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RISK MANAGEMENT FOR PUBLIC SAFETY DIVERS

MANUAL

RISK MANAGEMENT FOR PUBLIC SAFETY DIVERS

PUBLICATION OVERVIEW

The goal of this publication is to provide public safety team dive team members with information regarding reducing risk to exposure hazards, decontamination, alternative search tools, training, and personal health/fitness. This publication is geared towards risks posed during search and rescue or recovery operations above and below the surface of the water. DUI has a variety of products to address the exposure and thermal protection needs of the public safety diver and water rescue personnel. This publication is not a public safety "how to" manual. DUI recommends that all team members receive appropriate training for all anticipated team operations from a recognized training agency for public safety diving. If these operations involve activities in a contaminated environment (surface or underwater), dive team members must receive OSHA HAZWOPER training as well. This 40-hour course is available through many sources including local junior colleges and online programs. An 8-hour recertification course is required each year. All team operations should be done in compliance with all federal, state and local regulations.

If this guide is unavailable or lost, a copy may be obtained by contacting DUI as follows:

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DISCLAIMER

This manual is not a substitute for qualified instruction in basic diving, drysuit diving, or contaminated water diving. The purpose of this manual is to provide additional information as part of a training program conducted by a certified training agency. Equipment, technology, and procedures may change so a diver must continually refresh their training to be up to date.

This manual does not make any recommendations on safe exposures for contaminated water diving. As the risk will vary depending on the concentration, exposure time, equipment, and previous exposures, each operation must be evaluated by the dive team. If there is the slightest doubt about the safety of the operation, the diver must not dive.

Diving in contaminated water is extremely hazardous and is not recommended. Making a mistake in such a high risk environment may mean serious injury or death. While the information presented in this manual is the most current information at the time of printing, changes in equipment, technology and procedures may mean this is not up to date or applicable under all circumstances.

INTRODUCTION

Although DUI is known for its expertise in diver thermal protection, DUI is active in all aspects of contaminated water diving operations including chemical, biological and radiological contaminants. These efforts include the development of equipment and procedures for dealing with broad and specific threats and involve the establishment of both military and industrial standards.Sworn and un-sworn public safety dive teams are asked to conduct a variety of missions in or around water. These missions can be broken into two primary categories: rescue and recovery. In a rescue operation, human lives are at stake: both the individual(s) needing to be rescued and those making the rescue. In the rescue mission, time may be critical, and therefore higher levels of risks may be acceptable. However, in some rescue situations and in virtually all recovery operations, immediate action is not needed and steps can be taken to minimize the risks to all.

Every effort must be taken to minimize risk to all team members. In some recovery operations, there may be situations where the risks cannot be mitigated or are unacceptably high. In that case, it is vital that the dive team be able to evaluate the situation and be prepared to wait for greater resources or cancel the operation completely. Therefore, it is important when arriving at an incident to immediately determine if this is a rescue or a recovery operation. Once this decision is made, appropriate actions should be taken to minimize the risks. It is possible the best course of action is to not dive at all.

The challenge in the public safety arena is that there is not one single system suitable for all threats, and most departments and volunteer organizations are not adequately funded to equip themselves for every scenario. Also, the diversity of teams and operational requirements eliminates the “one-size-fits-all” cookie cutter approach to equipping teams. It is the goal of DUI to provide a spectrum of products to address and minimize risks while enhancing operational performance. Since different areas will have a variety of needs, it is important for teams to conduct an inventory of their potential missions and operating environments before selecting equipment.

ASSESSING THE NEEDS OF YOUR DIVE TEAM

When a dive team is getting started or is looking to improve its operational capabilities, the first step is to evaluate the conditions under which they will need to operate. The dive team must consider the types of dives they are doing or will be asked to do and any environmental conditions that may impact the level of risk they will be experiencing. Here are a few examples:

MISSION REQUIREMENTS

- Vehicle Recovery
- Evidence Recovery
- Body Recovery
- Search and Rescue
- Security surveys
- Hull Inspections
- Maintenance Inspections

Different missions will expose the divers to different conditions. Vehicle recovery will involve contact with fuel and potentially sharp metal or glass. Evidence recovery will often expose the divers to sediments that may be contaminated with the residual toxins of industrial pollution.

ENVIRONMENTAL CONDITIONS

Each type of mission and each dive site will be complicated by varied environmental conditions. While a dive team cannot "choose" where or when dive operations are needed, they can learn to evaluate the risk factors and choose to dive or not. This manual addresses how to do a proper risk assessment and how to mitigate certain environmental risks. A few of the more common environmental risks are listed below:

- Contaminated water: chemical, biological, and/or radiological
- Extreme water temperatures (warm or cold)
- Extreme air temperatures (warm or cold)
- Swift water (at and below the water)
- Low or no visibility
- Ice
- Pressure differential

EVALUATING ENVIRONMENTAL RISK FACTORS

Since the safety of the public safety divers is the first consideration when determining the appropriate equipment, you will first need to evaluate the water you will be entering for risk factors of which contaminated water is one of the most important. **Contaminated water is defined as water which contains any chemical, biological or radioactive substance which poses a chronic or acute health risk to exposed personnel.** As this is a very broad definition, most bodies of water will have some degree of contamination or pollution. It is a fact of life in an industrialized and heavily populated country.

In fact, the Canadian government considers all public safety diving operations to be contaminated water diving and requires contaminated water diving equipment and procedures for even the simplest dives. It is likely that regulatory agencies, public safety diver training agencies and organizations such as the NFPA in the US will move towards a requirement for full encapsulation (includes drysuit, attached hood and gloves and full face mask) of the diver as a protection against contaminants. More detailed standards are possible though there are inherent difficulties we will discuss later in this manual.

Remember, there is no single type of equipment or material that will protect the diver under all conditions or from all contaminants. Nor will any type of diving equipment guarantee you 100% watertight integrity so there will always be some risk.

Begin your risk assessment by researching available water quality information from local health offices, the EPA, or state agencies. Most bodies of water in which people swim or fish are tested for the more common contaminants such as *E. Coli* among others. While it is impossible for any agency to test for every possible contaminant, and real-time water analysis is not feasible, they can provide an excellent baseline and are usually willing to do additional testing if requested.

Depending on the area, you may want to ask for sediment testing as well as water quality testing. It is common in many industrialized areas for sediments to be highly contaminated with toxic chemicals. Most Departments of Health will also give you information on the potential effects of exposure to contaminants as well. For bodies of water for which you have no information, consider working with a local college to turn your water quality testing needs into a class project for the students. Most professors are very interested in real world applications for their work and love to get their students involved in practical field and lab work.

Once you have developed baseline information on the type and level of contamination in the bodies of water you will be diving in, you can use that information to assess the level of exposure protection, equipment and training you will need.

TYPES OF CONTAMINANTS AND HAZARDS

In conjunction with the level of contamination, we need to consider the type of contamination as some types of contamination are more hazardous than others and may need to be avoided completely in even tiny concentrations. While it is impossible to discuss all of the millions of possible contaminants, we will address the most common.

A. Biological Contaminants and Hazards: While the most common type of biological contamination is human sewage, other sources include animal sewage, urban and industrial sewage, commercial ships, marinas, agricultural runoff, hazardous waste disposal, urban storm water runoff and marine and fresh-water organisms. While most pathogens (disease-causing bacteria, viruses, and rickettsias) degrade quickly in water, it is appropriate to assume local bodies of water contain microbiological organisms consistent with the local population. Biological contaminants may be concentrated in the sediments.

- Pathogens may enter the body via the lungs, digestive system or absorption through the skin or mucous membranes. Bacterial contamination is by far the most common type. *E. coli* is found in human feces and is commonly used as an indicator of water quality so you may find that the local health department already tests for this pathogen in many bodies of water and beaches. Ingesting water containing *E. coli* can cause severe diarrhea and dehydration and, although rare, can be fatal. Other hardy bacteria that are a potential threat to divers include cholera, anthrax, and Salmonella. Salmonella is commonly found in animal feces and symptoms will be similar to *E. coli* poisoning. Dive teams should be immunized against cholera.

- Viruses, such as AIDS, are generally less of a hazard than bacteria as they are less likely to survive outside of the host's body. However, hepatitis A is a notable exception. Spread by contact with feces, hepatitis may have incubation periods up to 45 days and its symptoms include a high fever and vomiting. Divers should be immunized against Hepatitis A and B as well as tetanus, and personnel should be trained in the handling of potentially infected material including medical waste and human remains.

- Protozoans are single-celled marine and fresh water organisms. The organism known as *Giardia lamblia* is a protozoan and is a common contaminant in fresh water even in remote and pristine areas. Symptoms are similar to that of *E. coli* but are usually less severe. Another type of protozoan is the cause of Primary Amoebic Encephalitis. This organism, while rare, usually enters through the nose and is usually fatal as it attacks the brain and spinal cord.

- Rickettsias are a form of bacteria that spread from one person to another by means of a vector such as an insect. The most well known is probably typhus. These types of pathogens are rarely a factor for public safety divers.

- Toxins are poisonous substances produced by microorganisms, plants, and in some cases, animals. The most well-known and common toxin is the one known as "red tide." This is caused by a marine dinoflagellate and can cause gastrointestinal and respiratory problems in humans. This type of algal outbreak is usually associated with large fish kills. Another dinoflagellate called *Pfiesteria* is causing major problems in the southeastern United States. This highly toxic organism is also associated with fish kills but its effects are much more serious than its distant relative described above and include respiratory distress, neurological impairment and lesions. The effects may be felt for weeks after the initial exposure and its diagnosis is difficult. *Pfiesteria* has been classified as a Class 3 biohazard which is only one level below Ebola. Some states have begun requiring the use of drysuits and full encapsulation at all times in an effort to protect divers.

B. Chemical/Industrial Contaminants: There are literally millions of different chemicals in use today with great variability in toxicity and permeability. Sources of industrial contamination include industrial spills, urban sewage, hazardous waster dumps, agricultural runoff, marinas and ships, and vehicles entering the water. We will mention some of the more common contaminants here but the National Institute for Occupational Safety and Health publishes a handbook that describes the potential health hazards and exposure criteria for 1500 of the most common chemicals. Dive teams should have a copy as a reference.

- Hydrocarbons are one of the most likely contaminants a public safety diver will encounter. These include substances such as fuels, oils, solvents and polyaromatic hydrocarbons (PAHs) including creosote and benzene. Most of these substances are known carcinogens with low-level long-term exposure. With short-term high concentration exposures, they may cause headaches, vomiting, convulsions and even coma or death. Most are also flammable and can cause eye irritation and permanent eye damage with even short-term exposure. These substances tend to float on the surface and will cause damage to most types of dive equipment especially anything with a rubber component. While fuel from a vehicle entering the water is a relatively common problem, the concentration of fuel is relatively low as well and can be managed with a few simple precautions which we will discuss in more detail later.

- Solvents and PAHs are common components of industrial waste. Creosote is found near many marinas, particularly those that have newer pilings and docks. Toluene and xylene are very common solvents in use today and toluene in particular is very damaging to rubber. Even a diver in a helmet is at risk from toluene as the exhaust valve will degrade rapidly. Exposure to toluene should be avoided and any equipment that is exposed for even a brief period of time should be thoroughly examined before reusing.

- Heavy metals are found in the sediments of many urban harbors and rivers. While locked in the sediments, most represent a low risk to divers but it is not unusual for diving operations to disturb the sediment and increase the risk to divers. Most heavy metals are considered systemic poisons and long-term exposure can lead to liver, neurological and kidney damage as well as other serious health risks. Some of the heavy metals to watch out for include mercury, arsenic, cadmium, chromium, and lead. Divers with frequent exposure may need regular testing of their blood for lead or other heavy metal poisoning.

- PCBs have been banned in the US since 1977 but they are present in many bodies of water to this day. They do not readily decompose and the effect on the body is cumulative which means that even low levels will keep accumulating in the diver over time. PCBs also tend to accumulate in bottom sediments, and since they are not readily soluble in water, they can be found in a relatively concentrated form within or on top of the sediments. Divers must avoid any contact with PCBs as even low levels of exposure constitute a serious health risk.

- Pesticides are another substance that places the diver at high risk. Since most pesticides are organic phosphates, they can have devastating effects on the nervous system and related organs and tissues. Most will tend to sink and will be present in sediments. Waterways and bodies of water on or near agricultural areas and golf courses should be tested regularly.

- Anti-fouling paints represent a significant threat to divers in areas with heavy shipping. Like PCBs, tributylin (TBT) tends to accumulate in the silt and sediments and is extremely toxic. This chemical is known to attack the nervous and circulatory systems, liver, kidneys and skin. While its use has been severely curtailed in recent years, most large ships still use it. It is very slow to break down, particularly in murky waters with low light levels that are typical in many urban ports.

- Oxidants such as fluorine, bromine and chlorine and corrosives such as sulfuric and hydrochloric acid and sodium hydroxide are of immediate danger to the diver and their equipment. Some compounds can even attack the metal and plastics in diving helmets and can be dangerous in very low concentrations. Acids are commonly used in the photographic, metal, and battery industries and may be more prevalent than you think.

- Chemicals to absolutely avoid include: Carbon Tetrachloride, Dichloropropane, Ethyl Benzene, Styrene, Trichloroethylene, Xylene. If you suspect the water is contaminated with one or more of these chemicals, do not dive. There are more chemicals than can be covered here and it is rare that complete information is available in an emergency. One excellent resource is Chemtrec which stands for Chemical Transportation Emergency Center. This group located in Washington DC is sponsored by the chemical industry and is ready to assist public safety personnel who are responding to chemical emergencies. If you believe a chemical has been released into the water and you require urgent information about its effects, please call them at 800-424-9300. They will need detailed information about the incident and the nature of the suspected chemical. This hotline is for emergency use only.

C. Nuclear/Radiation - Diving in proximity to radiation should only be attempted by specially trained and equipped personnel. Radiological hazards are beyond the scope of this handbook.

CHANGING LEVELS OF CONTAMINATION

Obviously conditions can change rapidly which may require a change in the resources needed for the mission. The addition of a contaminant, such as a decomposing body, will dramatically increase the required level of exposure protection for divers during an operation. Other factors include:

Example of Complete Encapsulation

- **Rainfall/Runoff** - Nonpoint source pollution represents the most common type of pollution in many areas. Nonpoint source pollution usually comes from runoff and will be worse after a heavy rain. Dog feces, motor oil, fertilizers and pesticides are all examples of nonpoint source pollution. Many urban populations or areas where there is a great deal of farming will experience increased pollutants after a heavy rainfall. Also, when conducting diving operations within several hundred yards of a point of discharge such as a drainage pipe or runoff channel, similar precautions should be taken. Level A or B protection may be needed in otherwise Level C or D waters. Check with local health officials for known point and nonpoint source polluters.

- **Sediment** - Many lakes and commercial harbors have sediments with significantly higher levels of contamination than the water column. This is especially true of PCBs and heavy metals. Level A or B protection should be used on dives in these type of areas where disturbance of the sediment is expected.
- **Hazardous materials** - Working in areas with gross fuel contamination such as leaking ships, storage tanks or aircraft recovery or in confined areas with a high concentration of creosote soaked wood or anti-fouling paint requires Level A protection.

ENVIRONMENTAL RISK ASSESSMENT

Once you have received baseline information about your local bodies of water, you should perform a risk assessment to assist in determining the best ways to minimize risk and how to deal with accidental contamination. Using the information about local water quality and conditions, you can evaluate the possible risk of contaminated water to divers and surface support personnel for each location.

You should then have standard operating procedures in place to respond in the event of exposure. Remember the location of the contaminant may play a role in your risk assessment as some missions will bring the diver in more contact with the contaminant. An excellent example is searching for evidence in an area with heavy sediment. You are very likely to disturb the sediment during the search and expose the divers to any contaminants locked in the sediment.

CONTAMINATION EFFECTS ON DIVERS

Unfortunately, no scientific studies have ever been done on the effects of diving in contaminated water for public safety divers. A 2004 study in Israel did look at possible long term effects on Navy Divers who trained in the severely polluted Haifa Harbor. They found the cancer rate to be 6.6 times the national average. While cause and effect can not be determined, the research does suggest a potential long term effect for other divers who dive/train in these types of circumstances.

A 2005 survey done by a public safety diver with the North Carolina Department of Justice indicates that 80% of public safety divers report some type of job related illness. Unfortunately less than 25% of these same divers are protected to Level B for diving in Category Two water.

The following is a list of illnesses associated with diving in contaminated water...

- Parasites
- Purulent Otitis (toxic substance pass to the ear canal causing infection, permanent hearing loss, meningitis)
- Pulmonary gangrene (caused by untreated Pulmonary tuberculosis)
- Mild to severe diarrhea
- Urinary tract infection
- Dysentery (intestinal inflammation causing bloody diarrhea, can be fatal if untreated)
- Pneumonia
- Respiratory infection
- Inflamed/abscessed lymph nodes
- Variety of viruses
- Hepatitis A, B, and C
- Tetanus
- Typhoid
- Diphtheria
- Increased risk of certain cancers
- Leptospirosis (causing kidney failure if untreated)
- Sterility
- Neurological defects
- Liver damage
- Paralysis
- Suffocation
- Mild to severe cramping
- Tremors
- Death

Although contaminated water is certainly a vital factor to consider, it is also important to remember the other risk factors you may have in your area as they may also impact the selection of the equipment and the training and protection of the diver. Both ice rescue and swift water rescue require specialized training and may also require specialize equipment that is different from the equipment used for most dive team operations. While most dive teams endeavor to find the perfect equipment for all circumstances, that is rarely if ever possible and compromises must be made. If you do not have the appropriate equipment for a certain type of mission, you should call in additional resources. The amount of risk a dive team is willing to accept will vary depending on the potential for a rescue as opposed to a recovery. Obviously, most public safety divers are willing to accept a higher risk if there is the possibility of saving a life. However, the safety of the dive team is paramount.

For most dive teams, the best solution is to prepare appropriately for the most common types of missions and to learn the limitations of the equipment and training for more extreme situations. When performing a risk assessment, one should begin with the diver and his/her equipment. For each dive mission and type of risk you will be facing, the dive team should consider the following questions when assessing possible risk to the dive team and the equipment:

MINIMIZING RISK

With all of the hazards associated with Public Safety diving, what can divers do to minimize that risk?

A) Diver/Diver's Equipment - Exposure Protection
B) Decontamination
C) Alternate Search Tools
D) Training
E) Health

Before determining how best to minimize a dive team's risk, there are a few vital questions to answer.

- Is the equipment appropriate for the diving conditions? Does the equipment meet the requirements for the level of contamination expected in your area? This is absolutely critical. The PPE (Personalized Protective Equipment) must not inhibit completion of the task or introduce another hazard to the mission while protecting the diver. For example, a diver using a helmet and surface supply will probably have more difficulty performing tasks in swift water. The equipment must also provide reasonable protection to the diver against known contaminants, and its reaction to contaminants should be known and exposure minimized. Many contaminants will attack the rubber and plastics used in dive equipment so special consideration should be given to the material of the gloves, suit, o-rings, exhaust valves, diaphragm and hoses. These components are the weak link in the system.

- How will the diver's condition in the water be monitored? This usually means some type of communication system. A full face mask with communications is highly recommended for all types of public safety diving. Surface supply with a helmet is required for Category One contamination.
- How will you minimize contact with contaminants? As there is no material that will protect the diver from everything for an indefinite period of time, it is important to know the limitations of the equipment and how to minimize the potential exposure. This may seem obvious but there are some simple ways to minimize contact. Anything that can be done to keep surface contaminants away from the entry and exit point of the divers should be considered. Using dispersal techniques on the surface where the diver is entering and exiting the water or using booms/fire foam to prevent the spread of a contaminant will work particularly well.
- How can you prevent the diver from spreading contamination to surface personnel and equipment? How will you decontaminate the diver's equipment? How will you decontaminate the diver if needed? These questions need to be answered in advance. We will cover these procedures in more detail later in this manual.
- What is your emergency plan? It is very important to have standard operating procedures (SOP) in the event of an emergency and practice that SOP. Emergencies include an unconscious, lost or injured diver, loss of breathing gas to a surface-supplied diver, contamination of personnel, and damaged communication equipment. Everyone on the team should be familiar with the plan and be able to execute it.Surface support personnel will be responsible for implementation of your emergency action plan so all team members need to be prepared to respond to an emergency.

DIVER/DIVER'S EQUIPMENT

Over the years, many agencies have discussed implementing more defined standards for contaminated water diving. While the NFPA is working on standards, no national independent standard currently exists. As you see below, the Association of Diving Contractors uses four qualitative water quality categories. These standards are also referred to by OHSA as OHSA does not have standards for hazmat or contaminated water diving. These categories are very broad because it is impossible for dive teams to get detailed water analysis's in real time. It is also impossible to know exactly how different chemicals and biological contaminants will act in conjunction with one another. These categories may be broad but they are practical to use in the field. They reflect the difficulties of establishing detailed standards when exact water analysis is not possible, the diving conditions and mission constantly change and the long term effects of contaminated water on the diver and their equipment are not understood.

- Category One: Highest Contamination. Grossly contaminated with concentrated chemical or microbiological contamination. Examples include heavy fuel slicks and sewage operations. Divers should use full diving helmets with surface-supplied air and communications, vulcanized rubber suits with integrated helmet mating collar and dry gloves with rings. The helmet should be equipped with at least a double exhaust valve assembly design for use in contaminated water. The helmet must be used in the free-flow mode. This is Level A protection.

- Category Two: Moderate Contamination. Increased levels of both chemical and microbiological contamination are expected. Divers may use a positive pressure full-face mask and use it in the positive pressure mode. A block should be used for emergency gas switching to bail out gas in the advent of primary supply failure. A drysuit with a dry hood and gloves for complete encapsulation is required. This is Level B protection.

- Category Three: Baseline Contamination. No expectation of contamination above baseline that is normal for human habitation. Category Two and Three will be the type of contamination most dive teams and research divers will face during the normal course of events. Divers should wear a positive pressure full-face mask to avoid water contact with mucous membranes and mouth (unless water analysis shows contact with the mouth is an acceptable risk) and thermal protection appropriate for the diving conditions. This is Level C protection.

- Category Four: No contamination. This includes situations where no contaminated sources are known or expected such as offshore ocean locations, drinking water reservoirs, recreational areas such as swimming and skiing areas, or areas where water quality is routinely checked and no contaminants are reported. While any type of diving equipment appropriate for water temperature is acceptable for diver protection, local officials may dictate what the diver may wear in the water so that you do not introduce contaminants. This is Level D protection. Potable water supplies can have other challenges due to confined spaces and the possibilities of strong water flow. Special training and equipment is often needed.

TENDERS/SURFACE SUPPORT CREW

Protecting tenders and other support crew is just as important as protecting the divers as it is very common for contamination to affect them as well. That is especially true if there are fumes present or contaminants are aerosolized during the decontamination process. Navy test show that droplets of water containing contaminants can travel over 200' during the decontamination process. With that in mind, here are the EPA requirements for surface support personnel depending on the level of contamination the dive team is exposed to:

- Level A - Encapsulating breathing apparatus with SCBA
- Level B - Hooded chemical splash suit with SCBA
- Level C - Hooded splash suit for skin protection with respirator
- Level D - Splash suit and no respirator
  The tenders and other support personnel will be responsible for
- Handling and Containment of Contaminated Items: Handling tools, equipment, clothing, lines, air hoses etc. that have been in a contaminated environment pose a risk to the topside tenders and support personnel. Procedures must be in place to minimize exposure to surface support staff and to decontaminate items at once or to isolate them until definitive decontamination or disposal can take place.

EQUIPMENT SELECTION

As mentioned previously, there is no single equipment configuration or material suitable for all conditions or contaminants. While our focus here is the thermal/exposure protection, it is important to mention that we strongly urge dive teams to consider the benefits of full-face masks, and/or diving helmets as well as underwater communication systems. While the use of surface supply systems requires additional training and expense, they also decrease the risk to the divers as they are always connected to the surface.

However, the decreased mobility of a surface supplied diver must be considered against the mission parameters. Communication systems can be used with full-face masks as well as helmets and provide an extra measure of safety to the diver especially in low visibility situations.

Drysuits are essential equipment for public safety divers. In addition to the thermal needs in most areas (especially for long exposures), drysuits lessen the risk from contaminants in the water. As mentioned earlier, when considering the appropriate suit for a public safety team, it is important to evaluate the potential mission needs as well as the potential for diving in contaminated water.

In 1985, the EPA, in conjunction with NOAA, published a landmark report on diving operations in contaminated water. This report stated the best drysuit to use for contaminated water diving is something with a "smooth skin, integrated gloves and hood." While the vulcanized rubber suit was used as an example, they did not specify it was the only possibility. The prime reason for this recommendation was the relative ease of decontaminating a smooth skin suit. However, there are other criteria for selecting an exposure suit, and improvements in decontamination solutions make decontamination easier than ever. The needs of the dive team will dictate the weight given to each aspect of suit selection. Here are the primary things to consider:

• PERMEABILITY measures the rate at which a contaminant will permeate through the material of the suit, seams and seals at the molecular level. As you can see in FEMA table 26 (Summary of Chemical Permeation Resistance Test Results for Selected Contaminated Water Diving Drysuit Materials) and Chemical Permeation and Biological Penetration Tests for DUI RS1050 and RS1500 Vulcanized Rubber Drysuit Materials, different materials will perform differently in different contaminants and at varying concentrations. Often, TLS material performs as well or better than vulcanized rubber. As you can see, there are no suit materials that achieved FEMA's goal of lasting for 3 hours in all 5 classes of chemicals. No material did well in the hexane and only the neoprene lasted in the toluene (which is the most aggressive hydrocarbon). Of course, neoprene is also the most difficult material to decontaminate.

However, all drysuits share a common weakness in that the neck seals, wrist seals, and rubber of the zipper are some of the materials least resistant to many contaminants. Please note that all of these tests were conducted on new suits. Aging, abrasion, cuts or previous exposures to hazards may deteriorate the performance of the material. In addition there is no way to know how the suits will react to multiple contaminants or repeated exposures. We also do not know if permeability will be increased at pressure though it is certainly theoretically possible. Given these variables, chemical testing is of dubious value. This is especially true when no single material performs well in all contaminants. This testing also does not address the difficulties of the contamination resistance of the rest of the diver's equipment, especially the full face mask, hoses and BCD. Contamination of this type of equipment can cause cross contamination of the drysuit as well as introduction of contaminants into the breathing system.

Summary of Chemical Permeation Resistance Test Results for Selected Contaminated Water Diving Dry Suit Materials

Material	Permeation Breakthrough Time in Minutes (Permeation Rate in ug/cm2min)				
	Acetone	Dicloromethane	Hexane	Sulfuric Acid	Toluene
DUI TLS Trilaminate Fairprene Viton/Nylon Chlorobutyl Laminate	>180	76-88 (0.48-0.56)	4-12 (5.4-13.0)	120 (0.34-1.1)	<4-4 (6.5-16.0)
Henderson Neoprene (6mm)	8-12 (10-20)	8-12 (5.8-7.0)	<4 (6.5-12.0)	>180	>180
Parkway Nylon II (1/4")	84-96 (5.7-7.4)	12-16 (8.5-10)	24-32 (7.6-14.0)	>180	8-44 (37-160)
Viking Pro Vulcanized Rubber	60-64 (1.7-2.1)	24-28 (5.7-6.4)	12 (35-140)	>180	12-16 (2.7-8.6)
Viking Heavy Duty Vulcanized Rubber	140-160 (0.19-0.29)	60-64 (3.3-3.8)	24 (17-72)	>180	28-36 (2.9-3.3)

Permeation resistance testing per ASTM F 739, at 25°C for 3 hour period;
All chemicals diluted in distilled water at concentration of 25%.

SEE APPENDIX A FOR RS1050/RS1500 TESTING INFORMATION

- TENSILE STRENGTH and PENETRATION RESISTANCE are very important in situations where high wear is expected or the diver is particularly likely to contact sharp metal or other sharp edges. In these types of environments, the ability to decontaminate a suit may be less of an issue than ensuring the diver has a durable puncture resistant barrier. As you can see in FEMA Table 25 (Comparison of Selected Diving Suit Materials with Recommended Material Performance Requirements) durability is one of the main reasons many dive teams will choose the CF200 drysuit. This study by FEMA was aimed at recommending a suit for swift water use. The CF200 was recommended as the best suit for that situation. As you can see, however, even the TLS is more abrasion and puncture resistant than you might think for such a light material.

Comparison of Selected Diving Suit Materials with Recommended Material Performance Requirements

Material	Thermal Insulation (clo)	Tensile Strength* (lbs)	Burst Strength (psi)	Tear Resistance* (lbs)	Cut Resistance (lbs)	Puncture Resistance (lbs)	Snag Resistance (lbs(
Recommended Minimum Requirements	**1.00****	**150**	**300**	**20**	**12.0**	**6.0**	**11.0**
DUI CP200X Heavy Duty Neoprene	0.271	315/244	300	65.1/54.7	19.5	10.4	212.3/337.6
DUI TLS Laminate	0.084	310/262	423	13.2/10.5	10.0	13.2	9.9/11.9
DUI Vector Laminate	0.090	542/362	534	27.6/16.6	19.5	10.6	18.2/27.4
Fairprene Viton/Nylon/ Chlorobutyl	NT	158/152	306	NT	NT	NT	17.2/16.7
Viking Pro Vulcanized Rubber	0.116	226/175	304	65.2/48.1	12.0	6.8	71.4/86.6
Viking Heavy Duty Vulcanized Rubber	0.116	226-182	304	75.8	12.0	7.2	91.0/117.5

**** First value given is property measured in machine direction/second value in cross machine direction***
Shaded blocks meet recommended requirement
*****Measured in conjunction with underwear material***

- EASE OF DONNING can be an issue for many smaller dive teams. A self-donning suit with the ability to fit a wider range of divers may be very important as it will allow more divers to wear fewer suits and may facilitate entry into the water in an emergency rescue situation.
- FIT is often underrated in importance. However, a poor fitting suit can make it difficult for the diver to accomplish the task at hand. Vulcanized rubber suits come in few sizes and are difficult to customize. This is a particular problem for women divers. A baggier suit will make it harder to swim and may make the material more prone to snags.
- Ease of repair may be a significant consideration when equipment is limited and down time can mean some divers may not be able to report for duty. Zipseals, a field replaceable neck and wrist seal system only available from DUI, make latex seal replacements easy and fast so you can minimize down time. For teams with limited resources, Zipseals can also make it possible for divers to share suits as long as they have their own seals trimmed for them.

Some materials are easier to repair than others. Vulcanized rubber can be fixed with a simple inner tube patch kit in many cases. TLS material and other materials that dry quickly can also be repaired easily. Once dry, a mixture of AquaSeal® and Cotol® can be used to patch most trilaminate or crushed neoprene suits.

SPECIAL CONSIDERATIONS

There are many conditions within public safety diving which require special training and have specific equipment needs. The following are some examples: Swift Water Rescue usually requires the use of SCUBA due to the high rate of water flow. Drag is also a significant issue. Many dive teams use more streamlined and durable suits such as the CF200 or CNSE in these situations unless gross contamination is suspected. Other teams will use the TLS350 because it is lightweight and dries quickly even in very cold air temperatures. All of these suits will have excellent swimming characteristics which is also an important consideration in high-flow situations. The selection depends more on the durability needs of the team and how close fitting they would like the suit to be. As the FEMA report illustrates the CF200 suit is the most durable. Some other things to consider include:

- Surface suit only: only cuff dumps may be needed for some teams
- RockBoots for stability in rough water conditions
- Reinforcements in the knees, elbows, and buttocks
- Knife pocket on the suit

Ice Rescue may involve both surface and diving work. Most rescue situations are surface work and most recovery operations are diving. The TLS350 or RS1050 drysuits are better for very cold environments as they do not freeze in the air. This type of operation requires extensive special training and equipment for diving as well as the surface support personnel.

An Exposure Suit is used by law enforcement people or others who work on the water's surface and need protection should they unexpectedly fall in the water. Usually one of the main criteria is the ability to wear the suit comfortably all day. The material must be light and flexible. Some environments may require the material be "breathable" material however this characteristic will increase cost and decrease overall durability. Most users will wear a life vest with the suit so it is not usually necessary for the suit material to have inherent buoyancy. The neoprene exposure suits required on offshore fishing boats are not applicable. The Coast Guard Rescue Swimmer NOMEX TLS drysuit is standard issue for Coast Guard helicopter rescue swimmers. Here are a few other considerations:

- High visibility color and/or reflective tape
- Black option for covert operations
- Surface use only: no inlet valve with small cuff dump only for easier swimming
- Relief zipper
- Easy to wear all day: light weight and flexible

Search and Rescue/Search and Recovery diving is obviously a need for public safety divers. The risk assessment for contamination and fitting your divers will probably be the primary concerns when selecting equipment. Many dive teams prefer lighter weight, self-donning suits for faster response time in an emergency. Common options include:

- High visibility color and/or reflective tape
- Relief zipper or p-valve
- Pockets for tools, back up equipment or evidence collection bags. Anything glued onto the drysuit may make it harder to decontaminate. You can not glue pockets etc. onto vulcanized rubber.

There are many additional features and benefits of different types of suits for you to consider. Again, it is important to evaluate the needs of your dive team before making a final selection. Here are few things to consider:

- Ease of repair: Some materials are easier to repair than others. Vulcanized rubber can be fixed with a simple inner tube patch kit in many cases. Most materials that dry quickly, such as TLS material, can also be repaired easily as well. A mixture of Aquaseal® and Cotol® can be used to patch most trilaminate or crushed neoprene suits once dry.

- Type of boots: Vulcanized rubber suits have boots vulcanized to the suit. While this preserves the integrity of the material, they can be difficult to fit and changing boot sizes is extremely expensive and time consuming. RockBoots are an excellent choice for fit and durability. They will not hold up well to decontamination but can be easily and inexpensively replaced. Socks of Cordura trilaminate material can be installed on DUI drysuits instead of the crushed neoprene socks allowing for easier decontamination.

- Hoods: Attached latex hoods and hoods made of vulcanized rubber are excellent for diving in contaminated water and make it much easier to get a seal with a full face mask. While they do not provide the same level of protection as a helmet, they are more user friendly and do not require surface support. Attached hoods come in fewer sizes than standard hoods and may be hard to fit for smaller people. Some people report difficulty in clearing their ears. These hoods should be worn with a liner for warmth and comfort. Using an attached hood without a liner can significantly increase the risk of ear drum rupture.

- Dry gloves: Divers will often forget protecting their hands in cold and/or contaminated waters. Drysuits for public safety divers should have the ability to convert to a dry glove if needed. There are many choices of which most involve some type of ring system. DUI's ZipSeal™ System makes it simple to go from a seal to a dry glove and/or to replace a torn or worn out seal in the field in less than a minute. The SI-5 ring system is also popular with public safety divers as it is usable with a glove or wrist seal or both. Other systems do not require a dedicated ring on the suit but that type is usually not as reliable and are more prone to leakage.
- Helmet yokes: When using a surface supplied system, the drysuit will need to be fitted with a yoke that mates to a specific helmet. This connection is one of the areas a diver will need to check for contamination and deterioration.
- Method of Decontamination: How will the surface support personnel/tenders decontaminate the diver, tools, and equipment on the surface? How will they minimize contact with contaminated equipment or diver? How will the contaminated equipment or clothing be cleaned or disposed of? Protocols for decontamination need to established in advance.

We will address the specifics in the next section.

- Emergency Plan: This plan must address the "what if" scenarios. All personnel should be familiar with the proper response to situations such as lost diver, unconscious or injured diver, out of air diver, diver or surface personnel who has lost exposure suit integrity, contamination of personnel, unexpected type or quantity of contaminants, etc.

PROTOCOLS FOR DECONTAMINATION AND QUARANTINE

We need to differentiate between decontamination and definitive decontamination as it is important to make sure both steps are done to ensure the diver's safety and increase the equipment's longevity. Decontamination is done on the dive site to remove and/or neutralize surface contaminates from protective equipment such as a diving suit. This is done to allow the diver to take the suit off without becoming contaminated. With many decontamination solutions, this does not render the equipment contaminate free and the equipment should be handled as if still contaminated.

Definitive decontamination is rendering the equipment safe and contaminate free.

Depending on the contaminant type and level, this process is highly variable. In the case of diving in fuel contaminated water, all rubber components are replaced on breathing equipment. With severely chemically contaminated suits and equipment, the equipment may need to be disposed of as hazardous waste. Dive teams should be aware that the cost to replace or remediate contaminated equipment may be covered by insurance if the source and/or liability of the contamination can be determined.

Decontamination equipment should be suitable for the level of hazard and set up in advance of the dive. Minimum requirements include LOTS of water (55 gallons minimum), a decontaminating solution such as DF200, betadine, tincture of green soap or other cleaning solutions specific to certain chemicals, an enclosure to prevent decontamination fluids from escaping, scrubbing equipment, portable showers, and containers for holding contaminated equipment, clothing and tools.

MINIMIZE CONTACT

Every effort must be taken to minimize contact with a contaminated diver or equipment. Start by limiting the number of personnel to only those actually needed to run the operation. Use technology to minimize the amount of time the diver will need to spend in the water and use booms/fire foam to protect the entry/exit point from surface contamination. Once the diver is ready to enter the water, facilitate decontamination by prepping the surface of the equipment by wetting the outside of the drysuit, BC etc., with water and, depending on the type of contamination, a cleaning solution such as Simple Green. By saturating the outer layer of the suit and other materials, the absorption of a contaminant into the material will be minimized thus making it easier to decontaminate. This will work on most all materials that might absorb a contaminant such as drysuits, BCs, regulator hoses etc.

SETTING UP A DECONTAMINATION STATION

When conducting a diving operation in contaminated water, the diving area should be divided into three zones before diving operations begin.

HIGH CONTAMINATION ZONE

This is the area surrounding the point of water entry/exit. In this area, you will need a decontamination shower and/or high pressure fresh water rinse with cleaning solutions such as Betadine, tincture of green soap, Simple Green, or DF200 foam. Containment of all water and any other cleaning agents will usually be required. After the initial cleaning, the diver can remove his/her SCUBA equipment with the help of the tender. That equipment should be put into an airtight bag or container with a label on the outside that indicates the item inside, date of use, type and length of exposure, and type of contaminant. It should be kept in the low contamination zone until it is returned to the facility where it will undergo definitive decontamination.

LOW CONTAMINATION ZONE

The area to which divers and equipment will be directed after initial decontamination is the low contamination zone. In this zone, one or more decontamination showers should be constructed which in most cases will require containment pools also. Traditional cleaning agents such as betadine and tincture of green soap should be on hand as well as disposable brushes and other cleaning supplies. Use an alkaline agent such as sodium bicarbonate to neutralize acids. Conversely, a mild acid can be used to neutralize alkaline agents such as chlorine. Diver should enter with their drysuit and helmet or full face mask still on. This equipment will be removed in this zone.

CLEAN ZONE

This area is where all divers will be directed after undergoing decontamination and removing all of their equipment. Medical equipment should be kept here unless needed. This area should be upwind of the high contamination zone if possible.

At the last shower, the diver must scrub the body thoroughly for at least 5 minutes. Towels used also go into a disposal bag. Diver should change into clean clothes and undergo a medical evaluation if they have been

MITI Shower

exposed to higher levels of contamination. Water and cleaning solutions used in the decontaminating procedure should be disposed of properly and treated as hazardous material. Personal protection equipment used by surface personnel must also be treated in the same way.

Personal Incident Decontamination Spray

LIMITATIONS OF CURRENT DECONTAMINATION SOLUTIONS

All of the typically used decontamination solutions must be contained as they do not neutralize the contaminant being washed off, and in some cases such as bleach or TSP, are environmentally hazardous themselves. Large amounts of water are required to wash the person down and that effluent is all considered contaminated and must be disposed of properly.

Macaw Unit

Bleach and TSP are toxic to the environment, the diver and the diver's equipment. Nor is it as effective as we would like. Usually very high concentrations (10%- 20%) are required to effectively neutralize biological contaminants which increases the harmful effect. A 30 minute dwell time is recommended but it can be difficult to keep the bleach solution on the diver during the initial decontamination process.

It can also be difficult to get the required dwell time with antimicrobial soap so scrubbing is important as well as lots of water. While it is more effective than bleach at removing hydrocarbons, it requires large amounts of water which all must be disposed of properly.

Betadine,TSP and Simple Green all have the disadvantage of not working with both chemical and biological contamination. Fortunately there are better options available.

USING THE LATEST IN DECONTAMINATION SOLUTIONS

EasyDecon DF200 from Intelagard and DUI changes the rules for traditional decontamination in that most efforts at decontamination are designed to wash the contaminant off of the equipment and maybe kill it. Instead,

DF200 is designed to neutralize the contaminant into benign components, and the equipment is ready almost immediately for use again. Because the contaminant is neutralized, you do not need to catch the residue. Nor do you need to worry about further definitive decontamination.

This chemical is registered with the EPA and is completely biodegradable. Despite its power, the primary oxidants within the decon formulation will decompose into oxygen and water. Consequently the formulation has none of the problems of gaseous release from using chlorine or chemical residues associated with other chemical oxidants. In addition, since the formulation is totally miscible in water, it is perfectly safe to handle. The formulation does not produce any residues or vapors during decontamination procedures that are hazardous waste according to recommendations of the Resource Conservation and Recovery Act.

Here is a partial list of the biological and chemical agents neutralized by DF200.

E. coli
Staphylococcus aureus (MRSA)
Pfiesteria
Giardia
B. anthracis
Y. pestis
Bovine Coronovirus
Mold Spores
Blood and body tissues

Ammonia
Chlorine
Carbon disulfide
Malathion
Hydrogen and sodium cyanide
Hydrogen fluoride
Phosgene
Acetone
Toluene

The appendices at the end of the manual contain a more complete list. Scientific studies confirming the abilities of EasyDecon DF200 are available on DUI's website www.DUI-Online.com.

EasyDecon DF200 was originally designed to destroy weapons of mass destruction including weapons grade anthrax and nerve gas. Comparitavely, the types of contaminants encountered by dive teams are relatively easy to neutralize. DF200 works most effectively against all biological contaminants and most chemical contaminants such as organophosphates. While DF200 may take up to 30 minutes to neutralize anthrax, biological contaminants such as *E.coli*, or body fluids are neutralized in a few minutes. Fuel does not get neutralized, but as DF200 is a surfactant, it will help repel and facilitate the washing off of hydrocarbons for further definitive decontamination. In this case, the solution would need to be contained and disposed of as hazardous material.

Public Safety Diver Being Decontaminated by Macaw Unit and DF200 Solution

EasyDECON DF200 is non-corrosive and adds no environmental load to the appropriate clean up operation. Kill time occurs within 1 - 30 minutes after application. Dwell time will vary depending on contaminant and environmental conditions. The solution is safe to use on all fabrics, plastics, rubber, nylon etc. and will not corrode the dive gear. DF200 is commonly used to decontaminate meth labs, ambulances, blood and other body fluids, mold, etc.

The solution has a shelf life of up to 5 years and pot life once mixed is 8 hours. As the solution comes in a variety of containers, you can mix up as little or as much as you want. The Personal Incident Decontamination spray unit is ideal for one diver and their equipment; while 5 gallons will decontaminate approximately 15 divers when used in the Macaw. The Macaw is a compressed air foam unit which is designed to create the best foaming action for the DF200 turning 5 gallons of solution into 300 gallons of foam. This foam will provide even coverage to ensure maximum contact with the contaminant. It will also serve as a visual reference so you can see what has been sprayed.

One of the challenges of decontaminating many types of dive equipment such as buoyancy compensators is getting the decon solution into all of the hidden areas. The foam will more effectively reach those hard-to-reach places. The Macaw allows for easy and efficient foam application and is the ideal application tool when decontaminating larger objects such as boats, body bags, ambulances, squad cars, buildings, etc. The versatility of the DF200 makes it the best all-around decontamination solution.

In addition, the Macaw can be filled with fire foam and used to battle Class A fires. While DF200 can also be used to fight fires though its cost is much higher than that of fire foam. If you attach an aerating Mid-X nozzle to the Macaw, you can use it to create an excellent foam barrier to fuel. The fire foam acts as a surfactant and will repel fuel creating a fuel free area for divers to enter and exit the water. Solubilizing hydrocarbons is an effective method of decontaminating chemical and petroleum spills as well as containing them for future collection. The versatility of the Macaw and DF200 is impressive and should be a tool used by all public safety units.

DEFINITIVE DECONTAMINATION OF EXPOSURE PROTECTION EQUIPMENT

If DF200 is not available or is not the appropriate solution for your situation, there are many different commercial products available as washes for specific types of contaminants. Depending on the length and type of exposure, different cleaning agents should be used. For many biological exposures, products such as Simple Green, Betadine, and tincture of green soap should be adequate for cleaning. PPE equipment should be worn when decontaminating equipment. Here are a few simple things to watch out for:

- Scrub the suit with the appropriate cleaning solution. Use plenty of water and make sure to pay particular attention to areas where dry glove rings or helmet yokes may trap water. It is important to clean the drysuit as soon as possible after the dive in order to prevent any mildew or mold from forming.
- Use a toothbrush and the cleaning solution to wash the zipper. Zippers are very susceptible to fuel contamination and should be checked after every dive.

- Flush water and cleaning solution through valves. Remove valves from suit for further cleaning if necessary. Valves may need to be replaced if diving in fuel-contaminated water as the rubber diaphragm is particularly susceptible.
- Latex seals are also susceptible to fuel contamination and should be cleaned thoroughly after each dive. ZipSeals™ make it easy to change seals if needed.
- Equipment should be checked for contaminants after decontamination and again before being put into storage. See below for more information.

CHECKING FOR EFFECTS OF CONTAMINATION

Dive teams who operate in contaminated water must continually evaluate their equipment for deterioration from contaminants. Even proper decontamination procedures may not be enough to clean everything. The effect on the equipment of cumulative exposure to contaminants is unknown. It is likely that repeated exposure will result in a decreasing ability to protect the diver from aggressive contaminants. There is just no practical way to test for everything.

Some commercially available products will give you a visual indicator if contaminants remain after the decontaminating process. However this type of testing will usually only show significant contamination. In addition, it is possible for the drysuit to test clean on the inside after decontamination and to test positive for contamination hours later. This is because the contaminants continued to permeate through the suit material even after decontamination.

Here is a list of a few things to watch for:

- Seals, latex hoods, zippers and the diaphragm inside the exhaust valves are particularly vulnerable to contamination. Depending on the level and type of contamination, you may need to replace seals after a single use. Check for delamination from the suit, discoloration, and stickiness.
- Base suit material should be checked continuously for cracks, abrasions, bubbling, discoloration, delamination or other defects that may indicate damage from contaminants or may weaken the material to a degree that further use is not recommended. Suits can be weakened so that further use in a particular contaminant will cause a catastrophic failure.

ALTERNATE SEARCH TOOLS

Risk can be further minimized using equipment such as ROV's, video, and side scan sonar. This increasingly available technology can be used to locate bodies or other search targets before the dive team is sent in for recovery.

Certainly ROVs and side scan sonar may not be able fully replace a diver, however, they can help mitigate risk by minimizing the time the diver is exposed to the harsh environment.

ROVs are remotely operated vehicles that were built with the idea of being sent into underwater locations divers cannot reach or where it may be dangerous for them to do so. ROVs can be equipped with video and/or sonar technology.

Sonar can be used in dark and turbid water to find images very quickly. They can locate targets up to 150 meters away. Low to zero visibility may make it extremely difficult for a diver to pinpoint an object unless they literally swim into it. Sonar can identify objects under these conditions and give divers a GPS location. This allows divers to be more efficient with their time underwater by diving directly to the object to be recovered rather than spending that time underwater searching for the object. Less time underwater equals less time the diver is exposed to contaminants.

Common Uses for ROV (provided by VideoRay)

A) Port Security: Inspecting ships to monitor for contraband or explosive devices.

B) Customs and Border protection: Monitors ship hulls for drug containers

C) NYPD: Uses daily to get a virtual image of a device before sending divers down

D) US Navy: Explosive ordinance disposal, hull inspections, ship husbandry

E) Sheriff and Fire Depts: Locate objects under ice, underwater forensics, locating and recovering drowning victims, dam inspections, culvert inspections, and in areas with severe aquatic life dangers (ie: alligators).

Visit VideoRay.com for more information

TRAINING

Having formalized training specific to public safety diving and regularly practicing that training can certainly aid in minimizing risk.

"Risk management is the process of looking into the future, anticipating things that can go wrong, and then doing something in the present to prevent them from going wrong in the future."

Steve Orusa DRI

Proper training gives you the tools to do just that. Below is a list of considerations for dive team members.

1. Establish safety procedures including when to terminate a dive
2. Risk/benefit analysis
3. Dive action plan
4. SOP for dive operations
5. Emergency procedures/action plan
6. Briefing/debriefing
7. Pre-dive checklists
8. Lost diver procedures
9. Hand signals
10. Equipment standards
11. Family member etiquacy

Below is a list of training organizations specific to Public Safety training...

DRI	diverescueintl.com
ERDI	tdisdi.com
NAPD	napdonline.com
PSDA	publicsafetydivingassociation.com
Lifeguard Systems	teamlgs.com

To ensure skills are up to date, team members should undergo an annual scuba skills review (see appendix C).

HEALTH

It is extremely important for Public Safety divers to be in shape for the tasks they need to perform. A diver whose body is not up to the required performance level, is at risk of becoming another victim.

The following article on health and public safety divers is provided by Tom Greenhalgh an esteemed corporate trainer for Dive Rescue International and an IADRS member. As most recent public safety diver accidents are related to health issues, we felt this information was important enough to include in its entirety.

Public Safety Diver Health
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Historically, public safety dive teams spend a considerable amount of their time and resources on preparing for missions. Training for responses in various environments, standardizing equipment and procedures, and maintaining a state of operational readiness are often the main focus points of teams. Equally important as preparing the team as a unit is maintaining the overall fitness of the individual divers and support personnel.

Fitness for public safety divers is comprised of three main components. These components include: medical fitness, physical fitness, and mental fitness. To be considered in an operational ready state, a diver should not present with any challenges in any of these three areas that would preclude him or her from diving, or that would put themselves or others at substantial risk for harm.

The question of what medical conditions may preclude a person from diving varies greatly amongst agencies and medical experts. Equally varied is the type of medical evaluation that is required of someone to qualify them to dive. Depending on the certifying agency and locale, sport diving varies from simply completing the Recreational Scuba Training Council (RSTC) medical evaluation form to obtaining an actual physical. Commercial and military divers by contrast undergo extensive screening medical screening before being qualified for their work. Public safety diving does not currently have any set standard and to what extent a dive candidate needs to be evaluated often is the decision of the diver's agency.

Given the type of work conditions encountered by the public safety diver (PSD), the International Association of Dive Rescue Specialists (IADRS) has undertaken the task of trying to determine reasonable standards for medically evaluating public safety divers, a task which is still on-going. Representatives from the IADRS have met with members of the Underwater Hyperbaric Medical Society (UHMS) to develop a *standard that is suitable for PSDs. What may be an acceptable medical condition to allow a person to participate in emergency services work may place that same person at extreme risk in the hyperbaric environment. Unfortunately little is known about many of these conditions and how they will be affected while diving so there is a wide range of thought on what conditions should or should not preclude a person from diving in a PSD capacity.*

Physical fitness is the second component of determining a diver's overall fitness for diving. Many fitness evaluation standards exist in the civilian, military, and public safety worlds. The majority of these are comprised of a combination of agility and stamina testing including tests such as pushups, sit ups, and a timed distance run. While many of these standards provide a baseline standard of physical fitness, most often they do not accurately measure the fitness level required of PSDs. The IADRS looked at this issue to determine what test most accurately evaluated the physical fitness level needed by a PSD. After much consideration the IADRS watermanship test was determined to be a fair standard (appendix D). This test includes four timed events conducted in a pool. This test has been determined to provide an accurate challenge of the diver's cardiovascular system and fitness level, consistent with the mission work of the PSD. This standard has been adopted by the National Fire Protection Agency (NFPA) as the standard for PSDs associated with the fire service.

The last tenant of diver fitness, mental health, is perhaps the most overlooked. Ensuring that the diver is in a state of psychological readiness can be much harder to identify. Psychological challenges such as a major mental illness or fears such as claustrophobia are some of the more obvious conditions that would preclude a person from diving. What can often be missed are the effects of stress on a diver. The nature of the calls, the environments that PSDs work in, and the heavy gear configurations are but a few of the stressors that can impact the diver. Non-diving related personal and professional stressors can also have an impact on the psychological well-being of the diver.

While the majority of PSDs handle these stressors very well, occasionally the call is of such a nature so as to overtax the diver's normal coping mechanisms, such as can be the case when a young child is recovered. To help the diver remain in a state of mental readiness, the availability and use of stress management techniques is recommended. Ensuring that team members have adequate "down time" to "recharge" their emotional health is just as important as maintaining medical and physical fitness.

Critical Incident Stress Management (CISM) is a continuum of support services used throughout emergency service agencies. These services can range from educational *programs, individual peer-to-peer interventions, small group interventions such as debriefings, or more advanced psychological trauma techniques. It is important to note that not everyone will be effected the same way on a mission and that there may be some members who appear to be relatively unaffected by a call while another member may be very disturbed by the experience. Advancements in trauma intervention techniques have made it possible for team members to download the event in a healthy way rather than keeping their experiences "bottled-up" as was often the case in the past. Being able to talk about these experiences in a safe place, often with people who have had similar experiences, can normalize the feelings associated with the event.*

Much has and is being accomplished in the area of PSD fitness. Agencies such as the UHMS and NOAA have developed training programs for physicians to educate them in diving medicine. Research continues to be conducted by agencies such as the Divers Alert Network into diving physiology and how various medical conditions are impacted by the hyperbaric environment. The public safety diving community, through various training agencies and organizations such as the IADRS, continues to work towards improving itself and making this type of work safer for all of us. However, even with all that has been accomplished there is more to do. Ensuring diver and team member fitness is not just an organizational responsibility, but the responsibility of each and every team member regardless of their role in the organization.

HEAT STRESS

Before selecting the proper insulation you will need to consider how to handle heat stress. Since many public safety divers will be totally enclosed in a drysuit with thick insulation and maybe even a helmet, overheating can be a serious problem. This is particularly a problem when the water temperature is relatively warm and the diver has no way of cooling off. Before diving, it is important to keep the outside of the suit and head area wet on the surface to facilitate evaporative cooling. In particularly hot situations, try putting ice and a little water in two gallon zip lock bags. Sling two of them over the shoulders of the diver and then wear the suit over them. They should last around 2 hours and will extend the diver's time in the water. This technique was successfully used during the Valujet recovery in Florida and in New Orleans after Katrina.

Medical staff should be aware of the potential effects of heat stress such as dehydration, heat exhaustion, heat stroke, heat rash, and an elevated heart rate. The EPA recommends that divers and support personnel be evaluated for the effects of heat stress whenever the temperature is over 70° F. They recommend the following monitoring procedure:

- Dehydration: Divers and other encapsulated personnel should drink large quantities of water and/or rehydration fluids such as Gatorade. A diver in a drysuit will lose up to one pint of water per hour even without heavy labor or high temperatures. While the amount will vary depending on climate, conditions and the individual, allow for a minimum of one gallon of water per person. For longer operations, allow two gallons. Personnel should be weighed prior to the start of the operation and then afterwards. Weight loss should not exceed 1.5% of the starting body weight.
- Body Temperature: Starting body temperature should be normal (98.6°) and after working, the temperature should not be any higher than 99.6° while resting. If so, the person should be placed on light duty for the following work period and shorten the duty period by 1/3.
- Heart Rate: A baseline heart rate should be established for all personnel and then taken again after the end of a work period. The heart rate should be no higher than the maximum rate appropriate for someone of that age. The slow return to a resting heart rate also indicates heat stress so the heart rate should have decreased to at least 110 bpm within one minute after the work period.

INSULATION STRATEGIES

The amount of insulation you require will be determined by the water temperature you are diving in, the length of the dive, and the exercise rate of the diver. After all, the muscles are the heat engines of the body. The amount of heat produced by a person who is working hard may be as much as seven times greater than for someone at rest. That person will obviously not need the same level of insulation as someone at rest or swimming slowly.

While most divers can use the same dive computers and/or dive tables safely, we cannot use the same insulation guidelines for keeping warm. People vary greatly in heat production, and therefore in insulation requirement, due to ethnic ancestry, body type, age, gender and more. Some people have developed large muscle masses which mean large heat engines. As a result, large people with large muscle mass need less insulation for the same exercise rate and same water temperature than smaller people with a smaller muscle mass .As we age, our circulatory systems are not as efficient as they were when we were younger. Therefore what would keep us comfortable when we were younger will no longer keep us comfortable when we are older. You can look around any large room with lots of people, and notice that some will be wearing T-shirts and others will be wearing sweaters or sweatshirts. We are all different. Dive teams may want to consider using layering to accommodate different water temperatures and body types.

ALL INSULATION IS TRAPPED AIR/GAS

All insulation known to man is trapped air or other gas. For greatest efficiency, the smaller compartment that the gas is trapped in the better. The insulation is degraded by the thermal conductivity of the insulation material. Example: heavy fibers or strong, thick fibers normally conduct much more heat than do small, lightweight fibers. The only materials suitable for modern drysuit insulation are polyester and polypropylene.

Furthermore, once the diver enters the water and the water compresses against the drysuit, it sandwiches the insulation between the drysuit and the diver. Water pressure will also subject the insulation to a compression load. Whatever material the divewear is made of will need to resist that compression load. As a rule, the lower-priced materials have fewer threads per square inch and higher loft; thus lower compression resistance. Some materials will lose as much as 70% of their insulating value while under the sort of compression experienced by the average drysuit diver. High-quality materials will have more threads per square inch and are more compression resistant.

DIVEWEAR MATERIALS

Choosing the correct material for each diver is not easy. Often, selecting insulation is more difficult than selecting the right drysuit. Remember, all insulation is basically trapped air/gas. Therefore the more effective the material used is as trapping air, the more insulation it will provide. Here is a brief comparison of the materials used by DUI.

- **Thinsulate™:** Thinsulate™ is made of a polypropylene fiber that is 1/1000th the size of a human hair. Polypropylene is a modified wax. This type of insulation is the most efficient insulator known at this time (weight to warmth ratio). DUI uses Thinsulate™ Insulation Ultra BZ and Thinsulate™ Ultra Insulation 400. This brand of Thinsulate™ is compression resistant and is commonly referred to as Type B. This type of Thinsulate™ is commonly used in footwear as it will retain its insulating value even under compression from someone standing on top of it. In addition, the fibers are matted together so closely that the natural resistance of wax to water prevents water from entering the insulation even if water did enter the suit. Unless there is strong pressure on the material from a serious suit squeeze, the water droplets will not touch one another and they cannot conduct heat. The body will have to heat the water in the suit, but as long as the water droplets remain trapped in the fibers and do not touch each other, they can not conduct heat away from the insulation. This characteristic makes Thinsulate™ a great choice for divers who may not be able to exit the water immediately if they get wet. However, public safety divers diving in contaminated water must exit the water immediately if a leak in the drysuit is detected. It's biggest drawback is the difficulty in washing it and its relative bulk. Washing instructions are in the appendix of this manual. DUI uses Thinsulate™ and Thinsulate™ Ultra in their Xm250™ and Xm450™ jumpsuits.

- **Fleece:** There are many types of fleece available on the market today. Often the lowest priced fleece does not stretch and is used in combination with a nylon or microfiber layer for wind resistance. Because they do not stretch, they will fit loosely so the diver will be able to move without restriction. Some restriction is still possible in the drysuit as the loose fit of the fleece is compromised by the squeeze of the drysuit.

- Some fleece stretches in one direction. The price averages twice that of fleece that does not stretch. This material is normally cut so it stretches horizontally which allows the diver to move much more freely when the suit is under compression. However it has no vertical stretch. Both of these types of fleece can be found in different densities thereby having different abilities to resist the compression of the suit. The fleece used by DUI in the ActionWear™ line is of moderate density and is available in two thicknesses in a jumpsuit. ActionWear™ Professional™ is available in a two-piece garment (pullover and pants), in double thickness with a jersey outer. It is easy to wash.

- **Premium, two-way stretch Polartec® PowerStretch®:** It costs approximately three times as much as the one-way stretch material and five times as much as the nonstretch material. It provides the greatest freedom of movement and has the highest density of all fleece materials. Its close fit and high density mean that you can use less weight than any other type of insulation of equivalent warmth. It is a great choice for harder to fit people and smaller people who may be encumbered by the bulk of Thinsulate™. Remember, smaller people tend to get colder faster than larger people and may need to layer with this material in colder water. This material is also easy to wash.

WATER VAPOR

Within minutes of closing the zipper on your drysuit the air inside of your suit reaches 100% humidity. The average person gives off 1/2 pint of water per hour while at rest. That water will evaporate and migrate through the insulation to the inside of the drysuit. It will condense there because this part of the drysuit will be cold just as water vapor will accumulate on a cold window in the winter. When you take your drysuit off after your dive, you will find that the outer parts of your divewear and the inner parts of the drysuit are now slightly damp. This is the naturally occurring water that came out of your skin and condensed.

If you are wearing a porous material such as fleece, you can look on the outside of the material and see little shiny beads of water. The first time the wind blows over it, they will evaporate creating cold air and the diver will feel it immediately. If the divewear has a taffeta, microfiber or a smooth wind barrier on the outside, you will not feel the cold air. Although evaporation still takes place, the air will not come through the divewear.

ADDITIONAL FACTORS TO CONSIDER

ARGON

One can increase the insulating effectiveness of the suit by replacing the air inside the suit with argon. To do this effectively, the diver needs to purge the suit at least three times with argon prior to the dive. You can get up to a twenty percent increase in insulation. That twenty percent is quite noticeable. Many dive stores now fill argon bottles.

SPECIAL NOTE: Do not put argon in a bottle in which a breathing regulator can be attached. There have been several instances where children have put a regulator on an argon bottle and started breathing off of it. It only takes about four breaths to render someone unconscious.

HANDS AND DRY GLOVES

While we have mentioned dry gloves previously, keeping hands warm and the diver encapsulated is important enough to mention again. We have found that for most people, as the water temperature decreases, wetsuit gloves are simply not adequate to keep the hands warm. You need dry gloves. When you have dry gloves it is very important that the insulation be relatively loose around the fingers so it will not restrict blood flow which restricts heat flow. Suit-integrated gloves, such as ZipGloves, are a great option for those who get very cold hands and/or have a problem with blood circulation into the extremities or want to eliminate the large rigid ring of traditional dry gloves.

For use in contaminated water, DUI recommends using dry gloves with a back up wrist dam for protection in the event of a glove puncture. This dam can be loose enough to allow efficient air flow but still provide back up in the event of a leak. Divers with a leak in their glove in contaminated water should exit the water. Dry gloves are required for complete encapsulation of the diver which should be the goal for any dive team that dives in any type of contaminated water.

For divers concerned about durability, you may want to consider gloves made of a very thin compressed neoprene for puncture and tear resistance. These gloves will perform well in harsh environments.

WEIGHTING

Divers wear weights in several configurations. As a public safety diver, you may want to test dive different configurations to find what works best for your diving.

DUI Delta Buoyancy Control System

- **A traditional weight belt:** Usually not very comfortable and positions the weights high on the body. Should not be used except with small amounts of weight.
- **Weight-Integrated BC:** More comfortable than the traditional weight belt, this type of system has several variations: some fixed and some droppable; all droppable; droppable as one unit or two; all in the BC, or split between BC and some other weight system. Some weight-integrated BCs also position the weight too high on the body making good trim difficult. In addition, the combined package of the weights and tank can make it hard to carry.
- **Weight & Trim System:** This harness system can be worn with any BC, even a weight-integrated one, and is designed to allow you to position the weights more comfortably and for better trim. This harness can also be fitted with extra D-rings for attaching lights, gauges etc. Often, public safety divers will use more weight than the typical recreational diver so the Weight & Trim System makes it easy to carry the additional weight.
- **Ankle weights may be worn with any of the above:** Ankle weights are often used by drysuit divers as a way to get some weight down lower and keep their feet down. We do not recommend their use as they will make it harder to kick and redistributing the weight can be more effectively accomplished by a Weight & Trim System. Trim for a drysuit diver is different from a wetsuit diver as the buoyancy is evenly distributed over the whole body. Two-part wetsuits concentrate the buoyancy in the upper body. Weights should be worn in the same place as the center of buoyancy of the diver – usually around the hip, not the waist.

DIVE PREPARATION

Just as with any dive, a pre-dive checklist can make the difference between a good and a bad experience in the water. For public safety divers who may need to enter the water quickly on a rescue, proper maintenance and frequent between-dive inspections are mandatory.

Check list for **Drysuit and related equipment**

- Check that the seals are trimmed properly for the diver using the suit. Seals that are too tight can be dangerous as well as uncomfortable. Loose seals will obviously lead to leaks. ZipSeals™ make it easier for multiple divers to share suits as each can have their own seals ready to install if needed. Always check installation prior to diving.
- Seals should be washed after use and talc or soapy water will make them slide on easier. Keep the suits away from ozone generators if possible as ozone will make the seals decay faster. Do not use Seal Saver™ as the silicone can penetrate the suit material and make it impossible to install new seals when the time comes to change them out.
- Check the fit of the latex hood and make sure it does not cover too much of the face. These can be trimmed if necessary. Some divers have a problem with too much air in the hood especially if the hood is slightly loose. If so, you can install a one way purge valve in the top of the hood to vent excess air. These valves are susceptible to leakage and should not be used in contaminated water.
- Lubricate the drysuit zipper after every use. DUI provides zipper wax with each suit but you can also use paraffin or bees wax. If there seems to be a build up of wax, you can clean the zipper teeth with an old toothbrush.
- Check the inlet and exhaust valves. Make sure they move freely and are free of sand and debris. Flush the valves with fresh water after every use.
- If using dry gloves, make sure the rings are kept clean of sand and debris. Many dive teams have a ring permanently installed on their drysuit and this ring should be checked periodically to ensure it is attached to the suit properly. Check the dry gloves for leaks by turning the glove inside out, filling the glove with water and looking for any leakage.
- Check the fit of the fins with your boots and insulation. Make sure they are adjusted properly and the fin straps are in good condition.
- Divers must be trained in using a drysuit in conditions similar to what they

may encounter on a working dive. Such training must include emergency procedures such as how to get out of an inversion, how to deal with a faulty inlet valve, etc.

- Keep a maintenance log showing the repair/maintenance history of each piece of equipment and its exposure to contaminants.

GRANTS

Money availability via grants is offered through a multitude of organizations. Below is a list of categories grants are available that pertain most closely to Public Safety teams.

1. Capital support
2. Challenge monies
3. Conferences/seminars
4. Continuing support/continuation grant
5. Employee matching
6. Endowment
7. General/operating expenses
8. Matching funds
9. Program development
10. Seed money
11. Technical (consulting) assistance

Typically, there are 2 main types of grants. These are government grants and foundation grants.

Government grants are broken up into 3 branches; federal, state, and local. Information on federal grants including an overview of current grants available, grants that have been approved in the past, and grants that have been declined can be found in the Catalog of Federal Domestic Assistance (CFDA) and at the website grants.gov. The dive teams' local state legislator and/or state capital are the best resources for attaining information on state grant availability. Local government grants can be found by contacting the county of the team's jurisdiction.

Foundation grants can be offered through a variety of private organizations. The Foundation Center Cooperation Collections site (fdncenter.org) is an excellent resource listing private and public foundations. Additionally, local corporations typically put aside 5% or more of their profits towards grants as part of making a financial commitment to the community their headquarters are located.

FEDERAL GRANTS: TAKING ADVANTAGE OF OPPORTUNITIES

The increased emphasis on Homeland Security has lead to the availability of more funding for dive teams than at any other time in recent history. A dive team that knows how to use these funding priorities will be able to greatly improve their equipment and training. This is a brief overview of ongoing federal grant programs and some strategies to increase your chances of receiving funding. These techniques can be used for many grant programs not just federal programs.

USEFUL WEBSITES: These websites provide ongoing grant support including applications, grant deadlines and assistance in writing successful grants.

- www.grants.gov
- www.firegrantsupport.com
- https://www.rkb.mipt.org/
- www.chiefsupply.com
- www.fema.gov
- www.publicsafety.fcc.gov/pshs/clearinghouse
- www.diversalertnetwork.org
- www.diverescueinternational.com/eventsandgrants.aspx
- www.usgrantlist.com

CURRENT FEDERAL GRANT PROGRAMS

While there are many federal grant programs available, here are a few that have been particularly successful for dive teams in recent years. Dive team equipment, especially exposure protection, is usually considered personal protective equipment.

- Assistance to Firefighters Grant Program: Designed to assist rescue teams with improving their capabilities to respond to different emergencies.

- Port Security Grant Program: Designed to reinforce the protection of critical infrastructure.

- Law Enforcement Terrorism Prevention Program: Part of the Homeland Security Grant Program. Designed to support the development of antiterrorism activities and units.

- State Homeland Security Program: Part of the Homeland Security Grant Program. Designed to support the planning and equipment needs for dealing with acts of terrorism. Also, designed to improve state and local response to catastrophic and natural disasters.

- Urban Areas Security Initiative Program: Part of the Homeland Security Grant Program. Designed to support high density urban areas in the development of anti-terrorism programs which will improve the ability to respond to and recover from a terrorist attack.
- Transit Security Grant Program: Designed to improve the protection of public and mass transit systems and infrastructure. Can include bridges and ferries as well as subway systems etc.
- Emergency Management Performance Grants: Designed to improve the ability of governmental agencies to prevent, protect against, respond to and recover from major events in order to minimize the impact on lives, property and the economy.

WRITING SUCCESSFUL GRANTS

The key to writing successful grants is to make sure your application fulfills the mandate for that grant. Many of the above websites have detailed information about what each program is looking for and how to improve your chances of being selected. Here are a few things to highlight that work for most, if not all, grant applications.

• JUSTIFY YOUR EXISTENCE

- Amount of water in your area
- Water usage: swimming, fishing, diving, boating, commercial traffic
- Amount of bridges, dams, aqueducts, critical water supply infrastructure.
- Number of people living on the water or with direct access to the water if commercial area
- Number of calls in a year: Rescue, Recovery, Evidence Searches

• JUSTIFY YOUR NEED

- Expanding/strengthening capabilities such as the ability to dive colder, deeper or more contaminated water
- Improving safety of your dive team members
- Improving flexibility of the dive team members to respond to a greater variety of calls

- Improved durability/ easier maintenance with better equipment

- FUNDING PRIORITIES
- Enhancing regional efforts with standardization of equipment, joint training and sharing of resources within a region
- Improving disaster preparedness
- Developing/improving Emergency Management Plans
- Developing/improving Response and Recovery Plans
- Conducting hazard/risk assessment
- Conducting training exercises
- Enhancing/expanding capabilities of existing team
- Addressing EMS deficiencies
- Personal Protective Equipment for Contaminated Water: complete encapsulation
- Equipment and training to respond to CBRNE incidents
- Benefits community by enhancing daily operations and positively impacts ability to protect life and property
- Protection of critical infrastructure
- Training that leads to compliance with recognized standards
- Training in specialized rescue techniques

- PERSONAL PROTECTIVE EQUIPMENT (PPE)
- Personal Protective Equipment for Contaminated Water
- Equipment to respond to all hazards
- First priority is basic equipment with second priority to expand functional capabilities
- Equipment needed to bring team into compliance with recognized standards has high priority including efforts to provide complete encapsulation of divers
- Other priorities include first time purchasers, those looking to outfit an entire team, replacement of damaged or contaminated equipment,

decontamination equipment and those units with a high call volume. Using the terms/phrases they are looking for as outlined here will greatly increase your chances of getting your grant.

Be aware that some grants will require some matching state monies as well as significant support to administer the funds.

GRANT WRITING TIPS - SIMPLIFIED

#1 Keep it simple-Do not give them a reason to throw your application away before even looking at it

- If you can say it in 2 sentences, than say it in 2 sentences. The grant officer does not want to read 2 paragraphs of information when it can be read simply in 2 sentences.
- Grants will have very specific guidelines and format clearly stated. Follow those guidelines in the order they specify. If you do not follow the guidelines in order, they may just throw away your application without reading it.
- If they state a maximum number of pages, make sure your application does not exceed this number
- Make all deadlines.
- If there is a program officer, contact them and let them know about what you are trying to accomplish. Their feedback can be very helpful.
- Be careful with lingo. Try to avoid using lingo they may not understand. Do not assume they know what you are talking about.
- Do not forget the key points they are looking for...

    Who you are
    What you need and can do
    When you need it
    Where you can do it
    How you will do it

#2 Foundations (private banks, private associations, small businesses)

- May have to apply more than once to establish a rapport. The more you submit the grant, they will start to remember you and see that you are persistent
- If refused, ask them why and what you can do different
- Show that you meet the criteria

- Establish personal relationships...go to workshops, introduce yourself, give a card, talk about your project...this way they get to know you and will recognize your name when you submit your application
- They will not usually give you money for the sake of giving you money, they want to look good. Help them see how it would make them look good to give you money (maybe you give public recognition).

    *An example is the Walmart Community Grants program for Public Safety Grants (information found at http://www.chiefsupply.com/grants/other_walmart.asp)

#3 Federal

- Get local senator involved
- Review previous grants that were approved
- Find out what the priorities are for your local area

    - major transportation
    - water supply

FORMATTING GUIDELINES

Typically, federal grants have specific formatting guidelines. However, foundation grants can be a little more tricky.

The first thing you will want to do when applying for a foundation grant is verify if they do have a specific format they require. If they do have a specific format, definitely follow their guidelines. If they do not offer guidelines, there are a couple places to look for general guidelines to follow.

a) National Network of Grantmakers (NNG) www.nng.org

b) The Forum of Regional Association of Grantmakers www.givingforum.org

With all grants, use a checklist before sending it off to ensure you have all the guidelines completed correctly. Additionally, proofread your grant and have someone else proofread your final version.

CONCLUSION

Public safety diving will always entail risks particularly for those who must dive in contaminated waters. With certain precautions these risks can be minimized considerably. These precautions include, but are not limited to, identifying contaminants in the water, wearing exposure protection, having proper equipment for the given task, determining when to cancel a dive, established dive, emergency, and decontamination procedures, proper training, and determining the physical fitness of the team for the conditions the members will need to undergo.

BIBLIOGRAPHY & RESOURCE LINKS

BIBLIOGRAPHY: There are numerous excellent sources of information for public safety divers. Here is a listing of those resources we found to be most helpful.

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Code of Federal Regulations 1910.120; Hazardous Waste Operations and Emergency Responses.

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Manual of Practice for Marine Safety Officers and On Scene Coordinators Involved in Chemical and/or Biological Underwater Operations, NTIS, 1984.

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Quemerais, Bernadette, Diving in Contaminated Water: Health Risk Matrix, 2006

Smith, Nancy and Tremore, Judy, The Everything Grant Writing Book, 2003

Traver, Richard, Interim Protocol for Diving Operations in Contaminated Water, Environmental Protection Agency, 1984.

US Naval Sea Systems Command, Diving in Polluted/Contaminated Waters Manual, 2003.

US Department of Labor, OSHA, Hazardous Waster Operations and Emergency Response Standard, 2001.

Resource Links: provided by Tom Greenhalgh

International Association of Dive Rescue Specialists	www.iadrs.org
National Public Safety Solutions, Inc.	www.npssinc.org
Underwater Hyperbaric Medical Society	www.uhms.org

Additional Resource Links

PSDiver.com
diverescueintl.com
tdisdi.com
napdonline.com
publicsafetydivingassociation.com
teamlgs.com

Appendix A

CHEMICAL PERMEATION TEST RESULTS (MATERIAL SEAMS)

			ASTM Average Normalized Breakthrough Time (Min) 0.1 μg/cm^{2}*min		EN369 Average Normalized Breakthrough Time (Min) 0.1 μg/cm^{2}*min	
Chemical	% Con	% Max Water Solubility	DUI RS1050	DUI RS1500	DUI RS1050	DUI RS1500
Acetone	10	100	>480	>480	>480	>480
Acetonltrile	10	100	>480	>480	>480	>480
Ammonia Solution	10	100	>480	>480	>480	>480
Carbon Disulfide	100	0.2	<3	6	<5	10
Clichloromethane	100	1.3	9	17	12	19
Diethylamine	10	82	>480	>480	>480	>480
Dimethylformamide	10	100	>480	>480	>480	>460
Ethyl Acetate	8.7	8.7	172	251	369	>480
Hexane	0.014	0.014	412	420	>480	>480
Methanol	10	100	>480	>480	>480	>480
Sodium Hydroxide	10	50	>480	>480	>480	>480
Sulfuric Acid	10	100	>480	>480	>480	>480
Tetrachloroethylene	0.015	0.015	102	48	197	59
Tetrahydrofuran	10	100	231	179	446	344
Toluene	0.05	0.05	371	129	>480	338
ASTM Oil No.1	100	Not Sol.	>480	>480	>480	>480
ASTM Oil No-3	100	Not Sol.	>480	>480	>480	>400
Liquid B 70% Isooctane 30% Toluene	100	Not Sol.	53	56	65	71
Liquid C 50% Isooctane 50% Toluene	100	Not Sol.	26	45	31	52
Liquid F 80% Paraffin oil 20% Methylnaphthalene	100	Not Sol.	>480	>480	>480	>480
JP8 Jet Fuel	100	Not Sol.	195	285	360	>480

This data was derived from testing in accordance with ASTM Standard F739-96 and ENN369. These tests were performed under laboratory conditions. DUI neither warrants or guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure.

CHEMICAL PERMEATION TEST RESULTS (MATERIAL)

			ASTM Average Normalized Breakthrough Time (Min) 0.1 μg/cm^{2}*min		EN369 Average Normalized Breakthrough Time (Min) 0.1 μg/cm^{2}*min	
Chemical	% Con	% Max Water Solubility	DUI RS1050	DUI RS1500	DUI RS1050	DUI RS1500
Carbon Disulfide	100	0.2	7	7	7	9
Dichloromethane	100	1.3	9	12	9	15
Ethyl Acetate	8.7	8.7	52	116	52	234
Tetrachloroethylene	0.015	0.015	>260	>480	>260	>480
Tetrahydrofuran	10	100	112	137	>180	>480
Toluene	0.05	0.05	>180	189	112	206
Liquid C 50% Isooctane 50% Toluene	100	Not. Sol.	21	29	21	32
JP8 Jet Fuel	100	Not. Sol.	95	101	95	128

This data was derived from testing in accordance with ASTM Standard F739-96 and EN389. These tests were performed under laboratory conditions. DUI neither warrants nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure.

BACTERIOPHAGE TEST ASTM F1671
(MATERIAL SEAMS)

The viral penetration test method ASTM 1671 is used to assess the effectiveness of materials used in protective clothing for protecting the wearer against contact with blood-borne pathogens using a surrogate microbe suspended in a body fluid simulated under conditions of continuous liquid contact. Protective clothing material pass/fail determinations are based upon detection of viral penetration.

Exposure to biological fluids containing viruses which cause HEPATITIS B (HBV), HEPATITIS C (HBC), and ACQUIRED IMMUNE DEFICIENCY SYNDROME (HIV) can pose significant risks to health and life. This test method has been specifically defined for modeling viral penetration by these three viruses transmitted in blood and other potentially infectious body fluids.

The material is challenged for a specified time and pressure sequence with a nutrient broth containing Phi-XI74 bacteriophage which is not pathogenic to humans, but which does infect bacteria. After the challenge time is complete the inside surface of the material is washed with sterile nutrient broth to collect any bacteriophage which may have penetrated the material barrier. The solution is then assayed using E-coil C bacteria in agar media to determine the presence of bacteriophage. This is indicated by the formation of plaques (measured in plaque forming units (PFUs) in the bacterial lawn of agar media. Plaques are the visible clear areas in the E-coil C bacterial lawn where the bacteria have been destroyed by bacteriophage injection and cell breakup. ANY EVIDENCE OF VIRAL PENETRATION FOR TEST SPECIMEN CONSTITUTES FAILURE.

BIOLOGICAL PENETRATION TEST RESULTS

Cell	Collection Side Assay (PFU/ML)	DUI RS1050	DUI RS1500	Results
Blank	<1	*	*	Pass
1	<1	*	*	Pass
2	<1	*	*	Pass
3	<1	*	*	Pass

These tests were performed under laboratory conditions. DUI neither warrants nor guarantees protection by this material and assumes no liability for the use of this material with the biological agent. The user should determine the applicability of test conditions when assessing suitability of the material for actual anticipated exposure.

APPENDIX B

TIPS ON CLEANING THINSULATE™

If the divewear begins to have a strong odor it is because the body gives off not only water but oil. The oil contains bacteria which gets inside the divewear and grows creating the odor. We normally treat this by washing the divewear in a washing machine. Fill the washing machine with water, force the divewear into the water, then add a cup of bleach or white vinegar and run it through at least one wash cycle. DO NOT HANG IT UP TO DRY. Lay it flat and allow it to dry naturally - not in a dryer. The bleach or vinegar will kill all the bacteria and eliminate the odor.

If the diver wears a thin layer of polypropylene under the Thinsulate™, this layer will absorb the oil and bacteria. The diver will save on the washing of the Thinsulate™ divewear.

If saltwater gets inside the suit, the diver can run it through a rinse cycle to get rid of the salt. If the diver uses soap on Thinsulate™, it may need three complete wash cycles to get the soap out of the Thinsulate™. Soap inside the material can affect its ability to repel water. Therefore it is recommended you avoid using soap if possible.

FLEECE

Laundering fleece is much easier as it can be washed and dried similarly to normal clothing. The diver should use a small amount of soap in the washer and the low heat cycle on the dryer.

I.A.D.R.S. ANNUAL WATERMANSHIP TEST

Evaluation Parameters

There are five exercises that evaluate stamina and comfort in the water, each rated by points. The diver must successfully complete all stations and score a minimum of 12 points to pass the test. The test should be completed with not more than 15 minutes between exercises.

Exercise 1: 500 Yard Swim

The diver must swim 500 yards without stopping using a forward stroke and without using any swim aids such as a dive mask, fins, snorkel, or flotation device. Stopping or standing up in the shallow end of the pool at any point during this exercise will constitute a failure of this evaluation station.

Time to Complete	Points Awarded
Under 10 minutes	5
10-13 minutes	4
13-16 minutes	3
16-19 minutes	2
More than 19 minutes	1
Stopped or incomplete	Incomplete

Exercise 2: 15 Minute Tread

Using no swim aids and wearing only a swimsuit the diver will stay afloat by treading water, drown proofing, bobbing or floating for 15 minutes with hands only out of the water for the last 2 minutes.

Performance Criteria	Points Awarded
Performed satisfactorily	5
Stayed afloat, hands not out of water for 2 minutes	3
Used side or bottom for support at any time	1
Used side of bottom for support > twice	Incomplete

Exercise 3: 800 Yard Snorkel Swim

Using a dive mask, fins, snorkel, and a swimsuit (no BCD or other flotation aid) and swimming the entire time with the face in the water the diver must swim non stop for 800 yards. The diver must not use arms to swim a any time.

Performance Criteria	Points Awarded
Under 15 minutes	5
15-17 minutes	4
17-19 minutes	3
19-21 minutes	2
More than 21 minutes	1
Stopped at any time	Incomplete

Exercise 4: 100 Yard Inert Rescue Tow

The swimmer must push or tow an inert victim wearing appropriate PPE on the surface 100 yards non stop and without assistance.

Performance Criteria	Points Awarded
Under 2 minutes	5
2-3 minutes	4
3-4 minutes	3
4-5 minutes	2
More than 5 minutes	1
Stopped at any time	Incomplete

Exercise 5: Free Dive to a depth of nine feet and retrieve an object

Performance Criteria	Points Awarded
Performed satisfactorily	Pass
Stopped or incomplete	Incomplete

Additional copies available at no charge via the International Association of Dive Rescue Specialists webpage. Visit www. IADRS.org

I.A.D.R.S. ANNUAL BASIC SCUBA SKILLS EVALUATION

Divers Name______________________________ Department___________

Air Consumption: Start_______psi / Finish_______psi

Time: Start______________ / Finish______________ / Total______________

Water Depth:___________ Pool / Open Water (circle one)

Examiner:____

Task Grading: S = Satisfactory N = Needs improvement (specify)
N/A = Not Applicable (use for equipment only)

Equipment Handling and Set-Up

_______ - properly assembles equipment (basic gear / specialty gear)
_______ - shows familiarity and comfort with equipment
_______ - properly protects equipment (i.e. tank valve / regulator)
_______ - review (line and hand signals / air consumption rates / buddy awareness / emergencies / diver log)

Watermanship Skills

_______ - 500 yard continuous forward stroke swim - no swim aids for time (refer to grading criteria)
_______ - 15 minute tread / last 2 minutes with hands out of water (refer to grading criteria)
_______ - 800 yard snorkel swim (refer to grading criteria)
_______ - 100 yard inert diver rescue tow (refer to grading criteria)

Skin Diving Skills

_______ - mask clearing
_______ - snorkel clearing (popping & expansion)
_______ - snorkel without mask (led by partner, 1 lap)
_______ - fin kicks (flutter / dolphin) one length each, suing mask & snorkel
_______ - in water surface dives (head first / feet first)

SCUBA Diving Skills

_______ - entries (giant stride / seated or controlled entry)
_______ - neutral buoyancy control (oral / power) inflation
_______ - dry suit buoyancy control and emergency procedures (i.e. hose disconnect or flooding)
_______ - regulator clearing (blowing / purging) and retrieval

_______ - full face mask (removal / switch to regulator / clearing full face mask)
_______ - descent procedures (signal / check time & air / raise inflator hose / feet first descent / clear ears)
_______ - ascent procedures (signal / check time & depth / + buoyancy / raise inflator hose / ascend @20ft/min)
_______ - air sharing at depth and during ascent
_______ - buddy breathing at depth and during ascent
_______ - emergency swimming ascent procedures (simulate out of air / signals / ascends / continuous exhaling / surfaces / inflates BC orally using bobbing technique)
_______ - emergency buoyant ascent procedures (simulate out of air / signals / drop weights / ascends / continuous exhaling / surfaces / inflates BC orally using bobbing technique)
_______ - weight belt (removal / replacement) on surface and bottom
_______ - buoyancy control device (removal / replacement) on surface and bottom
_______ - OPTIONS: Blackout Mask / Night Dive / Navigation / Confidence Obstacle Course

Performance Comments:

____

____

Equipment Care and Storage

_______ - properly disassembles equipment
_______ - cleans and restores equipment properly

Additional copies available at no charge via the International Association of Dive Rescue Specialists webpage. Visit www.IADRS.org

Appendix E..

RAPID FIELD NEURO CHECK LIST

Diver's Name:____

Name of Examiner:______________________________ Date:__________

Initial Complaint:____

Time									Notes
Mental Status: Do they know:	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	
1) Their name?									
2) Where they are?									
3) Time of day?									
4) Most recent activity?									
5) Speech is clear, correct?									
Sight:									
1) Correctly counts fingers?									
2) Vision clear?									
Eye Movements:									
1) Move all four directions?									
2) Nystagmus absent?									
Facial Movements:									
1) Teeth clench OK?									
2) Able to wrinkle forehead?									
3) Tongue moves all directions?									
4) Smile symmetrical?									
Head/Shoulder Movements:									
1) "Adams Apple" moves?									
2) Shoulder shrug normal, equal?									
3) Head movements normal, equal?									
Hearing:									
1) Normal for that diver?									
2) Equal in both ears?									

Time									Notes
Sensations: Present, normal any symmetrical across?:	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	
1) Face									
2) Chest									
3) Abdomen									
4) Arms (front)									
5) Hands									
6) Legs (front)									
7) Feet									
8) Back									
9) Arms (back)									
10) Buttocks									
11) Legs (back)									
Muscle Tone: Present, normal and symmetrical for:									
1) Arms									
2) Hand grips									
3) Legs									
4) Feet									
Balance and Coordination:									
1) Romberg OK?									
2) If Supine: Heel-shin slide OK?									
3) Alternating hand movements OK?									
Vital Signs:									
1) Blood Pressure									
2) Pulse									
3) Respiration									

THE RAPID FIELD NEURO EXAM

Mental Status:

1) Ask the diver to state his name, where he is, the time of day, and most recent activity.
2) Evaluate his speech for clearness and appropriateness.

Cranial Nerves

1) Sight / Eye movements:
   a) Hold up different numbers of fingers for the diver to count.
   b) Have the diver follow your finger with his eyes while keeping his head straight. Move your finger up, down, left and right. Watch for nystagmus.
2) Facial Movements:
   a) Place your fingers at the angle of the diver's jaw and ask him to clench his teeth.
   b) Ask him to wrinkle his forehead as you smooth the skin.
   c) Instruct him to stick his tongue out and move it in all directions.
   d) Check the diver's smile for symmetry.
3) Head / Shoulder Movement:
   a) Ask the diver to tilt his head back and swallow. Watch for his "Adams Apple" to move.
   b) Push down lightly on his shoulders, asking him to shrug.
   c) Put your hand on one side of the diver's face and ask him to push against it. Do the same with the other side, and on the forehead and back of the head.
4) Hearing:
   a) Rub your fingers together close to the diver's ears to identify the sounds he's to listen for.
   b) Ask him to close his eyes.
   c) Continue to make the sound as you move your hand back towards the ear.
   d) Ask him to tell you when he can hear the sound again.

Sensations:

1) The objective is to evaluate the sense of light touch and make sure it's equal on both sides of the body.
2) Sensations are checked with the diver's eyes closed, pockets empty, and the diver dressed down to light clothing or bare skin.
3) Tell the diver that the light touch should feel normal and the same on both sides of his body.
4) Evaluate the body sections, checking the right and left sides at the same time. Overlap the sections slightly.
5) Run your fingers across the forehead, down the sides of the face and along the jaw line.
6) Then run you fingers down the diver's chest, abdomen, front of arms, legs and across the hands.
7) Turn him around and run your fingers down his back, buttocks, and the backs of the arms and legs.

Muscle Tone:

1) The objective is to evaluate muscle tone and determine that it's equal on both sides of the body.
2) Have the diver bend his arms so that his hands meet in the center of his chest. With his arms bent have him bring his elbows up level with his shoulders (or demonstrate the move and say "Do this").
3) Tell him to push against you as you push his elbows up, then down, and pull his hands away from his chest and push them back.
4) To evaluate grip strength in each hand, ask him to squeeze two of your fingers.
5) Leg evaluation: With diver sitting, evaluate both legs. Put you hand on his thigh and ask him to pick the leg up against resistance. Then put your hand under the thigh and ask him to pull down. Put your hands on the front of the lower legs and ask him to push out. Then put your hands behind the legs and ask him to pull back.
6) Leg evaluation: With diver laying, evaluate both legs. Ask him to do a straight leg raise as you lightly push down on the leg. Have him bend the leg up and push against your hand as you hold his foot.
7) Foot evaluation: Have the diver pull his feet up as you push them down and then push against your hands as if pushing on a pedal.

Balance and Coordination:

1) The objective is to make sure that the diver can hold himself upright, move without being off balance and that he has normal hand eye coordination. Protect the diver from falling.
2) Romberg Test: Have the diver stand upright with his eyes closed, feet together and arms outstretched in front of him. Ask him to stand this way for several seconds. Then ask him to walk in place, bringing his knees up. Eyes remained closed.
3) Heel-shin slide: If the diver is laying down, have him place the heel of one foot on the opposite leg, just below the knee. Then have him run the heel down his shin to the ankle. Do both legs.
4) Alternating hand movements: Have the diver alternately touch his index finger to his nose and then to your finger, held about 18" (.5 meters) away from his face. Repeat the movement several times and test both hands.

Vital Signs:

1) The objective is to evaluate the findings in the rapid field neuro exam with the baseline vitals.
2) Blood pressure
3) Pulse
4) Respriations

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