

Underwater Wet Welding Products Operating Instructions

Product Warnings

WARNING

Please read and understand these operating instructions thoroughly and follow the procedures contained herein before attempting to use Broco Underwater Wet Welding products. Failure to do so can result in death, serious injury, property damage and poor welding performance.

All personnel and supervisors engaged in underwater welding operations must be familiar with these instructions, the correct use of underwater welding equipment, and accepted safe commercial diving practices. Employers must provide operator training before allowing their personnel to begin using Broco Underwater Wet Welding products.

CAUTION

Underwater cutting & welding equipment is potentially dangerous to operate and must be used in strict accordance with the instructions provided. Underwater cutting & welding should only be performed by trained professional commercial divers and according to industry accepted safe diving practices.

WARNING

Never modify this equipment in any manner or use it in any way not specified in these instructions.

Always adhere to ANSI/ASC Z49.1:2012 "Safety in Welding and Cutting" standards, or similar locally prevailing standards when using this equipment.

Always follow industry accepted safe diving practices as found in the Association of Diving Contractors "Consensus Standards for Commercial Diving."

Always use surface supplied breathing air and hard-wire communications. Never conduct underwater cutting or welding while using self-contained breathing apparatus (SCUBA).

Never conduct underwater cutting or welding operations without a topside tender to monitor the diving operation and a standby diver for emergency response.

Never use life support equipment that has been altered or modified from the manufacturer's original specifications.

Never use any equipment that is unsafe or appears to be unsafe. Always replace damaged or worn components to reduce the risk of injury.

Always be aware of material that may fall and position yourself and your life support equipment accordingly.

Never use alternating current (AC) for any underwater operation.

Always ensure only direct current (DC) from a known power source goes into the water.

Always have electrical power to the welding electrode holder routed through a safety knife switch that must be located within reach of the topside tender.

Never use this equipment without proper eye protection. Always use an approved welding lens with a shade appropriate for the conditions of the water.

WARNING

Failure to heed these safety precautions may result in severe property damage, bodily injury or death.

Protect yourself and others. Explosive gas mixtures may be generated. Arc rays can injure eyes and exposed skin. Electric shock can kill.

Safety Precautions

WELDING POWER SUPPLIES

Welding power supply equipment should be operated according to the procedures and precautions specified by the welding power supply manufacturer in addition to the safety precautions listed below.

1. Always use a welding power supply with DC output only. Never use a welding power supply that can be switched to AC output when underwater welding. AC current in the water can kill a diver.
2. Make sure that the welding machine frame and its supporting structure are well grounded before starting operations.
3. Make certain that neither terminal of the welding machine is short-circuited to the machine frame before starting operations.
4. Make sure that all electrical connections are securely made before starting operations.
5. Always wear rubber or rubberized-canvas electrical insulating gloves that are in good condition when handling energized holders, cables or machines.

ELECTRODE HOLDERS

1. Use only electrode holders specifically designed for underwater use. They must be rated for the maximum current required for the electrodes used. Broco's BR-20 and BR-21 electrode holders are recommended.
2. Make sure that all current-carrying parts of the holder are fully insulated. This insulation must safely protect the diver against the maximum current encountered.
3. Inspect the electrode holder for worn or damaged parts and insulating material before starting operations. Damaged parts may endanger life and must be replaced immediately before further use.
4. Change or tighten the electrode only when there is no current flowing in the welding circuit.
5. Never hold the electrode holder so that it points toward you.
6. Special care should be taken to avoid touching the metal on the diving gear with the electrode, or with uninsulated parts of the electrode holder, or with the work.

POWER CABLES AND CONNECTORS

1. All parts of surface cables and submerged cables must be fully insulated.
2. Inspect all cables and connections for damaged

insulation before starting operations. The cables must be replaced or the defects repaired before starting operations.

3. Cables must have the capacity to handle the maximum current requirements for the work. Cable connectors must have a capacity at least equal to that of the cable.
4. All connections must be made tight and thoroughly insulated. All underwater connections should be given a final tight wrapping of rubber tape to prevent current loss.
5. Make sure all cables are free of splices for at least the last ten feet from the connections to the electrode holder and the ground.
6. Always connect the ground directly to the material being welded as close to the point of welding as possible. Never use an in-water floating ground.
7. Always face the ground connection while welding. Never position the diver between the ground and the welding electrode.
8. Do not allow the power supply power cable to get entangled with welding cables. Keep the two separated.

SAFETY SWITCH

1. The safety switch must be mounted vertically and with the handle in the upper-most position during welding. If the switch handle should accidentally fall, the circuit is broken (no current).
2. Always ensure the safety knife switch is in the open position (no current) before starting the welding power source.
3. Always keep current off at all times except when welding.
4. Do not operate the safety knife switch in a combustible atmosphere.
5. The safety switch should be within easy reach of the tender at all times.

GENERAL SAFETY PRECAUTIONS

When welding or cutting into a closed or blind compartment, keep in mind that explosive gases can develop. These gases must be vented to remove the possibility of an explosion.

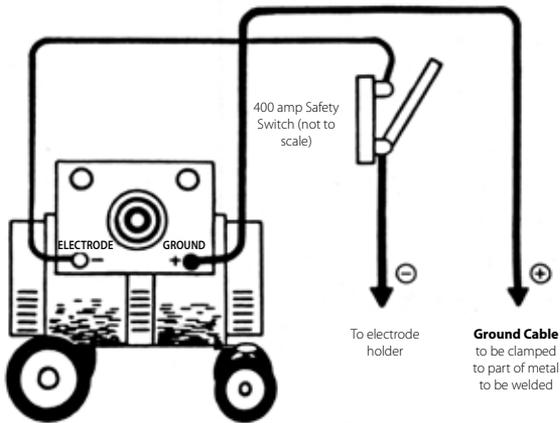
Oxygen and hydrogen are generated from the electrode flux and from the water. These gases will explode if trapped and ignited. They can collect in pipelines, manifolds, compartments and structures such as "H" beams. It is important that compartments are vented because sparks from cutting or welding contained in bubbles can rise several feet and cause trapped gases to explode.

Operating Instructions

NOTE: Broco SoftTouch and Broco EasyTouch wet welding electrodes, are to be welded using DC current, straight polarity (electrode negative).

EQUIPMENT LIST FOR UNDERWATER WELDING

1. A welding machine that produces only direct current
2. A knife switch rated at 400 amperes, 250 volts
3. Welding cables size 2/0 or as appropriate for the amperage and circuit length
4. Cable connectors
5. Electrode holder
6. Electrodes
7. Grounding clamp
8. Weighted wire brush
9. Chipping hammer
10. Scraper
11. Tong meter for measuring amperage (optional)
12. Personal protective equipment to include gloves, protective lenses, appropriate diver's dress



DC Welding Generator

UNDERWATER WELDING EQUIPMENT ARRANGEMENT FOR
STRAIGHT-POLARITY DIRECT-CURRENT OPERATION

METHOD FOR VERIFYING STRAIGHT POLARITY

1. With the welding machine switch in the off position, connect the safety knife switch jumper cable to the negative terminal of the welding machine, the electrode holder power cable to the safety knife switch, and the ground cable to the positive terminal of the welding power source.
2. Clamp an electrode to the ground cable and insert another electrode into the electrode holder.
3. Place the ends of the two electrodes in a container of salt water, keeping the tips about two inches apart.
4. Be sure that the operator is properly insulated, turn the welding power on and close the safety knife switch. Bubbles will flow from the negative (-) pole to the positive (+) pole. A very little amount of bubbles will be generated from the positive (+) electrode.
5. The polarity of the system is set correctly if the greatest amount of bubbles rise from the electrode secured in the welding electrode holder. If more bubbles are coming from the electrode in the ground clamp the cable connections at the welding machine terminals must be reversed.

Recommended current settings are listed in Table 1. The amperage values are averages and sample welds should be made and inspected to adjust the settings for specific conditions.

CATALOG NUMBERS	DIAMETER		WET WELD APPLICATION	CURRENT SETTINGS (AMPS)			
	INCH	MM		FLAT	HORIZONTAL	VERTICAL	OVERHEAD
UW/CS-1 & UW/EZ-1	1/8	3.20	MILD STEEL	160-170	150-170	140-165	140-160
UW/CS-2 & UW/EZ-2	5/32	3.97	MILD STEEL	180-210	170-210	170-210	170-190
UW/CS-3 & UW/EZ-3	3/16	4.76	MILD STEEL	250-280	240-280	240-280	235-275
UW/SS-1	1/8	3.20	STAINLESS STEEL	135-150	130-150	125-145	125-145
UW/SS-2	5/32	3.97	STAINLESS STEEL	150-200	140-200	140-190	140-180
UW/SS-3	3/16	4.76	STAINLESS STEEL	175-250	165-250	165-240	165-235

EQUIPMENT ASSEMBLY

1. With the welding machine switch in the off position, connect the safety knife switch jumper cable to the negative terminal of the welding machine, the electrode holder power cable to the safety knife switch, and the ground cable to the positive terminal of the welding power source.
2. Set the welding machine to straight polarity. Verify correct polarity: negative (-) to holder; positive (+) to ground.
3. Determine the amperage setting and check it with a tong meter or an ammeter.
4. Completely insulate all cable connections.
5. Make sure that cables and connections are in good operating condition, and that all cable within ten feet of holder is free of splices.
6. Secure ground clamp to work.

Welding Techniques

Two techniques are in use: the “self-consuming” or “drag” technique and the “manipulative” technique. With the self-consuming technique, the electrode is dragged across the work with a slight amount of pressure applied to the contact surface. In the manipulative technique, the arc is held as it would be on the surface, and little or no pressure is applied to the electrode, which is continually woven from side to side by the diver welder. This technique requires much more skill than the self-consuming method.

SELF-CONSUMING TECHNIQUE

Using the self-consuming method, the weld metal is deposited in a series of beads by dragging the electrode, which is melting, against the work. Typically fillet weld beads result in welds of approximately the same leg size as the diameter of the electrode used. For example, a single pass with a 5/32” electrode produces a fillet weld having 5/32” legs.

FILLET WELDING IN THE HORIZONTAL POSITION

1. Make sure the safety switch is open (off).
2. Thoroughly clean the surfaces to be welded.

3. Set the welding machine to deliver the proper current according to Table 1. Check the delivered current with a tong meter or fixed meter.
4. Place the striking end of the electrode against the work so the electrode is at an angle of about 30 degrees to the line of weld. This angle may vary from 15 degrees to 45 degrees, depending on electrode type and individual's preference.
5. At the diver's call for “switch on” the safety knife switch is closed, energizing the circuit. Tap the end of the electrode against the work until the arc forms, making sure the electrode is at the point where the weld is to begin. In some cases it may be necessary to scrape the tip before inserting the electrode in the holder. Exert enough pressure against the work to allow the electrode to consume itself. Do not hold an arc as in topside welding. Keep the electrode in contact with the work, maintaining the original angles between the work and the electrode. Run straight beads – do not weave. About eight inches of weld is deposited for every fourteen inch electrode consumed.

6. When the electrode is consumed, the diver calls for "switch off". The tender must then open the safety switch and keep it open while the electrode is being changed. Keep the electrode in the welding position after completing the weld until verification of "switch off" is received from the tender.
7. Before welding with a new electrode, clean the end of the old deposit. If a second pass is to be made on top of the initial deposit, the previously deposited weld must be cleaned.
8. Do not call for "switch on" until the new electrode is in position and against the work and ready for welding.

FILLET WELDING IN THE VERTICAL POSITION

Follow the same steps outlined above for horizontal fillet welding. The weld must start at the top and move down so that the bubbles generated will not interfere with the diver's vision as he follows the line of the weld. In the vertical position it may be necessary to vary the angle of the electrode to the work and adjust the current, to obtain the optimum weld.

FILLET WELDING IN THE OVERHEAD POSITION

Use the same procedures as described in the previous paragraph. The range of current is relatively narrow for the overhead position. Before making an actual weld, the diver should make several practice passes under actual working conditions. These welds should be brought topside and examined to determine whether the current setting is correct and the diver's technique is good. Dripping beads indicate that:

- (1) The current was too high
- (2) Insufficient pressure was applied
- (3) Both conditions were present

MANIPULATIVE TECHNIQUE

This method requires the welder to maintain a constant arc under water while maneuvering the electrode. It can be used to apply straight beads as well as beads with a slight to significant weave. The weave must be very tight to avoid slag entrapment.

To use this technique, the proper amperage and electrode type should be determined by testing a sample plate under wet working conditions. The correct position of the electrode and speed of travel should also be determined before beginning the actual weld.

The amperage settings will be the same as those described for the self-consuming technique, though the adjustment is over a narrower range. Proper current settings can be identified by looking for the same "puddle" characteristics as in topside welding.

WELDING POSITIONS

The procedures described above for horizontal, vertical and overhead welding using the self-consuming technique are applicable to the manipulative technique. Working conditions such as visibility, water depth, joint fit-up, and magnetism buildup in the base metal will affect the electrode angle, manipulation of the electrode and maintenance of the arc.

The manipulative method has some advantages over the self-consuming method. With the manipulative technique, vertical welding can be performed upwards. If the joint fit-up is poor and the opening is more than 1/8 inch a vertical up progression can be used with a weave to fill the gap and obtain full root penetration. Vertical up welding is also used to reduce the magnetic fields which tend to build up at the bottom of joints after a number of vertical down passes. To reduce the buildup, the lower three inches of the joint are deposited using vertical up welding, then welding the remainder of the joint by vertical down welding to tie in with the initial three inches.

In multi-pass welding, current settings must be changed as passes are added. Correct settings are obtained by running test beads prior to the actual weld.

Please call the Broco Sales and Customer Support staff at (909) 483-3222 with any questions.

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