

## Module and Syllabus



### 1: Module Details:

<b>Module name</b>	'WSC – Pro®
<b>Nominal duration</b>	One module (80 hrs) split over 2 weeks/phases
<b>Module code</b>	UWSW001 (Underwater Fillet Welder- Plate)

**2: Module purpose:** This module is designed to allow a commercial diver to become competent in MMA/SMAW welding, as prescribed by the International Institute of Welding (IIW) and European Welding Federation (EWF) document 570-01 fillet welder - plate. The programme is accredited / certified by EAL (EMTA Awards) with welder qualification testing conducted in accordance with BSEN ISO 15618-1 or AWS D3.6-99M-C. Dry MMA/SMAW welding skills are also taught, with testing available to class II standards in accordance with BS4872 Pt1 1982.

**3: Prerequisites:** A certified commercial diver trained in surface demand operations to (HSE) or other approved National, or International diving standards.

**4: Content:**

- Safe underwater welding
- Introduction to SMAW/MMA plant & equipment
- Underwater welding techniques
- Preparing to weld
- Electrode & weld terminology
- Basic weldability & common weld defects encountered
- Monitor & record welding operations
- QA/QC and welding procedures
- Join carbon steel plates using standard techniques

### 5: Assessment Strategy:

**Method** The underpinning theoretical knowledge for all learning outcomes will be assessed by a multichoice closed book examination and short answer assessments. Practical competency shall be assessed by production of a welder approval test piece for fillet welds in accordance with the above specifications.

### Condition of Assessment:

The practical test sample shall be conducted after all training practice has finished (ideally the following day). The diver shall be allowed a short warmup period (approx 30 mins) to set up any parameters. This test shall be conducted such that the instructor/assessor can see the diver at all times while underwater, with photographic evidence to support each welders test piece.

### 6: Learning outcome details:

- |                                       |  |
|---------------------------------------|--|
| 1: Safe underwater welding procedures | 5: Electrodes & weld terminology                               |
| 2: MMA welding plant & equipment      | 6: Basic weldability & common weld defects                     |
| 3: Underwater welding techniques      | 7: Monitor & control welding operations                        |
| 4: Preparing to weld                  | 8: Quality assurance & quality control                         |
|                                       | 9: Join C/steel plates using the three standard wet techniques |



## **Learning outcome 1: Safe underwater welding procedures**

- Assessment criteria:**
- 1.1 Selects correct polarity & current type.
  - 1.2 Explains need for safety knife switch, types available & where it should be placed in circuit.
  - 1.3 Describes 'IMCA' guidelines for safe use of electricity underwater.
  - 1.4 Demonstrates by use, correct welding precautions.
    - a) Correct laying out of cables
    - b) Suitable CSA of cables
    - c) Correct body position to cables when welding
    - d) Suitable joining of cables
    - e) Safe welding procedures (Hot/cold)
    - f) Polarity check
    - g) Required use of rubber gloves
    - h) Selection of welding filter
    - i) Aware of electrolysis dangers
    - j) Suitable diving dress
    - k) Suitable earthing of machine
    - l) Correct start-up/shut-down procedures
  - 1.5 Explains requirements of a suitable electrode holder
  - 1.6 States correct type of welding cable required
  - 1.7 Demonstrates test method for establishing machine is operating efficiently.
  - 1.8 Explains potential for electric shock & requirements to minimise potential for receiving a shock

## **Learning outcome 2: SMAW/MMA welding plant & equipment**

- Assessment criteria:**
- 2.1 Interprets a basic welding circuit for U/W welding
  - 2.2 Explains principles of heat ratio & polarity
  - 2.3 Uses basic electrical welding terms appropriately.
    - a) Open circuit voltage
    - b) Arc voltage
    - c) Ohms
    - d) Electric circuit
    - e) Direct current
    - f) Alternating current
    - g) Arc energy
    - h) Watts
    - i) Duty cycle
  - 2.4 Lists types of welding plant available
  - 2.5 Explains basic input/output electrical current required
  - 2.6 Explains the term drooping characteristic
  - 2.7 Explains information as shown on a typical data plate for welding plant
  - 2.8 Describes the difference between single/double insulated cables



### **Learning outcome 3: Underwater welding techniques**

- Assessment criteria**
- 3.1 Explains relationship between Current, voltage and resistance
  - 3.2 Demonstrates correct selection & use of standard techniques
    - a) Drag
    - b) Oscillation
    - c) Step-back
  - 3.3 Determines voltage drop
  - 3.4 Describes the three arc zones of a burning electrode
  - 3.5 Explains the role of both lead and slope angles for
    - a) Travel speed control
    - b) Deposition & run placement control
  - 3.6 Explains and recognises the following electromagnetic forces, its potential and control.
    - a) Back blow
    - b) Forward blow
    - c) Side blow
  - 3.7 Describes demagnetization techniques.
  - 3.8 Demonstrates correct placement & conditions of placement of the welding return cable (earth clamp)

### **Learning outcome 4: Preparing to weld**

- Assessment criteria**
- 4.1 Uses suitable material preparation procedures.
  - 4.2 Uses correct electrode preparation techniques.
  - 4.3 Carries out suitable polarity check prior to welding
  - 4.4 Demonstrates correct current selection
  - 4.5 Uses correct welding technique for given pass
  - 4.6 Produces suitable recording & monitoring records
  - 4.7 Follows welding procedure details

### **Learning outcome 5: Electrodes & weld terminology**

- Assessment criteria**
- 5.1 Describes classification of electrodes in general
  - 5.2 Describes types of underwater electrodes & when each should be used
  - 5.3 Stores & handles electrodes correctly
    - a) Above water
    - b) Below water
  - 5.4 Explains the functions of an electrode coating
  - 5.5 Describes the range of formal welding positions (AWS/BSEN ISO)
  - 5.6 Identifies all relevant terms of a typical fillet weld/joint
  - 5.7 Identifies typical joint types for fillet welds



## **Learning outcome 6: Basic weldability & common weld defects**

- Assessment criteria**
- 6.1 Describes the term weldability
  - 6.2 Lists the composition & properties of steel
  - 6.3 Describes the basic metallurgical problems of wet-welds
  - 6.4 States the meaning of the following terms;
    - a) Unaffected metal
    - b) HAZ
    - c) Weld metal
  - 6.5 Explains the term carbon equivalent
  - 6.6 Describes how steel hardens
  - 6.7 Explains causes & prevention of following defects;
    - a) Hydrogen cracking
    - b) Solidification cracking
    - c) Lamellar tearing
    - d) Arc strike
    - e) Lack of fusion
    - f) Cold lap
    - g) Slag inclusions
    - h) Spatter
    - i) Undercut
    - j) Porosity

## **Learning outcome 7: Monitor & control welding operations**

- Assessment criteria**
- 7.1 Describes & explains all relevant data to be recorded during underwater welding operations;
    - a) Amp & voltage
    - b) Change of current settings
    - c) Weld preparation/joint type
    - d) Lead/slope angles used
    - e) ROL & arc energy values
    - f) Welding techniques
    - g) Earth connection & weld direction
    - h) Polarity
    - i) Type/size of electrodes used
    - j) Number of passes
    - k) Cleaning techniques
    - l) Welding position
    - m) Problems encountered
    - n) Recommended actions for corrections
    - o) Depth
    - p) Water type
    - q) Current & sea state

- 7.2 Produces a welding procedure specification for a fillet weld



## **Learning outcome 8: Quality assurance & quality control**

**Assessment criteria** 8.1 Describes the meaning of the following

- a) Quality assurance/control
- b) Welder approval qualification
- c) Essential & non-essential variables
- d) Welding standards/specifications
- e) Welding procedure specification

8.2 Follows and produces a welding procedure specification (WPS) sheet

8.3 Uses AWS D3.6M / BSEN ISO 15618-1 welding specification as it applies to underwater wet welding

8.4 Explains the basics of the following destructive tests

- a) Tensile tests
- b) Bend tests
- c) Fracture tests
- d) Impact tests
- e) Hardness tests
- f) Macro examination

**Learning outcome 9: Join C/steel plates above water to BS4872 Standards.** This LOC is covered by an additional 40 hour 'dry' welding course and covers fillet welding – plate. Exercises are broken down into 'stages' and include as a minimum, the following stages; (additional stages are also available)

Stage 1, exercise 1 – single run weld deposit

exercise 2 – weaved weld deposit

exercise 3 – pad welds

Stage 2, exercise 1 – Tee joint fillet welds

exercise 2 - Lap joint fillet welds

**Learning outcome 9A: Join C/steel plates underwater using the 3 standard welding to AWS/ISO Standards.**

**Assessment criteria**

9.1A: Produces acceptable weldment for bead on plate

9.2A: Produces acceptable weldment for lap joint

9.3A: Produces acceptable weldment for tee joint

**Training Conditions:**

This work should be carried out using carbon steel plate in the order of 8.0mm thickness. The diver shall at all times be working in a team environment, using standard safe diving practices as detailed in 'HSE' or other National/International safety diving standards. The range of tools used may include either pneumatic, hydraulic or hand tools only. It's recommended that all training be conducted in a purpose built tank of dimensions adequate for such training, using surface demand diving equipment. The tank shall have a viewing window of adequate size to allow the instructor to see all operations at all times. However, the training may also be conducted in open water providing the trainer has equipment available to allow him to see the diver and welding techniques used at all times.