

A Guide to Public Safety Diving



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Acknowledgments

A Guide to Public Safety Diving has been prepared with materials and information from the General Industry Standards, 29 CFR 1910, Subpart T—Commercial Diving Operations, and OSHA Instruction CPL 02-00-151 (U.S. Department of Labor, Occupational Safety and Health Administration). This guide also contains information from sources such as U.S. Navy Diving Manual, National Association of Search and Rescue, California Department Fish and Game Diving Safety Manual, and the National Fire Protection Association, NFPA 1670—Standard on Operations and Technical Search and Rescue.

Through an existing alliance established between the N.C. Department of Labor's Occupational Safety and Health Division and the North Carolina Public Safety Divers' Association (PSDA), a collaborative effort was established to make this guide possible. The PSDA board of directors provided expertise involving public safety diving in sharing best practices and technical knowledge.

A special thanks to Chuck Elgin, North Carolina Underwater Response Team, for his dedication and hard work assisting in the development of this publication.

This guide is intended to be consistent with all existing OSHA standards; therefore, if an area is considered by the reader to be inconsistent with a standard, then the OSHA standard should be followed.

To obtain additional copies of this guide, or if you have questions about North Carolina occupational safety and health standards or rules, please contact:

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Phone: 919-807-2875 or 1-800-NC-LABOR (1-800-625-2267)

Additional sources of information are listed on the inside back cover of this guide.

The projected cost of the NCDOL OSH program for federal fiscal year 2011–2012 is \$17,841,216. Federal funding provides approximately 31 percent (\$5,501,500) of this total.



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Foreword

The term “public safety diving” is a generic term used to describe the underwater work conducted by law enforcement, fire rescue, and search and rescue/recovery dive teams. Public safety divers (PSDs) are different from recreational divers in many aspects. Unlike a recreational diver who can plan the date, time and location of a dive, PSDs respond to emergencies 24 hours a day, seven days a week, including holidays and weekends. It is not uncommon for PSDs to dive in the middle of the night, during inclement weather, in zero visibility “black water,” or in waters contaminated by chemicals and biohazards.

Public safety diving personnel are exposed to significant hazards and risks when engaging in an active dive operation and during training. Divers are often in a zero visibility environment under extreme physical and mental conditions. Hazard analysis and risk assessment of the dive area is always a factor to determine if a dive operation should take place (NFPA 1670, 1999).

A Guide to Public Safety Diving can help diving supervisors, dive safety officers, public safety divers and many others review safe procedures for public safety diving.

In North Carolina, the N.C. Department of Labor enforces the federal Occupational Safety and Health Act through a state plan approved by the U.S. Department of Labor. NCDOL offers many educational programs to the public and produces publications to help inform people about their rights and responsibilities regarding occupational safety and health.

When reading this guide, please remember the mission of the N.C. Department of Labor is greater than just regulatory enforcement. An equally important goal is to help citizens find ways to create safe workplaces. Everyone profits when managers and employees work together for safety. This booklet, like the other educational materials produced by the N.C. Department of Labor, can help.

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Commissioner of Labor

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Introduction

This guide has been prepared as an aid to public sector employers that employ dive teams, with information and guidance to help them protect employees' health and safety, particularly in reducing and preventing exposure to recognized occupational hazards.

Public safety diving is a diving operation performed solely for search, rescue, recovery, investigation or related public safety purposes conducted by divers working for or under the control of a governmental agency.

Federal OSHA received a number of comments from people engaged in diving incidental to police and public safety functions, and the agency concluded that an exclusion from 29 CFR 1910, Subpart T—Commercial Diving was appropriate for such applications. The purpose of the “by or under the control of a governmental agency” language is to make the exclusion applicable to all divers whose purpose is to provide search, rescue or public safety diving services under the direction and control of a governmental agency (such as local, state or federal government) regardless of whether such divers are, strictly speaking, government employees. In excluding these search and rescue operations, OSHA determined that safety and health regulation of the police and related functions are best carried out by the individual states or their political subdivisions. It is pointed out that this exclusion does not apply when work other than search, rescue and related public safety diving is performed (such as divers repairing a pier). Diving contractors who occasionally perform emergency services, and who are not under the control of a governmental agency engaging their services, do not come under this exclusion. Such divers may, however, be covered by the provision concerning application of the standard in an emergency (29 CFR 1910.401(b)).

Definition of Terms

As used in this industry guide, the listed terms are defined as follows:

ACFM: Actual cubic feet per minute.

Air sharing: The sharing of an air supply between divers.

ASME Code or equivalent: ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel Code, Section VIII, or an equivalent code that the employer can demonstrate to be equally effective.

ATA: Atmosphere absolute.

Bell: An enclosed compartment, pressurized (closed bell) or unpressurized (open bell), that allows the diver to be transported to and from the underwater work area and which may be used as a temporary refuge during diving operations.

Boat operator: The person controlling a vessel during boating operations.

Bottom time: The total elapsed time measured in minutes from the time when the diver leaves the surface in descent to the time that the diver begins ascent.

Bounce dive: A dive to a maximum depth with an immediate return to the surface.

Breathing air supply system: A system including reserve breathing air supplies, compressors, cylinders, hoses, mask, manifold/switch blocks, "J" valves, helmets, diver carried gauges and monitoring equipment.

Buddy diver: Second member of the buddy system.

Buddy system: Two comparably equipped scuba divers in the water in constant communication.

Buoyant ascent: An ascent made using some form of positive buoyancy.

Buoyancy control device (BCD): A floatation type vest that will allow the diver to establish neutral buoyancy in the water column.

Burst disk: Part of the valve, this safety device releases the air from the cylinder if it accidentally gets too much pressure in it.

Bursting pressure: The pressure at which a pressure containment device would fail structurally.

CERCLA: Comprehensive Environmental Response, Compensation and Liability Act.

Certified diver: A diver who holds a recognized valid certification from an organizational member of a recognized certifying agency.

Certified technician: A person capable of inspecting, repairing, and overhauling diving equipment and is skilled and trained to the manufacturer's specifications.

Closed circuit diving: Diving in which the breathing air is recirculated, scrubbed and rebreathed.

Competent person: A person who is capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous or dangerous to employees and who has authorization to take prompt corrective measures to eliminate them.

Compressor: A machine used to compress air to elevated pressures. This air is normally stored in cylinders for diver use.

Confined space:

- A. Is large enough and so configured that an employee can bodily enter and perform assigned work; and
- B. Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults and pits are spaces that may have limited means of entry); and
- C. Is not designed for continuous employee occupancy.

Controlled ascent: Any one of several kinds of ascents including normal, swimming, and air sharing ascents where the diver(s) maintain control so a pause or stop can be made during the ascent.

Cutting tool: A handheld cutting device; may include, but is not limited to, a dive knife or shears.

Cylinder: A pressure vessel for the storage of air.

Decompression chamber: A pressure vessel for human occupancy such as a surface decompression chamber, or deep diving system used to decompress divers and to treat decompression sickness.

Decompression sickness: A condition with a variety of symptoms that may result from gas or bubbles in the tissues of divers after pressure reduction.

Decompression table: A profile or set of profiles of depth-time relationships for ascent rates and breathing mixtures to be followed after a specific depth-time exposure or exposures.

Dive: A descent into the water, an underwater diving activity utilizing compressed air, ascent and return to the surface.

Dive computer: A microprocessor based device that computes a diver's theoretical decompression status, in real time, by using pressure (depth) and time as input to a decompression model, or set of decompression tables, programmed into the device.

Dive location: A surface or vessel from which a diving operation is conducted.

Dive-location reserve breathing air: A supply system of air at the dive location that is independent of the primary supply system and sufficient to support divers during the planned decompression.

Dive plan: A prearranged sequence of underwater events constituting the anticipated dive. The dive plan must incorporate emergency planning.

Dive platform: A surface or vessel from which a diving operation is conducted.

Dive safety officer (DSO): A competent member responsible for monitoring and assessing safety hazards or unsafe situations and for developing measures for ensuring dive team safety.

Dive site: The physical location of a diver during a dive.

Dive tables: See "Decompression table."

Dive team: Divers and support team members involved in a diving operation, including the designated person-in-charge.

Dive team leader: The certified public safety diver with experience and training to conduct the diving operation.

Diving: See "Dive."

Diving mode: A type of diving requiring specific equipment, procedures and techniques (scuba or surface-supplied air).

Diving supervisor: Diver with sufficient experience and demonstrated ability to supervise divers for the purpose of completing training, certification dives or mission dives.

Diver: An employee working in water using underwater apparatus that supplies compressed breathing air at the ambient pressure.

Diver-carried reserve breathing air: A diver-carried independent supply of air sufficient under standard operating conditions to allow the diver to reach the surface or another source of breathing air or to be reached by another diver.

Diver-in-training: An individual gaining experience and training in additional diving activities under the supervision of a dive team member experienced in those activities.

Emergency ascent: An ascent made under emergency conditions where the diver exceeds the normal ascent rate.

FFW: Feet of freshwater (or equivalent static pressure head).

FSW: Feet of seawater (or equivalent static pressure head).

Hazardous substance: Any substance designated or listed under A through D of this definition, exposure to which results or may result in adverse effects on the health or safety of employees:

- A. Any substance defined under section 101(14) of CERCLA;
- B. Any biologic agent or other disease-causing agent that after release into the environment and upon exposure, ingestion, inhalation or assimilation into any person, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformations in such individuals or their offspring;
- C. Any substance listed by the U.S. Department of Transportation as hazardous materials under 49 CFR 172.101 and appendixes; and
- D. Hazardous waste as herein defined.

Hazardous waste:

- A. A waste or combination of wastes as defined in 40 CFR 261.3, or
- B. Those substances defined as hazardous wastes in 49 CFR 171.8.

Health hazard: A chemical, mixture of chemicals or a pathogen for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term “health hazard” includes chemicals that are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, and neurotoxins, agents that act on the hematopoietic system, and agents that damage the lungs, skin, eyes or mucous membranes. It also includes stress due to temperature extremes. Further definition of the terms used above can be found in Appendix A to 29 CFR §1910.1200.

Hookah diving: A type of shallow water surface-supplied diving where the diver uses the second stage of a scuba regulator and hose connected to a surface air source.

Hyperbaric conditions: Pressure conditions in excess of surface pressure.

Incident commander: The individual responsible for the overall management of the response.

Inwater stage: A suspended underwater platform that supports a diver in the water.

Lifting bag: An item of diving equipment consisting of a robust and airtight bag with straps that is used to lift heavy objects underwater by means of the bag’s buoyancy.

Line-tended: The diver is connected to the surface, drop line or dive buddy via a safety line (at least 3/8 inch diameter) or umbilical.

Liveboating: The practice of supporting a surfaced-supplied air diver from a vessel that is underway.

Manifold/switch block: A switch block allows a diver to change between two separate air tanks without having to remove his or her full face mask.

Maximum working pressure: The maximum pressure to which a pressure vessel may be exposed under standard operating conditions.

MFW: Meters of fresh water (or equivalent static pressure head).

MSW: Meters of seawater (or equivalent static pressure head).

Mixed-gas diving: A diving mode in which the diver is supplied in the water with a breathing gas other than air.

NIOSH: National Institute for Occupational Safety and Health.

No-decompression limits: The theoretical depth-time limits of a dive, specified by a table or model, from which a diver can return directly to the surface at a control rate without being required to spend time at shallower depths to allow inert gas to be eliminated from the body.

Normal ascent: An ascent made with an adequate air supply at a rate of 60 feet per minute or less.

Open circuit scuba: No portion of the breathing air is rebreathed.

Permissible exposure limit: The exposure, inhalation or dermal permissible exposure limit specified in 29 CFR Part 1910, Subparts G (Occupational Health and Environmental Control) and Z (Toxic and Hazardous Substances).

Pressure-related injury: Any injury resulting from pressure disequilibrium within the body as the result of hyperbaric exposure such as decompression sickness, pneumothorax, mediastinal emphysema, air embolism or subcutaneous emphysema.

Primary diver: A qualified diver performing initial underwater activities relating to the dive request.

Psi (g): Pounds per square inch (gauge).

Public safety diver: A person performing diving operations solely for underwater search, rescue, recovery, investigation or related public safety purposes by or under the control of a governmental agency.

Public safety diving: A diving operation performed solely for search, rescue, recovery, investigation or related public safety purposes conducted by divers working for or under the control of a governmental agency.

Published exposure level: The exposure limits published in “NIOSH Recommendations for Occupational Health Standards” dated 1986, which is incorporated by reference as specified in §1910.6, or if none is specified, the exposure limits published in the standards specified by the American Conference of Governmental Industrial Hygienists in the publication “Threshold Limit Values and Biological Exposure Indices for 1987-88” dated 1987, which is incorporated by reference as specified in §1910.6(b)(2).

Qualified person: A person who by possession of a recognized degree, certificate or professional standing or who by extensive knowledge, training and experience has successfully demonstrated his or her ability to solve or resolve problems relating to the subject matter, the work or the project.

Repetitive dive: A dive made within six hours of a previous dive.

Rescue diver: A fully suited diver ready on the surface to respond to a rescue of a working diver. This rescue diver does not have to be on air but must be ready to begin immediately breathing compressed air.

Scuba diving: A diving mode independent of surface supply in which the diver uses open circuit self-contained underwater breathing apparatus.

Span of control: The relationship of a supervisor to workers under his or her direct control. Normally this is three to seven workers.

Standby diver: A fully equipped diver at the dive location capable of rendering assistance to a diver performing assigned tasks.

Surface-supplied air diving: A diving mode in which the diver in the water is supplied from the dive location with compressed air for breathing through an umbilical air hose.

Tender: A surface support person responsible for handling a single diver’s umbilical and for maintaining voice or standard line signal communications.

Time keeping: A method to document the duration of a diver beginning at the descent to arrival back on the surface where the diver begins to breathe atmospheric air through normal means. This documentation will include depth, time and amount of air consumed during the dive.

Treatment table: A depth-time and breathing gas profile designed to treat decompression sickness.

Two-way voice communication: Communication between the diver and the topside support personnel by either a hard-wire or wireless system.

Underwater breathing apparatus (UBA): A breathing apparatus for providing pressurized air to a diver.

Umbilical: The composite hose bundle between a dive location and a diver that supplies the diver with breathing air, communications, power or heat as appropriate to the diving mode or conditions and includes a safety line between the diver and the dive location.

Volume tank: A pressure vessel connected to the outlet of a compressor and used as an air reservoir.

Working pressure: The maximum pressure to which a pressure containment device may be exposed under standard operating conditions.

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Qualifications of Dive Team

General

Each dive team member should have the experience or training necessary to perform assigned tasks in a safe and healthful manner.

Each public safety diver should be trained, qualified and certified for the diving mode being used. Each diver should have experience or training in the following:

- The use of the instruments and equipment appropriate to the diving activity to be conducted;
- Dive planning and emergency guidelines;
- Diver rescue techniques, cardiopulmonary resuscitation, oxygen administration and other diving related first aid; and
- Diving related physics and physiology as well as recognition of pressure-related injuries.

A dive team should consist of at least four members who will include the primary diver with tender and a standby diver with tender. As span of control is expanded, the number of people will increase.

Assignments

Each dive team member should be assigned tasks in accordance with the employee's experience or training. Limited additional tasks may be assigned to an employee undergoing training provided that these tasks are performed under the direct supervision of an experienced dive team member.

Primary Diver

A qualified diver performing initial underwater activities relating to the dive request.

Dive Team Leader

An appropriately qualified diver should be designated by the dive team as the dive team leader for each dive or series of dives. The dive team leader should be responsible for the diving operation. Level of experience and training in dealing with the task at hand will supersede rank/classification in selecting a dive team leader. The dive team leader should be at the dive location during the diving operation.

Standby Diver

An appropriately qualified diver, who is part of the dive team, should have the level of experience and training in dealing with the task at hand. The standby diver should be fully dressed and ready to assist the primary diver.

Tender

A surface support person responsible for handling a single diver's umbilical and for maintaining voice and/or standard line signal communications should be part of the dive team.

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Safe Practices Manual

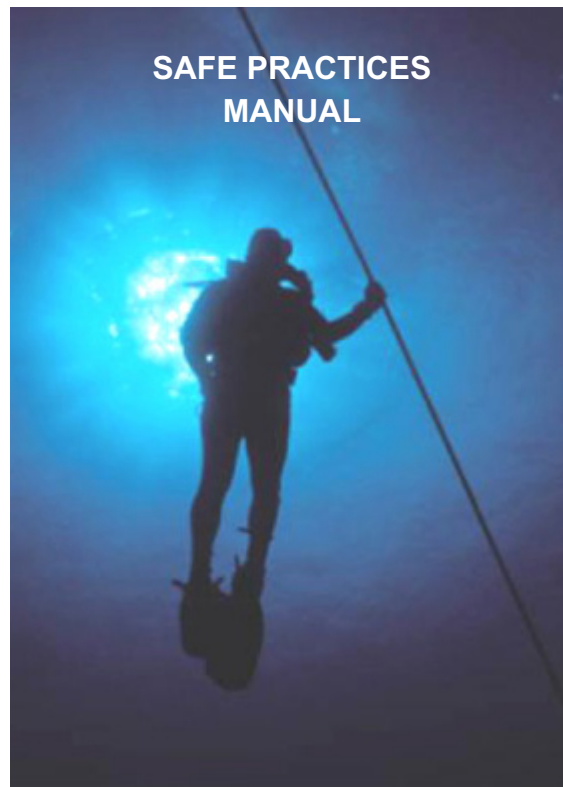
General

The employer should develop and maintain a safe practices manual that should be made available at the dive location to each dive team member.

Contents

For each diving mode engaged in, the safe practices manual should include:

- Safety procedures and checklists for diving operations;
- Assignments and responsibilities of the dive team members;
- Equipment procedures and checklists; and
- Emergency procedures for fire, equipment failure, adverse environmental conditions, and medical illness and injury.



Source: *Public Safety Diving—Wikipedia*

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Pre-dive Procedures

General

The designated person-in-charge (DPIC), or dive team leader, of the divers should conduct a briefing of dive team members prior to each dive.



Source: Public Safety Diving—Wikipedia

Dive Team Briefing

Emergency Aid

A review should be made of the Safe Practices Manual.

First Aid Supplies and Support Equipment

The following emergency and first aid equipment should be provided, maintained and readily available at the physical dive area:

- A first aid kit appropriate for the diving operation;



Source: N.C. Public Safety Divers Association

First aid kit

- An emergency oxygen cylinder; and



Source: N.C. Public Safety Divers Association

Emergency oxygen cylinder

- A stokes litter or backboard, with attached flotation device.



Source: N.C. Aquariums

Litter/backboard with flotation device

Planning and Hazard Assessment

Planning of a diving operation should include an assessment of the suitability, service, condition, and safety and health aspects of the following:

- Diving mode;
- Breathing air supply (including reserves);
- Thermal protection;
- Diving equipment and systems;
- Dive team assignments and physical fitness* of dive team members (including any impairment known to the employer);
 - *Assessment of physical fitness may include an on-site pre-dive medical screening for blood pressure, EKG strip and pulse.
- Repetitive dive designation or residual inert gas status of dive team members;
- Decompression and treatment procedures (including altitude corrections);

- Emergency procedures;
- Surface and underwater conditions and hazards;
- Hazardous materials; and
- Enclosed or physically confined spaces.

Prior to initiating a dive operation, the following conditions should be assessed, at a minimum, for potential or apparent hazards:

- Water speed;
- Water clarity/visibility; and
- Visible hazards.
- Potential hazards—In environments where there is a high probability of encountering a hazard not initially present (i.e., floating debris or entanglement hazards), someone should be assigned to scan the upstream area for potential hazards flowing into the worksite.
- Known hazards—In locations where previous dives have been made and the hazards are known or suspected.

Water quality should be assessed and characterized in one of four categories specified in Table 1.

Table 1—Water Contamination Categories

CATEGORY	DESCRIPTION	CONTAMINANTS	PROTECTION LEVEL
1	Highest contamination, grossly contaminated with concentrated chemical or biological contamination	Obvious fuel slicks, aircraft recovery with copious jet fuel present, sewage operations, hog lagoons	A
2	Moderate contamination with concentrated chemical or biological contamination	Above what is normally expected and in human remains recovery and fuel slicks caused from motor vehicle recoveries	A or B*
3	Baseline contamination (water quality expected is normal and has a demonstrated history of causing no adverse effects on divers)	The water quality that is normally expected and has a demonstrated history of causing no acute effects on divers	A or B
4	No contamination	Drinking water reservoirs, swimming pools or other bodies of water routinely analyzed for quality	A or B

*Primary suspect contaminant is microbiological

Personal protective equipment

Based on the hazard assessment, the appropriate protective diving ensemble should be selected.

- Protective ensembles should be chosen to provide the minimum level of protection necessary to protect against expected water contaminants.
 - Level A—diving helmet, encapsulating dry suit and mating neck-dam, dry gloves attached to integral cuff rings on dry suit sleeves.
 - Level B—full-face mask, encapsulating dry suit with hood, dry gloves attached over cuff rings.

In an incident where water quality cannot be readily assessed and there are no records to show the pathological or contaminant history of the site, the personal protective equipment (PPE) dress standard for the diver should be modified to that of a Level B or higher to avoid potential exposure.



Source: N.C. Public Safety Divers Association

Level B diving ensemble

Hazardous Activities

To minimize hazards to the dive team, diving operations should be coordinated with other activities in the vicinity that are likely to interfere with the diving operation.

Employee Briefing

Dive team members should be briefed on:

- The tasks to be undertaken;
- Safety procedures for the diving mode;
- Any unusual hazards or environmental conditions likely to affect the safety of the diving operation; and
- Any modifications standard or emergency procedures necessitated by the specific diving operation.

Prior to making individual dive team member assignments, the employer should inquire into the dive team member's current state of physical fitness and indicate to the dive team member the procedure for reporting physical problems or adverse physiological effects during and after the dive.

Equipment Inspection

The breathing air supply system and all diving equipment should be inspected and documented prior to each dive. A checklist should be developed and used to ensure all items are covered.



Source: Baltimore City Fire Department

Inspecting equipment

Diving Flags

When diving in areas capable of supporting marine vessel traffic, a rigid replica of the international code flag “A” or appropriate night signal should be displayed as required by

U.S. Coast Guard Navigation Rule 27(e) for a vessel restricted in its ability to maneuver. The additional use of a rigid recreational diving red and diagonal white stripe “diver down” flag is recommended.

When diving from shore or in shallow water in areas of vessel traffic, the “diver down” flag is a minimum requirement and should be prominently displayed.



Source: Montana Boating Laws and Responsibilities

Diver down flag



Source: Montana Boating Laws and Responsibilities

International code flag “A”

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Procedures During Dive

General

Diving operations should be conducted with at least two qualified fully suited ready-to-dive employees.

Mixed-gas diving should not be used.

Hookah diving should not be performed for diving and related support operations.

Water Entry and Exit

A means capable of supporting the diver should be provided for entering and exiting the water where necessary.

A means should be provided to assist an injured diver from the water.

Each diver should be continuously tendered while in the water.

Communications

An operational two-way voice communication system should be used between the diver and a dive team tender.



Source: N.C. Public Safety Divers Association



Source: Palatine, IL Fire Department

Communication system

Standard line signal communications should not be used between the diver and the tender as a primary means of communication.

An operational, two-way communication system should be available at the dive location to obtain emergency assistance.

Decompression Tables

Decompression, repetitive, and no-decompression tables (as appropriate) should be used at the dive location and consulted in the plan. No standard table applies (i.e., commercial, Navy, recreational); however, the team should work from one table, not multiples.

Dive Profiles

A depth-time profile should be maintained for each diver during the dive.

Timekeeping

A person should be designated to record all dive profiles.

Hand-held Underwater Power Tools

Hand-held equipment and power tools should be inspected prior to each use and maintained in a safe operating condition.

Electrical tools and equipment used underwater should be specifically approved for this purpose.

Electrical tools and equipment supplied with power from the surface should be de-energized before being placed into or retrieved from the water.

Handheld power tools should not be supplied with power from the dive location until requested by the diver.

Cutting Tool

Each diver should have a cutting tool, knife, wire cutters or EMT scissors (cutting shears) as appropriate. An alternate cutting tool secured in a different location on the diver is recommended.

Dive Light

Each diver should have a functional underwater light for use on night or low visibility dives. A backup light is recommended.

Termination of Dive

If conditions or an incident occurs that may jeopardize the health or safety of a diver, diving operations should be stopped and the diver(s) should immediately exit the water.

A dive should be terminated when:

- Any dive team member request termination;
- A diver fails to respond correctly to communications or signals from a dive team member;
- Communications are lost and cannot be quickly re-established between the diver and a dive team member at the dive location, and between the designated person-in-charge and the boat operator controlling the vessel in liveboating operations;
- A diver begins to use diver-carried reserve breathing air or the dive-location reserve breathing air;
- A breach of personal protective equipment; or
- Diving conditions degrade, e.g., thunderstorms.



Source: Public Safety Diving—Wikipedia

Terminating dive

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Postdive Procedures

General

The employer should comply with the following requirements, which are applicable after each diving operation.

Precautions

After the completion of any dive, the designated person-in-charge (DPIC) of the divers should:

- Check the physical condition* of the diver;
*Assessment of physical condition may include an on-site medical screening for blood pressure, EKG strip and pulse.
- Instruct the diver to report any physical problems or adverse physiological effects including symptoms of decompression sickness; and
- Alert the diver to the potential hazards of flying after diving.

For any dive outside the no-decompression limits, or deeper than 100 feet, the employer should monitor the diver for at least one hour after the dive to insure he or she remains awake.

After the completion of a dive, each diver should perform an equipment check and report any problems or malfunctions to the diving supervisor. Any defective equipment should be tagged and removed from service until repaired and tested by a qualified person.

Record of Dive

The following information should be recorded and maintained for each diving operation:

- Names of dive team members;
- Date, time and location;
- Diving modes used;
- General nature of work performed;
- Approximate underwater and surface conditions (visibility, water temperature and current); and
- Maximum depth and bottom time for each diver, including repetitive dives.

For each dive outside the no-decompression limits deeper than 100 feet, the following additional information should be recorded and maintained:

- Depth time and breathing gas profiles;
- Decompression table designation (including modification); and
- Elapsed time since last pressure exposure if less than 24 hours or repetitive dive designation for each diver.

For each dive in which decompression sickness is suspected or symptoms are evident, the following additional information should be recorded and maintained:

- Description of decompression sickness symptoms (including depth and time of onset) and
- Description and results of treatment.

Injury and Illness Assessment

The employer should:

- Investigate, evaluate and record each injury and illness incident; and
- Appropriate corrective action should be taken to prevent future recurrence.

Decontamination and Equipment Inspection

The diver should be decontaminated after exiting the water and prior to removal of any equipment.



U.S. Navy photograph (released)



U.S. Navy photograph (released)

Decontaminating diver

A proper decontamination solution should be used that is relevant to the contaminants encountered during the dive.

The diver's equipment should be cleaned and decontaminated following the manufacturer's specifications and recommendations.

All equipment should be checked following a dive.

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Public Safety Scuba Diving

General

Scuba diving (“scuba” originally being an acronym for self-contained underwater breathing apparatus, now widely considered a word in its own right) is a form of underwater diving in which a diver uses a scuba set to breathe underwater.



Source: National Academy of Police Diving

SCUBA diving gear

Employers engaged in scuba diving should comply with the following requirements.

Limits

Scuba diving should not be conducted:

- At depths deeper than 100 feet;
- Outside the no-decompression limits;
- Against currents exceeding 1.5 knots.

Procedures

A standby or rescue diver should be available while a diver is in the water. As span of control increases, additional divers may be needed.



Source: Josephine County Sheriff's Department, Oregon

Standby diver and tender

An operational two-way voice communication system should be used between the diver and the dive team tender.

- Line signal communications should not be used between the diver and the tender as a primary means of communications.

A diver should be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces.

A diver-carried reserve breathing air supply should be provided for each diver consisting of:

- A minimum size cylinder of 19 cubic feet; and
- An independent reserve cylinder connected to the underwater breathing apparatus by a manifold/switch block.



Source: N.C. Public Safety Divers Association

Manifold/switch block

The valves of the reserve breathing air supplies should be in the closed position prior to the dive. The valves should be easily accessible by the diver.

Surface-Supplied Air Diving

General

Surface-supplied air diving refers to divers using equipment supplied with air using a diver's umbilical from the surface, either from the shore or from a diving support vessel. The umbilical generally consists of a gas supply hose strength member, pneumofathometer hose, and communication line. The umbilical supplies a helmet or full-face mask. The diver may rely on the tender at the surface to keep up with the diver's depth, time and diving profile.



Source: Public Safety Diving—Wikipedia

Surface-supplied air diving



Source: N.C. Public Safety Divers Association

Diver tender

Employers engaged in surface-supplied air diving should comply with the following requirements.

Limits

Surface-supplied air diving should not be conducted at depths deeper than 100 feet.

A bell should not be used for dives.

Procedures

A diver should be stationed at the underwater point of entry when diving is conducted in enclosed or physically confining spaces. In addition, an orientation line should be used.

Each diving operation should have a primary breathing air supply sufficient to support divers for the duration of the planned dive, including decompression.

Where physical space does not permit, a diver-carried reserve breathing air supply should be provided whenever the diver is prevented by the configuration of the dive area from ascending directly to the surface.

Each surface-supplied diver should be hose tended by a separate dive team member.

Divers using the surface-supplied mode should maintain appropriate communications with the surface tender.

10

Liveboating

General

Liveboating is maintaining a mobile vessel in support of dive operations. This method of dive tending is preferred in instances where anchoring is difficult, under conditions with high currents, when the dive plan makes it likely that divers will move away from the initial dive location, and in locations where divers may need to be shielded from other vessel traffic.

Prior to operating any vessel, individuals need to be qualified as an operator.

Since there may be many different size boats used in diving operations, each with different equipment, prospective operators should be checked out and demonstrate skills in the operation of any size boat.

Employers engaged in diving operations involving liveboating should comply with the following requirements.



Source: Public Safety Diving—Wikipedia

Liveboating operations

Limits

Diving operations involving liveboating should not be conducted:

- Using surface-supplied air at depths deeper than 100 feet;
- In rough seas which significantly impede diver mobility or work function; or
- In other than daylight hours.

Procedures

The propeller of the vessel should be stopped before the diver enters or exits the water.

A device should be used that minimizes the possibility of entanglement of the diver's hose in the propeller of the vessel.

An operational two-way voice communication system between the designated person-in-charge and the boat operator should be used while the diver is in the water.

An operational two-way voice communication system should be used between the diver and a tender aboard the vessel. Line signals are not considered acceptable means of communication.

A standby diver should be present while a diver is in the water.

A diver-carried reserve breathing air supply should be provided for each diver engaged in liveboating operations.

11

Equipment

General

All equipment should meet standards as determined by the diving safety officer. Equipment should be used in accordance with safe diving practices and within the manufacturers' specifications.



Diving equipment

*Source: All three photos provided by
N.C. Public Safety Divers Association*

All employers should comply with the following requirements.

- The employer should ensure that the appropriate protective clothing and equipment is provided to protect personnel from hazards to which they are exposed or could be exposed.
- Such protective clothing and equipment should be appropriate to the tasks that are expected to be performed during diving operations.
- All diving equipment should be maintained in a safe and fully functional condition.
- Any damaged or defective equipment should be removed from service immediately and clearly identified in order to preclude its use.

Each equipment modification, repair, test, calibration or maintenance service should be documented and the work performed by a certified technician.

All equipment should be inspected at least monthly by a qualified person and a record maintained. Equipment subject to extreme use or adverse conditions may require more frequent testing and maintenance.

Air Compressor System

Compressors used to supply air to divers should be equipped with a volume tank with a check valve on the inlet side, a pressure gauge, a relief valve and a drain valve.

Air compressor intakes should be located away from areas containing exhaust or other contaminants.

Compressed breathing air should meet at least the requirements for Grade E breathing air described in Compressed Gas Association, Commodity Specification for Air, G-7.1-1997, including:

- Oxygen content of 20–22 percent;
- Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;
- Carbon monoxide content of 10 ppm or less;
- Carbon dioxide content of 1,000 ppm or less; and
- Less of a pronounced odor or taste.

Air compressor systems, both high pressure (scuba) and low pressure (surface-supplied) should be tested for air purity on a three-month basis by means of sampling at the connection to the distribution system, except that non-oil lubricated compressors need not be tested for oil mist. Purchased air should also be tested and certified.

Compressed air systems over 500 psig should have slow-opening shut-off valves.

All primary air compressors should be outfitted with an anti-ballistic fill station, designed to deflect or contain the ballistic shrapnel resulting from a cylinder rupture during fill.

Only trained fill station operators (FSO) should be allowed to operate and inspect air compressors.



Source: N.C. Aquariums

Compressed air fill station

Breathing Air Supply Hoses

Breathing air supply hoses should:

- Have a working pressure at least equal to the working pressure of the total breathing air system;
- Have a rated bursting pressure at least equal to four times the working pressure;
- Be tested at least annually to 1.5 times their working pressure; and
- Have their open ends taped, capped or plugged when not in use.

Breathing air supply hose connectors should:

- Be made of corrosion-resistant materials;
- Have a working pressure at least equal to the working pressure of the hose to which they are attached; and
- Be resistant to accidental disengagement.

Umbilicals should:

- Be marked in 10-foot increments to 100 feet beginning at the diver's end, and in 50-foot increments thereafter;
- Be made of kink-resistant materials;
- Have a working pressure greater than the pressure equivalent to the maximum depth of the dive (relative to the supply source) plus 100 psi;
- Have a safety line of at least $\frac{3}{8}$ inch diameter included as a separate or integral part of each umbilical;
- Have the open ends of the hoses closed by taping, capping or plugged when not in use; and
- Have the hoses tested at least annually to 1.5 times the working pressure.

Buoyancy Control

Helmets or masks connected directly to the dry suit or other buoyancy-changing equipment should be equipped with an exhaust valve.

A dry suit or other buoyancy-changing equipment not directly connected to the helmet or mask should be equipped with an exhaust valve.

An inflatable flotation device capable of maintaining the diver at the surface, having a manually activated inflation source independent of the breathing supply, an oral inflation device, and an exhaust valve should be used for scuba diving.

Each diver should have the capability of achieving and maintaining positive buoyancy.

Personal flotation systems, buoyancy compensators, dry suits or other variable volume buoyancy compensation devices should be equipped with an exhaust valve.

These devices should be functionally inspected and tested at least monthly.

Backpacks without integrated flotation devices and weight systems should have a quick release device designed to permit jettisoning with a single motion from either hand.



Source: Public Safety Diving—Wikipedia

Buoyancy compensator

Compressed Gas Cylinders

Compressed gas cylinders should:

- Be designed, constructed and maintained in accordance with the applicable provisions of §1910.101 and §1910.169;
- Be stored in a ventilated area and protected from excessive heat;
- Be secured from falling;
- Have shut-off valves recessed into the cylinder or protected by a cap, except when in use or manifold, or when used for scuba diving;
- Have an internal and external inspection at intervals not to exceed 12 months; and
- Be hydrostatically tested in accordance with Department of Transportation (DOT) 49 CFR Part 178, Subpart C.

Cylinder valves should be functionally tested at intervals not to exceed 12 months.



Source: N.C. Aquariums

Storage of compressed gas cylinders

Regulators

Regulators should be designed for contaminated water diving and be environmentally sealed.

Regulators should be inspected and tested by a certified technician prior to first use and every month thereafter.

Gauges and Timekeeping Devices

Gauges indicating diver maximum depth should be used for all dives.

A timekeeping device should be used at each dive location.

Gauges should be inspected and tested by a certified technician before first use and every 12 months thereafter against a known and calibrated gauge.

Full-face Masks and Helmets

Full-face masks and helmets should have:

- A non-return valve at the attachment point between helmet or mask and hose which should close readily and positively;
- A minimum ventilation rate capable of maintaining the diver at the depth to which they are diving;
- A reserve breathing air supply which can be immediately turned on by the diver in event of loss of air; and
- An exhaust valve.

Weights and Harnesses

Divers should be equipped with a weight belt or assembly capable of quick release.

A three-point harness should be used by divers.

When a safety harness is worn in diving, it should be equipped with:

- A positive buckling device; and
- An attachment point for the umbilical to prevent strain on the mask or helmet; and
- A lifting point to distribute the pull force of the line over the diver's body.

12

Recovery Operations



Source: N.C. Public Safety Divers Association

Sonar searching

Application

This section applies to all types of machinery and equipment used in diving recovery operations.

The machinery and equipment includes, but not limited, to the following:

- Slings, shackles, hooks and other related rigging equipment;
- Mobile cranes;
- Tow trucks and tow trucks with rotating booms; and
- Lifting bags



Source: Public Safety Diving—Wikipedia

Lifting bags

Metal drums and poly drums should not be used for recovery operations unless they are designed and rated for pressurization.

Inspections

The employer should designate a competent person who should inspect all machinery and equipment prior to use, and during use, to ensure that it is in safe operating condition.

Damaged or defective machinery and equipment should be immediately removed from service and repaired or replaced before further use.

Rigging Equipment

Rigging equipment should not be loaded in excess of its recommended safe working load.



Source: Public Safety Diving—Wikipedia

Recovery of vehicle with tow truck

A sling should not be loaded in excess of its recommended safe working load as prescribed by the sling manufacturer on the identification markings permanently affixed to the sling.

Rigging equipment, when not in use, should be removed from the immediate work area so as not to present a hazard to employees.

Special custom designed grabs, hooks, clamps or other lifting accessories should be marked to indicate the safe working loads and should be proof-tested prior to use to 125 percent of their rated load.

Alloy Steel Chains

Welded alloy steel chain slings should have a permanently affixed durable identification stating size, grade, rated capacity and sling manufacturer.

A thorough periodic inspection of alloy steel chain slings in use should be made at least every 12 months.

The employer should maintain a record of the dates and results of such tests.

Operation of Machinery

The employer should comply with the manufacturer's specifications and limitations applicable to the operation of any crane, tow truck or other hoisting apparatus.

Where manufacturer's specifications are not available, the limitations assigned to the equipment should be based on the determinations of a professional engineer competent in the field.

No modification or additions that affect the capacity or safe operation of the equipment should be made by the employer without the manufacturer's written approval.

Loads

All employees should be kept clear of loads about to be lifted and of suspended loads.



Source: Public Safety Diving—Wikipedia

Recovery of vehicle—Staying clear of load

13

Training

Employee Training

Employee training is an important part of diving safety. Without training standards, divers often are working beyond their capabilities. All divers and support team members should be trained in their duties prior to diving operations. Training should be conducted on two levels:

Initial Training

Initial training should consist of:

- The requirements of the diving Safe Practices Manual;
- An explanation of general hazards associated with diving operations;
- Local waterways—specific hazards and diving safety procedures; and
- The responsibilities of response to diving emergencies.

Emergency Rescue Team Training

Training for the emergency rescuers should consist of:

- Rescue plans and procedures for each type of diving rescue operation they are anticipated to encounter;
- Use of emergency rescue equipment; and
- First aid and CPR techniques (in coordination with external medical personnel—EMS).

Diver Retraining

Retraining should be provided for diving personnel:

- Upon identification of a previously unknown diving hazard;
- Whenever there is a change in their job assignments involving diving operations;
- Whenever there is a change in diving procedures;
- Whenever a periodic inspection or incident reveals that there are deviations from, or inadequacies in, a diver's or responder's knowledge or use of the Safe Practices Manual; and
- The retraining should re-establish employee proficiency and introduce new or revised control methods and procedures.

The employer should ensure all divers involved in diving operations have minimum training in the following:

- Open water certified;
- Dry suit certified;
- Validation of diving experience;
- Rigging and lifting procedures; and
- Full-face mask certified.

Pre-entry testing and evaluation of skills should include:

- Written tests to determine knowledge;
- Inwater evaluations;
- Basic skills evaluation; and
- Emergency procedures evaluations.

The employer should ensure that all divers involved in diving operations have current cardiopulmonary resuscitation (CPR) and first aid certifications.



Source: Public Safety Diving—Wikipedia

CPR Training

Dive supervisors should be trained in the exposure of others to hyperbaric conditions and be trained in diving-related physics and physiology.

The employer should provide a program to train all employees who perform diving operations in the hazards involved in those operations and the safety procedures to be followed.

The training should include, but not limited to the following:

- Planning and supervision of dive operations;
- Hazard recognition, evaluation and control;
- Personal protective equipment use;
- Decontamination procedures;
- Specialized equipment;
- Dangerous marine animals;
- Underwater communications;
- Emergency procedures;
- Use of tools, equipment and systems relevant to assigned tasks; and
- Techniques of the assigned diving mode.

The employer should evaluate each employee's ability to perform all tasks related to diving operations, and should provide additional training as necessary to assure that each employee maintains his or her proficiency.

All training should be performed by a qualified person.



Source: N.C. Public Safety Divers Association

Employee classroom training

Refresher training should be performed when deficiencies are observed in knowledge or performance.

Training should be provided to ensure that all equipment is used and maintained in accordance with the manufacturers' instructions.



Source: N.C. Public Safety Divers Association

Employee training of equipment

14

Medical

Medical Surveillance and Consultation

Diving places a physiological burden on employees that varies with the type of personal protective equipment worn, the job and workplace conditions, and the medical status of the employee. Accordingly, the employer should institute a medical surveillance program for all divers to determine the employee's ability to dive safely.

- The employer should not permit an employee to dive without receiving an initial baseline medical examination.
- The employer should not permit an employee to dive with a medical condition that is known to the employer and is likely to affect the employee's ability to dive safely until medical evaluation is obtained.
- Medical surveillance and consultation should be provided by or under the supervision of a licensed physician. When possible, a physician knowledgeable in the hazards of diving and hyperbaric conditions should perform the medical surveillance and consultation.

Frequency of Medical Examinations and Consultations

Medical examinations and consultations should be provided to each employee as follows:

- Each employee should receive a baseline medical examination;
- Each employee should receive a repeat medical examination every five years if under age 40; every three years if over age 40; and every two years if over age 60;
- The employer should make a medical examination available to each employee upon termination of employment or reassignment to an area where the employee would not be covered if the employee has not had an examination within the last six months;

The employer should make a medical examination available as soon as possible upon notification by an employee that the employee has developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards or that the employee has been injured or exposed above the permissible exposure limits or published exposure levels; and

- The employer should make a medical examination available at more frequent times, if the examining physician determines that an increased frequency of examination is medically necessary.

Content of Medical Examinations and Consultations

Medical examinations required by this paragraph should include a medical and work history (or updated history if one is in the employee's file) with special emphasis on the cardiovascular, neurological, otological and pulmonary systems, work-related chemical exposures as well as symptoms related to exposure to hazardous substances and health hazards, and to fitness for duty including the ability to wear any required personal protective equipment under conditions that may be expected at the worksite.

The content of each medical examination should also include the following:

Test	Initial exam	Repeat exam	All exams if \geq age 40
Chest X-ray	x		
Pulmonary function test	x	x	
Hematocrit or hemoglobin	x	x	
Urinalysis	x	x	
EKG and cardiac evaluation			x

The following conditions should be considered when determining whether the employee is capable of diving safely:

- History of seizure disorder other than early febrile convulsions.
- Malignancies (active) unless treated and without recurrence for five years.
- Chronic inability to equalize sinus and middle ear pressure.
- Cystic or cavitory disease of the lungs.
- Impaired organ function.
- Conditions requiring continuous medication for control.
- Meniere's disease.
- Hemoglobinopathies.
- Obstructive or restrictive lung disease.
- Vestibular end organ destruction.
- Pneumothorax.
- Cardiac abnormalities (e.g., pathological heart block, valvular disease, intraventricular conduction defects other than isolated right bundle branch block, angina pectoris, arrhythmia, coronary artery disease).
- Juxta-articular osteonecrosis.

Medical Examinations or Consultations

The content of medical examinations or consultations should also include any additional medical tests, consultations, or diagnostic procedures that the physician deems necessary to make a final determination.

Information Provided to the Physician

The employer should provide to the attending physician the following for each employee:

- A description of the employee's duties as they relate to the employee's exposures and a description of the conditions that may be expected at the worksite;
- The employee's known or anticipated exposures;
- A description of any personal protective equipment to be used; and
- Information from previous medical examinations of the employee that is not readily available to the examining physician.

Physician's Written Opinion

Prior to permitting an employee to dive, the employer should obtain a copy of a written opinion from the examining physician. The written opinion should contain the following:

- The physician's opinion as to whether the employee has any detected medical conditions that would place the employee at increased risk of material impairment when performing assigned work;
- The physician's recommended limitations, if any, upon the employee's assigned work; and
- A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions that require further examination or treatment.

The written opinion obtained by the employer should not reveal specific findings or diagnoses unrelated to occupational exposure or dive qualifications.

The employer should provide the employee with a copy of the physician's determination within 15 days of receipt.

Medical Records

Medical records should be maintained in accordance with 29 CFR 1910.1020.

Each record should include at least the following information:

- The employee's name, job title, date hired and employee I.D./position number;
- Physician's written opinions, recommended limitations, and results of examinations and tests;
- Any employee medical complaints related to diving; and
- A copy of the information provided to the examining physician by the employer.

15

Recordkeeping

Availability of Records

All training records should be maintained by the employer for the duration of employment.

Records and documents should be provided upon request by the employees.

Records and documents should be retained by the employer for the following period:

- A current list of authorized divers should be kept by the employer and dive safety officer.
- Medical and exposure records per §1910.1020. The transfer of records covered in §1910.1020(h) would not apply.
- Safe Practices Manual—current document only.
- Depth-time profile should be kept until completion of the recording of dive, or until completion of decompression procedure assessment where there has been an incident of decompression sickness.
- Completed dive plans/reports should be kept for a period of one year beyond the completion of the work. If there was an incident of decompression sickness or injury, the record should be kept for five years.
- Decompression procedure assessment evaluations should be kept for five years.
- Equipment inspections and testing records—current entry or tag, or until equipment is withdrawn from service.

Equipment maintenance

All equipment modification, repair, test, calibration, inspection and maintenance service should be logged, including the date and nature of work performed, serial number of the item, and the name of the person performing the work.

Compressor Operation and Air Test Records

Gas analyses and air tests should be performed on each breathing air compressor at regular intervals of no more than 100 hours of operation or six months, whichever occurs first.

- The results of these tests should be entered in a formal log and be maintained.
- A log should be maintained showing operation, repair, overhaul, filter maintenance, and temperature adjustment for each compressor.

OSH Publications

We provide a variety of OSH publications. These include general industry and construction regulations, industry guides that cover different OSH topics, quick cards, fact sheets and brochures that cover a wide variety of serious safety and health workplace hazards. Workplace labor law posters are available free of charge. To obtain publications, call toll free at 1-800-NC-LABOR (1-800-625-2267) or direct at 919-807-2875. You may view the list of publications and also download many of them at **www.nclabor.com/pubs.htm**.

Occupational Safety and Health (OSH)

Sources of Information

You may call 1-800-NC-LABOR (1-800-625-2267) to reach any division of the N.C. Department of Labor; or visit the NCDOL home page on the World Wide Web: <http://www.nclabor.com>.

Occupational Safety and Health Division

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Local Telephone: 919-807-2900 Fax: 919-807-2856

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 3rd Floor)

For information concerning education, training, interpretations of occupational safety and health standards, and OSH recognition programs contact:

Education, Training and Technical Assistance Bureau

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2875 Fax: 919-807-2876

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 4th Floor)

For information concerning occupational safety and health consultative services contact:

Consultative Services Bureau

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2899 Fax: 919-807-2902

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 3rd Floor)

For information concerning migrant housing inspections and other related activities contact:

Agricultural Safety and Health Bureau

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2923 Fax: 919-807-2924

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 2nd Floor)

For information concerning occupational safety and health compliance contact:

Safety and Health Compliance District Offices

Raleigh District Office (3801 Lake Boone Trail, Suite 300, Raleigh, NC 27607)
Telephone: 919-779-8570 Fax: 919-420-7966

Asheville District Office (204 Charlotte Highway, Suite B, Asheville, NC 28803-8681)
Telephone: 828-299-8232 Fax: 828-299-8266

Charlotte District Office (901 Blairhill Road, Suite 200, Charlotte, NC 28217-1578)
Telephone: 704-665-4341 Fax: 704-665-4342

Winston-Salem District Office (4964 University Parkway, Suite 202, Winston-Salem, NC 27106-2800)
Telephone: 336-776-4420 Fax: 336-767-3989

Wilmington District Office (1200 N. 23rd St., Suite 205, Wilmington, NC 28405-1824)
Telephone: 910-251-2678 Fax: 910-251-2654

To make an OSH Complaint, **OSH Complaint Desk:** 919-807-2796

For statistical information concerning program activities contact:

Planning, Statistics and Information Management Bureau

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2950 Fax: 919-807-2951

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 2nd Floor)

For information about books, periodicals, vertical files, videos, films, audio/slide sets and computer databases contact:

N.C. Department of Labor Library

Mailing Address:
1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-807-2848 Fax: 919-807-2849

Physical Location:
111 Hillsborough St.
(Old Revenue Building, 5th Floor)

N.C. Department of Labor (Other than OSH)

1101 Mail Service Center
Raleigh, NC 27699-1101
Telephone: 919-733-7166 Fax: 919-733-6197