U. S. Coast Guard
Marine Safety Office
Morgan City, LA

Investigative Report

<u>M/V MR FRED Diving Fatality: Mr. Chris Mouritsen</u>

July 6, 2002
Gulf of Mexico
Eugene Island Block 273

USCG MISLE Case Number 1645241

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III. Executive Summary

1. On July 6, 2002, Mr. Chris Mouritsen died while engaged in a commercial diving operation aboard the U. S. Coast Guard inspected vessel M/V MR. FRED in the Gulf of Mexico (Encl # 1, CG-2692 (Rev. 6-87) "Report of Marine Accident, Injury or Death"). The MR. FRED is owned and operated by CalDive/Aquatica out of Lafayette, LA, and was under contract to British Petroleum at the time. The accident occurred while the vessel was anchored in Eugene Island Block 273, at Latitude N28-25.5, LongitudeW91-36.8. Mr. Mouritsen was diving at a depth of 103 feet and breathing surface supplied air. He was using his personal Kirby Morgan Superlite 17B dive helmet in addition to other personal dive gear. He was also wearing a helmet-mounted video camera that recorded both visual images of the work he was performing and audio of his communications with the dive shack aboard the MR. FRED. His assignment was to make a smooth cut around the end of a 36-inch diameter pipe in preparation for the installation of a bell guide.

2. The first portion of the dive went well with nothing unusual to note. Forty-six minutes into the dive Mr. Mouritsen had a minor problem using his helmet mounted headset to communicate with the dive shack. The source of the problem was a loose fitting on his helmet. He adjusted the fitting and was able to communicate with the vessel again.

3. Four minutes and four seconds later, after a total of fifty minutes into his dive, Mr. Mouritsen experienced a sudden and catastrophic loss of breathing air. His last words to the vessel's Rack Operator were, "My air." The vessel immediately put the Standby Diver into the water to assist Mr. Mouritsen. When the Standby Diver descended to Mr. Mouritsen's location he found Mr. Mouritsen unconscious and laying over a cross beam that was attached to the structure at a depth of 107 feet. Mr. Mouritsen's helmet was off of his head and his neck dam was missing. By the time the Standby Diver was able to bring Mr. Mouritsen up to the surface he had been without air for seven minutes.

4. The dive team aboard the MR. FRED immediately began performing CPR on Mr. Mouritsen. They also administered oxygen and placed him in the onboard hyperbaric chamber in an attempt to revive him. They were unable to revive him.

5. A post casualty inspection of Mr. Mouritsen's personal diving gear conducted at the U. S. Navy's Experimental Diving Unit in Panama City, FL found that a foreign object had lodged inside of the regulator in such a fashion as to prevent the flow of air to the diver. This effectively disabled both the surface supplied air and the emergency air supply that Mr. Mouritsen carried with him. The inspection of Mr. Mouritsen's personal dive gear and interviews with crewmembers showed that there were other problems with his gear that likely contributed to the casualty.

6. The dive-support equipment owned by CalDive/Aquatica aboard the MR. FRED was inspected and tested as a part of this investigation. It was found to be operating properly and in accordance with the regulations. The investigation identified some procedural

deficiencies aboard the vessel. Had proper procedures been in place they may have helped identify some of the problems with Mr. Mouritsen's gear prior to the dive.

7. Investigators from the U. S. Coast Guard's Marine Safety Office in Morgan City, LA, conducted a thorough investigation into this incident. As a result of the investigation several recommendations were developed and are included at the end of this report. This report is written to be included in the U. S. Coast Guard's Marine Information for Safety and Law Enforcement (MISLE) system. As a result, the endorsement on the recommendations from the Eighth Coast Guard District and Commandant (G-MOA) will only be found in MISLE. In order to obtain a copy of this report the public should submit a request under the Freedom of Information Act to Commanding Officer (FOIA); U. S. Coast Guard Marine Safety Office; 800 David Drive, Suite 232; Morgan City, LA, 70380.

IV. Findings of Fact

A. Vessel Diving System Details

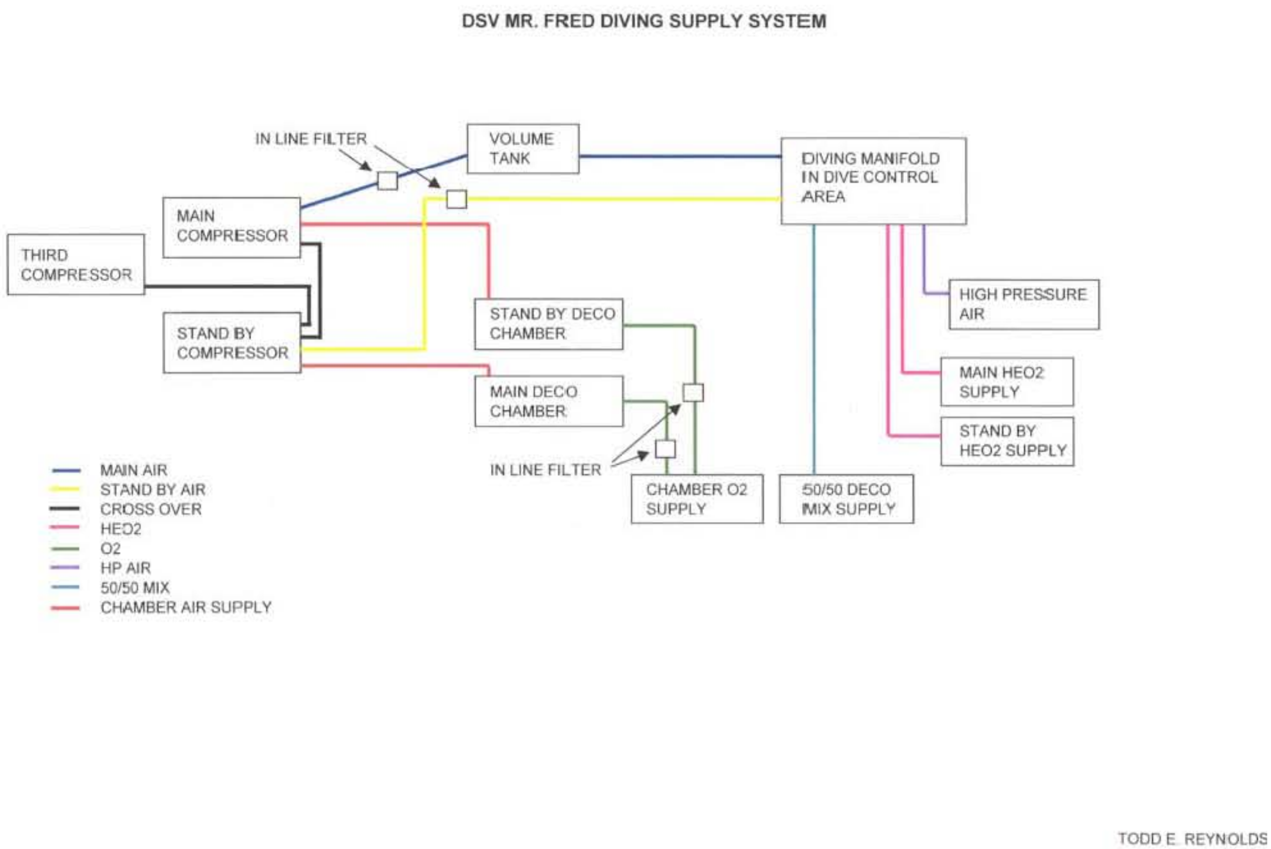
1. The M/V MR. FRED, Official Number 522170, (See Encl # 2, CG-841 (Rev. 4-2000) "Certificate of Inspection") is a 149 Gross Ton, 158 foot long, U. S. flagged Offshore Supply Vessel operated by CalDive/Aquatica Inc., in Lafayette, LA. It holds a U. S. Coast Guard issued Certificate of Inspection authorizing it to carry a total of 36 people including the crew on an Oceans route. It is designed to serve as a Dive Support Vessel.

2. To support diving operations the vessel is equipped with three air compressors, one independent volume tank/air receiver, one dive manifold, three dive umbilicals, and two hyperbaric chambers. In addition it carries one bank of compressed gas cylinders filled with high pressure air, five banks of cylinders filled with a mix of 86% helium and 14% oxygen, and one bank of cylinders filled with a mix of 50% nitrogen and 50% oxygen. All of these systems are integrated at the dive manifold, which is located in the vessel's dive shack. Diagram 1 below, drawn by Mr. [redacted], shows how all the components of the system tie together. The diagram can also be found attached to the "Diver Air Supply System Review" (Encl # 3, Diver Air System Review – M/V MR. FRED (O/N 522170)).

3. Each of the three air compressors can be used to supply air to the Main Diver, the Standby Diver and to the hyperbaric chambers. The compressors are mounted on separate skids and each has its own diesel-powered prime mover. All three are kept on the vessel's aft cargo deck and are referred to as the main compressor, the standby compressor, and the third compressor. There is a crossover hose that connects the third compressor to the standby compressor, and another that connects the standby compressor to the main compressor. Through this interconnectivity of the compressors any one of them can be used to supply air to the diving system.

4. In addition to the crossover hoses that interconnect the compressors, the main compressor has two additional air hoses that tie it into the diving system. The first air hose runs to the "volume tank," which in turns supplies air to the dive manifold. This dive manifold, which is called the "rack" by the crew and is discussed in more detail below, is located in the dive shack where the Dive Supervisor and the Rack Operator are stationed during diving operations. The second hose from the main compressor runs directly to the standby hyperbaric chamber.

Diagram 1: M/V MR. FRED Diving Life Support System Schematic



5. The standby compressor also has two additional air hoses that connect it independently to the diving system. The first hose runs directly to the dive manifold. The second hose runs to the main hyperbaric chamber. The third compressor does not have any hoses that connect it directly to the diving system. It can only feed compressed air to the diving system via the crossover hoses between the other compressors.

6. The system is designed so that any one of the compressors can be used to supply air to any of the listed system components through the crossover air hoses:

- Dive Manifold
- Volume Tank
- Main Hyperbaric Chamber
- Standby Hyperbaric Chamber

During normal diving operations the vessel will have two compressors running. This safety feature is in place so that the second compressor can immediately pick up the entire load in the event of a failure of the first. This setup eliminates the time it would otherwise take to start a second compressor during an emergency. Normally the main and standby compressors are running, and the third compressor is shut down but available as an additional backup.

7. In addition to the compressors, the vessel carries several banks of bottles containing high-pressure (2500psi) gases. One bank of bottles contains compressed air. These bottles are connected directly to the dive manifold and are ready to supply air to the diver should the compressor system completely fail. The vessel has a bank of bottles containing oxygen for use with the hyperbaric chambers. For diver safety reasons primarily related to preventing oxygen toxicity problems, the oxygen bottles are not connected to the dive manifold. The vessel also has five banks of high pressure mixed gas bottles containing 14% oxygen and 86% helium. Two of these banks are independently connected to the dive manifold via separate hoses—the main and standby bank. Lastly, the vessel carries one bank of bottles containing a mixture of 50% oxygen and 50% nitrogen. This bank connects to the dive manifold via an independent line.

8. The dive manifold (Diagram 2, produced by Mr. [redacted], see Encl # 3), or Rack, is a complex control panel that was built by CalDive/Aquatica. The dive manifold is a manually operated system that links the life support systems discussed above to the diver in the water (See Photo 1 below). The dive manifold is designed with multiple and redundant safety features. It receives air and/or mixed gas input from a total of six separate supply lines and can provide life support to three separate divers and air to a pneumofathometer system that is used to gauge the divers' depths (Table 1). The valves that control the air/gas flow are not labeled, but function as indicated below.

Diagram 2: M/V MR. FRED Dive Manifold Schematic

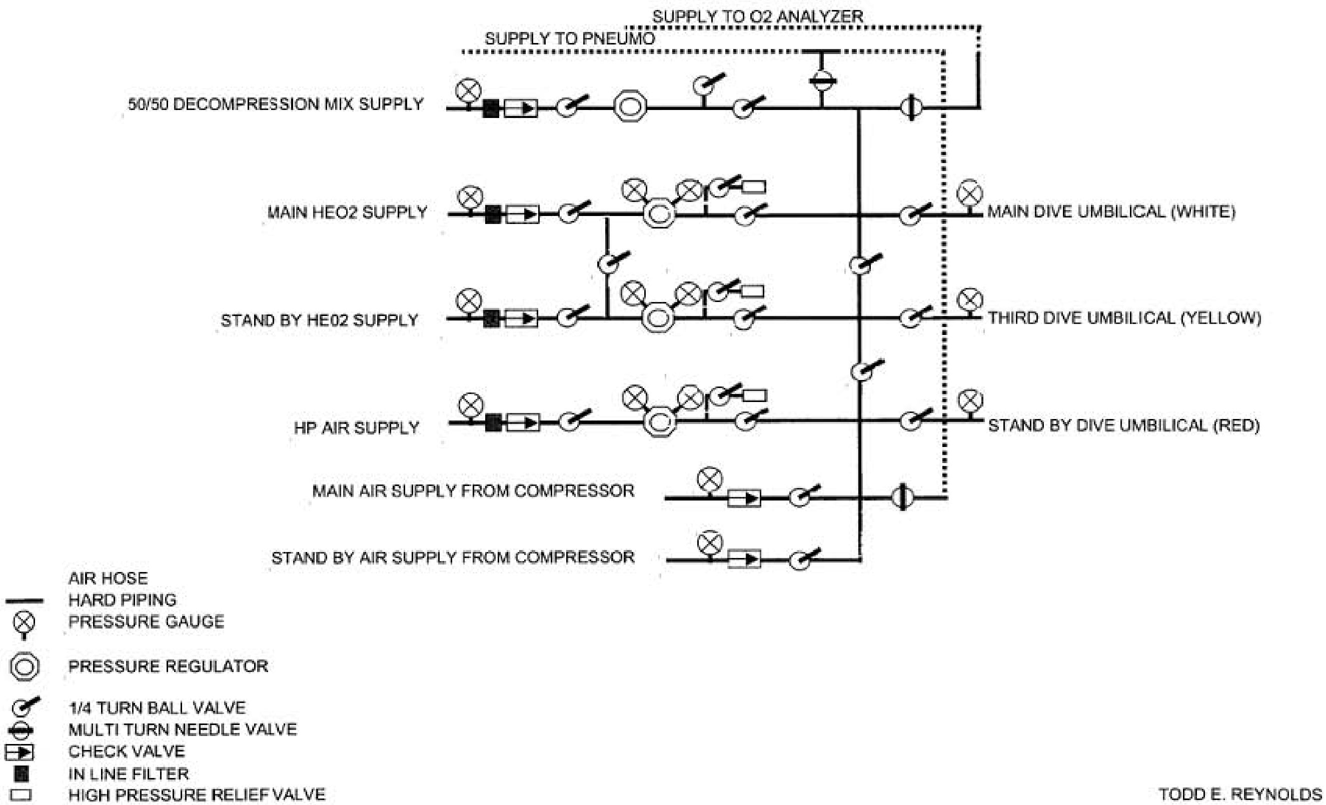


Photo 1 : Dive Manifold / Rack, Located in Dive Shack

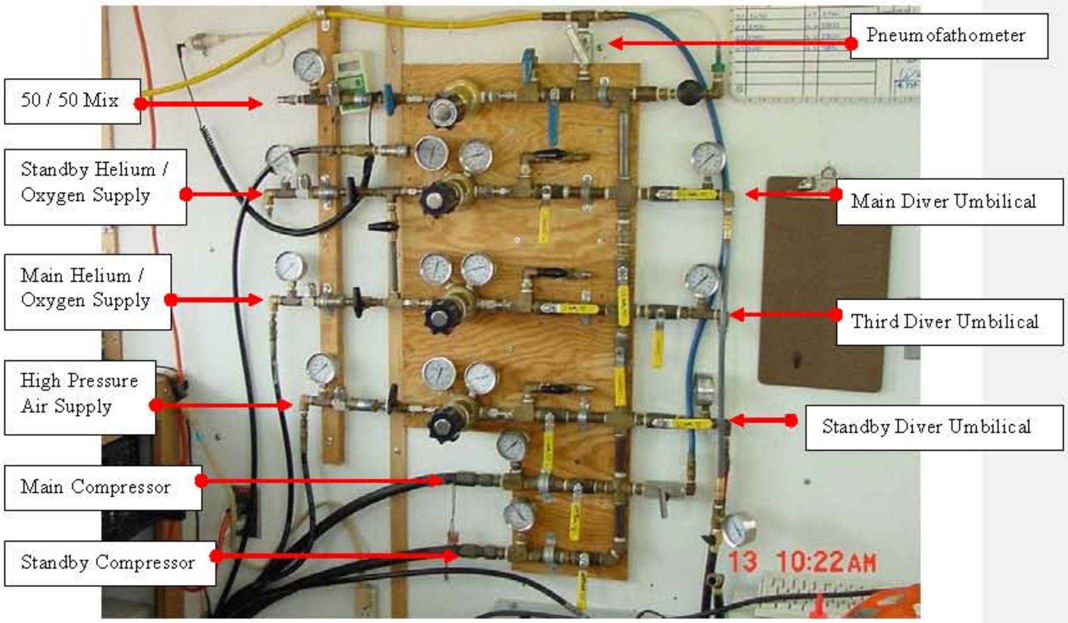


Table 1: Dive Manifold System

Dive Manifold Life Support System	
Inputs	Outputs
1. Main Compressor/Volume Tank	1. Main Diver Umbilical
2. Standby Compressor	2. Standby Diver Umbilical
3. High Pressure Air Supply	3. Third Diver Umbilical
4. Main Helium/Oxygen Supply	4. Pneumofathometer
5. Standby Helium/Oxygen Supply	
6. 50/50 Nitrogen/Oxygen Supply	

9. On the input side of the dive manifold the system has separate connections, control valves, and pressure gauges for each air or gas input. In addition to these controls the High Pressure Air Supply, Main and Standby helium/oxygen Supplies, and the 50/50 nitrogen/oxygen Supply systems each have individual pressure regulators to step down the pressure from 2500psi to a lower pressure. There is also a crossover valve that can be opened to connect the Main and Standby helium/oxygen supply systems.

10. On the output side the dive manifold can provide life support to three divers. Each diver is fed off of a separate umbilical that is independently connected to the system. The dive manifold has separate pressure gauges and flow control valves located where the umbilicals tie into it. This arrangement enables the Rack Operator to monitor the pressure of the air/gas each diver is receiving and to close off those umbilicals that are not in use. There are also crossover valves for isolating the different umbilicals. These crossover valves would be used when more than one diver is in the water and each is breathing from a different supply source. For example, the Main Diver may be breathing mixed gases while the Standby Diver breathes air. The crossover valves allow the Rack Operator to isolate and properly regulate the flow of gas and air to each diver without mixing the two. In the case of Mr. Mouritsen's dive, the crossover valves were open since both he and the Standby Diver were breathing air supplied from the same source.

11. The vessel supplies the divers with the umbilicals that they use. An umbilical consists of a bundle of six items:

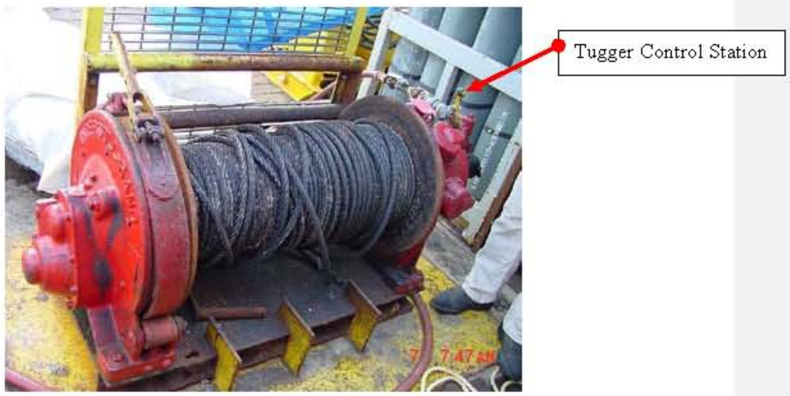
- A safety line
- A cable for the video camera
- A cable for communications
- A hot water hose
- The pneumofathometer
- The breathing air hose.

12. The functions of the safety line, and the cables for the video camera and communication, are self-explanatory. The hot water hose is used to pump hot water from the vessel into the diver's suit in order to maintain the diver's body temperature while in cold water. The pneumofathometer is a small open-ended air hose that the diver usually tucks into his dive harness. The Rack Operator uses it to monitor the diver's depth in the water by charging it with air until bubbles come out at the diver's end. The air supply for the "pneumo" is then turned off and the diver's depth is determined by reading the backpressure of the air as water flows into the open end of the pneumo.

13. The air hose is the main source of breathing air for the diver. It is secured to the diver's harness at the D-Ring and then attaches to the hose adapter on the side of the helmet. Gates Rubber Company manufactured the air hose used by Mr. Mouritsen. It is 600 feet long and has an inside diameter of 3/8 inch. The exterior cover of the hose is manufactured from black neoprene. The interior is reinforced with a braided, high tensile synthetic textile cord. The inner tube is made of black nitrile. According to the manufacturer's website, the hose is designed for "Handling mixtures of oxygen, helium and nitrogen gases customarily used in diving applications as air breathing hose." (See Encl # 4, Gates Breathing Hoses Technical & Application Information). The hose was marked with CalDive/Aquatica number "DH-6047."

14. The tugger (Photo 2) is a wire rope used to pull equipment up from the diver's workstation to the vessel. It is fed onto a winch located on the vessel's aft deck. The controls for the tugger are located at the winch. The Dive Tenders that are on duty normally operate it.

Photo 2: Tugger Winch



B. Personnel Information

1. The Dive Team aboard the MR. FRED during this incident was comprised of 14 members and led by a Dive Superintendent or "Person in Charge." In addition, the team had one Dive Supervisor, eight Divers, and several Dive Tenders. The Divers also filled the position of Rack Operator on a rotational basis when they were not diving.

2. The Person-In-Charge / Dive Superintendent for this voyage was Mr. [redacted]. He graduated from the Diver's Institute of Technology in Seattle, WA, in 1989 and has been in the diving industry since that time. CalDive/Aquatica first hired him in 1990 as a Dive Tender. He worked his way up to Diver, Dive Supervisor, and finally Dive Superintendent. He has been a Dive Superintendent for the last several years. He described the position as being the senior Dive Supervisor. The Superintendent oversees the entire operation including all personnel. The Superintendent is responsible for handling dive equipment and supplies, pre-job planning, anchor positioning and other functions. He also oversees the operation of the dive equipment aboard the vessel including the compressors, volume tanks, dive manifold, and compressed gas bottles. In addition to the above, he handles paperwork, payroll, performs the Job Safety Analysis (JSA's), and ensures that safety meetings are held. He also serves as the point of contact for the company that has contracted CalDive/Aquatica to perform the job at hand. At the time of this casualty the vessel was under contract to British Petroleum (BP). BP's

representative on board the vessel was Mr. [redacted]. (Encl # 5, Follow up interview – [redacted])

3. The Dive Supervisor on duty at the time of this casualty was Mr. [redacted]. He has been in the diving industry since 1993 when he graduated from Young Memorial's commercial dive school in Morgan City, LA. After graduation he worked for D & W Underwater Welding until 1997 when CalDive/Aquatica hired him as a Diver. He was promoted to Dive Supervisor in 2001. According to Mr. [redacted], the Supervisor stands duty in the dive shack and guides and oversees the Diver, Tenders, Rack Operator, and all other operations aboard the vessel that support diving. He maintains communications with the vessel's Master, and ensures that the dive tables are being followed during each dive (Encl # 6, Follow up interview – [redacted]). In addition to the above, CalDive/Aquatica's Diving Safety Manual (Encl # 7, Cal Dive International Diving Safety Manual, p. 18-19) requires the Supervisor to be "in immediate control and available to implement emergency procedures." As a practical matter, the Dive Supervisor typically remains in the vessel's dive shack during diving operations. From this location, he can easily oversee the entire operation. When asked, Mr. [redacted] said that he felt well rested while on duty at the time of the accident and had received eight hours rest on the nights of July 4 and July 5.

4. The Rack Operator on duty at the time of Mr. Mouritsen's dive was Mr. [redacted]. He has been in the diving industry since 1997 when he earned his diploma in diving at the vocational school Ocean Corp in Houston, TX. In January of 1998 CalDive/Aquatica hired him as a Dive Tender. In May of 1999 he was promoted to the position of Diver and has served as a Diver since that time. The Rack Operator is a fully qualified Diver. The role of "Rack Operator" is explained in CalDive/Aquatica's Diving Safety Manual, Appendix 3, Section 1.3.b. Primarily, the Rack Operator operates the "Dive Manifold" or the "Rack" as it is also known. Mr. [redacted] added that the Rack Operator has multiple duties:

- Keeps time for the diver in the water.
- Ensures diver has the proper air supply and the correct air pressure.
- Maintains communications with the diver and guides him throughout the dive.
- Relays orders from the diver to the Dive Tenders and ensures the Tenders comply.
- Completes Dive Sheets for each dive, recording such things as dive times and depths.

Mr. [redacted] indicated that he felt well rested and was not tired while on duty as Rack Operator on July 6, 2002. He received a full night's rest the previous evening and had not gotten out of bed until around 1000 that morning.

5. The Main Diver in the water at the time of this casualty was [redacted]-year-old Mr. Chris Mouritsen of Carencro, LA. He graduated from Diver's Institute of Technology in

Seattle, WA on August 31, 1990 as the number one student in his class. He was certified in First Aid/CPR, Rigging, Hat Repair including the Kirby Morgan SuperLite 17, Job Safety Analysis, Commercial Diving, and SCUBA Diving (Encl # 8, Transcripts from Diver's Institute of Technology). He was a highly experienced diver who had worked in the diving industry and for CalDive/Aquatica for twelve years. During this time he gained experience in the underwater installation of a variety of equipment including Risers, Valves, and Anodes to name a few. He also was qualified in dewatering operations, high-pressure pigging, salvage operations, underwater inspections and working on flanges. He had engaged in Mixed Gas Diving, Saturation Diving, Open Bell Diving, and surface Diving from vessels—including Live Boating. He was checked-off as having used a variety of underwater equipment, including saws, waterblasters, gritblasters, flange spreaders, cargo nets and others. (Encl # 9, Diving Experience Checklist – Chris Mouritsen).

6. On January 30, 2002, Mr. Mouritsen completed a physical exam and was found fit to perform the duties of a Diver by a company physician (Encl # 10, Physical Examination – Chris Mouritsen). Over the last eleven years Mr. Mouritsen had undergone ten dive physicals and was found "Fit For Diving" in all but one instance. The only instance where he was not fit occurred in 1992 and that was only due to his weight. Over that same period of time he participated in the company's random drug testing program. The last drug test administered was on January 30, 2002, (Encl # 11, Chemical Test (DOT) – Chris Mouritsen) and the results were [redacted]—as they were in all eighteen tests administered over the course of his employment with CalDive/Aquatica.

7. CalDive/Aquatica requires divers to follow instructions from the Dive Supervisor. They are also to ensure that their diving equipment has been properly maintained, prepared, and tested prior to each dive (See Encl # 7, p. 19). Divers rotate through three positions when out on a job-- Rack Operator, Standby Diver and Main Diver.

8. The Standby Diver on duty during this incident was Mr. [redacted]. Mr. [redacted] has been in the diving industry for 8 years. He graduated from the College of Oceaneering in Wilmington, CA, with a Commercial Diving diploma in September of 1994. After graduation he was hired by Global Industries and worked there as a Dive Tender and a Diver from September of 1994 until 1998. In December of 1998, CalDive/Aquatica hired him as a Diver. In June of 2001, he went to work for Stolt for one year and then returned to CalDive/Aquatica. The Standby Diver is a fully qualified diver that is required to be dressed-out properly and ready to enter the water immediately if needed in order to render assistance to a stricken diver (See Encl # 12, Association of Diving Contractors International – Consensus Standards for Commercial Diving Operations, p 3-14, and Encl # 7, p 19). He is also required to monitor communications between the Main Diver and the Dive Supervisor / Rack Operator as well as the progress being made on the job. Mr. [redacted] added that the Standby Diver is supposed to remain either on deck or in the dive shack while a diver is in the water. Mr. [redacted] was in compliance with all of these standards. At the time of the casualty he was in the dive shack, wearing his dive harness over his tee shirt and jeans, and was ready to enter the water immediately if needed. His helmet was pre-positioned on deck, already hooked up

to the Standby Diver's umbilical, and charged with breathing air at 200psi from the same air supply source that Mr. Mouritsen was breathing.

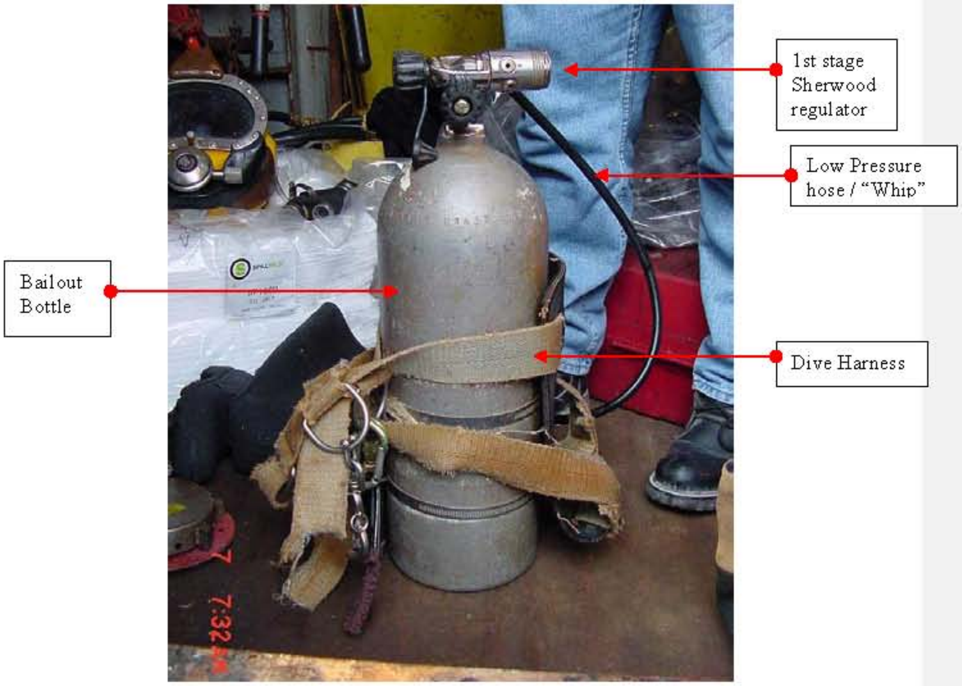
9. The Dive Tender is the entry-level position on the Dive Team and normally has the least experience. CalDive/Aquatica requires Tenders to have completed a formal course of study that provides them with the minimum qualifications in diving proficiency, technical proficiency, and experience. This is usually accomplished by attending a commercial dive school. Tenders are required by CalDive/Aquatica to assist the Main Diver with putting on dive gear and are to confirm that the diver's equipment is working properly. The Tender is required to continuously tend the diver during the dive and to operate the decompression chamber when that diver enters it. Tenders also serve as Main and Standby Divers when needed. While on deck, they are responsible for operating the tugger. Mr. [redacted], Mr. [redacted], and Mr. [redacted] were the Dive Tenders on duty out on the deck at the time of Mr. Mouritsen's dive. Mr. [redacted] was also on duty as a Diver Tender, but he was assisting another diver in the hyperbaric chamber at the time of the casualty. Mr. [redacted] was the Lead Tender.

C. Description of Personal Diving Gear Utilized by Mr. Mouritsen

1. In addition to using the life support systems carried aboard the MR. FRED, each Diver must provide his own personal diving gear. Primarily this consists of an air tank for carrying an emergency supply of breathing air, a diving helmet, a dive harness, and the low pressure air hose that connects the diver's emergency air supply tank to the dive helmet. Mr. Mouritsen also wore his own dive suit, boots, and gloves. He also was using a CalDive/Aquatica underwater cutting torch and had a CalDive/Aquatica video camera attached to the top of his helmet to record the dive.

2. Mr. Mouritsen's emergency air supply tank was a fifty cubic foot aluminum diving tank that had been refilled with compressed air aboard the MR. FRED that day. Divers frequently refer to this as the "bailout bottle" (see Photo 3 below). Attached to his bottle was a first stage Sherwood regulator. A low-pressure air hose, or "whip," connected the regulator on the bottle to the auxiliary valve on the helmet.

Photo 3: Mr. Mouritsen's "Bailout" Bottle, 1st Stage Sherwood Regulator, and Low Pressure Whip.

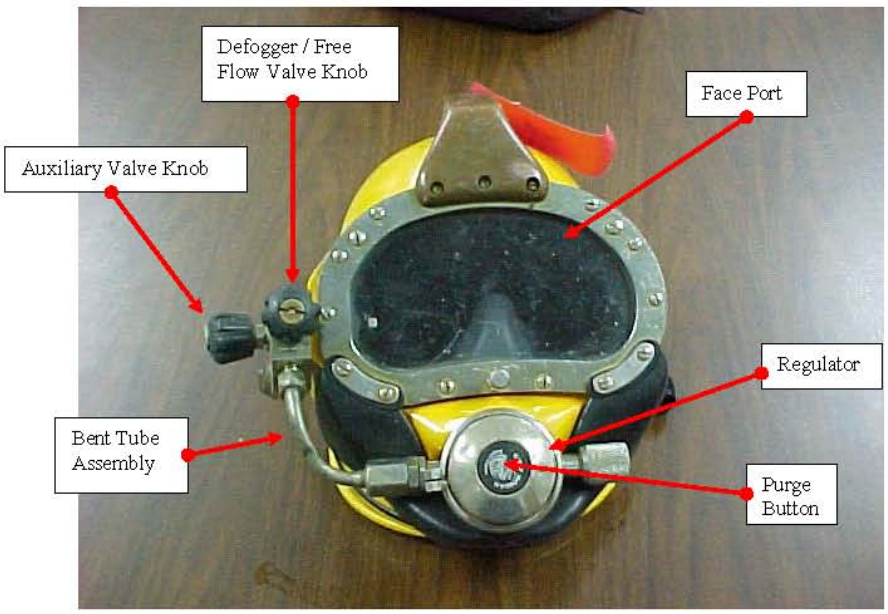


3. Mr. Mouritsen's dive helmet was a Kirby Morgan SuperLite 17B, serial number 19348 (see Photo 4 below). This is the second dive helmet that he has owned. He acquired it new from Jack Vilas & Associates in Morgan City, LA, in June of 1998 as a replacement for one that was lost by Acme Trucking Company while returning from a dive job (Encl # 13, Telephonic interview with [redacted], and Encl # 14, Receipts for the replacement of Chris Mouritsen's Hardhat).

4. The SuperLite 17B is a fiberglass helmet that weighs 29 pounds and comes equipped with a clear polycarbonate face port. It is designed to operate at depths of up to 220 feet. According to the manual Kirby Morgan publishes (Encl # 15, Kirby Morgan SuperLite 17 A/B Diving Helmet), the U. S. Navy's Experimental Diving Unit (EDU) has tested the helmet to a depth of 850 feet and the University of Pennsylvania has tested it to 1,600 feet. The helmet has fittings on its right side for two air hoses: one to provide surface supplied air from the dive support vessel, and one to connect to the emergency air supply/bailout bottle. The Superlite 17B has redundant systems built into it to ensure that breathing air is continuously available to the diver in the event of a single point failure. There are two routes that the helmet uses to deliver air. The first is through the demand regulator, which can be supplied with air "on demand" from the surface through an umbilical and from the emergency air supply/bailout bottle. The second air delivery

route is through the defogger/freeflow valve, which blows a steady stream of air directly into the interior of the helmet. The defogger/freeflow valve can also be fed air from the umbilical and the bailout bottle. These two systems are nearly independent of one another.

Photo 4: Mr. Mouritsen's Superlite 17B helmet, Serial Number 19348



5. Under normal circumstances the diver breathes surface supplied air through the demand regulator using the oral nasal mask inside the helmet. As the diver inhales, an automatic valve in the regulator senses the demand for air and supplies air to the diver. The valve shuts automatically during the exhalation cycle allowing the exhaled air to flow through the oral nasal mask, out the regulator body and the exhaust valve, and into the surrounding water.

6. If air stops flowing through the demand regulator, there are measures the diver can take to restore airflow to the helmet depending on the severity of the problem. If the diver has lost surface supplied air from the dive support vessel, he can breathe from the emergency air supply / bailout bottle by opening the auxiliary valve located on the side of his helmet where the low pressure air hose from the bailout bottle connects. Opening this valve will route air from the bailout bottle to the demand regulator, allowing the diver to breathe normally. If the demand regulator still fails to supply air, the diver can depress the purge button located on the front of the regulator to clear it and restart the "on demand" flow of breathing media. The diver can also hold the purge button down to

receive a steady flow of air rather than an "on demand" feed.

7. If after taking the above steps the diver still cannot breathe through the demand regulator, he can open the defogger/freeflow valve located on the side of the helmet. This valve is designed to blow a steady stream of air directly into the helmet. The air is blown inside of the helmet and onto the face port. Normally it is used to remove condensation that builds up on the face port, but it also serves as an emergency source of breathing air. Once the defogger/freeflow is opened the diver can breathe by simply inhaling the air circulating throughout the interior of the helmet instead of using the demand regulator.

D. Emergency Procedures

1. There are a variety of procedures that have been developed to address diving emergencies. CalDive's Diving Safety Manual (Encl # 7, p. 32, paragraph 9.0) and the Association of Diving Contractor's "Consensus Standards for Commercial Diving Operations" (Encl # 12, p. 3-37) contain nearly identical emergency procedures. The procedures for Loss of Breathing Media, Injured Diver in the Water, and Severance of the Diver's Hose Group are listed below. Some of the steps in these procedures assume that the diver is conscious:

Loss of Breathing Media:

- Activate topside secondary breathing media supply, or
- Diver go on bailout bottle, or
- Put breathing media to Diver's pneumo hose and have Diver insert pneumo hose into helmet/mask.
- If required, send Standby Diver to Diver's assistance

Injured Diver in Water:

- Diver informs topside and dive is aborted.
- Alert Standby Diver.
- Diver determines nature and extent of injury.
- If required, send Standby Diver down to assist Diver, administer first aid, and evaluate injury.
- Standby Diver should remain with Diver.
- Monitor breathing. If breathing stops, activate diver's free flow.
- Standby Diver assists injured Diver to surface, following proper decompression procedures, except when severity of injury indicates a greater risk than omitting decompression.
- Follow appropriate first aid guidelines and request required medical assistance.

Severance of Diver's Hose Group

- Put breathing media to diver's pneumo hose.
- Diver activates bailout bottle.
- Alert Standby Diver
- If required, Diver inserts pneumo hose inside helmet/mask.
- Diver returns to downline.
- If required, send Standby Diver down with additional bailout bottle or hose. If entire umbilical severed on deck and the end of the umbilical is still on deck, send Standby Diver down umbilical with new hose/bailout bottle. Otherwise send Standby Diver down the downline.
- Terminate dive and follow proper decompression procedure

2. Kirby Morgan includes emergency procedures guidance in the Superlite 17 manual (Encl # 15, p. 24-25, section 2.9). In particular, the manual includes guidance on what a diver should do in the event of helmet flooding, inhalation resistance and gas flow stops:

Helmet Flooding

- Put the helmet in an upright position, and
- Activate the defogger/free flow valve, or
- Press the manual purge button on the center of the regulator cover.
- If flooding continues, the dive is to be terminated.

Inhalation Resistance

- Adjust the Regulator Adjustment Knob.
- Press the Purge Button in the Regulator Cover if Problem Continues.
- Open the Defogger/Free flow Valve if above fails.
- Terminate the dive.

Gas Flow Stops

- Open the Auxiliary Valve (Emergency Gas Supply)
- If there is still no flow, Open Defogger/Free Flow valve.
- Terminate the Dive.

3. After explaining the above emergency procedures, Kirby Morgan's manual contains a warning:

"Danger: Ditching the helmet under water must be avoided. If the diver ditches the helmet underwater, he will not be able to see. In many instances, even if the air supply is interrupted, topside will be able to get it back on line quickly. Do not ditch the helmet under water unless you are completely out of breathing gas and it is impossible to return to the surface due to entanglement of your equipment or similar circumstances."

4. In general, various divers interviewed during the course of this investigation confirmed the procedures described above.

E. Sequence of Events Leading to Fatal Dive Accident

1. CalDive was contracted by British Petroleum to work on a subsea pipeline at Eugene Island Block 273, latitude N28-25.5 and longitude W091-36.8, in the Gulf of Mexico. The job was divided into two phases, each requiring several dives. The first phase of the job required the divers to locate the buried 12-inch pipeline by surveying the seabed in approximately 200 feet of water. After finding the pipeline, they were to use low-pressure waterjets to remove the mud that was surrounding it and then mark it with sonar reflectors. They were also to mark any "can holes" in the area with sonar reflectors. Can holes are indentations in the seabed left behind by the legs of platforms that had previously been stationed there. The second phase of the job required the divers to install a conductor guide jumper inside of an existing bellguide at the same location as the subsea pipeline. The existing conductor was at a depth of 103 feet, about 100 feet above the seabed, and was supported by a structure.

2. At 1430 on July 4, 2002, Mr. [redacted], the Person-In-Charge of the diving operations or "Dive Superintendent" for this voyage, boarded the MR. FRED while it was at the Tesoro dock in Fourchon, LA. That afternoon Mr. [redacted] inspected the dive equipment aboard the MR. FRED and ran the vessel's compressors to ensure they were functioning properly. All of the gear tested satisfactorily. (Encl # 16, Cal Dive/Aquatica Daily Reports dated 7/4/02) The MR. FRED got underway at 0015 hours on July 5, 2002 after the rest of the dive team had reported aboard, and arrived at Eugene Island Block 273 at 1000 hours on the morning of July 5, 2002. They picked up BP's representative, Mr. [redacted] after arrival (Encl # 17, Bridge Logs – M/V MR. FRED).

3. Mr. [redacted] had the Master bring place the vessel on the southeast side of the platform where, between 1100 and 1200, the vessel moored for the first phase of diving operations. The vessel set one anchor and ran a spring line to the structure. The vessel remained in this configuration until completion of phase one. Mr. [redacted] then completed a Job Safety Analysis (Encl # 18, Cal Dive International – Job Safety Analysis) for the work they were to perform. Each phase of the job required the vessel to be moored in a slightly different position.

4. Since Mr. Mouritsen dived during phase one, that operation was evaluated to determine whether or not it might have had a causal effect on the fatal accident that occurred during his phase two dive. All of the dives listed in this report are numbered sequentially and are referred to in the numeric order in which they occurred. Phase one of the job encompassed dives numbered one through seven, and phase two encompassed dives numbered eight through eleven. Mr. Mouritsen's fatal accident occurred during phase two of the operation on dive number eleven.

<u>July 5, 2002: Phase One of Job</u>

5. Phase one of the job was worked on from 1226 on July 5, 2002 until 0822 the next morning when the last diver surfaced. All seven of the dives were conducted with the divers breathing a mixture of 14% oxygen and 86% helium due to the depths involved as detailed in Table 2 below (See Encl # 19, Aquatica – Dive Sheets Numbers 1-7):

Table 2: Phase One Dive Results

Dive No.	Diver Name	Time Left Surface	Time Reached Surface	Total Bottom Time	Dive Depth	Decomp in Water	Decomp in Chamber	Gas/Air Breathed
1	[redacted]	1226	1507	54 min	197 feet	91 min	165 min	14% O2 86% He
2	Mouritsen	1528	1812	56 min	197 feet	91 min	165 min	14% O2 86% He
3	[redacted]	1826	2106	54 min	197 feet	91 min	165 min	14% O2 86% He
4	[redacted]	2128	2348	43 min	207 feet	80 min	155 min	14% O2 86% He
5	[redacted]	0010	0232	46 min	202 feet	80 min	155 min	14% O2 86% He
6	[redacted]	0247	0530	54 min	190 feet	91 min	165 min	14% O2 86% He
7	[redacted]	0601	0822	46 min	200 feet	80 min	155 min	14% O2 86% He

6. Mr. [redacted] was the first diver to enter the water during phase one, and Mr. Mouritsen was the second. Mr. [redacted] probed the bottom and located the twelve-inch pipeline that they needed to work on. During the next dive Mr. Mouritsen jetted the mud and sediment away from the twelve-inch pipeline out to a distance of 150 feet from the platform. Mr. Mouritsen worked at a depth of 197 feet and his bottom time totaled fifty-six minutes. While coming back up to the surface, he decompressed in the water at various depths for ninety-one minutes. Following his time in the water decompressing, he spent another 165 minutes decompressing in the hyperbaric chamber aboard the MR. FRED. Mr. Mouritsen's decompression times and depths are listed in Table 3 below.

The table shows under the column headed "In Water" that he made ten stops on the way up to the surface and decompressed for a total of ninety-one minutes at these stops. His total ascent time, however, was 101 minutes because it took a total of ten minutes for him to move from one stop to the next. Time spent moving between decompression stops is not included in the total decompression time.

7. Appendix 2 of the CalDive/Aquatica Diving Safety Manual (Encl # 7) specifies the use of the "200 – Surface Mixed Gas Decompression Table" for the dive Mr. Mouritsen completed. Mr. Mouritsen had a bottom time of 56 minutes and was at a depth of 197 feet. For safety purposes, when his decompression schedule was computed his bottom time was rounded up to 60 minutes and his depth rounded up to 200 feet. The in water decompression times and depths used during his ascent are in conformity with the times and depths required in the decompression table for a bottom time of 60 minutes at 200 feet of seawater.

Table 3 : Mr. Mouritsen's Decompression Schedule / July 5, 2002 Dive

Depth of Stop	In Water		Hyperbaric Chamber	
	Time	Breathing	Time	Breathing
140 Feet	5 Minutes	Air		
120 Feet	4 Minutes			
110 Feet	4 Minutes			
100 Feet	3 Minutes			
90 Feet	8 Minutes	50% O2 / 50% N2		
80 Feet	8 Minutes			
70 Feet	10 Minutes			
60 Feet	11 Minutes			
50 Feet	12 Minutes		15 Minutes	100% O2
50 – 40 Feet			10 Minutes	100% O2
40 Feet	26 Minutes		130 Minutes	Alternate O2 & Air
40 - 0 Feet		Air	10 Minutes	100% O2
Totals	91 Minutes		165 Minutes	

8. The Dive Safety Manual also specifies the amount of time the diver is required to spend in the hyperbaric chamber following a sixty-minute dive to 200 feet. It requires a total of 155 minutes of "chamber time" and an additional ten minutes for the diver to ascend from forty feet to the "surface." According to the manual, "chamber time" starts once the diver reaches a pressure equivalent to a depth of fifty feet. For the first fifteen minutes at fifty feet the diver is required to breathe 100% oxygen. Following that, the pressure is reduced over a period of ten minutes to a depth of forty feet, during which time the diver continues to breathe 100% oxygen. When the pressure is at forty feet, the diver breathes air for five minutes followed by 100% oxygen for twenty-five minutes. The diver alternates between breathing air and oxygen at these intervals until he reaches

the total time required in the chamber. Once the total chamber time is reached, the diver is then brought to the "surface" over a ten-minute period breathing 100% oxygen. The times Mr. Mouritsen spent in the chamber are listed in Table 3 under the column "Hyperbaric Chamber." These times conform to the requirements of the Dive Safety Manual. See Encl # 7 for a copy of "Table 1-26" from the Dive Safety Manual, which specifies the hyperbaric chamber Decompression Schedule. After completion of his decompression regime, Mr. Mouritsen exited the hyperbaric chamber at 2102 on July 5, 2002 and went off duty.

9. After Mr. Mouritsen finished his phase one dive, the other five divers continued the job by setting reflectors on the pipeline and in can holes. Phase one was completed without incident on the morning of July 6, 2002 when the last diver surfaced at 0822.

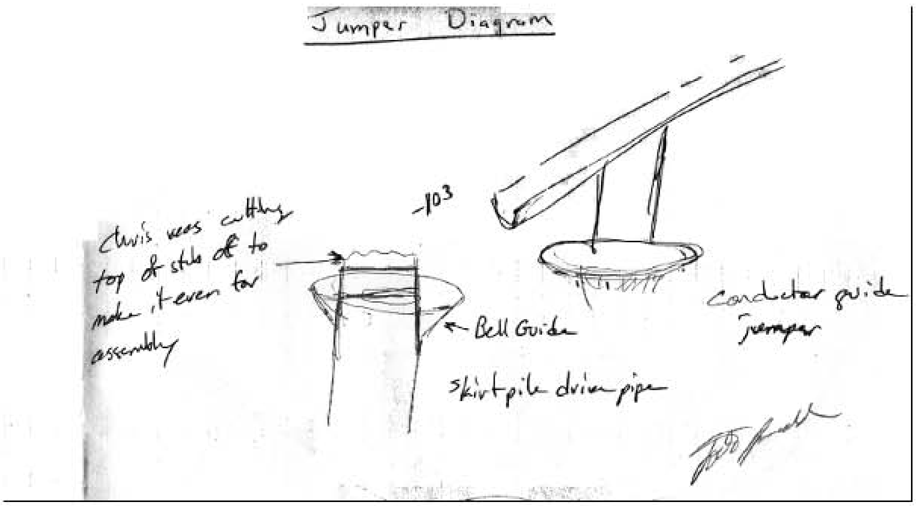
10. The Diving Safety Manual states that the diver must wait eighteen hours after exiting the chamber before diving again because the Decompression Schedule in the 200-Surface table is not designed for use with "Repetitive Dives." Mr. Mouritsen did not dive again until 1954 on July 6, 2002. This gave him a surface interval of twenty-three hours—five hours longer than the required eighteen-hour surface interval. As a result, there were no residual effects from his first dive at the time he began his next and last dive during phase two.

<u>July 6, 2002: Phase Two of Job</u>

11. On the morning of July 6, 2002, Mr. [redacted] directed the Master to move the MR. FRED to the opposite side of the structure in preparation for phase two of the job. Between 0900 and 1300 the vessel picked up its anchor and shifted positions. Mr. [redacted] had the Master run two anchor wires out to be used as spring lines from the stern of the vessel to the structure and set the two bow anchors. The vessel remained moored in this configuration throughout the rest of the job.

12. On the afternoon of July 6, 2002, Mr. [redacted] the BP representative, briefed Mr. [redacted] on the details of phase two of the assignment. Mr. [redacted] instructed him to have his divers cut off the end of an old conductor guide jumper in way of a bell guide where it had previously been removed with a rough edge. They were then to weld a new section of conductor guide jumper to the bell guide. The purpose of the jumper was to deflect a pipe that would be installed at a later date in order to prevent the new pipe from coming into contact with other pipes in the area. See Diagram 3 below drawn by Mr. [redacted].

Diagram 3 : Sketch of Conductor Guide Jumper and Bell Guide



13. After receiving the details on phase two of the job from Mr. [redacted], Mr. [redacted] developed a schedule of dive rotations. He then held a meeting with the divers and briefed them on the job. The dive rotation he developed was based on his estimate of the number of dives that it would take to complete the job. He assigned each of the divers different tasks (see Encl # 19, Aquatica – Dive Sheets Numbers 8-12, "Notes" sections). Mr. [redacted] would make the eighth dive of the voyage, which would be the first dive focused on phase two of the job. During his forty-six minutes on the bottom, Mr. [redacted] located the bell guide to be worked on, rigged the down line and tugger, and set up other equipment that would be used on the job. On the ninth dive of the voyage Mr. Hoyt videotaped the conductor, bell guide, and thirty-six inch pipeline that they were going to work on. The tenth diver was Mr. [redacted]. He was tasked with cleaning off the conductor and preparing the surface to be cut. Mr. Mouritsen was the eleventh diver to enter the water on this voyage. His job was to burn off the rough end of the conductor, leaving a smooth edge. The accident occurred before Mr. Mouritsen completed this task. The twelfth diver that had been scheduled to work on the project was Mr. [redacted]. His planned task was to weld the new conductor guide jumper to the bell guide. Instead of performing this task, he was sent into the water in an attempt to rescue Mr. Mouritsen. Additional divers would have been sent into the water to complete the job as needed had the accident not occurred.

14. The rotation Mr. [redacted] designed follows a standard sequence. Each diver rotates through the positions of Rack Operator, Standby Diver, and Main Diver. The rotation

schedule that was in effect for phase two of the job on July 6 is listed below in Table 4 (Encl # 5 and Encl # 19 Dive Sheets Numbers 8-12):

Table 4: Phase Two Diver Position Rotations

Diver's Name	*8th Dive*	*9th Dive*	*10th Dive*	*11th Dive*	*12th Dive*	*13th Dive*	*14th Dive*
Diver # 8 ([redacted])	Main Diver						
Diver # 9 (*Mr.* [redacted])	Tender	Main Diver					
Diver # 10 ([redacted])	Rack Op	Standby Diver	Main Diver				
Diver # 11 (*Chris Mouritsen*)		Rack Op	Standby Diver	Main Diver			
Diver # 12 ([redacted])			Rack Op	Standby Diver	Main Diver		
Diver # 13 ([redacted])				Rack Op	Standby Diver	Main Diver	
Diver # 14 ([redacted])	Standby Diver				Rack Op	Standby Diver	Main Diver

15. All of the divers during phase two breathed surface supplied air rather than mixed gas because the maximum depth was only 117 feet. Documentation for dives number eight and ten (Encl # 19, Dive Sheets Numbers 8 -10), however, have erroneous information on them that indicates Mr. [redacted] and Mr. [redacted] may have been breathing a mixture of oxygen and helium. Under the heading "breathing mix" on both dive sheets the Rack Operators erroneously recorded 86% helium and 14% oxygen. On those same two dive sheets, however, the Rack Operators entered an "N/A" and a slash mark where the time the divers started breathing mixed gases is logged. Despite the erroneous information on the dive sheets, all of the phase two dives were completed with the divers breathing only air. Mr. Mouritsen was the Rack Operator for dive number nine and he correctly listed that Mr. [redacted] was breathing low-pressure air. The Rack Operator on Duty when Mr. Mouritsen was diving, Mr. [redacted] correctly indicated on dive sheet number eleven that Mr. Mouritsen was breathing air. During his interview, Mr. [redacted] confirmed that he was breathing air.

16. Phase two of the job was worked on between 1354 and 2051 on July 6, 2002. The work stopped when Mr. Mouritsen's fatal accident occurred. A total of five dives were completed (See Encl # 19, Dive Sheets Numbers 8-12). Table 5 below lists the results of the dives for phase two of the operation—they are dive numbers eight through twelve. The hyperbaric chamber decompression times for these air dives are in conformance with U. S. Navy Dive Tables 1-10 and 1-26 as contained in the CalDive/Aquatica Diving Safety Manual, Appendix One, Section Three (Encl # 7):

Table 5: Phase Two Dive Results

Dive No.	Diver Name	Time Left Surface	Time Reached Surface	Total Bottom Time	Dive Depth	Decomp in Water	Decomp in Chamber	Gas/Air Breathed
8	[redacted]	1354	1445	46 min	117 feet	0 min	72 min	Air
9	[redacted]	1539	1631	48 min	104 feet	0 min	65 min	Air
10	[redacted]	1829	1938	65 min	107 feet	0 min	75 min	Air
11	Mouritsen	1954	2047*	53 min	107 feet	N/A	2111 (7/6)-1251 (7/7)	Air
12	[redacted]	2044	2050*	5 min	107 feet	N/A	N/A	Air

* Mr. [redacted] surfaced at the same time as Mr. Mouritsen, but the dive sheets record two different times. This is because Mr. [redacted] recorded the time Mr. Mouritsen was taken out of the water using his timepiece in the Dive Shack and then went out on deck to assist. When Mr. [redacted] got out of the water, Mr. [redacted] did not immediately record the time. He later filled in that portion of Mr. [redacted] Dive Sheet based on the time recorded on the videotape, which was a few minutes faster than the clock at the Rack Operator's station.

17. Mr. [redacted] was one of the Dive Tenders on duty that afternoon. He said that shortly before Mr. [redacted] authorized the dive team to start the job, he checked the status of the air in Mr. Mouritsen's bailout bottle. He found the bottle contained less than the minimum required 2,300psi of air, so he filled it using the bank of high pressure air cylinders aboard the vessel as was standard practice. After filling the bottle, he brought it out onto the deck in anticipation of Mr. Mouritsen's upcoming dive.

18. [redacted] was the tenth diver to enter the water on this voyage. Mr. [redacted] served as the Dive Supervisor at the beginning of the dive. He was relieved by Mr. [redacted] at 1900 and retired to his stateroom where he remained until the accident happened. Mr. [redacted] continued on duty in the position of Dive Supervisor for the remainder of Mr. [redacted] dive and for Mr. Mouritsen's dive. There were a total of eight members of the dive team on duty when Mr. Mouritsen initiated his fatal dive:

Dive Supervisor:	[redacted]
Rack Operator:	[redacted]
Main Diver:	Chris Mouritsen
Standby Diver:	[redacted]
Lead Dive Tender:	[redacted]
Dive Tender:	[redacted]
Dive Tender:	[redacted]
Dive Tender:	[redacted]

19. Mr. Mouritsen served as Mr. [redacted] Standby Diver, and [redacted] served as his Dive Tender. Mr. Mouritsen's helmet was connected to the Standby Diver's umbilical and sitting out on deck as was standard practice. In his interview, Mr. [redacted] said that during his dive he noted that the tugger had been routed so that it crossed over the top of one of the horizontal supports to the structure they were working on. He rerouted it so that it ran underneath the horizontal support, placing it in a better position for Mr. Mouritsen to use. (Encl # 20, Follow up interview – [redacted]). He added that the lines running from the surface to the equipment they were using at depth were all slack. They were kept slack in order to prevent them from tangling or being pinched. The lines that were slack included the tugger, the cutting torch, and the grounding cable. Mr. [redacted] surfaced at 1938, after a total bottom time of sixty-five minutes (Encl # 19, Dive Sheet Number 10) and entered the hyperbaric chamber.

<u>Mr. Mouritsen's Fatal Dive Accident</u>

20. Mr. Mouritsen was Main Diver number eleven in the rotation. The Standby Diver and the Dive Tenders are responsible for helping the Main Diver suit up and enter the water. This practice is done to provide assistance to the Main Diver and to verify that he has checked his gear. Mr. [redacted], the Standby Diver, Mr. [redacted], the Lead Dive Tender, and Mr. [redacted], a Dive Tender, all assisted Mr. Mouritsen. Their observations of the tests Mr. Mouritsen performed on his personal gear are discussed below.

21. Since Mr. Mouritsen had served as the Standby Diver for the previous dive, his helmet was still on the Standby Diver's umbilical and had to be moved over to the Main Diver's umbilical. Mr. [redacted] shifted Mr. Mouritsen's helmet to the Main Diver's umbilical and specifically recalls securely attaching the air hose to Mr. Mouritsen's helmet using an 11/16th-inch wrench. He also connected the communication wires to Mr. Mouritsen's helmet and made sure they were secure. He then put his own head into the helmet to test its communications with the dive shack. The communications tested fine. He did not open the helmet's defogger/freeflow valve to test it, nor did he depress the purge button on the helmet's demand regulator. He is not required to perform either of these tests by CalDive/Aquatica. Mr. [redacted] and Mr. [redacted] also put Mr. [redacted] helmet on the Standby Diver's umbilical. After the helmets were attached and the fittings were checked, the Rack Operator, Mr. [redacted] charged the air hoses for both umbilicals to 200psi from the vessel's air supply system. Throughout the entire dive, the Standby Diver's umbilical was left charged with air and ready for immediate use in the event of an emergency. This is standard procedure aboard the MR. FRED.

22. Mr. [redacted] stated that he checked the integrity of the seal between Mr. Mouritsen's helmet and neck dam after Mr. Mouritsen had put his helmet on, verified that Mr. Mouritsen had good communications with the dive shack, and inspected Mr. Mouritsen's bailout whip (Encl # 21, Follow up interview – [redacted]). He did not identify any problems with Mr. Mouritsen's equipment, but did note that the rubber outer jacket on the bailout whip was coming off. He advised Mr. Mouritsen of the damage. Mr. Mouritsen stated that he knew about it and that it was okay. After the casualty Mr.

Mouritsen's personal belongings aboard the vessel were inventoried, and it was noted that he had a new bailout whip in his stateroom (Encl # 22, Personal Belongings Inventory – Chris Mouritsen). Mr. [redacted] then watched as Mr. Mouritsen successfully tested the emergency air supply by opening the valve on the bailout bottle and the auxiliary valve on the helmet. When asked during his interview, he said that Mr. Mouritsen would normally open the defogger/freeflow valve to let air free flow into the helmet prior to a dive, but that he did not see Mr. Mouritsen do it on this dive. Kirby Morgan, the manufacturer of the dive helmet, requires the diver to open the valve in order to prevent the exhalation ports from reversing and allowing water to enter the helmet when the diver enters the water. The manual also recommends testing the purge button on the outside of the demand regulator (See Encl # 15, p.22 - 24). Mr. [redacted] did not report seeing Mr. Mouritsen test the purge button either.

23. The Lead Dive Tender, Mr. [redacted], was also present as Mr. [redacted] assisted Mr. Mouritsen. Mr. [redacted] said that he has helped or witnessed hundreds of divers don their helmets. He watched Mr. Mouritsen put on his helmet and saw that it was properly mounted on the neck dam. (Encl # 23, Follow up interview – [redacted]). The connection between the "rear hinge tab" on the helmet and the "alignment sleeve" on the neck dam was secure. (Encl # 24, Exploding Diagram – SuperLite 17 A/B Helmet).

24. Mr. [redacted] believes that he saw Mr. Mouritsen successfully test the auxiliary valve on the helmet. He did not, however, see Mr. Mouritsen test the helmet's defogger/freeflow valve. Mr. [redacted] overheard Mr. [redacted] tell Mr. Mouritsen that the whip from Mr. Mouritsen's bailout bottle was "bulging" and heard Mr. Mouritsen respond that he had another whip in his room. Mr. Mouritsen did not replace the damaged whip prior to the dive.

25. Mr. [redacted] added that Mr. Mouritsen's bailout bottle had a leak in it and that it had been leaking for at least 6 months prior to this dive. He said that Mr. Mouritsen was aware that the bottle had been leaking continually. The bottle would lose about 200psi of air per day. Mr. [redacted] said that the Tenders always had to refill Mr. Mouritsen's bailout bottle.

26. Mr. [redacted] was present as Mr. Mouritsen put on his bailout bottle, helmet and gloves. He said that the neck dam and the helmet appeared to be properly sealed with the O – Ring covered. Mr. [redacted] also confirmed that the "rear hinge tab" on the helmet and the "alignment sleeve" on the neck dam were properly connected. After Mr. Mouritsen put on the helmet, Mr. [redacted] saw that Mr. Mouritsen was able to breathe normally through the umbilical and regulator. He watched as Mr. Mouritsen connected the whip from the bailout bottle to the helmet. He also saw Mr. Mouritsen open the valve on the bailout bottle and the helmet's auxiliary valve to verify that the bailout system was working properly. When asked, Mr. [redacted] said that he did not see Mr. Mouritsen test the defogger/freeflow valve on the helmet. He did not see Mr. Mouritsen depress the purge button on the front of the demand regulator. 46 CFR 197.346(d) requires that the diver must have "a weight assembly capable of quick release." Mr. Mouritsen did have a weight belt capable of quick release, but told Mr. [redacted] said that he was not going to use

it on this dive. He did not offer an explanation for this decision to Mr. [redacted] (Encl # 25, Follow up interview [redacted]).

27. Mr. Mouritsen entered the water and began his dive at 1954 on July 6, 2002 (Encl # 19, Dive Sheet Number 11). On deck the main and standby compressors were both running. The main compressor was feeding air to the volume tank, the volume tank was lined up to supply air to the dive manifold, and the dive manifold was lined up to supply breathing air to Mr. Mouritsen at 200psi. The standby compressor was also ready to feed air directly to the dive manifold if needed. Its supply valve on the manifold was closed, but could easily be opened in an emergency. The positions of the valves and the readings of the pressure gauges on the dive manifold were as indicated in Table 6. Based on the design of this vessel's air supply system, everything was lined up and functioning normally and as designed.

28. In the dive shack Mr. [redacted] was serving as Dive Supervisor, and Mr. [redacted] was serving as Rack Operator. Out on deck Mr. [redacted] was serving as Lead Tender, Mr. [redacted] was the Dive Tender assigned to Mr. Mouritsen, and Mr. [redacted] was assisting. Mr. [redacted] was on duty as Standby Diver and was out on deck at the time Mr. Mouritsen entered the water, but went up to the dive shack to monitor the dive afterwards. The manning of the Dive Team was in compliance with ADC standards (see Conclusion # 31 of this report). Mr. Mouritsen was breathing normally and descended to a depth of 103 feet where he began cutting off the top of the old conductor guide jumper, as was his assignment. The helmet-mounted video camera was not turned on until after he started cutting the old conductor jumper off of the pipe.

Table 6: Dive Manifold Status at Start of Mr. Mouritsen's Last Dive

Valve/Gauge	Valve Position	Gauge Pressure
Main Compressor/Volume Tank	Open	200psi (upstream of valve)
Standby Compressor	Closed	200psi (upstream of valve)
High Pressure Air Supply	Press Regulator: Open	150-200psi
	Downstream Valve: Closed	N/A
Main Helium/Oxygen Supply	Closed	0psi
Standby Helium/Oxygen Supply	Closed	0psi
50/50 Oxygen/Nitrogen Supply	Hose Disconnected	Hose Disconnected
Main Diver Umbilical	Open	200psi
Standby Diver Umbilical	Open	200psi
Third Diver Umbilical	Closed	0psi
Crossover Valves	Both Open	N/A

29. The clock in the video camera mounted on Mr. Mouritsen's helmet displayed the time in the upper left corner of the video screen using hours, minutes, and seconds. There was a problem with the clock, however, because it recorded two separate minutes as 20:37:00 – 20:37:59 and two separate minutes as 20:48:00 – 20:48:59. The videotape successfully recorded both audio and images continuously after it was turned on, but after completing each of these two minutes the camera's clock backed up one minute and recorded the same minute a second time. Events of both the first minutes and the second minutes are on the video and documented in the Video Transcript (Encl # 26, Transcript of Videotape of Dive Incident). In order to accurately track elapsed time, all times referenced in this report will use the corrected time the clock would have shown had it not reset itself for each of those two minutes. The video transcript lists both the uncorrected time from the video camera's time display and the corrected time accounting for the clock errors. *(Investigator's note: The purpose of using only corrected time in this report is to accurately reflect elapsed time during the incident. Use of uncorrected time would result in a disjointed accounting of events. In order to see the uncorrected times, refer to the Video Transcript.)*

30. The image quality on the videotape is acceptable, but portions of the audio are hard to decipher. There are many instances where comments made by the diver and the Rack Operator are garbled. A copy of the videotape was sent to the Louisiana State Police's (LSP) Technical Services Division in an attempt to improve the audio. LSP reported that the background noises on the videotape were across the entire bandwidth of sound and could not be filtered out without reducing all sounds across the entire recorded spectrum. They improved the videotape where they were able, but the quality of the audio portion remained essentially unchanged.

31. When the camera was first turned on the clock on the videotape recorded the time as 20:08:00. From the beginning of the videotape until time 20:39:56, Mr. Mouritsen can be seen performing the tasks associated with the dive in a normal fashion. At 20:39:56 he picked up the end of the tugger, which was tied off a few feet away from his workstation, and began to reposition it. He also made a statement that was not clearly recorded on the videotape. Four seconds later, at minute 20:40:00, the Rack Operator, Mr. [redacted] said, "Your comms just, now you sound like you are talking with an echo" (Encl # 26, p. 3). Mr. [redacted] then asked Mr. Mouritsen to check the communications wiring on the side of his helmet because Mr. Mouritsen sounded "real distant." Mr. Mouritsen checked the wiring connections and found that they were loose. He reported that they were, "Just about all the way out." He adjusted them, and communications were satisfactorily restored by 20:40:47.

32. Mr. Mouritsen started working with the tugger at 20:39:56 and continued to do so until 20:44:11, when he first said "My air." Prior to handling the tugger his movements remained relatively small and localized because he had stayed in one position while working on the conductor guide jumper. As soon as he began handling the tugger his movements became significantly more animated. This was due to the change in tasks he was performing. His work with the tugger involved disconnecting it from where it had been tied off and then attaching it to the jumper. The tugger was going to be used to hoist

the old section of guide jumper up to the vessel. The casualty occurred before he could complete this task.

33. Between 20:41:20 and 20:42:33 Mr. Mouritsen attached a shackle to the end of the tugger and used his knife to cut the first of two lines securing the tugger to the anode it had been tied off on. Starting at 20:42:33 and continuing for the next forty-nine seconds a high-pitched whistling is heard on the videotape. This whistling is the sound of air flowing through the defogger/freeflow valve on Mr. Mouritsen's helmet.

34. At 20:43:02 Mr. Mouritsen said, "You coming up on some of that tugger slack?" This was the first time Mr. Mouritsen discussed movement of the tugger. Mr. [redacted] understood Mr. Mouritsen's statement as an order to come up on the tugger and responded, "Roger that…coming up on tugger slack." Mr. [redacted] later told Investigators that he relayed this order to the three Tenders on deck (Encl # 27, Follow up interview – [redacted]); Mr. [redacted], Mr [redacted], and Mr. [redacted] carried out the orders. All said that the order was to come up on the tugger (See Encl # 28, Initial Statement – [redacted], Encl # 25, Follow up interview – [redacted] and Encl # 29, Follow up interview – [redacted]). The Tenders were at the stern of the vessel and away from the tugger's winch at the time, so it took thirty to forty-five seconds for them to get into position to carry out the order.

35. The tugger was laid out so that it ran down the center of the vessel's deck, over the stern, and into the water (See Encl # 23). Mr. Mouritsen's umbilical ran a parallel path down the starboard side of the deck, over the stern, and into the water. A distance of about ten feet separated the tugger and the umbilical. Mr. [redacted], the Dive Tender assigned to Mr. Mouritsen, said that he could see the tugger and umbilical as they descended into the water and that they were both clear of each other. When Mr. [redacted] gave the first order to come up on the tugger, Mr. [redacted] was closest to the tugger's winch, so he went over to the controls to operate it. Mr. [redacted] picked up Mr. Mouritsen's umbilical and held it to ensure it remained clear of the moving tugger. Mr. [redacted] said that the umbilical did not get entangled with the tugger at any time (Encl # 25).

36. At 20:43:22, as the Tenders were getting ready to carry out the first tugger order, the background whistling sound recorded on the videotape stopped. Mr. Mouritsen pauses momentarily and can be seen reopening his knife. He can clearly be heard breathing normally during this pause and over the next thirty-two seconds.

37. At 20:43:28 Mr. Mouritsen used his knife to cut the second line that was holding the tugger in place. His one-handed attempts to cut the line appear awkward and his other hand cannot be seen in the video. Of interest is that while trying to cut the line, he moves his helmet from looking straight ahead to looking at a steep downward angle and then back up four times in quick succession. The four up and down movements of the helmet take place over a period of nine seconds and stop at 20:43:37.

38. At 20:43:39 Mr. Mouritsen again asked the Rack Operator, “Are you coming up on the tugger?” This was only thirty-seven seconds after giving the first tugger order. Mr. [redacted] responded, “Yeah, we’re working on it. Give us a sec, we’ve got to get some people into position.” Twelve seconds later, in a calm and normal voice Mr. Mouritsen said, “All stop.” Mr. [redacted] relayed the all stop order to the Tenders and told Mr. Mouritsen, “I don’t know if they did anything.”

39. By this time, out on deck, Mr. [redacted] had brought in the tugger a total of three or four feet only. He stopped bringing it in when he heard the “All Stop” order. At 20:43:54 the last sounds of Mr. Mouritsen breathing normally can be heard on the videotape. At 20:43:59 Mr. Mouritsen said, “Slack the tugger, slack the tugger.” Mr. [redacted] can be heard in the background saying to the Tenders, “Go ahead. Slack the tugger off.” Mr. [redacted] slacked the tugger out about twenty feet over a period of five seconds and then stopped.

40. At 20:44:04, twenty-seven seconds after Mr. Mouritsen made the repeated up and down motions with his helmet, the videotape records what sounds like Mr. Mouritsen attempting to inhale without receiving any air from the demand regulator. At 20:44:08, Mr. Mouritsen repeated the order to, “Slack the tugger.” For the first time recorded on the video, stress can be heard in his voice.

41. Then, at 20:44:11 in a highly distressed voice Mr. Mouritsen said, “My air, my air, my air, my air.” Immediately after this, Mr. [redacted] can be heard in the background on the video telling the Tenders, “Slack the tugger. Slack the tugger.” Mr. [redacted] slacked the tugger again for about ten seconds, letting out another twenty feet of cable approximately.

42. Mr. [redacted] said that he checked the dive manifold right away and saw that all of the valves were lined up properly and that the air pressure was correctly reading 200psi. He told Coast Guard Investigators that, except for operating the pneumo, he did not change the positions of any of the valves during Mr. Mouritsen’s dive.

43. Mr. [redacted] and Mr. [redacted] were in the dive shack monitoring the dive at the time. As soon as Mr. Mouritsen said, “My air, my air, my air, my air,” Mr. [redacted], the Dive Supervisor, looked at the dive manifold and saw that the valves were lined up correctly and that the pressure gauges were reading the proper pressures (Encl # 6). In particular, the valve from the main compressor/volume tank was open and its pressure gauge read 200psi as did the two gauges that read the air pressure being supplied to the Main and Standby Divers umbilicals. After Mr. [redacted] verified that nothing was wrong with the dive manifold, he instructed Mr. [redacted] to “charge the pneumo.” He watched as Mr. [redacted] did this, then verified that the valve for the pneumo was all the way open by attempting to turn it himself. He found that it was open.

44. As soon as Mr. Mouritsen made the statement about his air, Mr. [redacted], the Standby Diver, looked at the dive manifold and saw that the air supply gauges for the Main and the Standby Divers’ umbilicals both read 200psi. This indicated that Mr.

Mouritsen's umbilical was receiving the proper amount of air from the dive manifold and so was the Standby Diver's umbilical. Mr. [redacted] who was already wearing his diving harness, immediately went down to the vessel's stern to prepare to enter the water in anticipation that he would be ordered to rescue Mr. Mouritsen. Events transpired so quickly that by the time he reached the bottom of the stairs he heard the command, "Jump the Standby Diver," announced over the loudspeaker.

45. From 20:44:17 until 20:44:27, six seconds after saying "My air," Mr. Mouritsen can be seen grabbing his umbilical two times in a hand-over-hand motion. The audio portion of the videotape records the sounds of his strained attempts to breathe. Mr. Mouritsen again said "My air." While this was happening, Mr. [redacted] can be heard asking, "You alright?" and "Chris?"

46. At 20:44:32 Mr. Mouritsen said, "My air" one more time. These were his last words. The videotape then records the sounds of water flooding into the helmet for seven seconds followed by the visual image of water moving past the camera as the helmet appears to slowly drop several feet. A garbled statement from Mr. [redacted] can be heard.

<u>Rescue and Medical Treatment</u>

47. At 20:44:48 a background voice can be heard on the tape ordering, "Jump the Standby Diver." At 20:45:16 the sound of the Standby Diver breathing though the demand regulator on his helmet can be heard—indicating that Mr. [redacted] was at the stern, had put his helmet on, and was about to enter the water. Six seconds later, the sound of air free flowing into Mr. [redacted] dive helmet could be heard—indicating he was entering the water. A total of sixty-five seconds elapsed between the time Mr. Mouritsen first said "My air, my air, my air, my air" and the time the Standby Diver entered the water.

48. When Mr. [redacted] entered the water, he took hold of Mr. Mouritsen's umbilical and followed it down. At 20:46:49 Mr. [redacted] reached Mr. Mouritsen at a depth of 107 feet. A total of only two minutes and thirty-eight seconds had elapse from the time Mr. Mouritsen first indicated he had a problem with his air. Mr. [redacted] found Mr. Mouritsen unconscious and laying across one of the supports for the structure near where he had been working. His helmet and neck dam were both off of his head. The helmet was still connected to the air hose, which was still attached to the D-Ring on his dive harness. The neck dam was missing. Mr. [redacted] took hold of Mr. Mouritsen, and the Dive Tenders pulled them both up. At 20:51:01 they reached the surface and Mr. Mouritsen was brought aboard the vessel. Six minutes and fifty seconds had elapsed between the time Mr. Mouritsen lost air and the time he reached the surface. The video camera was turned off shortly after Mr. Mouritsen was brought onto the deck, so the times documented after Mr. Mouritsen returned to the vessel are taken from log entries and witness statements.

49. Mr. Mouritsen was unconscious, was not breathing, and did not have a pulse when he was brought aboard the vessel. Mr. [redacted], Mr. [redacted] Mr. [redacted] and the three

tenders helped get Mr. Mouritsen out of the water and onto the aft deck. At that time, Mr. [redacted] ordered the Dive Medical Technicians (DMT) out on deck. Mr. [redacted] and Mr. [redacted] (a certified DMT) disconnected Mr. Mouritsen's umbilical and dive harness. Mr. [redacted] got the medical equipment out and started performing CPR on Mr. Mouritsen with assistance from Mr. [redacted] (DMT) and Mr. [redacted] (Dive Tender). As a part of this procedure, this CPR team placed Mr. Mouritsen on his side to help drain any water out of his lungs. [redacted] assisted the CPR team by cutting Mr. Mouritsen's wet suit off. Mr. [redacted] left the dive shack and came out on deck to assist the DMT's. He monitored Mr. Mouritsen for a pulse, but never detected one.

50. While CPR operations were being conducted, the CPR team used an Oral Phlangal Airway (OPA) to keep Mr. Mouritsen's airway open. There was no medical O_2 apparatus available on board the vessel. Therefore, the CPR team attempted to use an O_2 tank from a nearby acetylene torch in conjunction with the OPA and a bag valve mask to administer the required O_2 (Encl # 30, Follow up interview – [redacted]). Mr. [redacted] contacted CalDive's Safety Representative, [redacted], and vessel project manager, Ed Moorman, for assistance. Mr. [redacted] was instructed to have Mr. Mouritsen placed in the decompression chamber and pressurized to 165 feet (Encl # 31, Initial Statement – [redacted]). The CPR team continued to work on reviving Mr. Mouritsen on deck for approximately 15 minutes. Mr. Mouritsen remained unresponsive.

[redacted]At 2105 Mr. Mouritsen was placed on a stretcher and transferred to the hyperbaric chamber (Encl # 16, dated 7/6/02). Mr. [redacted] and Mr. [redacted] went inside the chamber with him in order to continue CPR during decompression treatment. Mr. [redacted] was not allowed to enter the chamber because he had made an earlier dive. Had he gone into the chamber, he may have suffered adverse medical consequences. Several more phone calls were made back and forth among Mr[redacted], Mr[redacted], Mr. [redacted] and Hyperbaric Doctor, [redacted]

52. At 2111, after Mr. Mouritsen was secured in the decompression chamber with CPR continuing, Mr. [redacted]s ordered Mr. [redacted] to start an emergency evacuation from the site in order to get Mr. Mouritsen back to shore (Encl # 16, dated 7/6/02). This was done because Dr. [redacted] had notified the crew that Mr. Mouritsen needed to remain in the decompression chamber and could not be flown out via medivac (Encl # 32, Initial Statement [redacted]). Mr[redacted] and Mr. Bowman used a cutting torch to cut the two stern anchor wires that had been tied off to the rig as spring lines. They also cut away the other diving lines and cables that still ran into the water. At 2132 Mr. [redacted] the Rack Operator, was placed in the chamber to assist Mr. [redacted] and Mr[redacted] in performing CPR. At 2140 Mr. [redacted] and Mr. [redacted] raised the two bow anchors and the M/V MR. FRED got underway (Encl # 17, Bridge Logs – M/V MR. FRED, and Encl # 33, Initial Statement – [redacted]). CPR operations were continued until 2152, when Mr[redacted] was instructed by Mr. [redacted] to discontinue CPR per Dr. [redacted] orders (Encl # 31). The vessel arrived at the CalDive docks in Morgan City, LA, at 0630 the next morning (See Encl # 16, dated 7/7/02, and Encl # 17, dated 7/7/02).

Equipment Recovery

53. When the M/V MR.FRED arrived at the dock, two Investigators from the U. S. Coast Guard's Marine Safety Office in Morgan City, LA, boarded it. The Investigators, Lieutenant Junior Grade [redacted] and Ensign [redacted], met with the vessel's Master, BP's company representative, and the Dive Superintendent. Mr. [redacted] the Dive Superintendent, explained what had happened during the dive and showed the Investigators the equipment involved. The Investigators took initial statements from members of the dive team and took possession of Mr. Mouritsen's dive helmet, harness and bailout bottle for future testing.

54. Mr. Mouritsen's hard hat, bail out bottle, harness, wetsuit and booties had been secured in the vessel's tool locker after the accident and the locker was still secured when the Investigators went aboard the vessel. They were informed that the gear had been locked up immediately after the incident and had not been touched since. The locker was opened in their presence and they took initial photographs of the gear. LTJG [redacted] took custody of the gear and locked it in the trunk of the government vehicle he was using at the time. For safekeeping purposes, the gear was stored in an evidence locker at the St. Mary Parish Sheriff's Office, Morgan City, LA, and later at the Morgan City Police Department (Encl # 34, Chain of Custody Forms for Chris Mouritsen's Dive Equipment). On July 17, 2002, LTJG [redacted] hand-delivered the equipment to the U.S. Navy's Experimental Diving Unit (EDU) in Panama City, FL for testing as detailed in Section III.G of this report, "Post Casualty Inspection and Testing of Mr. Mouritsen's Personal Diving Gear."

55. At 0330 on July 10, 2002, with the approval of the U. S. Coast Guard's Officer in Charge of Marine Inspection in Morgan City, LA, CalDive/Aquatica's vessel the M/V MR. JACK departed Intracoastal City, LA for Eugene Island Block 273 to search for and recover Mr. Mouritsen's missing neck dam. The vessel arrived at EI-273, the location of the dive accident, at 1345 that day, and began diving operations at 1614. After three dives the neck dam was located at a depth of 187 feet sitting on one of the structure's cross members. The neck dam was found in the open/uncammed position. It was placed in a locked suitcase, and the vessel returned to Freshwater City, LA on the morning of July 11, 2002. Later that day, CalDive/Aquatica delivered the neck dam to the Marine Safety Office.

Coroner's Findings

56. According to the Coroner's autopsy report it was determined that the cause of death was "Asphyxia due to equipment failure – Dive accident." Other findings that were noted included: scleral hemorrhage – left eye; linear abrasion (2) left flank; maceration of the skin of the hands and feet; blue discoloration of the petrous ridges of the base of the skull; and hyperinflation of the lungs. A full drug toxicology was completed and the results were [redacted] (Encl # 35, Autopsy Report (426-02-SM) – Chris Thomas Mouritsen).

Comment [B1]: Mike…add detail.

F. Post Casualty Inspection and Testing of M/V MR. FRED's Diving System

Dive Umbilical

1. The dive umbilical that Mr. Mouritsen used was removed from the MR. FRED and inspected and tested on July 10, 2002. The inspection and testing were conducted by Mr. [redacted] of Vilas & Associates and attended by Coast Guard Investigators Lieutenant Commander [redacted] and ENS [redacted] (See Encl # 36, Jack Vilas & Associates, Inc – Report of Dive Equipment Test). The entire length of the umbilical was laid out and visually inspected. No signs of binding or crimping were noted. Air was blown through both the air hose and the pneumofathometer to check for blockages. Both lines were found to be clear. Finally, the breathing air hose was hydrostatically tested to a pressure 900psi for 15 minutes. The breathing hose passed the hydrostatic test showing no signs of leakage, bulging, or other discrepancies.

Dive Compressors

2. Each of the life support systems aboard the MR. FRED used to support Mr. Mouritsen's dive were also tested and inspected as a part of this investigation. This phase of the testing was conducted on July 13, 2002 at CalDive/Aquatica's docks in Morgan City, LA and supervised by Mr. [redacted]. Three Coast Guard Investigators, LCDR [redacted], LTJG [redacted], and ENS James Green witnessed the tests. (Encl # 36). The components that were tested in this phase of the inspection are listed.

- Diving Compressor CDV 197
- Diving Compressor CDV 116
- Diving Compressor CDV 107
- Volume Tank
- Dive Manifold (Rack)

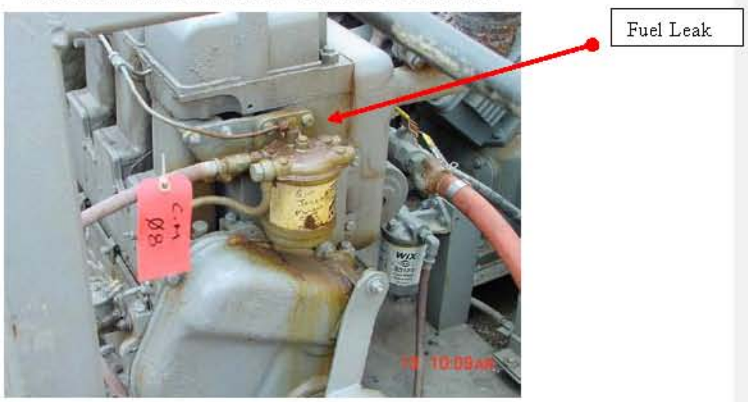
3. All three of the compressors were visually inspected, operated for twenty minutes, and then visually inspected again. In addition the safety relief valves, coils, belts, hoses, fluid levels and other components of each compressor were examined. All three of the compressors passed the inspection/testing process. Compressor CDV 197, the "Main" compressor, was found to have minor problems. In particular, the 250psi safety relief valve automatically lifted at 160psi. This did not occur, however, until after it had been manually lifted at a lower pressure. All of the other relief valves performed satisfactorily when operationally tested as installed on the compressors.

4. CalDive/Aquatica had the relief valves for the compressors and the volume tank removed and replaced with new ones. The valve that lifted at 160psi was taken to Jack Vilas & Associates dive shop for later bench testing. CalDive/Aquatica also directed Mr. Vilas to bench test the other valves as well. Mr. [redacted] reported that the relief valve from

compressor CDV 197 that had lifted at 160psi when operationally tested, lifted at 210psi when it was bench tested. The bench tests of the other valves produced mixed results. This was not an issue during the diving accident since the volume tank was supplying the dive manifold with air at a steady pressure of 200psi.

5. There were two other minor discrepancies noted with compressor CDV 197. It had a minor diesel leak at the fuel filter and it had a 3V drive-belt installed on it instead of a 4V drive-belt. Neither of these items affected the compressor's ability to supply breathing air to the diving system.

Photo 5: Location of Fuel Leak on Main Compressor



6. Air quality analysis was performed on the breathing air generated by each compressor. Levels of carbon monoxide, carbon dioxide, oxygen, hydrocarbons, and liquid particles were tested. Each compressor passed the tests except for the levels of liquid particles, which each compressor exceeded. This was expected due to the high levels of humidity along the Gulf Coast. The vessel had been taken out of service following the casualty and the compressors had been unused for several days. This allowed some condensation to build up. The maximum standards for hydrocarbon content used by Mr. [redacted] in Table 7 are stricter than those contained in Title 46, Code of Federal Regulations, Part 197.340(i) (see Encl # 36, Jack Vilas & Associates, Inc – Report of Dive Equipment Test and Encl # 37, Hydrocarbon Computations):

Table 7: Results of Compressor Air Quality Tests

Substance	CDV 197	CDV 116	CDV 107	Maximum Allowed by Vilas	Maximum Allowed by CFR
CO	<5ppm	<5ppm	<5ppm	<20ppm	<20ppm
CO2	<100ppm	<200ppm	<100ppm	<1000ppm	<1000ppm
O2	21.2%	21.3%	21.4%	20% to 22%	20% to 22%
Liquid Particle	30ppm	200+ppm	200+ppm	<25ppm	<5.0mg/m3
Hydrocarbons	<1.5mg/m3	<1.5mg/m3	<1.5mg/m3	<5.0mg/m3 (See note 1, below)	<25ppm
Odors	None	None	None	No objectionable	No objectionable

Note 1: 5.0mg/m3 of Methane (a light Hydrocarbon) would be equivalent to 7.6ppm. 5.0mg/m3 of Benzene (a heavy Hydrocarbon) would be equivalent to 0.5ppm, See Encl # 37.

7. A review of the results from the last set of air quality analysis test performed prior to this casualty showed that the compressors CDV 116, completed May 17, 2002, and CDV 197, completed May 28, 2002, were within specifications for carbon monoxide, carbon dioxide, oxygen, liquid particles, and hydrocarbons. CDV107, completed May 7, 2002, passed all tests conducted, but was not tested for the hydrocarbon content of the breathing air. (See Encl 38, Cal Dive/Aquatica Certificate of Air Analysis – CDV 116, Encl 39, Cal Dive/Aquatica Certificate of Air Analysis – CDV 197, and Encl 40, Cal Dive/Aquatica Certificate of Air Analysis – CDV 107, for last test results.)

Volume Tank

8. The volume tank was examined externally aboard the vessel and found to have no damage. The tank was pressed up to its maximum allowable working pressure and tested for leaks. No leaks were detected. The air quality tests of the volume tank were also within limits, except that it exceeded the permissible levels of liquid particles due to humidity, as was expected. For the internal examination, CalDive/Aquatica removed the volume tank from the vessel. Mr. [redacted] conducted the examination and found no problems.

Dive Manifold ("Rack")

9. The dive manifold, or Rack, was given a thorough inspection as noted in sections 6, 7, and 8 of Jack Vilas & Associates report (See Encl 36). In summary all lines were clear of obstructions, and all of the valves and gauges were tested under pressure and found to be working properly. The dive manifold was also checked for leaks. No leaks were detected.

10. At the conclusion of the tests, air was allowed to free flow for several minutes from the main compressor, through the volume tank, through the dive manifold, and then to a dive umbilical. The end of the dive umbilical was left open in order to test the system's

overall ability to maintain airflow. The breathing air supply system was able to keep up with the open umbilical and maintain pressure to the volume tank and to the dive manifold.

G. Post Casualty Inspection and Testing of Mr. Mouritsen's Personal Diving Gear

1. Mr. Mouritsen's personal dive gear was taken to the U. S. Navy's Experimental Diving Unit (EDU) in Panama City, FL, for testing and inspection. The tests were conducted on July 18, 2002. The EDU identified several problems with the equipment as discussed below (Encl # 41, Navy Experimental Diving Unit – Report on Dive Equipment Tests).

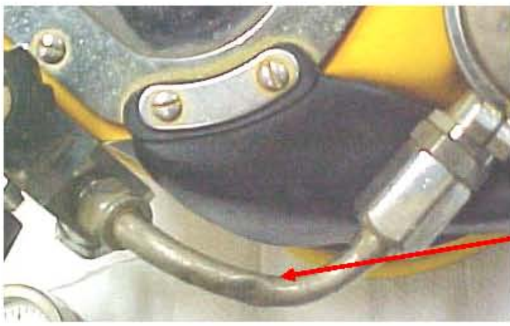
Kirby Morgan Superlite 17B Helmet

2. A visual inspection of the helmet was conducted by the EDU. The inspection found that the helmet had no serious external physical damage. The neck ring was in good condition as was the neck dam. The neoprene in the neck dam was slightly compressed. The EDU noted that mold was growing inside of the helmet's oral nasal mask, but the mask was functional. Coast Guard Investigators noted the growth of this mold when they took possession of the gear on the morning of July 7, 2002, (see Photo 6 below).

Photo 6 : Mold in Oral Nasal Mask as Photographed by USCG Investigators on July 7, 2002

EDU reported that the main helmet exhaust valve (water dump) also had dried mud around its edges. The bent tube assembly had a dent in it (Photo 7), but was able to deliver air when tested.

Photo 7: Dent in "Bent Tube"



3. The compression of the neoprene in the neck dam noted above is considered normal wear and tear. During his interview, Mr. [redacted] told Investigators that he had helped Mr. Mouritsen replace the neoprene on July 5, 2002 (Encl # 21 and Encl # 14). He said that Mr. Mouritsen had used the neck dam on a mixed gas dive later that day and did not report any problems with it. The exposure to mixed gases the previous day and the fact that it sat on the bottom in 187 feet of water account for the compression of the neoprene.

4. The EDU ran three separate operational tests on the helmet in the condition in which it was received. Each time the tests had to be halted due to water flooding into the breathing system. After the first attempt debris was found in the exhaust valve. The debris was keeping the exhaust valve from sealing properly. The valve was also noted to be dry-rotted and muddy. The debris was removed, and the helmet tested a second time. The second test was halted because water continued to enter the breathing system.

5. After the second attempt to test the helmet, the demand regulator body was opened. A foreign object approximately the size of a nickel was found inside of the regulator beneath the roller lever and on top of the bias adjustment tube (See Photos # 8 & 9 taken by LTJG [redacted], USCG MSO Morgan City, LA). The object left a rust colored stain on the regulator body indicating it had been present for a period of time. This object prevented the regulator from operating properly. Based on the size of the object, the EDU concluded that it could only have entered through the regulator body breathing tube. The roller lever was also noted to be loose to the point where it was outside of the manufacturer's specifications. This looseness prevented the purge button on the front of the demand regulator from providing air when depressed. The helmet was tested one

additional time, but water continued to enter it so the test was halted.

6. The foreign object was removed and the demand regulator disassembled. The internal components of the regulator were found encrusted with fine mud, which prevented them from moving freely within the regulator.

Photo 8 : Foreign Object as Found in Regulator

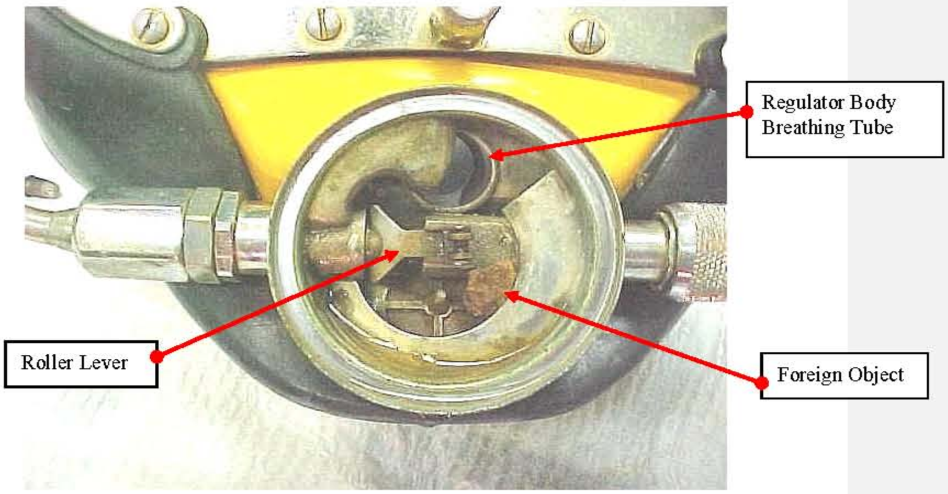


Photo 9: Foreign Object Removed from Regulator (Below)

7. The foreign object was later sent to "A and M Technical Services, Inc." in Houston, TX for analysis. The results of the tests showed that it was 83.49 % Iron. The remaining elements found it in were Aluminum, Silicon, Sulfur, Chlorine, Potassium, and Calcium.

(Encl # 42, A & M Technical Services, Inc.– Report on Foreign Object Body (FOB)).

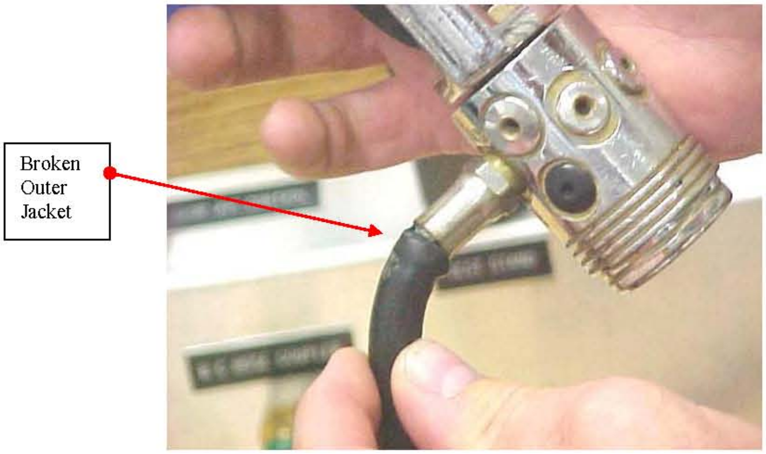
8. The defogger/freeflow valve assembly was examined and found to be in need of maintenance. It was tested in the condition in which it was received. EDU reported that when first pressurized, the valve was in the open position and it allowed a moderate rate of airflow. Attempts to turn the control knob, however, did not result in any increases or decreases in the rate of airflow. The control knob had considerable play in it and rotated approximately ¾ of a turn without any rotation of the valve stem itself. The stem could also be turned slightly without actuating the valve. The control knob was difficult to turn, and excessive force had to be applied to overcome resistance. After repeated attempts to turn the knob, resistance was overcome, and the valve opened and allowed increased airflow. On disassembly it was noted that the valve assembly was coated with fine mud, the stem was worn, and there was a leak at the packing gland.

9. A pull test was conducted to determine if the helmet could be pulled off of the neck dam. For the first test the helmet was properly mated to the neck dam. EDU reported that the helmet could not be pulled off. For the second test EDU deliberately misaligned the rear hinge tab and the alignment sleeve and found that the helmet could easily be pulled off of the neck dam.

<u>Emergency Air Supply ("Bailout")</u>

10. The emergency air supply / bailout system was also examined by the EDU. The air tank was received with the valve open and the tank empty, so an analysis of the emergency supply of breathing air could not be conducted. The outer jacket was broken at one end of the low-pressure hose (See Photo 10, taken by LTJG [redacted], MSO Morgan City) used to connect the tank to the helmet. The hose was tested under pressure and did not leak. It was then connected to the emergency gas supply valve (auxiliary valve) on the helmet, which was still in the position it had been in when received by the EDU. The line was pressurized, and a slight flow of air came from the auxiliary valve. The valve's control knob was tested, and the valve opened and closed properly.

Photo 10: Low Pressure Hose from Emergency Air Supply



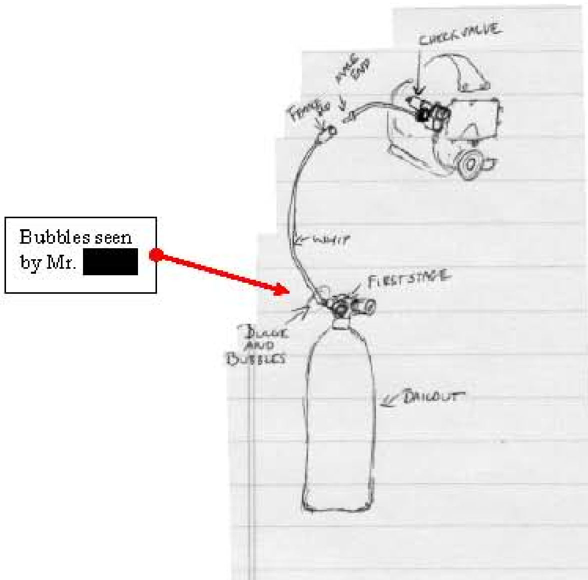
11. The first stage Sherwood regulator was examined and found to be leaking excessively. The regulator, typically referred to as a "dry air bleed valve," is designed to leak at a rate of 13-27 cubic centimeters/minute in order to keep the internal parts of the first stage dry. EDU measured the regulator's leak rate when attached to Mr. Mouritsen's bailout bottle at 4.5 liters/minute. EDU computed that this would not have drained the tank given Mr. Mouritsen's bottom time. Further investigation by MSO Morgan City revealed that Mr. Mouritsen had been diving for fifty minutes prior to the accident. A bleed down rate of 4.5 liters per minute over a fifty-minute period equates to a total loss of eight cubic feet of air from the tank. This leak rate would have left him with forty-two cubic feet of air in his 50 cubic foot bailout bottle at the time of the emergency. In addition, the filter in the regulator was encrusted with blue-green verdigris as seen in Photo 11 below.

Photo 11: Blue-Green Verdigris encrusted inside 1st Stage Regulator

12. The last hydrostatic test on the bailout bottle was performed in April 1997. 49 CFR 173.34(a)1 and (e) requires that bottles containing compressed gases be hydrostatically tested every five years. Bottles that do not have a current hydrostatic test cannot be placed into service.

13. Mr. [redacted] stated during his interview (Encl # 23) that he looked at Mr. Mouritsen's bailout before it was locked up on the M/V MR. FRED. He saw that the auxiliary valve on the helmet was open, the valve on the bailout bottle was open and the bailout whip was charged with air. He also noted that some air bubbles appeared to be coming out of the whip where the "bulge" was. See Diagram 4 below, drawn by Mr. [redacted], which shows the arrangement of the bailout system and the location of the small leak that he noted.

Diagram 4: Sketch of Bailout System Arrangement and Small Leak



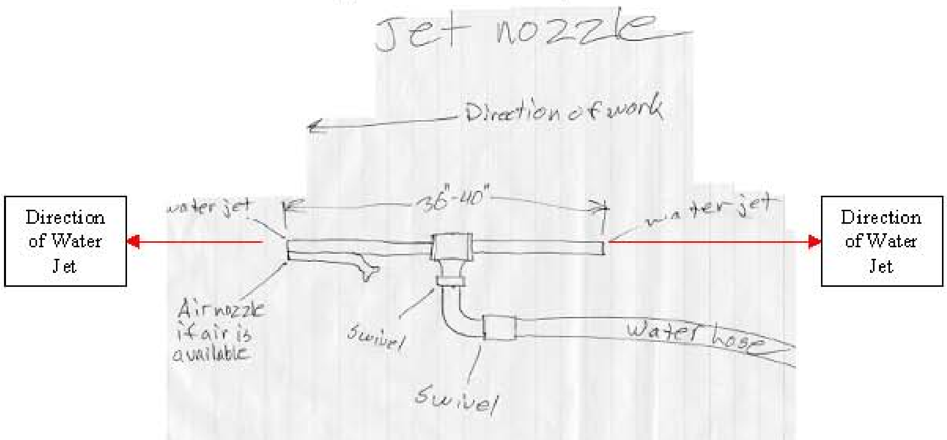
H. June 6, 2002 Diving Accident Involving Mr. Mouritsen

1. Mr. Mouritsen had an earlier diving accident (Encl # 20, Follow up interview – [redacted], and Encl # 43, Cal Dive International – Incident Report – June 6, 2002) in which his helmet was knocked off of his head. This incident occurred on June 6, 2002, at the Exxon Fuel Dock in Grand Isle, LA. CalDive/Aquatica's internal Incident Report Form states, "Diver's hat came off his head while jetting inside cofferdam." The dive was being conducted from the shore rather than from aboard a vessel. Mr. [redacted] was serving as Dive Supervisor, Tender and Rack Operator. During his interview (Encl # 44, Interview Summary – [redacted]), Mr. [redacted] stated that the job involved cutting away a corrugated metal sheet pile that was being used to keep shore side dirt and sand from falling into the water.

2. Mr. Mouritsen had been assigned the job of blasting the dirt and sand away from the base of the wall using a 200psi-waterjet system. He was working at a depth of twelve feet and was inside a portable cofferdam when his helmet came off. The cofferdam was required in order to prevent dirt and sand from falling in and engulfing him as he jetted. The waterjet he used was double ended. The front stream is directed toward the object being jetted and is used to perform the required work. The rear stream flows away from the object being jetted in order to balance out the force of the forward stream so that the diver does not get pushed away from the work area. Diagram 5 below is a sketch drawn

by Mr. [redacted] showing the type of nozzle Mr. Mouritsen was using. Mr. [redacted] added that the pressurized water flowing from both ends of the nozzle creates a great deal of turbulence inside of the cofferdam:

Diagram 5 : Sketch of Waterjet Nozzle



3. Mr. [redacted] was monitoring Mr. Mouritsen's dive when suddenly he could no longer hear Mr. Mouritsen breathing over the radio. Within a few seconds he saw Mr. Mouritsen appear at the surface of the water. Mr. Mouritsen was not wearing his helmet, but his neck dam was still cammed around his neck. The dive was terminated, and Mr. Mouritsen exited the water unharmed. Mr. [redacted] put on his dive gear and retrieved the waterjet nozzle because Mr. Mouritsen had dropped it when the accident happened. Mr. [redacted] said that he could not find the nozzle initially. So much debris and sediment had been stirred up during the jetting operation that when it settled on the bottom it completely buried the nozzle (Encl # 44). To locate the nozzle he had to restart the flow of pressurized water, which got the nozzle to stir up the sediment that had landed on it and dig itself out.

4. Mr. Mouritsen told Mr. [redacted] that the water flow from the backside of the jet nozzle had hit his helmet and knocked it off. Mr. [redacted] notified CalDive/Aquatica of the incident and then directed Mr. Mouritsen to tighten his helmet. Mr. Mouritsen later reported to Mr. [redacted] that he had fixed the problem and had even put the helmet back on his own head to ensure that it would be secure. He also told Mr. [redacted] that his helmet had never come off before. According to Mr. Mouritsen's Commercial Diver Logbook (Encl # 45), he used the helmet on five dives following the June 6, 2002 accident. He did not report any problems with the helmet after this incident.

5. Mr. [redacted], General Manager of Kirby Morgan Dive Systems, Inc in Santa Barbara, CA and Mr. [redacted], also of Kirby Morgan, were contacted to determine if Kirby Morgan had records indicating whether or not Mr. Mouritsen had taken his helmet in for servicing. Kirby Morgan does not do any helmet maintenance, but the company does authorize dealers to perform maintenance. Kirby Morgan indicated that they had contacted all authorized dealers in the Gulf of Mexico and that none of them had any records indicating they had serviced the helmet.

V. Analysis

(Investigator's Note: This section of the report contains the Investigators' analysis of the facts and of hypotheses which are not firmly supported by specific facts. It also describes the analytical process by which certain findings of fact led to particular conclusions.)

A. Tugger Operations

1. A careful analysis of the movement of the tugger during this incident needs to be conducted for two reasons. First, the communication problems Mr. Mouritsen had with the vessel started immediately after he began working with the tugger. Second, the loss of breathing air occurred shortly after he began giving orders to the MR. FRED to come up on and to slack the tugger. A close examination of tugger operations will show that it was not a causal factor in this incident.

2. The first issue is whether the tugger had anything to do with the communication problem that occurred. Mr. Mouritsen and Mr. [redacted] were able to understand each other during the dive and did not start having communication problems until after Mr. Mouritsen started working with the tugger at 20:39:56. Four seconds after Mr. Mouritsen took hold of the tugger, Mr. [redacted] reported that there was a problem with communications. Mr. Mouritsen checked the communications wiring on the side of his helmet and found that they had almost come completely out. He tightened the wires, and communications were restored.

3. The fact that the wires were loose can be explained by one of two possibilities. Either they were pulled loose during the dive, or they were not securely attached at the beginning of the dive and worked themselves loose. Since Mr. Mouritsen's communication problem developed only four seconds after he began to handle the tugger, it must be asked if the two events are connected in any way and if the dive should have been terminated after the communication trouble developed.

4. The tugger was tied off to an anode near Mr. Mouritsen's workstation. If it were pulling on the umbilical, it is possible that it could have pulled the wires loose. In the videotape, however, Mr. Mouritsen can be seen repositioning his umbilical before any communications problems developed. When he does so it is clear that there is no tension on the umbilical and that he can easily move it. At no time during the dive did Mr. Mouritsen make any statements indicating that there was tension on his umbilical. This makes it unlikely that the tugger pulled out the communication wires. Had the umbilical been entangled with the tugger, he likely would have felt the tension when repositioning the umbilical. This did not happen. In addition, the umbilical is secured to the dive harness, so any tension on the umbilical would have been transmitted to the harness and not directly to the helmet or the wiring attachments on the helmet.

5. Another factor to be considered is that the tugger was not in use prior to the communications problem. The problem occurred at 20:40:00, but it wasn't until three minutes later, at 20:43:02, that Mr. Mouritsen gave the first tugger order. When Mr. [redacted] relayed the order to the Tenders on deck it took them an additional forty-five seconds to carry it out. This means the first time the tugger was moved during the dive

was not until three minutes and forty-five seconds after the problem with the communication wires developed.

6. The helmet was inspected and tested by the EDU, and the umbilical was inspected and tested by Vilas & Associates; both were done in the presence of Investigators from U. S. Coast Guard Marine Safety Office, Morgan City, LA. While the communications connections on the helmet and the umbilical were not tested, no physical problems were noted. It is the opinion of the Investigating Officer, therefore, that the tugger did not pull the communication wires loose.

7. A more plausible scenario is that the communications wires were not properly secured at the start of the dive and worked themselves loose over the course of the dive. Mr. [redacted] said he securely attached the wires to Mr. Mouritsen's helmet at the start of the dive and that they were working properly. Mr. Mouritsen did not make any movements that would have caused properly secured communication wires to come loose. He did climb around on the pipe at his workstation, but his movements were within the normal range of activities conducted by divers. The fact that there were no communication problems until forty-six minutes into the dive generally supports this. Nevertheless, the wires did in fact come loose, and no other explanation can be found.

8. The 46 CFR 197.410(b), and CalDive/Aquatica's policy requires a dive to be terminated when, "Communications are lost and cannot be quickly reestablished…" (Encl # 7, p 13). Since communications were not "lost" and the problem they did have was quickly corrected, there was no reason to terminate the dive under the regulations or the policy. It is the opinion of the Investigating Officer that the communications problem was not related to the tugger, nor was it a causal factor in Mr. Mouritsen's loss of breathing air.

9. The second issue in need of analysis is whether or not the tugger was a causal factor in Mr. Mouritsen's loss of breathing air. When Mr. Mouritsen gave his first tugger order, the tugger could be seen in the video trailing off into the distance with no tension on it. This order was significant because it set in motion a series of actions involving the tugger that occurred at the exact time Mr. Mouritsen lost breathing air. To simplify the analysis of the tugger orders and the actions of the Tenders on deck, Table 8 was developed; it is included following paragraph 24 of this section.

10. Mr. [redacted] understood Mr. Mouritsen's 20:43:02 statement, "Are you coming up on some of that tugger slack?" as the first order to come up on the tugger and relayed it as such to the Tenders. Unbeknownst to Mr. Mouritsen, the Tenders were all at the vessel's stern and were not in position to carry out the order, so there was a delay. While the Tenders were getting into position, Mr. Mouritsen repeated the order at 20:43:39. At that moment, the videotape shows the tugger dangling at Mr. Mouritsen's feet with no tension on it. Mr. [redacted] advised him that the Tenders were still getting into position. A few seconds later Mr. [redacted] arrived at the controls for the winch and began to come up on the tugger. At 20:43:51 Mr. Mouritsen ordered, "All stop." When he gave this order, the videotape shows that he is holding the end of the tugger in his hands, and that the tugger

is slack. Mr. [redacted] relayed the "all stop" order, and Mr. [redacted] stopped coming up on the tugger after having only brought it in a few feet. A few seconds later Mr. Mouritsen ordered the tugger to be slacked, and Mr. [redacted] let it out about twenty feet.

11. At 20:44:04, as Mr. [redacted] was letting out the tugger, the first sounds of Mr. Mouritsen straining to breathe can be heard on the videotape. If the tugger did cut off Mr. Mouritsen's breathing air supply, it would have had to have happened during the thirteen second window between when Mr. [redacted] first came up on the tugger and when he let it out twenty feet a few moments later. Those were the only times the tugger had moved during the dive.

12. At 20:44:11 in a stressed voice Mr. Mouritsen said, "My air, my air, my air, my air." Mr. [redacted] immediately ordered Mr. [redacted] to slack the tugger again, and Mr. [redacted] let out another twenty feet. At 20:44:17 the video shows Mr. Mouritsen's umbilical to be free of tension as he grabs onto it in two hand-over-hand motions.

13. The fact that the vessel was moving the tugger for the first time during the dive right at the very moment Mr. Mouritsen lost his supply of breathing air makes it appear as though the tugger may have caused the accident. The evidence, however, indicates that this was merely a coincidence and the tugger was not a factor.

14. Mr. [redacted] had only brought the tugger up three to four feet when the all stop order was given. Bringing in only a few feet of tugger would not have been sufficient to have caused the loss of air flow unless the tugger and the umbilical were already entangled and under tension.

15. In order for the tugger to cut off a diver's air supply in such a sudden and catastrophic way, the umbilical would have to have been crimped close to where it attaches to the diver's harness. In such a case the residual air in the line would have been breathed out quickly. In Mr. Mouritsen's accident the loss of air was sudden and catastrophic, but the evidence indicates that this not caused by a crimp in the line near his location or at any other point along the umbilical. Not only does the video show there were no crimps, but witnesses also said the lines were not crimped or entangled. The key points are summarized below.

16. First, when the initial sounds of Mr. Mouritsen straining to breathe are heard, Mr. [redacted] was already in the process of slackening the tugger. If the tugger had crimped the umbilical as it was pulled in three or four feet, it would have loosened its grip when he let it out twenty feet less than ten seconds later. With 200psi of air flowing into the line, breathing air would have been restored near instantaneously. The fact that this did not happen indicates that the tugger did not crimp the line. In addition, the umbilical is a bundle of six lines, and it would take a great deal of pressure to cut off the air supply. It is unlikely that bringing in the tugger a few feet would create sufficient pressure on the line to cut off the flow of air.

17. Second, both the umbilical and/or the tugger can be seen slack in the video at critical times. At 20:43:51 the tugger is seen slack immediately prior to the loss of air, and at 20:44:17 the umbilical is seen slack immediately after the loss of air. In fact, every time the umbilical and tugger appear in the video, they are both slack. This lack of tension in either line indicates that they were not entangled with each other and that the tugger was not pinching the umbilical or pulling on it.

18. Third, if the tugger had crimped the umbilical, there should be evidence of that fact on the umbilical itself. In particular, significant damage should have been found on the air hose and at the same location on other items bundled in the umbilical. The umbilical was inspected as discussed above and it only showed the signs of normal wear and tear.

19. Fourth, the Tenders on deck saw no indication that the tugger and umbilical were entangled. Mr. [redacted] was holding Mr. Mouritsen's umbilical in his hands as the tugger was moving. Had an entanglement or pinching occurred, Mr[redacted] would have felt some movement of the umbilical as he was holding it. He did not feel any movement. He stated in his interview that the lines were clear on deck and as they descended below the surface of the water.

Comment [B2]: Indicate what paragraph or section of the report.

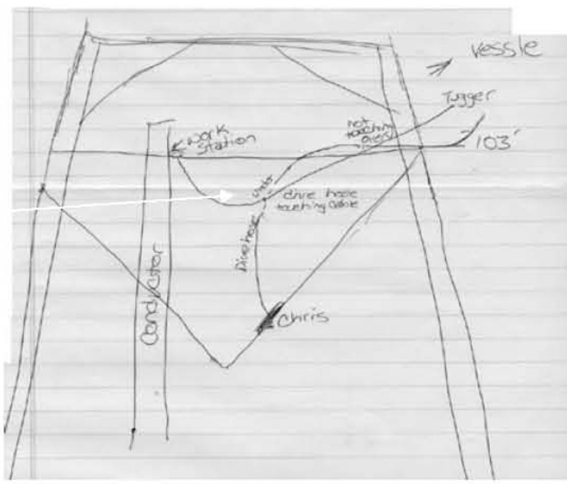
20. Finally, and most importantly, Mr. [redacted], the Standby Diver, said that he rescued Mr. Mouritsen by taking hold of Mr. Mouritsen's umbilical at the surface and following it all the way down. He said that he found the umbilical to be free and clear of entanglements for its entire length as he descended. As he reached Mr. Mouritsen, however, he saw that the umbilical had a "half wrap" on the tugger near where the umbilical attached to Mr. Mouritsen's dive harness. He explained that at the "half wrap" the umbilical was simply laid over the top of the tugger and then went back underneath it as the umbilical descended the last few feet to where Mr. Mouritsen was located. He said that the umbilical was not entangled or crimped. Diagram 6, drawn by Mr. [redacted], illustrates how the umbilical was touching the tugger and can be seen as a part of Mr. [redacted]s interview (Encl # 21). The "half wrap" can also be seen in the videotape at 20:45:00 (corrected time—the uncorrected time as shown on the videotape's clock is 20:44:00). It is clear that there is no binding or strain on the umbilical.

21. Based on his observations as the Standby Diver that entered the water sixty-five seconds into the incident and arrived at Mr. Mouritsen's location less than two minutes after that, it was Mr. [redacted] opinion that the tugger did not cut off Mr. Mouritsen's air supply.

Photo 12: Video Capture of "Half-Wrap"

Diagram 6: Sketch of Location of "Half Wrap"

Location of Half Wrap



22. It is important to keep in mind that Diagram 6 is not drawn to scale, but certain things can be learned from it that shed light on the incident. The workstation was at 103 feet as indicated in the drawing, and Mr. Mouritsen was found several feet below that. The critical item in the diagram is the point where the umbilical and the tugger touch—it is close to the end of the umbilical. This would be sufficiently close to Mr. Mouritsen to have caused a sudden loss of air supply had the tugger crimped the umbilical, but it would also have been close enough for Mr. Mouritsen to have clearly seen the entanglement/crimping if it had occurred. At 20:44:17, however, after Mr. Mouritsen loses his air supply he can be seen making two hand-over-hand motions pulling on his umbilical, and several more feet of the umbilical can be seen in the distance. There is no tension on the umbilical, and the line is clear of entanglements in the area where he was working.

23. In summary, the tugger and umbilical were clear of each other on deck, they were clear as they entered the water, and they were clear the entire length of their descent.

They were only found to be touching in a “half wrap” near Mr. Mouritsen’s workstation. Post casualty inspection and testing of the umbilical found only normal wear and tear on the air hose and umbilical.

24. Based on the above analysis it is the opinion of the Investigating Officer that the tugger did not cut off Mr. Mouritsen’s air supply, nor was it a causal factor in this accident.

Table 8: Analysis of Tugger Operations

Corrected Time	Main Diver	Rack Operator	Actions on Deck
20:43:02	• "You coming up on some of that tugger slack?" • Tugger visible and has no tension on it.	• To Diver: "Roger that…(Unintelligible) coming up…tugger slack" • To Deck: Gives tugger order to Tenders	• Mr. [redacted] moving to tugger control station • Mr. [redacted] moving to pick up umbilical
20:43:39	• "Are you coming up on the tugger?" • Tugger visible and still has no tension on it.	• To Diver: "Yeah, we're working on it. Give us a sec, we've got to get some people into position"	• Mr. [redacted] moving to tugger control station • Mr. [redacted] moving to pick up umbilical
20:43:51	• "All stop" • (Voice is calm and normal.) • Diver seen holding tugger in hands with no tension on it.	• To Deck: Mr. [redacted] relays "All Stop" order to Tenders • To Diver: "I don't know if they did anything."	• Mr. [redacted] comes up on tugger 3 – 4 feet • Mr. [redacted] stops coming up on tugger on "all stop."
20:43:59 to 20:44:04	• "Slack the tugger, slack the tugger" • (Voice is calm and normal.) • Followed by sounds of strained breathing	• To Deck: "Go ahead, slack the tugger off"	• Mr. [redacted] slacks tugger 5 seconds, lets out 20 feet.
20:44:08 to 20:44:10	• "Slack the tugger" • (Voice is stressed.)	• To Diver: "Slacking the tugger"	
20:44:11 to 20:44:14	• "My air, my air, my air, my air" • (Voice is highly stressed)		
20:44:15		• To Deck: "Slack the tugger, slack the tugger"	• Mr. [redacted] slacks tugger, lets out 20 feet over 10 second period then stops
20:44:17	• "My air." • (Voice is highly stressed.) • Grabs umbilical two times in hand over hand motion.		
20:44:50		• To Deck: "God darn it, slack the tugger"	

The above "Analysis of Tugger Operations" table was developed to isolate tugger operations and to illustrate what events took place involving the tugger. This table was developed using the statements from Mr. [redacted], Mr. [redacted], and Mr. [redacted] as well as the videotape transcript. Factoring in all these sources of information, this is the most likely series of events that transpired involving the tugger.

B. Impact of Problems with Personal Diving Equipment

1. The U. S. Navy's Experimental Diving Unit (EDU) performed a thorough examination of Mr. Mouritsen's personal dive gear and identified the problems that were detailed above. An analysis of these problems as they apply to this casualty is necessary to identify which ones may have contributed to the incident. It is also important to consider the impact of Mr. Mouritsen's June 6, 2002, diving accident. It appears that some of the events leading up to Mr. Mouritsen's fatal diving accident were set in motion on June 6, 2002, the day Mr. Mouritsen's helmet came off while jetting at a depth of twelve feet.

2. Mr. Mouritsen logged a total of forty-six dives in his Commercial Diver Logbook in 2002. The June 6, 2002, incident is not logged, but brings the total number of documented dives to forty-seven. Eleven of these dives involved jetting. A few things are noteworthy, however, about the June 6, 2002, dive. It was the only time he was engaged in jetting operations during which his helmet came off, and after the incident he told Mr. [redacted] that his helmet had never come off before.

3. On June 6, 2002, Mr. Mouritsen was jetting dirt and sand away from a retaining wall using a high-pressure water jet in Grand Isle, LA. When the water jet hit the dirt and sand, it blasted it away from the retaining wall and into the surrounding water. The cofferdam he was working inside of was filled with turbulent water containing sediment, debris, and sand/mud particles that had been stirred up by the water jet. So much sediment and mud were stirred up and suspended in the water that it completely buried the waterjet when Mr. Mouritsen dropped it as his helmet came off. This same sediment, debris, and sand/mud particles would also have flooded into his helmet when it came off. This certainly would explain the fine mud that the regulator and defogger/freeflow valve were coated with. It would also have provided the most likely opportunity for the foreign object to enter the regulator.

4. No evidence was found indicating that Mr. Mouritsen performed an in-depth cleaning of the helmet after it came off his head on June 6, 2002. Kirby Morgan reported that none of their authorized servicing centers on the Gulf had records indicating that they had done so either. Mr. Mouritsen had been trained in helmet maintenance while in dive school (Encl # 8), and it is known that he did some maintenance himself. He tightened the helmet/neck dam connection after the June incident and replaced the neoprene in the neck dam on July 5, 2002. The fact that the EDU found the helmet's internal components to be coated in fine mud and badly worn, however, indicates that no in-depth maintenance had been performed recently.

5. When the EDU examined Mr. Mouritsen's helmet the examiner noted additional problems, but certain ones are focused on here because they involve the demand regulator and the defogger/freeflow valve—the two key routes in the helmet that supply air to the diver. The critical items found to be coated with mud are listed in Table 9:

Table 9: Critical Helmet Issues

Helmet Component	Problem
Regulator Body	• Nickel-Sized Foreign Object • Reddish-Brown Stain • Encrusted with Fine Mud
Defogger/Freeflow Valve	• Coated with Fine Brown Mud
Exhaust Dewatering Valve	• Mud around Edges • Debris Inside

The mud and debris that prevented the exhaust dewatering valve from seating properly may have allowed water to enter the helmet during the dive, but it did not prevent air from flowing through the demand regulator or through the defogger/freeflow valve. This discussion will focus on the demand regulator and the defogger/freeflow valve. They are the two routes the helmet uses to supply breathing air to the diver, and it was the loss of breathing air that led to Mr. Mouritsen's asphyxiation.

6. It is the opinion of the Investigating Officer that the fine mud that was found inside of Mr. Mouritsen's helmet got into it during the June incident when the helmet came off of Mr. Mouritsen's head. The very nature of jetting stirs up exactly the kinds of sediments and debris that were found throughout the internal components of his helmet. That a large quantity of debris was stirred up by Mr. Mouritsen's jetting is evidenced by the fact that it completely buried the water jet after he dropped it. Nothing happened during any other dive that would have enabled mud and debris to work its way so deeply into the helmet as it had the opportunity to do during the June accident when the helmet came off. Other possibilities do exist which are discussed below, but they are not likely to have been the source of the debris and mud.

7. Clearly, the foreign object that was found inside of the demand regulator was the most significant problem because it initiated events by interfering with the operation of the regulator. The EDU determined that the only way the object could have entered was through the breathing tube in the regulator body—which means that it came through the inside of the helmet. The question that must be considered, however, is why this object did not interfere with Mr. Mouritsen's ability to breathe during the first fifty minutes of the dive or during any of the five dives he conducted after the June 6, 2002, accident.

8. One possible answer can be found in the video. Seventeen seconds before the last sounds of Mr. Mouritsen breathing normally can be heard he makes a series of steep up and down movements of the helmet four times in quick succession. He does this over a period of nine seconds beginning at 20:43:28 as he cuts one of the lines holding the tugger in place. This up and down motion most likely shifted the foreign object into the position where it finally disrupted the demand regulator.

9. Correlating the key steps in the various emergency procedures discussed in paragraph III.D above with the deficiencies noted in the helmet as discussed in paragraph III.G above, Mr. Mouritsen's options in responding to the emergency are listed in Table 10:

Table 10: Analysis of Emergency Procedure Options

Option Number	*Procedure*	*Status*
1	Depress Purge Button on Demand regulator	Inoperative
2	Open Defogger/Free Flow Valve	Inoperative
3	Open Auxiliary Valve on Helmet to Breathe Emergency Air Supply from Bailout Bottle	Valve and Bailout Bottle Operative, but air could not flow through Defogger or Demand Regulator
4	Insert Pneumofathometer under Neck Dam and into Helmet	Operative, but not charged until after helmet failure

As can be seen, due to the condition of his helmet, there was very little that Mr. Mouritsen or the duty personnel aboard the MR. FRED could have done to respond to the emergency.

10. The best analysis of the steps that Mr. Mouritsen took in response to the emergency, based on the evidence as discussed below, is that he opened the defogger/freeflow valve and activated the emergency air supply/bailout system. When both systems failed, he removed his helmet and neck dam.

11. During the emergency, Mr. Mouritsen's hands disappeared from the view of the video camera at 20:44:17. The videotape does not show his hands again, so it cannot be determined if he depressed the purge button on the front of the regulator as listed in option one in Table 10, but it is likely that a diver with his level of experience would have done so. If he did, he would have found it inoperative as discussed in the EDU's report—the EDU reported that the purge button delivered no gas even when fully depressed.

12. When the purge button on the regulator failed to restore airflow, the next emergency procedure was to open the defogger/freeflow valve. There are some conflicts in the evidence, but it does appear Mr. Mouritsen may have attempted to open the defogger/freeflow valve. This is a standard emergency procedure and is recommended by Kirby Morgan in the manual for the helmet (Encl # 15, Kirby Morgan Manual sections 2.9.2 and 2.9.3).

13. There are a few items that indicate Mr. Mouritsen may have tried to open the defogger/freeflow valve after he lost his air supply, but that the valve failed to function properly. That he opened the valve is supported first by the fact that when the EDU received the equipment, its examiners found the valve open enough to allow for a moderate flow of air. Second, Mr. Mouritsen had used the valve earlier in the dive, and common sense dictates that a diver with his level of experience would certainly have tried to use it again during the emergency before taking the risky step of removing his helmet at depth.

14. That the defogger/free flow valve failed to function properly when he opened it is supported first by the fact that if the valve had worked properly and he had succeeded in getting air to free flow into the helmet during the emergency, the sound of it would have been recorded on the videotape. The sound of whistling air free flowing through the defogger/freeflow valve was recorded on the video earlier in the dive, but is notably absent during the emergency—indicating that air was not flowing through the valve at the time.

15. Second, when the EDU turned the control knob on the valve, it did not change the rate of airflow. It was only after repeated attempts to turn the knob to its extreme settings and after using increased force to overcome resistance that the valve responded.

16. Third, Mr. [redacted] said that when Mr. Mouritsen was brought onto the vessel's deck following the accident, he left the dive shack and went out on deck to render assistance. When he left the dive shack, he left the air supply valve to Mr. Mouritsen's umbilical open. This means that 200psi of air was still flowing to Mr. Mouritsen's helmet. If Mr. Mouritsen's defogger/freeflow valve had been open, then personnel on deck would have heard it free flowing when the helmet came out of the water. No one reported hearing air flowing through the valve when the helmet was brought onto the deck.

17. Fourth, later that evening when [redacted] disconnected Mr. Mouritsen's helmet from the umbilical, he found that there was still air pressure in the line despite the fact that the air supply from the dive manifold already had been turned off. He said that he did not touch or adjust any of the valves on the helmet while working on it. Instead, he used a wrench to slowly crack the seal between the air hose and the helmet. It only took a few seconds for the air to bleed out (Encl # 46, Follow up interview – Freddie St. Peter), but air was trapped in the line. The fact that even a slight amount of air pressure remained in the umbilical indicates that the defogger/freeflow valve had not opened—regardless of the position the valve's control knob was set at; otherwise, the air would have already bled out of the line. The helmet was then stored in a locker aboard the vessel and taken into the custody of Coast Guard Investigators on the morning of July 7, 2002, as noted earlier.

18. The results of the helmet inspection and testing conducted by the EDU, as discussed earlier, revealed serious problems with the defogger/freeflow valve that made it difficult to operate—but not impossible. Mr. Mouritsen did operate the defogger/freeflow valve earlier in the dive, which indicates that he was able to overcome the problems under normal diving conditions. Nevertheless, the valve's problems appear to have been too great for him to overcome while under stress during the emergency. With only a few seconds to respond in a life-threatening situation, he was clearly unable to get the valve to open sufficiently. Had the valve been functioning as designed this accident could have been prevented.

19. The conflict in the evidence is the fact that the EDU found the valve partially open. Yet no one heard air free flowing when the helmet surfaced, and Mr. [redacted] found air pressure trapped in the umbilical after the accident. It is possible that someone aboard

the vessel turned the valve to the open position after the accident, but no one recalls doing so—those who do recall working on the helmet stated that they did not turn the valves. Mr. [redacted] was the only person who said he examined Mr. Mouritsen's gear, but said he checked the bailout system—not the defogger/freeflow valve. Regardless of how or when the control knob on the valve got turned to the open position, it is a clear fact that air did not flow through the valve during the emergency.

20. In the opinion of the Investigating Officer the most probable scenario is that Mr. Mouritsen did attempt to turn the control knob to open the defogger/freeflow valve, but the valve did not respond. Post-casualty inspection found that it was stuck and would not open or close unless forced.

21. It also appears that Mr. Mouritsen activated his emergency air supply. When he opened the auxiliary valve on his helmet, air should have immediately begun flowing from the bailout bottle and through the demand regulator. Obviously this did not happen, or Mr. Mouritsen would have been able to breathe again. The foreign object was lodged inside of the regulator, so Mr. Mouritsen was still unable to breathe.

22. The fact that Mr. Mouritsen did activate the emergency air supply comes from two sources. The U. S. Navy's EDU reported that when it received Mr. Mouritsen's equipment, the auxiliary valve on the helmet (for the emergency air supply) was in the open position and allowed for a slight flow of air. The EDU also found the valve on the bailout bottle open. Mr. [redacted], the lead Tender, examined the helmet's auxiliary valve and bailout system shortly after it came aboard the vessel following the accident. He noted that the auxiliary valve on the helmet was in the open position and the valve on the bailout bottle was open. Since this was the condition of the equipment when it came to the surface and it was later received by the EDU in this same condition, it is clear that Mr. Mouritsen did in fact activate the bailout system during the accident. Had the regulator functioned properly, this casualty could have been prevented.

23. After the helmet and the emergency air supply failed, Mr. Mouritsen removed his helmet and neck dam. This is not a normal procedure even during an emergency, but there may be a logical explanation. The most probable reason for his actions is that he had decided to make an emergency ascent and was removing heavy equipment. Since he had chosen not to wear a weight belt for this dive, all he needed to remove was the helmet, the neck dam, and the dive harness. After he succeeded at removing the helmet and neck dam all that remained was for him to remove the dive harness. He was probably overcome by asphyxiation before he could accomplish this last task.

24. The "bulge" in the bailout whip (Photo 10) and the leaks in the emergency air tank were not factors in this casualty. The bailout whip, while it was in need of replacement, was tested by the EDU and found to be functioning properly—it was not leaking. The leak in the first stage regulator on the bailout bottle was more than the manufacturer specified, but it was not so great as to drain the tank during the dive. Despite the leak, there was sufficient air left in the emergency tank for Mr. Mouritsen to breathe at the time he opened the auxiliary valve.

C. Fatigue Analysis

1. There is no evidence that fatigue was a causal factor in this incident. In an attempt to quantify this conclusion, a fatigue analysis was conducted utilizing the guidance provided in Commandant (G-MOA) Policy Letter 5-97, "Fatigue Investigation Worksheet." A "Fatigue Index Score" greater than 50 would indicate that fatigue "may have affected an individual involved in a marine casualty" (underline added). In this instance, none of the personnel involved had Fatigue Index Scores over 50.

2. The Basic formula used in this analysis is:

$$\text{Fatigue Index Score} = S(21.4) + WH(6.1) - SH(4.5)$$

S = Total number of fatigue symptoms (0-7) experienced while on duty,
WH = Total number of hours worked in the last 24 hours, and
SH = Total number of hours slept in the last 24 hours.

There are seven fatigue symptoms that a person may exhibit that are used for the variable "S" in this formula. If the person on watch is forgetful, distracted, has sore muscles, is less motivated, has a desire to sit or lay down, has difficulty keeping their eyes open, or has difficulty operating equipment, then the person is considered to be possibly exhibiting a symptom of fatigue.

3. The analysis was conducted on the three Dive Team members that were in a supervisory role and that had direct control over Mr. Mouritsen's activities in the water:

[redacted], Diver Superintendent
[redacted], Dive Supervisor, and
[redacted], Rack Operator.

4. Table 11 was developed to indicate the work hours (WH) and sleep hours (SH) for each of the three individuals. The accident occurred at approximately 2100hrs on July 6, 2002, so the table examines the 24 hour period prior to that time:

Table 11: Analysis of Work and Sleep Hours

	[redacted]	[redacted]	[redacted]
Hours Worked after 2100hrs July 5, 2002	**10.1 Hours Work** 2100 – 2106 (July 5) 0900 – 1900 (July 6)	**12.9 Hours Work** 2128 – 2359 (July 5) 0000 - 0822 (July 6) 1900 – 2100 (July 6)	**6.1 Work Hours** 2128 - 2359 (July 5) 0000 – 0228 (July 6) 1954 – 2100 (July 6)
Hours Slept after 2100hrs July 5, 2002	**7.0 Hours Slept**	**8.0 Hours Slept**	**8.0 Hours Slept**

5. Using the above work and sleep hour data for the 24 hour period preceding the accident, the formula from Policy Letter 5-97, and the fact that none of the individuals exhibited any symptoms of fatigue while on watch, Table 12, Fatigue Index Variables, was developed:

Table 12: Fatigue Index Variables

	[redacted]	[redacted]	[redacted]
S	0	0	0
WH	10.1	12.9	6.1
SH	7.0	8.0	8.0

6. Based on the above data, Fatigue Index Scores were computed for Mr. [redacted], Mr. [redacted], and Mr. [redacted]

a. [redacted]

Fatigue Index Score = (0)(21.4) + (10.1)(6.1) - (7.0)(4.5)
= 0 + 61.61 – 31.5
= **35.61**

b. [redacted]

Fatigue Index Score = (0)(21.4) + (12.9)(6.1) - (8.0)(4.5)
= 0 + 78.69 – 36.0
= **42.69**

c. [redacted]

Fatigue Index Score = (0)(21.4) + (6.1)(6.1) - (8.0)(4.5)
= 0 + 37.21 – 36.0
= **1.21**

Each person's Fatigue Index Score was computed to be less than 50. As a result, and as indicated in Table 13, there is no data to suggest that fatigue was a factor in this casualty.

Table 13: Fatigue Index Scores

	Fatigue Index Score	Greater than or Less Than 50?	Fatigue a Factor?
[redacted]	35.61	Less Than 50	No
[redacted]	42.69	Less Than 50	No
[redacted]	1.21	Less Than 50	No

7. An attempt was made to compute a Fatigue Index Score for Mr. Mouritsen, but the number of sleep hours (SH) that he had in the 24 hour period preceding the casualty could not be determined. Even computing for the worst case scenario, assuming that he did not sleep at all during the 24-hour period prior to the accident, his Fatigue Index Score would still have been less than 50. This also supports the conclusion that fatigue was not a factor in this incident:

Chris Mouritsen

S = 0
WH = 5.3
SH = 0 (Worst Case Scenario)

Fatigue Index Score = (0)(21.4) + (5.3)(6.1) – (0)(4.5)
= 0 + 32.33 - 0
= **32.33**

D. Other possible causes

1. Could the foreign object have worked its way into the regulator while the helmet was sitting out on deck? Yes, this is a possibility. The Standby Diver's helmet is routinely left out on deck after it is connected to the umbilical. The umbilical is coiled up, and the helmet placed on the top of the coil. While it is possible for the foreign object to have entered the regulator while the helmet was on deck, it is the opinion of the Investigating Officer that it is unlikely that this happened. Placing the helmets on deck does expose them to moving personnel, equipment and/or cargo, but not to the mud found throughout the helmet's internal components. A shard of metal could have worked its way into the regulator, but there is no indication that any unusual incident occurred on deck that might have strewn metal around or into the helmet.

2. Could the foreign object have worked its way into the regulator while the helmet was stored in its carry bag? Yes, it is possible. The foreign object could have fallen into the

carry bag that the helmet was stored in and then worked its way into the regulator, but it is the opinion of the Investigating Officer that this is unlikely. The carry bag is normally kept closed and stored, so the chances of an object falling into it are slim at best. While this could explain the foreign object, it still does not explain the fine mud coating on the helmet's internal components.

3. The problem with the above scenarios is that neither offers an explanation as to how mud got so deeply embedded in the helmet. It is highly unlikely that two separate incidents would have occurred one month apart, with the first disabling the defogger/freeflow valve and encrusting the regulator with fine mud, and the second further disabling the regulator by lodging the foreign object in it. The most probable explanation is that the mud and the foreign object entered the helmet at the same time—during the accident of June 6, 2002, when Mr. Mouritsen's helmet was knocked off his head. The quantity of sediment and debris stirred up during that jetting operation was sufficient to account for all the damage done to Mr. Mouritsen's helmet.

4. Could a valve on the dive manifold have closed inadvertently and cut off the air supply? The witness evidence is strongly against this. At the time of the emergency there were three people inside of the dive shack—Mr. [redacted], Mr. [redacted], and Mr. [redacted]. Each of them reported looking at the dive manifold when Mr. Mouritsen said he had no air. While the valves on the manifold are not labeled, they said that the valves were lined up properly and that the air pressure gauge on Mr. Mouritsen's umbilical, which is downstream of the last cut off valve, read 200psi. If any of the air supply valves had been closed accidentally, the pressure gauge for Mr. Mouritsen's umbilical would have read 0psi; instead it read 200psi at the exact moment of the emergency. Based on this, it is clear that when Mr. Mouritsen lost his breathing air, the vessel was still putting 200psi of breathing air into his umbilical and the valves were open.

5. According to statements made by various divers during interviews even if Mr. Mouritsen's air supply had been cut off, there would have been sufficient air remaining in the air hose for him to breathe. As this residual air was bled down, Mr. Mouritsen would have felt a slow and noticeable decrease in the rate of airflow. Some of the divers interviewed said that they had experienced the loss of air either in the field or as a part of the training they received while in dive school. They indicated that they were able to recognize the problem and had sufficient time to react accordingly. This did not happen to Mr. Mouritsen. A diver with his level of experience would have recognized the slow reduction in airflow with sufficient time to react.

6. The air hose in Mr. Mouritsen's umbilical was 600 feet long and had an inside diameter of 3/8th inch. The air pressure in the line at the surface was 200psi. Based on these facts and accounting for the pressure differential at 103 feet of depth, it was computed that slightly more than two cubic feet of breathing air remained in Mr. Mouritsen's air hose at the moment the source of air was cut off (Encl # 47, Jack Vilas & Assoc.- Fax Cover Sheet). This would have been a sufficient volume of air for him to breathe for a short period and note the slow decrease in pressure had the cause been a

closed valve.

7. Could the foreign object have come down from the surface through the breathing air hose in Mr. Mouritsen's umbilical and then into the regulator? The answer to this is clearly that it could not have happened. Both the airhose, which has a 3/8th inch inside diameter, and the fittings on the ends of the airhose are too small for the object to fit through. Even if it had somehow come through the airhose, it could not have traveled through the Bent Tube Assembly and into the regulator with the flow of air. The foreign object is rigid and is too large to fit through the metal bent tube. See Photo 12 below for size comparison. The bent tube has an outside diameter of less than 1/2 of an inch and the foreign object has a diameter of nearly 3/4 of an inch at the narrow point. It cannot physically fit through the metal bent tube:

Photo 13: Foreign Object Compared to Bent Tube Assembly

8. Could the foreign object have been a part of the helmet that was dislodged? Encl # 24 is a schematic of all the parts for the Kirby Morgan Superlite 17B dive helmet. The foreign object was compared to this schematic to see if it matched any of the parts of the helmet. It did not. In addition, while some of the helmet's internal parts were badly worn and in need of servicing, none of them matched the rough and deteriorated condition of the foreign object.

9. Could Mr. Mouritsen's helmet simply have come off, as it did June 6, 2002? Again, the answer is no. The work Mr. Mouritsen was involved in doing on July 6, 2002 was altogether different. He was not using a waterjet, as he had been during the previous

accident, nor was he using any other equipment that could have applied force to his helmet. In the opinion of the Investigating Officer, Mr. Mouritsen's helmet wasn't knocked off; he took it off.

VI. Conclusions

1. The immediate cause of Mr. Mouritsen's death was asphyxia. The asphyxia was precipitated by the fact that Mr. Mouritsen removed his Kirby Morgan Superlite 17B helmet while at a depth of 103 feet without an alternate source of breathing air available. He removed the helmet because it had stopped functioning as a result of simultaneous failures of its demand regulator and its defogger/free flow valve.

2. The demand regulator on the helmet was rendered inoperative by a combination of three problems. A metallic object about the size of a nickel had lodged in it, it was encrusted with fine mud, and the internal roller level was loose. As a result of these problems it was unable to provide Mr. Mouritsen with surface supplied breathing air from the M/V MR. FRED via the umbilical, nor could it provide him with emergency breathing air from the bailout bottle that he carried on his person.

3. The defogger/free flow valve was found to be badly worn and encrusted with fine mud. This made the control knob difficult to operate and rendered the valve unresponsive when the knob was turned. Mr. Mouritsen was apparently unable to actuate it during the emergency despite his success at having used it earlier in the dive. As a result, Mr. Mouritsen suffered a complete loss of airflow within the helmet.

4. Mr. Mouritsen removed his own dive helmet during this casualty. It did not come off of his head unintentionally. Prior to making his last dive on July 6th, 2002, Mr. Mouritsen properly secured the helmet's Alignment Sleeve to the neck dam's Rear Hinge Tab. Mr. [redacted], Mr. [redacted] and Mr. [redacted] all checked the seal on Mr. Mouritsen's helmet prior to the dive and all noted that it was securely attached to the neck dam. During post-casualty testing and inspection, the EDU conducted tests to see if the helmet could be pulled off of the neck dam. They found that when the helmet was properly seated, as it was at the beginning of Mr. Mouritsen's dive, it could not be pulled off. In addition, the umbilical was secured to Mr. Mouritsen's dive harness at the D-Ring, so any tension on the umbilical would have been transmitted to the harness rather than the helmet. Finally, in the videotape it can clearly be seen that the umbilical is slack as events unfold.

5. Only twenty-two seconds elapsed between the time Mr. Mouritsen first said he was out of air and the time he removed his helmet. During this extremely brief period it appears that he tried to follow most of the recommended emergency procedures. He attempted to activate the emergency air supply by opening the auxiliary valve on the helmet and thereby supply air to the demand regulator from his bailout bottle. It appears he also attempted to open the defogger/free flow valve on the helmet. Both of these efforts failed, however, because the demand regulator had been rendered inoperative and the defogger/free flow valve was difficult to operate.

6. It is not known whether Mr. Mouritsen attempted to clear the problem with the demand regulator by pressing the purge button on the regulator's cover. Had he done this it would have left no evidence because, when released, the button would have reset to the normal position. Nevertheless, had he pressed the purge button, it would have failed to provide air because the excessive looseness of the roller lever inside of the regulator had disabled it. In addition, the foreign object and the mud in the regulator also impeded the purge button's operation.

7. One step in the emergency procedures that Mr. Mouritsen did not follow, however, was to slide the pneumofathometer underneath his neoprene neck dam and into his helmet. This would have taken several seconds to do, but it could have provided him with an alternate source of breathing air. Also, the Standby Diver arrived on scene only two minutes and thirty-eight seconds after Mr. Mouritsen first indicated he had a problem. The Standby Diver could have inserted the pneumo into Mr. Mouritsen's helmet had Mr. Mouritsen left his helmet and neck dam on. This would have at least provided a supply of air in the event that Mr. Mouritsen attempted to aspirate while being rescued.

8. The loss of air was so sudden and catastrophic that neither Mr. Mouritsen, nor the Rack Operator, nor the Dive Supervisor had sufficient time to fully react. During the twenty-two seconds that elapsed between the time Mr. Mouritsen first said, "My air, my air, my air, my air" and the time he removed his helmet, everybody did as much as could be expected. When the Rack Operator and Dive Supervisor realized what was happening, they checked all the valves on the dive manifold for proper positioning, they checked the pressure gauges to ensure air was still flowing to Mr. Mouritsen, and then they charged the pneumo. This filled the twenty-two second window.

9. CalDive's Emergency Procedures for the Loss of Breathing Media states that the vessel should, "…have the diver insert the pneumo hose into the helmet." The vessel did not advise him to do this. The accident occurred so suddenly, that by the time the vessel would have been able to give the advice, he had already removed his helmet. The Severance of Diver's Hose Group procedures state that, "If required, diver inserts pneumo hose inside helmet." Mr. Mouritsen did not perform this step in the emergency procedures.

10. The rescue operation was initiated without delay by the Dive Supervisor and went as fast as could be expected. The procedures for the Loss of Breathing Media and the Severance of Diver's Hose Group both require the vessel to send the Standby Diver to assist the diver. The Standby Diver entered the water approximately sixty-five seconds after Mr. Mouritsen first indicated he had a problem. The Standby arrived at Mr. Mouritsen's location at a depth of 107 feet in only one minute and thirty-three seconds after entering the water. Total elapsed time between the point when Mr. Mouritsen first indicated he had a problem with his air and the point when the Standby Diver reached him was two minutes and thirty-eight seconds. The Standby Diver found Mr. Mouritsen unconscious. Mr. Mouritsen's helmet was off and dangling at the end of the umbilical, and his neck dam off and missing. The Standby Diver was not outfitted with any rescue-

related equipment to address the situation, so he immediately brought Mr. Mouritsen to the surface. That was all that could be done at the time.

11. It appears that the various problems with the SuperLite 17B helmet could have been rectified if preventative maintenance had been performed. The safety features built into the helmet to protect a diver from a single point failure were rendered ineffective by this lack of maintenance. The foreign object in the regulator, the deteriorated condition and looseness of the helmet's internal components, and the fine mud that was found encrusted in the defogger and the demand regulator contributed to the failure of the helmet. The heavy wear on the parts inside of the defogger indicates that the helmet was in need of servicing as does the fact that a rust-colored stain had developed in the regulator where the foreign object was found.

12. Kirby Morgan provides a recommended preventative maintenance schedule for the Superlite 17B helmet in section 4.0 of the helmet's Operations and Maintenance Manual (Enclosure # 15, p. 31). The manual recommends that annually or after 400 hours of use the sideblock assembly, including the defogger/freeflow valve, the demand regulator, and the one way valve all be rebuilt. In addition, it recommends that the communications set, main exhaust valve, and other items be replaced at that time. The manual also provides extensive instructions on how to rebuild and/or replace each of the components. At the beginning of section 4.0 the manual adds the statement, "The following service intervals are recommended minimums for helmets being used under good conditions. Helmets used in contaminated water, burning or welding operations, or heavy jetting must be serviced more frequently." Based on this and the fact that Mr. Mouritsen was frequently involved in jetting and burning operations, the maintenance of his helmet should have been more frequent that the 400 hour / annual interval.

13. Kirby Morgan surveyed their authorized service centers in the Gulf coast area and none of them had records indicating that Mr. Mouritsen's helmet had been serviced at any time. Mr. Mouritsen was trained while in dive school on how to service Kirby Morgan helmets, however, so he may have performed some maintenance himself. Based on the condition of the helmet, though, it appears that little maintenance had been performed on it recently.

14. Less critical problems were found with other pieces of Mr. Mouritsen's personal diving gear. These problems did not contribute to the casualty, but they do reflect a pattern of low maintenance:

- The dry bleed valve on the Sherwood first stage regulator attached to the bailout bottle leaked at an excessive rate of 4.5 liters per minute. The manufacturer's specifications allow for 13 to 27 cc leakage per minute. Even though leaking continually, the tank still had sufficient air in it for Mr. Mouritsen to breathe at the time of the accident. The dry bleed valve was also coated with verdigris.

- The 50 cubic foot aluminum bailout bottle was overdue for its hydrostatic test. The bottle, a "DOT – 3AL," is required by 49 CFR 173.34(e) to undergo hydrostatic testing every five years. Mr. Mouritsen's bottle was last hydrostatically tested in April 1997 as indicated by the test date stamped on the cylinder. This made the next test due in April 2002—more than two months prior to the accident. This servicing had not been performed and was overdue at the time of the accident.

- The low-pressure whip that connected the Auxiliary Valve on the helmet to the 1st stage Sherwood regulator on the bailout bottle had a broken outer jacket and needed replacing. The hose itself probably did not leak. Mr. Mouritsen was aware of this problem. He did not replace the hose despite having had another in his possession aboard the vessel and that the problem was pointed out to him by the Standby Diver prior to the dive.

- Lastly, a significant amount of mold was found to have built up inside of the helmet's oral nasal mask. Coast Guard Investigators noted this the morning after the accident when they collected Mr. Mouritsen's dive gear.

15. As a result of the various helmet problems noted above, Mr. Mouritsen was unable to execute the required emergency procedures properly. Specifically, he could not follow CalDive's & the Association of Diving Contractor's (ADC) procedures for Loss of Breathing Media and Severance of Diver's Hose Group. Both of the procedures require the diver to activate the bailout bottle. While Mr. Mouritsen's bailout bottle and auxiliary valve did open, they ultimately could not supply air because the demand regulator and the defogger/free flow valve were both inoperative. He was unable to follow the procedures that Kirby Morgan provides for Helmet Flooding, Inhalation Resistance, and Gas Flow Stops because each requires the diver to activate the Defogger/Free Flow Valve, open the Auxiliary Valve (bailout system), or to press the purge button on the front of the regulator. In all of these instances, the emergency procedures required Mr. Mouritsen to utilize functions on his helmet that had failed.

16. Mr. Mouritsen was in good physical health. He did not suffer from any physical conditions that contributed to this incident.

17. The use of drugs and/or alcohol was not a factor in this incident.

18. Fatigue was not an issue. The people in key positions all indicated that they were well rested. None of them displayed any signs of fatigue. In addition, Fatigue Index Scores for critical personnel were computed and all none were high enough to suggest fatigue was a factor.

19. The life support equipment aboard the M/V MR. FRED operated correctly during the incident. The vessel's air compressors, manifold, volume tank and other gear were tested and inspected and found to be in working order. No evidence of equipment failure was found. When bench tested, some of the relief valves on the compressors did pop early. This was not a factor in the accident, however, because at the time Mr. Mouritsen lost air, all three people in the dive shack noted that the gauges on the Dive Manifold indicated that he was receiving the full 200psi of air as required. The fuel leak on the one

compressor was not a factor in this incident either. The diver before Mr. Mouritsen and the Standby Diver both used the same air source, and neither reported any odors or other problems with the air. Also, the air passed the quality standards specified in the regulations. It was noted, however, that past air quality tests on one of the compressors did not check for the level of hydrocarbons as required by 46 CFR 197.340(i).

20. The tugger did not bind or interfere with the umbilical. This issue was carefully reviewed and it was determined that the tugger did not cause this incident.

21. The dive manifold, which was designed and built by CalDive/Aquatica, was operated correctly and functioned properly. The issue of whether a valve could have been closed accidentally was ruled out because three people in the dive shack at the time of the accident saw that Mr. Mouritsen was receiving the correct pressure of air at the moment of the accident. Both the Dive Supervisor and the Rack Operator checked the positions of the valves on the dive manifold and found them to be correctly aligned. When Mr. Mouritsen lost air, it was sudden and catastrophic. A valve closure would have resulted in a slower bleed down of air due to the volume of pressurized air remaining in the line. In addition, when the Standby Diver entered the water, he was breathing from the same source of air that Mr. Mouritsen was using. He had full pressure and airflow. According to the Rack Operator, the only valve he operated during Mr. Mouritsen's dive was the pneumo. That valve was used only to check Mr. Mouritsen's depth. It was also opened after the casualty occurred to provide an alternate air source for Mr. Mouritsen. The other personnel in the dive shack also stated that they did not see the Rack Operator adjust any valves except the pneumo during the dive.

22. CalDive did not have an effective pre-dive inspection program in place to ensure that problems with diver's helmet were identified and reported. 46 CFR 197.410(a)(2) requires that all equipment, including helmets, be inspected prior to each diving operation. Some pre-dive inspections of the diver's gear were performed, but there were no procedures in place to ensure that thorough inspections were performed. In this case neither the defogger/freeflow valve nor the purge button on Mr. Mouritsen's helmet were inspected. Had those tests been performed and verified, it is likely that the deficiencies with the helmet would have been noted and the dive terminated before Mr. Mouritsen even entered the water. In addition, when less critical problems like the worn low-pressure hose in the bailout system and the leaking bailout bottle were identified, they were not documented, not required to be corrected, and reports were not made to the Dive Supervisor.

23. CalDive filled Mr. Mouritsen's bailout bottle despite the fact that it was leaking and overdue for a hydrostatic test. 49 CFR 173.34(a)(1) states that no one can charge or fill a cylinder unless it has been properly tested. If CalDive had an effective program in place to ensure that divers' equipment was inspected, the expired hydrostatic test would have been noted and the vessel would not have filled the bottle.

24. The foreign object found inside of Mr. Mouritsen's regulator could only have entered it through the Regulator's Breathing Tube. This provided an open and unobstructed

pathway that allowed access to the regulator's internal components from inside of the helmet. This is the only way that such a large object could have worked its way into the regulator. Based on the size and shape of the object, it is concluded that:

- It did not come down from the surface through the umbilical,
- It did not come from the bailout bottle,
- It did not pass through the Bent Tube Assembly in the helmet, and
- It was not a piece of the helmet that had dislodged.

25. The foreign object and the fine mud that were found inside of Mr. Mouritsen's helmet most probably entered during his June 6, 2002, diving accident. During this earlier incident, his helmet was knocked off of his head while jetting in shallow water. The jetting operation stirred up large quantities of sediment and debris that flooded into his helmet after it came off. It was the only time when significant quantities of mud and debris would have had the opportunity to enter the helmet.

26. It does not appear that Mr. Mouritsen had the helmet professionally serviced, nor does it appear that he performed a thorough cleaning of the helmet himself after the June 2002 casualty. Had he done so, some of its problems would likely have been identified and corrected.

27. It is also noted that after the June 6, 2002, incident CalDive/Aquatica required an incident report to be completed, but did not follow-up on the accident by requiring Mr. Mouritsen to have his helmet inspected and/or serviced. He was allowed to make a total of five additional dives without any third party servicing or inspection of the helmet.

28. The June 6, 2002 incident was not reported to the Coast Guard. Casualties involving diver's personal gear are not required to be reported under the requirements of 46 CFR 197.484 or 46 CFR 4.05.

29. There are other possibilities as to where the foreign object came from and how it got into the regulator, but no evidence was found to support the scenarios. It is possible, but unlikely, that the object entered the regulator:

- While the helmet was sitting on deck attached to the Standby umbilical, or
- While the helmet was stored in it's carry bag.

30. 46 CFR 197.456(a)(1) requires the breathing hoses to be pressure tested every twenty-four months. CalDive did not have any records indicating the last time the breathing hose used by Mr. Mouritsen was pressure tested. MISLE Enforcement Activity # 1753037 has been opened to further investigate this matter.

31. Air quality analysis is required to be conducted every six months in accordance with 46 CFR 197.450(a)(1). The standards for the air are contained in 46 CFR 197.340(i) and include the testing for hydrocarbon content. CalDive has been performing the tests every six months as required, but the last set of tests performed prior to the July 6, 2002

accident did not test for hydrocarbon content on one of the compressors.

32. 46 CFR 197.432 requires that a Tender continuously tend the diver and that a Standby Diver be available. The vessel was in compliance with these regulations.

33. The Association of Diving Contractors (ADC) has published Consensus Standards for diving operations. For operations where divers will be breathing surface-supplied air at depths between 80 and 130 feet, the ADC recommends one Dive Supervisor, one Diver, one Standby Diver, and one Tender (Encl # 12, p. 3-25). The Consensus Standards also specify the minimum equipment requirements for air dives in excess of 80 feet (p. 3-27). Both of these standards were met during Mr. Mouritsen's July 6, 2002, dive. In addition, the ADC recommends annual hydrostatic testing of the breathing hoses, but CalDive did not have any records indicating these tests had been performed as stated above.

34. The Dive Tenders and the Standby Diver on duty at the time of the accident were attentive and did not contribute to the casualty. When the rescue operation had to be performed the Standby Diver was ready to go and entered the water quickly. The Rack Operator and the Dive Supervisor on duty in the dive shack were attentive to their jobs and did not contribute to this casualty. The Dive Superintendent/Person in Charge did not contribute to this casualty. It is noted, however, that neither the Dive Supervisor nor the Dive Superintendent was aware of the minor problems with Mr. Mouritsen's dive gear for the reasons noted in conclusion twenty above.

35. The mixed gas dive that Mr. Mouritsen completed on July 5, 2002, was not a factor in this casualty. The dive was conducted properly and there were no residual effects from it in his system. The Decompression Schedule that he followed was correctly performed and completed. The dive tables required him to wait a minimum of eighteen hours before diving again in order to ensure he did not fall into a repetitive dive group. In actuality, a total of twenty-three hours elapsed between the time he exited the hyperbaric chamber on July 5, 2002, and the time he commenced his last dive on July 6, 2002.

36. None of the emergency procedures in CalDive's Dive Safety Manual or ADC's Consensus Standards address failure of a diver's equipment. They all focus on what to do if there is a problem with the vessel's equipment. While this complies with 46 CFR 197.420 (d)(4), it does not address emergencies that originate with the diver's equipment.

37. The Standby Diver was not equipped with any form of substitute breathing media that could have been used under these circumstances. The book, "The Physiology and Medicine of Diving," 4th Edition, published by W. B. Saunders Company and edited by Peter B. Bennett and David H. Elliott, addresses the topic of Diver Rescue starting on page 256 (Encl # 48, "The Physiology and Medicine of Diving"- Fourth Edition, except from Chapter 10). In that section, D. F. Gorman, discusses bringing an unconscious diver to the surface. He refers primarily to divers that breathe through a gas regulator mouthpiece because those regulators often fall out of the mouth when a diver goes unconscious. Mr. Mouritsen, although not using a mouthpiece, was in the same basic circumstances because his helmet had come off. Mr. Gorman writes, "Before swimming

such an unconscious diver to the surface, his mouthpiece should be ventilated free of water (purged) and placed in the diver's mouth, if possible, so that any inspiration will be of gas." Mr. Mouritsen's helmet could not be placed back on his head because he had removed his neck dam. No other source of air was available.

38. The vessel did not have a supply of medical-use oxygen on board. After Mr. Mouritsen was brought back onto the vessel, CPR was performed for one hour. This included time out on the deck and in the hyperbaric chamber. The MR. FRED had the basic first aid equipment required by 46 CFR 197.314 aboard the vessel and the DMT's did use the bag-type resuscitator and mask. In order to administer oxygen out on deck, however, the DMT's had to use oxygen from the vessel's oxygen and acetylene welding system because no medical oxygen was available.

39. Despite the crew's efforts performing CPR, they were not able to revive Mr. Mouritsen.

VII. Recommendations

A. For the U. S. Coast Guard

1. (MISLE Recommendation # 5494) It is recommended that the U. S. Coast Guard amend 46 CFR Part 197 to require vessels engaged in commercial dive operations to carry medical rated oxygen for use during emergencies. In addition, personnel should also be trained and qualified to operate such equipment. This amendment should be included at 46 CFR 197.314(a)(1)(ii) as being an additional supply item required for treating minor trauma and illnesses resulting from hyperbaric exposure.

2. (MISLE Recommendation # 5495) It is recommended that the U. S. Coast Guard amend 46 CFR Part 197 to require vessels engaged in commercial dive operations to carry a portable Automatic External Defibrillator (AED) for use during medical emergencies.

- Modern defibrillators are durable, portable, and require minimal maintenance and training to use.
- According to the American Heart Association's Public Access Defibrillation program they are highly reliable (Encl # 49, and http://216.185.112.41/Cpr_aed/cpr_aed_menu.htm):

  "If the operator has attached the AED to an adult victim who's not breathing and pulseless (in cardiac arrest), the AED will make the correct "shock" decision more than 90 times out of 100 and a correct "no shock indicated" decision more than 95 times out of 100. This level of accuracy is greater than the accuracy of emergency professionals who must read and interpret the rhythms."

If AED's can be used safely in a shipboard environment, they will be an invaluable aid in ensuring the survivability of diving accident victims. AEDs will also be helpful during a variety of other medical emergencies that involve cardiac arrest.

3. (MISLE Recommendation # 5496) It is recommended that the U. S. Coast Guard amend 46 CFR Part 197 to require a separate air supply for the Standby Diver. In this fatal dive case the cause of Mr. Mouritsen's accident was initially not known, yet the Standby Diver entered the water breathing from the same air supply as Mr. Mouritsen. Had carbon monoxide poisoning, carbon dioxide poisoning, or some other contaminant in the air overcome Mr. Mouritsen, the Standby Diver would have suffered the same fate. On p. 257 in the book "The Physiology and Medicine of Diving," Mr. Gorman states that the Standby Diver should have a separate source of gas for this very reason. Rescuing a diver can be compared to rescuing someone from inside of a confined space—if the rescuer is breathing the same contaminated air as the first victim, then the rescuer is liable to become the second victim. Requiring an independent air source for the Standby Diver is the only way to prevent multiple deaths or injuries involving Standby Divers during an emergency. This should also be incorporated into any regulations developed relating to manifold design discussed in Recommendation A-8 (MISLE Recommendation # 5501)

below.

4. (MISLE Recommendation # 5497) It is recommended that the U. S. Coast Guard amend 46 CFR Part 197 to require Periodic and Post Casualty maintenance of dive helmets—preferably by a third party. Had either type of maintenance been performed on Mr. Mouritsen's helmet it is likely that this accident would not have been fatal. Post Casualty maintenance, had it been required, likely would have identified all of the helmet's deficiencies after the June incident—including the foreign object and the mud encrustation problems. Periodic maintenance, even if conducted prior to the June 6, 2002, incident, would at least have found the worn defogger parts and the excessive looseness of the demand regulator's roller lever.

5. (MISLE Recommendation # 5498) It is recommended that the U. S. Coast Guard amend 46 CFR Part 197 to require periodic shipboard drills that address various diving emergencies—including the rescuing of divers. At present different Coast Guard regulations require drills for such things as fires and abandoning ship, but none is required for responding to diving emergencies. The required drills should focus on what the different dive team members aboard the vessel are required to do. Participants should include the Dive Supervisor, dive manifold operator ("Rack Operator"), Standby Diver, and Tenders. In the July 6, 2002 accident that is the subject of this investigation the vessel did not advise Mr. Mouritsen to use the pneumo. Although events unfolded so quickly that this did not impact the casualty, practicing these procedures and developing the correct habits may save lives in the future. This recommendation dovetails with Recommendation A-6 (MISLE Recommendation # 5499) discussed below.

6. (MISLE Recommendation # 5499) It is recommended that the U. S. Coast Guard amend 46 CFR Part 197 to require employers to put divers through periodic training and drills designed to refresh the divers' knowledge of proper procedures for responding to underwater emergencies while at depth. Divers are trained in emergency procedures while attending Dive School, but there are no requirements for refresher training to keep their knowledge and skills current. Mr. Mouritsen appears to have attempted to perform some of the procedures required for loss of air, but he did not insert the pneumofathometer into his helmet. Had he been required to practice loss of gas flow procedures periodically, he might have had a greater chance of surviving this casualty. Requiring companies to put commercial divers through periodic drills or refresher training will accomplish this. This recommendation dovetails with Recommendation A-5 (MISLE Recommendation # 5498) discussed above.

7. (MISLE Recommendation # 5500) It is recommended that the U. S. Coast Guard amend 46 CFR Part 197.420 to require employers to update their Dive Operations Manuals with emergency procedures for responding to failures of a diver's personal gear.

8. (MISLE Recommendation # 5501) It is recommended that the U. S. Coast Guard amend 46 CFR Part 197 to include specifications for the design and construction of dive manifolds. At present the CFR does not specifically address dive manifolds, yet the manifold is the key point in the life support system where all gas inputs are controlled

and distributed to divers. Failure or improper operation of the diving manifold could have serious consequences for a diver in the water. While the manifold was operated properly and performed as designed during this incident, several items were noted:

- Valves, gauges, and gas input and output lines need standardized labeling. A brief look at pages six through nine of this report and the diagrams and photos thereon illustrate the complexity of the system. While companies can still be allowed to design manifolds that best suit their overall diving system, new regulations should at least ensure labeling is required and standardized so that all of the components can be clearly identified.

- The gas flow control valves do not have any method of being secured in either the open or closed position, nor are they labeled or tagged to indicate the position they should be in during an operation. Divers interviewed during this investigation reported that at times in their careers they had either had their own air supply inadvertently cut off while diving aboard other vessels or they were aware that such incidents had happened to other divers. At a minimum, new regulations should simply state that dive manifolds shall be designed so that all valves can be secured in either the open or closed position so as to prevent them from being inadvertently opened or closed. This can be accomplished with a quick-release mechanism.

- The training given to manifold operators ("Rack Operators") is on the job with no classroom time or formal qualification process included. While the Coast Guard does not license "Rack Operators," nor should the Coast Guard license them, it must be recognized that the individual that operates the manifold fills a critical role in the life support system for the diver. At a minimum, new regulations should require companies to establish a qualification process that involves formal training for manifold operators. The training should include operation of the manifold and instructions to the diver during emergencies. The regulations should also require that manifold operators be designated in writing similar to the way the "Person in Charge" is designated in writing. This designation will focus attention on the advanced training of individuals filling this critical position.

9. (MISLE Recommendation # 5502) It is recommended that the U. S. Coast Guard amend 46 CFR Part 197 to increase its casualty reporting requirements for diving incidents. Reporting should be required for operational failures of vessel diving system life support equipment and operational failures of diving helmets. It was clear from this investigation that no steps were taken after the June 6, 2002, incident to ensure that Mr. Mouritsen's helmet was still serviceable. While the June incident would only have fallen under Coast Guard jurisdiction per 46 CFR 197.202 if the dive had been conducted off of a vessel, the July incident was required to be reported by 46 CFR 197.486. The reason it was reportable, however, was because of the fatality involved and not because the helmet failed. Had Mr. Mouritsen not been injured, the incident would have gone unreported under current regulations. The Coast Guard has very few regulations on helmets at the present time, so the collection and evaluation of casualty data will help identify areas for future improvements. Requiring helmet and vessel life support system failures to be

reported will also facilitate the development of preventative measures by commercial dive companies.

10. (MISLE Recommendation # 5503) It is recommended that the U. S. Coast Guard amend 46 CFR Part 197 to require commercial diving vessels to have personnel aboard with professional medical training beyond First Aid, such as a Dive Medical Technician (DMT), during diving operations. The personnel should also be required to have training in the administration of oxygen as discussed in Recommendation A-1 (MISLE Recommendation # 5494) and in the use of AED's as discussed in Recommendation # A-2 (MISLE Recommendation # 5495).

11. (MISLE Recommendation # 5504) It is recommended that the U. S. Coast Guard amend 46 CFR Part 197.410(a)(3) to require the Dive Supervisor to instruct each diver to report problems with the diver's personal equipment prior to each dive. This reporting should include problems with the helmet and the emergency air supply system. Current regulations only require the diver to be instructed to report "…physical problems or physiological effects including aches, pains, current illnesses, or symptoms of decompression sickness prior to each dive."

B. For Kirby Morgan Dive Systems

1. (MISLE Recommendation # 5509) It is recommended that Kirby Morgan Dive Systems redesign the Regulator Body Breathing Tube in the Superlite 17B Dive Helmet to prevent foreign objects from entering it and passing into the regulator.

2. (MISLE Recommendation # 5510) It is recommended that Kirby Morgan Dive Systems update the "Kirby Morgan Superlite-17A/B Diving Helmet Operations and Maintenance Manual." Section 4.0 on page 31entitled, "Inspection Maintenance Timetable for Superlite 17," should include guidance on what the diver should do following any casualty and/or operational failure of the helmet's components. The guidance should require professional inspection and servicing of the helmet and include a warning statement that the helmet should not be used again until such servicing is performed.

C. For CalDive/Aquatica

1. (MISLE Recommendation # 5511) It is recommended that CalDive/Aquatica provide its dive vessels with medical quality oxygen for use during emergencies.

2. (MISLE Recommendation # 5512) It is recommended that CalDive/Aquatica provide its dive vessels with Automatic External Defibrillators (AED's) for use during emergencies.

3. (MISLE Recommendation # 5513) It is recommended that CalDive/Aquatica consider providing a supply of breathing air for the Standby Diver that is independent of the breathing air used by the main diver.

4. (MISLE Recommendation # 5514) It is recommended that CalDive/Aquatica establish requirements for Periodic and Post Casualty maintenance and inspections of helmets and other dive gear.

5. (MISLE Recommendation # 5515) It is recommended that CalDive/Aquatica initiate a program to conduct shipboard emergency drills focused on diving incidents. The drills should practice what the different dive team members aboard the vessel are required to do during the various emergencies and rescue operations that might occur. Participants should include the Dive Supervisor, dive manifold operator ("Rack Operator"), Standby Diver, and Tenders.

6. (MISLE Recommendation # 5516) It is recommended that CalDive/Aquatica initiate a program to require its divers to undergo periodic training and drills to practice emergency procedures. The goal of the training and drills is to enhance the divers' knowledge and abilities to respond properly to underwater emergencies when at depth.

7. (MISLE Recommendation # 5517) It is recommended that CalDive/Aquatica update its Diving Safety Manual to include emergency procedures to be followed in the event that a diver is rendered unconscious and in the event that the life support equipment a diver is using fails—such as a helmet.

8. (MISLE Recommendation # 5518) It is recommended that CalDive/Aquatica review its procedures for maintaining records of equipment tests and inspections performed as required by federal regulations. In particular, breathing air hoses are required to be pressure tested to 1.5 times their MAWP every two years and air quality analysis is required to be performed every six months as per 46 CFR 197.456(a)(1) and 197.450(a)(1), respectively. CalDive had no record of the last pressure test of the breathing air hose used by Mr. Mouritsen. The air quality analyses had been properly performed on two of the three compressors, but there were no records indicating that the air from one compressor was tested for hydrocarbon content within the six months preceding the accident.

9. (MISLE Recommendation # 5519) It is recommended that CalDive/Aquatica establish a pre-dive inspection program to insure that the diving gear used by Divers is properly inspected prior to each dive and that any deficiencies noted are reported to the Dive Supervisor for evaluation before the diver enters the water. The pre-dive inspection should include tests to verify the proper functioning of:

- Purge Button on helmet,
- Defogger/free flow valve on helmet,
- Auxiliary Valve on helmet,
- Communications system in helmet, and

- Bailout system

CalDive/Aquatica should also verify that the equipment used by divers, such as bailout bottles, has been properly serviced in accordance with federal regulations and that the servicing is current.

10. (MISLE Recommendation # 5520) It is recommended that CalDive/Aquatica review its procedures for conducting jetting operations. While the June 6, 2002, incident was not the focus of this investigation, it is apparent that the accident and the jetting operations that Mr. Mouritsen was involved in were a contributing factor in the July 6, 2002, fatal accident.

D. For the Association of Diving Contractors and Diver's Alert Network

1. (MISLE Recommendation # 5521) It is recommended that the Association of Diving Contractors develop consensus standards for the carriage of medical quality oxygen aboard vessels as well as standards for training dive team members in its use.

2. (MISLE Recommendation # 5522) It is recommended that the Association of Diving Contractors evaluate the feasibility of carrying AED's onboard commercial dive vessels. If feasible, then it is recommended that the ADC develop consensus standards for their carriage and use, as well as standards for the training of dive team members in how to use an AED.

3. (MISLE Recommendation # 5523) It is recommended that the Association of Diving Contractors evaluate the feasibility of providing a supply of breathing air for the Standby Diver that is independent of the breathing air used by the main diver. If feasible, then it is recommended that the ADC develop consensus standards for this.

4. (MISLE Recommendation # 5524) It is recommended that the Association of Diving Contractors develop consensus standards for requiring Periodic and Post Casualty inspections and maintenance of diving helmets and bailout systems.

5. (MISLE Recommendation # 5525) It is recommended that the Association of Diving Contractors develop consensus standards that require member companies to conduct shipboard drills focused on diving incidents. The drills should practice what the different dive team members aboard the vessel are required to do during the various emergencies and rescue operations that might occur. Participants should include the Dive Supervisor, dive manifold operator ("Rack Operator"), Standby Diver, and Tenders.

6. (MISLE Recommendation # 5526) It is recommended that the Association of Diving Contractors develop consensus standards that require member companies to put divers through periodic training and drills to practice emergency procedures. The goal of the training and drills is to enhance the divers' knowledge and abilities to properly respond to

underwater emergencies when at depth.

7. (MISLE Recommendation # 5527) It is recommended that the Association of Diving Contractors develop consensus standards that require member companies to update their Diving Operations/Safety Manuals. Updates should include emergency procedures to be followed in the event that a diver is rendered unconscious and in the event that the life support equipment a diver is using fails—such as a helmet.

8. (MISLE Recommendation # 5528) It is recommended that the Association of Diving Contractors develop consensus standards for dive manifolds. Standards should include labeling, methods for securing valves in place with quick releases, and the training of Rack Operators.

9. (MISLE Recommendation # 5529) It is recommended that the Association of Diving Contractors and Diver's Alert Network review this case to see if new equipment and/or emergency procedures might be developed to increase the chances of survival of a diver found unconscious and with no breathing media. The issue of making some form of breathing media available to an unconscious diver is worthy of consideration. In particular it is recommended that consideration be given to developing a portable air supply that the Standby Diver or other Rescue Diver can carry and place on the victim insitu. With such a device an unconscious victim would have a supply of breathing air in the event that the victim attempted to inhale while being brought to the surface.

E. Miscellaneous

1. (MISLE Recommendation # 5530) It is recommended that the U. S. Coast Guard send a copy of this report to the family of Mr. Mouritsen:

[redacted]

2. (MISLE Recommendation # 5531) It is recommended that the U. S. Coast Guard send a copy of this report to the U. S. Navy Experimental Diving Unit at

Commanding Officer
Attn: Mr. [redacted]
U. S. Navy Experimental Diving Unit
321 Bullfinch Road
Panama City, FL 32407-7015

3. (MISLE Recommendation # 5532) It is recommended that the U. S. Coast Guard send a copy of this report to CalDive/Aquatica at:

[redacted]

President
Aquatica, Inc
3209 Moss Street
Lafayette, LA 70509

4. (MISLE Recommendation # 5533) It is recommended that the U. S. Coast Guard send a copy of this report to Vilas & Associates at:

Mr. [redacted]
President
Jack Vilas & Associates, Inc.
701 Federal Avenue
Morgan City, LA 70380

5. (MISLE Recommendation # 5534) It is recommended that the U. S. Coast Guard send a copy of this report to the Association of Diving Contractors (ADC) at:

Association of Diving Contractors International
Attn: Safety, Medical & Education Committee
5206 FM 1960 West
Suite 202
Houston, TX 77069

6. (MISLE Recommendation # 5535) It is recommended that the U. S. Coast Guard send a copy of this report to Diver's Alert Network at:

Divers Alert Network
The Peter B. Bennett Center
6 West Colony Place
Durham, NC 27705

7. (MISLE Recommendation # 5536) It is recommended that the U. S. Coast Guard send a copy of this report to Kirby Morgan Dive Systems, Inc at:

Kirby Morgan Dive Systems, Inc.
425 Garden Street
Santa Barbara, CA 93101

8. (MISLE Recommendation # 5537) It is recommended that the U. S. Coast Guard send a copy of this report to Diver's Institute of Technology at:

Divers Institute of Technology
4315 11th Avenue NW
P. O. Box 70667
Seattle, WA 98107

VIII. List of Enclosures

Encl #:	**Enclosure Title:**
1.	CG-2692 (Rev. 6-87) "Report of Marine Accident, Injury or Death"
2.	CG-841 (Rev. 4-2000) "Certificate of Inspection"
3.	Diver Air System Review – M/V MR. FRED (O/N 522170)
4.	Gates Breathing Hoses Technical & Application Information
5.	Follow up interview – [redacted]
6.	Follow up interview – [redacted]
7.	Cal Dive International Diving Safety Manual (Excerpt)
8.	Transcripts from Diver's Institute of Technology
9.	Diving Experience Checklist – Chris Mouritsen
10.	Physical Examination – Chris Mouritsen
11.	Annual Chemical Test (DOT) – Chris Mouritsen
12.	Association of Diving Contractors International – Consensus Standards for Commercial Diving Operations (Excerpts)
13.	Telephonic interview with Jack Vilas
14.	Receipts in to the replacement of Chris Mouritsen's Hardhat
15.	Kirby Morgan SuperLite 17 A/B Diving Helmet
16.	Cal Dive/Aquatica Daily Reports
17.	Bridge Logs – M/V MR. FRED
18.	Cal Dive International – Job Safety Analysis
19.	Aquatica – Dive Sheets
20.	Follow up interview – [redacted]
21.	Follow up interview – [redacted]
22.	Personal Belongings Inventory – Chris Mouritsen
23.	Follow up interview – [redacted]
24.	Exploding Diagram – SuperLite 17 A/B Helmet
25.	Follow up interview – [redacted]
26.	Transcript of Videotape of Dive Incident
27.	Follow up interview – [redacted]
28.	Initial Statement – [redacted]
29.	Follow up interview – [redacted]
30.	Follow up interview – [redacted]
31.	Initial Statement – [redacted]
32.	Initial Statement – [redacted]
33.	Initial Statement – [redacted]
34.	Chain of Custody Forms for Chris Mouritsen's Dive Equipment
35.	Autopsy Report (426-02-SM) – Chris Thomas Mouritsen
36.	Jack Vilas & Associates, Inc – Report of Dive Equipment Test
37.	Hydrocarbon Computations
38.	Cal Dive/Aquatica Certificate of Air Analysis – CDV 116
39.	Cal Dive/Aquatica Certificate of Air Analysis – CDV 197
40.	Cal Dive/Aquatica Certificate of Air Analysis – CDV 107
41.	Navy Experimental Diving Unit – Report on Dive Equipment Tests

42. A & M Technical Services, Inc.– Report on Foreign Object Body (FOB)
43. Cal Dive International – Incident Report – June 6, 2002
44. Interview Summary – [redacted]
45. Commercial Diver Log Book – Chris Mouritsen
46. Follow up interview – [redacted]
47. Jack Vilas & Assoc.- Fax Cover Sheet
48. "The Physiology and Medicine of Diving"- Fourth Edition
49. Case for Public Access Defibrillation (PAD) Programs

<u>Encl #:</u> **<u>Additional Enclosures:</u>**

50. Video Tape of Dive Incident (July 6, 2002)
51. Cal Dive International – Incident Report
52. Initial Statement – [redacted]
53. Initial Statement – [redacted]
54. Initial Statement – [redacted].
55. Initial Statement – [redacted]
56. Initial Statement – [redacted]
57. Initial Statement – [redacted]
58. Initial Statement – [redacted]
59. Follow up interview – [redacted]
60. Follow up interview – [redacted]
61. Copy of the Platform Structure Diagrams
62. Aquatica - Chamber Log Sheets
63. Information on the search for C. Mouritsen's Neck Dam
64. Telephonic interview – [redacted]

IX. Index

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