



**CERTIFICATION SCHEME FOR WELDING AND INSPECTION PERSONNEL**

## **DOCUMENT NO. CSWIP-PW-6-96**

# **Requirements for the Certification of Plastics Welders**

3<sup>rd</sup> Edition January 2003

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

Issued under the authority of the Governing Board for Certification  
All correspondence should be addressed to:

TWI Certification Ltd  
Granta Park  
Great Abington  
Cambridge CB1 6AL  
United Kingdom

Tel: +44 (0) 1223 891162  
Fax: +44 (0) 1223 894219  
E:mail:twicertification@twi.co.uk.  
Web:http://www.cswip.com

CSWIP is administered by TWI Certification Ltd  
The use of the UKAS Accreditation Mark indicates accreditation in respect of those activities covered by  
Accreditation Certificate No 25

## **FOREWORD**

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

The Certification Body for CSWIP is TWI Certification Ltd and the Certification Management Board is the Governing Board for all the certification schemes operated by TWI Certification Ltd. TWI Certification Ltd is accredited to EN 45013 <sup>(1)</sup> under the National Accreditation for Certification Bodies (NACB) scheme which is an activity of the United Kingdom Accreditation Service (UKAS).

CSWIP certificates are generally well recognised by many different national bodies, including purchasers of welded plant and inspection authorities.

## **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. Details of training and testing are contained in Appendices 1, 2 and 3. Most of the categories of certification described in the document comply with EN 13067.<sup>(2)</sup> The only exceptions are the Entry level certification requirements for Thermoplastic Geomembrane welders, see Appendix 4.

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.

The scope comprises hot gas, extrusion, butt, socket, electrofusion and geomembrane welding of a range of plastics.

### **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. As a rule this is the case if one of the following conditions is met:

- 1.2.1 Completed a recognised Apprenticeship scheme as a plastics fabricator.
- 1.2.2 At least two years' experience in the relevant welding technique (company's certificate). For geomembrane welding, this must include installation experience of at least 80,000 square metres of thermoplastic geomembrane, gained on at least three different projects.
- 1.2.3 Completed a CSWIP approved technical and practical training course, followed by at least six months of on-the-job training supervised by a welder with a certificate in the relevant welding technique.

## **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 (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.

The pass mark is 80%.

## 2.2 Practical tests

The welder shall complete the test piece specified by the required sub-group, see Table 1, in accordance with the relevant WPS.

All welding equipment, materials and documents necessary to complete the test piece shall be available to the welder.

The time taken by the welder to complete the test piece shall correspond to that taken under production conditions.

## 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 CATEGORIES OF CERTIFICATION

Successful completion of the theoretical and practical tests will lead to certification in one or more of the following categories:

### **Hot gas and extrusion welding**

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

There is only one written test regardless of the number of categories of certification being sought in one sitting. Approval for hot gas welding of pipe is automatic when the welder is tested on flat sheet.

### **Butt, socket and electrofusion welding of pipe**

- 2.4 Heated tool welding of PP pipe (Diameter  $\leq 315$ mm)
- 2.5 Heated tool welding of PP pipe (Diameter  $> 315$ mm)
- 2.6 Heated socket welding of PP pipe
- 2.7 Electrofusion welding of PP pipe
- 3.4 Heated tool welding of PE pipe (Diameter  $\leq 315$ mm)
- 3.5 Heated tool welding of PE pipe (Diameter  $> 315$ mm)
- 3.6 Electrofusion welding of PE pipe (Diameter  $\leq 225$ mm)
- 3.7 Electrofusion welding of PE pipe (Diameter  $> 180$ mm)
- 3.8 Electrofusion saddle welding of PE pipe
- 3.9 Heated socket welding of PE pipe
- 3.10 Heated saddle welding of PE pipe
- 4.3 Heated tool welding of PVDF pipe
- 4.4 Heated socket welding of PVDF pipe
- 5.2 Heated tool welding of ECTFE/FEP/PFA pipe

### **Geomembrane welding**

- 7.2 Machine Hot Gas welding of PE lining membrane
- 7.3 Machine Hot Wedge welding of PE lining membrane (hot gas heated wedge)
- 7.4 Machine Hot Wedge welding of PE lining membrane (electric heated wedge)
- 7.5 Extrusion welded PE lining membrane lap joint.

The details of the practical tests for each of these categories are shown in Table 1 and the figures and the range of approval as a result of success in each test is shown in Table 2.

## **4 CERTIFICATION**

### **4.1 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.

### **4.2 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, a new approval test, comprising both theoretical and practical parts, shall be undertaken.

#### 4.3 **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 of two years 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.

#### 4.4 **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 accept that this is the case. The validity within the range of approval is extended under the original approval for a further two years provided the conditions according to 4.3 are fulfilled. Only one prolongation is allowed. When this expires, a new approval test is required.

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

#### 4.5 **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 individual to whom the certificate is awarded
- d) they are accompanied by a valid official CSWIP identity card.

**PHOTOCOPIES ARE UNAUTHORISED BY CSWIP** and should only be used for internal administrative purposes.

#### 4.6 **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.

## 5 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.

## 6 REFERENCES

- 1 EN 45013 'Criteria for Certification Bodies Operating Certification of Personnel.'
- 2 EN 13067 'Plastics Welding Personnel – approval testing of welders – thermoplastic welded assemblies.'
- 3 BS EN 12814-1:2000 'Testing of welded joints of thermoplastic semi-finished products – Part 1 bend tests.'
- 4 BS EN 12814-2:2000 'Testing of welded joints of thermoplastic semi-finished products –Part 2 tensile tests.'
- 5 BS EN 12814-4:2001 'Testing of welded joints of thermoplastic semi-finished products –Part 4: peel tests.'
- 6 BS EN 12814-8:2001 'Testing of welded joints of thermoplastic semi-finished products – Part 8: requirements.'
- 7 ASTM D6392-99 'Standard test method for determining the integrity of non-reinforced geomembrane seams produced using thermo-fusion methods.'

## ADDRESSES

For further general information contact:

TWI Certification Ltd  
Granta Park  
Great Abington  
Cambridge CB1 6AL, UK

Phone: +44 (0) 1223 891162  
Telefax: +44 (0) 1223 894219  
E: mail: [twicertification@twi.co.uk](mailto:twicertification@twi.co.uk)

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

TWI North  
Aurora Court  
Barton Road  
Riverside Park  
Middlesbrough TS2 1RY

Phone: +44 (0) 1642 210512  
Telefax: +44 (0) 1642 252218  
E: mail: [twinorth@twi.co.uk](mailto:twinorth@twi.co.uk)

**TABLE 1 – Categories of Practical Test**

Material	Test Category	Type of product (Note 1)		Welding process	Weld form (Note 2)	Position	Type of examination Test (Note 1)	Test piece according to figure
1 PVC	1.1	S	$e_n = 5$	Hot gas - Round nozzle	V	Flat	V/B f + r	1
	1.2	S	$e_n = 5$	Hot gas - High speed nozzle	V	Flat	V/B f + r	1
2 PP	2.1	S	$e_n = 10$	Hot gas - High speed nozzle	X	Flat	V/B f + r	1
	2.2	S	$e_n = 10$	Extrusion – Continuous	<u>V</u>	Flat	V/B f + r	1
	2.4	P	$d_n = 110$ SDR = 17.6	Heated Tool	Butt	Machine	V/B r	2
	2.5	P	$d_n \geq 400$ SDR $\leq 17.6$	Heated Tool	Butt	Machine	V/B s	2
	2.6	P	$d_n=63,$ SDR=11	Heated Tool	Socket	Machine	V/P c	3
	2.7	P	$d_n=63,$ SDR=11	Electrofusion	Socket	Machine	V/P c	3
3 PE	3.1	S	$e_n = 10$	Hot gas - High speed nozzle	X	Flat	V/B f + r	1
	3.2	S	$e_n = 10$	Extrusion - Continuous	<u>V</u>	Flat	V/B f + r	1
	3.4	P	$d_n = 110$ (or 180), SDR =11 (or 17.6)	Heated Tool	Butt	Machine	V/T	2
	3.5	P	$d_n \geq 400,$ SDR $\leq 17.6$	Heated Tool	Butt	Machine	V/T	2
	3.6	P	$d_n = 90,$ SDR = 11	Electrofusion	Socket	Machine	V/P d	3
	3.7	P	$d_n = 315,$ SDR = 17.6	Electrofusion	Socket	Machine	V/P d	3
	3.8	P	$d_n= 32$ (or 90), SDR=11	Electrofusion	Saddle	Machine	V/P d	4
	3.9	P	$d_n = 63,$ SDR = 11	Heated Tool	Socket	Machine	V/P c	3
	3.10	P	$d_n = 32$ (or 90), SDR=11	Heated Tool	Saddle	Machine	V/P c	4
	4 PVDF	4.1	S	$e_n = 4$	Hot gas - High speed nozzle	V	Flat	V/B f + r

Material	Test Category	Type of product (Note 1)		Welding process	Weld form (Note 2)	Position	Type of examination Test (Note 1)	Test piece according to figure
	4.3	P	d <sub>n</sub> = 110, e <sub>n</sub> = 5.3	Heated Tool	Butt	Machine	V/B r	2
	4.4	P	d <sub>n</sub> = 63, e <sub>n</sub> = 3	Heated Tool	Socket	Machine	V/P c	3
5 ECTFE or FEP or PFA	5.1	S	e <sub>n</sub> = 2.3	Hot gas - High speed nozzle	V	Flat	V/T	5
	5.2	P	d <sub>n</sub> = 110, e <sub>n</sub> = 3	Heated Tool	Butt	Machine	V/T	2
7 PE	7.2	M	e <sub>n</sub> = 2.5	Hot gas by machine	Double lap	Flat	V/P t	6
	7.3	M	e <sub>n</sub> = 2.5	Heated wedge by hot gas	Double lap	Flat	V/P t	6
	7.4	M	e <sub>n</sub> = 2.5	Heated wedge electric	Double lap	Flat	V/P t	6
	7.5	M	e <sub>n</sub> = 2.5	Extrusion manual	Lap	Flat	V/P t	7

**Note 1:** “/” = and  
“B” = Bend test (f:face, r:root, s:side(for thick materials))  
“V” = Visual examination  
“T” = Tensile test  
“P” = Peel test (t:t-peel, d:decohesion, c:crush)  
“S” = Sheet  
“P” = Pipe  
“M” = Membrane  
“e<sub>n</sub>” = nominal wall thickness  
“d<sub>n</sub>” = nominal pipe outside diameter  
“SDR” = Standard Dimension Ratio  
All dimensions in millimetres

**Note 2:** V = Single V preparation, X = Double V preparation, V = Single V preparation with backing run.

**TABLE 2: Range of approval resulting from successful completion of the test**

Range of approval			
Category	Dimensions	Type of joint	Position
1.1	All $e_n$	V, $\underline{V}$ , X, $\perp$	All
1.2	All $e_n$	V, $\underline{V}$ , X, $\perp$	All
2.1	All $e_n$	V, $\underline{V}$ , X, $\perp$	All
2.2	$e_n \geq 3$	$\underline{V}$ , X, $\perp$	All
2.4	$e_n \geq 3, d_n \leq 315$	Butt	Machine
2.5	$d_n > 315$	Butt	Machine
2.6	All $d_n$	Socket	All
2.7	All $d_n$	Socket	All
3.1	All $e_n$	X, V, $\underline{V}$ , $\perp$	All
3.2	$e_n \geq 3$	$\underline{V}$ , X, $\perp$	All
3.4	$d_n \leq 315$	Butt	Machine
3.5	$d_n > 315$	Butt	Machine
3.6	$d_n \leq 225$	Socket	All
3.7	$d_n > 180$	Socket	All
3.8	All $d_n$	Saddle	All
3.9	All $d_n$	Socket	All
3.10	All $d_n$	Saddle	All
4.1	$e_n \geq 2$	V, $\underline{V}$ , X, $\perp$	All
4.3	All $d_n, e_n \geq 1.9$	Butt	Machine
4.4	All $d_n$	Socket	All
5.1	$e_n \geq 1.6$	$\underline{V}$ , X, $\perp$ , V	All
5.2	All $d_n$ and $e_n$	Butt	Machine
7.2	$1 \leq e_n \leq 5$	Lap	Machine
7.3	$1 \leq e_n \leq 5$	Lap	Machine
7.4	$1 \leq e_n \leq 5$	Lap	Machine
7.5	$1 \leq e_n \leq 5$	Lap	All

Symbols are defined in Table 1.

Approval for hot gas welding of pipe is automatic when welder is tested on flat sheet.

All dimensions are in millimetres.

**TABLE 3: Test requirements**

Category	Test Type	Requirement <sup>(6)</sup>	Type of Requirement
1.1	Bend <sup>(3)</sup>	30° or 7mm	Bend angle or Ram Displacement
1.2	Bend <sup>(3)</sup>	30° or 7mm	Bend angle or Ram Displacement
2.1	Bend <sup>(3)</sup>	43° or 13mm	Bend angle or Ram Displacement
2.2	Bend <sup>(3)</sup>	43° or 13mm	Bend angle or Ram Displacement
2.4	Bend <sup>(3)</sup>	150° or 52mm	Bend angle or Ram Displacement
2.5	Bend <sup>(3)</sup>	Depends on wall thickness	Bend angle or Ram Displacement
2.6	Peel <sup>(5)</sup>	No fracture between pipe and fitting	Fracture length
2.7	Peel <sup>(5)</sup>	Fracture length $\leq$ distance between first two turns of wire	Fracture length
3.1	Bend <sup>(3)</sup>	65° or 19mm	Bend angle or Ram Displacement
3.2	Bend <sup>(3)</sup>	65° or 19mm	Bend angle or Ram Displacement
3.4	Tensile <sup>(4)</sup>	Ductile <sup>(2)</sup>	Failure mode
3.5	Tensile <sup>(4)</sup>	Ductile <sup>(2)</sup>	Failure mode
3.6	Peel <sup>(5)</sup>	$\leq$ 25% Brittle failure	Fracture length
3.7	Peel <sup>(5)</sup>	$\leq$ 25% Brittle failure	Fracture length
3.8	Peel <sup>(5)</sup>	$\leq$ 25% Brittle failure	Fracture length
3.9	Peel <sup>(5)</sup>	No fracture between pipe and fitting	Fracture length
3.10	Peel <sup>(5)</sup>	No fracture between pipe and fitting	Fracture length
4.1	Bend <sup>(3)</sup>	70° or 18mm	Bend angle or Ram Displacement
4.3	Bend <sup>(3)</sup>	41° or 15mm	Bend angle or Ram Displacement
4.4	Peel <sup>(5)</sup>	No fracture between pipe and fitting	Fracture length
5.1	Tensile <sup>(4)</sup>	$\geq$ 0.8	Short-term tensile welding factor
5.2	Tensile <sup>(4)</sup>	$\geq$ 0.8	Short-term tensile welding factor
7.2	Peel <sup>(5)</sup>	394N	Peel load
		Fracture in parent sheet <sup>(7)</sup>	Failure location
7.3	Peel <sup>(5)</sup>	394N	Peel load
		Fracture in parent sheet <sup>(7)</sup>	Failure location
7.4	Peel <sup>(5)</sup>	394N	Peel load
		Fracture in parent sheet <sup>(7)</sup>	Failure location
7.5	Peel <sup>(5)</sup>	341N	Peel load
		Fracture in parent sheet <sup>(7)</sup>	Failure location

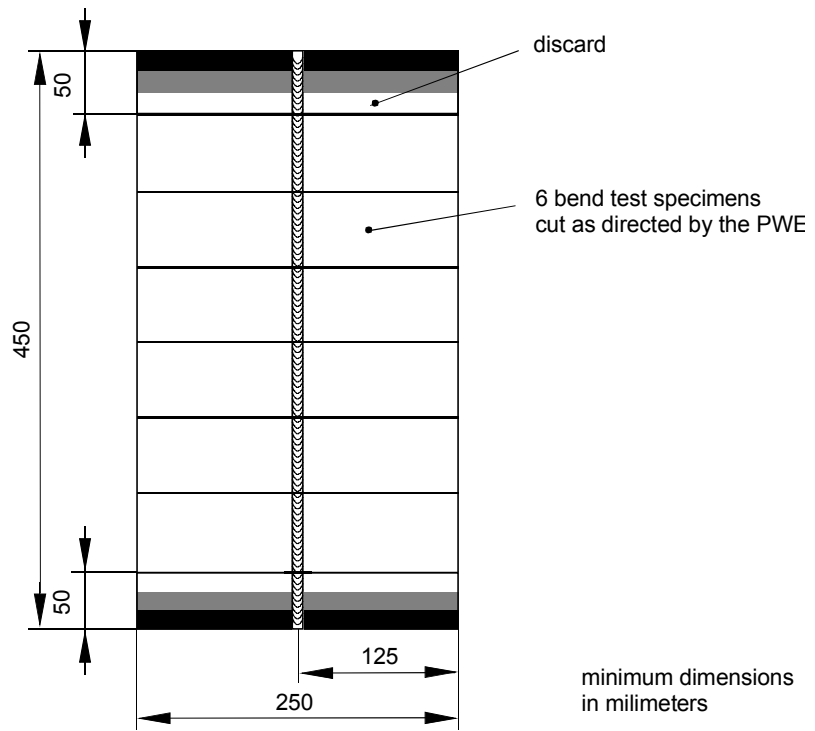


Figure 1: Test piece for a butt weld on sheet (for bend test specimens)

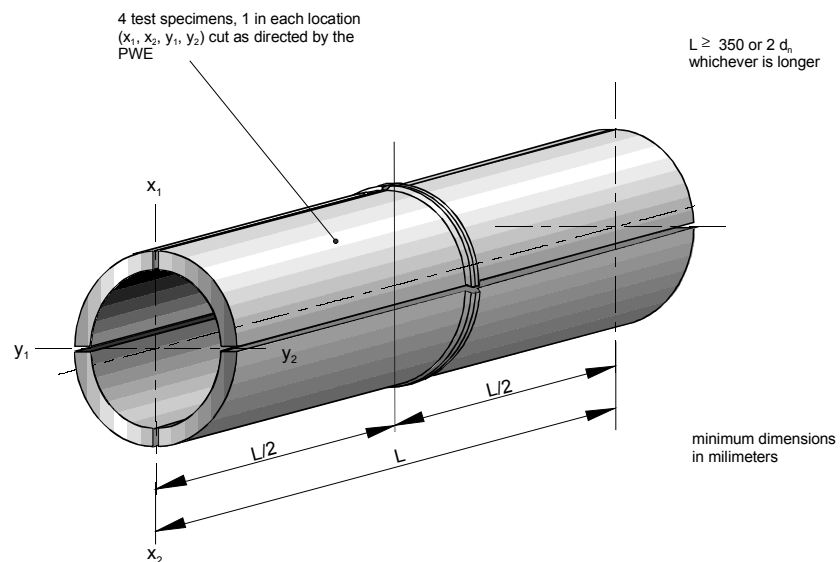


Figure 2: Test piece for a butt weld on pipe (for bend or tensile test specimens)

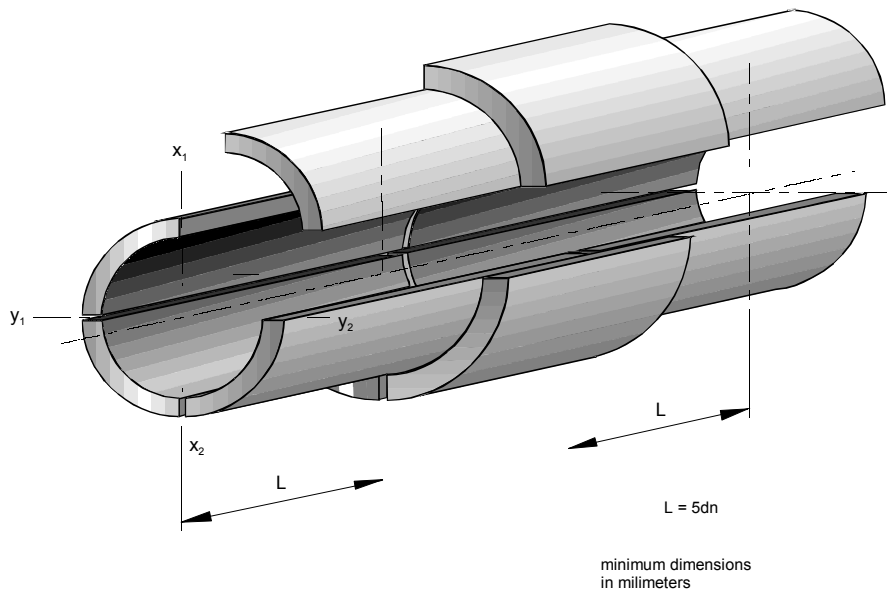


Figure 3: Test piece for a socket weld.

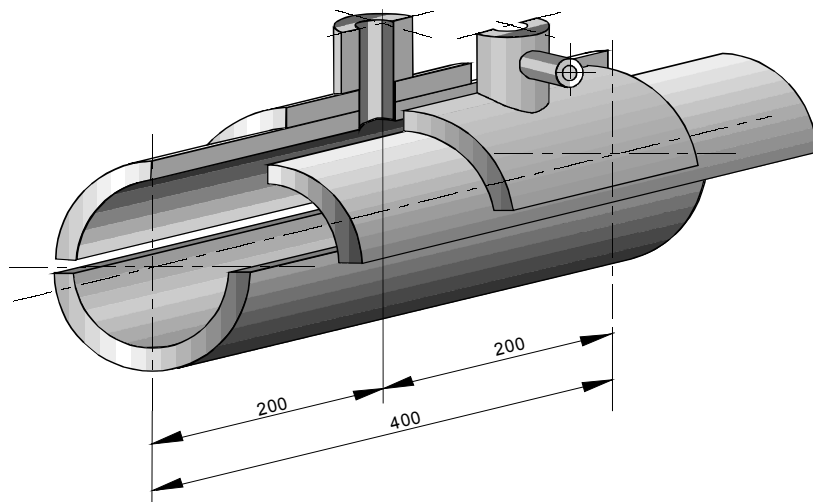


Figure 4: Test piece for a saddle weld

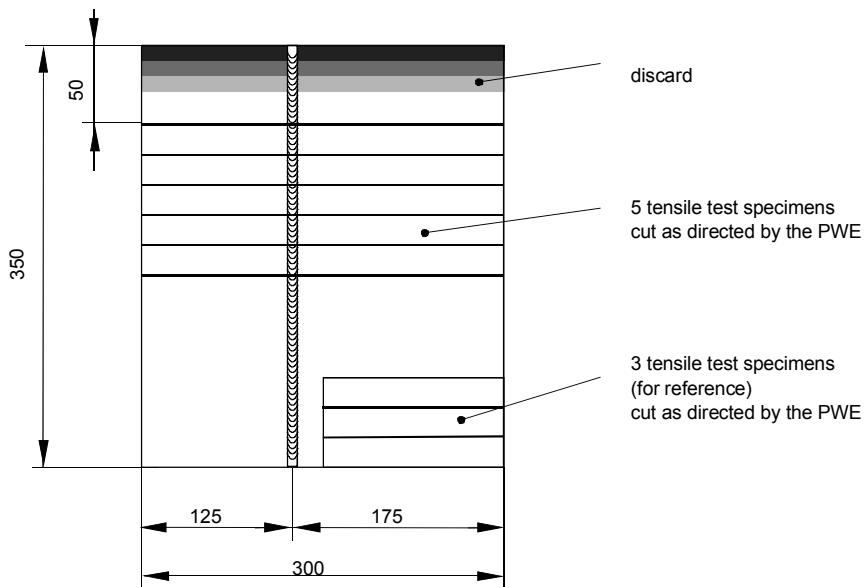
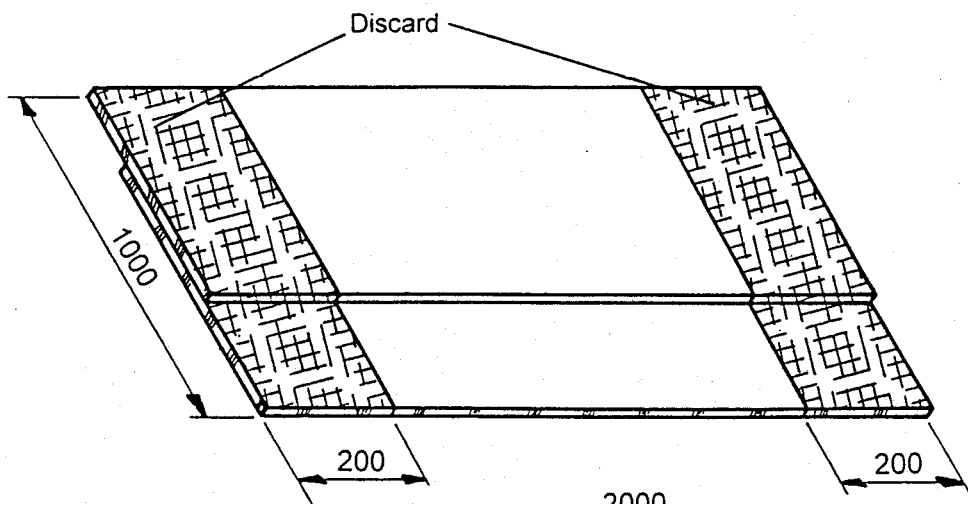
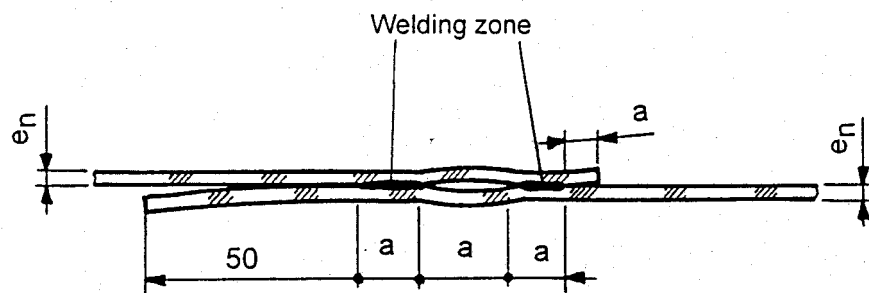


Figure 5: Test piece for butt weld on sheet (for tensile test specimens)

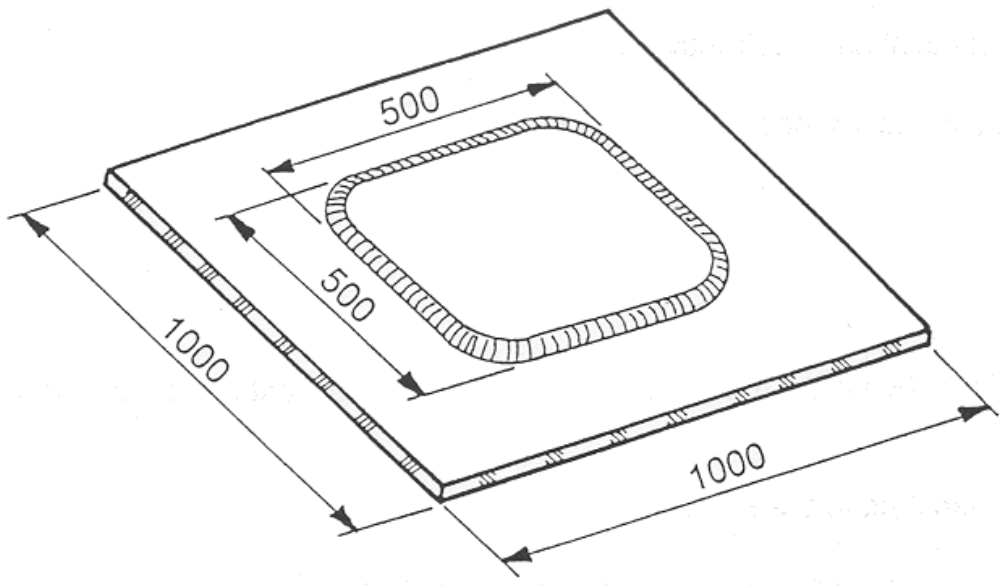


5 peel test specimens cut as directed by the PWE



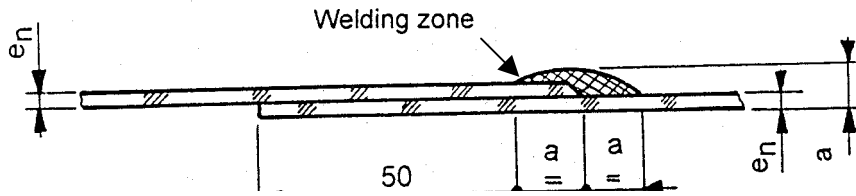
The dimensions 'a' are dictated by the machine Weld Procedure Sheet

Figure 6: Test piece for lining membranes - lap seam with testing channel.



minimum dimensions in mm

5 peel test specimens cut as directed by the PWE



The dimensions 'a' are dictated by the Weld Procedure Sheet employed

Figure 7: Test piece for lining membranes - lap seam extrusion welded

## 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.

- 2.1 Select the questions for the theoretical tests.
- 2.2 Check the eligibility and identity of the candidate. This includes attendance on a recognised course where applicable.
- 2.3 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.
- 2.4 Check test materials, welding procedure specification (WPS), machines and equipment to be used.
- 2.5 Identify the test pieces with the number or mark of the PWE and the candidate.
- 2.6 Witness the completion of the welding record sheet by the candidate.
- 2.7 Check that the completed test piece is visually acceptable before submission to the test house.
- 2.8 Ensure that the test pieces are delivered to an approved test house for the specified destructive or non-destructive tests.
- 2.9 Check the test house approval and training course approval if applicable.
- 2.10 Mark the theoretical test.
- 2.11 Evaluate the completed test piece, the test specimens and the results produced by the test house in accordance with prescribed procedures.
- 2.12 Forward the results of both theoretical and practical tests to TWI Certification Ltd.

2.13 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.

2.14 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. PWE's 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:**

### **HOT GAS WELDING**

#### **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

#### **2 Plastic Materials**

Molecules and polymer chains  
Plastic material classification  
Copolymers  
Glass transition temperature

#### **3 Common Thermoplastics for Fabrication**

Polyethylene (PE)  
Polypropylene (PP)  
Polyvinylchloride (PVC)  
Polyvinylidene fluoride (PVDF)

#### **4 Materials Identification**

Simple manual test  
Fourier transform infrared spectroscopy (FTIR)

#### **5 Processing of Plastics**

Injection moulding  
Extrusion  
Blow moulding

#### **6 Joint Types and Symbols**

Common joint type used in thermoplastic fabrications  
Symbols for welded joints

#### **7 Welding Processes**

Process  
Equipment  
Applications

#### **8 Welding Procedure**

Setting the gun  
Hot gas welding – hand tools  
Welding procedure – preparation of materials  
Welding procedure – hand welding

Welding procedure – speed welding  
Welding procedure – filling the weld  
Welding procedure – finishing the weld

9 **Welding Procedure Specification and Welding Record Sheet**

10 **Inspection**

Visual inspection  
Spark testing  
Dye penetrant test

11 **Destructive Testing**

Bend testing  
Tensile testing

12 **Certification**

**BUTT AND SOCKET FUSION WELDING**

1 **Health and Safety**

Personnel  
Machine design  
Maintenance, servicing and calibration  
Siting the equipment

2 **Plastic Materials**

Molecules and polymer chains  
Plastic material classification  
Copolymers  
Glass transition temperature

3 **Common Thermoplastic Materials for Plastic Pipe**

Polypropylene  
Polyethylene  
Polyvinylidene fluoride (PVDF)

4 **Pipe and Fittings Identification**

Standards  
Identification markings – fittings  
Identification markings – pipe  
Packaging, storage and handling of pipes  
Materials identification

5 **Processing of Plastics**

Injection moulding  
Extrusion

6 **Plastics Pipe Welding Processes**

Butt fusion welding  
Socket fusion welding

- 7      **Welding Procedures**
- Welding procedures and records
  - Manual butt fusion welding
  - Manual socket fusion welding
  - Machine socket fusion welding

- 8      **Testing of Welded Joints**
- Visual inspection
  - Non-destructive testing
  - Destructive testing

- 9      **Certification**

## **GEOMEMBRANE WELDING**

- 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
- 2      **Materials Technology**
- Molecules and polymer chains
  - Plastic material classification
  - Copolymers
  - Glass transition temperature
- 3      **Thermoplastic Geomembranes**
- Geomembranes
  - Manufacture
  - Polyvinylchloride
  - Polyethylene
  - Polypropylene
- 4      **Welded Joints and Terminology**
- Materials
  - Joint types
  - Symbols
- 5      **Thermal Fusion Processes**
- Principles of heated wedge welding
  - Joint preparation
  - Welding parameters
  - Principles of hot air welding
  - Equipment cleaning and maintenance
  - Welding documentation

**6 Extrusion and Manual Hot Air Welding**

Joint preparation  
Principles of extrusion welding  
Welding parameters  
Repairs  
Connections to pipes and structures  
Welding documentation

**7 Testing of Welded Joints**

Destructive testing  
Failure modes  
Non-destructive testing

**8 Weld Quality**

Types of imperfection  
Origins of imperfections

**9 Site Working**

Cleaning procedures  
Weather protection  
Handling of materials  
Subgrade acceptance

**10 Related Geosynthetic Materials**

Geosynthetic clay liners  
Geotextiles  
Geonet  
Geocomposite

**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.

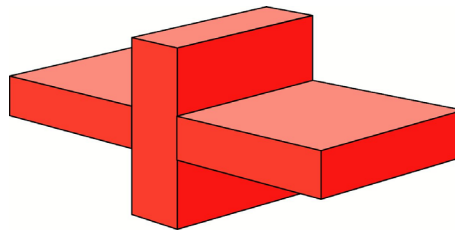
**1. What does OEL stand for?**

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 the Certification of Thermoplastics Geomembrane Welders – Entry Level**

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

### **1 SCOPE**

This Appendix specifies the method of testing the skill of a welder who is required to carry out welds on thermoplastics geomembranes in new constructions and repair work.

The categories of certification described are classified as ‘Entry Level’ because they do not require evidence of training or experience prior to taking the test and they do not require a knowledge test.

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 provides assurance that the examination is carried out according to a uniform procedure.

Certification in accordance with this Appendix is deemed to satisfy the ‘Level 2’ qualification standard of the UK Environment Agency.

### **2 TEST PROCEDURE**

The test procedure consists of a practical test, which must be supervised by an authorised Plastics Welding Examiner (see Appendix 1 of the main document).

The welder shall complete the test piece specified by the required sub-group, see Table A1, in accordance with the relevant WPS.

All welding equipment, materials and documents necessary to complete the test piece shall be provided by the welder.

The time taken by the welder to complete the test piece shall correspond to that taken under production conditions.

### **3 APPLICATION FOR TESTS AND FEES**

Candidates for testing are required to submit an application form.

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

### **4 CATEGORIES OF CERTIFICATION**

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

- 7.2 Machine Hot Gas welding of PE lining membrane – Entry Level
- 7.3 Machine Hot Wedge welding of PE lining membrane (hot gas heated wedge) – Entry Level
- 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

The details of the practical tests for each of these categories are shown in Table A1 and in Figures 6 and 7 of the main document. The range of approval as a result of success in each test is shown in Table A2. The acceptance criteria are shown in Table A3.

**TABLE A1 – Categories of Test**

Material	Test Category	Thickness of membrane, $e_n$ , mm	Welding process	Weld form	Position	Type of examination Test	Test piece according to figure
PE	7.2	2.5	Hot gas by machine	Double lap	Flat	V/Pt	6
	7.3	2.5	Heated wedge by hot gas	Double lap	Flat	V/Pt	6
	7.4	2.5	Heated wedge electric	Double lap	Flat	V/Pt	6
	7.5	2.5	Extrusion manual	Lap	Flat	V/Pt	7
<b>Notes:</b> “/” = and “V” = Visual examination “Pt” = T-peel test “ $e_n$ ” = nominal wall thickness							

**TABLE A2: Range of approval resulting from successful completion of the test**

Range of approval			
Category	Dimensions, mm	Type of joint	Position
7.2	$1 \leq e_n \leq 5$	Lap	Machine
7.3	$1 \leq e_n \leq 5$	Lap	Machine
7.4	$1 \leq e_n \leq 5$	Lap	Machine
7.5	$1 \leq e_n \leq 5$	Lap	All

**TABLE A3: Test requirements**

Category	Test Type	Requirement	Type of Requirement
7.2	Peel <sup>(5)</sup>	394N	Peel load
		Fracture in parent sheet <sup>(7)</sup>	Failure location
7.3	Peel <sup>(5)</sup>	394N	Peel load
		Fracture in parent sheet <sup>(7)</sup>	Failure location
7.4	Peel <sup>(5)</sup>	394N	Peel load
		Fracture in parent sheet <sup>(7)</sup>	Failure location
7.5	Peel <sup>(5)</sup>	341N	Peel load
		Fracture in parent sheet <sup>(7)</sup>	Failure location