description of Item
1	Drawing	Lift Bag Setup
2	Drawing	Air Lift Bag Component Identification
3	Document	Suggested Air Lift Bag QA check
4	Document	Pre Inflation Check List

Appendix #1

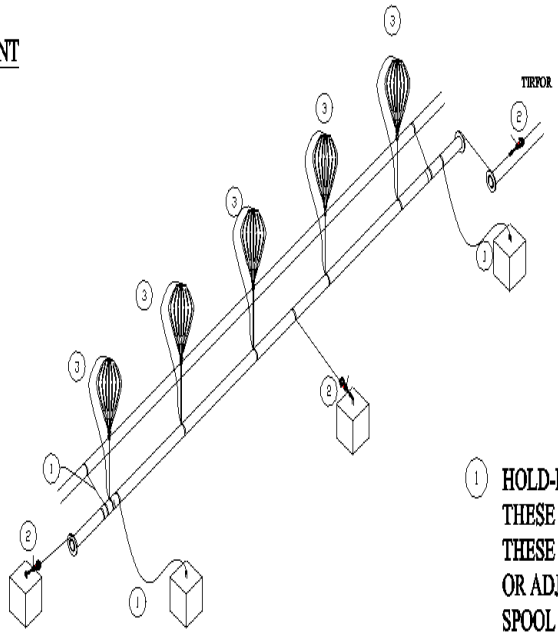


LIFT BAG ARRANGEMENT

THIS SKETCH SHOWS ONE POSSIBLE SET-UP. ACTUAL NUMBERS AND POSITION OF LIFT BAGS, DEAD MAN ANCHORS, TIRFORS ETC., WILL BE DEPENDENT ON WORKSITE ORIENTATION

TERMINOLOGY

IT IS IMPORTANT THAT LIFTING BAGS COMPONENTS ARE ALWAYS REFERRED TO USING TERMS SHOWN ON THE SHEET



TYPICAL EXAMPLE OF SUBSEA RIGGING

OF PARACHUTE LIFT BAGS

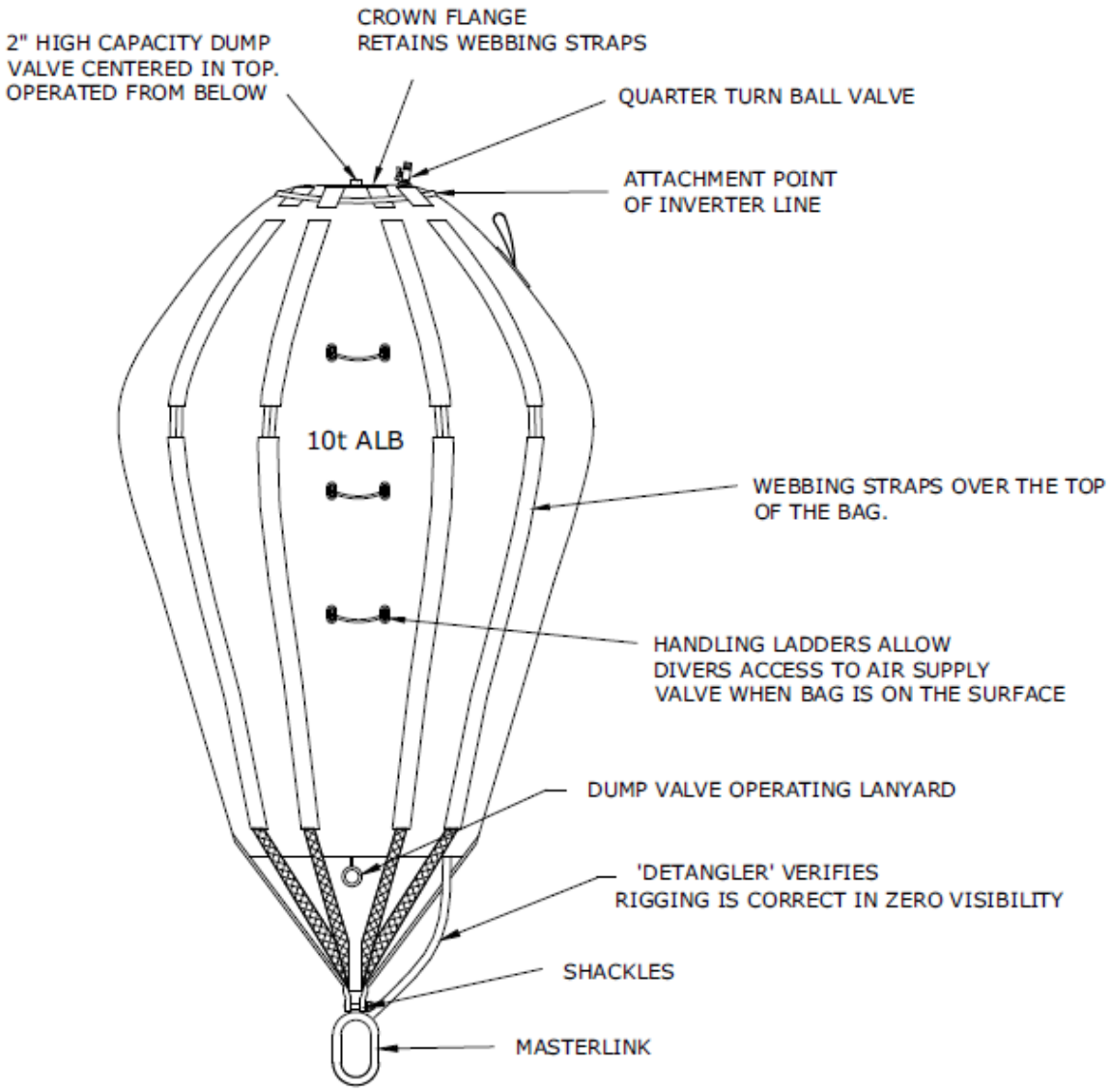
(1) HOLD-BACK LINE
THESE WILL HAVE ENOUGH SLACK TO ALLOW FOR MOVEMENT. THESE MUST BE CONNECTED TO EITHER DEAD MAN ANCHORS OR ADJACENT STRONG POINTS SUCH AS ANOTHER PIPELINE OR SPOOL

(2) TIRFORS ARE FOR CONTROL OF SPOOL MOVEMENT

(3) INVERTER LINES MUST BE CONNECTED TO LOAD BEING LIFTED

Appendix #2

GENERIC AIR LIFT BAG
COMPONENT IDENTIFICATION



Appendix #3

For Reference, the following documents can be reviewed to assist in quality planning and assurance for the buoyancy module:

- ADCI, "International Consensus Standards for Commercial Diving and Underwater Operations", 6th Edition – Section 5.33.6 para 6
- IMCA D016 Rev 3, "Air Lift Bags" – Section 5, Section 6, Section 9, App 2 & App 3.

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

- The factor of safety to which the underwater air lift bag is designed. Usually the minimum factor of safety is 5:1 on its safe working load (SWL) (the test criteria for webbing strops is 7:1);
- Certificate stating the serial number, manufacturing standard, its SWL and listing the component parts supplied with the bag.
- The design has been type tested to the stated SWL (using the factor of safety stated above;
- The bag supplied conforms to the type test;
- Adequate information about the use for which the underwater air lift bag has been designed;
- Details of maintenance requirements;
- The capacity of the bag;
- the up thrust of the lift bag should not exceed the stated fresh water working load limit, nor must it be less than 95% of the stated working load limit in fresh water

Appendix #4

LIFT BAG PRE-INFLATION CHECK LIST

Lift Bag Number:		**Date:**	
Location:			
Job Number:			
Supervisor:			
Diver:			

Done	#	Item
☐	1	Rigging from lift bag secured to load with safety shackles with safety pin installed.
☐	2	DMA set with correct sling attached for weight of load, attached with safety shackle and pin.
☐	3	Dump valve attached.
☐	4	Inverter line attached from top of lift bag to load.
☐	5	Fill whip on location and operational.
☐	6	Fill lift bag to vertical position.
☐	7	Check bag for leaks.
☐	8	Test dump valve for correction operation.
☐	9	Diver to verify his hose is clear of rigging.
☐	10	Once all checks are complete, begin filling bag.
☐	11	Upon reaching approximately 25% capacity of the lift bag, re-inspect rigging.