



Electric Fishing Machine (EFM300) Operators Manual V2.2

**NIWA Instrument Systems
Christchurch
New Zealand**

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Prepared for

Operators of Electric Fishing Machines EFM300

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WARNING

IMPORTANT

**Please read safety information in
Section 5 before using the EFM300**

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1. Introduction

Electric Fishing has become one of the most widely used techniques for sampling fish populations in New Zealand freshwaters.

However, due to the inherent dangers of combining water and electricity, there are strict regulations to govern the design, manufacture and use of Electric Fishing Machines (EFM) in this country.

All existing New Zealand EFM designs, have evolved as a result of many years of research and development, thus making them particularly well-suited to local conditions.

In early 1993, NIWA Instrument Systems assumed responsibility for the manufacture, support and re-certification of these existing EFMs.

2. Scope

This document describes how to operate the EFM300, a portable, battery powered Electric Fishing Machine (EFM) designed and manufactured by NIWA Instrument Systems.

It covers the standards, approvals and safety issues that are relevant to the user.

3. Standards and approvals

The IS EFM has been designed to comply with the following standards and regulations:

- IEC 335
 - X Safety of household and similar appliances
 - 1 General Requirements
 - 2 Particular Requirements for EFM.
- NZ Electrical Regulations 1993

4. General description

The IS EFM 300 consists of a battery powered generator unit, carried on a backpack by the user, and an insulated handheld electrode which allows current to be directed into a body of freshwater.

The purpose of the EFM is to apply a suitable Electric Field to a given body of freshwater in order to attract and induce a temporary state of narcosis in fish within the immediate area. This enables researchers to carry out tasks such as population studies, live capture and tagging. The most effective EFM output for fish capture used in NZ is pulsed DC with a voltage range adjustable from 100V to 600Vdc.

The main components of the EFM300 are:

4.1. Batteries

The EFM300 is powered by two series connected 12VDC 7 Ah SLA or LiFePO4 batteries which provide a nominal 24Vdc supply. The batteries are housed in a separate IPX5 enclosure, providing good protection and ease of access.

4.2. Control unit

Refer to Figure 1.

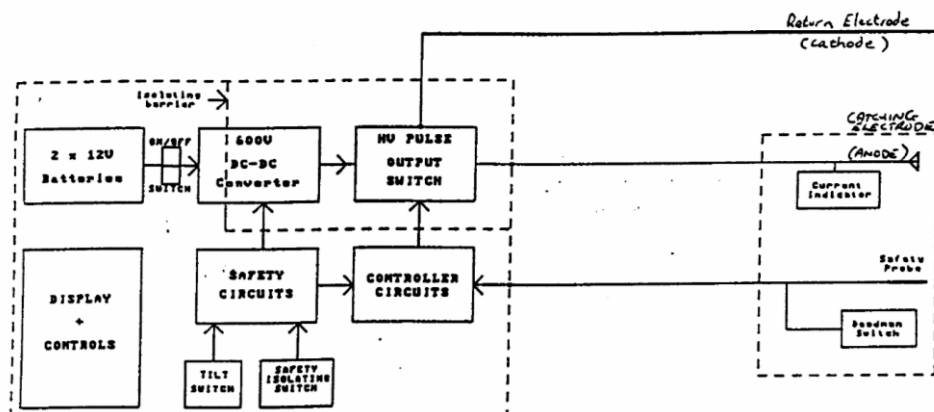


Figure 1: Functional Block Diagram

The control unit electronics are housed in an IPX5 enclosure and comprise of the following functional blocks:

- An efficient isolated dc-dc converter which provides a high voltage dc power source.
- Safety Circuits to monitor the status of the Tilt and Safety Isolation switches and provide a latched shutdown function.
- Controller circuitry to monitor the High Voltage (HVon) switch on the wand handle as well as the immersion probe, and use these inputs to control the operation of the pulse output switch, and hence the EFM output.
- HV Pulse output switch circuitry to control/condition the high voltage DC generated by the dc-dc converter, and direct the required High Voltage output pulses to the Anode electrode.

An operator interface to enable users to customise EFM output to suit water conditions.

4.3. Catching electrode (anode)

This comprises a handheld insulated pole, fitted with integral High Voltage (HV ON) switch to control the output HV passed to a removable metal electrode. The HV pulsed – dc output from the EFM is delivered to the water through this electrode.

The anode incorporates an integral safety probe, which ensures that EFM HV output can not turn on unless the electrode is in contact with the water.

The other main feature of the anode electrode is the ergonomically designed handle. This incorporates a high intensity Bar Graph display which indicates how much output current is flowing into the water.

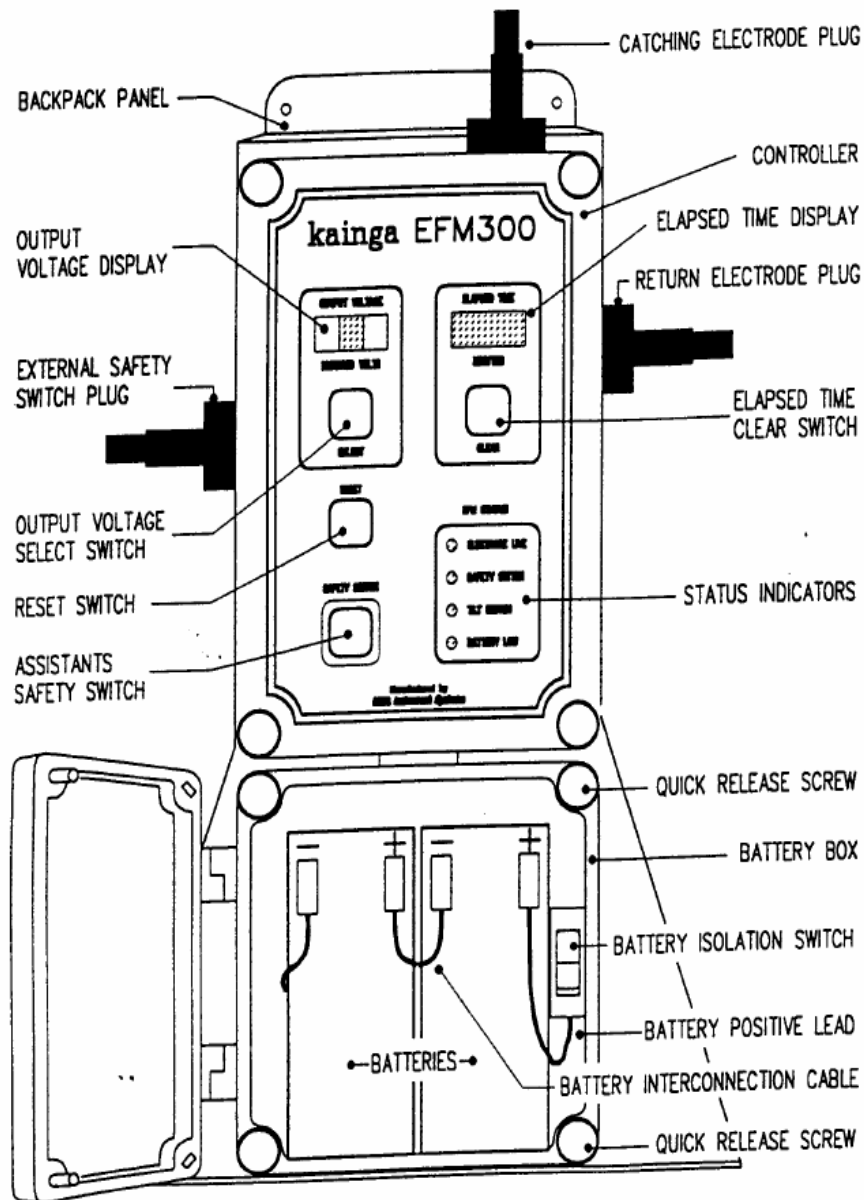
4.4. Return electrode (cathode)

This electrode provides the return path for the EFM output current. It comprises an insulated cable connected to uninsulated tinned copper flat braid, which is trailed in the water behind the operator.

4.5. Backpack

The control unit is mounted on a lightweight backpack to enhance portability.

4.6. User controls



Refer to Figure 2.

Figure 2: Controller unit.

4.6.1. Battery isolation switch

This switch electrically isolates the EFM300 control unit from its batteries. When this switch is OFF, the EFM300 is disabled and therefore safe to handle.

This switch is located inside the Battery Housing and is mounted on the right hand battery bracket.

4.6.2. Safety isolation switches

Two `Safety switches **have been provided** as a means for the operator, or an assistant, to disable the EFM300 **in** the event of an emergency

Once activated, electronic latching is employed to ensure that the EFM remains disabled until the `Reset' button is pressed.

The operator's external safety switch is plugged into the left hand side of the controller box and may be attached to the backpack harness. It is labelled `SAFETY SWITCH' and has a red button.

The assistant's safety switch is located on the front panel of the control unit. It is labelled `SAFETY SWITCH' and has a red border around it.

4.6.3. Electrode HV ON high voltage switch

This red momentary action switch labelled 'HV ON' is located on the wand and must be held in the ON position before High Voltage is applied to the catching electrode (anode). When in the OFF position, no voltages exceeding 12V are present outside of the Control Unit.

4.6.4. Voltage `Select' switch

This momentary pushbutton, on each successive press, steps around the six available output voltage settings — (100, 200, 300, 400, 500, 600, 100, 200 etc) as displayed by the Output Voltage display. It is located on the Control Unit front panel. The power up default setting is the lower output voltage (100V).

4.6.5. `Reset' Switch

This momentary pushbutton is located on the front panel of the Control Unit and provides a means of resetting the power down latch and re enabling EFM300 operation.

4.6.6. Frequency control

This control allows the output pulse frequency to be varied between 20 and 240 Hz. It is located inside the Control Unit enclosure.

4.6.7. Pulse width control

This control allows the output pulse width to be varied between 1 and 5 milliseconds. It is located inside the Control Unit enclosure.

4.6.8. Elapsed time `Clear' switch

This momentary pushbutton located on the front panel of the Control Unit, provides a means of resetting the displayed Elapsed Time back to zero.

4.6.9. Buzzer volume adjustment

The volume of the `electrode live' buzzer may be controlled by adjusting the `Buzzer Volume' control located on the inside of the controller lid (at bottom).

4.7. Indicators and displays

The following indicators and displays are provided by the EFM300. 4.7.1.

4.7.1. `Output Voltage' display

This single-digit, seven-segment display, displays the selected Peak Output Voltage (in hundreds of volts). It is located on the front panel of the Control Unit.

4.7.2. `Elapsed Time' display

This three-digit, seven-segment display, displays the period (in minutes) of actual fishing time (i.e., when power is applied to the water).

4.7.3. `Electrode Live' indicator (red)

This high intensity indicator indicates the presence of High Voltage on the electrodes and is located on the front panel of the Control Unit and flashes when the electrode is live.

4.7.4. `Safety Switch' indicator (red)

If either of the two Safety Switches is activated the EFM300 is disabled and the `Safety Switch' indicator flashes. It is located on the front panel of the Control Unit.

4.7.5. `Tilt Switch' indicator (red)

This high intensity indicator flashes when the `Tilt Switch' circuit has been triggered and latched. It is located on the front panel of the Control Unit.

4.7.6. `Battery Low' indicator (yellow)

The EFM300 continually monitors the state of the batteries and if the supply voltage drops to 21Vdc the `Battery Low' indicator flashes. This indicator is located on the front panel of the Control Unit.

If battery voltage continues to drop below 20.5Vdc then the EFM300 automatically shuts down.

4.7.7. Output current indicators (5 red)

This display, in the form of a five indicator bargraph, provides an indication of the current flowing between the catching and return electrodes, and is scaled in 100's of milliamps.

This display is located on the wand handle adjacent to the 'High Voltage' switch. The EFM300 output is overcurrent protected. If the output current exceeds approximately 3 Amps (peak), the output pulse is terminated and there will be no bar graph indicators on.

4.7.8. Buzzer

This buzzer operates when High Voltage is present at the electrodes. The buzzer will sound even when the overcurrent protection circuit is operating.

5. Safety

Electrofishing is, by its nature, a potentially dangerous operation. The IS EFM300 is capable of producing sufficiently high voltages and currents to cause a lethal electric shock. Therefore it is essential that users of this equipment have a good understanding of general electrofishing principles.

EFM users shall be properly qualified by an accredited authority, as defined by local regulations.

5.1. Safety standards

- This equipment is designed to be operated by a team of 2 or more licensed operators. It is not intended to be used by 1 person.

- The team shall consist of personnel that are currently certified to use electrofishing equipment as defined by local regulations.
- Electrofishing operators are strongly advised to wear approved rubber waders and rubber gloves.
- The EFM300 electrofishing equipment should be maintained in good condition, and shall be annually recertified for use by an accredited authority.
- Do not operate the EFM300 in rain, or in other conditions which could be dangerous. These could include fast water flow, high winds, lightning etc.
- Never touch any live part of the EFM300 or the water, when the batteries are fitted to the machine.
- Do not carry any metal objects either for carrying or catching fish.
- Always disconnect and remove the batteries before charging. Never charge the batteries while they are connected to the EFM300.

WARNING: DO NOT CONNECT TO MAINS OPERATED EQUIPMENT

- Nets used in conjunction with the EFM :
 - i. **MUST NOT** be made of or include any conductive material.
 - ii. **MUST** have handles that of sufficient length to avoid hand contact with the water.
 - iii. **MUST NOT** have wrapped or covered metallic handles
 - iv. **MUST NOT** have a metallic weighting chain extending beyond the bottom edge of the net proper.

6. Operating procedures

6.1. Pre-operational checks

Prior to field use, it is recommended that users carry out a general inspection of the EFM300 fishing machine.

In particular, the following checks should be made:

- Inspect the two housings, ensuring there are no external cracks or evidence of water intrusion inside the enclosures.
- Ensure that there is nothing loose or damaged inside.
- Ensure that all external cables and connectors (such as catching and return electrodes) are in good condition.

There should be no cuts or breaks in the insulation layers of these cables.

- Ensure that all batteries used are in good condition and fully charged before use.
- Ensure that the safety probe, located at the bottom of the wand pole, is clean and free from any foreign matter such as mud.
- It is recommended that the pulse-width and frequency controls (located inside the Control Unit enclosure) be set to their recommended positions (Pulse width 3mS and Frequency 60 Hz).

With experience, varying the pulse width and frequency can improve the catch in abnormal water conditions. Generally though, the recommended settings should be sufficient for most water conditions.

- Ensure that prior to transport, the EFM300 wand is placed inside its protective enclosure.

6.2. General operating procedures

The EFM300 electric fishing machine is a portable machine designed to be used by a team consisting of a minimum of two qualified operators.

Prior to field use, it is recommended that a visual check of all EFM300 equipment be carried out, ensuring that connectors and circuit boards have not become loose as a result of transport.

6.3. Operating procedure

The EFM300 electric fishing machine is designed to work in waters with an electrical conductivity of between 10 and 400RScm⁻¹. It is strongly recommended that water conductivity and temperature be measured prior to commencement of fishing operations.

NB: Water conductivity decreases by approximately 2.0% for each 1°C decrease in water temperature from 25°C.

- Connect the catching electrode (anode) to the wand pole coupling and tighten both screws using a suitable flat blade screwdriver.
- Install two series-connected (fully charged) batteries in the EFM300 battery compartment first ensuring that the main isolation switch is 'OFF' and that correct polarity (red-positive, black-negative) is observed.
- Connect the wand to the EFM300 Control unit via the 6 pin bulkhead connector, labelled 'Catching Electrode'.
- Connect the return electrode to the EFM300 Control Unit via the 2 pin bulkhead connector, labelled 'Return Electrode'.
- Connect the external safety isolation switch to the Control unit via the 2 pin bulkhead connector labelled 'Safety Switch'.

- Strap the EFM300 backpack assembly to the operator ensuring a tight but comfortable fit. Ensure that the operator knows the location of, and how to operate the quick release harness before fishing.
- The fishing team should walk up to the edge of the water, and place the return electrode in the water, ensuring that the bare section is completely submerged.
- The assistant should open the battery enclosure (first ensuring that the catching electrode is out of the water and the main operator is not pressing the HV ON switch) and place the Battery Isolation Switch in the ON position.
- To activate the EFM300 the assistant should press the Reset switch located on the front panel of the Control Unit.

- The Control Unit should then become active, with the following displayed:

Output voltage = 1 (Hundred volts)

Elapsed Time = **000** (Minutes) if not recently used

- Once the EFM300 has been powered up successfully, it is essential that each of the following safety circuits be tested:

(i) External Safety Switch

This switch is provided to allow the main operator the means of disabling the EFM300 output in the event of danger. This is normally located on the front webbing of the backpack, or held in the operator's free hand. Pressing this button will completely disable any high voltage output produced by the Controller. This is a latched condition.

Once this has been verified, the assistant should press the front panel 'Reset' switch, to restore normal operation.

(ii) Safety Switch

This switch is provided to allow an assistant the means of disabling the EFM300 output in the event of danger. This control is located on the front panel of the Control Unit, and operates in the same manner as (i) above.

Once this control has been verified, the assistant should press the front panel `Reset' switch, to restore normal operation.

(iii) Tilt switch

The purpose of the Tilt Switch is to disable the EFM300 in the event of the main operator falling. When the Control Unit tilts beyond a nominal 45° from the vertical, the Tilt Switch circuit should activate. Verify that the main displays blank and the "Tilt Switch" indicator flashes.

Once this control has been verified, the assistant should press the front panel `Reset' Switch to restore normal function.

Verify that the main display and the `Safety Switch' indicator lamp flashes.

(iv) Safety probe circuit

The purpose of the safety probe is to only allow High Voltage output to be present when the catching electrode (anode) is in contact with the water. The safety probe is an integral part of the Wand assembly and is located at the bottom of the pole. With the EFM300 powered up and the catching electrode (anode) out of the water, the main operator should verify that no output occurs (ie no audible buzzing and `Electrode Live' indicator OFF]. When pressing the 'HV ON' switch. The next step is to place the catching electrode (anode) into the water and press the `HV ON' switch. HV output should now occur, and is indicated by both an audible buzzing and the 'Electrode Live' lamp flashing.

- The assistant should verify that the EFM300 output voltage setting is 100 volts.

Next, the main operator should place the catching electrode (anode) into the water, ensuring that no-one is touching or otherwise in contact with the water and press the 'HV ON' switch to enable HV output.

Output voltage should be selected by successively pressing the `Select' pushbutton until 2 or 3 of the wand output current indicators located in front of the 'HV ON' switch, of the wand are visible. This is the optimum power

setting for the EFM300 under most conditions and indicates 200-300mA output current.

- Press the `Clear' pushbutton located on the front panel of the Control Unit. This ensures that the elapsed time Timer is reset before use.

The EFM300 is now ready for fishing.

7. Manufacturer's recommendations

- 1 It is not recommended that the operator use settings above 3ms and 60pps as above this setting may cause damage to fish.
- 2 At the above settings, the machine is rated for a maximum continuous duty cycle of 4 minutes ON followed by 11 minutes OFF. A longer duty cycle may cause thermal damage to components or cause the fuse to blow.
- 2 Use only the battery type specified in Section 8.

Note that batteries should be maintained on float charge when not in use.

Proper maintenance of batteries is essential for correct performance of the EFM300.

- 3 Treat the Fishing Machine with care.

Although great effort has been made to design a robust electrofishing machine, care should always be taken with the EFM300.

Before transit, and storage, protect the wand by placing it inside its protective enclosure.

- 4 Users should have access to a good quality Conductivity Meter and Temperature Indicator.

- 5 The Control Unit enclosure 'O' ring should be periodically coated with a light smear of MAF grade silicon grease. Contact your EFM300 supplier who will be able to recommend a suitable type.
- 6 Never attempt to use the EFM300 if there are visual defects, loose parts or inactive safety circuits. You could be placing someone at risk of serious electric shock.

SAFETY – ALWAYS.

If there is any doubt about the operation of your EFM300, return it to the manufacturer or an approved service centre.

8. Technical specifications

PHYSICAL:

Backpack size	(app) H 500mm, W 300mm, D 220mm
Enclosure materials	High impact polycarbonate
Wand	L = 1.8 tapered spun fibreglass
Weight	2 x 12kg (including batteries)

ELECTRONICS:

Input power	24 volt DC nominal at 15A
Batteries -	2 x 12 volt, 7 Ah SLA or LiFePO4
Output: Power	100 watts (nominal)
Voltage	100 — 600 volts (pulsed DC selectable in 100V steps)
Frequency	20 — 240 Hz
Protection	Output disabled on current overload (3A)
Conductivity range	10 — 400 microS/cm
Visual indicators:	
Fishing minutes elapsed	7 segment red LED (1)
Peak output voltage	7 segment red LED (3)
Peak electrode current	Red LED x 5
Electrode live	Red LED x 1
Safety switch operated	Red LED x 1

Tilt switch operated
Battery low

Red LED x 1
Yellow LED x 1

Audible indicator:
Electrode live

85 dB at 300mm

External controls:

Safety switch
'HV ON' switch (located on wand)
Peak output voltage select switch
Safety latch reset switch
Elapsed Time display reset switch

Internal controls:

Output pulse width
Output pulse frequency
Audible indicator volume

Safety devices:

Water conductivity switch
Tilt switch
Safety switch
'HV ON' switch