Electric fishing operations: equipment and working practices

Operational Instruction 993_08 Published: [dd/mm/yyyy]

Audience:

- Environment Agency staff involved in electric fishing surveys
- External agencies or contractors who undertake electric fishing on behalf of the Environment Agency

What's this document about?

This document describes the requirements for all aspects of electric fishing to ensure that surveys are carried out safely, efficiently and effectively, and to ensure that equipment is safe and fit for the task.

Contents

1. Introduction

What is electric fishing?

Electric fishing uses the physiological effect of an electric field in water to attract and immobilise fish. Electrodes, immersed in the water, stimulate a fishes nervous system so that it swims towards the operator, or is unable to swim away, and can be caught.

Electric fishing is an essential and effective technique for monitoring fish populations in lakes and rivers.

Scope of this instruction

The mixture of electricity and water makes electric fishing a potentially hazardous activity.

This instruction explains the health and safety requirements, working practices and equipment design that enable us to electric fish safely and effectively.

You must comply with this instruction when you carry out electric fishing.

Prerequisites for field workers

This instruction expects that people carrying out field work:

- are fit for the task that they are being asked to carry out;
- have read the generic risk assessment for electric fishing and, where these risks are present, be satisfied that appropriate control measures are in place;
- comply with all generic health and safety instructions that relate to field work, and boat work where applicable.

Any employee that has, or who develops, what they consider may be a significant medical condition (such as heart or respiratory problems, diabetes or epilepsy) must contact their manager or occupational health adviser to discuss the implications before continuing with electric fishing duties.

2. Health and safety in electric fishing

2.1 Training requirements

Before you take part in electric fishing operations you must:

- successfully complete ‘Part 1: Health and Safety in Electric Fishing’ training;
- read and understand the working procedures described in this instruction;
- have been instructed on site by a competent and experienced officer about safe working practices.

You cannot take part in electric fishing operations without direct supervision until:

- you are deemed competent in the method you are using and are Part 2 certificated (refer to Certifying electric fishing field competence);
- you have completed Working in Water training.

You maintain your competence by:

- receiving full instructions on using any new equipment or following any new procedures, whenever they are acquired or introduced;
- attending a 'refresher' training session if, during the previous three years, you have not actively participated in at least three electric fishing survey days per year.

You must keep a record of the surveys you participate in, including dates, locations and the Officer in Charge (OIC).

Minimum training requirements for a field team are outlined in the Team Size section. This contains information relating to number of inexperienced staff, trained first aiders, and officer in charge requirements.

2.2 Hazards when electric fishing

Electrical hazards

Electric shocks may injure or kill, or cause indirect injuries by making a worker recoil so that they endanger themselves and others by sudden movement. Direct effects include electrical burns, heart failure or interference with breathing.

The main sources of risk of electric shock during electric fishing operations are:

- contact with energised electrodes;
- contact with water within the radius of the electric field;

- shocks from damaged, inadequately constructed or poorly insulated equipment.

The following rules apply to protect staff against electrical hazards:

- do not allow unprotected parts of the body to come into contact with the water when electric fishing equipment is operating;
- only the person in charge of the hand held electrode can remove debris from the electrode by hand and only after they are sure that the fishing circuit is de-energised with all stop buttons in the locked off position;
- do not leave electrodes unattended when they are connected to a live power source;
- under no circumstances allow the electrode head to leave the water before the safety control circuit switch is released;
- do not use electrode rings as dip nets;
- do not simultaneously use more than one set of electric fishing equipment at any one site;
- do not carry energised control boxes other than backpacks;
- all personnel must be fully familiar with the operation of the equipment before being allowed to use it for electric fishing.

Non-electrical hazards

These are described in 53_04 Electric fishing GRA and other generic health and safety protocols.

You must carry out the correct risk assessments in accordance with Environment Agency procedures.

Spectators

If fishing activity is likely to attract spectators, erect temporary warning signs that display ‘Danger, electric fishing in progress’.

Warn spectators to keep away from the water and equipment. Keep animals away.

Stop fishing if people or animals come within five metres of the electrodes.

2.3 On site safety

Assess the risks

You must carry out site specific risk assessments before any work commences.

Before the start of each days work, the OIC must:

- carry out or be familiar with the site-specific risk assessment;
- brief the team on the site-specific risk assessment and the work to be done;
- specify the tasks each person has to perform.

Set up communication

The team should have at least one mobile phone available.

On arrival at the site:

- ensure that there is mobile phone coverage at the location;
- if there is no mobile phone signal, make sure that everyone knows where the nearest working telephone is;
- if you regularly work at sites with no mobile phone signal, consider using a satellite phone;
- set up a clear system of working signals before operations begin and make sure it is followed by all members of the team;
- in case of emergency, ensure you have a postcode or grid reference to direct emergency services;
- when working in small teams and remote locations, make sure your line manager knows where you are. Consider using the lone worker system.

Starting up and closing down

Only start generators and energise the control units when:

- the electrodes are in the water;
- each team member has acknowledged that they are ready for operation.

Stopping

- Put a clear communication procedure in place for signalling the end of the fishing exercise.

Emergency and accident procedure

The table below describes what to do in an emergency.

Step	Action
1	If there is an accident, before you give assistance, immediately: • switch off the electrodes; • switch off the emergency stop button; • stop the generator.
2	Apply appropriate first aid.
3	Report all accidents in accordance with the Environment Agency procedures.

3. Working procedures

Overview

In shallow streams you can generally wade using a backpack or generator powered equipment, either secured on the bank or towed on a small boat.

In deeper rivers and the margins of stillwaters you will need to work from a boat using generator powered equipment.

In large water bodies you may need to use a custom built boom boat which has anode arrays mounted on the bow.

The officer in charge has ultimate responsibility for selecting the most appropriate method.

The table below provides a guide to choosing electric fishing method according to the site width and depth.

Width (m)	Mean depth (m)	Wading	Boat	Single anode	Two anodes	Lane nets	Boom boat
< 5	< 0.8	Y		Y			
5 – 8	< 0.8	Y		Y	Y		
8 – 15	< 0.8	Y			Y		
> 15	< 0.8	Y			Y	Y	
< 5	> 0.8		Y	Y			
< 15	> 0.8		Y		Y		
> 15	> 0.8		Y		Y	Y	Y

Water temperature

Electric fishing should be avoided in extremes of temperatures. The maximum water temperature for coarse fish is 20oC and for salmonids is 18oC.

Anode use

There are two methods of working that operatives can use:

- Work in pairs with a separate anode operator and hand netter.
  This is the default method that all operators are advised to follow. This method minimises the risk of musculoskeletal injuries to the anode operator. This method must be used when working in deeper water, strong flows, or where large numbers of fish are expected to be present.
- Hold an electrode in one hand and a hand net in the other.
  This method should only be used in situations where deemed necessary and where appropriate risk management measures are in place to minimise the risk of musculoskeletal injuries. It must also only be selected where you are confident it will not reduce capture efficiency.

Fish capture / care during capture

During electric fishing, anode and net operators must minimise the length of time that fish are held in the active electric field, and how long they are out of water following capture.

Anode operators must:

- draw the anode away from narcotized fish to avoid tetanus and anode contact with fish. If necessary switch off the current to avoid damage to fish;
- have clear lines of communication with the hand net operator.

Hand net operators must:

- be alert and in a good position relative to the anodes at all times during sampling;
- quickly transfer netted fish to holding containers.
- avoid multiple shocking of fish. Do not repeatedly sweep a net containing a few fish in order to catch more from a group of narcotised fish.

Look for signs of damage, e.g. sustained tetanus, burn marks, bleeding from the gills, mortalities. If you see any of these you must inform the OIC immediately

3.1 Electric fishing by wading

You must only use electric fishing by wading if the water in the majority of the site is less than thigh deep.

Do not wade into water deeper than hip height until you have made a risk assessment on the flow and substrate in relation to partial buoyancy causing a loss of footing.

When estimating depth, take account of soft sediments that may make the effective depth of the river channel much greater.

Where site depth is variable you might need to use boat-mounted gear, with operators embarking and disembarking as needed.

When electric fishing by wading, work in an upstream direction to avoid obscuring the fish catching area with disturbed sediment drifting downstream.

Choose from three sampling strategies

You have a choice of three strategies for electric fishing by wading:

- backpack fishing using a portable battery powered control unit;
- using hand-held electrodes fitted with long cables connected to a bank-based control box and generator;
- placing the generator, box and holding bins in a small boat that is towed or pushed behind the fishers by one of the team.

You can use more than two anodes when wading providing all electrodes are operated via a single control unit.

Bank based control box and generator

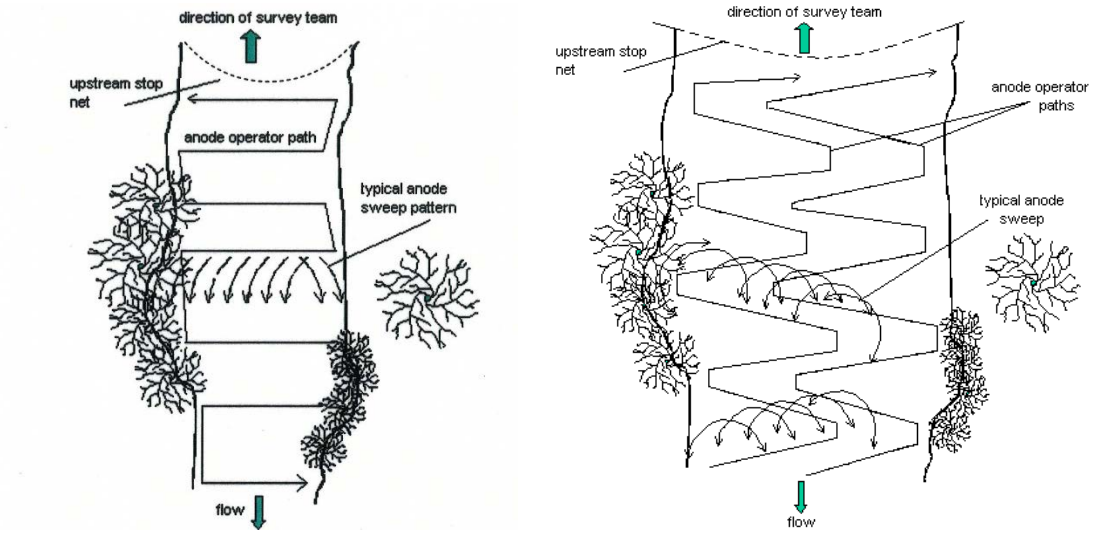
Ensure that the generator and control gear are secure, to prevent them falling into the water.

Do not carry a control box while it is energised or move the generator when it is running.

There must be ready access to the generator or control box STOP buttons at all times. Never leave electric fishing gear unattended, whether energised or not.

Operating procedure when wading

The diagram below shows the method for electric fishing by wading, using a single anode (left) and two anodes (right).



3.2 Electric fishing by boat

When electric fishing from a boat you must:

- use a suitable vessel;
- comply with 730_06 Boatwork;
- wear a lifejacket at all times;
- securely stow equipment to minimise the risk of movement, boat instability and operators tripping;
- ensure easy access to the power STOP button at all times.

Choose from three sampling strategies

You have a choice of three strategies when electric fishing by boat:

- A boat propelled by an outboard motor;
  This is particularly suitable when depths are over 1 m and/or where currents are strong (>0.7 m/s).
- A boat propelled by oars or paddles;
  Suitable when currents are gentle and habitat is more varied. This method can also work well when fishing in a downstream direction in a stronger current.
- A boat drawn by ropes;
  The boat is drawn back and forth across the current, using ropes pulled by staff on the bank gradually working along the length of the survey site. This is good for covering wider watercourses that are fairly uniform and have relatively unobstructed banks and gentle current.

Direction of fishing

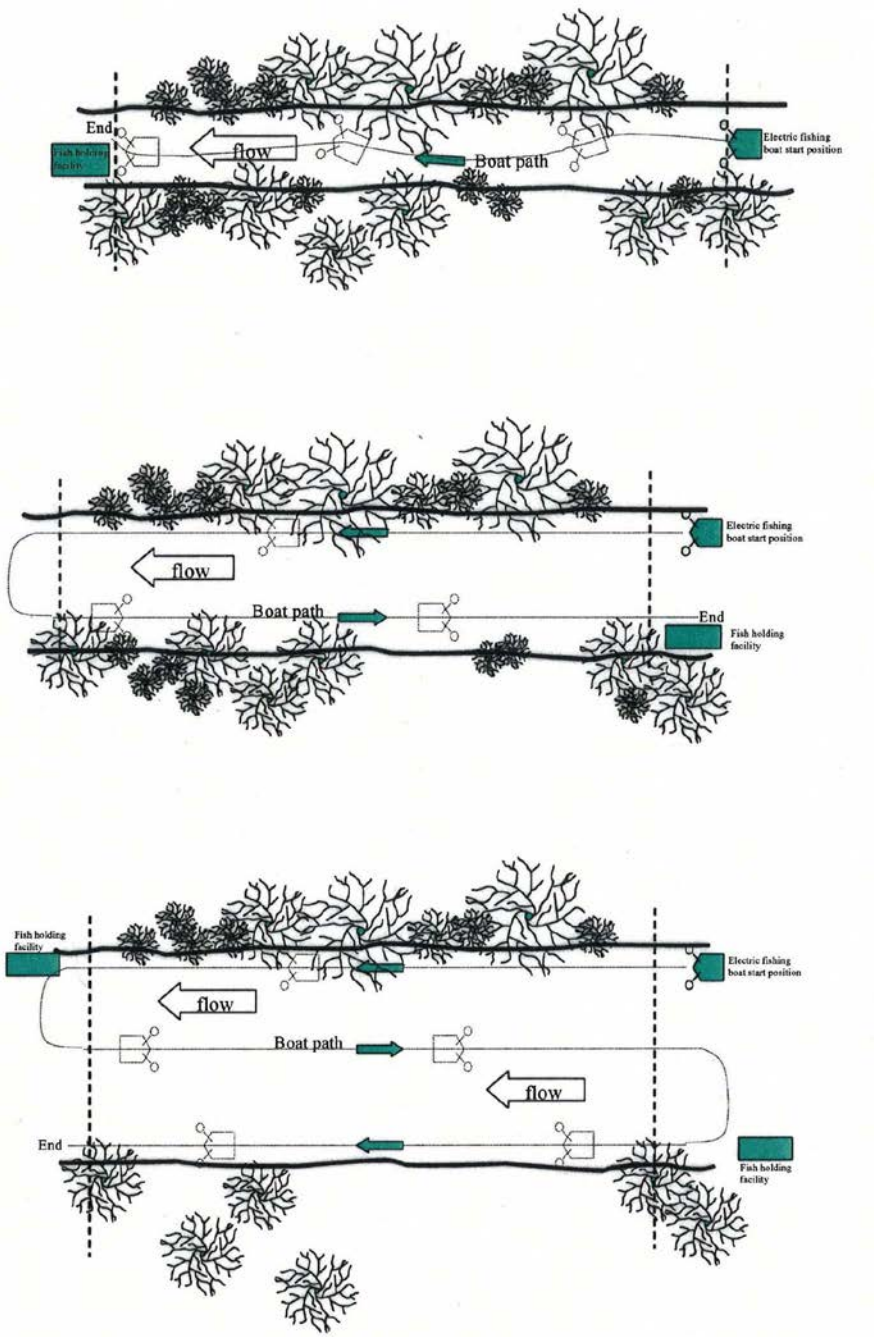
The direction of fishing with a boat depends on current and depth. Upstream fishing generally has a number of advantages:

- fish driven ahead of the boat tend to tire and come back downstream to the boat or seek cover in the margins;
- fish that are missed are not repeatedly stunned when the boat drifts over them;
- sediment drifts downstream away from the fish catching area;
- stunned fish do not become entangled in the downstream stop nets that would expose them to repeated stunning;
- boats propelled by outboard motors are easier to manoeuvre against the flow.

In watercourses with very little flow, many of the advantages above are not applicable therefore it may make no difference whether to fish upstream or downstream.

Using a boat in rivers with varied widths

The diagram below shows possible strategies for electric fishing by boat in rivers of various widths. A single sampling effort is shown for each width.



3.3 Team size and personnel requirements

Determining team size

Electric fishing teams are a minimum of three persons. The one exception is for backpack surveys where a two person team is acceptable, providing that each of the following conditions are met:

- you have carried out a risk assessment to ensure suitability of the watercourse;
- both operators are certified as competent;
- you establish reliable mobile telephone communications with base before the survey starts.

Field team sizes are determined by:

- Survey type: such as backpack, wading, boat or boom boat;
- Number of anodes needed: depends on the width of the site;
- Number of catching nets needed: depends on the width of the site and the number of fish;
- Number of fish: at sites where large numbers of fish are likely to be caught you may consider having additional staff to process the fish;
- Public safety: at sites where there is public access you may need additional staff to ensure that members of the public are not put at risk.

Experience

Only one person in the team can be inexperienced / not able to undertake the survey without direct supervision.

The only permissible exception is when inexperienced users are being trained and are working under the separate supervision of a competent officer, not directly involved with the fishing activity.

Office in Charge

All survey teams must have an Officer In Charge (OIC). The OIC takes on-site responsibility for safety, first aid, equipment and PPE. However, every member of the team has a responsibility to work in a safe manner and to inform the OIC of any problems or concerns.

First aid requirements

At least two members of the team must have completed R77 Emergency First Aid at Work training. This is a minimum requirement; having additional trained staff is considered best practice.

3.4 Selecting the electrical output

Overview

Selecting the electrical output is important to ensure optimum catch efficiency and fish welfare.

Factors that influence the choice of output include:

- ambient conductivity;
- target fish species and size;
- presence of vulnerable species.

You can achieve the optimum electrical output by varying:

- voltage;
- frequency;
- power output (pulse width);
- anode size;
- cathode size.

An electric fishing summary field sheet to help select control box settings in the field can be found on the Environment Monitoring SharePoint site. Also on this site is Electrocalc, a spreadsheet that can be used to calculate power requirements and voltage gradients for electric fishing systems.

Voltage

Voltage is the potential or electromotive force of the electricity. The voltage required to attract and immobilise fish varies, according to:

- the ambient water conductivity;
- the output type (smooth direct current (DC) or pulsed DC);
- the size of the effective capture field required.

Low conductivity waters generally require higher applied voltages for fish capture than higher conductivity waters. Under any field conditions, start electric fishing at the lower end of the range of voltages recommended for those conditions.

The table below shows the voltage ranges to use, depending on the ambient conductivity and output type.

Conductivity (µs/cm)	Applied voltage (V) - pulsed DC	Applied voltage- (V) - DC
< 150	250 – 300	300 - 400
150 -500	200 – 250	250 - 300
500 – 800	150 – 200	Not applicable

800 – 1000	120 – 180	Not applicable
> 1000	100 – 150	Not applicable

Frequency

Frequency is the number of electrical pulses per second. Choice of frequency is influenced primarily by the species you are targeting.

The table below shows optimum frequencies for attraction and immobilisation of different fish groups or species.

Species	Pulsed DC frequency (Hz)
Salmonids	40 - 60
Cyprinids	30 - 50
Percids	10 - 40
Pike	30 - 50
Eel	10 - 40

Pulse width

Pulse width is the duration of each individual pulse of electricity. It can be expressed in milliseconds or as a percentage of the cycle. Note:

- Increasing pulse width increases the current and the power required;
- When fishing with pulsed DC, keep duty cycle to a minimum to reduce the possibility of fish damage and conserve power;
- A 100 per cent duty cycle is the same as smooth DC.

The table below shows the recommended duty cycles for different levels of ambient conductivity.

Conductivity	Duty cycle (%)
< 150	10
150 -500	10 – 20
500 – 800	10 – 30
800 – 1000	10 – 40

Specific and ambient conductivity

Conductivity of water varies with temperature. Most conductivity meters are calibrated to 25 C. This means the reading is the value that the conductivity would be at 25 C.

Follow these instructions to calculate the ambient conductivity before you start your survey.

1. Measure the specific conductivity and water temperature
2. Select the nearest values in the Conductivity look up table at the end of this document to find the ambient conductivity.
3. Record all three values on your field sheet.

4. Data requirements

Site information

The following site and survey information must be recorded for all electric fishing surveys. This is inline with data requirements stated in the British Standards Water quality: sampling of fish with electricity (BS EN 140011:2003, available to download via the Barbour index). A standard field sheet is available that should be used for all electric fishing surveys.

What	Information required
Where when who why	• Site name and river name • Survey purpose • Date • NGR • Team (OIC and team members)
Equipment	• Survey method • Equipment used • Field settings, anode number and type • Number of runs • Survey strategy • Fishing direction • Use of stop-nets
Conditions	• Weather conditions • Water level / flow • Visibility (colour and/or turbidity of the water) • Ambient conductivity of water (µS) • Temperature of water (oC)
Site details	• Length of river surveyed (m) • Average width of wetted area (m) • Average depth (m) and maximum depth (m) • Flow type • Substrate • Habitat type and sources of cover

Fish processing

The requirements for fish processing, including data requirements, measuring fish, collecting fish scales and sub-sampling fish lengths are all detailed in 149_03 Fish handling, processing and storage.

Number of runs

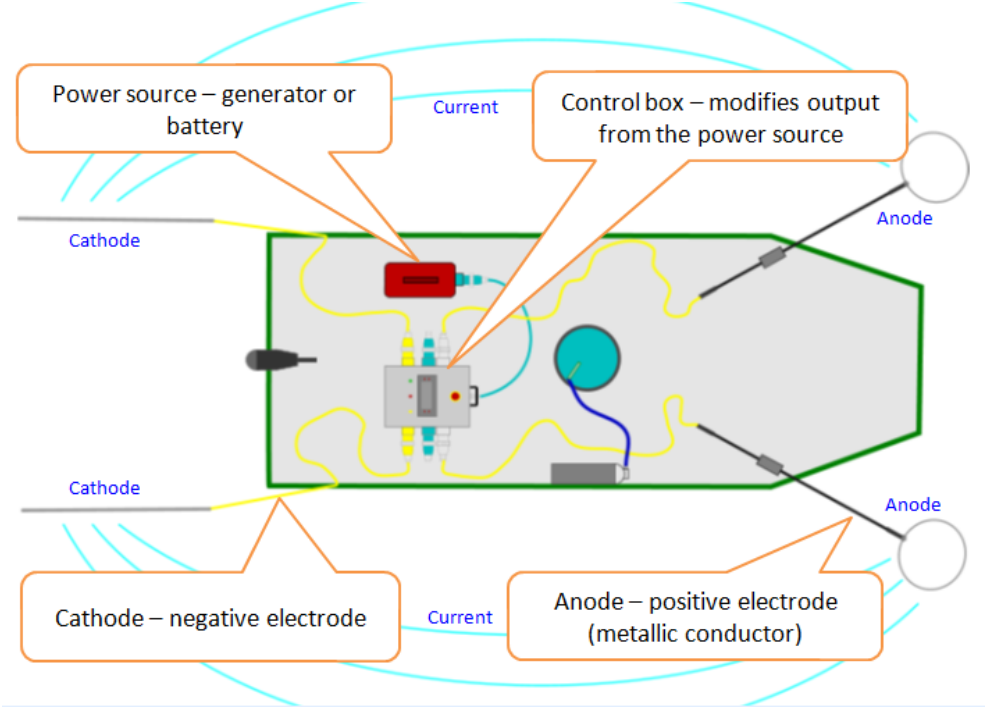
The number of runs to complete per survey is determined by the survey purpose. Requirements are detailed in 995_14 EMM - rivers manual.

5. Equipment

5.1 Equipment design criteria

Components

The diagram below shows the typical components of electric fishing gear.



Technical specifications

All equipment must be comply with the following Environment Agency specifications:

- Technical specification for generator powered electric fishing machines;
- Technical specification for battery powered electric fishing machines.

All new or modified electric fishing equipment must undergo routine safety checks before being brought into use; refer to 995_08 Maintenance of Electric Fishing Machines.

Power supply

Power must always be fed through a control box, i.e. never feed directly from the power source to any fishing electrode.

Never use electricity supplied direct from the mains for electric fishing.

The following rules apply for generators:

- only use generators modified for electric fishing;
- never use electric fishing generators for other purposes.

Anodes and cathodes

You must follow the rules and recommendations below for anodes and cathodes:

- always use the largest anode that is practicable - avoid using very small anodes; the recommended anode size is a 40 - 60 cm diameter anode 10 mm gauge;
- do not fish with anodes held too close together (<3m for large ones);
- always use a cathode that has a surface area of at least three times that of the anodes; the recommended cathode size is at least 3 m by 25 mm braid or 75 cm by 75 cm expanded mesh or plate;
- using multiple cathodes is preferable to single cathodes, however these should be widely separated to avoid electrical coupling;
- if the surface area of anodes is increased, increase the cathode surface area by at least the same factor.

A range of anode designs are available with different switch positions and lengths. You should trial each design to ensure you select the anode style most comfortable to use.

Boats

When selecting boats to use in electric fishing operations, consider the following points:

- the boats must be large enough to accommodate both the crew and equipment and operated within the ratings plated on the vessel;
- boat decks should have an anti-skid surface;

- you must make provision for securing the electric fishing equipment against accidental movement in the boat;
- boats used for electric fishing must be constructed from non–conducting material;
- any anchoring, mooring or shore lines used with the boats must be non-conducting.

Ancillary equipment

The following rules apply:

- equipment such as buckets, landing net handles and fish containers, must be made of non-conducting material, as far as is reasonably practicable;
- outboard motors must have non-conductive engine covers.

5.2 Protective clothing and safety equipment

Clothing

Clothing worn for electric fishing must suit the conditions you are operating in. Clothing should not have:

- buttons or buckles that could snag on cables and landing nets;
- unprotected metallic zips that could be a current path if they enter the water during fishing operations.

Chest waders and dry suits

Chest waders and dry suits must be made from non–conductive material.

Chest waders must not be worn in boats unless a supplementary risk assessment has identified them as the most appropriate form of protective equipment.

Lifejackets

You must comply with the lifejacket policy when selecting and using lifejackets for electric fishing surveys. Refer to: 14_10 Selecting, using and maintaining lifejackets and buoyancy aids.

First aid and rescue

A standard first aid kit and throw line must form part of the equipment and staff must be aware of its location.

Fire fighting equipment

Fire extinguishers, suitable for electrical and petrol fires, must be readily available near the fishing gear and staff should be familiar with their use.

The fire extinguishers must be serviced and inspected in accordance with the manufacturer's recommendations.

6. Maintenance and storage

Maintenance and safety checks

You must maintain electric fishing equipment properly and check it regularly for mechanical and electrical faults.

Carry out safety checks every three months in accordance with the 995_08 Maintenance of Electric Fishing Machines. The pre-operational checks carried out by field staff are in addition to three monthly safety checks and not a substitute.

Equipment which is not in regular use may be taken out of service. Whilst out of service this equipment does not need regular checks but it must be checked before being brought back into service.

Service intervals are related to the degree and conditions of use but must not be longer than twelve months for full service of generators and control boxes. You must comply with any additional service requirements specified by the equipment manufacturer.

Depot inspection

Before the equipment is taken into the field for use, make a visual inspection of the equipment to ensure there is no visible damage. Self tests should also be done where equipment has this function.

Site inspection

Establish and follow a system for checking equipment on site. This must include checks on the mechanical operation of safety switches before the equipment is energised.

Reporting faults

Report any faults found during inspection of equipment before it is used or while fishing to the OIC.

Take faulty equipment out of use, clearly label it with the defect and that it is waiting for repair.

Repairs

You must not attempt any electrical repairs on electric fishing equipment at any time.

Storage

Store electric fishing equipment in secure, safe, dry and clean conditions.

After use, return all equipment to storage in a state that makes it suitable for use on the next occasion.

Store battery powered equipment with the battery disconnected.

Disposing of equipment

When equipment that has reached the end of its service life you must dispose of it in accordance with the Waste Electrical and Electronic Equipment Directive. Guidance on the disposal of unwanted electric fishing equipment is available on the Environment Monitoring SharePoint site.

Related documents

Guidance

- 142_03 Selecting suitable fisheries survey sites
- 97_04 Using stop nets for fisheries survey work
- 778_06 Sampling eel populations in Rivers
- 149_03 Fish handling, storage and processing
- 995_14 EMM - river manual
- 995_08 Maintenance of Electric Fishing Machines

Health and safety

- 426_05 Working In or Near Water GRA
- 07_10 Generic Risk Assessment – fieldwork in rural location
- 53_04 Generic Risk Assessment Electric fishing
- 10_10 Boatwork
- 14_10 Selecting, using and maintaining lifejackets and buoyancy aids
- 357_07_SD02 Manual handling guide
- 350_07_SD07 Manual handling control measures - Fisheries

Competence

- 183_04 Certifying electric fishing field competence

Further reading

Beaumont, W.R.C (2016) Electricity in fish research and management: Theory and practice, Second Edition. Blackwell.

BS EN 14011:2003 BS 6068-5.32:2003 Water quality -Sampling of fish with electricity

BS EN 60335-2-86:2001 Safety of household and similar electrical appliances - Part 2-86: Particular requirements for electric fishing machines

R&D W2 – 054 Guidelines for EF best practice

R&D note 303 / 304 (1995) Electric Fishing in Deep Rivers

Conductivity look up table

Use this table to correct for temperature when measuring conductivity with a meter calibrated to 25oC.

	Temperature				
Specific conductivity	***5***	***10***	***15***	***20***	***25***
50	32	36	40	45	50
100	63	71	80	89	100
150	95	107	119	134	150
200	127	142	159	179	200
250	159	178	199	223	250
300	190	213	239	268	300
350	222	249	279	312	350
400	254	284	319	357	400
450	286	320	358	402	450
500	317	355	398	446	500
550	349	391	438	491	550
600	381	427	478	536	600
650	412	462	518	580	650
700	444	498	558	625	700
750	476	533	597	669	750
800	508	569	637	714	800
850	539	604	677	759	850
900	571	640	717	803	900
950	603	675	757	848	950
1000	635	711	797	893	1000

1050	666	747	836	937	1050
1100	698	782	876	982	1100
1150	730	818	916	1026	1150
1200	761	853	956	1071	1200
1250	793	889	996	1116	1250
1300	825	924	1036	1160	1300
1350	857	960	1075	1205	1350
1400	888	995	1115	1250	1400
1450	920	1031	1155	1294	1450
1500	952	1066	1195	1339	1500
1550	984	1102	1235	1383	1550
1600	1015	1138	1275	1428	1600