

ELECTROFISHING SYSTEMS

Tab 11



Dang,
low bid!

Session Objectives

(Page 11-1)

- Provide an overview of electrofishing systems, components, and their variations.
- Discuss equipment safety features
- Describe equipment modifications that help improve electric field characteristics or that allow system function in conductivity extremes
- Discuss equipment calibration & trouble shooting

Components of an Electrofishing System

- ① **Power supply:** provide energy
- ① **Power conditioner:** modify input energy to selected specifications
- ① **Instrumentation:** provide knowledge of system electrical performance

Components... (continued)

- ① **Interconnection system:** to safely carry conditioned power to electrodes
- ① **Electrodes:** transfer power from system circuits to water
- ① **Auxiliary equipment:** peripheral electrical functions (lights, pumps, aerators, etc.)



Wisconsin
array anode

Dropper
cathode



Boat hull is cathode

Smith-Root, Inc. Electrofishing Boat

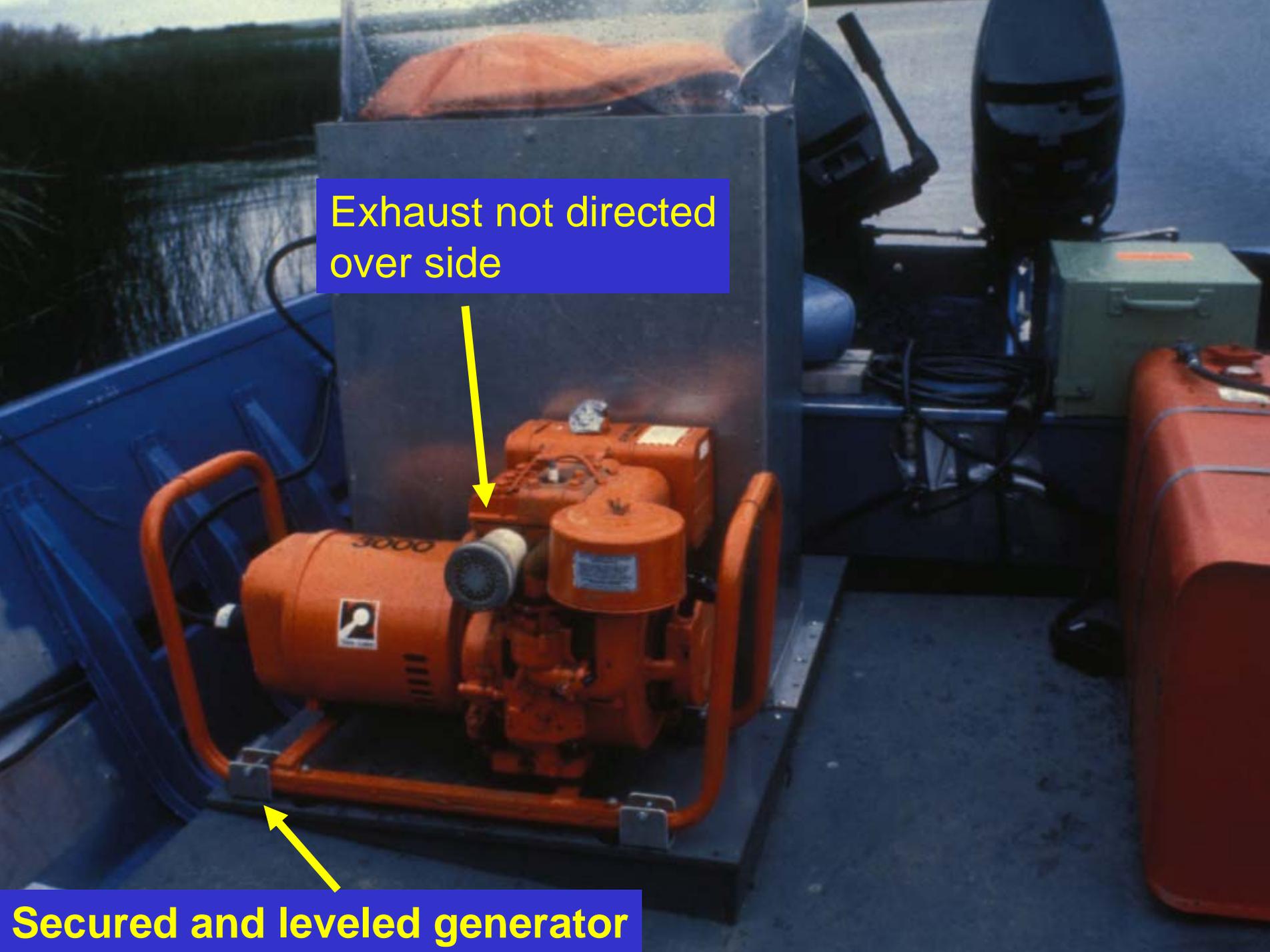


A first approximation-



Some projects still don't use important safety features (e.g., no rails)...



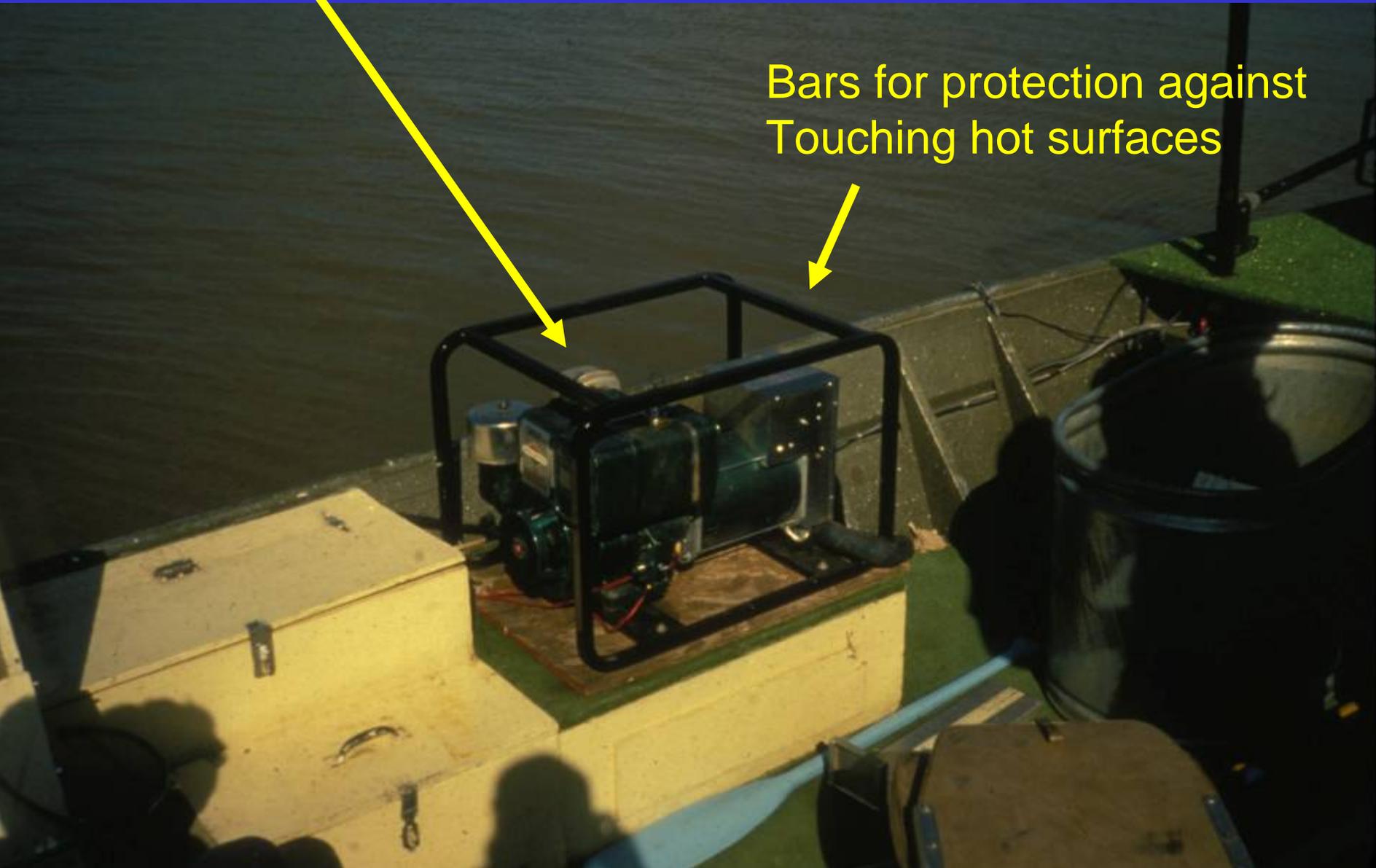


Exhaust not directed
over side

Secured and leveled generator

Generator securely mounted with exhaust directed over side

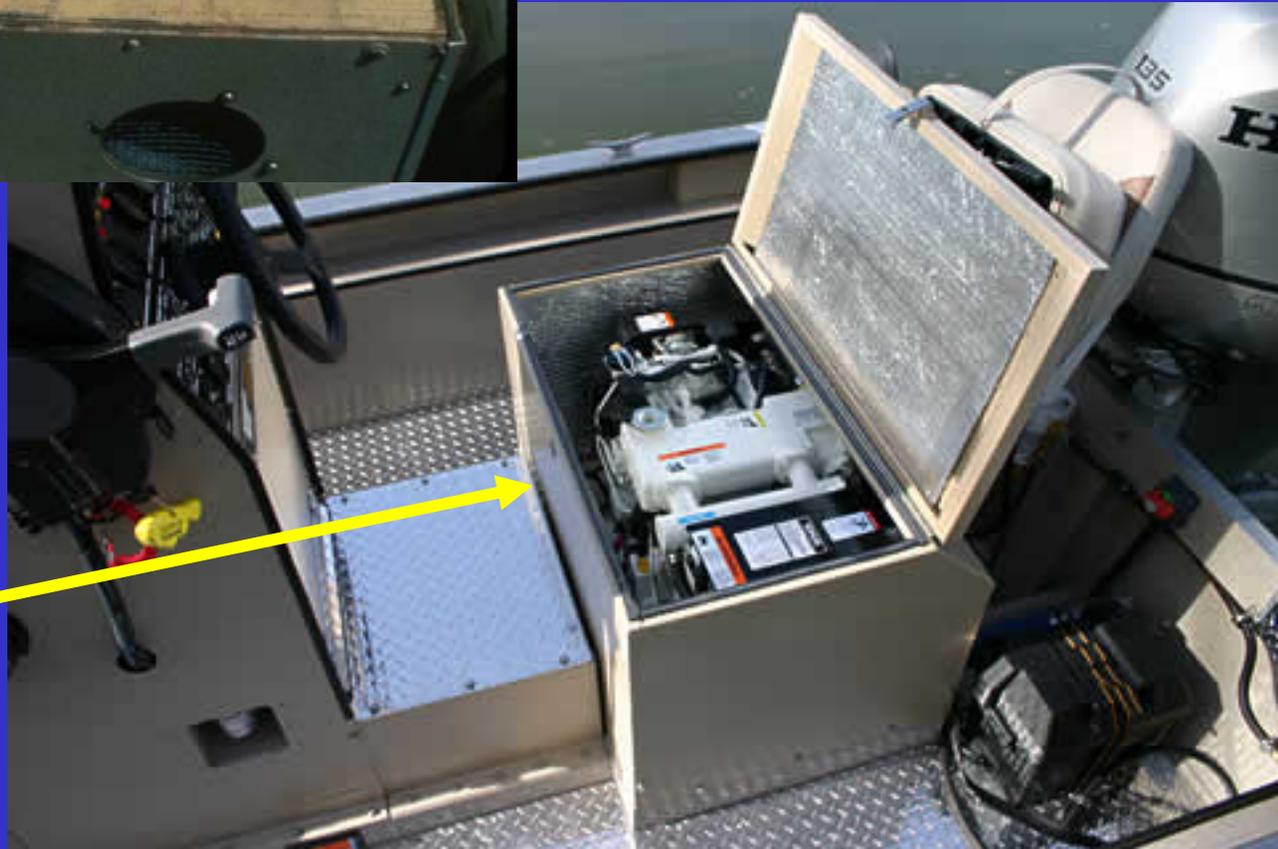
Bars for protection against
Touching hot surfaces



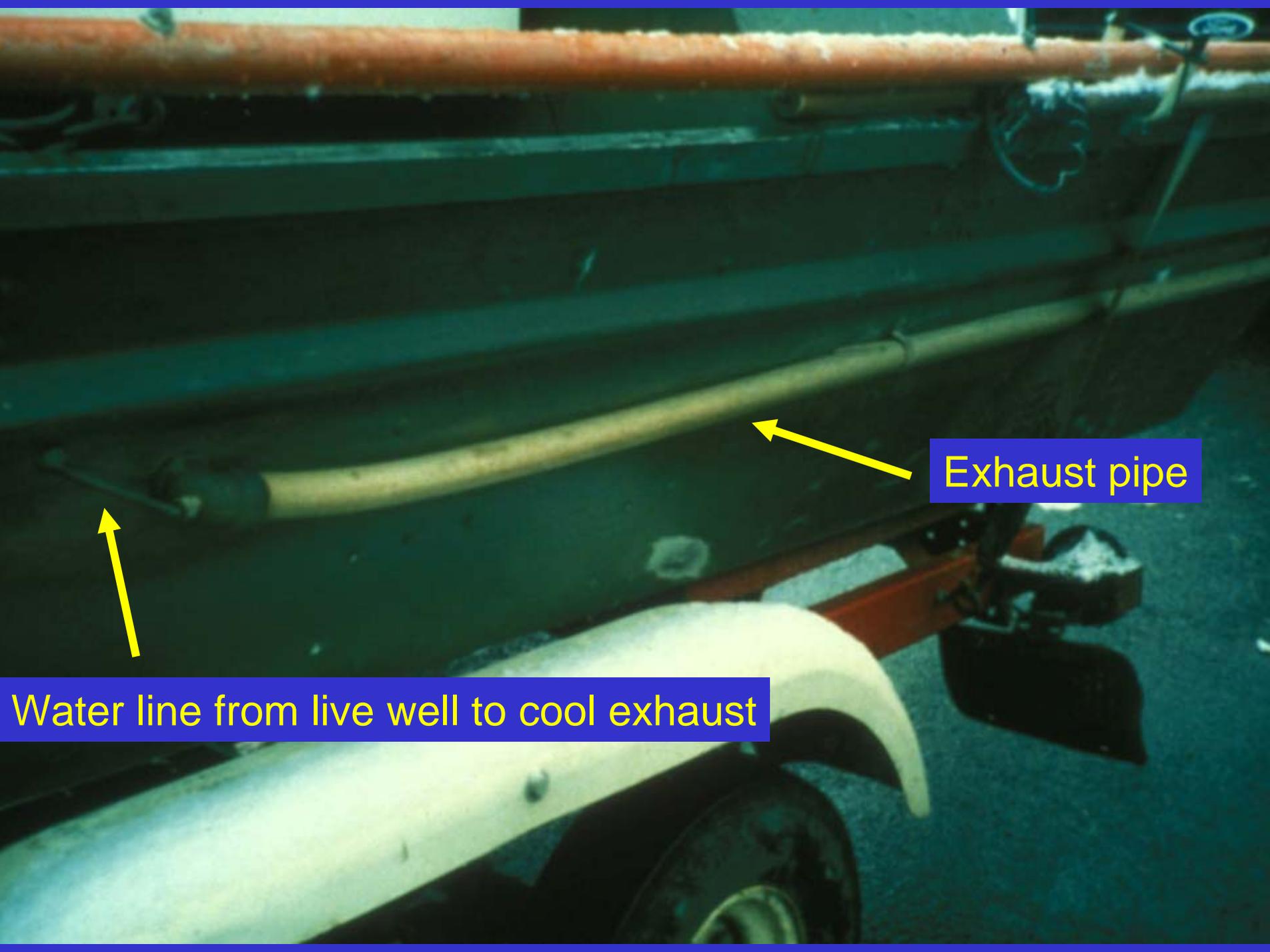


Noise Reduction...

Air (fan) cooled generator



Water cooled generator



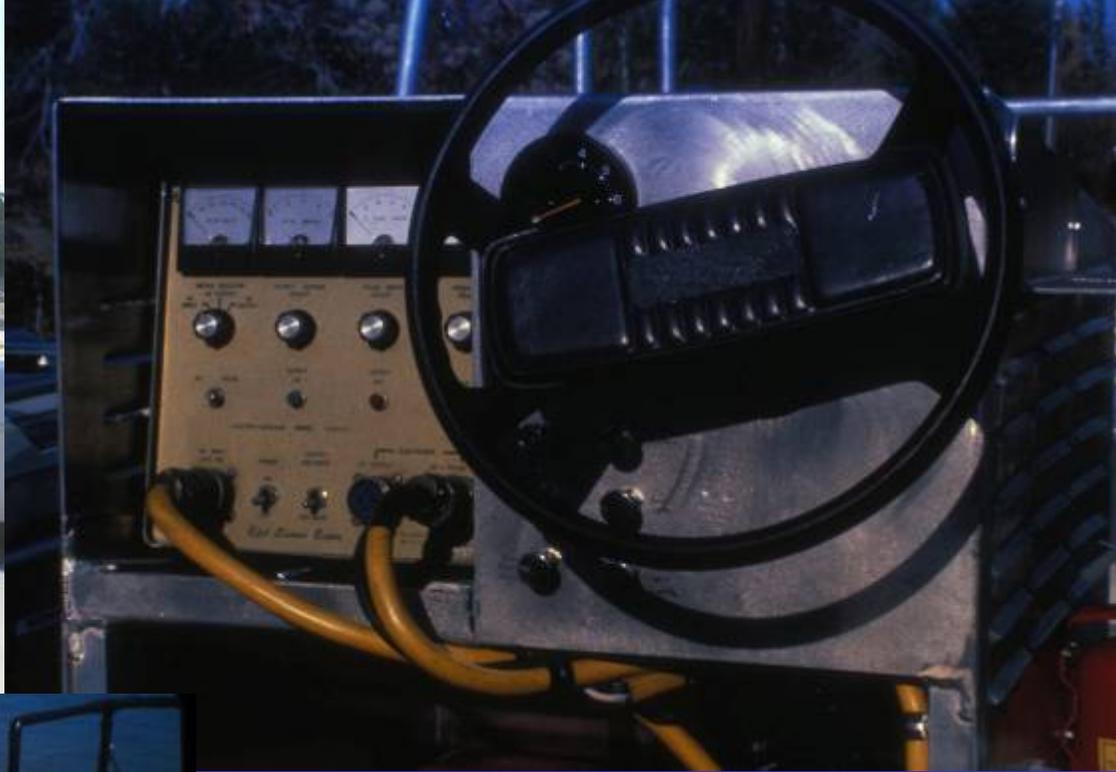
Exhaust pipe

Water line from live well to cool exhaust



HIGH VOLTAGE / KEEP CLEAR

Exhaust pipe and muffler



Control boxes (pulsators) are moisture sensitive and should be protected from rain and being struck by branches, etc.

- Some pulsators are self enclosed (e.g., the Smith-Root **GPP** series)
- The **GPP** pulsators are still moisture sensitive and the cover must be on during rain

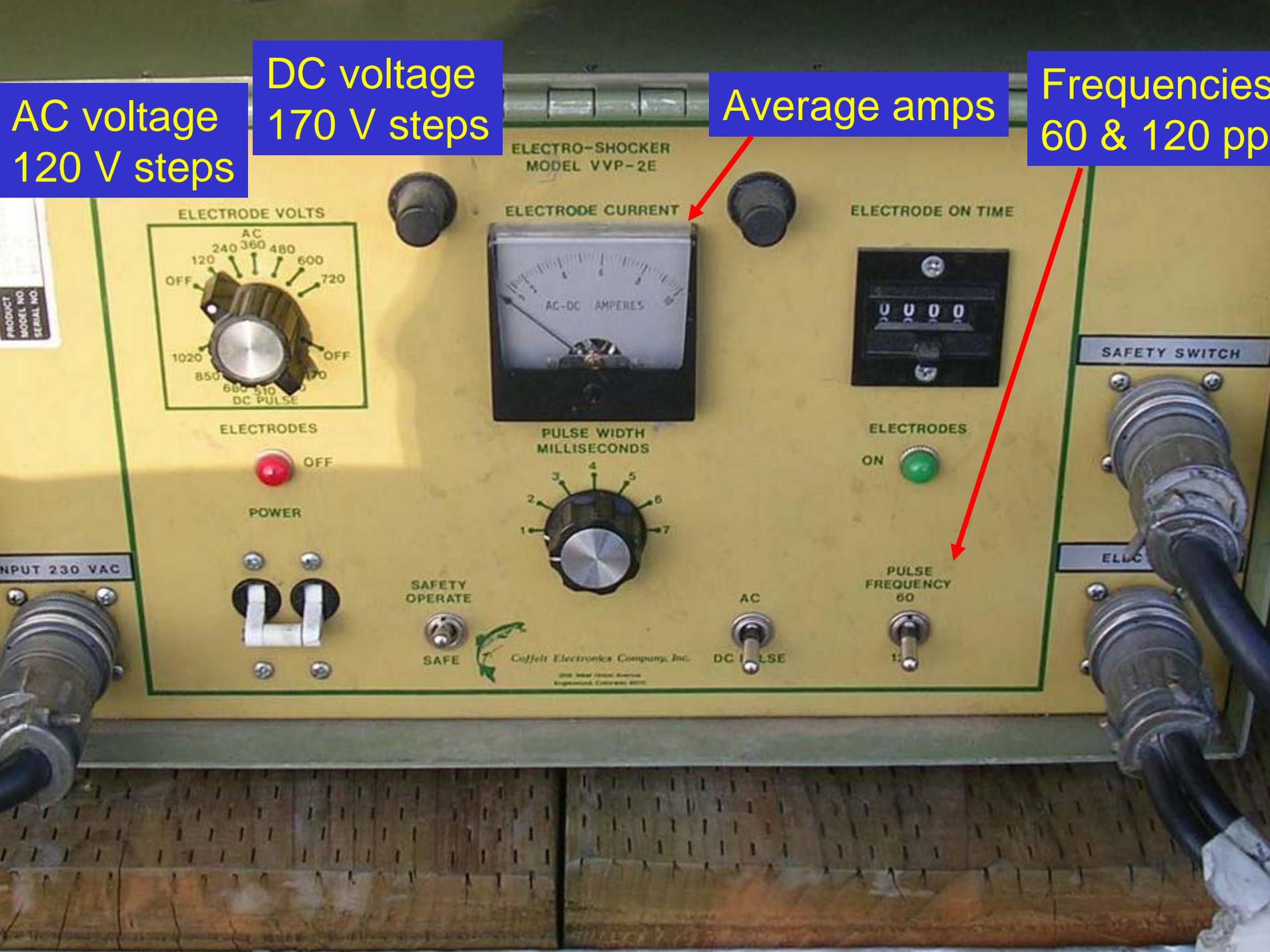


AC voltage
120 V steps

DC voltage
170 V steps

Average amps

Frequencies
60 & 120 pp



DEPARTMENT OF THE INTERIOR
U 606357 S
FISH AND WILDLIFE SERVICE

Coffelt Electronics Company, Inc.

NEGATIVE SELECTOR

POSITIVE SELECTOR

BOOM REAR BOAT

LEFT BOTH RIGHT

POWER ON OFF

LIGHTS ON OFF

INPUT OUTPUT VOLTAGE

OUTPUT CURRENT

PERCENT PULSE WIDTH

FREQUENCY



METER SELECTOR
AC INPUT AC OUTPUT DC OUTPUT

OUTPUT VOLTAGE ADJUST

PULSE WIDTH ADJUST

FREQUENCY ADJUST

DC PULSE

OUTPUT ON

OUTPUT OFF

AC OFF DC

DEPARTMENT OF THE INTERIOR
U 606348 S
FISH AND WILDLIFE SERVICE

ELECTRO-SHOCKER MODEL VVP-15

AC INPUT 230 VAC

POWER ON OFF

OUTPUT 600 VOLTS

ELECTRODES AC OUTPUT DC - PULSE OUTPUT

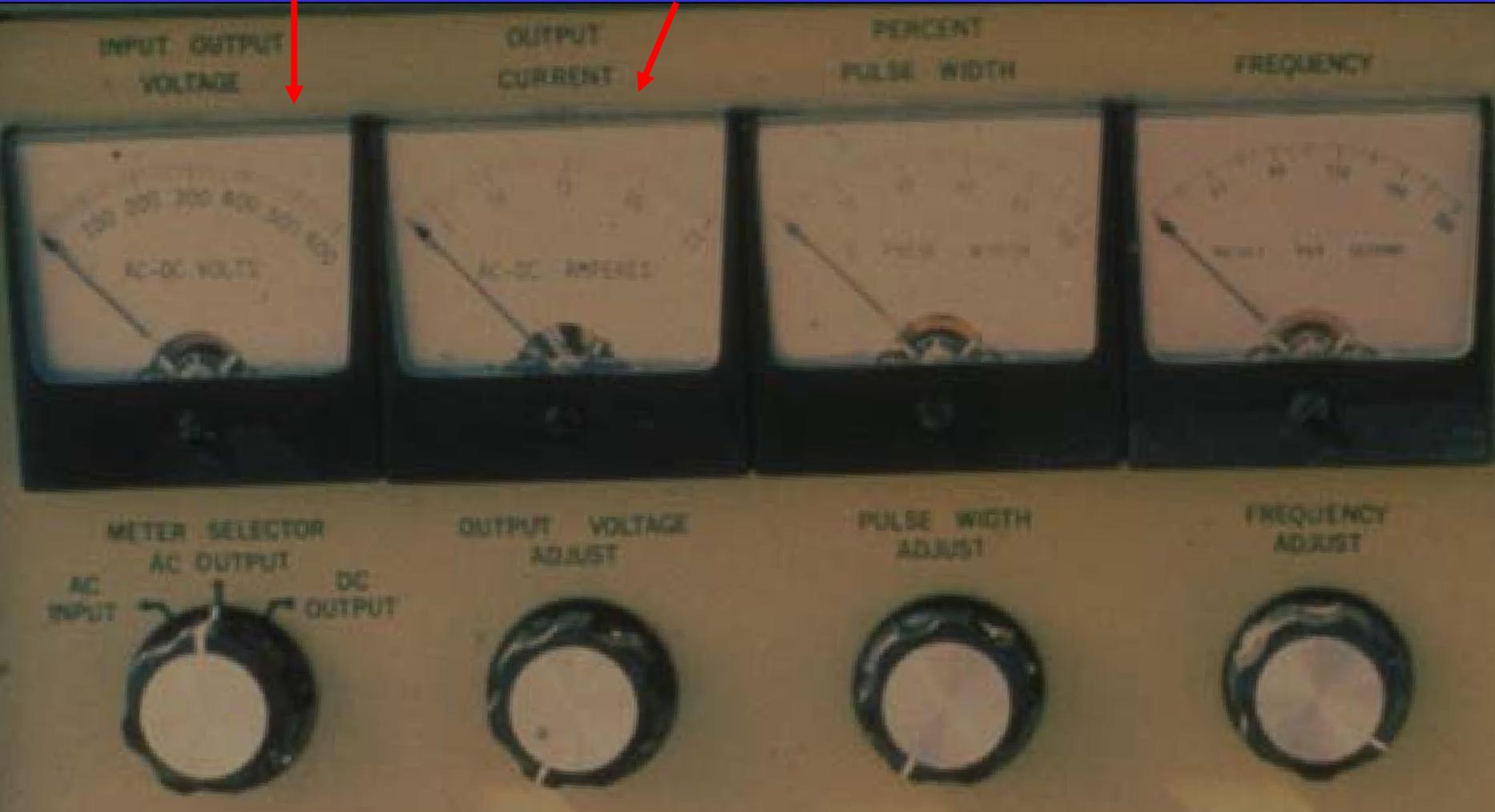
Coffelt Electronics Company, Inc.

Coeffelt V V P-15

Peak DC V or RMS V

Average or RMS amps

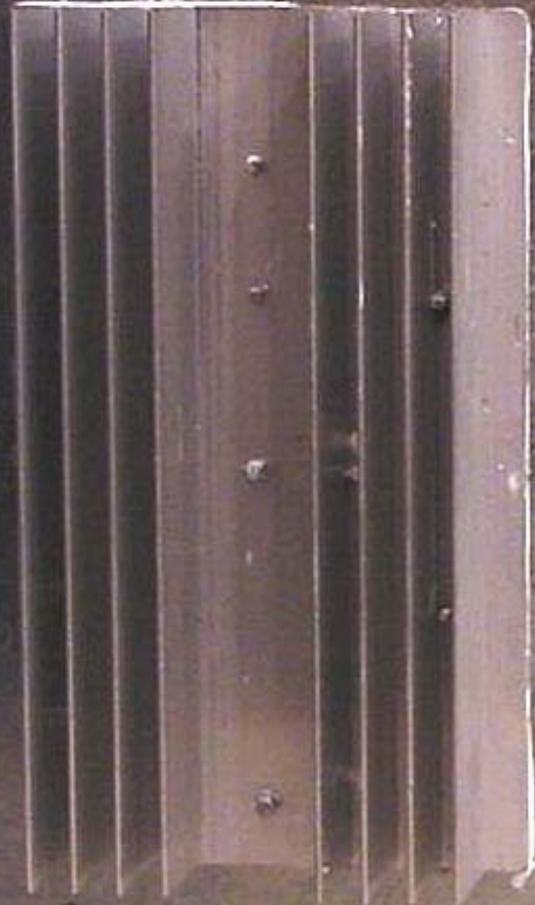
Analog metering



Continuous voltage, pulse width, and frequency controls

MBS-2D
ETS
Pulsed DC
AC

Digital peak or
RMS V & I
metering



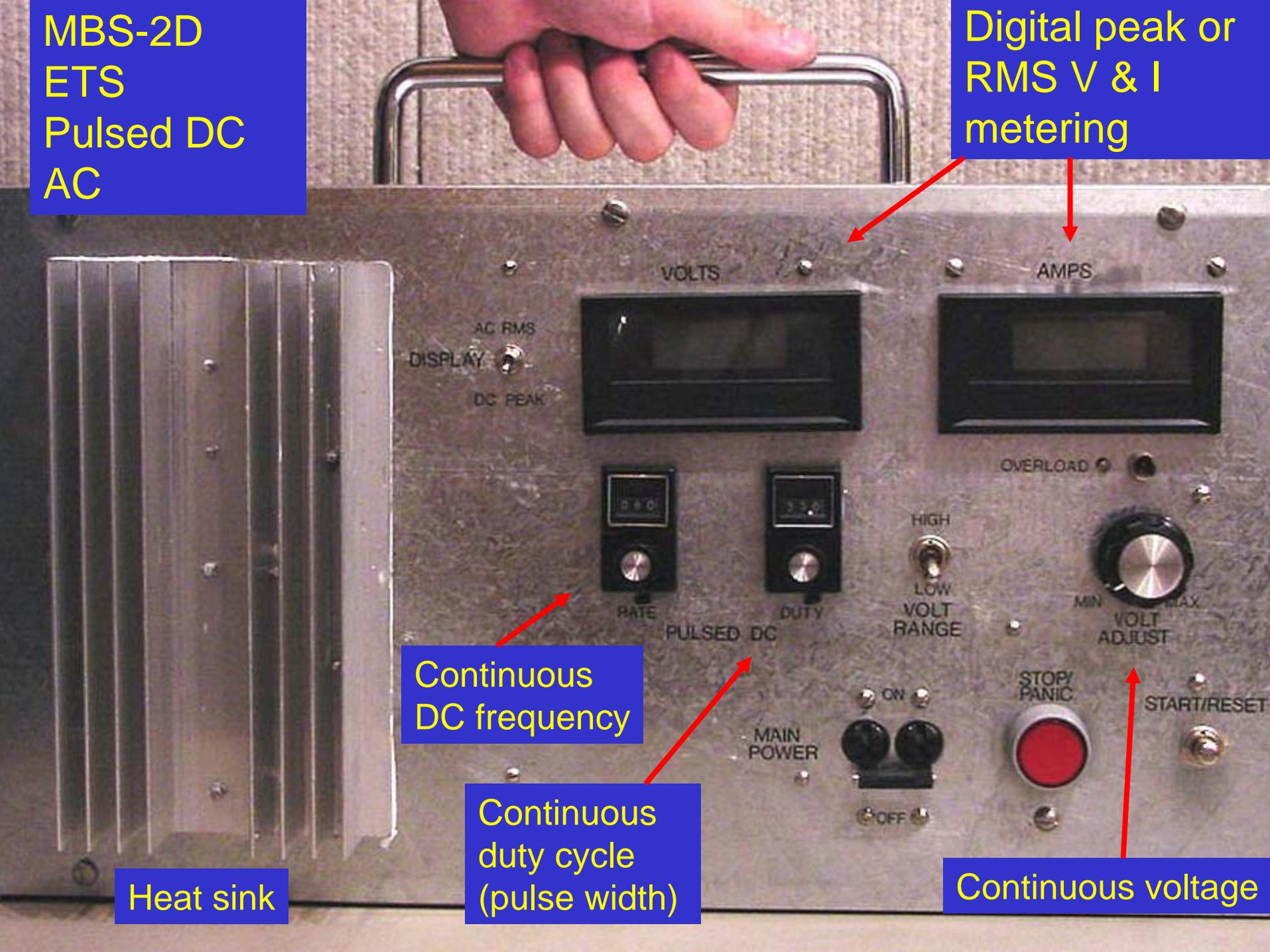
Heat sink



Continuous
DC frequency

Continuous
duty cycle
(pulse width)

Continuous voltage



GPP
Smith-Root, Inc.

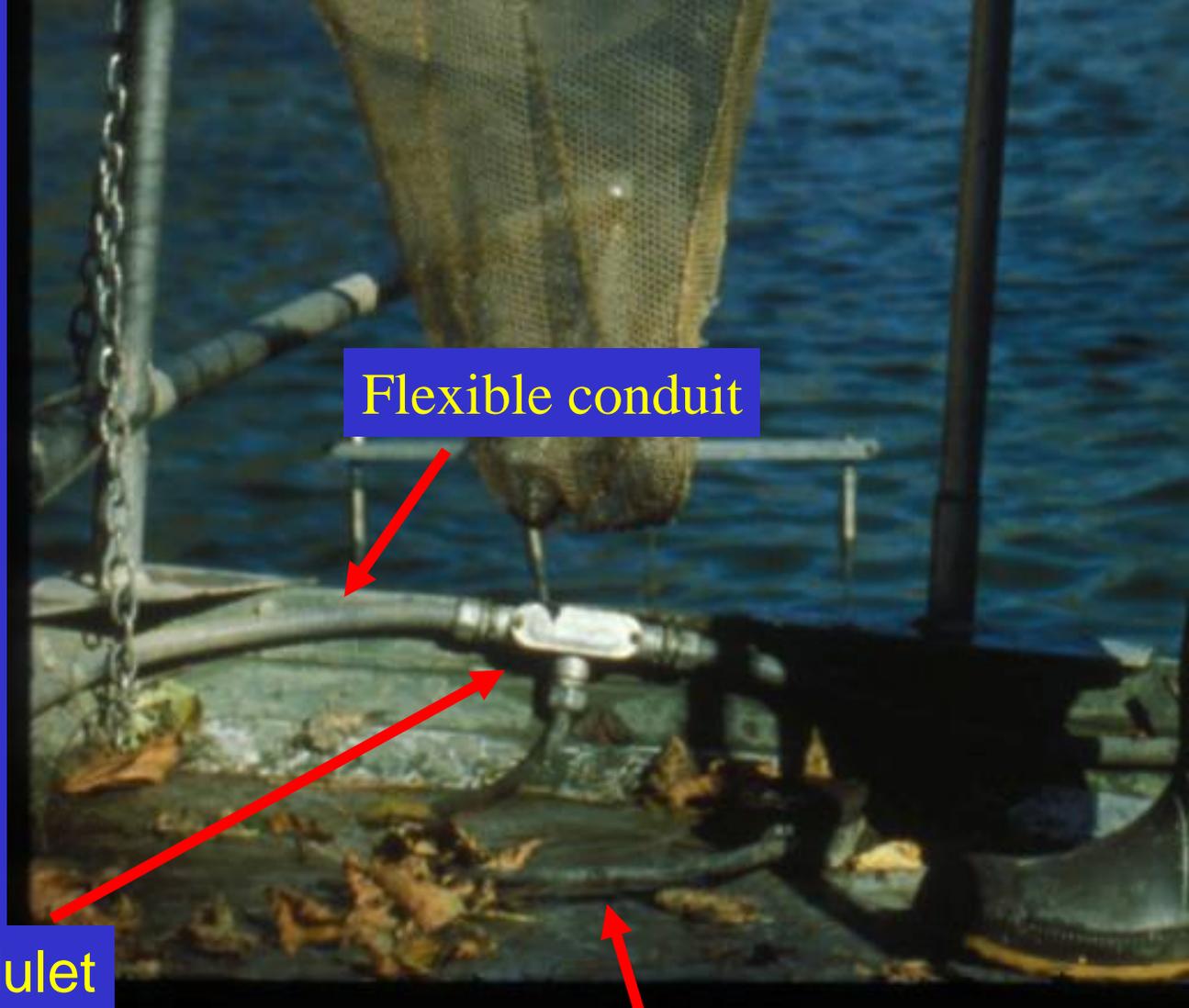
Note: peak reading digital
voltmeter and ammeter (optional)



Continuous voltage control?

Frequency

- Conductors of sufficient gage should be contained within conduit whenever possible
- All splices to wiring are made in water-resistant condulets (with exceptions noted later)



Flexible conduit

Condulet

Power cable (leading to foot switch)



Power cable rating

Pay attention to conductor capacities (voltage & current)

- **Conductor Voltage.** The insulation value for all wiring must meet or exceed the maximum voltages generated by the power source or pulsator. In general, the branch circuit conductors will require the highest breakdown voltage capacity to sustain the peak magnitudes of the voltage pulses. For insulated wires that are specified with a V rms rating, the peak breakdown voltage (AC, DC, or PDC) can be estimated to equal 1.41 times the V rms rating.

Pay attention to conductor capacities (voltage & current)

- **Conductor Size.** Conductor size (i.e., for copper wire, chassis wiring) will be approved for rated RMS amperage of equipment as listed in the following table. Always check manufacturer specifications for conductors

• 11	20 AWG
• 16	18 AWG
• 22	16 AWG
• 32	14 AWG
• 64	9 AWG
• 73	8 AWG
• 158	3 AWG
• 181	2 AWG

High Voltage Power Cable

- You can obtain 2000 V power cable that has a small, workable diameter (~0.25 inches or 0.64 cm).
- U.S.A. Wire & Cable, Inc. distributes 2kV diesel locomotive (or oil rig) flexible power lead cable



Legend:

A: Flexible Strand

B: EPR Insulation

C: Hypalon Jacket

Hubbell watertight safety-shroud receptacle & plug



Not as weather-proof as a shroud receptacle & plug



Foot pedal switch



Low voltage (less than 24 V)

Foot Pedal Switch





Mat foot switches



Auxiliary Circuits

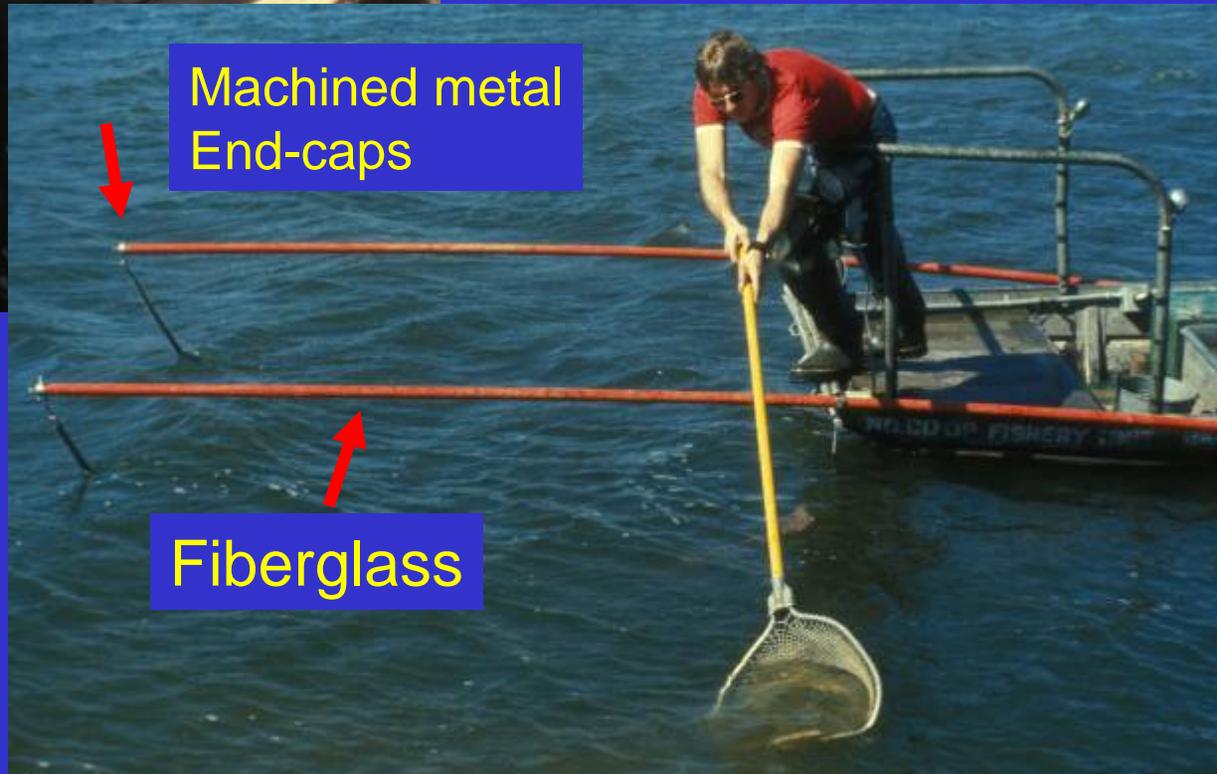
- If lights, aerators, pumps, etc. are run on 12 V auxiliary circuits, then there is less power demand on the generator



Boom materials



PVC



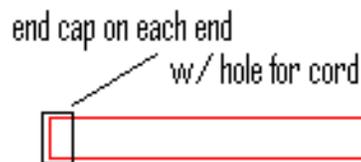
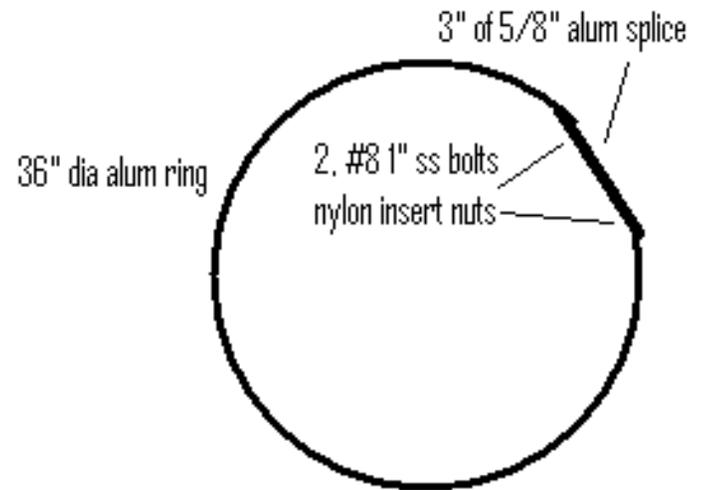
Machined metal
End-caps

Fiberglass

Boom Design Example

Boom Assembly

1. 112" of 1/2" aluminum tubing
2. 3" 5/8" alum. tubing- splice
3. 2, 1" #8 ss mach. screws w/ss nylon insert nuts.
4. 1, 16' x 1/1/2" fiberglass pole.
5. 2, 1 1/2" plastic pole end caps.
6. 20' #10 stranded 600 volt rubber or neoprene water/oil resistant cord.
7. 1, #10-12 ss ring terminal.
8. 1, Hubble HBL741C plug or similar.



2" from end, 36" apart

17/32" holes

plug

cord runs through boom

attach to ring splice #8 ss bolt

ring term

Attaching booms



Oarlock receptacle



Oarlock on rear of boom

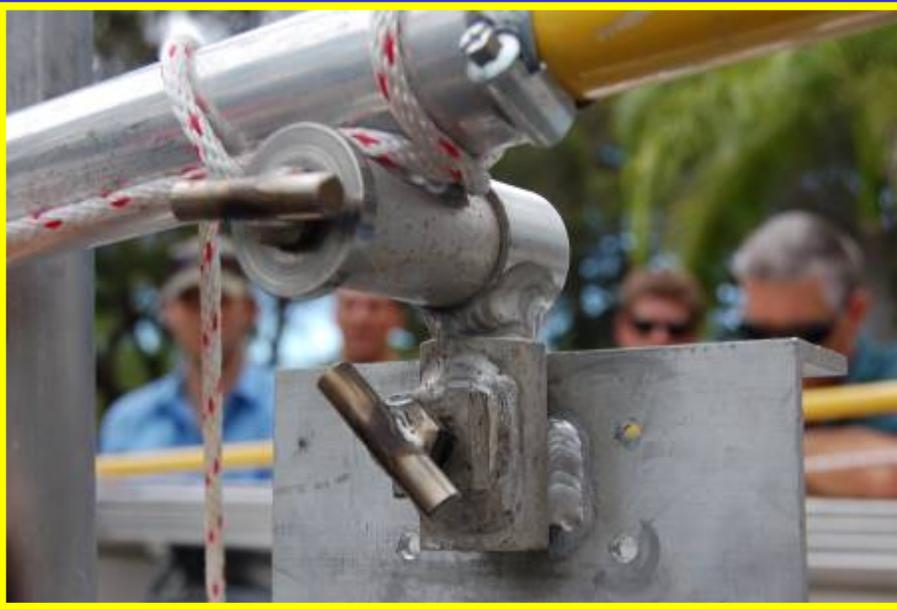
Holds anterior portion of boom



Attachment that allows vertical adjustment



Another version



More versions

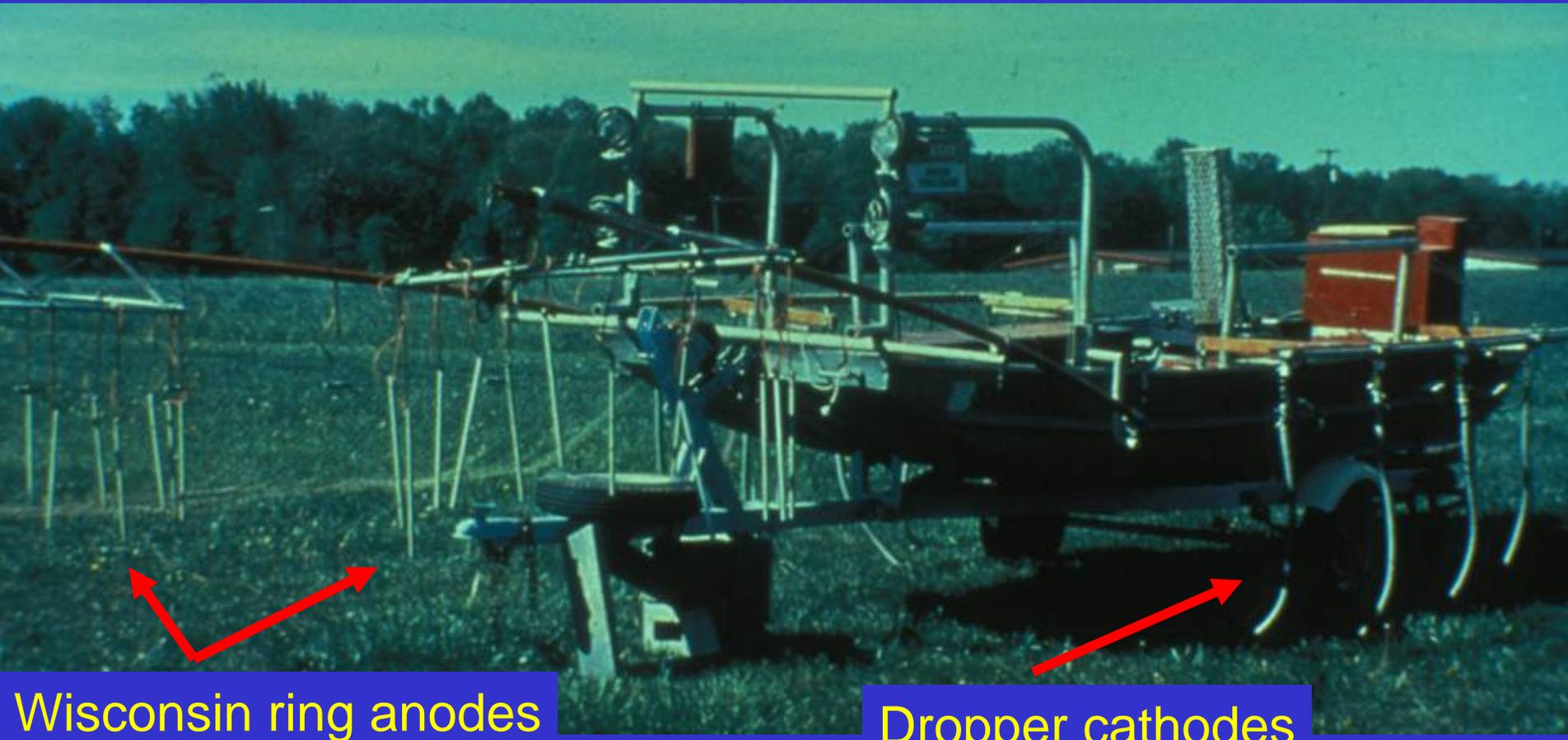


- A “rapid deployment” system!



Electrode Configuration

A bit overdone (the James Bond 007 approach)



Wisconsin ring anodes

Dropper cathodes

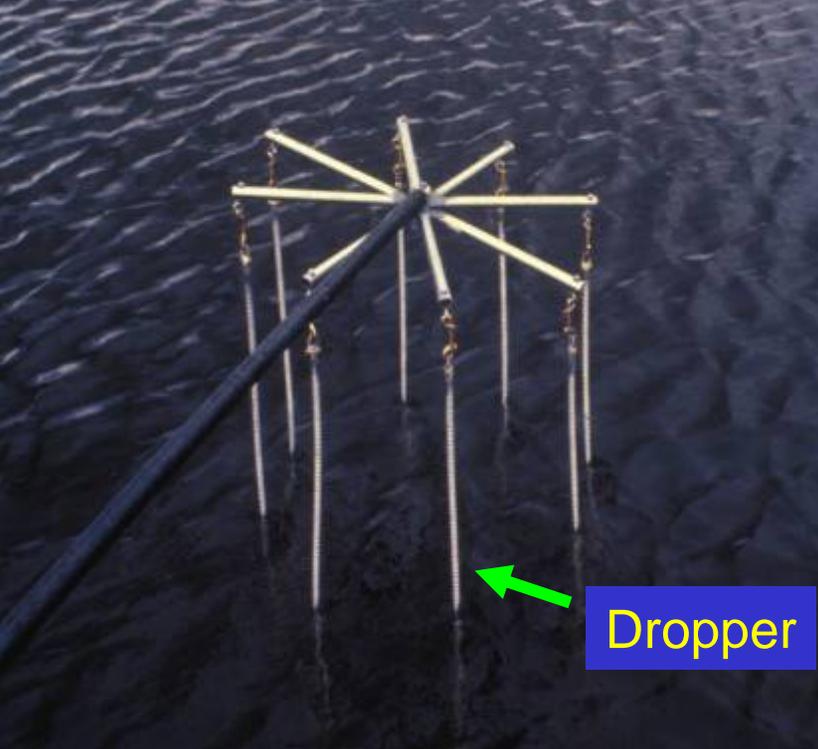
Boom electrodes

the simple...



to the more complex

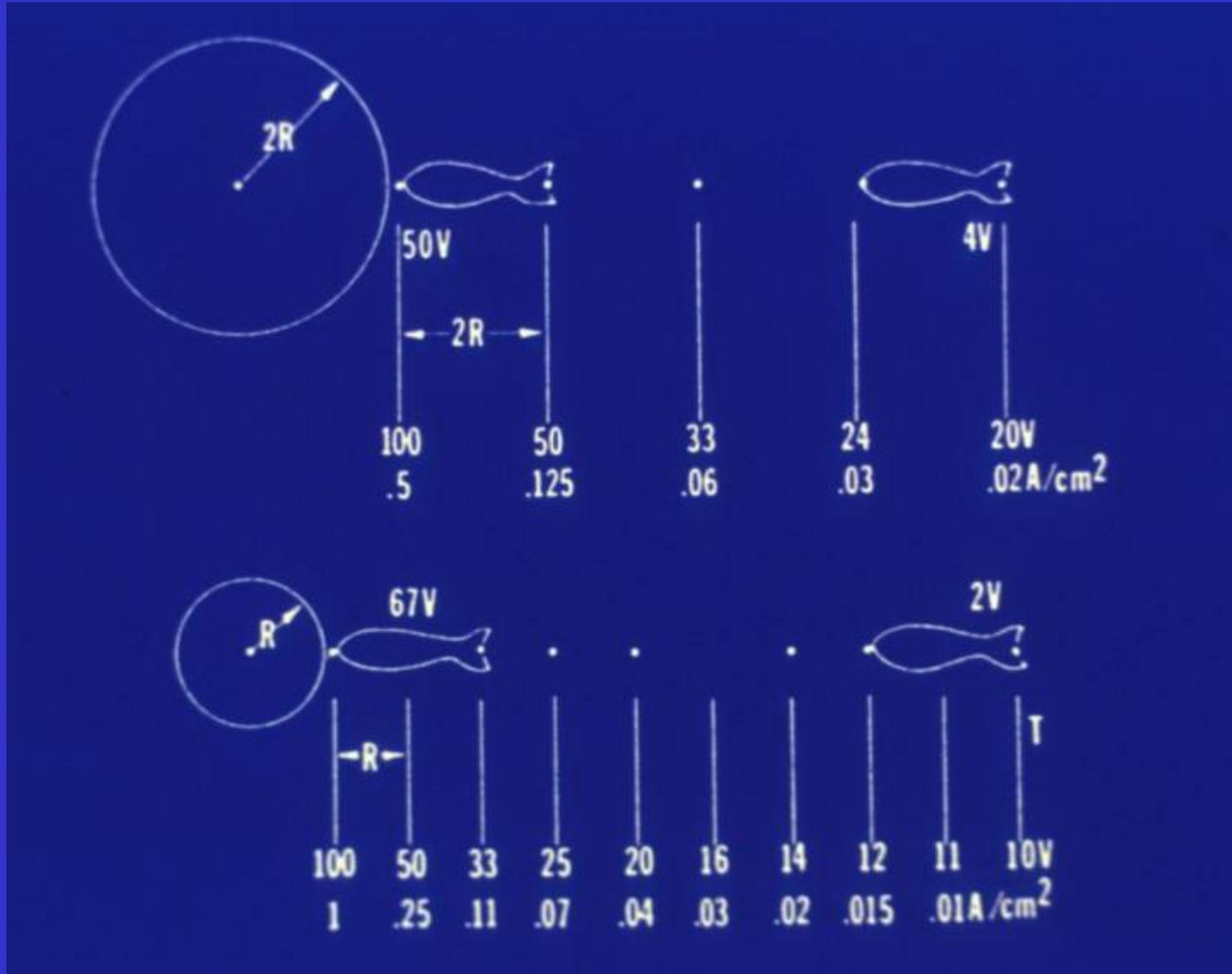
“Wisconsin rings”



Dropper



Larger diameter cylinders (or spheres) project the electric field farther

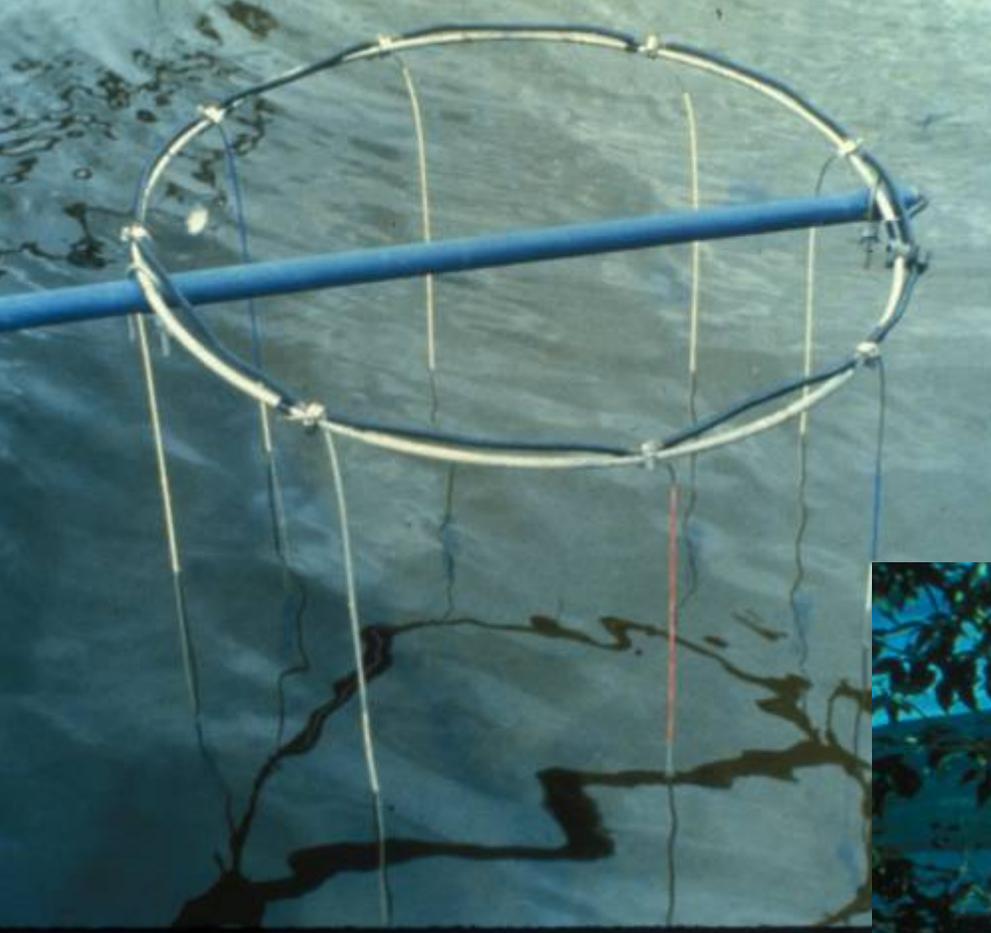


For dropper-style anodes...

- What diameter should the droppers be?
 - Try for at least 1.0 cm diameter (diameters of 1.3 cm to 2.5+ cm are used)
- How many droppers (1 - ?)
 - Try for a minimum of 6; depends upon how much metal your power source can “drive”



So, what do you think about these designs?



Non-commercially made



Commercially made

Some reasons...

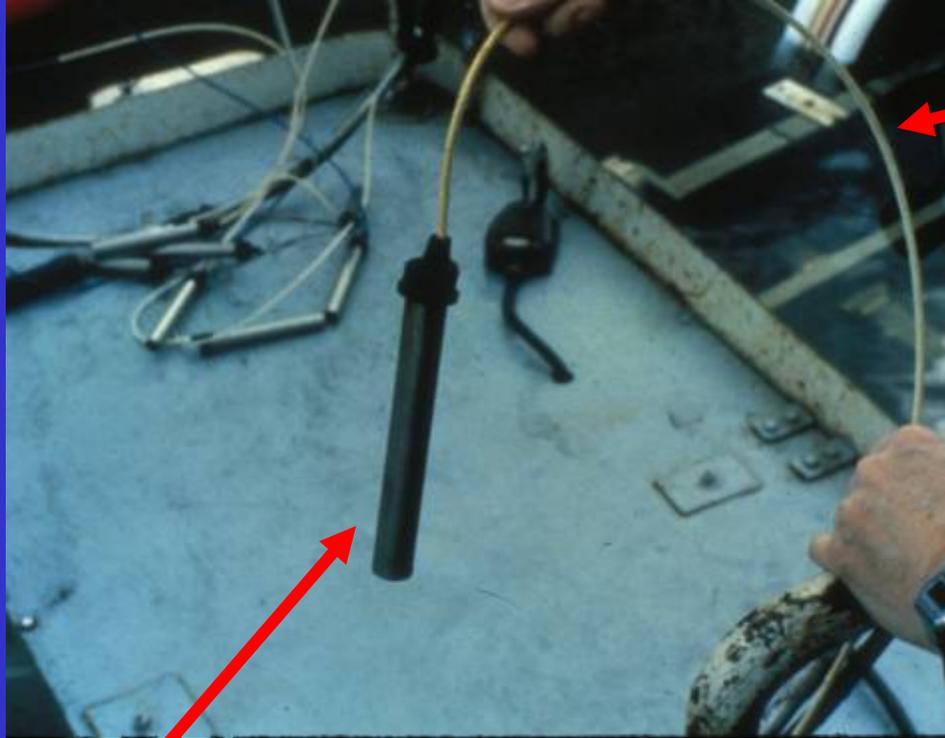
Ease of packing



Can fish over a wide range of conductivities. Equals happy customers.



But problems can arise...



Insulated conductor

Striped bass mortality issue

Exposed metal



Dropper Metal Type

- The largest resistor in the system is the water. Thus all metal types (stainless steel, copper, galvanized) conduct electricity equally.
- The considerations are cost and durability
 - Stainless steel is more expensive but durable
 - Galvanized metal is less expensive but corrodes easily

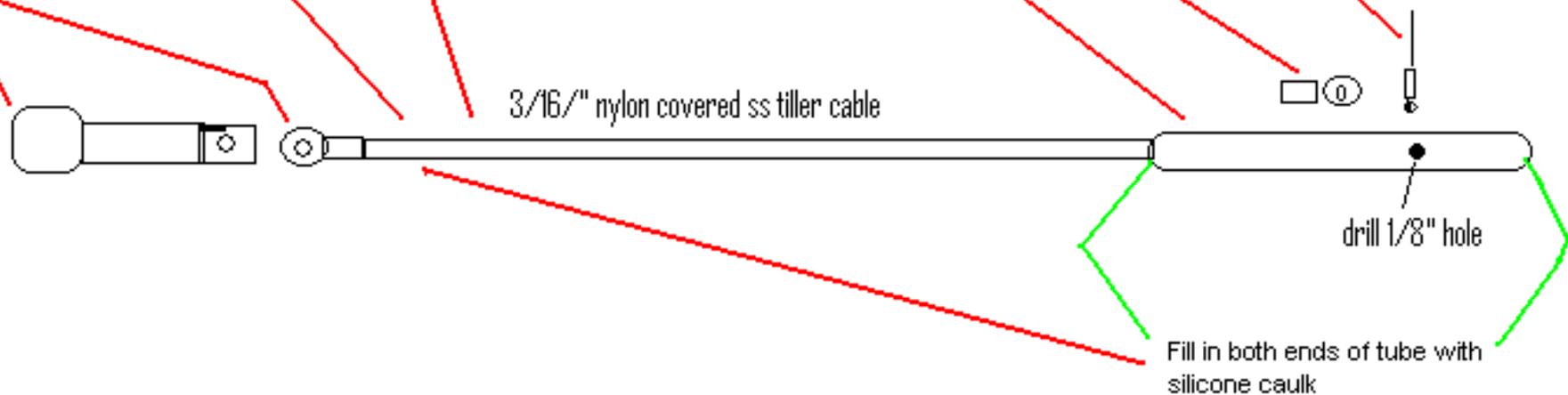


Dropper Design Example

DC ring droppers

Parts

1. 50A test clip
2. ss #10 ring term
3. 24" tiller cable
4. ss 1/8" ring term
5. 1/8" ss pop rivet
6. 6" of 5/8" ss round tube
7. silicone caulking



Other boom electrode designs...

Spheres

Commercially made



Salad bowls
Bolted together



Spheres deployed



Other boom electrode designs...

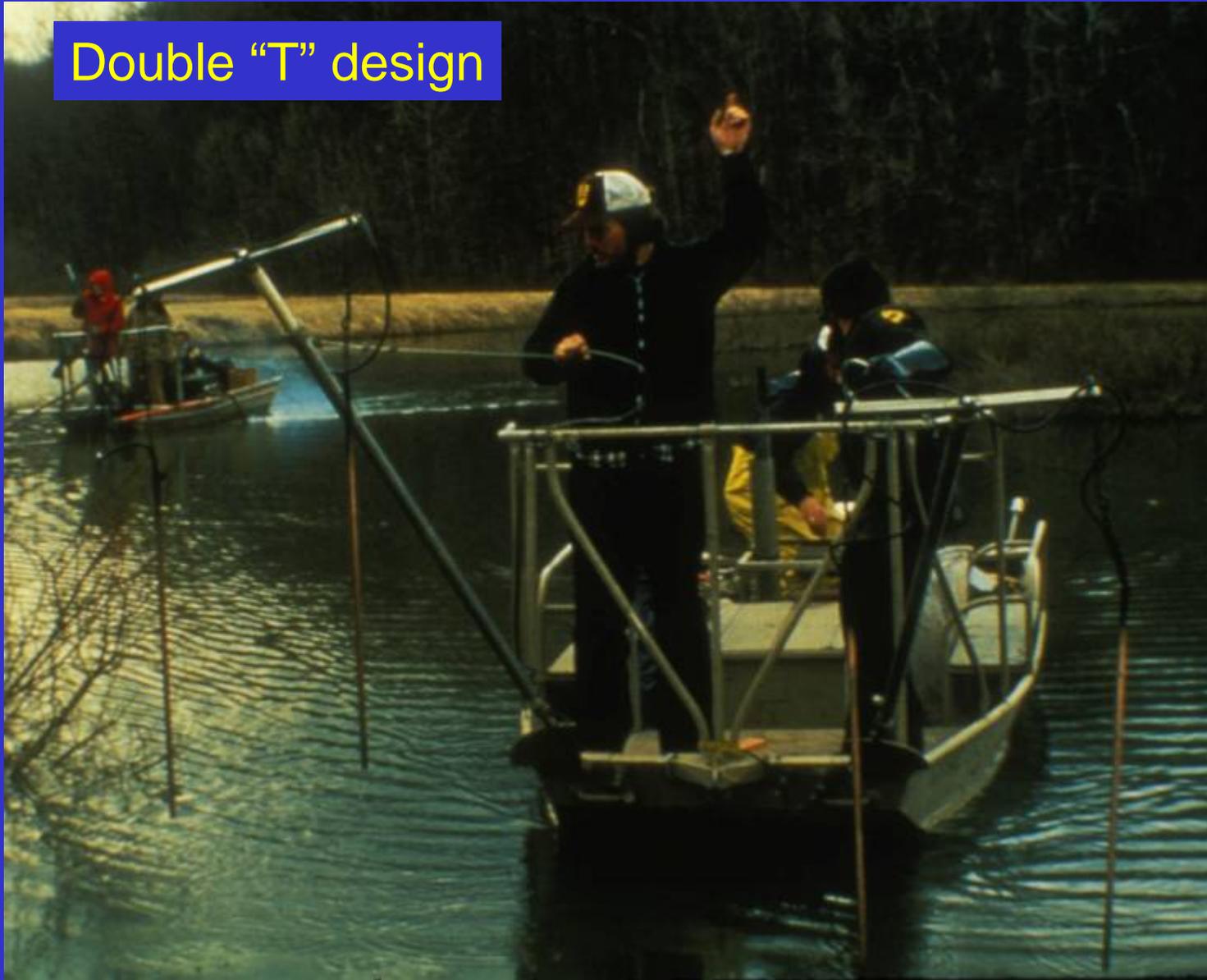


“T” design



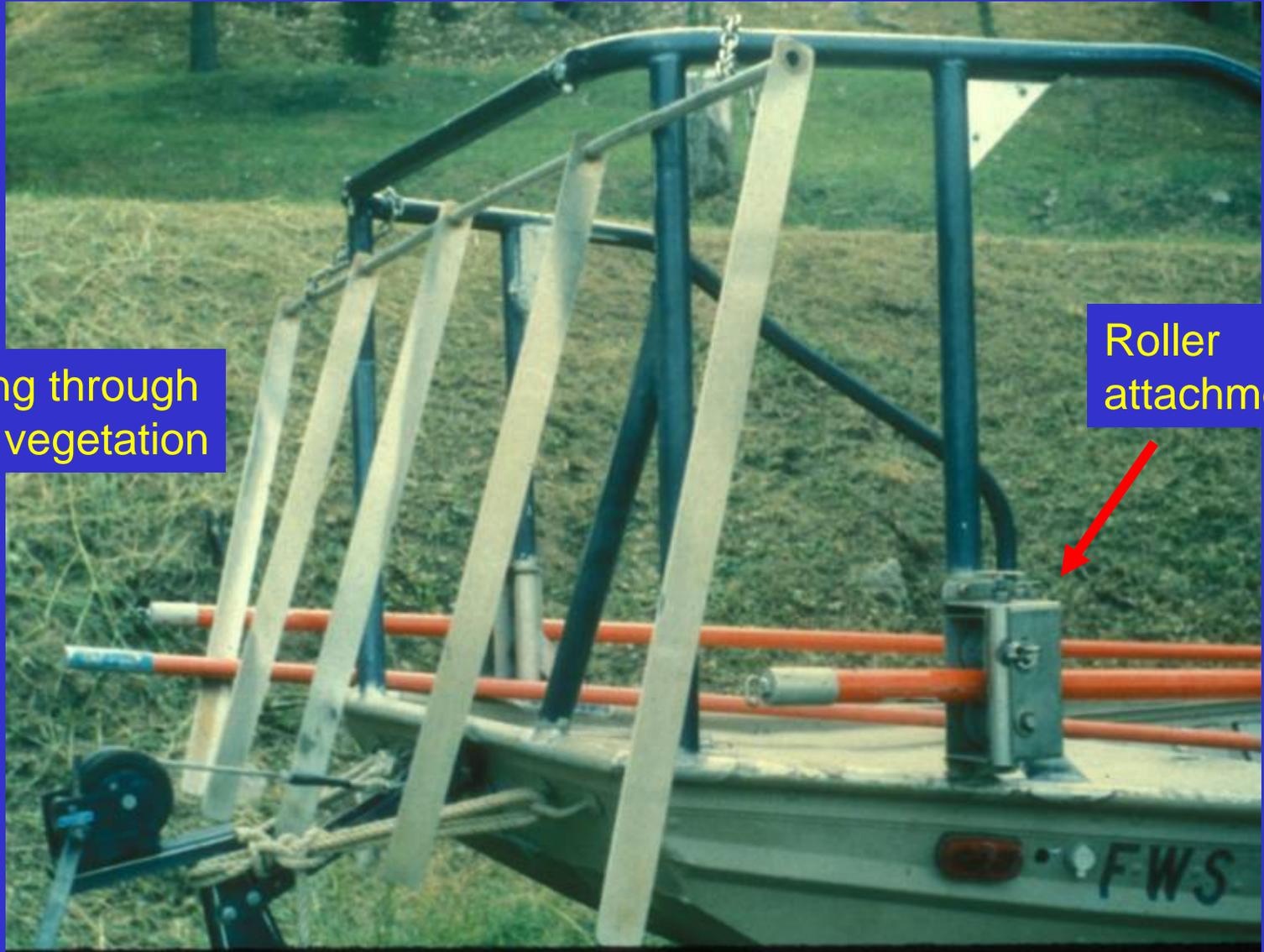
Other boom electrode designs...

Double "T" design



Other boom electrode designs...

For going through aquatic vegetation



Roller attachment

Other boom electrode designs...

Single boom with
Wisconsin array



Other electrode designs...

Deep-water
electrofishing for
larval lampreys



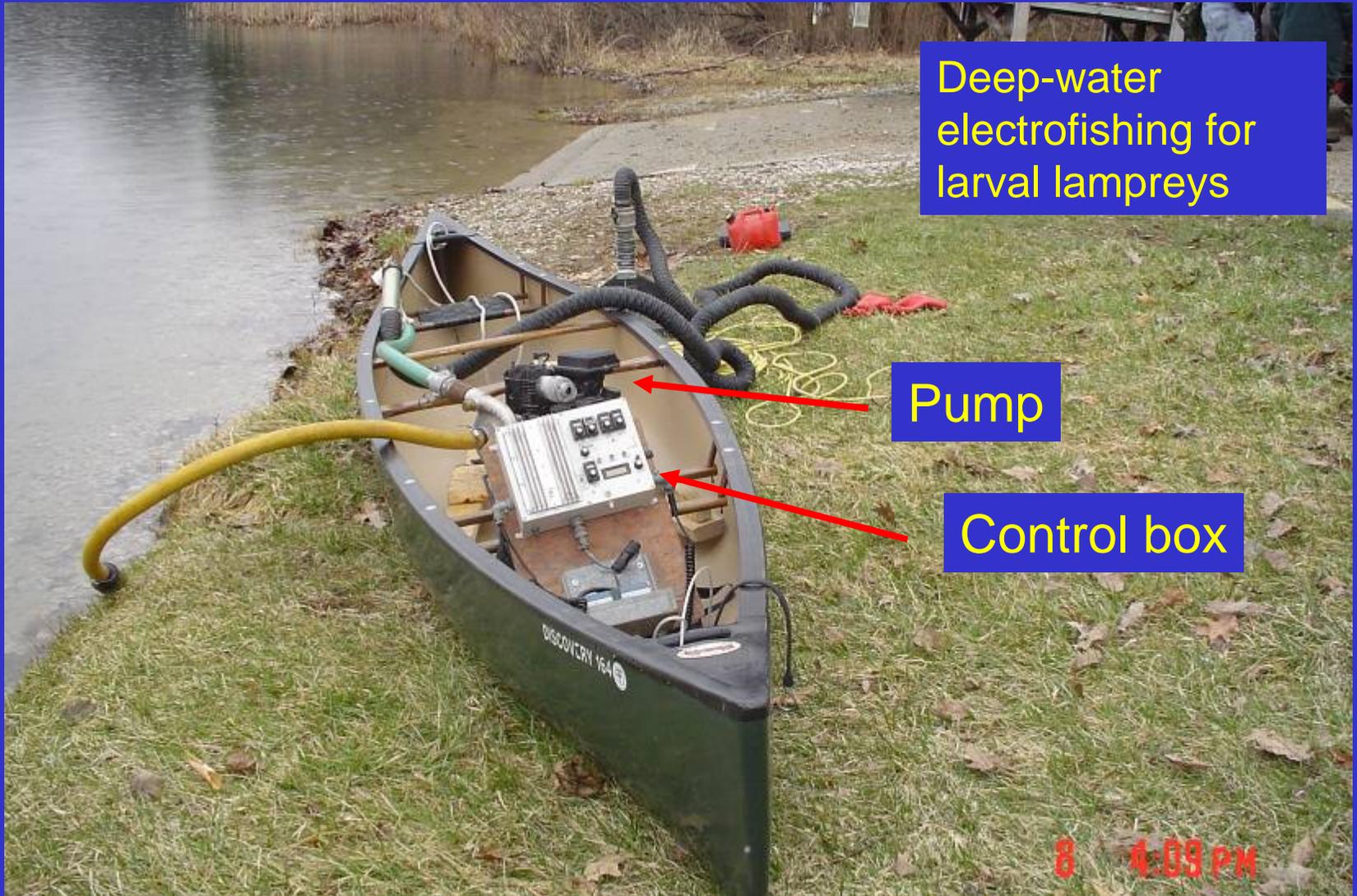
Other electrode designs...

Deep-water
electrofishing for
larval lampreys

Pump

Control box

8 4:09 PM



Other electrode designs...



Deep-water
electrofishing for
larval lampreys

The results

Cathode or Rear Electrodes



Metal boat hull often the cathode; large metal surface allocates more power to the anodes



Dropper cathodes
on metal hull
(former design)

Dropper cathodes (needed if hull non-conductive)



Cathode or Rear Electrodes

- “Isolation cathode”:
directly wired
- Cathode skirt:
in electrical continuity with
the metal hull



Railings



Can accommodate a single boom arrangement

Railings

Padding; not needed for electrical purposes



Railings

Collapsible for fitting
into airplanes



Lights

120 V circuit



Protective covering



Additional lights on bottom of railing



Underwater Lighting



Travel position

Operating position



Probably not a good idea...



Livewells



Faraday principle
protects fish from shock





Headphone communicators- nice!

Rafts



Anode spheres

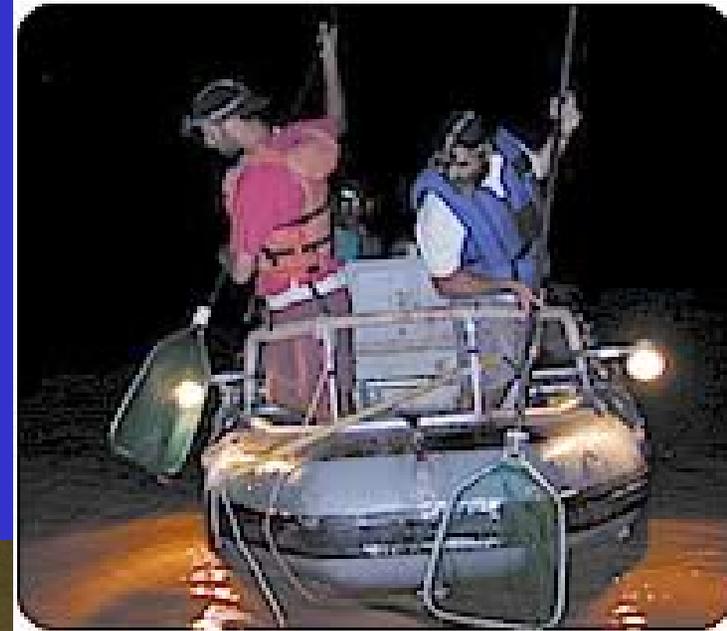
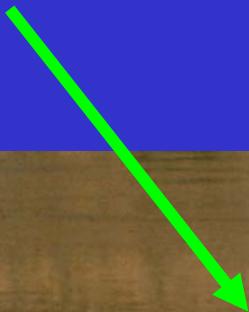
Dropper cathodes

Rafts



Rafts

Big river, whitewater capable
(Colorado R., USA)



Anode & cathode
spheres are
exchanged very
hour to maintain
clean surface

Backpack Electrofishers



Backpack Electrofishers

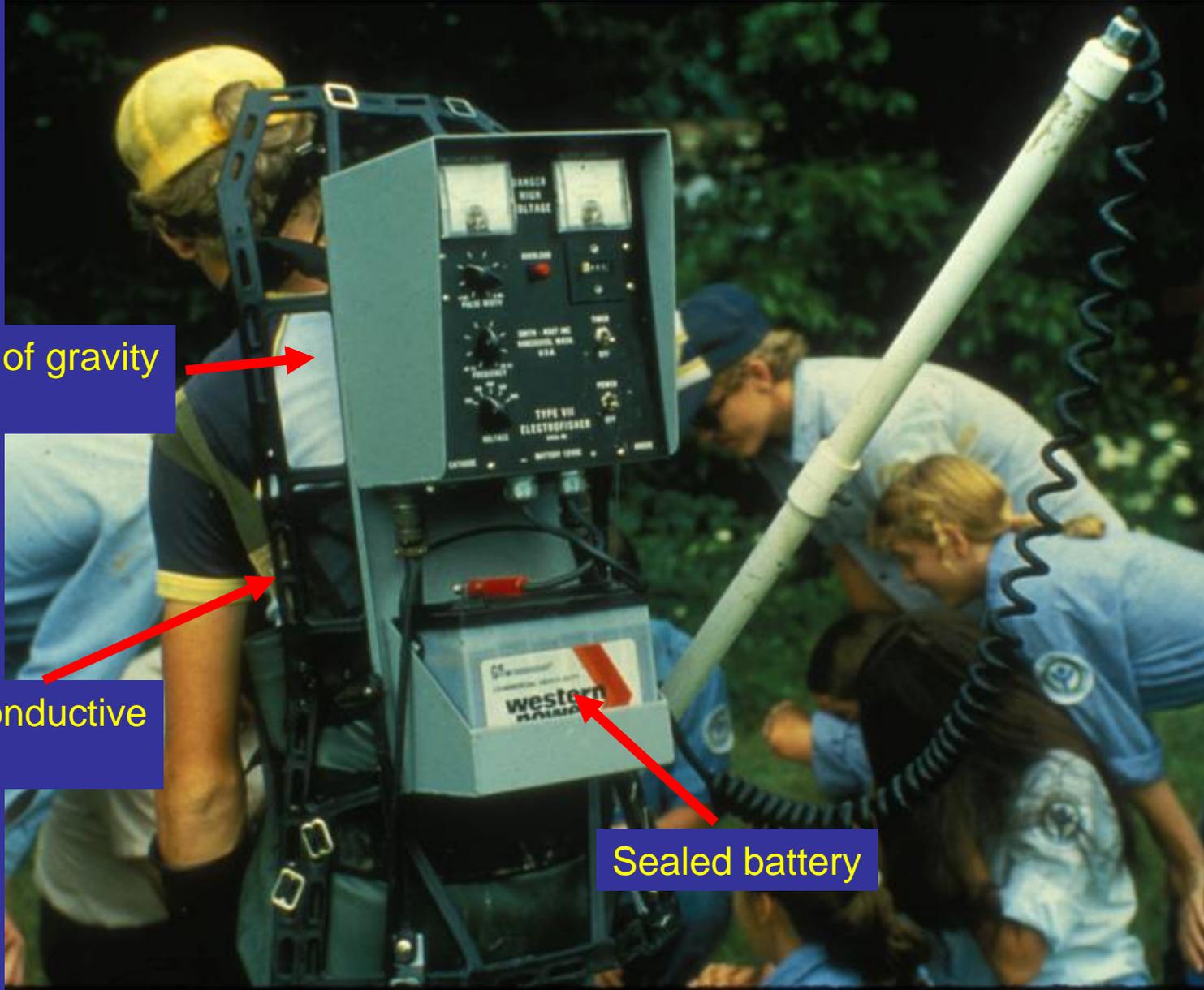


12 V battery

Metal frame
backpack



Backpack Electrofishers



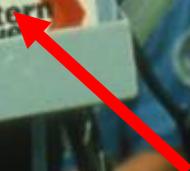
Center of gravity
is high



Non-conductive
frame



Sealed battery



Some Recent Backpack Models



Hans-Grassl



Smith-Root
LR-24



ETS
ABP-3

Safety Features

Smith-Root
LR-24

(other than circuit breakers, thermal sensors, fusible links)

Emergency shutdown switch

Internal tilt switch (forward 55-, side 45-, backward 35-degrees)



Audio alarm
1-4 beeps/sec
depending upon
average power
output

Flashing red light

Lower right of frame

Splash cover must
be latched

Immersion sensor



Quick-
release
harness

Internal
anode
out-of-
water
switch

Anode switch

Backpack Controls

Table on back of pulsator that provides alpha-numeric code for selection of waveform type (DC, PDC, Gated Burst), frequency, and pulse width

Letter = frequency
Number = pulse width

Standard Pulses							
	1	2	3	4	5	6	
A	1Hz	2ms	3ms	4ms	6ms	7ms	8ms
B	5Hz	1ms	2ms	3ms	4ms	6ms	8ms
C	10Hz	500µs	1ms	2ms	4ms	6ms	8ms
D	15Hz	500µs	1ms	2ms	4ms	6ms	8ms
E	20Hz	500µs	1ms	2ms	4ms	6ms	8ms
F	30Hz	500µs	1ms	2ms	4ms	6ms	8ms
G	40Hz	500µs	1ms	2ms	4ms	6ms	8ms
H	50Hz	500µs	1ms	2ms	4ms	6ms	8ms
I	60Hz	500µs	1ms	2ms	4ms	6ms	8ms
J	70Hz	500µs	1ms	2ms	4ms	6ms	8ms
K	80Hz	500µs	1ms	2ms	4ms	6ms	8ms
L	90Hz	500µs	1ms	2ms	4ms	6ms	8ms
M	100Hz	100µs	500µs	1ms	2ms	4ms	6ms
N	110Hz	100µs	500µs	1ms	2ms	4ms	6ms
O	120Hz	100µs	500µs	1ms	2ms	3ms	4ms

Wide to Narrow Varying Width						
	7	8	9	10	11	
		2sec	4sec	6sec	8sec	10sec
A	8-0.4ms	15Hz	15Hz	15Hz	15Hz	15Hz
B	6-0.3ms	15Hz	15Hz	15Hz	15Hz	15Hz
C	4-0.2ms	15Hz	15Hz	15Hz	15Hz	15Hz
D	8-0.4ms	30Hz	30Hz	30Hz	30Hz	30Hz
E	6-0.3ms	30Hz	30Hz	30Hz	30Hz	30Hz
F	4-0.2ms	30Hz	30Hz	30Hz	30Hz	30Hz
G	8-0.4ms	45Hz	45Hz	45Hz	45Hz	45Hz
H	6-0.3ms	45Hz	45Hz	45Hz	45Hz	45Hz
I	4-0.2ms	45Hz	45Hz	45Hz	45Hz	45Hz
J	8-0.4ms	60Hz	60Hz	60Hz	60Hz	60Hz
K	6-0.3ms	60Hz	60Hz	60Hz	60Hz	60Hz
L	4-0.2ms	60Hz	60Hz	60Hz	60Hz	60Hz
M	8-0.4ms	80Hz	80Hz	80Hz	80Hz	80Hz
N	6-0.3ms	80Hz	80Hz	80Hz	80Hz	80Hz
O	4-0.2ms	80Hz	80Hz	80Hz	80Hz	80Hz

High to Low Varying Frequency						
	12	13	14	15	16	
		2sec	4sec	6sec	8sec	10sec
A	80-8 Hz	1ms	1ms	1ms	1ms	1ms
B	60-6 Hz	1ms	1ms	1ms	1ms	1ms
C	40-4 Hz	1ms	1ms	1ms	1ms	1ms
D	80-8 Hz	2ms	2ms	2ms	2ms	2ms
E	60-6 Hz	2ms	2ms	2ms	2ms	2ms
F	40-4 Hz	2ms	2ms	2ms	2ms	2ms
G	80-8 Hz	4ms	4ms	4ms	4ms	4ms
H	60-6 Hz	4ms	4ms	4ms	4ms	4ms
I	40-4 Hz	4ms	4ms	4ms	4ms	4ms
J	80-8 Hz	6ms	6ms	6ms	6ms	6ms
K	60-6 Hz	6ms	6ms	6ms	6ms	6ms
L	40-4 Hz	6ms	6ms	6ms	6ms	6ms
M	80-8 Hz	8ms	8ms	8ms	8ms	8ms
N	60-6 Hz	8ms	8ms	8ms	8ms	8ms
O	40-4 Hz	8ms	8ms	8ms	8ms	8ms

Settings available on previous electrofishers are in bold.

All Gated Bursts show the number of pulses. 900µs wide, 900µs between.

Gated Bursts 15Hz								
	1	2	3	4	5	6	7	8
P	2	3	4	5	6	7	8	9

All varying waveforms start at their beginning values, sweep to their ending values in the set amount of time, and then remain at the end value until the output is switched off and then on again.

Gated Bursts 30Hz															DC
	9	10	11	12	13	14	15								16
P	2	3	4	5	6	7	8								DC

MODEL
12-B POW
ELECTROFISHER

OUTPUT AMPS
(Average)

SERIAL No. 173447

SMITH-ROOT, INC.
VANCOUVER, WA. USA
U.S. Patent No. 5,327,854.



INSTRUCTIONS

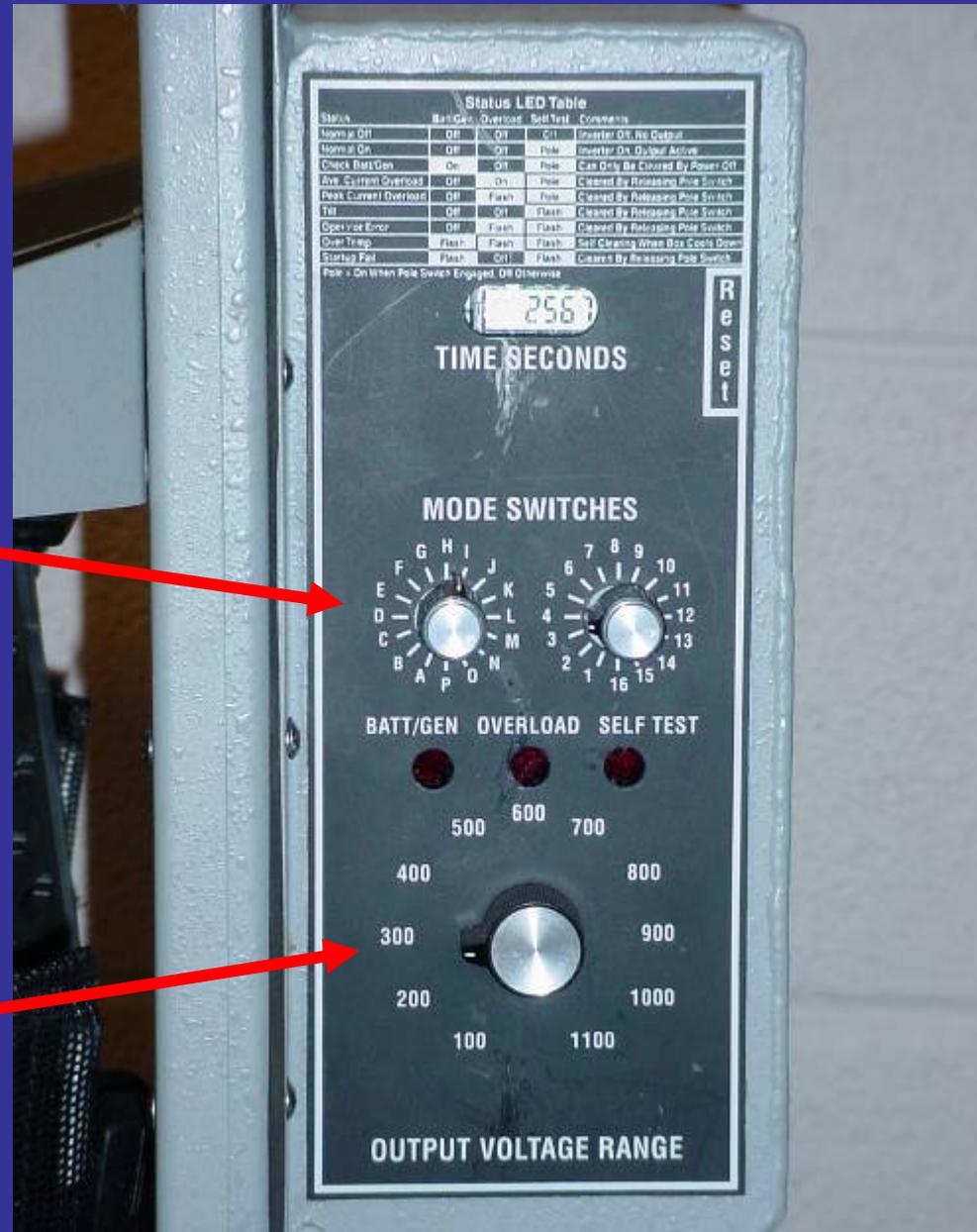
1. Set the MODE SWITCHES to D and 4, (15Hz 4ms) and the OUTPUT VOLTAGE RANGE switch to 100.
2. With the electrodes in the water, and all safety precautions taken, depress the ANODE POLE switch. The audio tone and self-test indicator should both come

- WARNING:** Do not change Voltage or Mode settings while Anode Pole switch is pressed.
4. Try different Mode switch settings to see if you can reduce power drain without losing effectiveness. Narrower pulses and lower frequencies use less power

Backpack Controls

Mode switches set a H, 3
(= 50 Hz, 2 ms pulse width)

Voltage at 100 V steps (coarse)



Backpack Controls- better



Peak reading metering

5 V increments

1 Hz increments

1 % increments

Generator-Powered Backpacks

“Houston, we have a launch”



Generator-Powered Backpacks (better)



Power capacity = 350 W average



MODEL 15-B POW ELECTROFISHER
SMITH-ROOT INC. VANCOUVER, WA, USA

INSTRUCTIONS

1. Set the MODE SWITCHES to 7 amp h, and the OUTPUT VOLTAGE RANGE switch to 100.
2. With the electrodes in the water, and all safety precautions taken, depress the ANODE POLE switch. The audio tone and red light indicator should both come on.
3. Try increasing the voltage setting until satisfactory results are obtained.
4. Try different Mode switch settings to see if you can reduce power drain without losing effectiveness. However, please and never trespassers use this device. Fish under docks and higher frequencies. Larger fish are more sensitive than smaller fish, and small fish power is through the same electrode.

WARNINGS: Do not change Voltage or Mode settings while Anode Pole switch is pressed!

MODE	100	50	25	10	5	2.5	1.25	0.625	0.3125	0.15625	0.078125	0.0390625	0.01953125	0.009765625	0.0048828125	0.00244140625	0.001220703125	0.0006103515625	0.00030517578125	0.000152587890625	0.0000762939453125	0.00003814697265625	0.000019073486328125
VOLTS	100	50	25	10	5	2.5	1.25	0.625	0.3125	0.15625	0.078125	0.0390625	0.01953125	0.009765625	0.0048828125	0.00244140625	0.001220703125	0.0006103515625	0.00030517578125	0.000152587890625	0.0000762939453125	0.00003814697265625	0.000019073486328125
AMPS	7	3.5	1.75	0.875	0.4375	0.21875	0.109375	0.0546875	0.02734375	0.013671875	0.0068359375	0.00341796875	0.001708984375	0.0008544921875	0.00042724609375	0.000213623046875	0.0001068115234375	0.00005340576171875	0.000026702880859375	0.0000133514404296875	0.00000667572021484375	0.000003337860107421875	0.0000016689300537109375
WATTS	700	350	175	87.5	43.75	21.875	10.9375	5.46875	2.734375	1.3671875	0.68359375	0.341796875	0.1708984375	0.08544921875	0.042724609375	0.0213623046875	0.01068115234375	0.005340576171875	0.0026702880859375	0.00133514404296875	0.000667572021484375	0.0003337860107421875	0.00016689300537109375

IN CASE OF DIFFICULTY

1. Check all connections to the generator, as well as the Anode and Cathode connections.
2. While the Anode Pole switch is pressed, check the "Red" light. If it is flashing, you have that the unit is not working as safety times. Release the Anode Pole switch and return the unit to an upright position to clear the problem.
3. While the Anode Pole switch is pressed, check the "Green" light. If it is on, release the Anode Pole switch and reduce the voltage setting, or use a lower power setting on the Mode switches.

CATHODE **ANODE**

WARNING:
Current To Handle EX-350 Only.

Battery- or Generator-Powered?

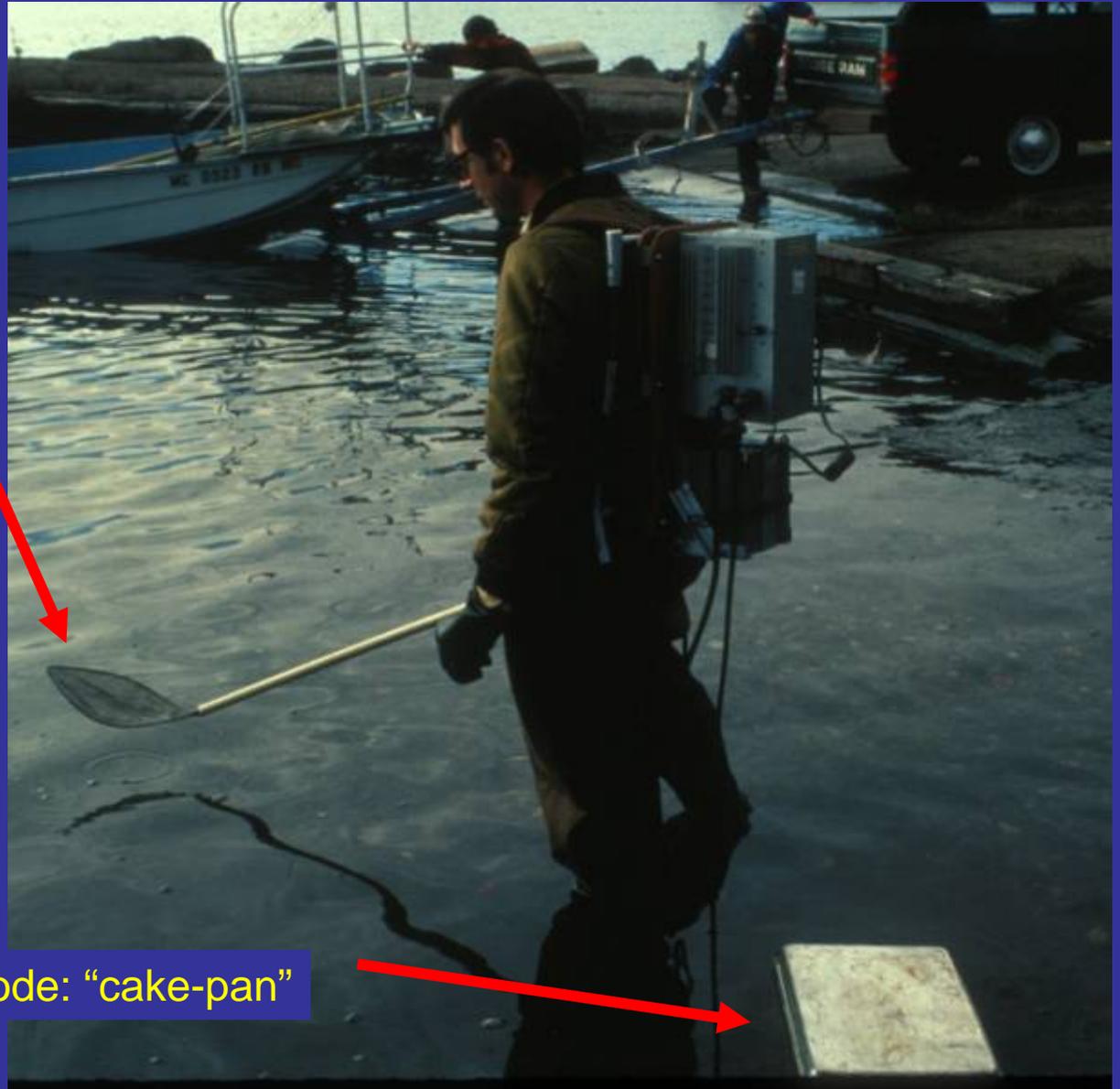
- In the U.S., **generator** and **battery** backpacks can have similar average power output (**350 W** vs. **400 W**)
- **Battery-powered**: quiet
- **Generator-powered**: in high conductivities, due to the amperage draw, may be easier to carry-in additional gasoline versus extra batteries; also, can deliver AC (often most effective in extreme conductivities)
- Larger capacity 2-cycle engines in U.S. now not legal to manufacture (need to go to 4-stroke engine)

Electrodes

Anode: diamond



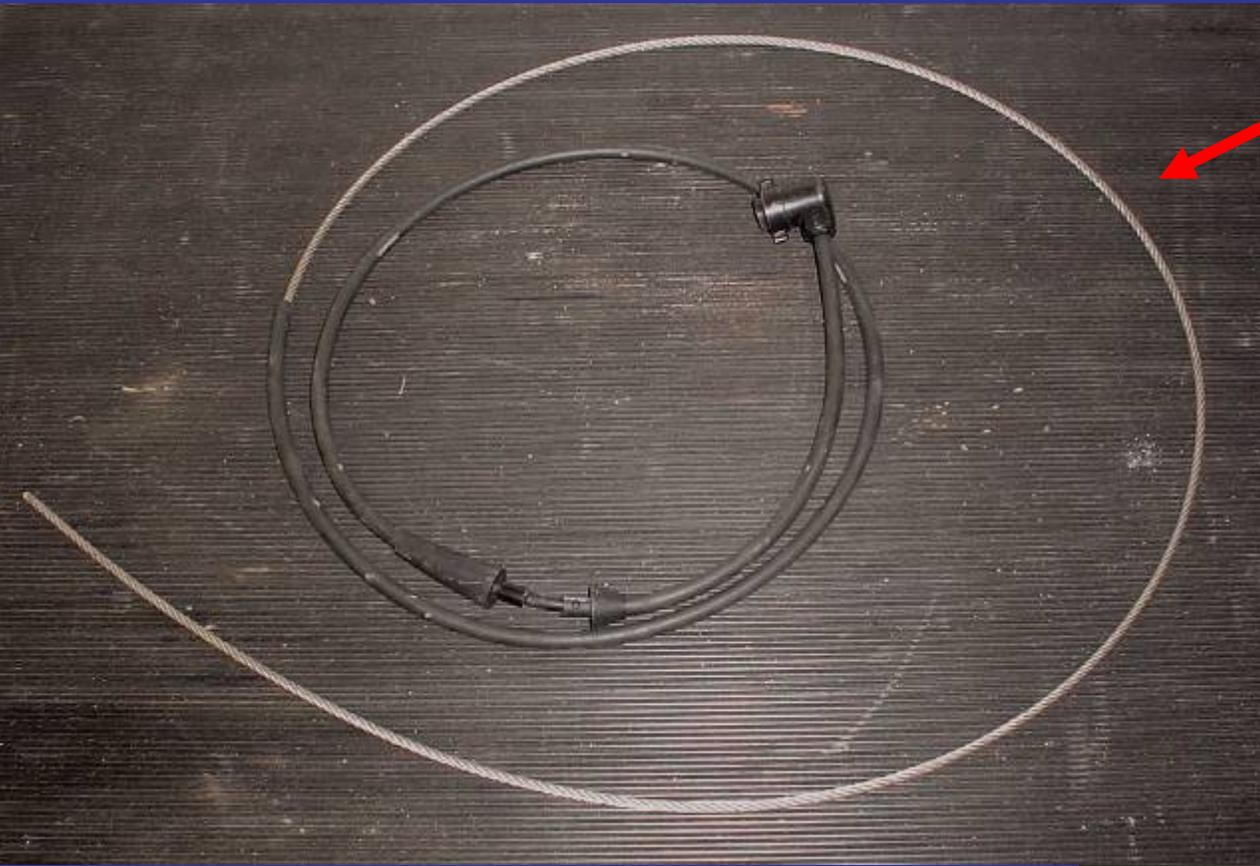
Cathode: "cake-pan"



Electrodes- Anodes



Electrodes- Cathodes



“Rattail”, note long length;
runs along bottom



“Beavertail”, floats

Dual-channel Application



ETS ABP-2 (also LR-24)

Channel 1: 1 – 10 pps

Channel 2: 10 – 1,000 pps

Sea Lamprey Larvae Sampling



Power off



Low frequency

Backpack Protocols

Note: 2 hand-held electrodes

Note: no gloves



A “pass” or random walk



Area sampling along transects

Two hand-held electrodes is a common configuration when using AC

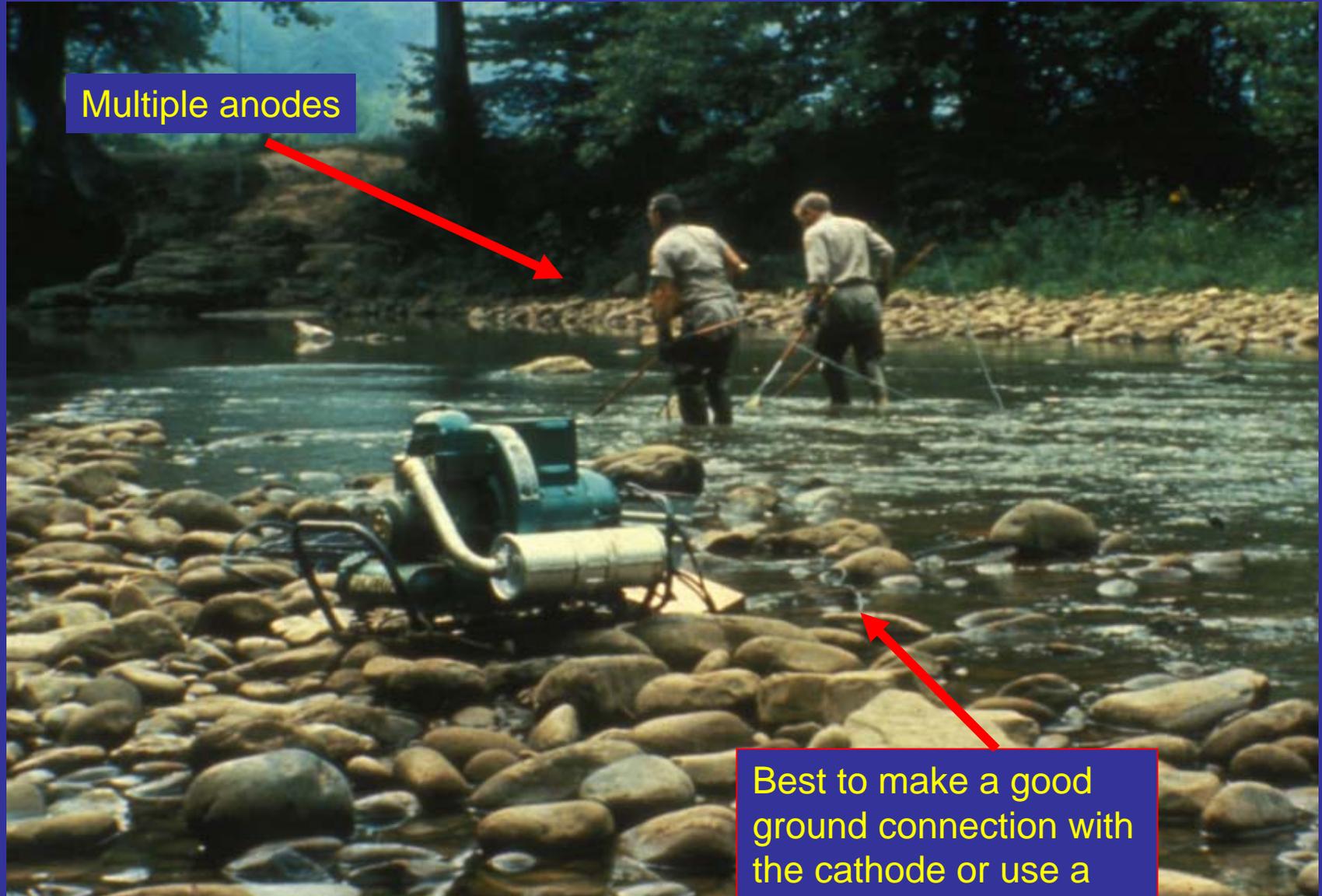
Backpack Protocols

Electrofishing removal
of an exotic species
Green sunfish, in
Arizona



Portability all
to many hard

Shore-based Electrofishing



Multiple anodes

Best to make a good ground connection with the cathode or use a large plate

Safety note: nobody on generator

Tow Barge Electrofishing



If you need more power or sampling over a long distance,
then go with a tow barge system

Tow Barge Electrofishing



Junction box for anodes and safety circuits



Cathode plate on bottom

Tow Barge Electrofishing



Tow Barge Electrofishing



Catarcraft (Tow Barge)



10/11/2000 12:02pm

Catarcraft

Dorsal view



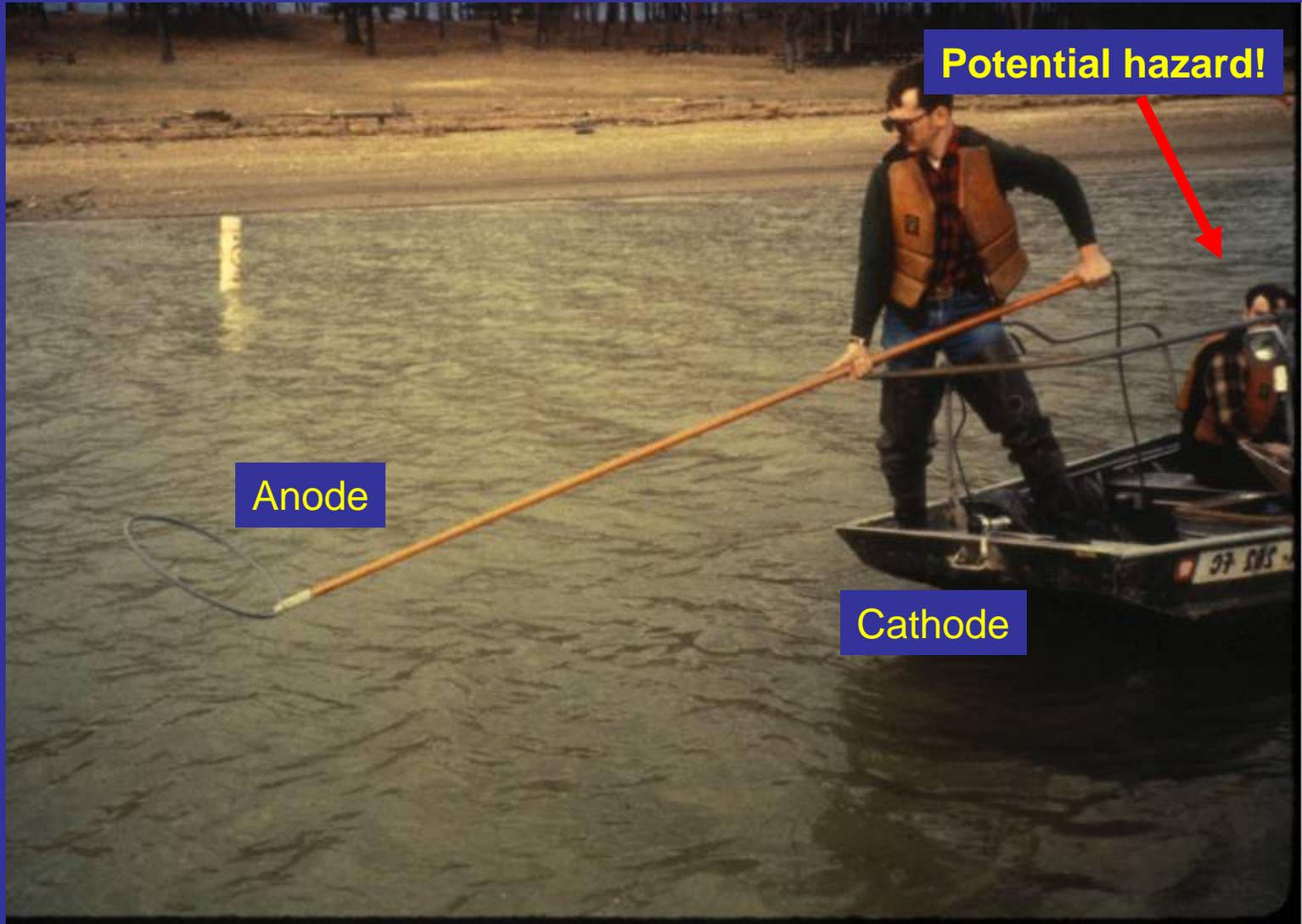
Cataract

Ventral view

Dropper cathodes



Moveable Anodes



Moveable Anodes

Using DC to capture trout by taxis



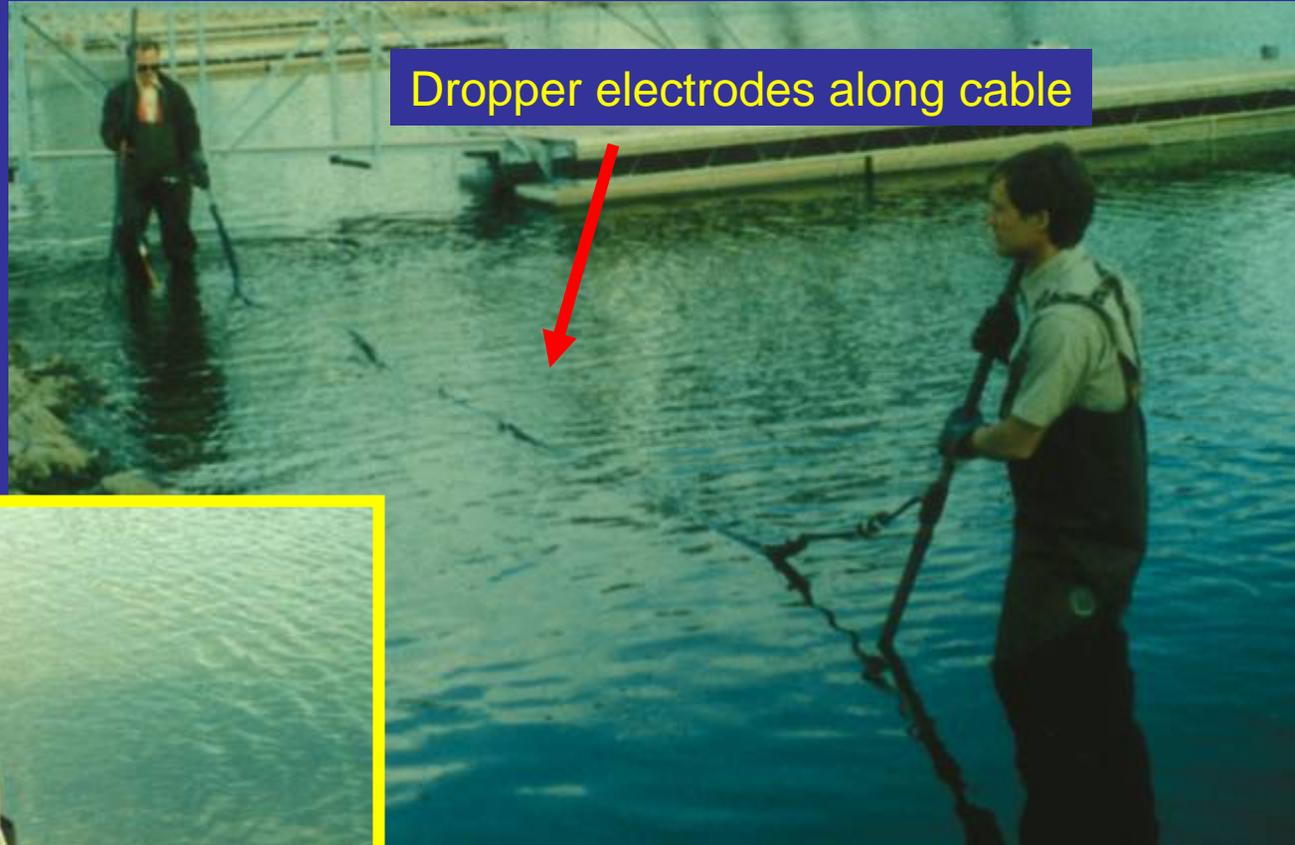
Cathode isolated on bottom of hull

Note shape of anode



Electric Seine

Used in conjunction with block nets in streams; originally AC used



Dropper electrodes along cable



Each braille (pole) is an electrode

Parallel Wires



Pre-positioned Area Shockers (1)



Power on

Pre-positioned Area Shockers (2)



Kicking through the quadrat



Pulling up the seine



Examining the catch

Diver Operated Anode (DOA)

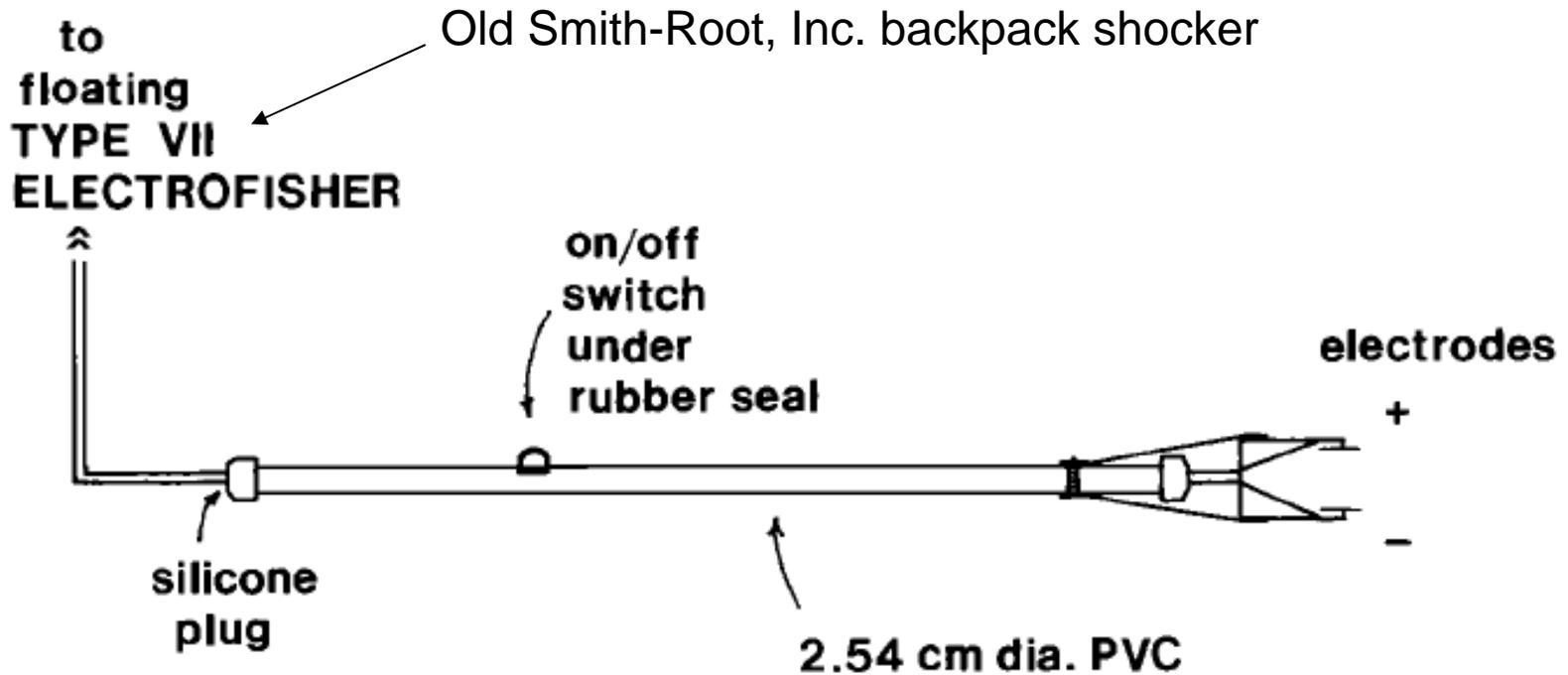


FIGURE 1.—Details of the underwater probe used with a diver-operated electrofishing device.

Accessory Equipment



Measure environmental conditions



Multimeter for trouble-shooting

Voltage-gradient probe/meter for field mapping



Equipment Checks

(Page 11-14)

- **Calibration of meters or dials**
 - voltage (peak, average, RMS)
 - current (peak, average, RMS)
 - duty cycle, pulse width, pulse frequency
 - other waveform characteristics (spikes, ripple, negative excursions)
- **Multimeters (especially volt-ohm)**
 - read AC and DC; might give avg. PDC

Equipment Checks

(Page 11-16)

- **Trouble-shoot wiring (couplers, electrodes, pulsator)**
 - **Example: possible circuit break in the hand-held electrode**
 - switch
 - main circuit
 - anode surface



Set multimeter to resistance

Equipment Checks

(Page 11-17)

- **Do not recommend getting into the pulsators due to shock potential from the capacitors unless directed by manufacturer**
 - e.g., ETS units have replaceable circuit boards