



# Electrofishing



Electrofishing equipment is used by biologists to shock fish in order to survey fish populations by sending an electric current (either AC or DC) into the water momentarily, which stuns fish within the effective range of the unit, so people can dip them from the water and into nets.

1. Electrofishing is the most effective means of finding out the year/class ratio of fish in any body of water. Netted fish are identified, counted, measured, weighed and examined for identifying marks, such as tags, clipped fins or brands. The fish are then returned unharmed to the water from which they were netted.

## Accident potential

2. Electrofishing can be a dangerous operation with the most obvious accident being electrical shock. Most boats have aluminum hulls and are floating in water being subjected to an electrical discharge great enough to stun fish. In addition, an electrical short in the equipment or its wiring can electrify the entire boat and cause electrical shock.
3. As with any operation in or near water, there is also a hazard of drowning. Personnel netting

fish from the water who are standing in the bow of a boat have the potential of falling overboard. Even personnel on a boat with a waist-high railing could fall overboard while reaching too far out for the fish. Also, because the tank for holding captured fish is located midship, wet fish in the net often must be passed over the deck, creating a slipping hazard.

4. Because the electric generator is usually located near the boat operator, the exhaust pipe and cylinder head present a burn hazard, especially in rough water.

## Types of equipment required

5. Electrofishing is conducted in a variety of environments, each with distinct problems. Electrofishing is conducted both during daylight and in darkness with the use of lights. Electrofishing involves surveys on major rivers, streams, reservoirs, large and small lakes and in ponds. The types of electrical needs are dictated by the water chemistry and the species of fish involved. The electrical needs include DC (pulsed and non-pulsed) and both two- and three-phase AC.

6. Each electrofishing unit requires the same basic equipment. The primary boat used is the flat-bottomed john boat. Generators can vary but should be capable of producing AC or DC. The maximum electrical output capacity is determined by specific needs. Choice of outboard engines to power the boat also may vary, depending on need. Boats require a fish-holding tank complete with aerator. Because of the noise created by the outboard motor and the generator, each electrofishing unit should be equipped with an intercommunication system providing a minimum of four headphone jacks (i.e., two jacks at the bow for the dip net operator(s), one jack at the boat operator position, and one jack for the supervisory position). Cordless receiver-transmitter units may be used to replace cord-type models. Handles for dip nets should be made of nylon or wood, or glass fiber-wrapped aluminum.
7. A power control box must be incorporated into the system. It should be located near the boat operator. It should have an instant cut-out device so power can be cut immediately to all electrofishing circuits in the event of an emergency.

## Crew composition and responsibilities

8. In each electrofishing activity, one person must be designated as the crew supervisor. This person should be thoroughly trained and qualified to operate all equipment. The crew supervisor is responsible for the electrofishing operation, including enforcement of safety standards.
9. The boat operator is responsible for operating the boat safely, for following the directions of the crew supervisor and for operating the electrical

control panel. He or she will respond to the guidance of the dipnetter(s) regarding underwater obstructions. If required, the crew supervisor also may operate the boat.

10. The dip-netter(s) will work from the bow of the boat to retrieve fish that have been stunned by the electrical shock. Each dip-netter must be on the lookout for underwater obstructions and immediately advise the boat operator of them. No passengers should be permitted on board (luring actual shocking projects; exceptions to this rule must be made only by high-level management, if at all).

## Equipment construction generator/alternator

11. The generator/alternator must have enough capacity to provide for all electrical requirements without overloading. Because power and lighting requirements vary widely, no standard can be set for generator size, wiring configuration and electrical supply voltage.
12. The battery enclosure for wet-cell batteries should be acid-proof, non-metallic and vented.
13. An isolating transformer is required on the output of all generators/alternators.

## Voltage and insulation thickness

14. The rated voltage of the insulation of conductors used to deliver output current from the generator/alternator to the pulsator and from the pulsator to the electrodes must exceed the maximum potential voltage of the generator/alternator or pulsator by the next higher rating as shown in Table 1.

**Table 1. Voltage and Insulation Thickness**

Pulsator or generator/alternator	Minimum insulation rating of conductor
0-249 volts	250 volts
249-599 volts	600 volts
599-899 volts	900 volts
900-12,999 volts	13,000 volts

**Table 2. Conductor Size**

Conductor size shall be approved for rated amperage of equipment as follows:		
Amperage	Conductor Size	mm
0-15	14 American wire gage	1.628
16-20	12 American wire gage	2.053
21-30	10 American wire gage	2.568

## Conductor size

15. Conductor size must be approved for rated amperage of equipment as shown in Table 2.

## Conductor type

16. Conductors must be of the stranded type and insulated with a type recommended for wet locations. All conductors in the boat must be enclosed in raceways, conduit or liquid-tight flexible conduit. However, when greater flexibility in installation is desired, appropriate heavy-duty, rubber-covered cord may be used.
17. If connections are necessary, the rating of the connector (plastic wire nut) must be the same or greater than that of the wire. Connectors used with flexible cords must be of the locking, water-resistant type. No wire splices are permitted.
18. All conductors within a given raceway or conduit must be rated at or above the maximum voltage of any conductor in the raceway or conduit. For example, if 12-volt lighting conductors are contained within conduit also carrying an 800-volt conductor, then all other conductors must be rated at or above 800 volts.
19. Junction boxes must be made of cast iron, cast aluminum, glass fiber or plastic. Depending on use, all boxes must be either weatherproof or watertight.
  - Boxes with switching equipment must be weatherproof. According to the National Electrical Code (NEC), Article 100, Section A, this means the boxes must be “so constructed or protected that exposure to the weather will not interfere with successful operation.”
  - Boxes without switches must be watertight. According to the NEC, this means the boxes must be “so constructed that moisture will not enter the closure.”
20. All junction boxes must be labeled as to voltage and designated by caution labels. To prevent

mistakes in using the electricity, use a different type of plug for each voltage.

## Circuit breaker

21. Power output conductors for the generator or alternator must include a circuit breaker or fuse to protect branch circuits. As defined in the NEC, a circuit breaker is “a device designed to open and close a circuit by a non-automatic means and to open the circuit automatically on the predetermined over-current without injury to itself when properly applied within its rating.” The NEC definition of a branch circuit is “the circuit conductors between the final over-current device protecting the circuit and the load(s).”
22. Circuit breakers or fuses used for protecting branch circuits must be enclosed in a weatherproof enclosure or cabinet complying with Article 373-2, Section A of the NEC. That requirement states: In damp or wet locations, cabinets and cut-out boxes of the surface type shall be so placed or equipped so as to prevent moisture or water from entering and accumulating within the cabinet or cut-out box, and shall be mounted so there is at least 1/2 inch air space between the enclosure and the wall or other supporting surface. Cabinets or cut-out boxes installed in wet locations shall be weatherproof.
23. Unless located otherwise by the manufacturer, all circuit breakers, switches and controls must be placed in a central control box within easy reach of the boat operator.
24. An instant-stop switch device from power box and outboard motor should be attached to the outboard motor operator. This is designed to ensure the operator’s safety if he or she falls overboard.
25. Indicator lamps (i.e., a neon circuit tester) should be mounted in the power-output circuit to indicate to boat and dip net operators when circuits are energized.

## Deadman switch

26. Each dip-netter should have an emergency stop or deadman switch controlling the power from the pulsator or generator/alternator. This type of switch requires constant pressure to supply power. If there are two or more dip-netters, each should have a stop switch, electrically connected in series. The boat operator also must have an emergency stop switch connected in series with the netters.
27. Power control circuits—which control the current from the pulsator or generator to the electrodes—may not exceed 24 volts AC or DC.

## Electrodes

28. Metal boat hulls may not be used as the cathode (the negative terminal). The anode (positive terminal) and cathode must be electrically insulated from their respective booms.

## Grounding and bonding

29. All metal surfaces within the boat, including any electrically conductive cathode and anode booms, must be electrically connected or bonded to the boat hull. In this sense, connected means a connection between conductors and a terminal by means of mechanical pressure and without the use of solder. Bonding refers to permanently joining metallic parts to form an electrically conductive part ensuring electrical continuity and the capacity to conduct safely any current likely to be imposed.
30. Grounding, as defined by the NEC, is a conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

## General lighting requirements

31. The boat should have internal lighting to illuminate walking and work areas. Safety low-voltage, direct-current lighting should not exceed 24 volts,

with 12 volts preferable. If the lamp is shielded with a non-conductive cage, 110-volt lamps may be used.

## Ground-fault circuit interrupters

32. All circuits must be provided with ground-fault circuit interrupters.

## Tank and aerator

33. The fish-receiving tank and the aerator should be located just forward of the midship position. The tank should be located so the dip-netter(s) can empty the nets without undue stress, strain or reaching.

## Safety rails and decks

34. Safety rails should be provided around the outside of the dip-netting area and should be at least 42 inches high and constructed of heavy-wall steel pipe at least 3/4 inch in diameter or heavy-wall aluminum pipe 1/2 inch in diameter. Rails must be designed to withstand lateral pressure of 200 pound-force.
35. Work decks must be covered with non-skid material. They should be sloped to allow drainage.

## Boat and electrical control panel console

36. To correct the problem of the operator constantly facing toward the rear to operate the motor, all electrofishing boats should be equipped with a steering console. For larger boats, the control console is best mounted in an elevated position, such as a conning tower, so the operator can see the water around the electrodes.

## Exhaust from power source

37. Exhaust from the motor generator/ alternator must be piped away from the boat operator. To reduce the potential of burns resulting from contact with the exposed hot pipes, all piping should be enclosed in protective railing



or screening. The use of galvanized pipe for exhaust is prohibited because toxic gases may be produced under extreme heating conditions. Mufflers, where applicable, should be used.

## Fuel storage

38. Gasoline and diesel fuel must be stored and transported in approved containers. For design requirements, see 29 CFR 1910.106.

## Warning signs

39. All areas of access or possible access to energized equipment must be equipped with at least two warning signs. Any moving equipment or hot machinery also must be color-coded and labeled with appropriate warning signs.

## SAFETY AND GENERAL PRECAUTIONS

### Communication

40. The electric power generator can produce sound levels greater than 95 dBA. Together the generator, the boat engine and the aerator used to oxygenate the fish-holding tank can produce a noise level exceeding 100 dBA. Hearing protection is, therefore, necessary.
41. All personnel should wear communications headsets for communication between positions and for hearing protection. Hearing protection should be provided for all participants in the boat not equipped with communication headsets.

### Life vests

42. All boat occupants must wear Coast Guard-approved life vests at all times. Life vests must meet the requirements of Type II as a minimum. A Type II vest is an approved device designed to turn an unconscious person in the water from a face-down position to a vertical or slightly backward face-up position.
43. Follow U.S. Coast Guard or local applicable fire safety regulations, whichever are more restrictive.

As a minimum, each boat must be equipped with at least two 5-pound and one 10-pound-type ABC fire extinguisher. These should be mounted in a holder for easy access to the boat operator and away from potential sources of fire.

### Dip net

44. The dip net must not be used as an electrode. Net handles must be constructed of a non-conductive material such as nylon, wood or glass fiber-wrapped aluminum. It should be long enough for dipnetters to avoid hand contact with water.

### Clothing and footwear

45. Dip-netters must wear footwear with rubber soles.
46. Dip-netters must either wear long pants or wear hip boots when wearing shorts, swim trunks or swim-suits.
47. Dip-netters should be provided with rubber gloves. Studies have indicated that personnel who wore rubber gloves depended upon them for protection and became less cautious about handling electrical connectors. People should not stick their hands into the water to retrieve lost fish or equipment.

### Labeling and color-coding of significant hazards

48. Identify and mark with warning signs and color-coding specific and significant hazards. For example, although yellow is the code for physical hazards, such as slipping or tripping, it is not helpful to color-code the entire deck.
49. All areas of access or possible access to energized equipment should be color-coded or labeled with appropriate warnings. Exposed moving equipment or hot machinery that cannot be safeguarded and could cause injury if contacted also should be color-coded and/or labeled with appropriate warning signs.
50. Red is the color for marking the following critical locations:

- *Fire extinguishers.* Besides identifying the extinguishers themselves, red should be used on the housing, bulkhead or support to identify the location of the fire extinguishers.
- *Danger.* Safety cans or other portable containers of flammable liquids should be red, with the name of the contents conspicuously stenciled or painted on the can in yellow.
- *Stop.* Stop buttons or electrical switches used for emergency stopping of equipment should be red.

- 51.** *Yellow.* Yellow is the basic color for designating caution and for marking significant physical hazards, such as striking against, stumbling, falling, tripping and getting caught between.
- 52.** *Orange.* Orange designates dangerous equipment: parts of machines and equipment that may cut, crush, shock or otherwise injure.
- 53.** Labeling and color-coding do not serve as a substitute for physical guarding where necessary.

## Hearing protection

- 54.** Through engineering methods, maintain noise levels of the generator within acceptable exposure of 85 dBA for an eight-hour day. Ways to accomplish this include using a hooded and shrouded recreational vehicle-type generator/alternator or installing an insulated, sound-absorbing cover, vented to the outboard side of the boat.
- 55.** If the combined noise level exceeds the dBA permissible exposure limit, crew members should be provided with hearing protection. Communications headsets for primary crew members will meet the requirement. Observers, when authorized, should have hearing protection; the disposable type is permissible.

## Training of crew members

- 56.** Everyone who will be operating electrofishing equipment should be thoroughly trained on each

position's responsibilities. Training should include both normal and emergency procedures. Each crew member also should be trained in first aid and CPR.

- 57.** The electrofishing boat supervisor and all crew members must have training in basic electrical safety.

## Operation checklist

- 58.** Checklists should be developed for all phases of electrofishing operations. These checklists should include procedures from launching, operating the boat on the water, and taking the boat out of the water. Procedures for electrical hookup are particularly important and must be included.
- 59.** Checklists for boat, equipment and operational procedures should be enclosed in a waterproof plastic container. They should be readily available at all times during the electrofishing operation.

## Maintenance schedule

- 60.** Because electrofishing equipment is exposed to water, wiring must be periodically checked for corrosion. A schedule for maintenance inspection should be developed. The time intervals depend upon the frequency of use and the severity of the exposure.

## Warning

- 61.** Where appropriate, supervisors must provide adequate warning and take positive steps to ensure the public is not exposed to the potential hazards of electrofishing operations. In addition, only a minimum number of employees may participate in electrofishing operations.

## Design

- 62.** General boat design and equipment layout must provide adequate working space to conduct operations. The boat must be kept clean and orderly at all times.

## Emergencies

63. The supervisor must provide for emergencies, as appropriate. Examples include submerged logs, sandbars and a crew member overboard with power on.

## Gauges

64. Adequate instrumentation should be provided to monitor the electrical power equipment on the boat.

## Refueling

65. To refuel the generator/alternator, turn off all equipment and allow hot surfaces plenty of time to cool. Fill all tanks before each operation.

## ELECTROFISHING RESTRICTIONS

### Private waters

66. Conducting electrofishing operations on private waters should only be done if the owner or owner's appointed representative is present, or a signed written request has been received.

### Storms

67. Electrofishing should not take place during electrical storms, rain, high winds or any other conditions considered unsafe by the crew supervisor.

### Participants

68. Only qualified personnel may participate in electrofishing operations. Infrequent exceptions to this rule may be made and only with written approval of upper management.

## Operations in the vicinity of other vessels

69. Electrofishing operations may not be conducted near other craft. A rule of thumb is to maintain a minimum distance of 100 feet.

## Sources of information

29 CFR Part 1910.106. Flammable and combustible liquids.

American National Standards institute, Safety Color Code, ANSI Z535.1-2006 (R2011). Washington: ANSI.

National Fire Protection Association Electrical Code, NFPA 70. Quincy, MA: NFPA, 2014. 1 Batterymarch Park Quincy, MA USA 02169-7471.

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