Annex E: Swordfish™ Non Exothermic Cutting Electrode User Manual

Registered Trade Mark of Speciality Welds

SWORDFISH™ NON EXOTHERMIC CUTTING ELECTRODE

USER MANUAL

Swordfish™ User Manual -Version-02

USER MANUAL CONTENTS

LIST OF ILLUSTRATIONS

Chapter 1 INTRODUCTION

The function of this instruction manual is to provide information only. It is subject to alteration without notice and does not represent a commitment on the part of Shell and Speciality Welds or their agents.

The success and speed of an underwater cutting operation depends upon the conditions under which the diver must work. The underwater environment imposes numerous limitations and restrictions on the operator and the equipment being used. Diving equipment, currents, lack of visibility and poor footing are all factors that will make underwater cutting challenging.

Only competent persons should use the procedures and techniques contained within this manual. Those wishing to use Swordfish™ without the necessary skills, training and experience do so at their own risk.

Prior to delivery your Swordfish™ Cutting Equipment was in a dry and serviceable condition.

Chapter 2 GENERAL DESCRIPTION

Swordfish™ is a non-exothermic arc cutting electrode designed for the cutting of metallic objects, surface and subsurface, where gas entrapment from a conventional exothermic cutting process may present a safety issue. It is not designed to replace normal open water cutting processes.

2.1 SPECIFICATIONS

Electrode Length	46 cm
Electrode Diameter	4.0mm / 5.0mm
Number in Box	4.0mm 60 electrodes (By weight) 5.0mm 41 electrodes (By weight)
Power Range	4.0mm = 200-350 Amps (270 – 300 Amps theoretical optimum) 5.0mm = 290-390 Amps (330 – 360 Amps theoretical optimum)
Composition	A high iron oxide flux coating

2.2 USES

- Mild Steel Plate & Pipe (Including Concrete Lined)
- Forged Steel
- Cast Iron
- Aluminium
- Phosphorous Bronze
- Stainless Steel

2.3 LIMITATIONS

- Swordfish™ requires a welding plant with an output of between 200 – 400 amps.
- Cutting can be hampered in poor visibility.
- Poor footing/stage can hinder good cutting technique.
- Swordfish™ cutting electrodes are currently only available from the manufacturer.

DEPTH LIMITATIONS (WATER)

- Cable lengths – Providing the necessary current can be maintained there is no depth limitation.
- Double insulated cable with orange rubber butadiene nitrite cover.

OPERATING TEMPERATURES

- Surface / Sub-surface – Arc plasma will provide heat intensity of 5000°C+.

OPERATING CURRENT

- Surface – A range between 200 - 350 for 4mm and 290 - 390 for 5mm.
- Sub-Surface – A range between 200 - 350 for 4mm and 290 - 390 for 5mm.

OPERATING VOLTAGE – 2 TYPES

- Open Circuit Voltage (OCV) which would typically be between 55 – 80 volts.
- Arc or Closed Circuit Voltage which would typically be between 25 – 40 volts.

DEPTH LIMITATIONS (MATERIAL THICKNESS)

During testing and evaluation the maximum thickness cut was 50mm mild steel during a surface cutting exercise. It is worth noting that the thickness of the material that can be cut is only limited by the electrode length and the cutting angle required.

ANGLE LIMITATIONS

Angles for cutting should be between 45 – 90 degrees. In the unlikely event that an area for cutting is difficult to reach the electrode can be bent, however the manufacturer does not recommend this procedure. If the water proofing was to crack water could be absorbed, which could affect performance and gas producing elements. If absolutely necessary to bend the cutting electrode, it would be best achieved where it joins the neck of electrode holder.

2.4 GLOSSARY OF ABBREVIATIONS

Abbreviation	Definition
AODC	Association of Offshore Diving Contractors
CCV	Close Circuit Voltage
DCRP	Direct Current Reverse Polarity
DCSP	Direct Current Straight Polarity
HSE	Health & Safety Executive
IMCA	International Marine Contractors Association
LEV	Local Exhaust Ventilation
OCV	Open Circuit Voltage
PPE	Personal Protective Equipment
ROV	Remotely Operated Vehicle

Chapter 3 SYSTEM OPERATION

3.1 SAFETY

This chapter is intended to cover the safety precautions to be followed while preparing for and conducting underwater cutting operations with Swordfish™. Serious injury or death may result when protocols are not followed during underwater cutting operations – supervisors shall ensure that all personnel become thoroughly familiar with the information contained within this manual.

Deviation from established standards are of course potentially dangerous, however the most serious aspect of disregarding safety rules may not be the initial deviation but the tendency to treat other rules just as casually. Safety must be the paramount consideration throughout every operation, and the more safety conscious each team member becomes, the safer each diving operation will be.

3.1.1 Electrical Safety

POSSIBLE SHOCK HAZARDS

The electric shock hazard associated with arc welding may be divided into two categories:

- Primary Voltage Shock, i.e. 240, 415 / 440 volts
- Secondary Voltage Shock, i.e. 60 – 100 volts

The primary voltage shock is extremely hazardous, and on no account should any unqualified person interfere with a primary supply. Personnel can receive a shock from the primary (input) voltage by touching a lead inside the machine with the power on, whilst touching the machines case or other grounded metal. The case must be earthed so that if a problem develops inside the machine, the fuse will blow.

Other factors to be considered include:

- Adequate duty cycle of the machine
- Isolation switches are readily accessible
- All mains and secondary cables, terminals and cable connectors are of adequate size and construction for the maximum welding current
- Terminals and live components are adequately protected

It is not sufficient to expect that the welding machine is earthed through its earth lead in the mains plug. Although this will take care of any primary side problems it will not stop current leakage occurring on the secondary side of the circuit.

A secondary voltage shock can occur if the operator touches a part of the electrode circuit (a bare spot on the cable for example), while at the same time another part of his body comes into contact with another side of the welding circuit.

All personnel responsible for or engaged in underwater cutting/welding should understand and be aware of the following:

- Read and understand the safety and operating instructions of all involved equipment prior to use.
- Read and comprehend this manual.
- Know the capabilities of assigned equipment and strictly follow operational procedures.
- Use this manual in association with the equipment for ready reference.
- Follow all warnings printed on system components.
- Adhere to pre-use, use and post use routines.
- There are no hazardous substances used in the electrodes, however the manufacturer's guidelines must be followed when cutting. It is advisable for the operator to keep his or her head clear of the gas plume during surface use, and employ Local Exhaust Ventilation where appropriate.
- Adhere to the Safety Data Sheets that are supplied with the electrodes.
- During surface cutting, ensure a well ventilated area is used – whenever possible the user should use a ventilated welding visor and or extractor fans.
- There is no toxic gas risk during a dive except for the gasses that will rise to the surface, therefore ensure all surface crews are aware of toxic gas hazards.
- Arc Rays can cause serious damage to eyes and skin.
- Always use Personal Protective Equipment (PPE) – Eye protection and suitable clothing with rubber gloves. When diving is taking place ensure that surgical gloves are worn under normal diving outer gloves, and that the outer glove cuffs are taped.
- Always use an approved electrode holder (Stinger) with the electrode
- Prior to the start of any underwater cutting it is good practice to consult and study any drawings and physical configurations of the work area. Areas where cutting is to take place must be studied to determine areas / voids that could contain or trap potentially explosive gasses. These areas / voids must be vented or made inert to prevent possible explosions. To this end a cutting methodology should be adopted.
- When cutting, hydrogen and Oxygen is disassociated from the water and will travel separately as bubbles. These bubbles can collect in trapped or confined spaces overhead. If hydrogen bubbles combine with oxygen bubbles, which could come from the divers expelled gas they may ignite causing a popping sound. If this occurs cutting should cease and the cause must be investigated immediately.
- Care should also be taken when cutting in or around dead or rotting marine growth / leaves / foliage, or mud because trapped methane gas, given the appropriate concentrations, can explode.

- Explosive gasses may be produced by one or any of the following:
  - Corrosion,
  - The electrode itself,
  - Decaying or vegetable or animal matter,
  - Epoxies, solvents or adhesives,
  - Paint mediums such as linseed oil or thinners,
  - Petroleum products, fuel oil or greases.
- To reduce the risk of explosions from trapped gasses do the following:
  - Gasses may be vented to the surface via a vent tube (flexible hose) secured in place from the high point, whereby gasses would collect to a position above the water line, if practicable;
  - Start cutting at the highest point and work downwards, allowing gasses to vent as the cut is progressing;
  - When cutting vent holes, if flammable gas is suspected use cold cutting techniques.
- If cutting overhead beware of falling or rolling away of cut-away pieces or molten metal if in close proximity.
- Take care if cutting tightly bound wire rope.
- Prior to cutting ensure umbilical and any diving equipment is clear and will not be in the path of slag from the cutting operation.
- If cutting overhead is deemed unavoidable, ensure appropriate Personal Protective Equipment (PPE) is worn. The diver is not to be directly beneath any molten metal falling from the cutting procedure.
- Divers should ensure cutting operations are carried out from one side of the area to be cut and not directly facing or beneath it. This will ensure that should an explosion occur the blast energy is not channelled directly towards the diver. The supervisor should remind the operator of this throughout the operation.
- The diver shall ensure that while “power is on” (hot) the torch is never left unattended.
- Only change the electrode when cold (disconnecting safety switch) – When the electrode has been consumed to within 75mm (3") of the torch, the diver is to stop cutting and signal for the torch to be made cold, via the disconnecting safety switch (knife switch), before attempting to change electrodes. Maintain the torch in the cutting position until the surface has confirmed the torch is cold. The diver should tap the electrode twice to make sure the current is off.
- When starting the cut the hand should never be closer than 100mm (4") from the electrode tip. As the electrode is consumed and becomes more manageable a one handed grip can be used.
- Never get between the electrode and the return lead.
- Arcing can damage welding machine switch contacts. Do not change the range switch position whilst welding or under load (arcing causes pitting and will eventually render the contacts inoperative).

- A diver is at risk to severe electrical shock when performing a cutting or welding operation if only partially immersed in water. Hence, the splash zone is the most hazardous location in which a diver can be placed.
- Never enter a diving bell with Swordfish™ when the welding generator is still running.
- AC power shall not be used for underwater cutting using Swordfish™ due to the extreme danger involved with AC current underwater. Electrical shock produced by AC current prevents voluntary relaxation of the muscles controlling the hand, consequently the diver may not be able to let go if his or her body or equipment accidentally enters the electrical circuit.
- AC power is however acceptable in a surface / air environment.
- When conducting a risk assessment consider the following:
  - The material being cut,
  - Any coatings on, in or around the material to be cut,
  - The content of the material being cut, i.e. old gas / fuel pipe,
  - Local and surface environment ,
  - Type of sea bed, e.g. rotting vegetation gives off gas (Methane),
  - Conducting an initial survey with an ROV.
- Only use DC welding power, which should be set-up by competent experienced personnel and that all electrical connections are securely made before operations commence. In particular, the correct polarity should be selected.

Figure 1: Piranha Combo

- Ensure a positive operating, disconnecting safety switch (Fig 1), (normally rated at 400 Amps) is in the welding circuit. The diver will then be fully isolated from electric current when the disconnecting safety switch (knife switch) is open and can safely change electrodes in this state.
- All cables that are intended to be submerged shall be double-insulated and watertight. Cables should be checked at regular maintenance intervals, as part of a planned preventative maintenance programme, for integrity.
- When working in deep water a strain relief should be used to provide support for the additional cable weight.

- If joining lengths of cable together, use connectors which have a current carrying capacity that is equivalent to the cable being used, and are appropriately insulated.
- The position of the return lead in relation to the diver must be such that at no time does the diver or equipment become positioned between the ground and the electrode. The diver must avoid becoming part of the electrical circuit, due to electrolysis.

An underwater cutting operation with Swordfish™ involves several hazards, including potentially harmful electrical current / voltage, and very high electrode tip temperatures. It is impossible to anticipate all possible situations that may arise from underwater cutting; consequently it cannot be assumed that safe operating conditions will exist simply by blindly following the guidelines laid out in this manual. Nonetheless, with a thorough knowledge of cutting fundamentals, and electrical safety, combined with the use of suitable and sufficient control measures, the procedures described within can be performed in maximum safety.

For sub-surface operations only competent and certified divers are allowed to perform underwater cutting operations. All diving operations shall be carried out in accordance with recognised national and international diving regulations.

Figure 2: Fume Extraction

Follow all employees' safety practices. The guidelines as specified by the Association of Offshore Diving Contractors (AODC). Safe use of electricity underwater code of practice and the International Marine Contractors Association (IMCA) publication D003.

3.2 RISK ASSESSMENT

The following document is provided as an example of possible format to be used for the conduct of a risk assessment:

RISK ASSESSMENT

Assessment No:	PMT 023-Sh ABC	**Revision No:** Original	**Date:** 14/10/2003
Project:	Shell / ABC / 123		
Location:	Defence Diving School		
Description of Event:	Underwater Non-exothermic Iron Oxide Electrode Cutting of Pipeline		
Personnel Conducting Assessment: ***(Specifically Named)***	Project Manager, Shell Representative, Health and Safety Advisor, Diving Supervisor, Divers.		

Activity / Event	Hazards	Hazard Impact / Effect / Consequence	Hazard Severity	Hazard Probability	Uncompensated Risk Value	Risk Reduction / Mitigation Measures	Residual Risk	Action Who / When
Initial cut of target pipeline	Cutting in wrong location	Structural asset damage Explosion Diver injury / death	5	2	10	Consult plans and diagrams prior to operation Confirm with ROV, hat camera and diver prior to cutting	4	Sup in plans prior to cut
Cutting area with increased explosive gas content	Gas (methane / Oxygen) entrapment in pipe / hollows / voids	Structural asset damage Explosion / blow-back Diver injury / death	5	4	20	Remove all corrosion, wrappings and marine growth from area to be cut.	10	
Cutting area with no escape route for gas that is being released from the process	Gas (methane / Oxygen) entrapment in pipe / hollows / voids	Structural asset damage Explosion / blow-back Diver injury / death	5	5	25	Provide ventilation / gas escape points at top of area to be cut. Monitor gas release during the process Cut from highest point downwards	10	
Hot cut with Swordfish™ cutting electrode	Non-compliance with stated procedures	Asset damage Diver injury / death	5	1	5	Cold cutting is primary option, with Swordfish™ as a contingency	3	

Activity / Event	Hazards	Hazard Impact / Effect / Consequence	Hazard Severity	Hazard Probability	Uncompensated Risk Value	Risk Reduction / Mitigation Measures	Residual Risk	Action Who / When
Hot cut with Swordfish™ cutting electrode	Inexperience / incompetence of diver for Swordfish™ cutting operations	Asset damage Diver injury / death	5	2	5	Confirm competence and currency of diver qualification in equipment Provide adequate information, instruction, training and supervision Allow time for proofing on test-pieces	5	
Overhead Hot cut with Swordfish™ cutting electrode	Molten slag / molten material falling onto diver / diving equipment	Equipment damage Diver injury	4	3	12	Avoid overhead cutting. Ensure good umbilical management and housekeeping	5	
Hot cut with Swordfish™ cutting electrode	Electricity	Electric shock Diver injury / burns / death	5	3	15	Diver to clean an area forward of the cut, and secure the earthing clamp. At no stage should diver position himself between the work-piece and earth clamp.	5	
Hot cut with Swordfish™ cutting electrode	Equipment failure	Asset damage Diver injury / death	5	2	10	Ensure all plant and equipment is certified and maintained in accordance with planned maintenance programme. Conduct pre-use and function tests top side prior to deployment	5	

The above Risk Assessment is provided merely as a guide to possible format. All cutting operations must be Risk Assessed, employing the Assessment as a part of the overall Hazard Reduction Process.

3.3 STORAGE & TRANSPORTATION

For storage and transportation, each of the following must be understood and considered.

1. Swordfish™ electrodes should be stored in a dry environment, in the manufacturer's containers. Suitable conditions for storage would be for example: 60° Humidity and a temp between 20° / 30° (room temperature). There are no hazards regarding the storage of Swordfish™.
2. Electrodes should remain in their packaging until required.
3. Electrodes should be handled and stored in a manner that prevents any physical damage. Any damage to the electrode coating may have a detrimental effect on cutting performance; therefore caution must be exercised so as not to cause physical damage to the electrode coating.
4. Part used boxes can easily be resealed. Tests in water have revealed that providing the cutting electrodes water proof coating has not been damaged, they can be left immersed for long periods and used with no degradation in performance (follow manufacturers recommendations).
5. It is recommended that electrodes are not taped together as this could cause damage to the protective waterproof coating. Use of a suitable quiver is required.
6. Shelf Life: There is no limitation specified, however it is good practice to use batches in order, which can be determined from the batch number as indicated in the illustration below:

Figure 3: Batch Number

7. Electrodes can be taken directly from the packaging into the water.
8. Transportation: There are no transportation restrictions with the electrodes. They can be transported safely and easily by Road, Rail, Sea or Air; however it is good practice to make the Data Sheets available to drivers and loading personnel.

The following pages illustrate Safety Data Sheets:

Speciality Welds

MATERIALS HEALTH, SAFETY ENVIRONMENTAL DATA SHEET (CEE/91/155)
FOR 'SWORDFISH' CUTTING ELECTRODE:

1: IDENTIFICATION OF PRODUCT & COMPANY:

1.1 Product Identification:

Trade Name: Swordfish

Application: Underwater cutting/burning of steels.

1.2 Manufacture/Supplier:

Name: Speciality Welds

Address: Unit 3 Moorlands Business Centre
Balme Road, Cleckheaton West Yorkshire BD19 4EW (UK)

1.3 Office & emergency numbers: Tel: +44 (0) 1274 879867 Fax: +44 (0) 1274 855975

2: COMPOSITION & INFORMATION ABOUT CONSISTUENTS:

Core wire: carbon steel
Flux coating: high iron oxide coating
Waterproofing: (<2%) 4-methyl-2-pentanone (25-100%), Xylene (10-25%), butaone (1-10%)

3: RISKS:

Electric arc welding may create one or more of the following hazards:
Cutting fumes and gases may be dangerous to health
Arc rays (UV) can injure eyes and burn exposed skin
Infa-red heat rays can injure eyes and skin
Electric shock can kill

4: FIRST AID INSTRUCTIONS:

Inhalation: bring affected person to fresh air, if breathing is difficult administer oxygen
In case of burning: flush with plenty of cold water for several minutes (at least 5-10 minutes)
In case of arc burn: call a physician
In case of eye contact: flush open eyelid with water for several minutes

5: FIRE FIGTING INFORMATION:

The product is non-flammable: N/A
Extinguishing media: N/A
Extinguishing media to avoid special fire fighting procedures: N/A
Hazardous decomposition products: N/A

6: PRECAUCTIONS TO BE TAKEN IN CASE MATERIAL IS RELEASED:

Personal protection: N/A
Cleaning methods: N/A
Waste disposal method: N/A

7: HANDLING & STORAGE

Handling: fume extraction needed if cutting fumes may be released when cutting on the surface.
Storing: N/A

8: PROTECTION OF PERSONNEL:

Technical precautions: during welding the necessary precautions have to be taken:
Use enough and adequate ventilation and local exhaust to keep fumes and gases from the welders breathing zone and the general area. Train the welder to keep his head out of the fumes. Wear protective clothing and welder protection equipment.

TLV-values: (UK list 2002 – KB 11.03.02 – CEE91/322	CASnr	TLV
Cutting fume	----	5 mg/m^3
Iron oxide (fume)	1309-37-1	5mg/m^3
4-methyl (soluble compounds)	108-10-1	208 mg/m^3
Xylene	1330-20-7	440 mg/m^3
2-butaone	78-93-3	599 mg/m^3

The cutting fume evolved during cutting operations depends on the metal that is cut and the surface condition from it. Cutting of stainless steel will develop fumes containing chromium and nickel compounds. These values pertain to use of this product in air.

Speciality Welds

Personal protection:
Respiration protection: use fume respirator or air supplied respirator when welding/cutting in confined space or in general work area when local exhaust does not keep exposure below TLV.
Eyes: Wear shaded filter lens. The choice of appropriate light filtration will be based on visual acuity and may vary from one individual to another, particularly under different current densities, materials and electrode diameter, suggested filter shade number for shielded metal arc welding is 9 – 12.
Hands: Wear protective gloves to prevent injuries from radiation, sparks and electrical shock.
Skin: Wear protective clothing to prevent injuries from radiation, sparks and electrical shock. Welder may not permit electrical live parts or electrodes to make contact with skin.

9: PHYSICAL AND CHEMICAL DATA:

Physical form:	solid, coated metallic rod	Explosion limits:	
Odour:	odourless	LEL (lower):	N/A
Colour:	purple/black	UEL (upper):	N/A
pH:	N/A	Vapour pressure:	N/A
Boiling point	N/A	Specific gravity::	N/A
Melting point	1400 – 1500 degrees C	Solubility in H_2O:	Nill
Flash point:	N/A (method)		

10: STABILITY AND REACTIVITY:
Stability: stable
Conditions to avoid: N/A
Products to avoid: N/A
Hazardous decomposition products: these cutting electrodes at normal ambient temperatures evolve no fumes or vapours but in use (cutting) fumes will be evolved (see section 8.)

11: TOXICOLOGICAL INFORMATION
Primary routes of entry: Inhalation of welding fumes
Symptoms/effects: Inhalation of excessive fume concentrations may result in following signs and symptoms: Respiratory tract irritation, dizziness, nausea and/or metal fume fever. Long-term overexposure to welding fumes can lead to lung diseases and affect pulmonary function.

12: ECOLOGICAL INFORMATION:
N/A

13: WASTE REMOVAL:
Discard any product or residue as ordinary waste (scrap) in an environmentally acceptable manner unless otherwise noted.

14: INFORMATION CONCERNING TRANSPORTATION:

Un-mr:	N/A	IMDG:	N/A
ADR/RID:	N/A	IATA:	N/A

15: LABELLING:
R-phrases: N/A
S-phrases: N/A

16: OTHER INFORMATION:
N/A = not applicable N/D = not determined N/D/A – no data available

This information only refers to the described product and is based on actual knowledge and experience known by us, because operating conditions are unknown to us and does not belong to our sphere of influence.
The product may not be used without written permission for a use other than mentioned in pt. 1.
This information may not be taken nor as a guarantee nor as a quality indication of our product.
This material safety information describes the product in relation with safety rules and is not meant as a technical description. At any time the user is responsible for taking the necessary precautions to fulfil all local laws and regulations.

Name: D.J. Keats
Date: Nov 2002

3.4 UNPACKING SWORDFISH™

When unpacking Swordfish™, check the packaging for damage. If any of the boxes are damaged, the contents must be carefully checked and any damaged electrodes discarded. If they arrive in damaged condition they should be returned to the manufacturer.

It is good practice to record batch numbers and use them sequentially. This will assist in keeping cutting electrodes in prime condition.

3.5 SWORDFISH™ AND ASSOCIATED EQUIPMENT SET-UP

User checks in accordance with manufacturer's guidelines on welding plant equipment must be followed.

The integrity of the welding leads must be inspected and damaged leads should not be used.

Figure 4: Good Lead

Figure 5: Damaged Lead

An appropriate earthing clamp is to be checked for wear and tear and the cable connection is positively secured as close to the cut as possible.

The approved electrode holder (Stinger) has been marinised with resin compound and is CE marked, in accordance with the use of underwater electrical equipment guidelines.

The electrode holder (Stinger) is recommended for use with Swordfish™ by the manufacturer. If an alternative holder is employed it shall be fit for purpose; all connections shall be visually checked and rust free. Operation of the holder shall be confirmed. The operator is to ensure that the cutting electrode can be held securely, and easily released by the jaws.

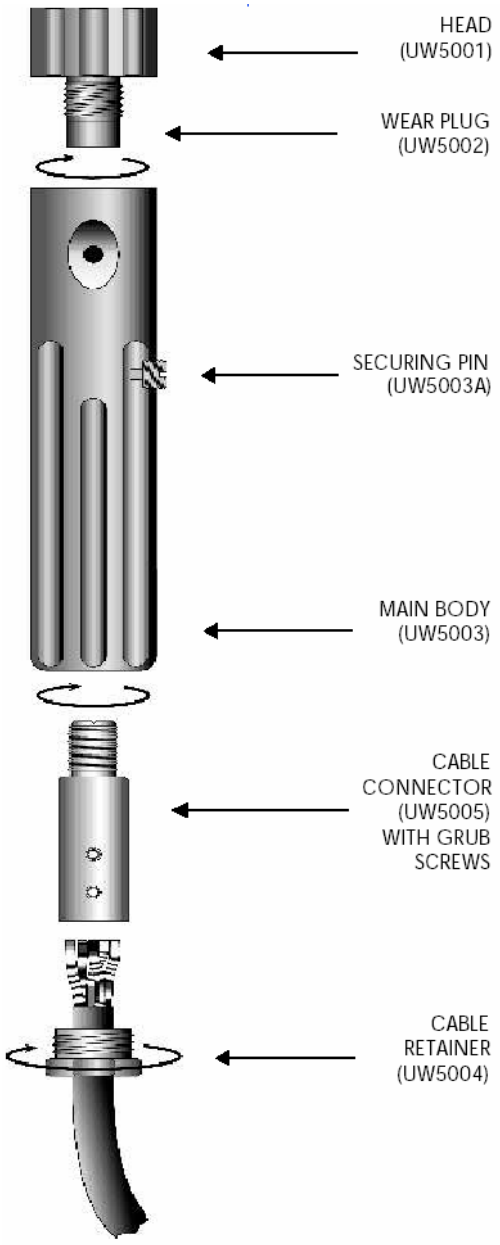

Figure 6: Electrode Holder

Suitable personal protective equipment (PPE) is to be made available and in good repair:

- Welders coveralls / smock for surface use
- Protective gloves
- Eye protection
- Suitable head protection
- Underwater visor for sub-surface work
- Gloves / Neoprene diving gloves with latex under gloves for sub-surface work

Figure 7: Coveralls and Headgear

Figure 8: Protective Gloves

Figure 9: Head Protection

Ensure a suitable Open Circuit Voltage (OCV) is available from the machine (55 – 80 volts), and check to ensure constant voltage is maintained. If no metres are fitted to the equipment, refer to the manufacturer's data plate. The cutting process will be hampered if the welding generator is in a poor state of repair or fluctuates during the process

Figure 10: Check Voltage

3.5.1 Welding Generator - Pre-Set-up Inspection

Successful underwater cutting is highly dependent on the efficient running of the power supply unit, and the integrity of the secondary welding circuit. Before any underwater work takes place, conduct the following:

- The cutting power source should be fully inspected by qualified personnel.
- The commutators on motor-generators should be clean. Brushes must not be excessively short or worn. Slack brush rigging springs must be replaced.
- All welding machinery and secondary circuit must only operate within its duty cycle rating.
- All power sources should be checked for confirmation of rated capacity before use, by use of the manufacturer's data plate, as shown in the following illustration:

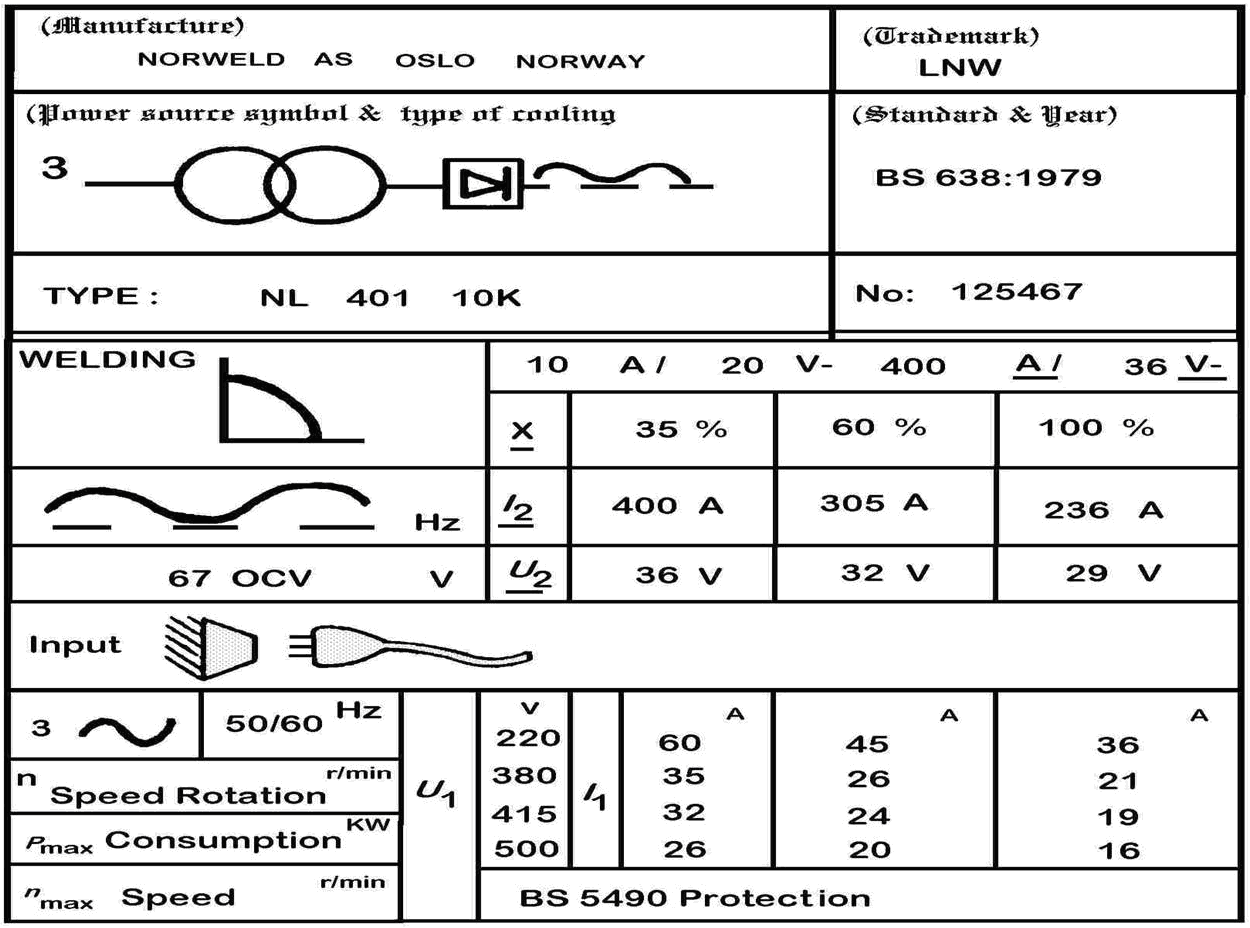

Figure 11: Rated Capacity

Arc welding and plant equipment is addressed within BS EN 60974-1: 1998

3.5.2 Polarity[1]

Underwater cutting and welding operations are usually performed with DC electrode negative, i.e. Direct Current Straight Polarity (DCSP), but may also be used with Direct Current Reverse Polarity (DCRP). However, greater care needs to be exercised as electrolysis may cause discomfort / shock potential.

- The cable from the electrode holder is connected to the negative (-) terminal of the DC power supply
- The positive (+) or ground cable is connected to the work.

The majority of the electrode manufacturers call for a DC electrode negative set up**.** Occasionally, there may be a requirement for a reverse polarity, sometimes referred to as Direct Current Reverse Polarity (DCRP), electrode positive for a particular electrode, or for improved cutting.

This will normally be at the recommendation of the electrode manufacturer and will be printed on the electrode box or included in accompanying literature.

[1] Final piece here dependant on gas analysis

3.5.3 Tong Test Ammeter

The Tong Test Ammeter is a portable instrument that will measure current flowing in a circuit without making electrical connections to it. It is a most important tool to have on hand while setting-up for and during underwater cutting operations. This is especially true when there is uncertainty as to the output of a particular welding machine. Costly mistakes and wasted bottom time may be avoided by simply taking an ammeter reading before the diver enters the water. This step will eliminate any doubt as to the actual welding generator amperage output. Excessive burning can be achieved by a diver who has assumed the welding machine was functioning properly, when in fact it was delivering amperage far in excess of the dial setting. On the other hand, there have been many man-hours wasted by divers trying to cut with too little amperage.

To determine the exact amperage output of the welding generator:

- Take a tong meter reading.
- Wait until the diver has established an arc and is cutting and simply encircle the welding lead with the tongs of the test ammeter and close them.
- A clear accurate reading will instantly register on the scale. This will be the closed-circuit reading.

It is recommended that you do not rely exclusively on the values indicated by the control panel knobs or installed meters. The meters are not intended for exact current or voltage measurements. The Tong Test Ammeter will read the actual current passing through the welding cable.

3.6 PRE-USE ROUTINE (SURFACE)

For ease of demonstration 3 phase DC equipment has been the preferred power source. However, fundamentally all equipment checks are similar and should be carried out prior to use.

It is recommended that these measures are incorporated into local procedures. Any deviation from these measures should be fully justified and recorded within the risk assessment.

9. A task risk assessment is carried out prior to any surface operation.
10. Surrounding areas are checked and clear of combustible materials, such as fuel stowage's etc.
11. Electric generator is in a suitable position, is grounded and does not interfere with surface operations.
12. When preparing an electrical generator for use the following procedure is recommended:
    a. Ensure power isolating switch is in the off position
    b. The disconnecting safety switch (knife switch) is in the open (cold) position breaking the circuit.

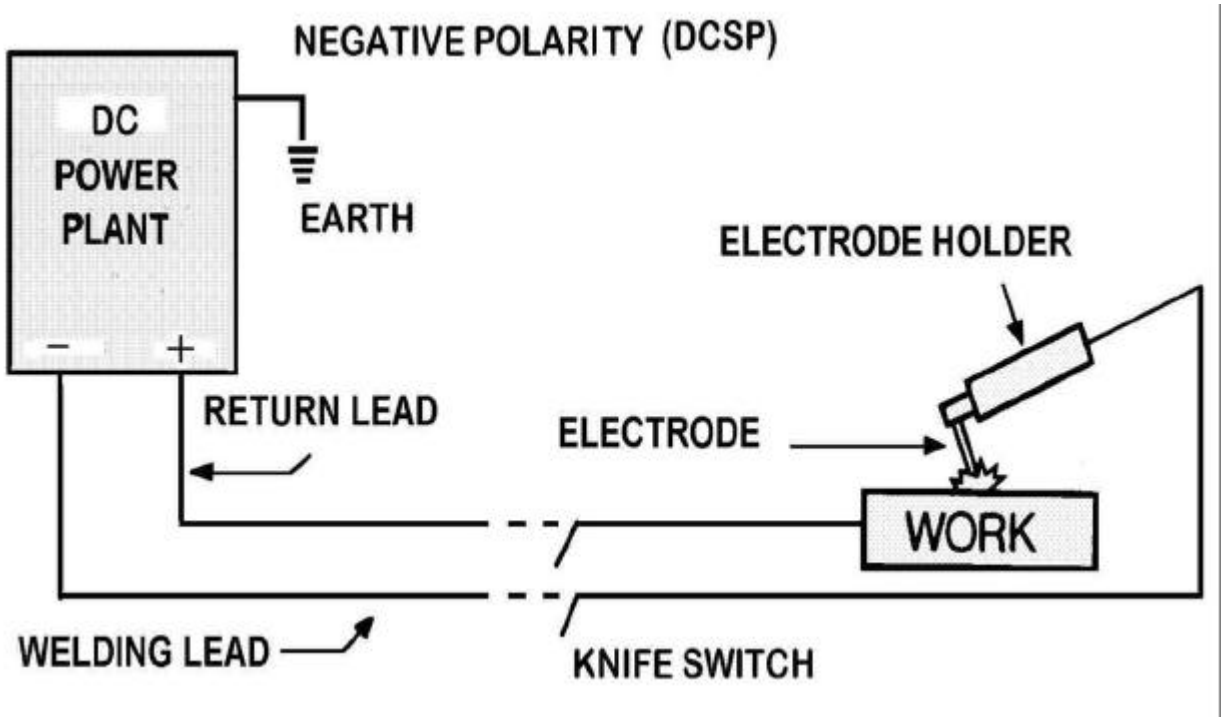

Figure 12: Safety Switch

13. Connect the Negative cable bayonet connection to its appropriate port on the generator.

Figure 13: Negative Cable Connection

14. Connect the Positive cable bayonet connection to its appropriate port on the generator.

Figure 14: Positive Cable Connection

15. Set desired current on selector dial of the welding generator

Figure 15: current Selection

16. Ensure the welding generator power switch is in the off position prior to the mating of cables to the power supply.

If 3 phase DC equipment is being used ensure all connections have been checked for damage prior to use. If damaged do not use!

Figure 16: Switch Off the Welding Generator

Figure 17: Connect the Power Supply

17. The cable must be flaked out and the material to be cut must be suitably earthed.

Personal protective equipment (PPE) must be worn ready to cut, this includes bystanders. Safety point: Arc rays can cause serious damage to eyes and skin.

18. If a motorised generator is being used ensure fumes are down wind of any compressors.
19. Material to be cut is free of loose particles and clean prior to cutting taking place.
20. Carry out a visual check of the Swordfish™ cutting electrodes for damage prior to use and position the electrodes in vicinity of job for ease of use.

Figure 18: Check Cutting Electrodes for Damage

Figure 19: Connect Electrode to Stinger

21. Connect the cutting electrode to the electrode holder (Stinger) ready for use.
22. Turn the power switch on the welding generator to on.

23. Close the disconnecting safety switch (knife switch), making the circuit (Hot).
24. When ready to cut it is advised to finally check that there is enough cable (slack) to prevent snagging on the job, thus ensuring a smooth and unhindered cut.

You are now ready to commence cutting.

3.7 PRE-USE ROUTINE (SUB-SURFACE)

It is recommended that these measures are also incorporated into local procedures. Any deviation from these measures should be fully justified and recorded within the risk assessment.

For electrical welding generators follow pre-use routine for surface cutting, including the additional recommendations within this section.

Prior to the start of any underwater cutting it is good practice to consult and study any drawings and physical configurations of the work area. Areas where cutting is to take place must be studied to determine areas/voids that could contain or trap potentially explosive gasses. These areas/voids must be vented or made inert to prevent possible explosions.

25. Careful examination of the target area and surrounding environment should be made before starting the cutting operation. Particular attention should be made as to how the cut away piece or molten metal will fall, and whether there are any projections, wires or any other objects, which may foul lines or cause a piece to swing around in an unexpected manner.
26. If available an ROV can be deployed to obtain images of the site and surrounding areas where cutting is to take place.
27. Ensure a task risk assessment is carried out prior to all sub-surface cutting operations. The Risk Assessment shall receive input from all concerned with the process, including the diver.
28. Check material to be cut for any types of coating or wrapping as this may hamper cutting or cause unknown gasses to be released. If coatings are detected, then the cutting operation may have to be delayed until any potential hazard has been identified and the subsequent risk has been eliminated or reduced to an acceptable level.
29. If an electric generator is being used ensure that it is in a suitable position, is earthed and does not interfere with diving or surface operations.
30. All cables integrity have been checked, flaked out suitably, and the correct placement of the ground connection (earth) is made prior to cutting. The manufacturers recommended distance from the cut line is 300mm.
31. When working in deep water, due to the weight it is sometimes beneficial if the cables can also be supported by rigging a strain relief to assist the diver.
32. It is recommended that the area to be cut is cleaned and free of marine growth as it is known that marine growth releases gases into the water and may have contributed to some explosions.

No work directly above the diver is to be carried out.

33. The diver is to wear appropriate personal protective equipment prior to cutting:

- HSE approved diving helmet with suitable welding visor fitted;
- Neoprene gloves with latex under gloves – gloves taped to the diving suit.

34. When making any connections ready for use, always ensure the welding generator power switch is off and the disconnecting safety switch (knife switch) is open (cold). Follow the set up procedures for connecting cables as for the surface pre-use routine above.
35. Ensure all connections of cable extensions are suitably insulated and water proofed to prevent electric shock.
36. Earthing clamp is securely attached to the material to be cut.
37. The diver must ensure that he or she is not between the return lead and the welding lead.
38. All umbilicals / hoses are clear of the job.
39. Set the desired current on the selector dial of the welding generator.
40. Place cutting electrodes in a position where they are easily accessed for the job, normally in a quiver.
41. Connect a cutting electrode to the electrode holder (stinger) ready for use.
42. Ensure suitable eye protection is worn, or welding filters are provided when using Swordfish™.
43. Welding generator has been powered up but the disconnecting safety switch (knife switch) is cold.
44. As the diver, you inform the surface supervisor to make it hot (the disconnecting safety switch (knife switch) will be closed, making the circuit).
45. The supervisor will then inform the diver that the circuit is hot.
46. When ready to cut it is advised to finally check that there is enough cable (slack) to prevent snagging on the job, thus ensuring a smooth and unhindered cut.

You are now ready to commence cutting.

The following Check List is provided to aid supervisors, and contribute to the management of a safe and comprehensive procedure.

It is emphasised that the Supervisor's Check List illustrated overleaf is provided for guidance only. It should be used in conjunction with this User Manual and local procedures, being adapted to meet the specific circumstances of each cutting operation.

Swordfish™ Iron Oxide Cutting Electrode Supervisor's Check List

The following checks are to be conducted:

Surface Preparation:

		Yes	No
1.	Are the torch, earthing clamps and cable joints insulated correctly?		
2.	Is the generator earthed correctly?		
3.	Has the generator polarity been checked and confirmed?		
4.	Has the equipment been function tested prior to sub-surface deployment?		
5.	Are all cables free to run and clear of sharp edges or snag hazards?		
6.	Has the target area been confirmed with the client?		
7.	Have potential gas entrapment areas been identified?		
8.	Has the diver been included in the risk assessment process and briefed by the supervisor?		
Comments:			

Sub-Surface Preparation:

		Yes	No
1.	Does the diver have the correct Personal Protective Equipment available?		
2.	Is the electrical power isolated to the torch prior to and during deployment to the diver?		
3.	Is the diver established in the correct position, and **NOT** between the return lead and the welding lead?		
4.	Is the diver's umbilical clear of the cutting operation?		
5.	Has the diver checked above and around the cutting area to ensure there are no potential areas of gas entrapment?		
6.	Has the area to be cut been cleaned of marine growth and corroded material?		
7.	Has the diver checked beneath the cutting area to ensure that any molten material will fall clear of equipments?		
8.	Do vent holes need to be cut to release any trapped gas?		
9.	Is it safe to cut vent holes (*If required ensure the diver knows to cut from the top down*)?		
10.	Is electrical power isolated when changing electrodes or performing maintenance to the cutting equipment?		
11.	Is electrical power isolated when the diver leaves the work site, returns to the bell or returns to the surface?		
12.	Can the structure being cut fall on the diver or on his or her equipment?		
Comments:			

Supervisor Signature .....

Printed Name.....

Task .....

Date .....

Time .....

3.8 OPERATION (SURFACE / SUB-SURFACE)

The Swordfish™ electrode provides an effective and efficient cutting result and is to be used with a constant current DC welding generator set on straight polarity (electrode negative) supplying current to the electrode. With the work grounded, the electrode will ignite as it touches the work.

AC power can be used for surface cutting operations

3.8.1 Advantages

- Cutting technique is simple and easily mastered with appropriate tuition
- Metals up to 75mm in diameter can be cut
- Cutting is accurate on most materials
- Neat, trim and narrow cuts are produced
- Power required is between 200 & 400 Amps of welding power supply

3.8.2 Disadvantages

- The burning time of the electrode is short (approximately one minute)
- It produces a narrow gap which may be difficult to locate in poor visibility
- A welding supply is required

3.8.3 Cutting Techniques

DRAG

The drag technique can be used for cutting thin gauge metal by dragging the electrode along the desired line of cut, but ensuring the tip of the electrode is always in contact with the metal being cut. This technique works more effectively using larger electrodes and higher currents. The diver may find that using the drag technique in a flat position is more effective than in other positions.

STEP FORWARD

The step forward technique can be used for cutting heavy gauge metal by using the electrode in a sawing motion to push away the molten metal out of the far side of the cut.

Skilful application of this sawing technique makes the metal-arc cutting process practical over a wide range of thicknesses. When cutting non-ferrous metal round stock, a sawing motion should be used, starting at the bottom and pushing through.

When using underwater, prior to cutting if not already done so, it may be necessary to cut gas escape holes.

3.8.4 Getting Ready to Cut

1. The Electrode should be held between 45° - 90° to the work, thicker the target the steeper the angle should be.

Figure 20: Preparing to Cut

2. To commence cutting – Lightly remove the waterproof coating from the end of the electrode by rubbing it against a file. Put welding visor into position. Place the electrode exactly where you wish to start the cut. When diving is taking place, inform the supervisor to "Make it Hot." *One of two things may now occur.*

   a. The Arc is struck, but sticks to the work.

   If the electrode sticks, simply rub the electrode gently up and down until the arc is struck, a slight twisting action may aid this process.

   b. Nothing happens at all

   If nothing happens, the waterproof coating is still preventing electrical contact. Continue to remove the waterproof coating. With the power still hot, scrape the electrode along some scrap metal (as if striking a match) until the exposed core wire is level with the flux coating again.

3. When cutting, maintain a firm pressure to keep the electrode against the work, while steadily moving along the line of cut. To achieve an efficient cut, pressure must be maintained in keeping the electrode against the target.

4. When it becomes necessary to change electrodes underwater, the diver is to inform the supervisor that he wishes to do so by giving the command, "MAKE IT COLD." The supervisor will then break the circuit by opening the disconnecting safety switch (knife switch) and will return a report back to the

diver, "Cold" when the disconnecting safety switch (knife switch) is in the open position.

It is important that the operator does not operate the switch unless specifically directed to do so by the diver. Furthermore, when directed to do so he should confirm each change to the diver.

Once electrodes have been changed, the diver will inform the supervisor of this by stating, "Make it Hot" the supervisor will close the disconnecting safety switch (knife switch) and inform the diver of this by stating, "Hot."

3.8.5 Emergency Shut down

If at any time a problem an emergency occurs the following procedure is to be followed:

5. Stop cutting (Inform the surface);
6. Isolate the cutting circuit immediately – Make it cold;
7. Turn the power isolating switch to off;
8. Seek medical assistance if necessary.

Chapter 4 MAINTENANCE

4.1 GENERAL CARE

After the equipment has been used, the following procedures are recommended:

- Wash all equipment that has been immersed in salt water with fresh water.
- Cables – The electric cables are to be washed in fresh water and dried before storing the cable ends and stinger can be coated in anti-water dispersant.
- Connections – All cable connections should be stripped, cleaned and re-insulated. If not being used again for extended periods, all cables and hoses should be dusted with French chalk.
- For surface cutting, check the cables and associated equipment for damage / burns and replace if necessary.
- Equipment should be stored in an oil free environment.
- Electrodes that have been exposed to salt water should be checked for damage and blown dry and stored to manufacturer's recommendations.

4.2 MECHANICAL SERVICING

There is no mechanical servicing required with Swordfish™, however if the stinger or an alternative electrode holder is used the appropriate servicing procedure should be followed.

Chapter 5 TROUBLESHOOTING

5.1 IDENTIFYING THE FAULT

If you cannot get an arc check the following:

- Is Open Circuit Voltage (OCV) available?
- Has the disconnecting safety switch (knife switch) connection been made?
- Are all connections tight and secure?
- Is the cutting electrode damaged?
- Check the earth clamp is secure and well attached.
- Is the power source turned on and set to the required ampage for the job?
- Is the electrode holder (stinger) fit for use?

5.2 ORDERING PARTS

The Underwater Welding Stinger and Swordfish™ Cutting Electrodes can be ordered from:

Speciality Welds
Office Suite 18
Moorlands Business Centre
Balme Road
Cleckheaton
West Yorkshire
BD19 4EW

Tel: + 44 (0) 1274 879867
Fax: + 44 (0) 1274 855975
Email: Sales@Specialwelds.com
Website: http://www.specialwelds.com

Chapter 6 LIMITED WARRANTY

If found to be defective, providing the equipment has been used within the manufacturers guidelines the cutting electrodes will be replaced at no additional cost.

Chapter 7 QUALITY CONTROL

If at any time Swordfish™ becomes defective or results have deteriorated for unknown reasons then the manufacturer should be contacted for advice / feedback.