

Approved:


Department of Transportation

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BRIDGE UNDERWATER OPERATIONS

PURPOSE:

To establish procedures for underwater bridge inspection operations under the responsibility of the Florida Department of Transportation.

AUTHORITY:

Sections 20.23(3)(a), 334.048(3), Florida Statutes (F.S.):

SCOPE:

The principal users of this procedure will be all persons involved with bridge operations, maintenance, inspection, and repair.

GENERAL:

This procedure provides methods and systems designed to efficiently, effectively, and safely conduct the activities associated with underwater bridge inspection.

DEFINITIONS:

Appurtenances – These are items that are not technically part of the bridge but are generally associated, inspected, and maintained with the bridge. Examples include approach guardrail, fender systems, traffic control devices, and approach slabs.

Bridge – *23 CFR 650, Subpart C, the National Bridge Inspection Standards*, defines a bridge as a structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between the

undercopings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; which may include multiple pipes, where the clear distance between openings is less than half the smaller contiguous opening.

Section 334.03(2), Florida Statutes, defines a bridge as a structure, including supports, erected over a depression or an obstruction, such as water, a highway, or railway, and having a track or passageway for carrying traffic as defined in **Chapter 316, Florida Statutes**, or other moving loads.

Culvert - A type of structure which conveys water or forms a passageway through an embankment and is designed to support superimposed loads of earth or other fill material plus a live load. A culvert will be considered a bridge if it meets the above definition of a bridge.

REFERENCES

The following publications are available on the Office of Maintenance share point site and from the Florida Department of Transportation Maps and Publication Sales, 605 Suwannee Street, Mail Station 12, Tallahassee, Florida 32399-0450, (850) 414-4050, unless stated otherwise.

Bridge Work Order Handbook – Provides instructions for the processing of data collected by Bridge Inspectors. This document is available from the Office of Maintenance.

Bridge Inspectors Field Handbook – Provides guidance for inspectors in selecting elements and assigning quantities to condition states for selected elements. This document is available from the Office of Maintenance.

Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges – Provides instructions for coding data items required by the Federal Highway Administration. This document is available from the Federal Highway Administration and a link is provided from the Office of Maintenance share point site to an electronic version of this document.

Underwater Inspection of Bridges FHWA-DP-80-1 - Provides information on the underwater inspection of bridges. This document is available from the Federal Highway Administration.

29 CFR 1910, Subpart T - Commercial Diving Operations - Occupational Safety and Health Administration (OSHA) regulations covering commercial diving operations. These regulations may be downloaded at: <http://www.ecfr.gov/cgi-bin/ECFR?page=browse>.

46 CFR 197, Subpart B - Commercial Diving Operations - United States Coast Guard (USCG) regulations covering commercial diving operation in areas under USCG jurisdiction. These regulations may be downloaded at: <http://www.ecfr.gov/cgi-bin/ECFR?page=browse>.

1.0 GENERAL

The primary objective of underwater bridge inspection is to protect the safety and welfare of the motoring public and safeguard the public's investment as part of the Department's Bridge Inspection Program. The Bridge Inspection Program identifies bridge deficiencies that are critical enough to endanger public safety. Non-critical deficiencies are also identified. By correcting non-critical deficiencies, the structure's service life is lengthened, total maintenance costs reduced, and the public receives a better return on their investment. A bridge inspection will:

1. Provide for immediate action to limit the use of or close any structure which is revealed by inspection to endanger public safety.
2. Establish a chronological record of periodic and special inspections, listing structure components and component condition at the time of each inspection, thus allowing detection of progressive changes.
3. Determine the extent of any deficiency, critical or minor, resulting from deterioration or any other cause.
4. Enable bridge maintenance, repair, and rehabilitation to be programmed more effectively through early detection of structure deficiencies by which the public investment in the highway system will be safeguarded and repair costs minimized.
5. Collect data on frequently occurring deficiencies to support a change in design and/or construction practices to eliminate the cause of the deficiency.
6. To collect, record, and store bridge inventory and inspection data required to support the bridge management system.

This procedure provides guidance on how to accomplish the primary objectives stated above.

2.0 ENTRY-LEVEL UNDERWATER INSPECTOR REQUIREMENTS AND CERTIFICATION

2.1 Position Descriptions – Personnel conducting underwater bridge inspections shall meet the requirements of the appropriate position descriptions.

2.2 Evaluation – This section details the evaluation requirements for the new underwater bridge inspector. The evaluation shall take part during the applicant's probationary period.

2.2.1 Medical Evaluation – The newly hired employee for an Underwater Inspector position shall be certified by a licensed physician, using **Form 850-010-12 "Medical Questionnaire for Diving"**, to be medically qualified for diving before proceeding with the evaluation.

2.2.2 Swimming Evaluation – The applicant shall successfully demonstrate the following tasks, or the equivalent, in the presence of either a Certified Bridge Underwater Inspector or a Senior Certified Underwater Bridge Inspector.

- Swim underwater without swim aids for a distance of 70 feet without surfacing.
- Swim 1000 feet in less than 12 minutes without swim aids.
- Tread water for 10 minutes without swim aids or 2 minutes without the use of hands without swim aids.
- Without the use of swim aids, transport another person weighing 180 pounds 70 feet in the water.

2.2.3 Scuba Evaluation – The newly hired employee must satisfy either a Certified Bridge Underwater Inspector or a Senior Certified Underwater Bridge Inspector of the employee's ability to perform the following in open water:

- Enter water with full equipment.
- Clear face mask.
- Demonstrate buddy breathing as both donor and recipient, with and without a face mask.
- Demonstrate the ability to alternate between snorkel and scuba while kicking.
- Demonstrate understanding of underwater signs and signals.
- Demonstrate in water mouth to mouth resuscitation.
- Rescue and transport, as a diver, a passive simulated victim of an accident.
- Demonstrate the ability to remove and replace equipment while submerged.
- Demonstrate all around ability with scuba equipment to the satisfaction of the senior underwater inspector.
- Surface dive to a depth of 10 feet in open water without scuba.
- Enter and leave open water or surf, or leave and board a diving vessel, while wearing scuba or surface supplied gear.
- Kick on the surface 1000 feet while wearing scuba gear, but not breathing from the scuba unit.
- Complete a simulated free ascent.
- Demonstrate clearing of mask and regulator while submerged.
- Demonstrate the ability to achieve and maintain neutral buoyancy while submerged.
- Demonstrate techniques of self-rescue and buddy rescue.
- Navigate underwater.

- Plan and execute a dive.
- Successfully complete 5 open water dives for a minimum total of 4 hours. At least one dive must be a dark water dive. No more than 3 dives shall be made in 1 day.
- Demonstrate the ability to handle small craft.

2.2.4 Surface Supplied Evaluation – The applicant must satisfy the either a Certified Bridge Underwater Inspector or a Senior Certified Underwater Bridge Inspector of the applicant's ability to perform at least the following using surface supplied dive equipment:

- Effectively set up Surface Air System.
- Perform pre dive inspection of equipment.
- Perform a line pull signal test (in the event of loss of hard wire communication).
- Don air hat without assistance.
- Hose stretch exercise.
- Dark water exercise.
- Breakdown and secure dive station.

2.2.5 Probationary Period – The District Structures Maintenance Office shall evaluate the new Underwater Inspector during the probationary period.

2.2.6 CPR and First Aid Certification – If the Underwater Inspector does not possess current valid CPR and First Aid Certification when hired by the Department, the Underwater Inspector will be scheduled to obtain these during the probationary period.

2.3 FDOT Diver Certification

2.3.1 Issuing Certification – When the Underwater Inspector has met the above requirements to the satisfaction of the District Structures Maintenance Office, the Underwater Inspector will be issued a Certification Card. If the Underwater Inspector has not successfully met the above requirements during the probationary period, the Structures Maintenance Engineer must either remove the individual from the underwater inspection operation or extend the individual's probationary period following the Department's personnel procedures.

2.3.2 Continuation of Certification – During any 12 month period, each FDOT Certified Underwater Inspector must log a minimum of 12 dives, either work related or recreationally. Failure to meet these requirements may be cause for revocation or restriction of certification.

2.2.3 Requalification of Certification – Once the initial certification requirements are met, Underwater Inspectors, whose certification has lapsed, may be requalified by performing a successful dive to the satisfaction of either a

Certified Bridge Underwater Inspector or a Senior Certified Underwater Bridge Inspector.

3.0 UNDERWATER OPERATIONS

No Department employee shall engage in underwater operations under the auspices of the Department unless that person is a Certified Department Diver or an entry-level diver under the direct supervision of a Certified Department Diver.

3.1 Diving Safety Board – The Diving Safety Board oversees the Department's underwater inspection program and makes recommendations to maintain the safety of the underwater bridge inspection program and changes to this procedure. The Diving Safety Board consists of either a Senior Certified Underwater Bridge Inspector or a Certified Bridge Underwater Inspector from each District, the Structures Maintenance Engineer from each District, and a representative from the Office of Maintenance.

3.2 Underwater Procedures – Operations in a marine environment present a number of hazards which can lead to personal danger. This procedure has been designed to prevent accidents and maintain diver safety.

3.2.1 Underwater Team Size – The lead diver will use the following tables as a guideline for establishing the underwater team size:

DIVES OF LESS THAN 30 FEET IN DEPTH					
TYPE AND DEPTH	NUMBER OF DIVERS	STANDBY	LEAD DIVER	TENDER (g)	RECOMMENDED CREW SIZE
SCUBA under 13 ft clear water, observation of diver at all times from surface.	1 (a)	1 (b)	(c)	1	3
SCUBA under 13 feet limited visibility	1 (d)	1 (b)	(c)	1	3
SCUBA over 13 feet and less than 30 feet	1 (d)	1 (b)	1	0	3
SCUBA "Buddy" diver safety system over 13 feet less than 30 feet	2 (a)	2	(c)	1 (e)	4
Surface Supplied	1	1 (b)	1 (f)	1 (e)	3

Notes:

(a) Divers may dive without a tending line.

- (b) The standby diver may alternate with the working diver.
- (c) One of the Certified Department Divers on the crew shall be qualified as a lead diver and shall assume the duties and responsibilities of that position.
- (d) The diver should be tethered. The lead diver may waive this requirement if diving tethered creates a hazardous situation.
- (e) The tender's function may be performed by the standby diver or the lead diver. If the tender is an additional crew member, the tender is not required to be a diver.
- (f) In an emergency situation, the lead diver may act as the tender if the standby diver is required to dive.
- (g) The tender is not required to be a qualified diver, when there is a qualified standby diver.

DIVES OVER 30 FEET IN DEPTH					
TYPE	NUMBER OF DIVERS	STANDBY	LEAD DIVER	TENDER (e)	RECOMMENDED CREW SIZE
Surface Supplied	1	1 (a)	1 (d)	1 (c)	3
"Buddy" Diver Safety System	2	2 (a)	1 (b)	1 (c)	4

Notes:

- (a) The designated standby diver shall not have been diving during the previous 12 hour period except in emergencies. The standby diver shall also function as a time keeper to ensure that the dive time stays within the limits of a no decompression dive.
- (b) The lead diver may be one of the active divers or a standby diver.
- (c) The standby diver or lead diver may function as the tender.
- (d) The lead diver may function as the tender if the standby diver is required to dive in an emergency.
- (e) The tender is not required to be a qualified diver, when there is a qualified standby diver.

Note: If an underwater operation requires more qualified personnel than are available in the District, the District Structures Maintenance Engineer will arrange to obtain sufficient qualified personnel from another District for the operation.

3.2.2 Enclosed or Confined Spaces – Where an enclosed or confined space is not large enough for two Underwater Inspectors, an Underwater Inspector shall be stationed at the underwater point of entry and an orientation line shall be used. The diver should be line tethered and surface supplied diving is the preferred method.

3.2.3 Diving Flags – The diving flag (white diagonal on a red field) shall be displayed during all underwater operations. The Alpha (A) flag shall be flown on vessels engaged in diving operations whenever the vessels are restricted in their ability to move.

3.2.4 Dive Tables – A set of appropriate dive tables must be available at the

dive location. These tables must be at least as conservative as the United States Navy Diving Tables.

3.2.5 Depth and Time Limits – Except in an emergency, the depth and time of all dives shall be limited to be within the non-decompression limits of the Dive Tables. (U.S. Navy or equivalent.)

3.2.6 Refusal to Dive – The ultimate responsibility for safety rests with the individual. It is the individual's responsibility to refuse to dive, if in the individual's judgment, conditions are unsafe or unfavorable, or if the individual would be violating the precepts of this manual. The District Structures Maintenance Engineer may require written documentation of the reasons for refusing to dive. However, inspectors who refuse to perform their duties without just cause may be subject to the Department's disciplinary procedures.

3.2.7 Termination of the Dive – It is the responsibility of the individual to terminate the dive, whenever the individual believes it is unsafe to continue the dive, unless it compromises the safety of another diver already in the water. The dive shall be terminated while there is still sufficient tank pressure to safely exit the water at the conclusion of the dive with 500 psi of air remaining in the tank.

3.2.8 Surface Supplied Air

3.2.8.1 Underwater Inspectors using the surface supplied mode shall be equipped with a diver carried independent breathing gas supply (bailout bottle).

3.2.8.2 Each surface supplied Underwater Inspector shall be hose tended by a separate dive team member while in the water.

3.2.8.3 Underwater Inspectors using the surface supplied mode shall maintain voice communication with the surface tender.

3.2.8.4 The surface supplied breathing gas supply shall be sufficient to support all surface supplied Underwater Inspectors in the water for the planned duration of the dive as well as standby diver(s).

3.2.8.5 During surface supplied diving operations there must be a standby diver in attendance at the dive location for each diver in the water.

3.3 Conducting Underwater Operations

3.3.1 Lead Diver – For each dive, one individual shall be designated as the lead diver. The lead diver shall be responsible for:

3.3.1.1 Coordination – Diving shall be coordinated with other known activities in the vicinity which are likely to interfere with diving operations.

3.3.1.2 Briefing – The team members shall be briefed on:

- Dive objectives.
- Unusual hazards or environmental conditions likely to affect the safety of the diving operation.
- Modification to diving or emergency procedures necessitated by the specific diving operations.
- Reporting any physical problems or adverse physiological effects including symptoms of pressure related injuries.

3.3.1.3 Dive Planning – Planning of a dive operation shall include considerations and health aspects of the following:

- Diving mode.
- Surface and underwater conditions and hazards.
- Breathing gas supply.
- Thermal protection.
- Diving equipment.
- Team assignments.
- Emergency procedures.

3.3.2 Dive Plans – Before conducting any diving operations, the lead diver for a proposed operation should consider the following information:

- Qualifications of all dive team members.
- Approximate number of proposed dives.
- Location(s) of proposed dives.
- Estimated depth(s) and bottom time(s) anticipated.
- Repetitive dives, if required.
- Proposed work, equipment, and boats to be employed.
- Any hazardous conditions anticipated.

3.3.3 Pre-Dive Safety Check**3.3.3.1 Underwater Inspector's Responsibility:**

- Each Underwater Inspector shall conduct a functional check of their diving equipment.
- Each Underwater Inspector shall determine if it is safe to conduct the dive.
- No team member shall be exposed to hyperbaric conditions against their will, except when necessary to prevent or treat a pressure related injury.
- No team member shall be permitted to dive for the duration of any known condition which is likely to adversely affect their safety and health or that of other dive team members.

3.3.3.2 Equipment Evaluations:

- Each Underwater Inspector shall perform a check of the submersible pressure gauge, timing device, and depth gauge.

- Each Underwater Inspector shall have the capability of achieving and maintaining positive buoyancy.

3.3.4 Post Dive Safety Checks – After the completion of a dive, each Underwater Inspector shall report any physical problems, symptoms of decompression sickness, or equipment malfunctions.

3.3.5 Emergencies and Deviations from Regulations – Any Underwater Inspector may deviate from the requirements of this manual to the extent necessary to prevent or minimize a situation which is likely to cause death, serious physical harm, or major environmental damage. A written report of any significant deviation from the requirements of this manual must be submitted to the Diving Safety Board, explaining the circumstances and justifications with copies to the District Structures Maintenance Engineer.

3.3.6 Consequences of Violation of Regulation by Department Underwater Inspectors – Failure to comply with the regulations of this procedure may be cause for revocation of the diver's certification and subject the Underwater Inspector to the Department's disciplinary procedures.

3.4 Safety Practices

3.4.1 General – All applicable OSHA, Coast Guard, and State regulations shall be followed.

3.4.1.1 All scuba dives shall employ only open circuit system using compressed air.

3.4.1.2 All dives shall be within the no decompression limits as specified in the U.S. Navy Decompression Tables except in extreme emergency.

3.4.1.3 No dive shall exceed 100 feet in depth in the absence of a working decompression chamber attended by trained personnel at the dive site.

3.4.1.4 A standard first aid kit, a pressurized O₂ oxygen resuscitator, aurocaine or equivalent (swimmer's ear), and a first aid handbook shall be available at the dive site.

3.4.1.5 All applicable marine boating regulations shall be complied with at all times.

3.4.1.6 No diving operation shall be conducted during lightning storms or in severely inclement weather.

3.4.1.7 No night dives will be permitted except in emergencies and approved by the District Structures Maintenance Engineer.

3.4.1.8 Underwater Inspectors should attempt to be familiar with all hostile marine life particular to each diving area, and appropriate precautions should be taken.

3.4.1.9 A cellular phone and a back up communication system shall be available at the dive site. The back up communication system may be a two way marine band VHF radio or a two way department radio. The needs will be determined by the on-site lead diver.

3.4.1.10 No Florida DOT Underwater Inspector will use any personal or substandard dive equipment while working on any FDOT projects.

3.4.1.11 The lead diver will be responsible for securing the safety of the diving area. If required, authorities with jurisdiction over the dive area should be notified that the dive will be taking place at least 24 hours in advance.

3.4.1.12 No work operation will begin unless each team member has experience or training in the use of tools, equipment, and systems relevant to the assigned tasks.

3.4.1.13 Hand held power tools will be de-energized before being placed into or retrieved from the water (includes electric, hydraulic, and pneumatic types).

3.4.1.14 Welding and burn cutting requires voice communication with the individual performing the welding and burning.

3.4.1.15 DOT Underwater Inspectors shall receive Bloodborne Pathogens Awareness Training in accordance with the Department's Bloodborne Pathogens Occupational Exposure Control Plan.

3.4.1.16 DOT Underwater Inspectors are not allowed to transport, store, or use explosives. This proscription does not apply to bang sticks or spear guns approved for use by the lead diver.

3.4.2 Emergency Aid

3.4.2.1 Decompression Facilities – Each District Structures Maintenance Office will compile a list of decompression facilities in the District with phone numbers. Each year the District Structures Maintenance Office will verify the phone number of the decompression facility. A copy of this list shall be with all dive teams while they are out in the field. In addition, the National Divers Alert Network (DAN) headquartered at Duke University is available 24 hours a day for emergency diving accident information. They can be contacted in an emergency at (919) 684-9111.

3.4.2.2 Emergency Hospitals – Each District Structures Maintenance Office will also compile a list of emergency hospitals in the District with phone numbers. Each year the Structures Maintenance Office will verify the phone number of the emergency hospital. A copy of this list shall be with all dive teams while they are out in the field.

3.4.3 Emergencies

3.4.3.1 Operations – Emergency situations occasionally arise concerning public safety of bridges. It is beyond the scope of this procedure to cover all contingencies. In case of an unusual event, the following rules apply:

- First priority considers the safety of the Underwater Inspectors.
- An on-site assessment of the situation should be made by the lead diver to determine the necessary actions.
- In cases where individuals are requested to deviate from standard procedures they have the right to refuse to dive if, in the individual's judgment, conditions are unsafe or unfavorable.
- Notify the District Structures Maintenance Engineer of emergency situations.

3.4.3.2 Procedures – The single most important rule to observe in any underwater emergency is "DON'T PANIC." Taking a few seconds to assess the situation can keep the emergency from becoming an accident. It is the responsibility of the lead diver to ensure that all personnel are familiar with the following situations:

- Fouling and entanglement.
- Aquatic injuries.
- Environmental conditions.
- Equipment Problems.
- Loss of air supply.
- Loss of communications.

3.4.4 General Precautions

3.4.4.1 Water entry and exits will be evaluated for adequacy and safety prior to the dive operation. When the lead diver deems the means are appropriate, the operation may proceed.

3.4.4.2 The lead diver will determine the depth and duration of the dive planned and will advise all affected personnel of any unusual hazard and emergency procedures.

3.4.4.3 A First Aid Kit will be readily available at the dive site when diving near the shore. No operation will be started until the lead diver is satisfied that all hazards have been removed or suitable safety measures have been taken.

3.4.4.4 The project or assignment **shall never** take precedence over safety.

3.4.4.5 Each diver has the responsibility and privilege to refuse to dive if the individual believes the diving conditions are unsafe, unfavorable, or violate safe dive practices. If at any specific time the diver believes that the individual is not physically or mentally able to engage in diving operations, the diver shall be excused. The conditions and reasons for refusal may require documentation and may be subject to disciplinary actions. If the individual is physically or mentally unable to work or has a medical condition that precludes diving, that individual will not be allowed to dive.

3.4.5 Safety Regulations

3.4.5.1 Whenever diving operations are underway, a boat with motor and communication capability (cellular phone, marine radio, etc.) will be stationed topside if deemed necessary by the lead diver.

3.4.5.2 The individual shall time the dive to return to the surface with a minimum tank pressure of 500 psi.

3.4.5.3 Any gear attached to the diver that could hamper the ascent to the surface will be of the quick release type.

3.4.5.4 During any heavy exertion dive, such as in current, sand bagging work, heavy manual labor work, etc., the lead diver shall consider fatigue and take proper precautions for safety.

3.4.5.5 When towing an individual from one work area to another, it is preferable to attach the tow line to the bow and operate the boat in reverse.

3.4.5.6 When an individual is entering or leaving the water to or from a boat, the motor shall be off or in neutral.

3.4.5.7 The dive boat shall not leave the dive area unless all divers are aboard.

3.4.5.8 The dive boat will be manned and positioned to protect the divers.

3.4.5.9 The dive boat will be maintained, operated, and equipped in compliance with ***Florida and U.S. Coast Guard Regulations***.

3.4.5.10 In the event of an injury causing bleeding, the injured individual will leave the water immediately and seek first aid.

3.4.5.11 Underwater Inspectors must carry knives in case of being entangled in fishing lines or nets.

3.4.5.12 In case of any diving accident, with or without injury, the dive operation will be terminated until corrective action is taken.

3.4.5.13 Prior to beginning dive operations the lead diver will determine the location of the nearest emergency aid facility (physician, ambulance, decompression chambers, hospital) and all personnel will be aware of the location and contact method.

3.4.5.14 When power equipment is being used, a second Underwater Inspector should be in close contact in order to assist as needed.

3.4.5.15 Due to the air pressure needed to operate pneumatic power tools and minor explosive effect of the released air, it is required that the nearby Underwater Inspector's ears be protected. This can be best accomplished by using a helmet.

3.4.5.16 When using a compressor for surface supplied air, only a commercial type low pressure air compressor with filters, water separator, volume tank, and commercial type hardware (hoses, fittings, etc.) will be used. All equipment and hardware should be in good condition. In addition, all applicable OSHA regulations must be followed concerning the use of a compressor for surface supplied air.

3.4.5.17 A surface tender shall be assigned to the surface supplied air control console compressor, hydraulic unit, and/or water blaster when in use.

3.4.5.18 Two way communications will be used with surface supplied air dives.

3.4.5.19 Only compressed air purchased from established commercial sources will be used in scuba tanks.

3.4.5.20 When using the water blaster, a tender shall be prepared to shut down the equipment in an emergency. Two way communication shall be maintained between the operator and tender.

3.4.5.21 Only qualified personnel or qualified companies approved by the District Structures Maintenance Office shall service dive equipment.

3.4.5.22 Decompression dives will be prohibited except in extreme emergency.

3.4.5.23 When inspecting substructures in severe water current, safety lines and safety boats shall be used. When possible, the Underwater Inspectors shall return to the surface at a location protected from boat traffic.

3.4.5.24 If a night dive is absolutely necessary, it is preferable to use surface supplied air. When using scuba, a safety line should be securely attached to the

Underwater Inspectors and tended by a tender on the surface.

3.4.5.25 Night diving in strong currents can be particularly hazardous. Surface supplied diving shall be used. In addition to the normal lighting and hand held lights, each Underwater Inspector will be equipped with an emergency submersible strobe light.

3.4.5.26 Caution will be observed when placing hands, feet, or arms under footings during inspection operations.

3.4.5.27 Divers shall descend slowly in case there are sharp objects at the bottom.

3.4.5.28 Caution shall be observed when diving near sharp marine growth or sharp steel flange edges.

3.4.5.29 Be alert for any loose material left by original construction such as wire, reinforcing steel, steel cables, pipes, false work, etc., that could harm the diver.

3.4.5.30 There is a potential danger of loose rip rap rolling onto the inspector. Caution should be taken not to push loose stones.

3.4.5.31 Underbrush and accumulations of drift and debris in and around the culvert barrels may harbor rodents, snakes, or other animals. This could represent a hazard. Caution should be exercised in these areas. Poles or probes should be used to sweep areas prior to inspection.

3.4.5.32 Inspectors should never enter a box culvert without carrying some type of protective device, i.e., chipping hammer, machete, hatchet, pole spear, or stout probe.

3.4.5.33 Inspectors should use good judgment before entering culverts which are blocked or clogged at one end. Surface supplied diving shall be used.

3.4.5.34 Where air quality or water quality is questionable in a box culvert, safety procedures should be followed, such as wearing protective equipment, wearing air quality detection equipment, mechanical ventilation inside the barrel, etc. When a dive is required surface supplied diving shall be used.

3.4.5.35 The inspector shall use caution when working in areas with poison ivy, ticks, wasps, and other stinging or biting insects.

3.4.5.36 When diving in the vicinity of movable spans, two way communications shall be maintained between the Underwater Inspectors and the bridge tender.

3.4.5.37 A diver acting as a stand by diver shall have no residual nitrogen time.

3.4.5.38 Ladders should be used for water entry.

3.4.6 Environmental Conditions – Surface and subsurface conditions at a dive site play a vital role in dive operations.

3.4.6.1 Surface conditions

- Weather reports and long range weather forecasts must be studied to determine if conditions will be acceptable for diving. Conditions may dictate that weather reports be continually monitored while an operation is in progress.
- Exposure to cold or heat can have detrimental effects on an Underwater Inspector's physical and mental well being. Provisions should be made to protect the Underwater Inspectors from undue heat or cold.
- In cold, windy weather, the "wind chill factor" must be considered. Movement of cold air over exposed skin will have an effect equivalent to that of much colder air.
- When working during hot weather or sunny days, the staging area should be shaded to prevent over exposure to the sun.
- During cold weather, Underwater Inspectors and surface personnel should not be expected to don or remove diving dress in an open, unprotected area. When working from small boats, Underwater Inspectors should dress prior to entering the boat.

3.4.6.2 Subsurface Conditions – Subsurface conditions have a major influence on the selection of Underwater Inspectors, diving technique, and the equipment to be used. Those conditions of particular concern are:

- Type of Bottom: The type of bottom affects an Underwater Inspector's ability to work and also is a factor in determining visibility.
- Mud (Silt and Clay) Bottoms - are generally the most restrictive for Underwater Inspectors. The slightest movement will stir sediment into suspension and restrict visibility. The Underwater Inspector must orient himself so that current, if any, will carry the suspended sediment away from the work area.
- Sand Bottom - Presents little problem for Underwater Inspectors. Visibility restrictions from suspended sediment are less and footing is firm.
- Marine Growth/Coral - Contains many sharp protrusions. An Underwater Inspector should wear gloves, booties, and coveralls or a wet suit for protection during bridge inspections.
- Currents: Currents can be particularly hazardous. Underwater Inspectors must always account for currents when executing a dive. When currents exceed one knot, adequate provisions for the safety of the divers shall be made. The effects of current can be mitigated by using buoyed safety line trailed from the stern of a dive boat, a pick up boat operating down current

- form the dive and/or tether, or bottom lines in the inspection areas.
- Water temperature: Diving in thermoclines (layers of water having different temperatures), the diver frequently will require protective clothing.
 - Underwater visibility: Special consideration is required for diving operation in low visibility, and diving in this condition needs experience and competence.
 - Polluted Water: In planning for operations in waters known to be polluted, protective clothing and appropriate preventive medical procedures must be provided. It is highly recommended that the diver use maximum protection in polluted water. Upon completion of a dive in polluted or contaminated water, the underwater Inspector shall demobilize and take showers at once where practical.

3.4.6.3 Obstacles, Hazards and Site Conditions

- During flooding, an Underwater Inspector needs to be aware of the possibility of being struck or pinned by floating or submerged debris.
- Where timber and debris have piled up and lodged against a structure, the Underwater Inspector should not swim in or through these objects.
- When a crane, dragline, or other heavy equipment is being operated, Underwater Inspectors shall not position themselves under any load or boom passing overhead or being lowered.
- Prior to working under a work platform, bridge, or boat, all loose objects, which could fall or be accidentally kicked overboard, shall be secured or removed.

Ensure that electrical equipment, movable bridge machinery, or intake pipes will not be activated while divers are working in the area.

3.5 Recordkeeping Requirements

3.5.1 Personal Diving Log

3.5.1.1 Each Department Underwater Inspector shall log every dive made as a Department employee deeper than 30 feet or longer than 30 minutes in duration, and is encouraged to log all other dives. Log sheets shall be submitted to the District Structure Maintenance Office to be placed in the Underwater Inspector's permanent file. The dive log should be kept on ***Form No. 850-010-13, Dive Log***.

3.5.1.2 If pressure related injuries are suspected, or if symptoms are evident, the following additional information shall be recorded and retained by the Department, with the record of the dive, for a period of 5 years:

- Complete incident report and FDOT injury report.
- Description of symptoms, including depth and time of onset.
- Description and results of treatment.
- Physician report of follow up examination.

3.5.1.3 The Diving Safety Board will investigate and document any incident of

pressure related injury and prepare a report that will be distributed to all of the District Structures Maintenance Offices.

3.5.2 Record Maintenance – The District Structures Maintenance Office shall maintain permanent records for each Department certified Underwater Inspector. The file shall include evidence of certification, log sheets, results of current physical examination, waivers, and reports of disciplinary information deemed necessary.

3.5.2.1 Availability of Records

3.5.2.1.1 Medical records shall be available to the attending physician of an Underwater Inspector or former Underwater Inspector when released in writing by the Underwater Inspector.

3.5.2.1.2 Records and documents required by this procedure shall be retained for the following period:

- Physician's written reports of medical examinations for dive team members - 5 years.
- Dive logs - 1 year, except 5 years where there has been an incident of pressure related injury.
- Pressure related injury assessment - 5 years.
- Equipment inspection and testing records - current entry or tag until equipment is withdrawn from service.

3.5.2.2 Termination of Underwater Inspector or Underwater Dive Program – When an Underwater Inspector ceases working as an Underwater Inspector, the records for that individual shall be maintained for 5 years. If the use of Department personnel for underwater operations is terminated, then the Department will maintain dive records for 5 years after the program is terminated.

4.0 DIVING EQUIPMENT

4.1 Dive Equipment

4.1.1 General Policy – All equipment shall meet requirements contained in **29 CFR 1910, Subpart T- Commercial Diving Operations (OSHA)** and/or (as appropriate), **46 CFR 197, Subpart B - Commercial Diving Operations (USCG)**. All diving equipment shall be inspected and tested according to manufacturers recommendations. Equipment that is subjected to extreme usage should require more frequent testing and maintenance. The lead diver will determine the equipment required to accomplish the task. Unnecessary equipment should not be carried underwater. When diving in strong current or limited visibility, each additional item of diving equipment increases the possibility of fouling the Underwater Inspector.

4.1.2 Recordkeeping – Each equipment modification, repair, test, inspection, calibration, or maintenance service shall be logged, including the date and nature of work performed, serial number of the item, and the name of the organization performing the work must be kept for the following equipment:

- Regulators
- Submersible pressure gauges
- Depth gauges
- Scuba cylinders
- Cylinder valves
- Diving helmets
- Submersible breathing masks
- Compressors
- Surface supplied air consoles
- Air storage cylinders
- Air filtration systems
- Analytical instruments
- Buoyancy control devices
- Diving hoses and umbilicals

No item of listed equipment shall be used unless it has been inspected and tested within the last 12 months. **Form No. 850-010-11, Quality Standards Inspection**, shall be used to document the inspection and testing of equipment.

4.1.3 Breathing Masks and Helmets – Breathing masks and helmets shall have:

- A non-return valve at the attachment point between helmet or mask hose, which shall close readily and positively.
- An exhaust valve.
- A minimum ventilation rate capable of maintaining the Underwater Inspector at the depth of the dive.

4.1.4 Scuba Cylinders – Scuba cylinders shall be designed, constructed, and maintained in accordance with the applicable provisions of the Unfired Pressure Vessel Safety Orders.

- Scuba cylinders must be hydrostatically tested in accordance with the United States Department of Transportation standards. No cylinders with expired hydrostatic testing dates shall be used.
- Scuba cylinders must have an internal inspection at intervals not to exceed 12 months. All cylinders must display a current visual inspection decal.
- Scuba cylinder valves shall be functionally tested at intervals not to exceed 12 months.

4.1.5 Personal Flotation Device (PFD) – Each Underwater Inspector should wear an inflatable flotation or buoyancy compensation device capable of being

filled by at least two methods, one method other than orally. The PFD must be capable of maintaining the Underwater Inspector at the surface in full scuba gear.

4.1.6 Submersible Cylinder Pressure Gauge – A pressure gauge shall be utilized by each Underwater Inspector.

4.1.7 Quick Release – Tank harness and weight belts must have a quick release mechanism, operable by a single motion by either hand.

4.1.8 Depth Gauge – A depth gauge shall be worn by each Underwater Inspector when diving.

4.1.9 Diving Watch – It is mandatory that the Underwater Inspector monitor his bottom time to ensure the dive is within the no decompression limit.

4.1.10 Diving Knife – The divers knife shall always be carried for emergency use. Two knives may be required, one kept sharp to cut entangling lines, the other to scrape barnacles, etc.

4.1.11 Swim Fins/Snorkel – The type used is a matter of personal preference of the Underwater Inspector.

4.1.12 Diving Light – A waterproof diving light is used when operating in areas where visibility is restricted.

4.1.13 Line – When a diver's line or safety line is required, it should be made of nylon, dacron, or polypropylene.

4.1.14 Defense Devices – The lead diver will decide when defense devices (spear guns or bang sticks) are required. These are last resort measures and can be carried by permit. The Department certification card is a permit for carrying these devices.

4.1.15 Protective Clothing – The Underwater Inspector should be wearing appropriate protective clothing (i.e. bottom boots, etc.) for the dive environment. Hazards to be considered are cold water, sharp or rough objects, polluted water, and various forms of marine life.

4.1.16 Weight Belt and Weights – The weight belt is used by the Underwater Inspector to achieve slightly negative buoyancy. The weight carried should be just sufficient so that the Underwater Inspector is slightly negative with an empty tank.

4.1.17 Underwater Compass – The underwater compass shall be waterproof and pressure resistant. It should be designed to give reasonably accurate readings in positions other than in a true horizontal plane. It should have

reference line scribes across the face for reference and sighting.

4.1.18 Face Mask (Scuba) – Personal preference, but should be low volume, provide for wide angle vision and be constructed of a non allergenic material and tempered safety glass.

4.2 Inspection Equipment

4.2.1 General – Inspection specific equipment is required for the Underwater Inspector to conduct a thorough inspection.

4.2.2 Hand Tools – The hand tools are used for either cleaning or measuring. For cleaning, an Underwater Inspector may use a chipping hammer, a scraper, a wire brush or a small pry bar. For measuring, an Underwater Inspector may use a ruler, tape, calipers or levels.

4.2.3 Power Tools – Power tools may be used to clean elements of the bridge to speed the inspection process, they may also be used for drilling and cutting. Individuals using power tools shall be qualified and experienced to operate the specific tools being used. If inexperienced in the use of the specific power tool, training shall be obtained in the proper use of the specific power tool.

- The whirlaway is a rotary cleaning tool. The toothed rollers are placed against the surface to be cleaned and, as their circular housing rotates, abrade the surface, cleaning back to the original material.
- The water blaster is also a power tool designed for the speedy cleaning of the bridge structure to enable detailed inspection.
- The power hammer or jack hammer is often used for cleaning or clearing debris or encrustation from substructure elements.
- The underwater power drill is commonly used to drill attachment points for protection or reinforcement of structure elements.
- The underwater saw typically is used as a submersible version of a circular saw.
- The underwater cutting torch is used for cutting steel, concrete, or wood.

4.2.4 Analysis Tools – There are sophisticated devices which may be used to aid the Underwater Inspector. When these tools are used, an independent testing method should be used to verify the accuracy and reliability of the equipment.

4.2.5 Recording Tools and Equipment – The documentation of inspection findings is vital for a complete inspection. Various methods may be used:

- Underwater paper and pens may be used by the Underwater Inspector to document the inspections findings.
- Voice communication between the diver and a topside note taker. The diver may communicate the inspection findings during the inspections. The note taker should repeat the findings to the diver to verify the findings.

- Voice recording may be made and transcribed later.
- Underwater cameras or video cameras may be used.

4.2.6 Vehicle and Boat – The underwater inspection team require a boat, motor, and trailer. The boat operator shall demonstrate competence in small boat handling to the lead diver. The boat operator shall take course ST-09-0128 “Boating Safety” before operating the boat.

4.3 Equipment Maintenance and Inventory System

4.3.1 Equipment Storage and Maintenance – All diving gear and accessory equipment will be stored when not in use in a cool, dry place (environmentally controlled if possible). The storage area shall be secured. All rubber goods shall be marked with a waterproof indelible substance, while regulators and metallic equipment shall be etched with an identifying mark. Leaving diving equipment in a vehicle or boat unattended overnight should be avoided. Manufacturer's recommended servicing policy shall be followed for equipment maintenance. Depth gauges shall be periodically calibrated. Field calibration is acceptable.

4.3.2 Equipment Inventory – All diving equipment and related hardware shall be inventoried in accordance with the Department's regulations and inventory updated when equipment is purchased or surplussed.

4.0 UNDERWATER BRIDGE INSPECTION

4.1 General – The life of the bridge depends on the preservation of the physical integrity of the structure. A quality underwater inspection program is a vital component of the bridge inspection program. The underwater bridge inspection is performed either by certified FDOT Underwater Inspectors or consultants. Divers working for consultants shall perform the underwater inspections according to the standards in this section and OSHA regulations for commercial diving.

4.2 Inspection Related Training Requirements – Before a diver can participate in an underwater inspection beyond the safety diver/tender level, the diver must complete either NHI Course 13055 “Safety Inspection of In-Service Bridges” or NHI Course 130091 “Underwater Bridge Inspection.” It is recommended that the diver take both courses.

4.3 Levels of Inspections – The FHWA Underwater Inspection of Bridges (FHWA-DP-80-1) defines three levels of underwater inspection. The minimum level for an underwater inspection is 100% Level I and 10% Level II.

4.3.1 Level I – Level I Underwater Inspection is a swim by inspection at arms length of all underwater elements of the structure. When visibility is limited the Level I inspection would consist of feeling all surfaces of the underwater portion

of the structure. The Level I underwater inspection would also include looking for evidence of scour, undermining of foundations, and the exposure of normally buried portions of the structure.

4.3.2 Level II – Level II Underwater Inspection involves cleaning and close inspection of a limited portion of the structures. For 10% of the piles clean 10 inch high bands at the waterline, mudline, and midway in between. Three sides of rectangular piles, six sides for octagonal piles, and three fourths of the perimeter for round piles. For steel piles outside flange faces and one side of web. Four equal spaced 1 foot by 1 foot areas for large (> 3 ft) diameter sections. For all large solid faced structures (piers and abutments) 1 foot by 1 foot areas at three levels on each face. Document the portion of the bridge that receives a Level II Inspection in the bridge inspection report. The portions receiving a Level II Inspection shall not be repeated in successive inspections.

4.3.3 Level III – A Level III inspection is a highly detailed inspection of a critical structure or structural element, or a member where extensive repair or possible replacement is contemplated. This level of inspection includes extensive cleaning, detailed measurements, and selected non destructive and partially destructive testing techniques. Detailed documentation is required and may include, photographs, sketches, and/or videos of the deficiencies found.

4.4 Inspection Items

4.4.1 General – Underwater inspections are carried out to determine the condition of structural members of the bridge. Bridge deficiency and deterioration may be caused by any one or a combination of the following factors:

- Age of bridge.
- Environmental attack on bridge.
- Excessive loading of the bridge.
- Collision damage to the bridge.
- Deficiencies in the original construction of the bridge.
- Inadequate design.
- Changes in bottom elevation in and around the substructure units of the bridge due to scour or other causes.

4.4.2 Inspection Items – The following items, at a minimum, should be inspected during an underwater inspection.

4.4.2.1 Pile Bents – Check piles for any signs of deterioration or damage.

- Steel piles. Steel piles are susceptible to corrosion in the splash zone and tidal zone, and have been found to be severely deteriorated at deeper water depths. Where piles are concrete jacketed in the tidal zone, the diver should carefully check for signs of corrosion from the area just below the concrete jacket all the way down to the mud line.
- Timber Piles. Timber piles should be observed carefully from the water

- line to the mud line for marine borer attacks.
- Prestressed Piles. Check prestressed piles for longitudinal cracking. Pay particular attention to hollow prestressed piles.
 - Piles under Piers. The above instructions also apply to piles under piers where the footing is set above the river or sea bottom.

4.4.2.2 Dolphins and Fenders – Dolphins and fenders shall be examined below the water for deterioration and borer attack, and for any damage caused by vessels or large floating objects.

4.4.2.3 Pier and Abutments – Where portions of these substructures are exposed below water, they should be examined for any deterioration and any evidence of movement.

4.4.2.4 Scour – The bottom around the piers of abutments shall be checked for local scour and the stream bed and channel shall be inspected for general scour and stream shifting. All scour countermeasures shall be inspected.

4.4.2.5 Submarine Cables – Cables should be inspected for the following:

- Damage to the cable from vessels or floating debris.
- Kinks in the cable.
- Exposure of the cable when it should be buried.
- Age and condition of the cable and any need for replacement.
- If the cable location is not charted, plot the current cable location.

Note: Care should be exercised in working around any electrical cable.

4.4.2.6 Culvert – The stream channel of the culvert shall be checked for erosion, scour, and alignment shifting. The culvert ends should be inspected for undermining, scour, and evidence of piping.

4.5 Inspection Procedures

4.5.1 Preparation – The underwater inspection team should be familiar with the construction of the bridge and the site conditions before starting the inspection. Proper planning and preparation will save time in the field and result in a more accurate inspection. The preparation for the inspection should consist of the following:

- Review the as-built plans of the substructure, if available. This review should include a study of environmental features such as the stream channel, current, soil conditions, stream profile, stream protection devices, and underwater utilities. Stream elevations at both normal and high water levels should be obtained.
- Review the previous inspection reports. This will allow the underwater inspectors to pinpoint those areas which had previous deficiencies and assure that an accurate comparison can be made between the previous inspection and current condition.

- Review scour evaluation reports if available. This will contain information on the morphology and hydrology of the stream and predict potential scour depth. If the actual behavior of the stream does not match the scour evaluation reports, the inspectors should report this to the Bridge Inspection Supervisor and the Structures Maintenance Engineer.
- Plan for adequate personnel and equipment based on the size and type of the bridge and the environmental conditions.
- Document the inspection findings.

4.5.2 Cleaning – Cleaning marine growth from the underwater portions of the bridge substructure to facilitate inspection and detection of deficiencies is almost always required. The extent of the cleaning will depend on the amount of growth present and the type and level of inspection being performed.

4.5.3 Inspection Process

4.5.3.1 Spread Footing

- Inspect and document scour near footing (upstream or adjacent to footing). Measure size of scour and document location.
- Inspect and document scour or soft material under footing by surveying perimeter of footing. Use probing rod and rule during inspection.
- Inspect and document condition of concrete.
- For footings keyed into rock, inspect for separation at base of footing and rock foundation. Inspect and document voids between footing and rock foundations.

4.5.3.2 Pile Footing – Inspect and document scour at piling and record approximate depth of scour.

- Measure and document size of footing if unknown.
- Measure and document size, number, and spacing of piles under footing if unknown.
- Inspect and document condition of concrete.
- If a footing was designed to be embedded in the stream and is now exposed, document the extent of the exposure and number of piles exposed.
- Inspect and document piles for soundness and section loss.
- Inspect and document debris lodged between piling.

4.5.3.3 Reinforced and Prestressed Concrete Piles

- Inspect and document condition of concrete.
- Inspect and document scour at piles.

4.5.3.4 Steel Pile Inspection

- Inspect and document condition of pile and pile coating.
- Document corrosion.

- Document areas of section loss and record remaining thickness of flange and web.
- Inspect and document scour.
- If cross bracing exists, inspect and document condition with special attention to connections.
- Inspect and document condition of any cathodic protection.

4.5.3.5 Timber Pile

- Inspect and document condition.
- Inspect and document scour.
- Inspect and document marine life attack.
- Inspect and document cross bracing and condition of connecting bolts.

4.5.3.6 Concrete Seal – Inspect and document condition of concrete.

4.5.3.7 Dolphins and Fenders

- Observe and document the general overall condition.
- Document missing or broken piles, wales, and wire rope.
- Document any fire or impact damage.
- Inspect and document scour condition.
- Document any debris buildup on piling.

4.5.3.8 Scour

- Take the channel profile and compare with past records to find any scour tendencies, channel shifting, or degradation. The datum for the channel profile shall be set in the initial inspection and confirmed with the topside bridge inspectors.
- Take sounding to check for local scour around the substructure and record the measurements.
- Observe the effect of wave action on the bridge and its approaches.
- Check the condition of channel protection work and scour protective devices.
- Observe and document any erosion of approach fills and embankments.

4.5.3.9 Culvert

- Inspect and document inlets and outlets for scour activity.
- Inspect and document the condition of the culvert.
- Document the extent of debris and sediment buildup in the culvert and channel.

4.6 Coordination of FDOT and Other Agencies – FDOT's Underwater Inspectors might work with divers from other agencies, consultant firms, or contractors in underwater operations. The smooth coordination between parties is an essential factor in the successful achievement of the task.

4.6.1 Define Task – Prior to any operation, the scope of work and task assignment shall be defined clearly.

4.6.2 Work Plan – All parties shall fully understand the overall working process and the operation sequence of each part shall be specified specifically.

4.6.3 Communication – When parties need to work together the method of communication shall be established beforehand.

4.6.4 Qualifications – The other agencies or firms should provide qualifications of their diving personnel to the lead diver.

4.6.5 Safety – The safety regulations of this procedure will be used as the basic safety standard. All personnel including non Department personnel must adhere to all applicable OSHA regulations.

4.6.6 Coordination – All the coordination conditions shall be prepared in writing as a mutual agreement for the implementation of the underwater operation.

5.0 MEDICAL REQUIREMENTS FOR THE UNDERWATER INSPECTION TEAM

5.1 General

5.1.1 The Department will determine that underwater inspection team members who are exposed to hyperbaric conditions have passed a current diving physical examination and have been declared by the examining physician to be fit to engage in diving activities as may be limited or restricted in the medical evaluation report.

5.1.2 All medical evaluations required by this procedure will be done by, or under the direction of, a licensed physician, preferably one trained in diving/undersea medicine.

5.1.3 The Underwater Inspector should be free of any chronic disabling disease and be free of any conditions contained in the list of conditions for which restrictions from diving are generally recommended.

5.2 Frequency of Medical Evaluations – Medical evaluation will be completed:

5.2.1 Before an inspector may begin diving, a medical evaluation must have been given within the preceding 12 months and that examination result has been reviewed and found satisfactory by the Department.

5.2.2 Thereafter, at one year intervals from the date of the previous medical

evaluation.

5.2.3 After any injury, illness, or surgery requiring hospital admission or debilitation.

5.2.4 After a diving accident resulting in injury to the inspector.

5.2.5 After any episode of unconsciousness.

5.3 Information Provided the Examining Physician – The Department will provide a copy of the medical evaluation form to the examining physician.

6.0 TRAINING

There is no training required for this procedure.

7.0 FORMS

The following forms may be accessed in the Department's Forms Library:

- Quality Standards Inspection (850-010-11)
- Medical Questionnaire for Diving (850-010-12)
- Dive Log (850-010-13)