Dive Lab, Inc.
1415 Moylan Road, Panama City Beach, FL 32407
Phone: 850-235-2715 Fax: 850-235-0858 E-mail: divelab@aol.com

Complete Support & Testing of Underwater Diving Equipment

Dirty/Contaminated Water Diving Tips

Mike Ward, July 6, 2010

Dive Lab and Kirby Morgan get a lot of inquires / questions from divers about what kind of chemicals and contamination the KMDSI helmets can protect against, and what can be done to minimize water exposure. The information herein primarily discusses the use of KMDSI helmets, and gives information, and tips that will help to minimize the chances of getting water into the helmet by explaining and identifying factors, conditions and situations that can make water entry possible. This information is primarily for KMDSI helmets however the concepts apply to other demand mod diving helmets.

KMDSI recommends that persons engaged in contaminated water diving be properly trained in contaminated water diving and techniques. No diver is 100% safe when diving in contaminated water, regardless of what brand, model, or type of helmet and suit is being used. Besides water leakage, chemical gas permeation through the rubber and fabric components can be a factor to deal with which can be deadly. To get a good idea of stay times and risks, you would have to know exactly what chemicals are present, at what concentrations, and then you would also need to know if any of the chemicals when combined add to the hazard. Also, when it comes to permeation, gases like phosgene and chlorine, know few boundaries. It is virtually impossible to cover all the scenarios and combinations.

The main purpose of this paper is to educate helmet users how to best operate and use Kirby Morgan helmets from the diver's point of view so the diver stays dry. Simply put, if you don't use and dive a helmet and dry suit the right way, you are probably going to get wet, and once wet you are exposed.

Diving in contaminated waters can pose serious health risks and requires special equipment, procedures, and techniques. Most diving schools do not teach the detailed specifics when it comes to how the diver must actually operate and adjust the helmet for contaminated water diving.

For a helmeted diver to stay dry, a dry, properly maintained, good quality dry suit attached directly to the helmet is required. For maximum protection, a helmet equipped with a DIVEX™ (Dirty Harry) return line system is probably the best choice because it

exhausts to the surface and minimizes the possibility of water entering the exhaust system due to suspended debris and / or chemical deterioration of the exhaust system. Return line systems have a supply and return hose and basically provide the helmet with breathing gas, then exhausts the exhalation gas up the exhaust hose to the surface so the exhaled breathing gas is never in contact with the water. Even a return line system is not perfect, and getting water in the helmet and suit is still a possibility under certain circumstances. In addition, return line systems are extremely expensive making them out of reach for many companies because quite often the customers are not willing to pay a diving contractor the extra money for having this type of equipment, especially if he can get a SCUBA diver to do it with a full face mask for ¼ of the price. The competitive nature of diving contract work, lack of labor enforcement, and prospect of saving money, often results in safety being compromised.

Dirty Diving: For contaminated water diving, any of the Kirby Morgan helmets equipped with the quad valve system and properly mated to a dry suit will offer a high degree of protection from biological, chemical, and petroleum contaminated waters. Of all the KMDSI helmets used for contaminated water diving the KM-37 and KM-77 seem to be the helmets of choice. Regardless of the helmet model used, in order to stay dry throughout the dive requires not only a good sealing system between the helmet, cuffs, suit, and suit penetrations, but also a good understanding of how and why water can enter the suit system, and how to minimize the possibility of water entering. Regardless of the type of helmet or dry suit used, getting water into the helmet or suit is always possible if the diver does not take precautions and / or does not operate and maintain the system properly.

Demand Systems: Demand mode diving by the very name means the diver receives breathing gas when he demands it. Unlike free flow helmets, which flow air into the helmet continuously throughout the inhalation and exhalation cycle, demand mode helmets are mainly intended to deliver air on demand during the inhalation cycle only. As the diver starts to inhale, a negative pressure is created within the oral nasal / demand regulator body drawing the regulator diaphragm against the inlet valve lever activating gas flow into the oral nasal. The “Crack” or “Lift Off” is the term given to the very first start of gas flow. The crack is brief point where the valve soft seat just starts to lift away from the sharp edge of the inlet orifice. The force required to cause the “crack” is normally measured and expressed in millibars (mbr) of pressure. For good breathing performance it is essential that the “lift off” be as low as possible typically around 3-7 mbr, and remain as low as possible throughout the inhalation cycle. With all KMDSI helmets, the cracking effort can be controlled by the diver using the regulator bias adjustment located on the left side of the demand regulator. The bias adjustment simply increases or decreases the amount of pressure that seals the inlet valve to the seat surface. The actual inhalation effort required during the inhale phase of the breathing cycle is primarily a function of the supply pressure and the bias setting, but the diver attitude also comes into play. Keeping the inhalation effort as low as possible requires a light enough bias setting to allow the inlet valve to lift away with minimal suck, and a supply pressure high enough and steady enough to allow a venturi (vacuum) assist to develop to help float the inlet valve. If the supply pressure is too low at the start of inhalation, the side block

pressure will drop too far, killing the venturi action, therefore, reducing the pneumatic assist and flow, requiring the diver to suck harder to open the inlet valve further to get enough air. Because the diver now has to suck harder, a greater negative pressure is created within the helmet and neck dam, which in turn is an invitation for water and vapor permeation into the helmet.

Exhaust Valve Lift Off: Lift off is the term given to the very first start of gas flow during exhalation. The exhaust lift off is also measured and expressed as pressure in mbr. Typically, all KMDSI exhaust valve systems lift off between 3-5 mbr depending on the physical attitude of the diver. The primary factors that influence exhalation effort are the positioning of the exhaust valves, stiffness of the valves, number of valves, and the shape and position of the exhaust (Whiskers).

Physical Attitude: Another major influence on demand regulator and helmet internal pressure is the diver's physical attitude. The further the demand regulator is from the diver's centroid, (Lung Center) the greater the inhalation effort will be. The closer the regulator gets to the centroid, the easier the breathing will be. As an example, a helmet diver standing on the bottom looking up at the surface will have a harder time inhaling than he would if he was looking down at the sea floor. Normally, the easiest breathing effort (least) overall is when the diver is in an almost face down angle. In this position, the exhaust valves and demand diaphragm are closest to the lung centroid, requiring the least differential pressure to make things work. A diver standing upright looking up can back out slightly on the bias adjustment and make the inhalation easier. If the diver ends up changing to head down position, he can simply dial in on the bias to keep the demand regulator from free flowing.

Minimizing Water Entry: To minimize water entry into any demand mode helmet, the two most important things the diver can do is to keep the inhalation effort as low as possible, and avoid getting the demand regulator in a position that places the regulator cover parallel or close to parallel to the bottom (sea floor). Cover "face down" to the bottom is the position that the diver would be in if laying face down or attempting to stand on his head, and in this position any water that was trapped in the exhaust body would be directed to the demand regulator exhaust valve making it possible to get into the regulator during exhalation. If for some reason you need to get into a weird position, the diver should crack open the steady flow valve 1/8- 1/4 turn or so, two to three times for about 1-2 seconds to purge out any water that has accumulated in the quad valve plenum body. This is something divers should get in the habit of doing every few minutes anyway to help eliminate any water that has accumulated in the exhaust system. Keep in mind, when the valve opens, its opening in the water, the flapper is "In" the water! and it gets water on it. When the flapper valve slams shut against the exhaust cage very small amounts of water splash into the exhaust body and after a few minutes you have at least a tea spoon or so of water in the dry sump of the exhaust body. The KMDSI quad valve is is designed to minimize water build up and normal breathing will usually dispel most of the water. Even if there was no water from outside there will be condensation forming from the diver's breath, and this will accumulate in the exhaust body and system. During the inhalation phase of the breathing cycle, internal helmet pressures remain slightly less

than the surrounding water pressure on average of about 3-5 mbr for light to moderate work, (11-37rmv) 5-10 mbr for heavy work 38-54 rmv, and as high as 12-18 mbr for extremely heavy work 62.5 rmv and above. Keep in mind, a lot of this depends on the divers depth, and work rate, supply pressure, and bias adjustment. At shallower depths and/or lower work rates, inhalation and exhalation pressures will be lower, significantly reducing the risk of water intrusion.

Exhalation Effort: The primary factors that influence exhalation effort are the positioning of the exhaust valves, stiffness of the valves, number of valves, and the shape and position of the exhaust (Whiskers).

Inhalation Effort: The primary factors that influence inhalation resistance are supply pressure, the bias adjustment setting of the demand regulator, and position of the diaphragm in relation to the lung center due to the divers in water position. "Proper Adjustment" Making sure regulator Bias Adjustment (Regulator adjustment knob) is backed out to the lightest setting to ensure the lowest inhalation resistance for the particular attitude the diver is working in will keep the negative pressure in the helmet as low as possible reducing or minimizing the possibility of water entering through the exhaust valves or small leaks in the suit or sealing surfaces.

Divers Attitude: The closer the demand valve diaphragm and exhaust valves are to the lung center, the easier breathing will be. The further away the exhaust valves get from the divers lung center, the greater the exhalation effort will be resulting in increased helmet pressure. If the diver can minimize this distance, the result will be lower positive pressure, and lower exhalation effort.

Dry Suit: It is extremely important to know how to properly use, operate, and maintain the particular dry suit being used. It is important to minimize the negative pressure within the suit because as the negative pressure increases so too does the possibility of water leakage and gas permeation due to micro-pin holes, or worn or damaged seems.

Maintenance: The diver can significantly minimize or eliminate water intrusion by knowing what conditions or circumstances can cause the water intrusion. First and foremost, the helmet and equipment must be properly maintained. This means proper cleaning, inspection, maintenance and pre dive testing IAW the KMDSI checklists and operations manuals and the dry suit manufacturers' recommendations and instructions.

Cleaning: Proper cleaning will keep the components free of corrosion and will make it much easier to spot worn or damaged components and will help determine the serviceability of components before failure occurs.

Petroleum and Exhaust Valves / Diaphragms: Some dives should not be made. Making a dive inside tanks or compartments that are filled with fuel oils or chemicals should never be attempted "period"! Even with a return line system. Fuel oils, as well as other types of chemicals can permeate directly through the suit material and flexible components and then it can be directly absorbed into the skin.

The most vulnerable and sensitive components on the helmet are the neck dam, exhaust valves, and diaphragm. The exhaust valves and diaphragms used on all KMDSI Helmets are molded of high quality liquid silicone. Silicone just like rubber, will swell when it comes in contact with high concentrations of most petroleum products such as crude oil, diesel, gasoline, and hydraulic fluids to name a few. Once the valves swell beyond 10%, they will not seal properly and exhaust leakage can occur. The amount of swelling depends on the type of fluid, concentration, and exposure time. Unless the valves remain in contact with the high concentrations for more than a minute or two, they will usually work and hold up fairly well, however, it is safer to start off with short duration dives, then pull, and inspect the two quad valves after each dive. If inspection of the flapper valves reveals swelling or damage, adjustments to the dive plan will need to be made and/or the valves and diaphragm will require frequent changing. Keep in mind that fuel and oils will rise in water and collect on the surface. When making water entries and exits, use a water hose if possible to make an entry and exit point for the diver reducing exposure of the suit and helmet during entry and exit reducing high concentration exposure. Keep in mind, dry suits are considered a consumable item and after the first use in certain chemicals and oils, all bets are off. At $1500-$2500, many companies cannot afford to only use the suit for one dive. Diving in high concentrations of oil and chemicals can be extremely hazardous because gases can permeate through the suit and polymer components. The worst case is direct exposure to high concentrations of refined fuels like gasoline, diesel, found in retention ponds, fuel camels, and sunken barges. In cases like this, other practices must be brought into play. This information does not just apply to KMDSI helmets, but many other brands of helmets as well.

Dive Safe and Stay Dry.

Reminder: Please don't hesitate to call or e-mail technical questions or problems. It is important to include e-mails (CC) to KMDSI as well. KMDSI is interested in any and all comments, problems and anything that can make it better for the user/maintainer.

Best Regards,

Mike Ward
Dive Lab, Inc
850-235-2715