

1: Module Details:

Module name: 'WeldCraft – Pro®

Nominal duration: One module (80 hrs) split over 2 phases (wet and dry welding).

Module code: 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) and is recognised by IMarEST as a CPD, with welder qualification testing conducted in accordance with BSEN ISO 15618-1, AWS D3.6-99M-C or BS4872-1 welding standards.

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 closed book, multichoice examination paper and include assessment of candidates course work. Practical competency shall be assessed by a welder approval test piece for a fillet weld(s) on plate, in accordance with one or more, of 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 warm-up period (approx 60 minutes) to set up and complete the weldment. This test shall be conducted such that the instructor/assessor and/or inspector can see the diver at all times while welding, with photographic evidence to support each welders test piece.

6: Learning outcome details:

1: Safe underwater welding procedures
 2: MMA welding plant & equipment
 3: Underwater welding techniques
 4: Preparing to weld

5: Electrodes & weld terminology
 6: Basic weldability & common weld defects
 7: Monitor & control welding operations
 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) Required use of rubber gloves
 - g) Selection of welding filter
 - h) Aware of electrolysis dangers
 - i) Suitable diving dress
 - j) Suitable earthing of machine
 - k) 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 electrical input/output requirements need for welding
 - 2.6 Explains the term drooping characteristic
 - 2.7 Explains data plate details for typical 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 welding 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 prevention and control.
 - a) Back blow
 - b) Forward blow
 - c) Side blow
- 3.7 Describes demagnetization techniques.
- 3.8 Demonstrates correct placement & conditions for the welding return 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 Produces a suitable underwater welding record sheet

Learning outcome 5: Electrodes & weld terminology

Assessment criteria

- 5.1 Describes classification of electrodes in general terms
- 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/ISO)
- 5.6 Identifies all relevant terms for a fillet weld
- 5.7 Identifies typical joint types as used 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 for 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 Produces a preliminary welding procedure specification (pWPS) for a fillet weld and describes all relevant data necessary to be recorded
 - a) Amps & volts
 - b) Current settings
 - c) Weld preparation/joint type
 - d) Lead/slope angles used
 - e) ROL & arc energy values
 - f) Welding techniques available
 - 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) Water depth/type and sea state, etc
 - p) Material type and grade
 - q) Electrode handling and storage

Learning outcome 8: Quality assurance & quality control

Assessment criteria

- 8.1 Describes the meaning of the following
- Quality assurance/control
 - Welder approval qualification
 - Essential & non-essential variables
 - Welding standards/specifications
 - Welding procedure specification
- 8.2 Identifies the ISO underwater welding standard for qualification of welder-divers
- 8.3 Describes underwater welding as detailed in AWS D3.6
- 8.4 Explains the basics of the following destructive weld tests
- Tensile tests
 - Bend tests
 - Fracture tests
 - Impact tests
 - Hardness tests
 - Macro examination

Learning outcome 9: Join C/steel plates, (dry). Dry welding exercises are broken down into 'stages' and include the exercises as shown below.

Learning outcome 9A: Join C/steel plates, (wet). Wet exercises are broken down into 3 basic welding techniques covering drag, oscillation and step-back.

Assessment criteria

DRY:

- Stage 1 – (Flat) exercise 1 – single run weld deposit
 exercise 2 – weaved weld deposit
 exercise 3 – pad weld
- Stage 2 - (H-V) exercise 1 – Tee joint fillet welds (single/multipass)
 exercise 2 - Lap joint fillet welds (single/multipass)
- Stage 3 – (Vertical-Up) exercise 1 – Tee joint fillet welds (single/multipass)

WET:

- 9.1: Bead on plate
 9.2: Lap joint fillet weld
 9.3: Tee joint fillet weld

Formal Assessment: On the last day of training, a formal welder qualification test(s) (fillet weld on plate) will be performed, in accordance with AWS D3.6-99M, ISO 15618-1: 2002, or BS 4872-1: 1982 Standards. In addition, the candidate will undertake a multi-choice theory examination paper.

Training Environment:

This work should be carried out using carbon steel plate in the order of 8.0mm thick. 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, using surface demand diving equipment. The tank shall have a viewing window of adequate size to allow the instructor and/or inspector to witness welding operations at all times. However, training may also be conducted in open water, providing the instructor and/or inspector can witness all welding operations.