

Use of Surface-Supplied Gas for Scientific Diving



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Environmental Response Team (ERT) Lockheed Martin SERAS

- ERT Established in 1978
- 41 Experienced Responders
- About 75 Dedicated Lockheed Martin Contractors
- Focus: “Classic Environmental” Emergencies



Sampling/monitoring

Characterization

Hazard Evaluation

Decon/Disposal

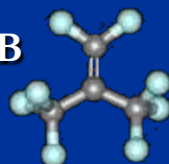
Risk Assessment/Safety



2-chloro-6-fluorophenol



PFIB



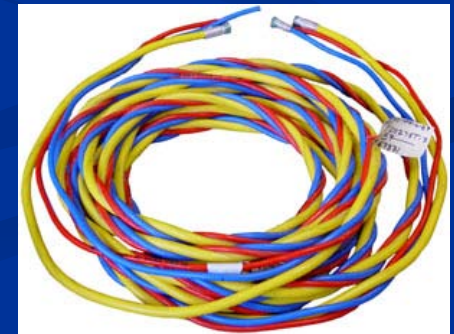
ERT Dive Support

- Contaminated and Clean Water Dive Operations
- ERT's Divers Support a Variety of Agency Needs
 - Benthic Habitat Assessments/Coral Research
 - Survey of Ocean Dredge Disposal Sites
 - Environmental Criminal Investigations
 - Sunken Drums
 - Multimedia Aquatic Sampling
 - SUPERFUND Assessments
 - Biological Assessments



What is Surface-Supplied Diving?

- Surface-Supplied Air to Diver via Umbilical
 - Virtually Unlimited Air Supply
 - Tanks or Compressors
- Diver Carried Air tanks for Emergency Gas Supply (EGS) Only
- Three Part Umbilical
 - Breathing Gas Hose
 - Pneumofathometer (pneumo) Hose
 - Communication line (comm line)/Strength Member
- Surface Control Box/Station
- Dive Controlled By Surface as Opposed to Diver



Equipment

- AIR SUPPLY

- SCUBA Tanks
- Air Bank
 - Large Banks – slower air usage
 - Safer and less tank switching
- Compressor
 - High Volume; Low Pressure
 - Back up with Compressed Air
 - Air Testing/Compressor Maintenance
- Air or Nitrox* May be Used for a Breathing Gas



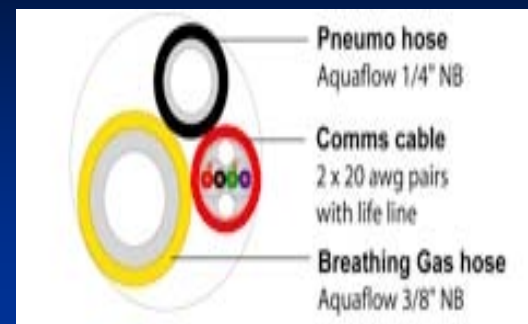
*As approved by equipment manufacturer

Equipment

- Dive Umbilicals

- Sinking or Floating
- Smooth Polyurethane Spiral-Wound
- Length Typically Ranges from 150 to 500 feet
- Three Part Umbilical

- *Air Line (Typically 300 psi and 3/8 inch ID)*
- *Pneumofathometer (pneumo) Hose*
- *Communication line (comm line)/Strength Member*



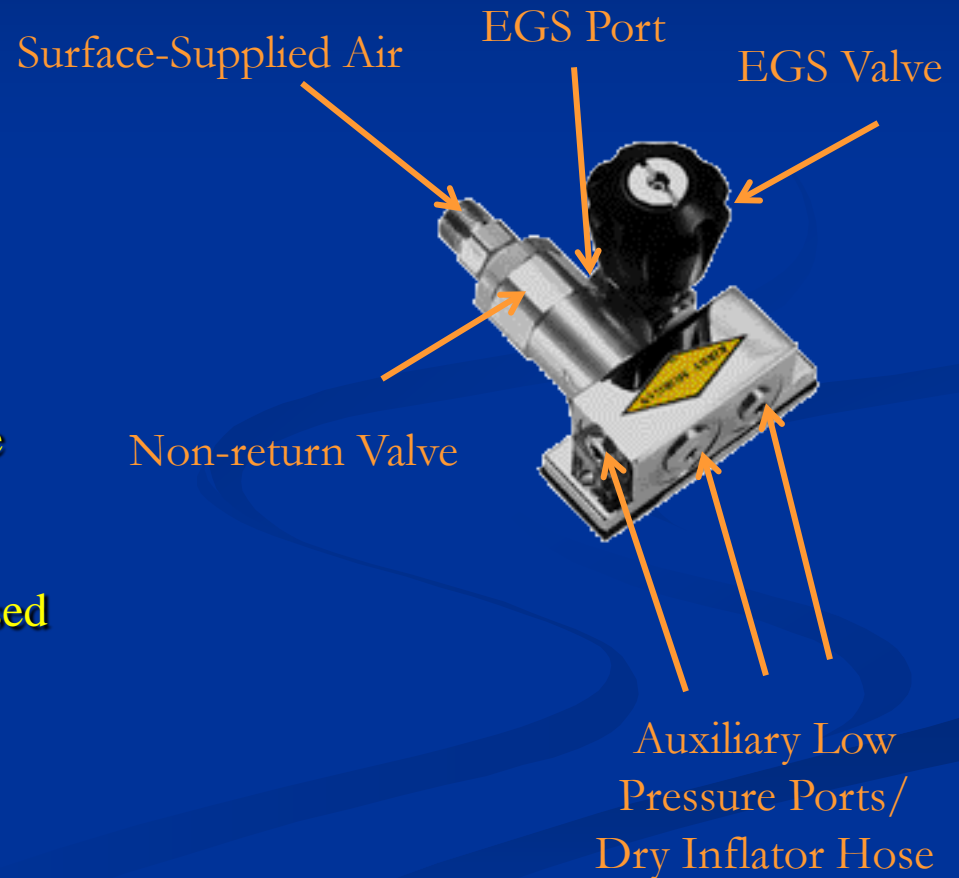
Equipment

- Emergency Gas Supply (EGS)
 - SCUBA Tank (Bail-Out Bottle) Worn by Diver
 - Size May Range from 6 to 80 Cubic Feet
 - Size Dependant Upon Dive Profile and Dive Environment
 - Attached to Manifold Block
 - Pressure Checked and Open at Start of Dive
 - Visible Tank Pressure Gauge
 - Over Pressure Relief Valve on First-Stage Regulator
 - Prevents hose failure if First Stage Reg. Fails
 - Accumulation Bottle
 - Small Bottle Used with Light Weight (1/4") Umbilicals



Equipment

- **Manifold Block**
 - **Must Always be Accessible to Diver**
 - **Helmet or Harness Mounted**
 - **Multiple Ports**
 - *Surface-Supplied Air*
 - *Non-return Valve or One-way Valve*
 - **Tested Prior to Every Dive**
 - *EGS*
 - **EGS Valve MUST be Closed Until Needed**
 - *Dry Suit Inflator Hose*
 - *Auxiliary Low Pressure Ports*



Equipment

- **Harness**
 - **Must Always Be Worn for Surface-Supplied Dive Operations**
 - **Attachment Point for:**
 - **Comm. Line/Strength Member**
 - **EGS/Bail-out Bottle**
 - **Possibly Manifold Block**
 - **Allows Diver Be Safely Pulled to Point of Entry in an Emergency**
 - **No Strain on Vital Gas or Communication Links**



Equipment



- **Helmet or Full Face Mask**
 - Required for Communications During Surface-Supplied Air Dives
 - **Helmet**
 - Head Protection
 - Potentially Better Protection from Contaminates when Mated to Dry Suit
 - Potentially Increased Air Consumption Rates
 - **Full Face Mask**
 - Less Cumbersome
 - Diver Remains more Mobile

Equipment

- Surface Control Box

- Dive is Controlled On Surface

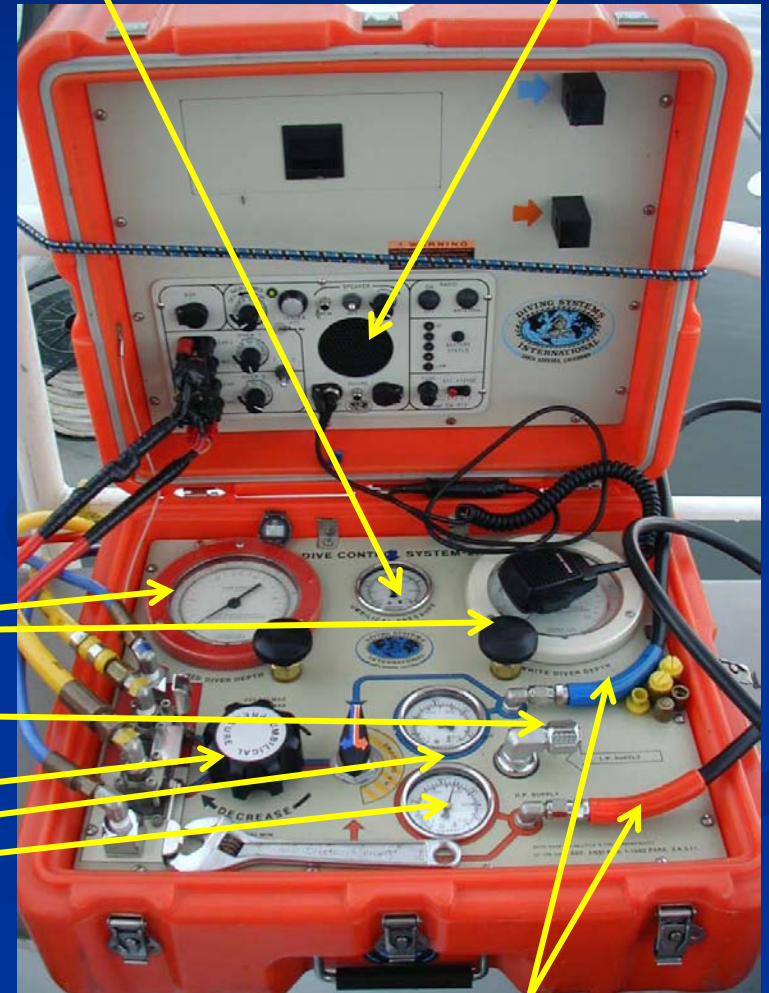
Not By Diver

- Box Operator Monitors and Controls:

- Duration/Timing of Dive
- Diver Depth
- Air Supply to Diver
- Communication with Diver

Umbilical Pressure Gauge

Communication Box



Pneumo Gauges

Compressor Inlet

Umbilical Pressure Control Knob

Tank Pressure Gauges

Hoses to Air Tanks

Dive Team

- Minimum 4 Person Dive Team
 - Multiple Dives/Deeper Dives Require Additional Team Members
 - Two Divers in Water = 6 Person Team
 - Each Diver in Water Needs a Dedicated Tender
 - Dive Team Roles:
 - Diver
 - Stand-by Diver
 - Tender
 - Control Box Operator
 - Divemaster/Dive Supervisor
 - May also act as Control Box Operator or Tender
 - Must be on Surface – Not in Water While Overseeing Operations



Dive Team Responsibilities

- Diver
 - Diver Must Assure All Gear is Present and in Working Order Prior to the Dive
 - Understanding and Implementing Dive Plan
 - Performing In-Water Work
 - Remain Focused on Completing Tasks is NOT Burdened with Monitoring Depth, Bottom Time and Air Pressures
 - Be in Communication with Box Operator



Dive Team Responsibilities

- **Stand-by Diver**
 - **MUST Be Ready to Enter Water PROMPTLY in Case of Emergency**
 - **Typically the Next Diver in the Rotation**



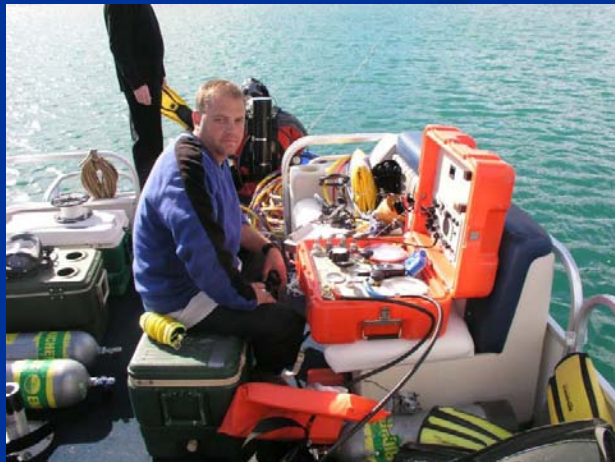
Dive Team Responsibilities

- Tender
 - Assist Diver Continuously (Preparation, During Dive, After Dive)
 - Maintain Control of Dive Umbilical
 - Move Freely, But Not Present Entanglement Hazard
 - Tracking Divers Location in Water at ALL Times
 - Watching For Vessel or Other Hazards Enter Dive Area
 - Must Be Trained to Perform Function



Dive Team Responsibilities

- Control Box Operator
 - Dedicated Person Who is Responsible For:
 - Maintaining Sufficient Breathing Gas Delivery to Diver
 - Track Divers Profile (Depth and Bottom Time)
 - Ensure Diver Does Not Exceed Depth or Time Limits
 - Communications With Diver, Tender and Divemaster/Dive Supervisor



Dive Team Responsibilities

- **Divemaster/Dive Supervisor**
 - Overall Person Responsible For Daily Dive Operations
 - May Also Fill Role of Surface Control Box Operator or Tender
 - If Diving, Must Designate Acting Divemaster/Dive Supervisor While In Water
 - Coordinating Between All Team Members While Implementing Dive Plan



Scientific Diving Operations

- Unit Specific SOPs or Consensus of Standards
 - EPA Diving Safety Manual
 - ERT/EPA Surface-Supplied Air SOPs
- Compliance with OSHA Regulations or Dive Program Requirements
- Dive Plan and Health and Safety Plan
- Check Lists/Pre-Dive Checks
- Suitable Work Area/Work Vessel
- Access To Water – Diver Entry/Egress
- Dive Team Rotation – Efficient and Safe Operations



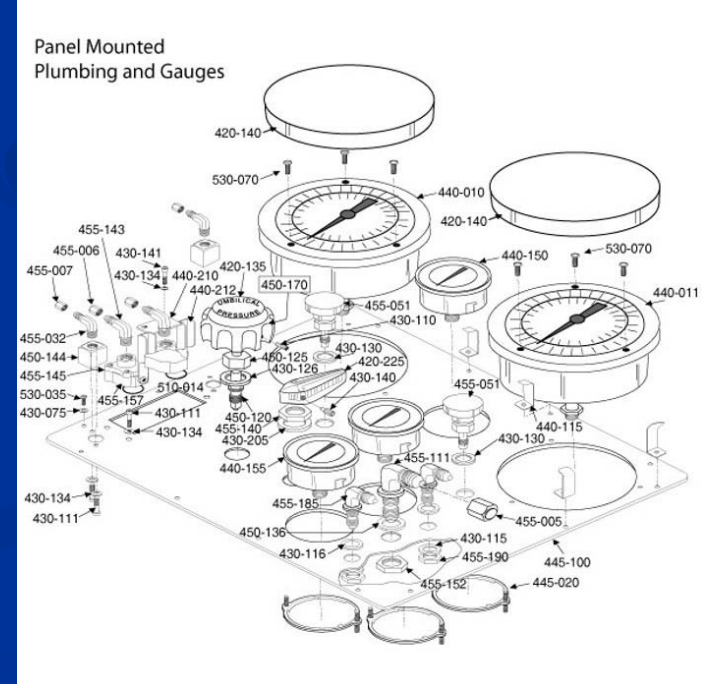
Training and Experience

- All Team Members Must Be Trained and/or Have Suitable Experience Performing Roles on Dive Teams
- Initial and Annual Training with Equipment and Procedures
- Training Occurs In Controlled and Safe Environment NOT on the Job Site!
- Equipment Specific and Emergency Procedures
- Classroom and Hands On Training



Equipment Maintenance

- Daily, Weekly and Annual Equipment Maintenance
- Control Box Serviced on Annual Basis or as Recommended by Manufacturer
- Dive Umbilical Annual Pull and Pressure Test (1.5 x Working Pressure)
- Helmets and Full Face Masks



Modes of Diving

- **SCUBA (Old Reliable)**

- Maximum Diver Mobility
- Least Equipment and Training Intensive
- Ideal for Shallow Dives Where Objectives Can Be Completed With Air In SCUBA Tank



- **Tethered SCUBA (Some Significant Improvements Over SCUBA)**

- Some Additional Equipment and Training Costs
- Always a Line From Surface to Diver
- Improved Communication (Hardwired) – Surface Documentation of Diver Data
- Direct Divers to Targets Using Umbilical and Communications
- Hold Diver in Position in Strong Currents (SCUBA typically limited to < 1 knot)
- Decreasing Diver Mobility (situational)

- **Surface Supplied Air – All of Line-Tended and.....**

Advantages of Using Surface Supplied Air

- **DIVER SAFETY - Virtually Unlimited Air to Diver**
 - Single Greatest Hazard to Diver is Running Out of Air - This Hazard is Greatly Reduced
 - Extended Time If Needed for Decontamination
- **Diver is NOT Limited to Bottom Times Based On Air that can be Carried**
 - No Need to Interrupt Dive and Return to the Surface Just to Change Tanks
 - Minimizes Unnecessary Bounce Dives and Risks Associated With Divers Entering and Exiting the Water



Advantages of Using Surface Supplied Air

- **Diver Can Fully Concentrate on Completing Objectives**
 - Bottom Time, Depth and Air Pressure Monitored on Surface
 - Can Be Monitored on Surface Even in Zero Visibility
- **Some Tasks Can be Completed More Efficiently and Safely Using a Single Diver – Especially in Low/Zero Visibility Environments**
- **Diver Will Need to Carry Less Weight – No SCUBA Tanks Just Project Appropriately Sized EGS (routinely 13 to 29 Cubic Feet)**



Disadvantages of Using Surface Supplied Air

- Additional Equipment
- Additional Training
- Larger Dive Team
 - Typically Four Person Dive Team
- Umbilical Drag or Limited Diver Range
 - Diver Range = Umbilical Length – Depth
 - Diver Range = 40' = 150' – 110'
 - With 150' Umbilical in 110' feet of water



Resources for Scientific Diving Using Surface Supplied Air

- U.S. EPA Dive Units
 - Environmental Response Team (ERT)
 - Alan Humphrey (Humphrey.Alan@epa.gov)
 - Scott Grossman (Scott.C.Grossman@lmco.com)
 - Region 10
 - Sean Sheldrake (Sheldrake.Sean@epa.gov)
 - www.epa.gov/region10/dive
 - US EPA Diving Safety Manual
 - EPA Standard Operating Procedures