



CERTIFICATION SCHEME FOR WELDING AND INSPECTION PERSONNEL

DOCUMENT NO. CSWIP-PW-6-96

Requirements for the Certification of Plastics Welders

6th Edition April 2007

**Hot gas and extrusion welding
Butt, socket and electrofusion welding of pipe
Geomembrane welding**

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CSWIP is administered by TWI Certification Ltd
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Accreditation Certificate No 25

FOREWORD

The Certification Scheme for Personnel (CSWIP) is a comprehensive scheme which provides for the examination and certification of individuals seeking to demonstrate their knowledge and/or competence in their field of operation. The scope of CSWIP includes Welding Inspectors, Welding Supervisors, Welding Instructors, Cathodic Inspection personnel, Bolting Technicians, Plant Inspectors, Underwater Inspection personnel, Plastics Welders and NDT personnel.

CSWIP is managed by the Certification Management Board, which acts as the Governing Board for Certification, in keeping with the requirements of the industries served by the scheme. The Certification Management Board, in turn, appoints specialist Management Committees to oversee specific parts of the scheme. All CSWIP Boards and Committees comprise member representatives of relevant industrial and other interests.

This document describes the requirements of a scheme for the testing and certification of personnel engaged in plastics welding.

ACCESS TO CERTIFICATION

Access to certification schemes is not improperly restricted. The sole criteria for certification are given in this document (and any subsequent amendments) and no other criteria will be applied. Certification is not conditional on the candidate applying for other services or membership from TWI Certification Ltd, its parent, or any other groups or associations.

1 GENERAL

1.1 Scope

This document specifies the method of testing the knowledge and skill of a welder who is required to carry out welds on thermoplastics in new constructions and repair work. The skill examination of a welder is an essential condition for the assurance of the quality of the welding work. The application of this document guarantees that the examination is carried out according to a uniform procedure.

Qualification testing and certification is available in accordance with the current issues of the standards listed below:

BS EN 13067: Plastics welding personnel – Qualification testing of welders – Thermoplastics welded assemblies.

AWS B2.4: Specification for welding procedure and performance qualification for thermoplastics.

Details of training and testing are contained in Appendices 1, 2 and 3.

Certification in accordance with the above standards shall be denoted Standard Level certification. The requirements for Entry Level certification, which is not in accordance with the above standards, are specified in Appendix 4.

1.2 Requirements prior to taking an approval test

Only welders whose training and/or whose previous activities show that they are likely to pass the planned test may be admitted. In addition to the conditions specified in the above standards, for geomembrane welding, a welder must have installation experience of at least 80,000 square metres of thermoplastic geomembrane, gained on at least three different projects.

2 TEST PROCEDURE

The test procedure consists of both theoretical and practical tests all of which must be supervised by an authorised Plastics Welding Examiner (PWE) (see Appendix 1).

2.1 Theoretical tests

The welder's knowledge of the practical working rules for skilful and safe working shall be established in the theoretical test.

The theoretical written test is a multiple choice paper (specific to the category of certification sought) consisting of 20 questions covering the following:

- designation and rules for welding of thermoplastics to which the test is designed to apply, meaning of the welding signs and symbols of the range of work;
- operation and monitoring of the welding equipment;
- welding processes;
- knowledge concerning on-site welding;
- correct preparation of the work pieces for welding;
- familiarity of the characteristics of thermoplastics within the sub-groups;
- preventing and correcting faults when making welds;
- knowledge concerning the types of imperfections for the applied welding process(es);
- knowledge of the welding procedure specification (WPS) and welding record sheet;
- awareness of the consequences of misapplying welding parameters and/or procedures
- knowledge of non-destructive examinations and destructive tests necessary for the applied welding process(es);
- awareness of health and safety requirements for the above work.

Completion of the theoretical test shall be continuous without access to teaching aids.

Only one theoretical test per welding method group (hot gas and extrusion welding of sheets; butt fusion, electrofusion and socket fusion welding of pipes; extrusion and heated wedge welding of geomembranes) is required to be taken, regardless of the number of categories of certification being sought.

The pass mark is 80%.

2.2 Practical tests

The welder shall complete the test piece specified by the required welding technique and material group, in accordance with the relevant WPS.

All welding equipment, materials and documents necessary to complete the test piece shall be available to the welder except for tests involving the welding of lining membranes, where the equipment and materials shall be provided by the welder.

The time taken by the welder to complete the test piece shall be specified in the Examination Declaration Form and shall correspond to that taken under production conditions.

The test piece may be examined visually by the PWE at any time during the practical test, and the test terminated at any stage if the necessary skills are not exhibited. The completed test piece shall be examined visually without magnification and shall meet the acceptance criteria specified in Evaluation Group I of the current issue of AWS G1.10M.

The test piece shall then be tested destructively, as defined in the relevant standard. Details of the practical tests specified in BS EN 13067, together with the range of approval, for each category are given in Table 1 for information. Examples of mechanical test acceptance criteria for examination test specimens are given in Table 2.

2.3 Application for tests and fees

Candidates for testing are required to submit an application form, an authenticated CV and experience checklist and, if appropriate, evidence of successful completion of a recognised course of training. Applications will not be considered confirmed until correctly completed and authenticated documents are received. In the event of a false statement being discovered in the application documentation, any testing will be declared null and void. A certificate is automatically invalidated if there are any outstanding fees in respect of that certificate.

Arrangements may be made for testing to be carried out on the employer's premises.

3 CERTIFICATION

3.1 Successful candidates

Two copies of a certificate of approval will be issued to the sponsoring organisation or person. Duplicate certificates to replace those lost or destroyed will be issued only after extensive enquiries.

3.2 Unsuccessful candidates

A standard results notice will be issued to all candidates and their sponsoring organisation. If applicable it will indicate those parts of the tests in which success has not been achieved.

Candidates who fail to obtain a certificate shall undertake further training before taking a new approval test. One retest in the part of the examination that was failed can be undertaken, providing this is done within four months from the date of the original examination. After this time, or if the retest is failed, a new approval test, comprising both theoretical and practical parts, shall be undertaken.

3.3 Initial approval

The validity of the welder's approval begins from the date when the overall assessment pass is awarded. This date may be different to the date of issue marked on the certificate.

A welder's approval shall remain valid for a period as defined in the relevant standard, providing all the following conditions are fulfilled:

- a) the welder shall be engaged with reasonable continuity on welding work within the range of approval corresponding to the approval test certificate. An interruption period for longer than six months is not permitted.
- b) the welder's work shall be in general accordance with the technical conditions under which the approval test certificate is awarded.
- c) there shall be no specific reason to question the welder's skill and knowledge.

The sponsoring organisation shall advise TWI Certification Ltd at twelve monthly intervals on each welder's activity and the welder's quality performance.

If any of these conditions are not fulfilled, the approval shall be cancelled.

3.4 Prolongation

Prolongation is only allowed when TWI Certification Ltd is advised before expiry of the period of initial approval.

Prolongation is only allowed when proof of welding quality is available to TWI Certification Ltd, who accepts that this is the case. The proof shall consist of test results from TWI Ltd or an independent, nationally accredited test house on specimens taken from a test piece appropriate to the category or categories being submitted for prolongation.

The validity within the range of approval is extended under the original approval for a further period of time, as specified in the relevant standard, provided the conditions according to 3.3 are fulfilled.

3.5 Period of validity of certificate

Approval test certificates have a period of validity of one year. A new certificate shall be awarded annually, provided that the approval is maintained in accordance with 3.3 and 3.4.

3.6 Approval test renewal

An approval test taken within three months before the expiry of the period of validity shall commence from that date of expiry.

3.7 Exemptions

Certificate holders who wish to take an examination on a different material/pipe size but on the same welding technique for which they hold a valid certificate, can be exempt from sitting the theoretical test again. In this case, the validity of approval for the new category shall be from the date of the original approval.

If a certificate holder wishes to take an examination on a different welding technique to that which they hold a valid certificate, they must take both the theoretical and practical examinations for that category. In this case, the validity of approval for the new category shall be from the date when the overall assessment pass for this category is awarded.

3.8 Validity of certificates

Certificates are only valid provided:

- a) they are within date;
- b) they are on standard cream CSWIP paper bearing the CSWIP logo in black on gold signed by an officer of CSWIP and embossed with the CSWIP stamp;
- c) they have been signed by the PWE;
- d) they have been signed by the individual to whom the certificate is awarded;
- e) they are accompanied by a valid official CSWIP identity card.

Photocopies are unauthorised by CSWIP and should only be used for internal administrative purposes.

3.9 Complaints and appeals

An aggrieved party in a dispute which considers itself to have reasonable grounds for questioning the competency of a CSWIP qualified person may petition the Governing Board for non-renewal of the certificate. Such a petition must be accompanied by all relevant facts, and if in the opinion of the Board an adequate case has been presented, a full investigation of the circumstances under dispute will be initiated. If the petition is substantiated to the satisfaction of the Board, the certificate will not be renewed without further test.

Appeals against failure to certify or against non-renewal of the certificate may be made by the welder or the employer upon application in writing to the Governing Board.

4 RECORDS

TWI Certification Ltd maintain records of successful and unsuccessful candidates. These records are accessible to the Governing Board or its nominees at all reasonable times. Full records are only held for a period of eight months from the date of the test, only outline details of the test and the results are maintained on file.

5 REFERENCES

ASTM D6392-99: 'Standard test method for determining the integrity of non-reinforced geomembrane seams produced using thermo-fusion methods.'

AWS B2.4: 'Specification for welding procedure and performance qualification for thermoplastics.'

AWS G1.10M: 'Guide for the evaluation of hot gas, hot gas extrusion, and heated tool butt thermoplastic welds.'

BS EN 12814-1:2000 'Testing of welded joints of thermoplastic semi-finished products – Part 1 bend tests.'

BS EN 12814-2: 2000 'Testing of welded joints of thermoplastic semi-finished products – Part 2: tensile tests.'

BS EN 12814-2:2000 'Testing of welded joints of thermoplastic semi-finished products –Part 2 tensile tests.' Annex B: 'Notched tensile test specimen.'

BS EN 12814-4:2001 'Testing of welded joints of thermoplastic semi-finished products –Part 4: peel tests.'

BS EN 12814-8:2001 'Testing of welded joints of thermoplastic semi-finished products – Part 8: requirements.'

BS EN 13067 'Plastics Welding Personnel – approval testing of welders – thermoplastic welded assemblies.'
ISO 17024 'Conformity Assessment - Criteria for Certification Bodies Operating Certification of Personnel.'

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For specific information on training and examinations and tests and arranging for them to be carried out, contact the approved Examination Body:

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Table 1 Details of practical tests as specified in BS EN 13067

| Material Group | Test Category | Examination test piece (Note 1) | | Welding process | Weld form (Note 2) | Position | Type of examination test (Note 1) | Range of qualification | | |
|----------------|---------------|---------------------------------|--|-----------------------------|-----------------------------|----------|-----------------------------------|--------------------------------|--------------------------|--------------------------|
| | | | | | | | | Dimensions | Type of joint | Position |
| 1 PVC | 1.1 | S | $e_n = 5$ | Hot gas - round nozzle | V | Flat | V/B _{f+r} | All e_n | V, <u>V</u> , X, \perp | All |
| | 1.2 | S | $e_n = 5$ | Hot gas - high speed nozzle | V | Flat | V/B _{f+r} | All e_n | V, <u>V</u> , X, \perp | All |
| 2 PP | 2.1 | S | $e_n = 10$ | Hot gas - high speed nozzle | X | Flat | V/B _{f+r} | All e_n | V, <u>V</u> , X, \perp | All |
| | 2.2 | S | $e_n = 10$ | Extrusion - continuous | <u>V</u> | Flat | V/B _{f+r} | $e_n \geq 3$ | <u>V</u> , X, \perp | All |
| | 2.4 | P | $d_n = 110$, SDR = 17.6 | Heated Tool |]] | Machine | V/B _r | $e_n \geq 3$ $d_n \leq 315$ |]] | Machine |
| | 2.5 | P | $d_n \geq 400$, SDR ≤ 17.6 | Heated Tool |]] | Machine | V/B _s | $d_n > 315$ |]] | Machine |
| | 2.6 | P | $d_n = 63$, SDR = 11 | Heated Tool | Socket | Machine | V/P _c | All d_n | Socket | Machine |
| | 2.7 | P | $d_n = 63$, SDR = 11 | Electrofusion | Socket | Machine | V/P _c | All d_n | Socket | Machine |
| 3 PE | 3.1 | S | $e_n = 10$ | Hot gas - high speed nozzle | X | Flat | V/B _{f+r} | All e_n | V, <u>V</u> , X, \perp | All |
| | 3.2 | S | $e_n = 10$ | Extrusion - continuous | <u>V</u> | Flat | V/B _{f+r} | $e_n \geq 3$ | <u>V</u> , X, \perp | All |
| | 3.4 | P | $d_n = 110$ (or 180) SDR = 11 (or 17.6) | Heated Tool |]] | Machine | V/T _w | $d_n \leq 315$ |]] | Machine |
| | 3.5 | P | $d_n \geq 400$, SDR ≤ 17.6 | Heated Tool |]] | Machine | V/T _w | $d_n > 315$ |]] | Machine |
| | 3.6 | P | $d_n = 90$, SDR = 11 | Electrofusion | Socket | Machine | V/P _c | $d_n \leq 225$ | Socket | Machine |
| | 3.7 | P | $d_n = 315$, SDR = 17.6 | Electrofusion | Socket | Machine | V/P _d | $d_n > 180$ | Socket | Machine |
| | 3.8 | P | $d_n = 32$ on $d_n = 90$ SDR = 11 | Electrofusion | Saddle | Machine | V/P _c | All d_n | Saddle | Machine |
| | 3.9 | P | $d_n = 63$, SDR = 11 | Heated Tool | Socket | Machine | V/P _c | All d_n | Socket | Machine |
| | 3.10 | P | $d_n = 32$ on $d_n = 90$ SDR = 11 | Heated Tool | Saddle | Machine | V/P _c | All d_n | Saddle | Machine |
| | 4 PVDF | 4.1 | S | $e_n = 4$ | Hot gas - high speed nozzle | V | Flat | V/B _{f+r} | $e_n \geq 2$ | V, <u>V</u> , X, \perp |
| 4.3 | | P | $d_n = 110$, $e_n = 5.3$ | Heated Tool |]] | Machine | V/B _r | All d_n $e_n \geq 1.9$ |]] | Machine |
| 4.4 | | P | $d_n = 63$, $e_n = 3$ | Heated Tool | Socket | Machine | V/P _c | All d_n | Socket | Machine |

| Material Group | Test Category | Examination test piece (Note 1) | | Welding process | Weld form (Note 2) | Position | Type of examination test (Note 1) | Range of qualification | | |
|--|---------------|---------------------------------|----------------------|-----------------------------|--|----------|-----------------------------------|------------------------|---------------------------------|----------|
| | | | | | | | | Dimensions | Type of joint | Position |
| 5 ECTFE or FEP or PFA | 5.1 | S | $e_n = 2.3$ | Hot gas - high speed nozzle | \underline{V} | Flat | V/T | $e_n \geq 1.6$ | V, \underline{V} , X, \perp | All |
| | 5.2 | P | $d_n = 110, e_n = 3$ | Heated Tool |]] | Machine | V/T | All d_n All e_n |]] | Machine |
| 7 PE | 7.2 | M | $e_n = 2.5$ | Hot gas by machine | Double lap | Flat | V/P _t | $1 \leq e_n \leq 5$ | Lap | Machine |
| | 7.3 | M | $e_n = 2.5$ | Heated wedge by hot gas | Double lap | Flat | V/P _t | $1 \leq e_n \leq 5$ | Lap | Machine |
| | 7.4 | M | $e_n = 2.5$ | Heated wedge - electric | Double lap | Flat | V/P _t | $1 \leq e_n \leq 5$ | Lap | Machine |
| | 7.5 | M | $e_n = 2.5$ | Extrusion - manual | Lap | Flat | V/P _t | $1 \leq e_n \leq 5$ | Lap | All |
| Note 1: / = and B = Bend test (f: face, r: root, s: side) V = Visual examination T = Tensile test (w: waisted specimen) P = Peel test (t: t-peel, d: decohesion, c: crush) S = Sheet P = Pipe | | | | | M = Membrane e_n = nominal wall thickness d_n = nominal pipe outside diameter SDR = Standard Dimension Ratio All dimensions in millimetres | | | | | |
| Note 2: \underline{V} = Single V preparation $\underline{\underline{V}}$ = Single V preparation with backing run \overline{X} = Double V preparation | | | | | \perp = Fillet weld]] = Butt weld | | | | | |

Table 2 Examples of mechanical test acceptance criteria for examination test specimens

| Material | Test Category (BS EN 13067) | Examination test piece | Welding process | Mechanical test | Mechanical test requirements | No. of specimens to be tested | Acceptance criteria | |
|--------------------------|-----------------------------|------------------------|--|-----------------------------|------------------------------|--|--|---|
| PVC | 1.1 | S | $e_n = 5$ | Hot gas - round nozzle | Bend | 30° bend angle or 7mm ram displacement | 6 initial (3 per side) + 2 additional | Max. of 1 failure from 6 specimens + 2 further passes |
| | 1.2 | S | $e_n = 5$ | Hot gas - high speed nozzle | Bend | | | |
| PP-H or PP-B | 2.1 | S | $e_n = 10$ | Hot gas - high speed nozzle | Bend | 43° bend angle or 13mm ram displacement | 4 initial + 2 additional | Max. of 1 failure from 4 specimens + 2 further passes |
| | 2.2 | S | $e_n = 10$ | Extrusion - continuous | Bend | | | |
| PP-R | 2.4 | P | $d_n = 110$, SDR = 17.6 | Heated Tool | Bend | 85° bend angle or 22mm ram displacement | 4 initial + 2 additional | Max. of 1 failure from 4 specimens + 2 further passes |
| | 2.5 | P | $d_n \geq 400$, SDR \leq 17.6 | Heated Tool | Bend (side) | 150° bend angle or 52mm ram displacement 118° bend angle or 38mm ram displacement | | |
| PP-H or PP-B | 2.5 | P | $d_n \geq 400$, SDR \leq 17.6 | Heated Tool | Bend (side) | 70° bend angle or 19mm ram displacement | | |
| PP-H, PP-B or PP-R | 2.6 | P | $d_n = 63$, SDR = 11 | Heated Tool | Peel (crush) | No fracture between pipe and fitting | 4 (2 per side) | No failures |
| | 2.7 | P | $d_n = 63$, SDR = 11 | Electrofusion | Peel (crush) | Fracture length \leq distance between first two turns of wire | | |
| PE | 3.1 | S | $e_n = 10$ | Hot gas - high speed nozzle | Bend | 65° bend angle or 19mm ram displacement | 6 initial (3 per side) + 2 additional | Max. of 1 failure from 6 specimens + 2 further passes |
| | 3.2 | S | $e_n = 10$ | Extrusion - continuous | Bend | | | |
| | 3.4 | P | $d_n = 110$ (or 180) SDR = 11 (or 17.6) | Heated Tool | Tensile (waisted) | Ductile failure mode | 4 | No failures |
| | 3.5 | P | $d_n \geq 400$, SDR \leq 17.6 | Heated Tool | Tensile (waisted) | | | |
| | 3.6 | P | $d_n = 90$, SDR = 11 | Electrofusion | Peel (crush) | Fracture length \leq distance between first two turns of wire | 4 (2 per side) | No failures |
| | 3.7 | P | $d_n = 315$, SDR = 17.6 | Electrofusion | Peel (decohesion) | \leq 25% brittle failure | 8 | No failures |
| | 3.8 | P | $d_n = 32$ on $d_n = 90$ SDR = 11 | Electrofusion | Peel (crush) | Fracture length \leq distance between first two turns of wire | 2 (1 per side) | No failures |
| | 3.9 | P | $d_n = 63$, SDR = 11 | Heated Tool | Peel (crush) | No fracture between pipe and fitting | 4 (2 per side) | No failures |
| | 3.10 | P | $d_n = 32$ on $d_n = 90$ SDR = 11 | Heated Tool | Peel (crush) | | 2 (1 per side) | No failures |

| Material | Test Category (BS EN 13067) | Examination test piece | Welding process | Mechanical test | Mechanical test requirements | No. of specimens to be tested | Acceptance criteria | |
|-------------------|-----------------------------|------------------------|------------------------|-----------------------------|------------------------------|---|---------------------------------------|---|
| PVDF | 4.1 | S | $e_n = 4$ | Hot gas - high speed nozzle | Bend | 70° bend angle or 18mm ram displacement | 6 initial (3 per side) + 2 additional | Max. of 1 failure from 6 specimens + 2 further passes |
| | 4.3 | P | $d_n = 110, e_n = 5.3$ | Heated Tool | Bend | 41° bend angle or 15mm ram displacement | 4 initial + 2 additional | Max. of 1 failure from 4 specimens + 2 further passes |
| | 4.4 | P | $d_n = 63, e_n = 3$ | Heated Tool | Peel (crush) | No fracture between pipe and fitting | 4 (2 per side) | No failures |
| ECTFE, FEP or PFA | 5.1 | S | $e_n = 2.3$ | Hot gas - high speed nozzle | Tensile | Short-term tensile weld factor ≥ 0.8 | 3 parent and 5 initial + 2 additional | Max. of 1 failure from 5 specimens + 2 further passes |
| | 5.2 | P | $d_n = 110, e_n = 3$ | Heated Tool | Tensile | | 4 parent and 4 initial + 2 additional | Max. of 1 failure from 4 specimens + 2 further passes |
| PE | 7.2 | M | $e_n = 2.5$ | Hot gas by machine | T-peel | 394N peel load and fracture in parent sheet | 7 | Max. of 2 failures |
| | 7.3 | M | $e_n = 2.5$ | Heated wedge by hot gas | T-peel | | | |
| | 7.4 | M | $e_n = 2.5$ | Heated wedge - electric | T-peel | | | |
| | 7.5 | M | $e_n = 2.5$ | Extrusion - manual | T-peel | 341N peel load and fracture in parent sheet | | |

(all dimensions in millimetres)

APPENDIX 1

Tasks and Responsibilities of Plastics Welding Examiners

1 Definition

A Plastics Welding Examiner (PWE) is a qualified person acceptable to the contracting parties who verifies the compliance with the CSWIP document for the approval testing of welders of thermoplastics.

The PWE may not be the examiner for any individual that he/she has trained and shall reach his/her professional decisions independently.

2 Tasks and Responsibilities

Note: Some of the items listed below will not apply to tests conducted under Appendix 4 of this document.

- Select the questions for the theoretical tests.
- Check the eligibility and identity of the candidate. This includes attendance on a recognised course where applicable.
- Supervise the approval test - both theoretical and practical parts including welding of the test piece(s), ensuring that normal examination conditions are maintained at all times.
- Check test materials, welding procedure specification (WPS), machines and equipment to be used.
- Identify the test pieces with the number or mark of the PWE and the candidate.
- Witness the completion of the welding record sheet by the candidate.
- Check that the completed test piece is visually acceptable before submission to the test house.
- Ensure that the test pieces are delivered to an approved test house for the specified destructive tests.
- Check the test house approval and training course approval if applicable.
- Mark the theoretical test.
- Evaluate the completed test piece, the test specimens and the results produced by the test house in accordance with prescribed procedures.
- Forward the results of both theoretical and practical tests to TWI Certification Ltd.
- Take action in the case of difficulties during the test, for example:
 - i) stop the test if the welding conditions are not in with the WPS or if it appears that the welder does not have sufficient skill to obtain a satisfactory result;
 - ii) allow tests to be restarted if difficulties arise which have not been caused by the candidate;
 - iii) allow errors during the welding practical test to be repaired if appropriate;
 - iv) allow the candidate to restart the welding process in an electro fusion test piece after cooling if appropriate and if the WPS allows it.
- Verify compliance with the conditions for prolongation of certificates and inform the Certification Body accordingly if the conditions are satisfied so that a new certificate can be issued.

3 Authority

The PWE acts only on the written authority of TWI Certification Ltd obtained through the Plastics Welder Certification Management Committee. PWEs seeking such authority must apply to the Certification Body. The performance of PWEs is subject to monitoring and audit by TWI Certification Ltd.

APPENDIX 2

Examination Syllabus

- 1 Hot Gas Welding**
 - 1.1 Health and safety**

Electrical safety; fume; care and use of electrical/hand tools and lifting tackle commonly used by the welder; heat burns and fire.
 - 1.2 Plastic materials**

Molecules and polymer chains; plastic material classification; copolymers; glass transition temperature.
 - 1.3 Common thermoplastics for fabrication**

Polyethylene; polypropylene; polyvinylchloride; polyvinylidene fluoride.
 - 1.4 Materials identification**

Simple manual test; fourier transform infrared spectroscopy (FTIR).
 - 1.5 Processing of plastics**

Injection moulding; extrusion; blow moulding.
 - 1.6 Joint types and symbols**

Common joint type used in thermoplastic fabrications; symbols for welded joints.
 - 1.7 Welding processes**

Process; equipment; applications.
 - 1.8 Welding procedure**

Setting the gun; hand tools; preparation of materials; hand welding; speed welding; filling the weld; finishing the weld.
 - 1.9 Welding procedure specification and welding record sheet**
 - 1.10 Inspection**

Visual inspection; spark testing; dye penetrant test.
 - 1.11 Destructive testing**

Bend testing; tensile testing.
 - 1.12 Certification**
- 2 Butt and Socket Fusion Welding**
 - 2.1 Health and safety**

Heat burns; fume; machine safety; pipe and fittings storage; handling of pipe and equipment.

2.2 **Plastic materials**

Molecules and polymer chains; plastic material classification; copolymers; glass transition temperature.

2.3 **Common thermoplastic materials for plastic pipe**

Polypropylene; polyethylene; polyvinylidene fluoride.

2.4 **Pipe and fittings identification**

Standards; identification markings – fittings, pipe; materials identification.

2.5 **Processing of plastics**

Injection moulding; extrusion.

2.6 **Plastics pipe welding processes**

Butt fusion welding; socket fusion welding.

2.7 **Welding Procedures**

Welding procedures and records; manual butt fusion welding; manual socket fusion welding; machine socket fusion welding.

2.8 **Testing of Welded Joints**

Visual inspection; non-destructive testing; destructive testing.

2.9 **Certification**

3 **Electrofusion Welding**

3.1 **Health and safety**

Electrical safety; use of 240V and 110V equipment; care and use of tools commonly used by the welder; pipe and fittings storage; handling of pipe, fittings and equipment.

3.2 **Plastic materials**

Molecules and polymer chains; plastic material classification; copolymers; glass transition temperature.

3.3 **Common thermoplastic materials for plastic pipe**

Polyethylene; polypropylene.

3.4 **Pipe and fittings identification**

Identification markings – fittings, pipe; materials identification.

3.5 **Processing of plastics**

Injection moulding; extrusion.

3.6 **Welding process**

3.7 **Welding procedure**

3.8 **Testing of welded joints**

Visual inspection; non-destructive testing; destructive testing.

3.9 **Certification**

4 **Geomembrane Welding**

4.1 **Health and safety**

Electrical safety; use of 240V and 110V equipment; fume; care and use of electrical/hand tools and lifting tackle commonly used by the welder; heat burns and fire.

4.2 **Materials technology**

Molecules and polymer chains; plastic material classification; copolymers; glass transition temperature.

4.3 **Thermoplastic geomembranes**

Geomembranes; manufacture; polyvinylchloride; polyethylene; polypropylene.

4.4 **Welded joints and terminology**

Materials; joint types; symbols.

4.5 **Thermal fusion processes**

Principles of heated wedge welding; joint preparation; welding parameters; principles of hot air welding; equipment cleaning and maintenance; welding documentation.

4.6 **Extrusion and manual hot air welding**

Joint preparation; principles of extrusion welding; welding parameters; repairs; connections to pipes and structures; welding documentation.

4.7 **Testing of welded joints**

Destructive testing; failure modes; non-destructive testing.

4.8 **Weld quality**

Types of imperfection; origins of imperfections.

4.9 **Site working**

Cleaning procedures; weather protection; handling of materials; subgrade acceptance.

4.10 **Related Geosynthetic Materials**

Geosynthetic clay liners; geotextiles; geonet; geocomposite.

4.11 **Certification**

APPENDIX 3

Specimen Questions for the Theoretical Test

Candidates are required to tick the correct answer in the section provided. There is only one correct answer for each question.

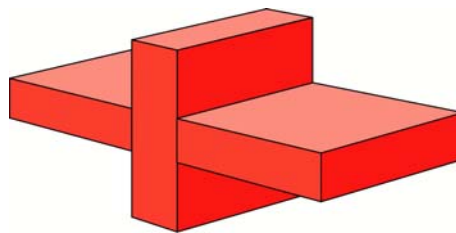
1. What does OEL stand for?

Occupational Exposure Law

Ozone Exposure Limits

Occupational Exposure Limits

Occupational Ethylene Limits



2. The above picture shows which joint type?

Butt joint

T joint

Edge joint

Cruciform joint

3. Why would you adjust the speed of an electric hot wedge-welding machine during welding?

To get the site work finished quickly

To compensate for ambient temperature fluctuations

To prevent the equipment stalling

To ensure constant speed

APPENDIX 4

Requirements for Entry Level Certification of Thermoplastics Welders

1 SCOPE

The categories of certification described in this appendix are classified as 'Entry Level' because they do not require evidence of training or experience prior to taking the test.

Certification in accordance with this Appendix is deemed to satisfy the 'Level 2' qualification standard of the UK Environment Agency for welding PE lining membrane.

Unless otherwise stated, the provisions of the main part of this document apply.

2 TEST PROCEDURE

2.1 Hot gas and extrusion welding of sheet

The test procedure consists of a practical test only, which must be supervised by an authorised PWE.

The welder shall complete the test piece specified by the required sub-group, see Clause 4, and according to the relevant test piece geometries specified in Figures 1 and 3 of BS EN 13067 and in Table A1, in accordance with the relevant WPS.

2.2 Welding of pipe

The test procedure consists of both theoretical and practical tests, all of which must be supervised by an authorised PWE.

2.2.1 Theoretical test

The theoretical written test is a multiple choice paper (specific to the category of certification sought) consisting of 20 questions covering the following:

- operation and monitoring of equipment;
- knowledge concerning on-site welding;
- correct preparation of the pipes for welding;
- preventing and correcting faults when making welds;
- knowledge concerning the types of imperfections in pipe welds;
- knowledge of the welding procedure specification (WPS) and welding record sheet;
- awareness of the consequences of misapplying welding parameters and/or procedures;
- awareness of health and safety requirements for pipe welding processes.

Completion of the theoretical test shall be continuous without access to teaching aids.

The pass mark is 80%.

2.2.2 Practical test

The welder shall complete the test piece specified by the required sub-group, see Clause 4, and according to the relevant test piece geometries specified in Figures 2, 4 and 5 of BS EN 13067 and in Table A2, in accordance with the relevant WPS.

For Category 3.4, tests shall be carried out using either automatic or semi-automatic welding machines.

The test piece shall be subjected to a visual examination only and shall meeting the acceptance criteria specified in Evaluation Group I of the current issue of AWS G1.10M.

2.3 Welding of PE lining membrane

The test procedure consists of a practical test only, which must be supervised by an authorised PWE.

The welder shall complete the test piece specified by the required sub-group, see Clause 4, and according to the relevant test piece geometries specified in Figures 7 and 8 of BS EN 13067 and in Table A3, in accordance with the relevant WPS.

3 APPLICATION FOR TESTS

Candidates for testing are required to submit an application form.

4 CATEGORIES OF CERTIFICATION

Successful completion of the test will lead to certification in one or more of the following categories:

Hot gas and extrusion welding of sheet

- 1.1 Hot gas, round nozzle welding of PVC sheet – Entry Level
- 1.2 Hot gas, high speed nozzle welding of PVC sheet – Entry Level
- 2.1 Hot gas, high speed nozzle welding of PP sheet – Entry Level
- 2.2 Continuous extrusion welding of PP sheet – Entry Level
- 3.1 Hot gas, high speed nozzle welding of PE sheet – Entry Level
- 3.2 Continuous extrusion welding of PE sheet – Entry Level
- 4.1 Hot gas high speed nozzle welding of PVDF sheet – Entry Level
- 5.1 Hot gas high speed nozzle welding of ECTFE, PFA or FEP sheet – Entry Level

Butt fusion and electrofusion welding of pipe

- 2.4 Heated tool welding of PP pipe (Diameter \leq 315mm) – Entry Level
- 2.5 Heated tool welding of PP pipe (Diameter $>$ 315mm) – Entry Level
- 2.7 Electrofusion welding of PP pipe – Entry Level
- 3.4 Heated tool welding of PE pipe (Diameter \leq 315mm) – Entry Level
- 3.5 Heated tool welding of PE pipe (Diameter $>$ 315mm) – Entry Level
- 3.6 Electrofusion welding of PE pipe (Diameter \leq 225mm) – Entry Level
- 3.7 Electrofusion welding of PE pipe (Diameter $>$ 180mm) – Entry Level
- 3.8 Electrofusion saddle welding of PE pipe – Entry Level
- 4.3 Heated tool welding of PVDF pipe – Entry Level
- 5.2 Heated tool welding of ECTFE, FEP or PFA pipe – Entry Level

Heated wedge and extrusion welding of PE lining membrane

- 7.4 Machine Hot Wedge welding of PE lining membrane (electric heated wedge) – Entry Level
- 7.5 Extrusion welded PE lining membrane lap joint - Entry Level

5 CERTIFICATION

5.1 Period of validity of approval

Entry Level approval is only valid for a maximum of four years. At the end of this period a welder cannot renew his/her Entry Level approval. Any further approval must be to Standard Level.

5.2 Prolongation

Prolongation is only allowed when proof of welding quality is available to TWI Certification Ltd, who accepts that this is the case. For butt fusion and electrofusion welding of pipe, the proof shall consist of a welded test piece appropriate to the category or categories being submitted for prolongation.

5.3 Exemptions

Holders of sheet or lining membrane Entry Level certificates who have sufficient experience and wish to take the Standard Level approval test on the same welding technique(s) for which they hold a valid certificate, can be exempt from sitting the practical test again providing the Standard Level approval test takes place within four months of the Entry Level approval test.

Table A1 Entry Level categories for hot gas and extrusion welding of sheet

| Material | Test Category | Examination test piece | Welding process | Weld form |
|----------------------|---------------|------------------------|-----------------------------|-----------|
| PVC | 1.1 | $e_n = 5$ or 6 | Hot gas – round nozzle | V |
| | 1.2 | $e_n = 5$ or 6 | Hot gas – high speed nozzle | V |
| PP | 2.1 | $e_n = 9$ or 10 | Hot gas – high speed nozzle | X |
| | 2.2 | $e_n = 9$ or 10 | Extrusion - continuous | <u>V</u> |
| PE | 3.1 | $e_n = 9$ or 10 | Hot gas – high speed nozzle | X |
| | 3.2 | $e_n = 9$ or 10 | Extrusion – continuous | <u>V</u> |
| PVDF | 4.1 | $e_n = 4$ | Hot gas – high speed nozzle | V |
| ECTFE, FEP or PFA | 5.1 | $e_n = 2.3$ | Hot gas – high speed nozzle | <u>V</u> |

(all dimensions in millimetres)

Table A2 Entry Level categories for welding of pipe

| Material | Test Category | Examination test piece | Welding process | Weld form |
|----------------------|---------------|--|-----------------|-----------|
| PP | 2.4 | $110 \leq d_n \leq 180, SDR \leq 17.6$ | Heated tool | II |
| | 2.5 | $d_n \geq 400, SDR \leq 17.6$ | Heated tool | II |
| | 2.7 | $d_n = 63, SDR \leq 17.6$ | Electrofusion | Socket |
| PE | 3.4 | $110 \leq d_n \leq 180, SDR \leq 17.6$ | Heated tool | II |
| | 3.5 | $d_n \geq 400, SDR \leq 17.6$ | Heated tool | II |
| | 3.6 | $d_n = 90, SDR \leq 17.6$ | Electrofusion | Socket |
| | 3.7 | $d_n \geq 315, SDR \leq 17.6$ | Electrofusion | Socket |
| | 3.8 | $d_n = 32$ on $d_n \geq 90, SDR \leq 17.6$ | Electrofusion | Saddle |
| PVDF | 4.3 | $63 \leq d_n \leq 110$ | Heated tool | II |
| ECTFE, FEP or PFA | 5.2 | $63 \leq d_n \leq 110$ | Heated tool | II |

(all dimensions in millimetres)

Table A3 Entry Level categories for welding of PE lining membrane

| Test Category | Examination test piece | Welding process | Weld form |
|---------------|------------------------|-------------------------|------------|
| 7.4 | $e_n = 2.0$ or 2.5 | Heated wedge - electric | Double lap |
| 7.5 | $e_n = 2.0$ or 2.5 | Extrusion - manual | Lap |

(all dimensions in millimetres)