AUSTRALIAN CODE OF ELECTROFISHING PRACTICE

This national code was prepared under the auspices of the Fishery Management sub-committee of the Standing Committee for Fisheries and Aquaculture (SCFFA). The contribution of all those who were involved in the preparation of the code is gratefully acknowledged. The Code of Practice resulted from the international Workshop on Developments in Electrofishing conducted in Canberra, March 1995, by the Cooperative Centre for Freshwater Ecology. The code was approved at SCFFA 37 in Adelaide on July 23rd 1997.

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1. OBJECTIVES OF THE CODE OF PRACTICE

Electrofishing has become an essential sampling tool in the study of freshwater fish ecology. Although used by research groups in Australia for over 30 years, there has been no national code of practice to ensure safe operation and certification of equipment. Several states have had their own guidelines, but increasing use throughout the country means the time has come for a consistent and coordinated approach to training and safety.

To ensure safe operation of electrofishing equipment -

i) The apparatus must conform to a national standard in design and construction, and be maintained and inspected by qualified electrical mechanics and electronic technicians.

ii) Electrofishing personnel must be certified free of major heart or respiratory complaints by a medical practitioner; be trained in the fundamentals of electricity, correct and safe electrofishing procedures and first aid including cardio-pulmonary resuscitation (CPR).

iii) All electrofishing operations must follow the standard safety guidelines outlined below.

2. HAZARDS OF ELECTROFISHING

Electrofishing equipment uses voltages and currents that can be lethal to humans. Direct effects of electric shock may include heart failure, respiratory interference or electrical burns. There may also be indirect injuries through a worker recoiling violently and striking an object.

The main sources of potential risk of electric shock during electrofishing operations are:

i) Bodily contact with energised electrodes of opposite polarity.

ii) Bodily contact with water within the electric field.

iii) Shocks from inadequately constructed or insulated equipment.

Other hazards that must be recognised include drowning, fire, exhaust gases, and the increased risk of accident due to fatigue.

It is easy for experienced operators to become complacent about the dangers involved in electrofishing, but they are always present and must be constantly guarded against by regular checks and maintenance to minimise the risk of accidents.

3. STAFF TRAINING AND CERTIFICATION

All electrofishing operations must be carried out under the supervision and control of a Senior Operator who has been awarded a Certificate of Competency in Electrofishing Procedures and Safety for the particular type of equipment being used i.e. backpack, shore-based, or boat-mounted.

Initially, certificates will be awarded to persons who can provide evidence of having experience using a particular electrofishing gear type for at least 20 sessions (an electrofishing "session" as cited in this document refers to a single complete electrofishing operation consisting of gear set up, safety checks, sampling, and gear dismantling. In this way, several "sessions" may occur in one day if more than one site is sampled).

The evidence of experience may consist of a signed statement from a university department, research section or commercial licence authority, plus a current Senior First-aid Certificate or equivalent including CPR, and a recent medical certificate stating freedom from major heart or respiratory complaints that the examining doctor considers could pose a significant risk should even a minor electrical shock occur. Certificate holders will be provided with a manual outlining electrofishing theory, procedures and safety which they will be required to follow.

The onus will then be on these Senior Operators to train and supervise other staff and students under their control, complying strictly with the requirements outlined in the above manual. All electrofishing team trainees must have also completed a first aid certificate and pass a medical examination, and are required to keep a log of their hours using each gear type. On reaching 50 hours, their supervisor will sign and forward the log to the National Electrofishing Safety and Training Administrator, who will issue a certificate *for that gear type only*.

For persons who have already qualified as Senior Operators with one gear type, a further 5 sessions will be the requirement to gain authorisation for additional electrofishing types. Trainees will need to keep a separate log of their hours of use with each gear type.

First-aid certificates and medicals must be updated every 2 years.

4. EQUIPMENT

4.1 Construction standards

4.1.1 General

i) All Electrofishing equipment must be constructed only by qualified electrical mechanics and electronic technicians. Wiring and general construction must comply with the Standards Association of Australia regulations (AS 3000, AS 3004, AS 3010.1, AS 3100, AS 1939).

ii) Each electrofishing unit must be accompanied by a detailed instruction manual and gear log book that contains hours and places of use, operators' names, maintenance and electrical checklists.

iii) Mains electricity must ***never*** be used for any electrofishing operation. Non-standard plugs must be used to prevent connection to the public power supply.

iv) The maximum voltage output allowable is 1000V. Only DC current is to be used for the electrical fields due to its tendency to cause fewer injuries to fish and being less dangerous to operators in the event of an accident. Approval to use AC may be granted in special research circumstances only, e.g. for studies into the effects of different electrical fields on fish behaviour, physiology and mortality.

v) All cable and connectors must be non-interchangeable, waterproof, and give adequate mechanical protection, and all cabling must be of stranded multicore conductors.

vi) Batteries must be sealed type or housed in spill proof marine battery containers.

vii) Generator ***output*** must not be earthed but must be ***isolated from the frame*** so that power can only enter the water via the electrodes. This involves removing the earth wire that grounds the frame to the output circuit. The ***frame*** however must still be earthed via an earth stake for shore mounted units, or by grounding to all other metal objects within a boat, whether the boat is metal or non-metal. In non-metal boats, the outboard motor must be grounded as well. Electrofishing generators must be clearly labelled and ***must not*** be used for other purposes.

viii) Generators and control boxes must not be carried while running or energised (except specifically designed backpack units).

ix) Control boxes must be IP34 rated (see Appendix B), protected by current and/or thermal overload, and fitted with a large red latching "STOP" button to interrupt power supply from the generator to the control circuitry. An ammeter must be fitted to measure control box ***output***, and a lamp to indicate when the unit is energised and the electrodes are live. It is recommended that a voltmeter and audible signal emitter be fitted as well. Large, easily visible warning signs indicating the danger of high voltage are to be attached.

Due to the cooling vents present on the control boxes of some electrofishing equipment, care must be taken to prevent the entry of water into the electronics when cleaning or during rain. A waterproof cover is recommended when the apparatus is not in use.

x) Power to the electrodes must be switched by at least one "deadman" or fail-safe switch. All control-switch circuits must be extra low voltage (< 32VAC or < 115VDC) - ***never*** directly switching the anode supply.

xi) Hand held anodes ***must not*** be used in metal boats or be fitted with dip nets except when connected to a backpack rather than generator powered unit, although this procedure is not recommended. All anode poles and dipnet handles must be made of a non-conductive material with no metal core but ***not*** wood. Carbon-fibre reinforced poles are likely to be conductors of electricity and must be thoroughly tested for insulation properties if being considered for use.

4.1.2 Backpacks

i) Battery powered backpack units must use only fully sealed dry cells as a power source. Specifically designed generator powered units are not recommended, but if used it is recommended that they be fitted with earth leakage circuit breakers at the generator output.

ii) The backpack unit ***must*** incorporate a quick release harness, a deadman switch on the anode pole, and be fitted with a mercury tilt switch that cuts off power input from the battery or generator whenever the unit is tilted at more than a 45^0 angle. The tilt switch can have an automatic reset - although a manual button that can be reset by the operator is recommended. The unit must have an audible alarm when in use.

iii) Backpack electrofishing is not recommended in water deeper than operator crotch depth.

iv) If a backpack unit is operated from a boat, it must be ensured that the cathode is isolated from the boat hull. It is also recommended that two foot-pedal safety switches connected in series be incorporated.

v) Backpack units must meet IP 37 standards (see Appendix B)

4.1.3 Shore-based units

i) Generators must be safely anchored and not capable of falling or being pulled into the water by the anode cable. The generator must be manned at all times during electrofishing operations, and electrode and dipnet crew must be in line of sight or in radio contact with the generator attendant.

ii) Only one anode is permissible per generator unit. Generators and control boxes must not be carried while energised. Hand held anodes must incorporate a deadman switch on the anode pole.

iii) Electrode and dipnet crews may operate from a boat using a shore-based generator in safe conditions providing the anode is fixed not hand held, and floating cable is recommended to minimise the risk of snagging. Boat size and requirements such as foot switches and hand rails are as for boat-mounted units.

4.1.4 Boat-mounted units (min. 3.5m)

i) The boat driver must be a holder of the relevant local boating licence and be sufficiently experienced with the size of boat being used and in the river or lake conditions present. The boat must be adequately stable and have ample freeboard when fully loaded with gear, crew, plus with a full catch of fish on commercial electrofishing boats.

ii) For boats under 4.0m x 1.2m, a crew of only two is allowed and maximum generator size is 5 kVA.

iii) Anodes must be fixed to the bow and not capable of touching any part of the boat, and cables are to be channelled or clipped to boat sides to prevent tripping.

iv) To reduce the risk of dipnetter staff accidents, fixed or removable hand rails of at least 700mm height must be fitted and non-skid flooring is recommended.

v) The drivers of electrofishing boats must use foot operated deadman switches which must be operated simultaneously with boat netters, who must have either:
a) at least one foot operated switch (several may be connected in parallel if more than one netter is used), or
b) “life-line” belt cord cut-out switches.

vi) All lighting and ancillary electrical equipment must be extra-low voltage (<32VAC or <115VDC).

vii) Large red DANGER warning signs must be displayed on each side of the boat.

viii) Generators and control boxes must be fixed in position during operation.

4.2 Suppliers

It is recommended that only approved, commercially produced equipment (e.g. Smith-Root, Coffelt, etc.) be used. Locally built units must undergo strict testing and comply with the checklist in Appendix A.

4.3 Maintenance requirements

i) All equipment should be carefully inspected by a Senior Operator for mechanical faults, worn insulation, loose components and connections etc. prior to and following all operations.

ii) Each electrofishing unit must have its own log book to record details of hours of use, maintenance, repairs and inspection details.

iii) Regular electrical safety checks must be performed by a licensed electrician on all electrofishing units, the minimum requirement being insulation and voltage-output testing. These checks must be performed every 12 months or 600 logged hours (whichever is reached first) for fisheries research agencies and universities, and every 6 months or 600 logged hours for commercial operations.

iv) Multiple units (e.g. several backpacks) should be individually numbered to allow accurate records of maintenance and repairs to be kept.

4.4 Personal insulation and safety

i) Rubber boots or waders, plus 1000V rated linesmen gloves must be worn by all electrofishing team members during operations.

ii) Life jackets must be worn by backpacking and shore based crews (self-inflating jackets that use at least 33g CO_2 cylinders are permissible) in any dangerous situation where the water depth is greater than 500mm. It is recommended that they or standard PFD type 1 or 2 jackets be worn by boat dip-netters as well.

5. OPERATIONS PRACTICES

5.1 Size of teams

A minimum of two operators are required for all electrofishing except shore-based units where two plus the generator operator are needed.

5.2 Public safety

i) Spectators must be warned to keep away, and no electrofishing can be performed within 50m of other boats or shore viewers. In public areas, it is recommended that signs be erected warning people to keep their distance.

ii) It is not recommended that observers be allowed on electrofishing boats during operations. If present, they must be warned of the dangers involved and fully equipped with all necessary safety equipment. They may be required to sign indemnity forms stating that they suffer from no major heart or respiratory complaint, and that the crew will not be held responsible in the event of an accident.

5.3 Weather and site limitations

Electrofishing should never be conducted in rain or rough water conditions. It is up to the Senior Operator to decide whether conditions such as current, wind, navigability and weather are safe and suitable or not.

5.4 Working procedures

i) Senior Operators are responsible for checking correct setup of equipment, crew safety clothing and readiness before starting the generator. Anodes must be in the water, and are treated as live at any time the generator is running.

ii) Relevant local authorities must be notified prior to any electrofishing, e.g. Fisheries Officers, National Parks and water management bodies.

iii) Never put unprotected parts of the body in the water if the generator is running. Stunned fish must only be removed from the water using insulated dip nets - never attempt to grab a fish by hand!

iv) If anodes become fouled on snags or trees, the generator must be stopped before attempting to free them.

v) No smoking is allowed in the vicinity of petrol tanks or during operations.

vi) It is recommended that the electrofishing team have access to communications at all times in case of emergency.

vii) All equipment should be stored in a dry, clean, and secure place.

5.5 Care of fish

Only the minimum power necessary to attract and stun the fish effectively should be used. Contact of fish with live anodes should be avoided, as the resulting shock will be much greater. If threatened species are observed that are not being targeted, appropriate measures must be taken to minimise disturbance and stress to these fish. Commercial operations must also take action to

minimise harm to any species that they are not authorised to catch under the conditions of their licence.

5.6 Care of other fauna

i) Electrofishing must be halted within 15m of any animals standing in or about to drink from the water, or in contact with a wire fence line that enters the water.

ii) The utmost care possible should be taken to avoid shocking platypus, birds and other native aquatic animals.

5.7 Transfer of Biological Material

The utmost care must be taken to prevent the transfer of biological material between waterways. There are risks of introducing major weeds such as alligator weed or water hyacinth; noxious fish such as carp, redfin perch and gambusia; or disease organisms such as EHN virus.

All gear (including nets, traps, boats, trailer, etc.) must be thoroughly cleaned of plant material and sun dried. The live-well and deck of electrofishing boats should be flushed with pool chlorine solution or sodium metabisulphite when on land to ensure no material is transferred.

Extreme care must be taken when entering pristine or protected (such as municipal water supplies) waterways, or when sampling is done in waterways infested with weeds or alien species.

5.8 Accidents and emergency procedures

Appropriate first aid kits and dry chemical type fire extinguishers should be present on all electrofishing boats larger than 4.5m, in the vicinity of all other gear types, and be readily accessible in an emergency.

In the event of an accident:

i) switch off power supply at control box
ii) stop generator
iii) if casualty is consciousness, check pulse and respiration
iv) begin resuscitation if either is absent
v) apply first-aid for any injuries
vi) have any electric-shock casualty examined by a doctor as soon as possible even if they appear to be fully recovered
vii) report all accidents involving electrocution to the National Electrofishing Safety and Training Administrator within 14 days.

Any generator, control box or backpack unit that is not of a completely sealed type and is accidently immersed in water must be removed from service immediately and tested for water damage by a licensed electrician before further use.

6. REFERENCE MATERIALS

Fishing with Electricity. Edited by I.G. Cowx and P. Lamarque (1990).
- Fishing News Books, Blackwell Scientific Publications Ltd, Oxford

Developments in Electric Fishing. Edited by I.G. Cowx (1990)
- Fishing News Books, Blackwell Scientific Publications Ltd, Oxford

Standards Association of Australia regulations:
- AS 1939 Degrees of Protection Provided by Enclosures for Electrical Equipment (IP Code)
- AS 3000 SAA Wiring Rules
- AS 3004 Electrical Installations - Marinas and Pleasure Craft at Low-voltage
- AS 3010.1 Electrical Installations - Supply by Generating Set
- AS 3100 Approval and Test Specification - General Requirements for Electrical Equipment

APPENDIX A

Electrofishing Apparatus Safety Features Checklists

Equipment type - **SHORE-BASED**
Equipment No.....
Manufacturer of equipment.....
Owner of equipment.....

Check performed by.....
Date.....Log hours.....
Date of last inspection.....Log hours.....

		Yes/No
Generator	Earth link disconnected	_____
	Labelled "For Electrofishing Only"	_____
	Output socket only compatible with control box cables	_____
	Moving parts and exhaust adequately guarded	_____
Control Box	IP34 rated	_____
	Output voltage maximum 1000V	_____
	DC output **only** (commercial operations)	_____
	DC output **available** (research operations)	_____
	All wiring in stranded multicore	_____
	Ammeter measuring control box output	_____
	Indicator light	_____
	"WARNING - HIGH VOLTAGE" signs present	_____
	Double pole latching "STOP" button on input	_____
	Input plug only compatible with e/fishing generator	_____
Anode	Submersible "deadman" control switch on anode pole	_____
	Extra-low voltage control circuit	_____
	Anode pole made from non-conductive material	_____

Electrofishing Apparatus Safety Features Checklist

Equipment type - **BOAT-MOUNTED**
Equipment No.....
Manufacturer of equipment.....
Owner of equipment.....

Check performed by.....
Date.....Log hours.....
Date of last inspection.....Log hours.....

		Yes/No
Generator	Earth link disconnected	_____
	Labelled "For Electrofishing Only"	_____
	Output socket only compatible with control box cables	_____
	Moving parts and exhaust adequately guarded	_____
Control Box	IP34 rated	_____
	Output voltage maximum 1000V	_____
	DC output **only** (commercial operations)	_____
	DC output **available** (research operations)	_____
	All wiring in stranded multicore	_____
	Ammeter measuring control box output	_____
	Indicator light	_____
	"WARNING - HIGH VOLTAGE" signs present	_____
	Double pole latching "STOP" button on input	_____
	Input plug only compatible with e/fishing generator	_____
Anodes	Extra-low voltage control circuit	_____
	Anode poles made from non-conductive material	_____
Boat	Submersible "deadman" foot switch for driver and at least one netter	_____
	Electrical cables channelled or clipped to boat sides	_____
	Hand rails for dipnetters at hip height	_____
	All lighting and ancillary equipment extra-low voltage	_____

Electrofishing Apparatus Safety Features Checklist

Equipment type - **BACK-PACK**
Equipment No.....
Manufacturer of equipment.....
Owner of equipment.....

Check performed by.....
Date.....Log hours.....
Date of last inspection.....Log hours.....

		Yes/No
Back-pack	IP37 rated	_____
	Output voltage maximum 1000V	_____
	DC output **only** (commercial operations)	_____
	DC output **available** (research operations)	_____
	If battery powered - only sealed dry cell batteries	_____
	Quick release harness	_____
	Tilt switch cut off at angles > 45^{o}	_____
	Audible power-on indicator	_____
Anode	Submersible “deadman” control switch on anode pole	_____
	Anode pole made from non-conductive material	_____

APPENDIX B

Insulation Protection Ratings (IP Code) - extract from AS 1939

Element	**Numerals or letters**	**Meaning for the protection of *equipment....***	**Meaning for the protection of *persons....***
First numeral		....against the ingress of solid foreign objects....	....against access to hazardous parts with....
	0	(non-protected)	(non-protected)
	1	> 50mm diameter	back of hand
	2	> 12.5mm diameter	finger
	3	> 2.5mm diameter	tool
	4	> 1.0mm diameter	wire
	5	dust-protected	wire
	6	dust-tight	wire
Second numeral		....against ingress of water with harmful effects by....	
	0	(non-protected)	
	1	vertically dripping	
	2	dripping (15 ^{o} tilted)	
	3	spraying	
	4	splashing	
	5	jetting	
	6	powerful jetting	
	7	temporary immersion	
	8	continuous immersion	

e.g. for control boxes, IP34 means "protected against the ingress of solid foreign objects > 2.5mm diameter, against access to hazardous parts with tools, and ingress of water with harmful effects by splashing". For backpack units (IP37), the last section reads "....and against the ingress of water with harmful effects by temporary immersion".

Some minor modifications may be necessary to commercially available electrofishing control boxes, including some Smith-Root modules, to enable them to comply with these requirements. For example, the grills covering the air vents may need to be replaced with a finer mesh.

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