CERTIFICATION SCHEME FOR PERSONNEL

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Requirements for the Certification of Installers and Supervisors of Composite Patch Repair for Marine and Civil Structures (CPRMCS)

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CSWIP is administered by TWI Certification Ltd

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, Heat Treatment Operatives, Drillstem Inspectors, 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. TWI Certification Ltd is accredited by UKAS to BS EN ISO/IEC 17024 for certification of personnel.

TWI Certification Ltd understands the importance of impartiality in carrying out its certification activities, managing conflict of interest and ensuring the objectivity of all its certification activities, in accordance with BS EN ISO/IEC 17024.

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 group or associations.

1 General

1.1 Scope

This document describes the requirements of a scheme for the examination and certification of personnel engaged in surface preparation, application and inspection of fibre composite patches in the strengthening of metallic marine and civil engineering structures e.g. ships and bridges, see Appendix 1.

Fibre-reinforced composites materials are used increasingly in a large range of aerospace and civil infrastructure applications, in both new build and repair. The growth in the use of composite materials systems for structural applications, either as the sole material component or for applications that involve metallic materials in marine and civil structures, has highlighted the need for more rigorous training and competence assurance in the surface preparation, installation and approval processes.

The installation stage is summarised by the following five steps:

- Surface preparation
- Preparation for installation of composite patch
- Application of composite reinforcement
- Curing the composite system.
- Quality control checks.

This document specifies the examination and certification of personnel who are required to apply and inspect composite patches to strengthen and repair large steel structures with defect. Details of examinations are contained in Appendices 2 and 3. The categories of certification described in this document relate to installer and supervisor levels.

Many of the details of the operations considered are given in the following technical reports issued as formal outputs from the CO-PATCH project supported under the FP7 “Sustainable Surface Transport”; project title “Composite Patch Repair for Marine and Civil Engineering Infrastructure Applications” Grant Agreement No. 233969 and are available from the CO-PATCH project website: http://www.co-patch.com/.

- Full reports:
    - D3.2: Manufacturing and short-term tests results of plate specimens.
    - D3.3: Manufacturing and short-term tests results of beam specimens.
    - D3.4: Manufacturing and long-term tests results of plate specimens.
    - D3.5, D3.6, D3.7: Manufacturing and Testing of each marine large-scale laboratory test (Three marine (Static loading) and two civil test cases (fatigue loading)).
    - D3.8: Manufacturing and Testing of the four bridge structural details.
    - D4.3: Report with the parametric study results.
    - D6.3: Report describing in detail the patch application procedure, for each one of the full-scale test cases.
    - D6.4: Report presenting the experimental measurements for each one of the test cases.

- Publishable summary only:
    - D2.9: Report on the development of procedures for monitoring the patch laminate condition.
    - D5.1: Best practice design and applications procedures.
    - D5.2: Design and applications procedures for standard cases – pre-designed solution.
    - D6.2: Report describing the patch design for each one of the full-scale test cases.

The competence of an installer or supervisor is an essential condition for the assurance of the quality of the installation work. The application of this document ensures that the examination is carried out according to a uniform procedure.

The scope of examination includes an understanding of the scope of repair and strengthening project and consists of initial work (i.e. inspection of defect, repair strategy, process design, materials selection), surface preparation, application of composite patch (including a glass fibre insulating layer if required), curing, inspection during and after installation.

1.2 Requirements for Installer Prior to Taking an Approval Test

Only installers whose training and/or whose previous experience 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:

- At least 2 years’ recognised experience in the relevant application technique by verified CV/employment records.
- Completed a CSWIP recognised training course, followed by at least 6 months on-the-job training supervised by an installer or supervisor with a certificate in the relevant application technique. See Appendices 1 and 2.

1.3 Requirements for Supervisor Prior to Taking an Approval Test

Only supervisors whose training and/or whose previous activities show that they are likely to pass the planned test may be admitted.

- Must have CSWIP Installer certificate with either:

1. A completed CSWIP recognised training course, followed by at least 6 months on-the-job training in the relevant application technique.
2. Experience of at least one year supervisory role in the relevant application technique.

2 Test Procedure

The assessment procedure consists of both theoretical and practical examinations.

2.1 Installer

2.1.1. Theoretical examinations, see Appendix 2

The installer'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 closed book multiple choice paper (specific to the category of certification sought) covering the following:

- Health, safety and environmental aspects of materials, equipment used and their disposal.
- Materials conformity before strengthening.
- Surface preparation.
- Awareness of environmental exposure on the materials used prior to application.
- Aspects of mixing, application and curing of resin and pre-pregs.
- Application of pre-formed patch to bonded surface.
- Remedial works.
- Post installation finish.

- 20 multiple choice questions.
- Time allowed 30 minutes.
- Pass mark 70%.

2.1.2. Practical examination, see Appendix 3

The installer shall complete the test pieces specified in Appendix 3

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

The time taken by the installer to complete the relevant test shall correspond to that taken under production conditions.

2.2 Supervisor

2.2.1. Theoretical examinations, see Appendix2

- Method statement production.
- Inspection of materials prior to installation.
- Inspection of surface prior to strengthening.
- Inspection of materials preparation.
- Inspection regimes during strengthening.
- Inspection of fabricated joint post installation.
- Routine maintenance and repair.

- 40 multiple choice questions.
- Time allowed 60 minutes.
- Pass mark 70%.

2.3 Application for examinations and fees

Candidates for assessment are required to submit an application form, an authenticated Curriculum Vitae 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 assessment will be declared null and void. A certificate is automatically invalidated if there are any outstanding fees in respects of that certificate.

Candidates proved to have cheated, or found to have attempted to remove, or found to have removed, examination material in a CSWIP examination will not be accepted as a candidate for any CSWIP examination for a minimum period of five years from the date of the examination where cheating, attempt to remove or removal of examination material, was established to have taken place.

3 Categories of Certification

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

- Installer of Composites Patch Repair for Structural Strengthening.
- Supervisor of Composites Patch Repair for Structural Strengthening.

4 Certification

4.1 Results notices

All candidates will be sent a results notice. This notice will also be sent to the organisation paying the examination fee, if not paid by the candidate.

4.2 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.

4.3 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.

4.4 Initial Approval

The validity of the installer or supervisor'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.

An installer or supervisor approval shall remain valid for a period of 2 years providing all the following conditions are fulfilled:

- The installer or supervisor shall be engaged with reasonable continuity on composite patch repair and strengthening work within the range of approval corresponding to the approval test certificate. An interruption period for longer than one year is not permitted.
- There shall be no specific reason to question the installer or supervisor's skill and knowledge.

The sponsoring organisation shall advise TWI Certification Ltd at twelve monthly intervals on each installer or supervisor's quality performance.

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

4.5 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 installation experience is made available to TWI Certification Ltd, who accept that this is the case. This may take the form of signed and dated log book entries for previous installations carried out.

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

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

4.6 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; and
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.

4.7 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 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 installer or supervisor upon application in writing to the Governing Board.

5 Records

TWI Certification Ltd maintains records of successful and unsuccessful candidates. These records are accessible to the Governing Board or its nominees at all reasonable times.

6 REFERENCES

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7 Further Reading

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3. Colombi P, Bassetti A, Nussbaumer A (2003), Analysis of cracked steel members reinforced by Pre-stress composite patch, Fatigue and Fracture of Engineering Materials and Structures, 26, 59-66.

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APPENDIX 1

Tasks and Responsibilities of Installers and Supervisors for FRP Plates for Strengthening Structures

FRP Strengthening of Structures: identification of the different roles of installers and supervisors

OPERATIONAL STEP*	ACTIVITIES	SUPERVISOR	INSTALLER
Design and specification Materials Selection	*Design by Engineer in association with client*		
Method Statement(s)	*Contractor develops methods to satisfy requirements of specification documents*	✓	
Site activities prior to installation of strengthening system	*Install plant /equipment*	✓	✓
	Erect access and sheeting		✓
	Start repairing record	✓	
	Site inspection of materials and conformance with specification	✓	✓
	Site trials		✓
Surface preparation	*Prepare surface(s)*		✓
	QC tests – mechanical	✓	✓
	Assessment of surface condition	✓	
Installation of buffer layer	*Install buffer*		✓
	QC tests – mechanical	✓	✓
	Assessment of buffer layer	✓	✓
Application of strengthening system	*Preparation of materials*		✓
	Application of composite material(s)		✓
	Curing		✓
	QC test specimens	✓	
	Witness plates (if applicable)	✓	✓
	Provision of particular curing conditions	✓	✓
	Bonding records	✓	✓
	Inspection	✓	
Final QA checks, inspection and approval	*Inspection*	✓	
	Propose repair methods (if applicable)	✓	
Remedial works (if applicable)	*Materials removal*		✓
	Materials reinstatement		✓
	QC test specimens	✓	✓
	Bonding records	✓	
	Inspection	✓	
Finishing, maintenance and monitoring	*Apply finishing coatings and paints*		✓
	Signage		✓
	Inspection	✓	

*Adapted from CO-PATCH Project

1. Installer Role and Responsibilities

The installer, following the instructions provided in the method statement, is primarily responsible for initial substrate preparation prior to application of the strengthening system,

mixing and application of the adhesive and strengthening system, appropriate QC test specimen preparation and final finishing procedures.

2. Supervisor Role and Responsibilities

The supervisor is responsible for the production of the method statement, based on initial information provided by the designer, inspection and sign off of all materials and equipment to be used, supervising adequate substrate surface preparation prior to installation of the strengthening system, supervision of the application of the strengthening system, supervision of fabrication of QC specimens and final inspection of the finished installation.

APPENDIX 2: EXAMINATION SYLLABUS

1. Installer

The content of the examination will cover the following technical topics:

- **Health, safety and environmental aspects of the materials, equipment used and their disposal**
    - Dry fibre handling e.g. glass fibre, carbon fibre
    - Pre-preg handling
    - Resin handling
    - Solvents,
    - Datasheets
    - Equipment and PPE
- **Materials conformity before strengthening**
    - Dry fibre acceptance specification
    - Pre-preg acceptance specification
    - Resin acceptance specification
    - QC testing
- **Surface preparation**
    - Surface cleaning
    - Surfaces protection before patching
    - QC test specimens
- **Awareness of environmental exposure on the materials used prior to application**
    - Materials handling
    - Moisture and UV exposure
    - Temperature
    - Storage
- **Aspects of mixing, application and curing of resin and prepregs**
    - Materials data sheets
    - Mixing specifications
    - Procedures and methods for application
    - Tools for application
    - Control of thickness
    - Finish
- **Preparation and application of composite patch to the surface to be repaired**
    - Application specifications
    - QC test specimens
    - Witness specimens if appropriate
    - Finish
- **Remedial works**
    - Removal of reinforcement
    - Re-preparation of surfaces
    - Resin application
- **Post installation finish**

- Final coating painting
- Fire protection intumescent coatings
- Repair Coatings
- Signage

2. Supervisor

The content of the examination will cover the following technical topics:

- **Method statement production**
  - Health, safety and environmental considerations
  - Key elements
  - Acceptance
  - Compatibility of materials
  - Appropriate QC tests
- **Inspection of materials prior to installation**
  - Data sheet and batch information
  - Life and storage history
- **Inspection of surface prior to strengthening**
  - Methods of assessing cleanliness, coherence, wettability, roughness
  - Requirements for surface repair prior to strengthening
- **Inspection of materials preparation**
  - Health, safety and environmental aspects of the materials, equipment used and their disposal
  - Storage during job
  - Cutting
  - Cleaning
  - Mixing
  - Temp control/ dew point
  - QC testing
    - Lap shear tests
    - Bulk adhesive, on and off site
- **Inspection regimes during strengthening**
  - Maintaining records
  - Staff training
  - Site trials
  - Working environment (tenting etc)
  - H&S for job
  - Routine visual inspection
  - Detailed inspection
  - Control samples and QC tests
    - Pull-off test
- **Inspection of fabricated joint post installation**
  - Maintaining records
  - Visual inspection and conformity
  - Detailed inspection and conformity
  - Inspection of QC tests
    - Pull-off test

- **Routine maintenance and repair**
    - Finish
    - Maintenance
    - Repair.

APPENDIX 3: PRACTICAL EXAMINATION TEST PIECES

The practical exam is in three parts and candidate has to pass all three parts in order to be accredited for the practical exam.

All specimens should be made in a simulated site condition.

1. Production of a set of QC test specimens selected by the examiner from one of the following three categories.

1.1. On site orthogonal composite specimen/dynamic mechanical thermal analysis (DMTA) strip specimen (made by candidate, tested by examiner).

- Number of specimens to be made
  - 5 good specimens
- Criteria for Pass/Fail
  - Fully-filled moulded shape, void-free by visual inspection when cured
  - Specimens must exceed minimum mechanical values for modulus, and strength to failure according to the adhesive used when tested to destruction*. ISO 527-1
  - Minimum of three samples to pass the above criteria

1.2. Lap shear specimen using composite material bonded to steel made by candidate, tested by examiner).

- Number of specimens to be made
  - 5 good specimens
- Criteria for Pass/Fail
  - Good alignment and uniform bondline by visual inspection
  - Joints must exceed a minimum mechanical strength value (typically 8 MPa*). ASTM D 3163 and
  - 75% cohesive failure in adhesive/substrates*
  - Minimum of three samples to pass the above criteria

1.3. Bulk adhesive state of cure hardness test (using a bulk prism specimen) (made by candidate, tested off side by examiner). BS EN ISO 868:2003

- Number of specimens to be made
  - 5 good specimens
- Number of tests to be carried out
  - 10 Shore D durometer readings (minimum of 2 tests per specimen)
- Criteria for Pass/Fail
  - Typically 77 Shore D at 24 hours*
  - Minimum of three specimens, 2 reading each to pass the above criteria

2. Production of a representative section of composite patch repaired, including surface preparation, installation buffer layer, mixing resin, resin infusion, application, strengthening system application and finish. This will be carried out in the presence of the examiner with the candidate discussing the procedure and answering questions posed by the examiner during the test.

- Number of specimens to be made
  - 1 horizontal, and 1 vertical or overhead
- Criteria for Pass/Fail at each stage

- Primarily visual inspection (free of visual defects, properly tooled bondline fillets, parallel substrates and tap-test)
- A pull-off test carried out by candidate to assess adhesion and strength, to compare with control data for the system involved*†. BS EN 1542:1999

3. Surface preparation and pull-off test specimen for a metallic substrates, for horizontal, vertical or overhead surfaces (made on site, tested off site). BS EN 1542:1999

- Number of specimens to be made
  - 5 numbers 25mm diameter steel dollies bonded to metallic substrates

- Criteria for Pass/Fail
  - Evaluation of appropriate surface preparation for metallic substrates
  - Dollies must be parallel to substrates and the spew fillet removed

*** :** The examining body should provide the actual figures for minimum acceptance data for particular materials from the control data established from the Compclass Classification Scheme. http://www.co-patch.com/.

†: To establish candidates' competency to carry out pull-off test, the examining body will provide a pre-fabricated representative section of composite patch strengthened substrate to enable on site testing. The sections made by the candidates shall be tested off site by examiner).