

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. It follows the guidelines, as prescribed by the European Welding Federation (EWF) document 570-01 fillet welder - plate. The programme is accredited/certified by EAL (EMTA Awards) and is recognised by IMarEST under their CPD programme. Welder qualification testing is conducted in accordance with BSEN ISO 15618-1, or AWS D3.6-10 class B 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:

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|---------------------------------------|--|
| 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) 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

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

8.2 Identifies the ISO underwater welding standard for qualification of welder-divers

8.3 Describes underwater welding as detailed in ISO 15618-1 / AWS D3.6

8.4 Explains the basics of the following destructive weld 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, (dry). Dry welding exercises are broken down into 3 stages and include the exercises 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 – single run and weave weld deposit – pad weld - PA

Stage 2 - Tee joint fillet welds - (single/multipass) - PB

Stage 3 – Tee joint fillet welds -(single/multipass) - PF

Wet

9.1: Bead on plate - PA

9.2: Lap joint fillet weld- PB

9.3: Tee joint fillet weld- PB & PG

Formal Assessment: On the last day of training, the diver will take a welder qualification tests, in accordance with ISO 15618-1: 2002, AWS D3.6M-10, or BS 4872-1: 1982. The exact detail of this test will be confirmed on test day, but will be limited to a fillet weld on plate. This test shall be witnessed by the official approved surveyor. In addition, the candidate will also undertake a closed book, multi-choice examination paper.

Training Environment:

Training shall be carried out using plain carbon steel plates (S275) in the order of 100 x 225 x 8.0mm. The diver shall at all times be working in a team environment, using standard safe diving practices as detailed in **HSE ACop L104** or other National/International safety diving standards. The range of tools used may include either pneumatic, hydraulic or hand tools. It's highly recommended that all training be conducted in a purpose built tank, using surface supply diving equipment. The tank shall have a viewing window of adequate size to allow the instructor and/or inspector to witness welding operations. This window should be at the same viewing level as the diver. However, training may be conducted in open water, providing the instructor and/or inspector can witness all welding operations through appropriate use of cameras. Cameras shall allow for the instructor to view the diver and his orientation with regards to welding, as well as the welding arc.