CHAPTER 4
DIVING EQUIPMENT

DESCRIPTION AND OPERATING PROCEDURES, COMPRESSED AIR BREATHING APPARATUS (CABA) AND ACCESSORIES

401. DESCRIPTION

1. The CAF diver using Compressed Air Breathing Apparatus (CABA) is normally an attended diver in self- contained mode. Canadian waters normally require the diver to be fully suited and to use the accessories described in this Chapter.

2. The standard CABA ensemble is comprised of the following:

   a. Dry suit;

   b. Fins;

   c. Full facemask (FFM);

   d. High-pressure air aluminum twin cylinders with blanking plug cap;

   e. Regulators;

   f. Buoyancy compensator (BC);

   g. Digital depth gauge/Dive Computer; and

   h. Knives.

3. Weighted boots, the Ultra-Light Surface Supply Diving System (ULSSDS), wetsuits, search and rescue ensembles, and half-masks are available for specific operational requirements.

4. The CABA ensemble has been designed based on an assumption that all divers are subject to exposure to moderately contaminated waters in the normal course of CAF diving operations.

   a. Generally and unless proven otherwise, all waters - including but not limited to harbours, rivers, inlets and landlocked waters - shall be considered MODERATELY CONTAMINATED. Even waters in large bays and the open sea may be contaminated; and

   b. Contaminated water diving is described and discussed further in Chapter 5, which includes specific guidance on how to determine the degree of contamination.

5. The use of the CABA ensemble provides the capability for fully encapsulating the diver, affording adequate protection to a normal and healthy CAF member for diving operations.

6. There are a number of CABA variants permitted for operational requirements. The basic ensemble consists of:

a. CAF CABA dry suit with optional latex hood and liner (or neoprene hood), wrist seals, gloves, and CAF Diver Thermal Undergarments;

b. Buoyancy compensator (BC) with integral weights;

c. Double 2265-litre, (80 cu/ft) cylinders with cylinder valve and a blanking plug cap;

d. A regulator with suit inflation, submersible pressure gauge (SPG), primary second-stage regulator with a full facemask (FFM) fitted, and a redundant second-stage regulator;

e. Distress flare for open water dives less than 30 msw. Does not apply when diving Surface Supply System;

f. Lifeline harness;

g. Working knife;

h. Safety knife;

i. Fins (or optional weighted boots);

j. Digital depth gauge/Dive Computer;

k. Half mask;

l. Ankle weights (optional); and

m. Strobe light (Mandatory for night diving).

7. In temperate waters and areas known to be uncontaminated, wetsuits of various thicknesses are authorized for use by selected teams.

8. This Chapter contains a general description of CABA equipment and accessories. Specific operating procedures are found in Chapter 5. Details of function and second- and third-line maintenance are contained in the relevant CFTOs.

402. ENDURANCE

1. The endurance of CABA depends on the number of breaths a diver takes per minute and on the volume of each breath. These factors vary considerably with individual ability and degree of training, the amount of work being done (exertion), depth, and temperature of water. An increase in physical exertion and working in cold conditions result in greater consumption of air and decreases in endurance. Depth decreases endurance since the mass of air consumed increases with depth for a constant tidal lung volume.

   a. Figure 4-1, CABA Endurance Graph should be reviewed early in the dive planning process;

   b. Figure 4-1 shows the endurance of a fully charged pair of aluminum cylinders, to a depth of 51 msw, for either light work or normal swimming; and

2. During the planning phase of a dive, using any variant of the CABA ensemble, careful consideration must be given to:

   a. The diver's ability to read the submersible pressure gauge in the expected U/W visibility; and

   b. The planned duration of the dive, which must be reduced to account for the diver's increased air consumption. A planning factor of one-third of the expected endurance will normally provide a suitable safety margin. For example, an estimated endurance of 30 minutes would result in the diver being recalled to the surface at 20 minutes. Decompression stops must also be considered.

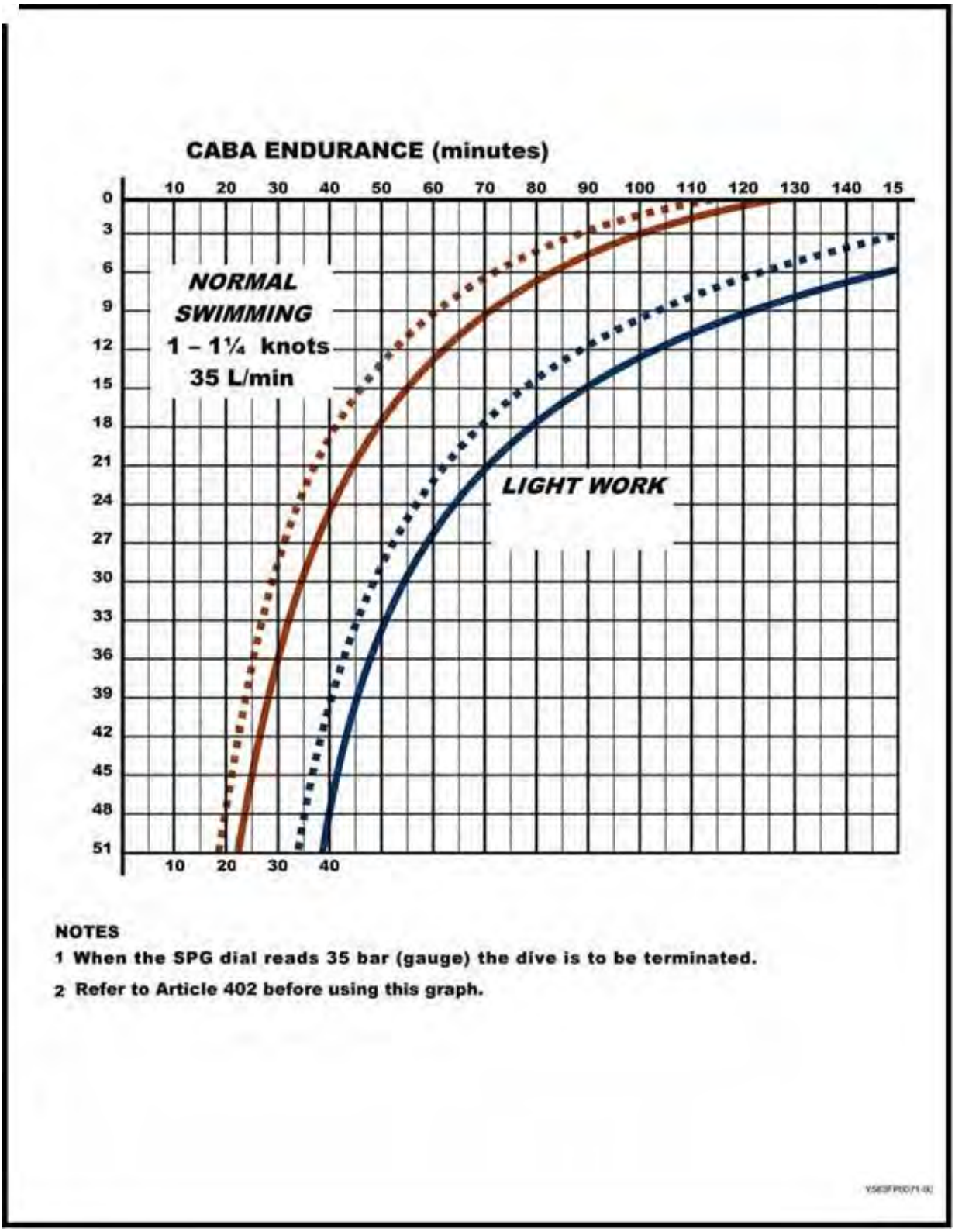


Figure 4-1 CABA Endurance Graphic

EXPOSURE PROTECTION

403. DRYSUIT

1. The primary dry suit used by divers in all elements of the CAF is a self-entry, multi-laminate incompressible shell-type suit. Its use encapsulates the diver except for the hands and head. The head and hands may also be encapsulated via the additional features described below. CAF Incompressible Dry suit consists of the following:

a. Heavy-duty UV resistant latex/Silicon rubber wrist and neck seals;

b. **Optional Detachable Latex Hood**. The latex hood is required when operating in known or suspected moderately contaminated waters;

c. **Optional Detachable Gloves**. Either dry gloves (for use when conducting underwater welding/cutting) or if permitted, neoprene gloves. Neoprene gloves are permitted when operating in waters known to be uncontaminated;

d. A self-entry pressure sealed slide fastener (zipper);

e. Quick-disconnect LP swivel inflation valve;

f. Suit exhaust valve; and

g. Optional dry shell sock with accompanying boot or integral molded boot.

2. A dry suit provides a higher level of protection than a wetsuit from the surrounding environment (primarily cold and water contaminants).

3. It provides increased protection from the cold by maintaining an air envelope between the diver and the water thereby keeping the diver and insulating garments dry.

4. A diving dry suit provides a barrier between the diver and potentially hazardous material thereby increasing the chemical and biological protection.

5. A cooling system such as a cooling vest may be required when diving in hot waters that require the use of a dry suit.

6. Suit squeeze is a significant factor when using a dry suit. This will be prevented with the wearing of undergarments. Experience has shown that the latex hood alone will likely result in ear squeezes. To minimize this squeeze, a diver wearing a latex hood must always wear some form of under-hood layer to prevent the latex sealing against the outer ear. Options such as a fleece toque, an open-cell foam hood liner, or the CAF- issue toque have all proven effective.

7. The multi-laminate dry suit shell material permits easy decontamination of the suit following exposure to salt water or moderately contaminated water. The suit will also afford

limited single exposure to more heavily contaminated waters if accidentally exposed. Refer to Chapter 5 for further detail.

8. The CAF dry suit may either be a made-to-measure suit or off the shelf version. It is to be replaced when required or when beyond economical repair.

9. The dry suit must be fully donned when travelling in an open boat, otherwise an approved PFD must be worn.

10. A diver candidate undergoing initial training will be issued a training suit until successful completion of the training.

11. Dry suits hold a considerable volume of air. This air provides thermal protection and buoyancy. Buoyancy control in a dry suit requires practice.

Buoyancy Control in CAF Dry suits:

a. Dry suits are fitted with an air inflation valve and an air exhaust valve for buoyancy control and to prevent suit squeeze or suit over-inflation. The inflation valve is located in the center of the diver's chest for ease of access. However, this can increase the possibility that one of the other equipment straps rides up on the valve. Tension on the straps can lead to unintended actuation of the valve during the dive, followed by uncontrolled ascent. The diver may also become trapped if in a confined space, and may be unable to reach the exhaust valve. By attaching the suit inflation hose last, over the top of all other straps, the hose can be arranged so as to prevent the straps riding over the top of the valve. Supervisors shall verify this arrangement by sighting the inflation valve and straps during the pre-dive check.

b. Air is supplied to the inflation valve via an IP hose from an intermediate pressure port on the first-stage regulator. The diver operates the inflation valve manually.

c. An exhaust valve, located on the left forearm of the dry suit, is used to vent excess air from the dry suit and aid in controlling buoyancy. The diver may adjust the level of venting by rotating the valve face plate, either clockwise (closed) or counter-clockwise (open). The diver may also manually release air from the dry suit by pushing down on the valve face plate. Optimal performance will be achieved by raising the left arm as air in the suit will travel to the highest point. The valve will also open automatically to protect the suit from rupture due to over-inflation.

WARNING

The misuse of dry suit inflation or exhaust valves, the use of suit buoyancy to lift heavy objects or an inverted ascent may all result in an uncontrolled ascent with the possibility of serious injury or death.

12. Refer to CFTO C-87-235-000/NY-001 and C-87-235-000/NY-Z01 for Pre/Post dive procedures and maintenance routines.

405. DRYSUIT THERMAL UNDERGARMENTS

1. The use of dry suit thermal undergarments provides the diver with passive thermal protection. Alternatives such as active heating and cooling systems are being developed for use with the new CAF Divers' Thermal Undergarments.

2. There are several versions of thermal undergarments available that provide varying level of thermal protection.

3. The use of a base layer of clothing is required to prevent suit squeeze and to wick moisture away from the diver's skin.

406. WETSUITS

1. Wetsuits are available for specialized operations. Wetsuits are made of foam neoprene rubber and are designed to permit a small amount of water between the diver and suit. The fit should not restrict movement or circulation or to cause discomfort.

2. The thickness of the suit governs its insulating and buoyancy properties and these properties will reduce as water depth increases. The increase in pressure as depth increases results in the cells in the neoprene being compressed, resulting in partial loss of thermal efficiency and buoyancy. Divers unaccustomed to deeper depths must be attentive to the significant buoyancy changes in order to maintain control of descent and ascent.

3. The common sizes used by CAF members are:

   a. 7-mm (standard wetsuits issued to authorized personnel),

   b. 3-mm dive skins for specific operational and training requirements, and

   c. 0.5-mm for diving teams conducting operations and training in tropical/temperate waters.

407. WETSUIT MAINTENANCE AND STOWAGE

1. Proper maintenance and storage increases the normal-use life expectancy of a wetsuit.

2. Repairs to a wetsuit can be done easily and quickly with liquid adhesives recommended by the manufacturer. A suit that requires repair must be completely dry and salt-free in the area where the adhesive is to be applied. Normally, 15 minutes is sufficient time for the adhesive to

bond. However, full curing IAW the manufacturer's instructions should be followed whenever possible.

3. **Proper Stowage of a Wetsuit**:

a. Ideally, the suit should be rinsed with fresh water and suspended on wooden hangers in a well-ventilated compartment;

b. For stowage in confined spaces, the suit should be rolled, avoiding folds;

c. Heavy weights will break down the unicellular structure of the neoprene and should never be placed on top of the wetsuit;

d. The life of the suit will be shortened if it is dried with excessive heat or if it is stored in very warm areas; and

e. Do not store wetsuits in areas where electric motors are running. The ozone gas generated by electric motors is harmful to the molecular structure of the wetsuit material.

LIFE SUPPORT EQUIPMENT

408. CANADIAN ARMED FORCES BUOYANCY COMPENSATOR

1. The BCD is a buoyancy-compensating device used by all divers in the CAF. It does not meet civil Personal Flotation Device (PFD) - lifejacket - requirements and is not intended for use as such. It is provided in two colour styles: either all black (for Combat Divers) or with distinctive red reflective bands (for all other divers). It contains no internal bladder.

a. The buoyancy compensator (BC1) has the following features:

(1) An integral harness that permits use of either single or double cylinders;

(2) A releasable weight system;

(3) Adjustable waist strap/cummerbund mounting two releasable weight pouches;

(4) Two non-releasable weight pouches mounted on the harness back;

(5) Two shoulder releases with swivel quick-release;

(6) Quick-adjust shoulder strap rings;

(7) Adjustable chest strap;

(8) Back comfort pad;

(9) Shoulder and waist attachment rings;

(10) Integral front and side pockets;

(11) Crotch strap (optional);

(12) Strobe light holster on right shoulder;

(13) SPG retainer clip;

(14) Four D-rings;

(15) Carrying handle (refer to BC Precautions and Warnings, paragraph 3.);

(16) Low-pressure (LP) inflator with dual exhaust valves;

(17) Three overpressure relief valves; and

(18) Up to 23 kg (52 pounds) positive buoyancy.

2. Pre/Post dive procedures:

    a. Pre/Post dive procedures are contained in C-87-E22-000/ML-001.

3. BC Maintenance:

    a. Fully detailed operator's maintenance instructions are contained in C-87-E22-000/ML-001; and

    b. Complete overhaul, planned and corrective maintenance procedures for use by qualified Clearance Diver Maintainers (MOS ID 00342) are contained in C-87-E22-000/MS-001.

4. BC Precautions and Warnings:

    a. Before every dive, perform a complete pre-dive inspection according to the procedures in the next section to ensure all components are functioning properly and no signs of damage or leaks are present. If the BC is not functioning properly or is damaged remove it from service until it can be repaired.

    b. The BC is NOT a lift bag. Divers are cautioned NOT to use its buoyancy to carry heavy objects to the surface. Dropping a heavy object could lead to a rapid uncontrolled ascent. This could result in serious injury or death due to embolism or decompression sickness.

    c. Failure of the BC could also lead to a rapid uncontrolled ascent or descent. This could result in serious injury or death due to embolism or decompression sickness.

        (1) In the event of an uncontrolled, rapid ascent: IMMEDIATELY begin venting air from the BC. Continue venting air to slow the ascent rate if neutral buoyancy cannot be re-established.

        (2) In an emergency such as an out-of-air situation or uncontrolled descent IMMEDIATELY remove and jettison weights. Do NOT depend solely on the BC's power inflator for lift.

    d. Personnel not trained or authorized must not attempt to disassemble, repair or lubricate this equipment.

    e. Lifelines shall NOT be attached to the BC. The buddy line attachment loop may be secured to the waist BC D rings only.

f. The carrying handle has limited strength and is NOT intended to lift divers out of the water. Do NOT use the carrying handle as the sole carrying point when CABA cylinders are attached.

g. This BC has the potential to position a stricken diver face down on the surface.

409. INTEGRAL DIVING WEIGHTS

1. The BC1 enables sufficient weight to be worn by the diver so that separate weights are normally not required (except in specific operational modes, e.g. ULSSDS plodding operations).

2. It is very important for the diver to be thoroughly familiar with the correct method for installing and releasing weights before diving the equipment.

3. Divers will normally remove the BC weight pouches before exiting the water in order to reduce strain on both the diver and the equipment.

4. Additional soft ankle weights may be worn as required by the diver. They should be easily removable, normally by means of a Fastex® connection.

5. Weight pouches shall be treated as life support equipment and stored in a location which prevents damage to the plastic componets. Damage to the plastic components can prevent the weights from being released from the BC1.

410. CABA HP AIR CYLINDERS

1. CABA cylinders are rated for a minimum working pressure of 205 bar (gauge).

2. Cylinders used in CAF operations are normally made of aluminum.

3. The difference in buoyancy between fully charged and empty cylinders is significant enough to affect the diver. For example, a set of double 2265-litre aluminum cylinders lose approximately 4 kilograms in weight from fully charged to empty and will gain considerable buoyancy as the air is consumed.

4. Cylinders fitted with a "K"-valve do NOT have a reserve of air. CABA cylinders with this valve should only be used when fitted with a submersible pressure gauge (SPG). When the SPG needle reads 35 bar, the dive is to be terminated. Refer to Article 402 for additional air endurance precautions. The CAF currently uses the following CABA cylinders:

a. 368-litre (13 cu ft) Cylinder Fitted with a "K"-valve. Used primarily in SAR operations as Survivor Auxiliary Air Cylinders (SAAC);

b. 850-litre (30 cu ft) Cylinders Fitted with a "K"-valve. Used in specific applications. (e.g. SAR missions);

c. 2265-litre (80 cu ft) Cylinders Fitted with a blanking plug cap; and

d. 2832-litre (100 cu ft) Cylinders. Used by SAR Techs, and Clearance Divers.

e. Interspiro Small Cylinder pack: 2040-litre (72 cu ft).

f. Interspiro Large Cylinder pack: 4020-litre (142 cu ft)

5. Units shall develop and post cylinder filling SOP's IAW the particular compressor in service.

411. AIR REGULATOR SYSTEM

1. The diving regulator is a two-stage demand mechanism that reduces the high-pressure air in the supply cylinder to breathable, ambient pressure at the diver's mouthpiece. It automatically compensates for changes in cylinder pressure and diving depth. To safely and effectively operate the regulator, divers must be thoroughly familiar with its operation.

a. The first-stage regulator, fitted to the cylinder valve, reduces the air from the supply cylinder to an intermediate pressure of approximately 9.3 bar; and

b. The second-stage regulator, provides air to the diver by reducing the intermediate pressure to a breathable, ambient pressure.

2. The first stage regulator will be fitted with:

a. Two intermediate pressure hoses of different lengths, which supply air to a primary and a redundant second- stage regulator;

b. The primary second-stage is normally fitted to a FFM. For mission specific operations, a conversion to AGA half mask may be performed at the discretion of the on-site diving supervisor (refer to Article 412 for procedure);

c. The redundant second-stage regulator is intended for use as an emergency air source for a buddy diver; and

d. Regardless of the CABA variant being used, the redundant second-stage regulator shall be secured within the diver's safety triangle. The only method of securing the redundant second-stage regulator may is special purpose holder (MOUTHPIECE, BREATHING APPARATUS, NSN 4220-01-597-0312). This will prevent the regulator from accumulating debris from the seabed, which could render it non-functional. It also ensures the divers can locate it quickly during an emergency.

3. Each diver's first stage regulator is also fitted with:

a. A high-pressure hose fitted with a submersible pressure gauge (SPG):

i. The SPG is attached to the first-stage regulator via a flexible HP hose. This gauge allows the diver to monitor air supply.

ii. The SPG reading is to be compared for accuracy by the diver with the cylinder pressure test gauge after cylinder filling, and shall be tested for accuracy annually by CL Diver Techs during the diving equipment technical maintenance inspection.

NOTE
SPG accuracy tests will be within 15 bar (gauge) and SPGs found to be outside that range shall not be used.

WARNING
If at any time during a dive the indicating needle reads 35 bar or less the dive is to be terminated.

b. A low-pressure inflation hose for the BC.

c. A low-pressure dry suit inflation hose.

412. AGA "Divator" MK II FFM

1. Detailed Pre/Post dive procedures can be found in CFTO C-87-273-000/MF-001 pages 3-4 to 3-7.

2. AGA "Divator" MK II FFM description:

a. The Interspiro AGA "Divator" MK II full facemask (Figure 4-2) is made of soft rubber/silicon with a visor of high impact polycarbonate plastic;
b. The masks flat clear faceplate is matt-finished to reduce optical distortion;

c. The mask incorporates a demand second-stage regulator and can be fitted with a microphone/earphone assembly for hardwire or through-water communications;

d. The mask is secured to the diver by a five-strap rubber "spider" harness that is fastened and tightened with stainless steel buckles. The wide, double-flanged sealing edge of the mask is held to the contours of the face by the harness creating an effective seal;

e. The regulator utilizes a balanced design resulting in low breathing resistance;

f. The mask is fitted with an inner oral-nasal mask and an adjustable nose block push pad;

g. The regulator is attached to the full facemask using a bayonet coupling. The lightweight material and low- profile design reduce hydrostatic drag and conforms to the shape within the mask. There are no protruding parts to be fouled or to unbalance the mask;

h. The inner oral-nasal mask incorporates one-way valves that minimize dead air space. Additionally, separate one-way valves in the inhalation and exhalation ports do not allow the supply and exhaust gases to be mixed; and

i. During inhalation, gas is delivered from the AGA regulator through the mask de-fogging ports, across the visor and into the oral-nasal mask. Exhaled gas is expelled to the ambient water from the oral-nasal mask through the regulator exhalation valve.

Figure 4-2 AGA MKII FFM

413. AGA Octopus Second-stage Regulator:

a. The AGA full face mask regulator and redundant second stage regulator are similar in appearance and are both demand regulators. The significant difference is that the redundant second stage regulator has a locking lever and mouthpiece;

b. The locking lever is fitted in order to reduce the possibility of a free flow by physically holding the inlet valve shut until the diver takes a breath or pushes the purge button; and

c. Both divers and supervisors shall perform a function test during pre-dive checks and ensure that the locking lever is against the valve housing, in the locked position prior to diving.

d. Converting an AGA second stage regulator to an Octopus second stage regulator can be found in CFTO C-87-273-000/NY-001.

414. Redundant Second Stage Monthly Non-return Valve (NRV) Leak Check:

a. This test only applies to the Redundant Second Stage (RSS). The NRV in the FFM regulator is fully encapsulated and does not require this testing;

b. The NRV shall be inspected and leak tested monthly to ensure the integrity of the red NRV. This test may be performed with mouthpiece attached or removed; and

c. **Procedure for NRV leak check**:

(1) Fill NRV free space with water (approx. 1 tsp);

(2) Check that no water leaks into the second stage (the water level must not drop);

(3) Empty the water and blow the valve dry by pressing the purge button; and

(4) If the NRV fails this test, contact the nearest FDU repair facility.

415. CABA LITE AND ULTRA LIGHT SURFACE SUPPLY DIVING SYSTEM (ULSSDS)

1. The CABA Lite and ULSSDS shares components between the systems.

2. In CABA Lite the divers are free from the umbilical, and in Surface Supply the divers are provided breathing air via an umbilical. The following specifications apply to both configuration.

a. DIVATOR MKII REGULATOR WITH RESERVE VALVE. This is the standard regulator for use with both ULSSDS and CABA Lite configurations:

(1) In ULSSDS mode, all supplied air will be taken from the Surface Supply Panel as long as the Surface Supply pressure is greater than 20 BAR;

(2) In case of loss of main air supply, air will be taken from the diver's reserve cylinders. No action is required from the diver for this to happen;

(3) The diver gets an active breathing resistance warning when air supply drop between 60 and 70 BAR;

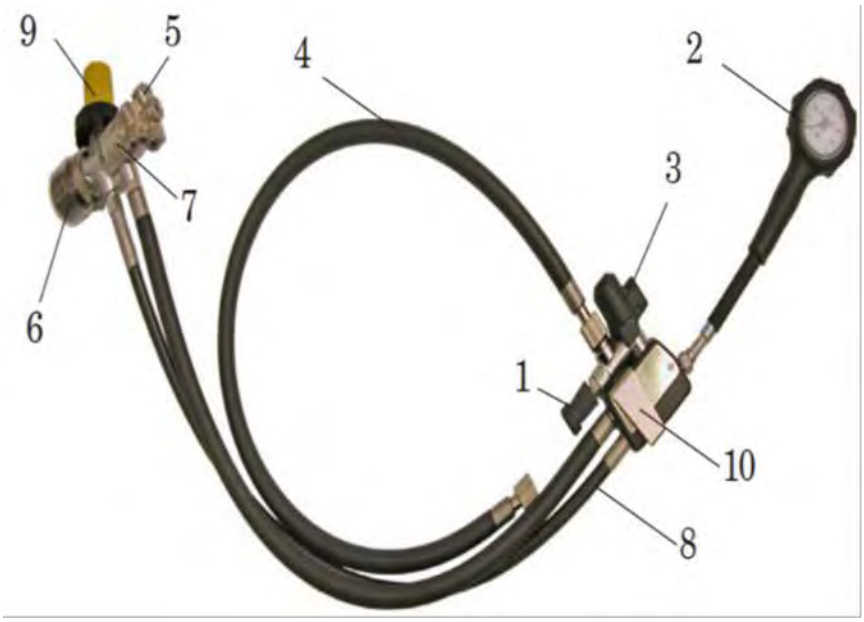
(4) The breathing resistance warning will get shorter and shorter until the reserve valve becomes completely closed or until the reserve lever is actuated (pushed down);

(5) Above 80 BAR, the HP cylinder air pressure disengages the detent which allows the lever to stay in the up position;

(6) Below 70 BAR, the HP cylinder air pressure will allow the detent to re-engage locking lever in down position and activate the reserve air supply. When actuated, the reserve valve lever will be locked in the open position (down); and

(7) It is not possible to inadvertently or prematurely activate (push down) the reserve valve lever.

(8)



1	Male Quick Connect for Surface Supply with protective rubber cap.
2	Pressure Gauge displaying pressures from 0 to 300 BAR
3	Chest-mounted Reserve Valve assembly with lever
4	Breathing Hose
5	Medium pressure 4-port swivel for BC inflator, Dry suit inflator and Octopus hoses
6	Anti-freeze Cap
7	MKII Regulator, First stage
8	High Pressure Hose
9	Dust Cover
10	Retaining Clip for Reserve Holder Strap (to attach to BC)

Figure 4-3 MKII Regulator

b. BREATHING VALVE. The breathing valve is a demand valve, supplying air only during inhalation. The breathing valve is balanced to maintain extremely low breathing resistance at all depths. Each diver has a Primary breathing valve and a Secondary Octopus breathing valve.

c. FULL FACE MASK.

d. HEADS UP DISPLAY (HUD). The HUD is a warning light that activates when the Divator SCUBA cylinders reaches a reserve pressure of 80 BAR. The Divator HUD can be mounted on any Interspiro Divator Full Face Mask or breathing hose. When the reserve cylinder air pressure drops to 55 bar, the Divator HUD begins to blink.

Figure 4-4 Head-Up Display (HUD)

e. CYLINDER PACK. The cylinders are fully composite cylinders made of carbon and glass fiber, and wrapped with plastic liners. Used for air only. The cylinder hand wheel must be pushed in and turned to close the cylinder valve. This prevents inadvertent closing of the valve. The burst disc on the cylinder pack is designed to rupture at a pressure of 450±50 BAR. Carelessness when handling the cylinder pack with its weight fitted may result in deformation of the spacing rod or weight shaft. The cylinders packs are available in two different size.

(1) 323.4 Small Pack:

(i) Capacity 3.4 liter, 2040 L;

(ii) Weight empty 7.2 kg (15.9 lb); and

(iii) Wight full of air 9.4 kg (20.7 lb).

(2) 326.7 Large Pack:

(i) Capacity 6.7 liter, 4020 L;

(ii) Weight empty 12.3 kg (27.0 lb); and

(iii) Weight full of air 17.0 kg (37.5 lb).

(3) Service pressure: 300 BAR;

(4) Test pressure: 450 BAR;

(5) Minimum burst pressure: 900 BAR;

(6) Life Cycle: 15 years;

(7) Approvals: DOT and CE;

(8) Internal Inspection: Not required;

(9) Hydrostatic Test: Every 5 years.

Figure 4-5 ULSSDS Cylinders

f. AQUA LUNG BC1 BUOYANCY COMPENSATOR. The Aqua Lung BC1 version is a modular design buoyancy compensator, with contour back pack, integrated weight system, and back inflation bladder. The bladder provides lift (buoyancy) of 230N (52 lb.). To enable the use of CABA Lite Cylinders, a mounting rail have been set on the BC.

Figure 4-6 BC Rail Kit

g. WEIGHTS. The CABA Lite Cylinders pack are positively buoyant. They must be compensated with weights in order to be neutral or negative in water. The cylinders weight is mounted on a shaft on the cylinders pack. The weight is secured in place by a cotter pin. The weight is easy to remove, which allow the cylinders pack to be handle ergonomically. The weights are made of brass.

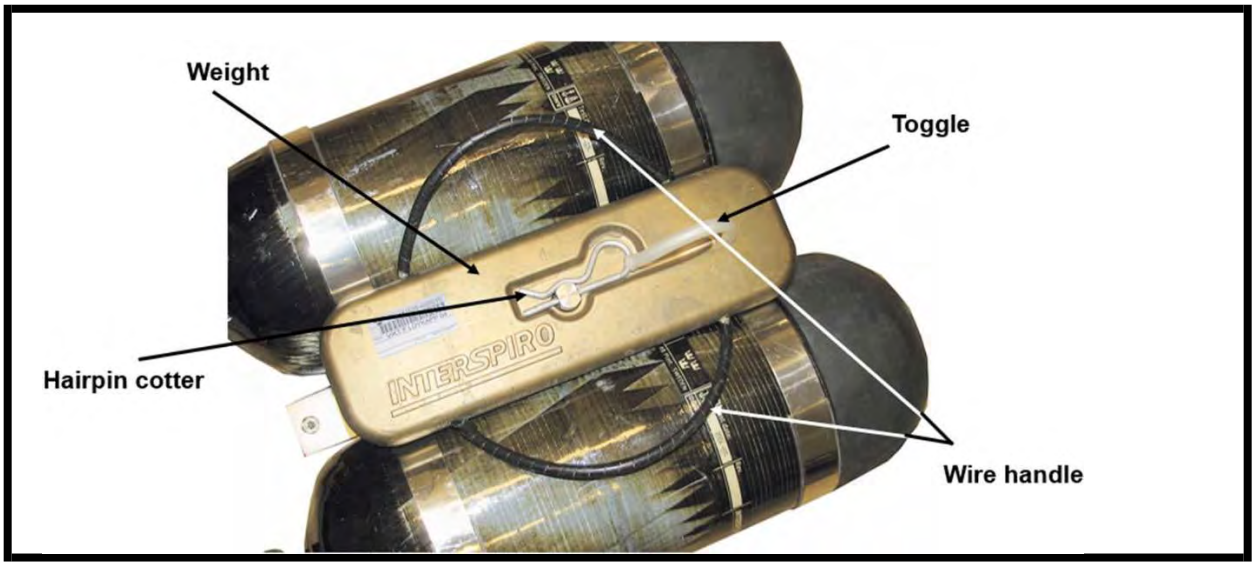


Figure 4-7 ULSSDS Weights

h. ACCESSORIES.

Cylinder Pressure Gauge.

Fill-Adapter with Restrictor. It MUST be used if cylinder pressure is less than 30 BAR.

DIN Fill-Adapter (206 BAR). For filling using yoke connection.

DIN to Yoke Adapter (206 BAR). For use with standard aluminium cylinders and valves. There is 2 Adapter per surface supply panel.

Figure 4-8 ULSSDS Accessories

3. CABA LITE CONFIGURATION

Figure 4-9 CABA Lite Configuration

416. ULTRA LITE SURFACE SUPPLY DIVING SYSTEM (ULSSDS)

1. The ULSSDS is a surface supply diving system with an operating pressure of up to 300 BAR. It has two high-pressure supply cylinder connections, each are connected to a high pressure supply cylinder or cylinders pack. A shuttle valve allows the attendant to change the supply cylinder or cylinders pack during the diving operation. The ULSSDS consists of:

a. SURFACE SUPPLY PANEL. It comprises an automatic shuttle valve, low air warning whistle, pressure gauge, adapter hoses for air supply cylinders and a connection to the high pressure air lifeline hose for the diver. The connections to the air supply sources are suitable for both 200 and 300 BAR pressure "DIN" fittings.

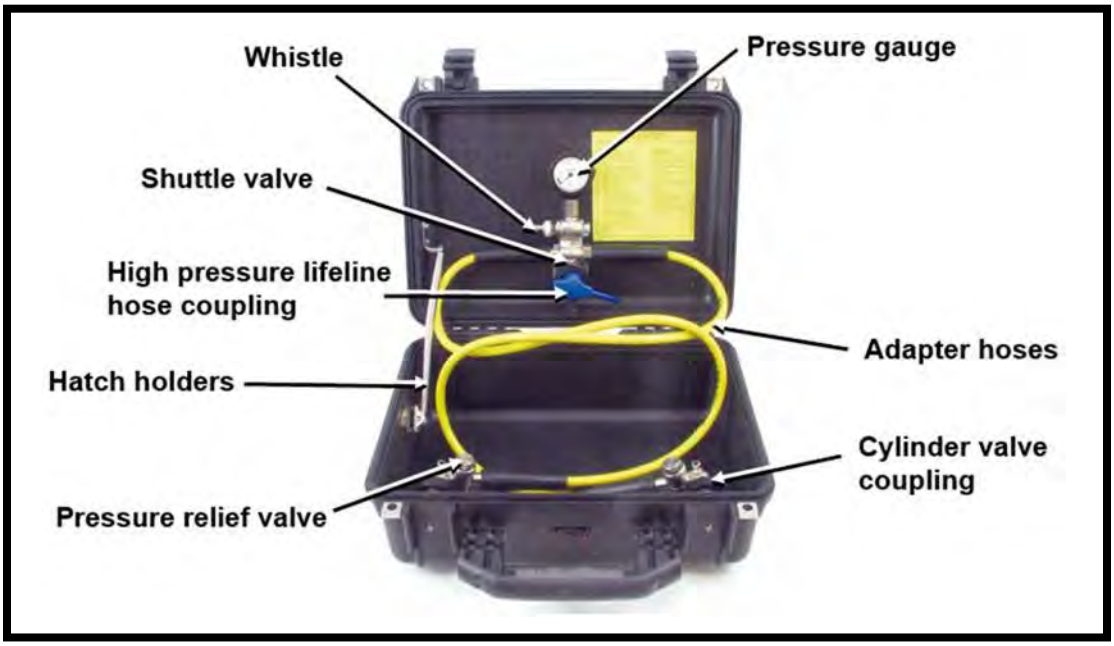


Figure 4-10 Surface Supply Panel with Hoses

b. SURFACE SUPPLY ADAPTER FOR TWO DIVERS. The adapter enable to supply air for two divers simultaneously. The unit also have the advantage of being able to support two divers at different depths, using the same cylinder supply source. Without the adapter, the panel can support only one diver.

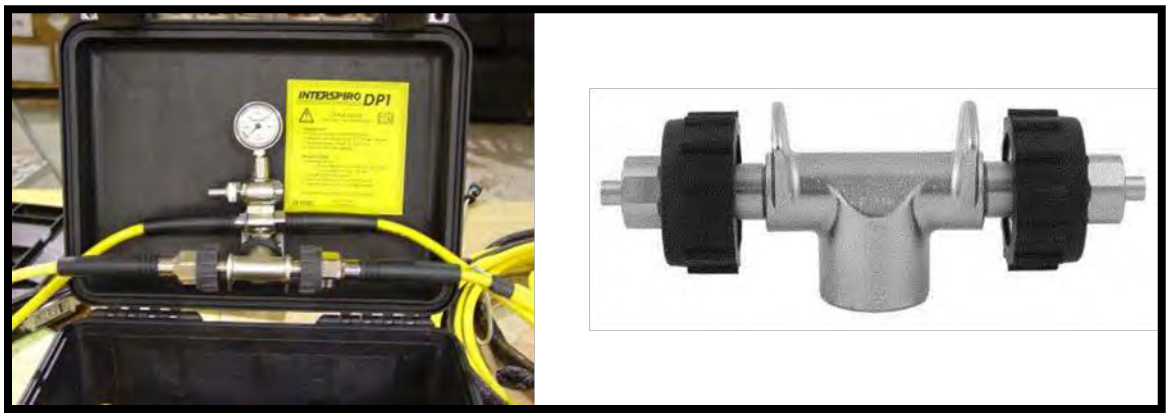


Figure 4-11 Surface Supply Adapter for two Divers

c. HIGH PRESSURE AIR LIFELINE HOSE. The ULSSDS has been approved with an air supply hose up to 120 meters in length for a maximum operational depth of 45 m. The HP air lifeline hose is attached to the diver's manifold with a quick-connection on the P+ regulator.

(1) Lightweight and neutrally buoyant design.

(2) Inner diameter: 2 mm (0.08 in).

(3) Outside diameter: 10 mm.

(4) Material: Aramid type synthetic fiber for strength. External polyurethane layer for cleaning/decontamination.

(5) Working Pressure: 300 BAR.

(6) Burst Pressure: Over 1500 BAR.

(7) Tensile Load: 900 kg.

(8) P+ Regulator MP: 10.0 BAR.

(9) DND Lengths: 90/60 meters.

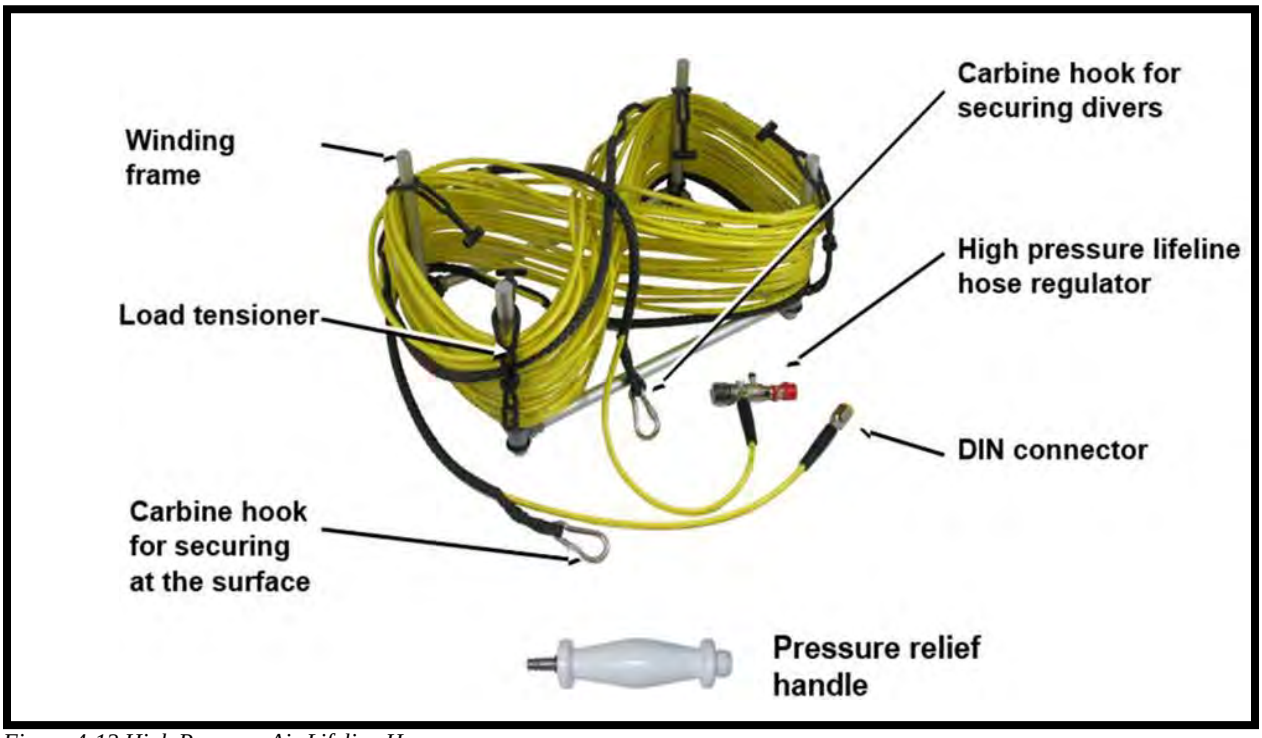


Figure 4-12 High Pressure Air Lifeline Hose

d. REGULATOR, POSITIVE PRESSURE (P+). The P+ Regulator is attached to the end of the HP air lifeline hose and is connected to the diver's regulator. The P+ regulator will supply the diver with a higher secondary pressure (10±0.3 BAR) than the regulator used for the DIVATOR SCUBA cylinder. The P+ regulator will automatically compensate the secondary pressure for depth variations done by the diver and no continuous adjustment is needed by the surface attendant.

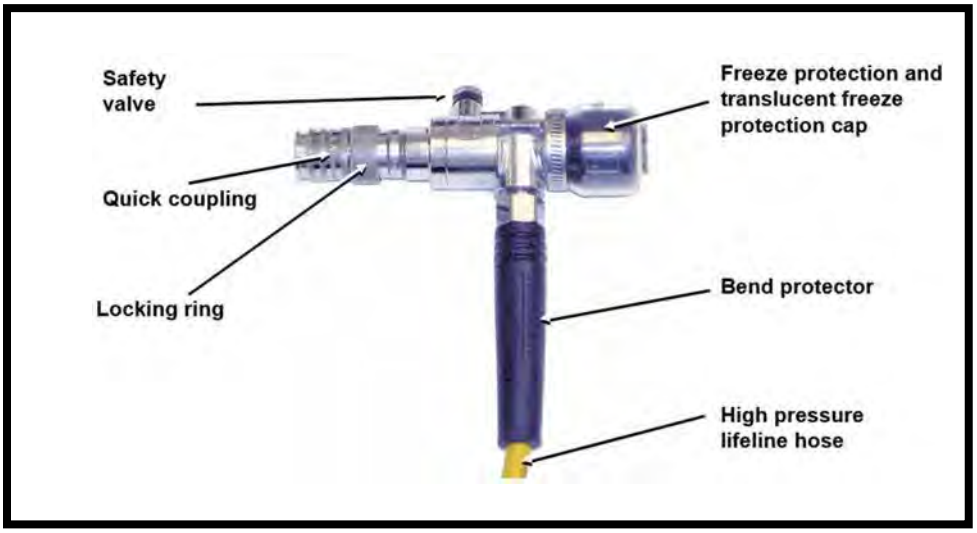


Figure 4-13 High Pressure Air Lifeline Hose P+ Regulator

e. COMMUNICATIONS SYSTEM. The Mark-7 Buddy Line system is a compact self-contained two diver air intercom providing clear communications between the

supervisor and diver(s). This is a hardwire system that has a physical connection between the listener and the talker. The system consists of a surface unit, a headset with a microphone, communications cable from surface to diver(s), a diver microphone-earphone assembly, and Divator AGA with a microphone.

Figure 4-14 ULSSDS Communications

417. CABA/SAR TECH RESCUE DIVING ENSEMBLE

1. The purpose of the CABA/SAR TECH Rescue Diving ensemble is specifically aimed at entry into a hazardous, confined underwater environments, in order to extract survivors and provide them a breathing air source. It is similar to the CABA diving ensemble with the addition of:

a. AGA MK II FFM fitted with the Interspiro Hatch Ambient Breathing Valve (ABV) and through-water/hard wired comms;

b. A single 2832-litre (100 cu ft) @ 205 bar diving cylinder fitted with a reserve mechanism blanking plug;

c. A 368-litre (13 cu ft) cylinder, fitted with a "K"-valve, is connected to a first stage regulator with mini SPG and redundant second stage regulator. This is affixed to the front of the diver. This cylinder is designated the Survivor Auxiliary Air Cylinder (SAAC);

ANCILLARY DIVE EQUIPMENT

418. DIVER'S HALF MASK

1. A half mask provides protection to the eyes and nose, insulation, and an airspace so that the diver's vision is not distorted by direct water contact.

2. To prevent squeeze the mask is designed to enclose both the eyes and nose so that air pressure inside the mask can be made equal to ambient water-pressure by expelling air through the nose. For this reason, goggles are never to be substituted for a half mask.

3. The safety glass of the mask faceplate tends to fog easily because of poor ventilation. To minimize fogging, thoroughly smear the inside of the faceplate with saliva or anti-fog compound and rinse lightly prior to donning. If the faceplate fogs during use, admit a small amount of water into the mask and sluice it across the fogged area, provided that the dive site water is not contaminated.

4. To clear a flooded half mask, gently press the upper portion of the mask to the forehead. Exhale into the mask. This will force the water out of the bottom. Gradually tilt the head backward and keep exhaling until the mask is clear.

5. A half mask shall be carried by all CABA divers as a backup mask. It may be required when switching to the redundant second stage regulator. It may be carried in the diver's dry suit pocket or BC pocket.

419. DIVER'S DAY/NIGHT DISTRESS FLARE

1. A combination emergency flare and smoke generator shall be carried by divers during open water diving, free- swimming and night operations.

NOTE

Flares are not permitted deeper than 30 msw. The flare is only waterproof to that depth.

Day/night distress flares are not required when diving with Surface Supply System.

2. The flare must be secured to the diver where it is readily available in an emergency. It may be strapped to the diver or placed in a BC pocket. It shall not be attached to the breathing apparatus.

3. Flares shall only be used if emergency assistance is required. They shall not be used for the routine indication of the diver's position, which is done with the indicating light.

4. Instructions for igniting the flare are printed on the flare; however, the supervisor must ensure that all divers are familiar with its operation before starting the dive. The diver must be on the surface before firing the flare and hold it well out of the water to aid visibility.

5. Regardless of their water-resistant construction, flares are subject to water damage that can render them dangerous or useless. They must be examined carefully prior to every use for signs of damage, such as rusting or swelling of the container. If in doubt, replace the flare.

6. When diving in pairs and one diver gets into difficulty, it is the responsibility of the "buddy" to bring that diver to the surface and fire the flare. The second flare must be retained in reserve and used after a suitable interval, if it is apparent that no assistance is forthcoming.

7. Day/night distress flares are to be stored in approved lock-ups when not in use for diving.

420. DIVER SIGNAL RECALL

1. The Diver Signal recall shall be on-site when conducting diving operations or exercises.

2. The Diver Signal Recall is a pyrotechnic sound-producing device used by the Diving Supervisor to recall divers to the surface.

WARNING

The recall signal is sufficiently powerful to injure a diver or maim the user and must be deployed well away from divers.

3. Diver signal recalls are to be stored in approved lock-ups when not in use for diving.

4. The use of Electronic Diving Recall is authorized.

421. DIVER'S LIFELINE HARNESS

1. The lifeline harness is provided to permit a secure, load-spreading method of attaching the lifeline to a diver in a manner that will not impede the diver and that will aid in the recovery of a stricken diver. In the event that a heavy load is placed on the lifeline (for example, during an emergency), the harness will reduce injuries and can prevent excessive pinching of the diver's chest.

NOTE
The harness is neither designed for nor capable of lifting a fully laden diver out of the water.

2. The harness is worn across the diver's sternum (above or below the suit inflation valve) with two heavy stainless steel rings and VELCRO™ straps to prevent diaphragm compression or broken ribs and to ensure a safe and comfortable lead to the lifeline. The harness is designed to keep the diver in a comfortable and effectively horizontal position regardless of the angle of tending. It may be used with CABA and other equipment.

3. The front tether is slightly off-centre to allow for proper swimming at a 45° angle away from the tender. The front strap should be tightened only to a point where the diver can comfortably place a hand under the strap.

4. The harness incorporates both shoulder and front adjustments so the diver can easily adjust for different suit styles (wetsuit/dry suit) and thickness of undergarments.

5. A colour-coded size indicator is used to quickly determine if the proper size is available.

422. DIVING KNIVES

1. The CABA diver will wear two (2) knives.

2. The standard knife is heavy duty and is generally considered to be a tool.

3. The second knife is a "safety knife" designed for emergency use to free a fouled diver. It is not a work tool and shall not be used as such. It shall be worn in within the diver's "safety triangle" between the diver's neck and waistline. Either on the BC cummerbund grommets or either shoulder, provided that the sheath is secured by at least two securing methods. No ancillary equipment shall be secured to this safety knife.

4. Proper retaining straps must be utilized to prevent knives from dropping from their sheaths and being lost. Operators are permitted to replace broken or deteriorated straps.

5. Knives should be kept sharp and lightly coated in silicone grease or a similar protective coating.

423. SWIM FINS

1. Flexible swim fins are important accessories for the swimming diver. Fins increase the efficiency of the propulsive force transmitted from the legs to the water. It is important for the diver to learn and practice the correct method of swimming with fins so that maximum efficiency can be maintained over long periods. Allowing the knees to bend too much is a common mistake among inexperienced divers.

2. Swim fins must fit properly. Tight or loose fins can chafe and blister the feet and cause foot cramps and poor circulation (e.g. cold feet). Fins with adjustable straps may be prone to working loose and precautions should be taken to prevent this.

424. DIGITAL DEPTH GAUGE

1. Wrist-type depth gauges are designed for use by divers to check their depth during diving operations.

2. A diver should use a depth gauge when diving in unfamiliar areas. Depth gauges may also be used to supplement soundings in deep diving.

3. Digital Depth gauges are extremely accurate (± 0.1 m). The digital depth gauge measures the diving depth independently of air pressure and is therefore not affected by altitude.

4. The digital depth gauge is calibrated in meters of fresh water. Therefore the saltwater depth reading will be deeper than the actual saltwater depth.

5. Digital depth gauge function should be checked prior to diving.

6. Depth gauges must be tested annually in conjunction with the Technical Inspection.

425. COMPASS

1. Magnetic compasses for underwater use can be either carried in the palm of the hand, secured by a lanyard or strapped to a swim board.

2. The graduation and lubber's line are in luminous paint, enabling the compass to be read in the dark.

3. Bearings are taken on the surface by viewing the object over the top of the compass. The course can then be swum by keeping the bearing in line with the lubber's line. With practice, courses of considerable accuracy can be attained.

4. Care should be taken to ensure the compass is level while underwater to ensure an accurate reading.

426. SWIM BOARD

1. Swim boards are used in underwater swimming operations in which the diver requires that course, depth and time underwater be readily displayed. The swim boards can be made locally from a variety of materials, with slots for securing the straps of the compass, depth gauge and watch.

2. The swim board is secured to the diver by a lanyard.

427. DIVER'S WATCH

1. A waterproof and pressure-proof wristwatch is essential to the diver/supervisor for computing the time of the dive, checking the rate of descent and ascent and for timing various diving operations.

428. INDICATOR LIGHT

1. During night diving operations a diver must carry an indicator light is attached to the cylinder valve to indicate position in the water. The indicator light can be battery or chemical powered.

429. STROBE LIGHT

1. During night diving operations a diver must carry a strobe light in addition to an indicator light, for use if assistance required but not an emergency.

430. UNDERWATER LIGHTING

1. An underwater light can be useful in searching for or observing objects in more detail. Even in relatively clear water a light beam is full of reflections from the particles of suspended matter in the water and these reflections may prevent the diver from seeing through the beam. The light should, therefore, be placed so that the beam obliquely strikes the object to be illuminated with as little beam as possible between the diver and the object.

2. Standby divers should be equipped with hands-free lighting system whenever possible.

3. Hands-free lighting offers advantages to standby divers, SAR Techs or working divers who require light with both hands free. However, divers must be aware of the potential to inadvertently cause another diver to lose night vision if not used carefully. Divers attempting to resolve a problem that requires them to work closely together may compound their difficulties by blinding each other.

4. Dive lights attached to the divers half mask or FFM shall be completely head-mounted to reduce potential fouling of the diver by a power cord. This requirement does not apply to the SAR CABA ensemble.

431. LOST DIVER MARKER

1. A Lost Diver Marker is to be readily available during all diving operations.

2. In the event of a lost diver, the marker shall be thrown overboard at the diver's last known position to provide a datum for the search.

3. Until a CAF standard pattern Lost Diver Marker is introduced, the marker shall be constructed of locally procured items. The following general construction criteria should be considered:

a. The minimum length of the marker line must at least be equal to the maximum depth of the water.

b. The marker buoy must be readily visible day or night and large enough to prevent being pulled underwater by wave action or current and

c. The sinker must be heavy enough to prevent shifting by wind, wave or current action.

4. A 9-metre line shall be attached to the weighted end to provide a search line for the standby diver.

5. The Lost Diver Marker is to be easily identifiable from any other marker and shall not be used for any other purpose.

432. THROUGH-WATER COMMUNICATIONS

1. Through-water communications systems involve transmission of sound or voice signals by means of a modulated acoustic wave through the water column. There are a variety of off-the-shelf systems in use in the CAF. Some function as one-way broadcasts while others operate as two-way systems.

2. One-way broadcast systems generally are made of a surface unit and hard-wired hydrophone. They are particularly useful in a training environment where the Diving Supervisor or instructor can communicate to a large group of students in a relatively confined area (such as a jetty camber or swimming pool).

3. Two-way systems generally consist of a surface unit, a hard-wired hydrophone positioned in the water to best advantage, and a diver-carried unit. The diver-carried unit consists of a transceiver pack with transducer and an earphone and microphone assembly fitted to a FFM.

4. Through-water communication systems suffer from signal attenuation and ranges can vary considerably from those specified by the manufacturer. Caution should therefore be exercised, particularly when operating with free- swimming divers.

433. AGA MK II FFM / ULSSDS COMMUNICATIONS

1. When dived in SSBA mode, the AGA MK II FFM utilizes standard ULSSDS hard-wire underwater communications.

a. A water proof microphone is positioned within the oral-nasal mask;

b. There are two potted, waterproof earphones that are placed against the diver's ears over the wet or dry hood;

c. A hard-wire communications whip with an OTS Hi-Use connector connects the diver's microphone and earphones to the umbilical communications cable; and

d. Any one of the four-wire diver communications systems in current service use is compatible with the ULSSDS diver microphone and earphone.

2. Voice communications are the primary method of communicating with the ULSSDS.

a. Provided communications can be maintained utilizing Manual Line Signals, loss of voice communications does not constitute an emergency.

b. The dive is to be aborted In the event both voice and manual line signals fail.

Figure 4-15 AGA MK II FFM w/Comms

434. ACOUSTIC PINGERS

1. Divers can be equipped with active acoustic pingers for safety, homing and locating. These pingers are battery operated, should be lightweight and relatively low powered. They are intended for use in conjunction with a locator unit, which can be designed for surface use or for use by a rescue diver.

2. A variety of diver tracking systems used by the CAF, in all cases, batteries should be replaced before use and the effect of water conditions on nominal range should be taken into account.

3. It is strongly recommended that free-swimming divers carry acoustic pingers.

SUPPORT EQUIPMENT

435. DIVING LADDERS

1. A ladder is normally required to enable a diver to climb out of the water (except with a craft of very low freeboard).

2. Many types of ladders can be used for diving but it is important to ensure that they are firmly secured to the boat or diving platform and rigged to prevent lateral movement. The ladder should be of sufficient length to enable the diver to start climbing from the water without excessive effort.

3. The bottom of the ladder should be rounded or padded to prevent injury to a surfacing diver.

4. To prevent injury from a falling diver, divers in the water shall remain clear of divers on the ladder exiting the water.

436. AIR COMPRESSORS

1. High-pressure (HP) compressors provide a low volume of compressed air at high pressure and may be driven by a gas, diesel or electric power source. HP compressors are used primarily to supply compressed air for CABA cylinder charging or to charge a large volume bank of storage cylinders. Electric-powered and gasoline-powered models are supplied in the CAF. The high-pressure flexible lines that connect the compressor to diving cylinders are subject to wear and tear and their failure under pressure presents a serious injury hazard to personnel. Installation of strain relief lines is known to dramatically reduce the chance of injury in the event of failure of the HP line or its components. A strain relief simply acts as a snubber by restricting the movement of an HP line in the event of failure under pressure.

a. Strain relief lines are mandatory for all high pressure flex lines which are over 45 cm in length and are operated at over 15 bar (gauge).

b. Strain relief may be made from cable, chain, or synthetic line which has a breaking strain of not less than 1400 Kg, married to the flexible HP line at a minimum of every 45 cm, and at the ends of the hose. Marrying cord shall be high quality synthetic line 3 mm or material of equivalent strength. Tie wraps, tape, and marlin are not authorized for this purpose. Care is to be taken not to damage the HP line by excessively tight application of the marrying cord or by kinking of the HP line caused by the angle of lead of the strain relief.

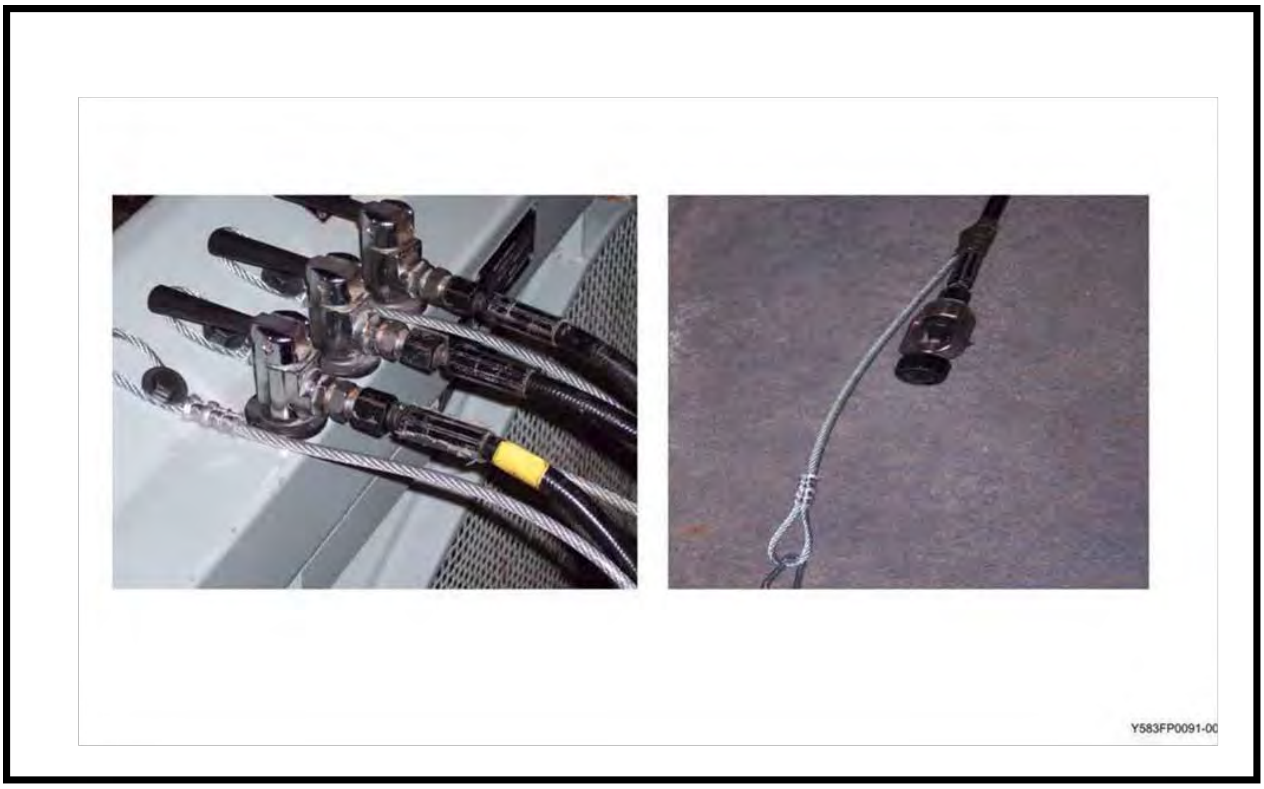


Figure 4-16 HP Lines Strain Relief

c. All hoses, used in CAF diving, shall be labeled by the manufacturer/FMF and should include the following information, as a minimum:

(1) Manufacturer/Hose type;

(2) Manufacture Date;

(3) Pressure Rating; and

(4) Cleaned for oxygen use (if applicable).

d. The user unit is also responsible to tag the hose with the IN-SERVICE DATE, the max system working pressure and NSN. This is the date upon which the hose is installed in the system. The tag is to be of sufficient durability and attached appropriately to ensure that it is not removed through regular use and can only be deliberately removed. Aluminum tags with punched data are recommended although a suitably robust tag will suffice. Paper tags shall not be used.

e. Tite-Flex R157 Wire braided hoses, used in CF diving, have a shelf life of 10 years from manufacture date of hose and shall be pressure tested every 5 years after the in-service date.

f. Thermoplastic hoses have a shelf life of 5 years from manufacture date of hose and shall be replaced in accordance with this schedule.

2. Each compressor is furnished with a complete instruction manual containing information on its operation, maintenance, storage and accessories. This manual should accompany the compressor unit at all times and personnel using the air compressor should be completely familiar with the information contained in it.

3. A log book shall be used to record all maintenance, air sample results and running time.

4. Never use a compressor for other than designated purpose and then only in accordance with the appropriate handbooks or technical manuals.

5. Compressed air samples are to be tested semi-annually for purity IAW Article 140, Purity of Compressed Breathing Air and Gases for Divers.

6. Operators of the HP compressors generally are trained divers, while the maintainers are members of the engineering department. Ideally, a diving-qualified engineer should be a member of the diving team.

7. Operators and Maintainers are to refer to C-87-010-010/MS-003,Operating and Maintenance Manual, Divers' HP Air Compressor, NSN 4310-21-869-3745 (Gasoline Engine-Driven), NSN 4310-21-869-3746 (Electric Motor- Driven). If using GSA Unit High Pressure Breathing Air Compressor Unit, refer to C-97-380-AA0-MS-001.

8. The Diving Officer is to ensure that all divers are properly instructed and familiar with the operating procedures found in SOPs concerning air compressors.