CERTIFICATION SCHEME FOR PERSONNEL

DOCUMENT No. CSWIP- IRT- 09

Requirements for the Certification of Personnel Responsible For Review and Approval of Thermographic Inspection Procedures and Qualifications

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Issued under the authority of the Governing Board for Certification
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CSWIP is administered by TWI Certification Ltd
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FOREWORD

The Certification Scheme for Welding and Inspection Personnel (CSWIP) is a comprehensive scheme that 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, Plant Inspectors, Underwater Inspection personnel, NDT personnel and Heat Treatment operatives.

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.

ACCESS TO CERTIFICATION

Access to certification is not improperly restricted. The sole criteria for certification are given in the 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 prescribes procedures by which personnel may be examined, and, if successful, certificated for the duties of Thermographic Inspector Levels One, Two and Three as defined in Clause 1.2. This document does not purport to cover personnel who do not have the responsibilities defined in Clause 1.2. The examination is intended for those involved in condition monitoring of plant operation and maintenance.

1.2 Responsibilities of personnel

Typical areas of work activity of personnel for whom CSWIP procedure approval would be suitable are given below:

1.2.1 Thermographic Inspector Level 1 (under the supervision of a Qualitative or Senior Thermographic Inspector)

a) Maintain, set-up and correctly operate an infrared imaging system, including manual adjustment of the image, capture and storage of images.

b) Understand the basics of infrared theory including historical development.

c) Understands basic heat transfer and relevance to the application of thermography.

d) Follow basic inspection procedures and undertake a qualitative thermography test (BS ISO 18434-1:2008), be able to identify various surface patterns, anomalies and to make simple temperature measurements.

e) Be familiar with the conditions required to inspect typical electrical, mechanical and energy systems and any associated limitations.

f) Understand basic safety concerns that must be addressed in order to conduct thermographic inspections.

g) Maintain a database, classifying and retrieving data using the report generation software supplied by camera manufacturer.

h) Application of the requirements of codes and standards.

1.3 Quantitative Thermographic Inspector - Level 2

Those given above plus:

i) Supervision of Thermographic Inspector in the conduct of activities a) to h) above and provide technical instruction.

j) Radiometric accuracy and challenges as a temperature measurement technique.

k) Applied heat transfer including conductance, heat capacitance, convection, radiation state change and how the environment affects measurement accuracy.

l) Optical limitations of spatial and measurement resolution including, Minimum Resolvable Temperature Difference (MRTD), Noise Equivalent Temperature Difference (NETD) and Slit Response Function (SRF).

m) IR equipment and detector types including operating characteristics, advantages and disadvantages.

n) Develop an inspection route identifying the object, location and frequency of data collection.

o) Perform and supervise a quantitative test report (BS ISO 18434-1:2008) on equipment condition.

p) Produce a written instruction to carry out a thermographic examination.

q) Interpretation of results using various analytical tools and acceptance standards or customer specifications.

1.3.1 Senior Thermographic Inspector - Level 3

Those given above plus:

r) Supervision, guidance and have practical experience of Thermographic Inspector Level 1 and 2 in the conduct of activities i) to q) above.

s) Thermal instrumentation overview and understanding thermographic results.

t) Responsible for managing thermographic program including cost benefit analysis and design of future infrared monitoring systems including periodic and real-time.

u) Written practice and thermographic inspection procedures. Integrate and interpret any current health and safety procedures with the requirement of thermographic testing, evaluate any relevant codes, standards and specifications into current work environment.

v) Certification of compliance, determination of severity criteria and acceptance testing for new, in-service and repaired equipment. Final acceptance and certification that the requirements of the specification have been met.

w) Be familiar and able to direct the use of other diagnostic monitoring techniques such as for example vibration analysis, ultrasonics, acoustic emission, lubricant monitoring and wear debris analysis.

x) Review and approve sub contractor thermographic procedures and thermographic qualifications or who have the responsibility for reviewing and approving their company thermography procedures and associated qualifications.

1.4 Requirements prior to taking a certification test

Job responsibilities and experience criteria for examination eligibility as given below are strictly adhered to. To obtain Level 3 the candidate must have a minimum requirement of Level 2 and Level 1 certification.

1.4.1 Thermographic Inspector (Level 1)

Candidates are expected to have an engineering background. It is recommended that a Thermographic Inspector should have a minimum of three months of experience prior to certification, if the candidate does not have the required three months, this can be gained within 12 months after successful completion of the examination (no certificate will be issued until the experience has been gained)..

1.4.2 Quantitative Thermographic Inspector (Level 2)

A Quantitative Thermographic Inspector should have a minimum of six months experience for certification.

1.4.3 Senior Thermographic Inspector (Level 3)

A Senior Thermographic Inspector should have a minimum of nine months experience for certification.

1.4.4 Training

All candidates must attend a CSWIP approved course of training prior to examination. Details of such courses are available on request.

1.4.5 Health/Eyesight

Candidates need to be in satisfactory physical condition and the person completing the application form will be required to signify that the candidate's health and eyesight are adequate to enable him/her to carry out his/her duties.[*] An eyesight test certificate must be submitted with the application form.

2 Examination Procedure

2.1 Thermographic Inspector Level 1

The examination procedure for the Thermographic Inspector consists of a multiple choice theory examination and practical examination. Please refer to Appendix A Examination Syllabus.

2.1.1 Written examination

The written examination consists of 40 multiple choice questions designed to test the candidate’s knowledge of the syllabus.

2.1.2 Practical examination

Candidates will be required to inspect and report on the following:

[*] Unaided or corrected near visual acuity in at least one eye shall be such that the candidate is capable of reading N4 Time Roman type or Jaeger J1 at a distance of not less than 30cm on a standard reading test chart.

a) Correct operation of infrared camera, control of errors and data acquisition.

b) Produce an IR Qualitative test report as per BS ISO 18434-1:2008 paragraph 16 (a to s).

2.2 Quantitative Thermographic Inspector Level 2

Candidates who do not already hold a Qualitative Inspector Certificate must also complete the full Quantitative Infrared Inspector examination below. This consists of a written multiple choice theory examination and three practical examinations.

2.2.1 Written examination

This consists of a 40 multiple choice questions designed to test the candidate's knowledge of the syllabus.

2.2.2 Practical examination

In addition to clause 2.1.2 above, candidates will be required to:

a) Produce a written instruction to carry out a thermographic examination.

b) Carry out radiometric measurements including emissivity and reflected apparent temperature corrections of various materials to BS ISO 18434-1:2008.

c) Produce an IR quantitative test report to BS ISO 18434-1:2008 (a to x).

2.3 Senior Thermographic Inspector Level 3

Candidates who do not already hold a Quantitative Inspector Level 2 must also complete the full Quantitative Infrared Inspector examination below. This consists of three written multiple choice examinations and one practical examination.

2.3.1 Written examination

Three multiple choice question papers (30 questions, 30 questions and 10 questions respectively) and one written procedure, designed to test the candidate's knowledge of the syllabus:

a) 30 multiple choice questions on thermal instrumentation and understanding thermographic results.

b) 30 multiple choice questions on appreciation of other monitoring techniques.

c) 10 multiple choice questions on general requirements for qualification and certification for thermographic personnel.

2.3.2 Practical examination

In addition to clause 2.2.2 above, candidates will be required to produce a written procedure to cover all aspects of a thermographic examination.

2.4 Application for examination and fees

Candidates will be required to submit an application form and a CV. All the information requested must be on these forms. No applications can be considered confirmed until receipt of correctly completed documents. Application forms ask for specific details of experience and training and must be signed to the effect that these details are correct.

In the event of a false statement being discovered on forms or on CVs any examination undertaken will be declared null and void. A certificate is automatically invalidated if there are any outstanding examination fees in respect of that certificate.

Examinations may be taken at any one of a number of Test Centres in the UK and overseas. Lists are available on request.

Candidates who are found cheating during an examination will automatically be banned for a minimum of five years from taking any CSWIP examination.

3 CATEGORIES OF CERTIFICATION

Candidates may apply for one of the three following certification categories beginning with Level 1:

3.1 Thermographic Inspector Level 1
3.2 Quantitative Thermographic Inspector Level 2
3.3 Senior Thermographic Inspector Level 3

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 proficiency will be issued to the sponsoring organisation. Duplicate certificates to replace those lost or destroyed will be issued only after extensive enquiries.

4.3 Unsuccessful candidates

Candidates who fail to obtain a certificate may attempt one retest on those parts of the examination in which success was not achieved. The retest must be completed within one year of the initial test; otherwise candidates will have to repeat the complete examination.

4.4 Period of validity

The certificate is valid for five years from the date of completion of the initial test and may be renewed for a further five years on application, provided evidence is produced in accordance with Clause 4.5.1. 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.
e) the holder is still employed by the sponsoring organisation.

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

4.5 Renewal

4.5.1 Five year renewal

In order for the certificate to be renewed after five years, the holder has to demonstrate that he/she has maintained his/her competence by:

i) Providing evidence of continuous work activity in thermography inspection; and
ii) Providing evidence that the holder has kept up to date in thermography technology.

The certificate will not be renewed without further test if a substantiated complaint is notified by the Governing Board during the period of its validity. Further instruction and retest may then be required.

Renewal must take place not later than 21 days after the date of expiry. It is the certificate holder's responsibility to ensure that renewal takes place at the appropriate time. Only under extreme circumstances will certificates be renewed up to a maximum of six calendar months from the date of expiry shown on the certificate and late renewal will be subject to a special fee.

4.5.2 Ten year renewal

Certificates are renewed beyond ten years from the initial examination (or from a previous ten year renewal) by the holder successfully completing a renewal examination prior to the expiry of the certificate in addition to the renewal procedure given in Clause 4.5.1. Requests for the appropriate documentation should be sent to TWI Certification Ltd.

4.5.3 Written examination

This consists of a 40 multiple choice questions designed to test the candidate's knowledge of the syllabus.

4.5.4 Practical examination

In addition to clause 4.5.3 above, candidates will be required to:

a) Produce a written instruction to carry out a thermographic examination.

b) Carry out radiometric measurements including emissivity and reflected apparent temperature corrections of various materials to BS ISO 18434-1:2008.

c) Produce an IR quantitative test report to BS ISO 18434-1:2008 (a to x).

One retest, within six months of the 10 year renewal examination, will be allowed.

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 inspector or the employer 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 ADDRESSES

For further general information contact:

TWI Certification Ltd
Granta Park
Great Abington
Cambridge
CB21 6AL
UK

Phone:	+44 (0) 1223 899000	Fax:	+44 (0) 1223 894219
Email:	twicertification@twi.co.uk	Website:	www.cswip.com

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

TWI Training and Examinations
Granta Park
Great Abington
Cambridge
CB21 6AL
UK

Phone:	+44 (0) 1223 899000	Fax:	+44 (0) 1223 891630
Email:	trainexam@twi.co.uk	Website:	www.twi.co.uk

7 References

BS EN 473:2008	General principles for qualification and certification of personnel.
ISO 9712:2005	Non-destructive testing - Qualification and certification of personnel
BS ISO 18434-1:2008	Condition monitoring and diagnostics of machines - Thermography - Part 1: General procedures.
ISO/FDIS 18436-7:2008	Condition monitoring and diagnostics of machines - Requirements for qualification and assessment of personnel- Part 7: Thermography
ASTM E 1934:	Standard guide for examining electrical power distribution equipment with infrared thermography.
ISO 13372	Condition monitoring and diagnostics of machines: Vocabulary
ISO 13374-1	Condition monitoring and diagnostics of machines - data processing, communication and presentation: Part 1 - General guidelines.
ISODIS 1334-2	Condition monitoring and diagnostics of machines - data processing, communication and presentation: Part 2 - General data processing and analysis procedures.
ISO 17359	Condition monitoring and diagnostics of machines; General guidelines.

ISO 18431-1	Mechanical vibration and shock-signal processing: Part 1 - General introduction.
PSL/44	Vision requirements
PSL/30	Log of pre-certification experience
PSL/42	Log of pre-certification on-the-job training
PSL 70	Request for L2 certificate issue to a L3 certificate holder

APPENDIX A – EXAMINATION SYLLABUS

1 Thermographic Inspector (Level 1)

1.1 Examination format

Theory Part A1: 40 multiple choice examination designed to test the candidates' general knowledge and theory of thermography. Time allowed 60 minutes.

Practical Part B1: Correct operation of infrared camera, control of errors and data acquisition. Time allowed 30 minutes.

Practical Part C1: Produce an IR Qualitative test report as per BS ISO 18434-1:2008 paragraph 16 (a to s). Time allowed 30 minutes.

Part A1 is closed book

Pass mark for all parts is 70%

1.2 Subjects

Candidates will need to demonstrate their knowledge of:

a) Terminology
Infrared radiation, reflectivity, atmospheric transmission, conduction, convection, emissivity, spatial and thermal sensitivity, BS ISO 18434-1:2008.

b) Basic camera operation
Pre-operational check, focusing, adjusting emissivity, ambient temperature correction, manual image adjustment, saving and retrieving data.

c) Principles of infrared thermography
Understand the basics of heat transfer conductance, convection and radiation.

d) Qualitative thermography
Recognise surface patterns and anomalies from various objects and understands the limitations.

e) Simple temperature measurements
Carry out basic temperature measurements including characterising the background and understand the factors that that could affect accuracy of measurement.

f) Inspection criteria
Be familiar with the inspection conditions required to assess condition of electrical and mechanical machines and components.

g) Qualitative reporting
Complete a qualitative test report to BS ISO 18434-1:2008.

h) Database development
Maintain a database as part of a route inspection.

i) Safety
Health and Safety requirements regarding safe thermographic inspections.

2 Quantitative Thermographic Inspector (Level 2)

2.1 Examination format

Theory Part A2:	40 Multiple choice questions. Radiometric theory, applied heat transfer and imaging limitations. Time allowed 60 minutes.
Practical Part B2:	Written instruction to carry out a thermographic examination. Time allowed 90 minutes
Practical Part C2:	Carry out an emissivity and reflected apparent temperature assessment of a material. Time allowed 15 minutes.
Practical Part D2:	Produce an IR Quantitative test report as per BS ISO 18434-1:2008 paragraph 16. Time allowed 45 minutes.

Theory Part A2 is closed book

Pass mark for all parts is 70%

2.2 Subjects

Candidates will need to demonstrate their knowledge of:

j) Radiometric measurements.
Emissivity measurement and reflected apparent temperature to BS ISO 18434-1:008 transmissivity, humidity, blackbody reference and limitations.

k) Applied heat transfer
Thermal conductance, thermal capacitance, convection, radiation state change and thermal diffusivity.

l) Imaging limitations
Minimum Resolvable Temperature Difference (MRTD), Noise Equivalent Temperature Difference (NETD) and Slit Response Function (SRF).

m) Infrared detectors
Detector performance including wavelength considerations and planckian distribution.

n) Written instruction
Produce written instructions to carry out a thermographic examination.

o) Development of inspection route
Develops an inspection route identifying the object, location and frequency of data collection.

p) Interpretation techniques
Interprets results using various analytical tools and acceptance standards or customer specifications.

q) Quantitative Reporting
Quantitative test reporting with reference to ISO 18434-1:2008 16, and assessment of equipment condition and fault diagnosis.

3 Senior Thermographic Inspector (Level 3)

3.1 Examination format

Theory Part A3:	30 multiple choice questions on thermal instrumentation and understanding thermographic results. Time allowed 45 minutes.
Theory Part B3	30 multiple choice questions. Appreciation of other monitoring techniques. Time allowed 45 minutes.
Theory Part C3	10 multiple choice questions. General requirements for qualification and certification for thermographic personnel. Time allowed 15 minutes.
Practical Part D3	Written procedure to cover all aspects of a thermographic examination. Time allowed Four hours.

Theory Part A3 and B3 is closed book

Pass mark for all parts is 70%

3.2 Subjects

Candidates will need to demonstrate their knowledge of:

r) Thermal instrumentation
Thermal instrumentation and understanding thermographic results

s) Certification of compliance
Determination of severity criteria and acceptance testing for new, in-service and repaired equipment. Final acceptance and certification that the requirements of the specification have been met.

t) Programme management
Responsible for managing thermographic program including cost benefit analysis and design of future infrared monitoring systems including periodic and real-time.

u) Written thermographic procedures.
Integrate and interpret any current health and safety procedures with the requirement of thermographic testing, evaluate any relevant codes, standards and specifications into current work environment.

v) Reporting
Recommend all types of machinery engineering corrective actions.

w) Training
Assess thermographic inspector training needs. Personnel who review and approve sub contractor thermographic procedures and thermographic qualifications or associated qualifications.

x) Other monitoring techniques
Be familiar and able to direct the use of other diagnostic monitoring techniques such as for example vibration analysis, ultrasonics, acoustic emission, lubricant monitoring and wear debris analysis.