

Certification Services Division
1 Spencer Parade, Northampton
NN1 5AA, United Kingdom

Tel: +44(0)1604-259-056.
Fax: +44(0)1604-231-489.
E-mail: pcn@bindt.org



PCN WI Issue 3, Revision A approved by PCN CAB 3rd October and by CMC 10th October 2006 for implementation on 1st April 2007 (publication date: 1st January 2007).

This revision removes reference to EN 473, directs the reader to PSL/44 for vision standards, and includes a change to the rules for retests of failed examinations [referring the reader to PCN Inspection and Testing (General)].

SPECIFIC REQUIREMENTS FOR THE CERTIFICATION OF PERSONNEL FOR WELD INSPECTION

CONTENTS

1. SCOPE.....	2
2. RESPONSIBILITIES OF WELDING INSPECTION PERSONNEL.....	2
3. ELIGIBILITY FOR EXAMINATION	3
4. EXAMINATION CONTENT.....	4
5. EXAMINATION GRADING	5
6. RETESTS.....	5
7. CERTIFICATION AVAILABLE	5
8. ELIGIBILITY FOR CERTIFICATION.....	5
9. SUPPLEMENTARY CERTIFICATION.....	6
10. VALIDITY OF CERTIFICATION	6
11. REVALIDATION UPON EXPIRY	6
12. TRANSITION.....	7
ANNEX A: EXAMINATION SYLLABUS FOR WELD INSPECTION LEVEL 1, 2 AND 3.....	8
ANNEX B: SPECIMEN EXAMINATION QUESTIONS	11
ANNEX C: BIBLIOGRAPHY.....	14



The British Institute of Non-Destructive Testing is an accredited certification body offering personnel and quality management systems assessment and certification against criteria set out in international and European standards through the PCN Certification Scheme.



1. SCOPE

- 1.1. This document prescribes the specific requirements and procedures by which personnel may be examined and, if successful, certificated for Weld Inspection at three levels (Level 1, Level 2 and Level 3 see paragraph 1.3). It includes requirements for certification, examination syllabus, specimen examination questions, and a bibliography.
- 1.2. It is intended, through publication of these documents, to provide PCN candidates and certificate holders with all relevant information. However, if further information or advice is required on any certification matter, please contact the Certification Services Division of BINDT on telephone number +44 (01604) 259056, or email questions to pcn@bindt.org.
- 1.3. Copies of PCN documents are available free of charge from BINDT Certification Services Division at 1 Spencer Parade, Northampton NN1 5AA, United Kingdom. Organisations requiring at all times to be in possession of the most up to date PCN documents may register with the "PCN Update Scheme" which, for a small annual fee, guarantees that they automatically receive all new or revised PCN documents.

2. RESPONSIBILITIES OF WELDING INSPECTION PERSONNEL

2.1 The Weld Inspection Level 1 individual will:

- 2.1.1 Have a basic understanding of welding techniques, welding positions, welding consumables, weld preparation and welding drawing requirements.
- 2.1.2 Be able to use welding inspection gauges and other commonly used measuring devices to check pre-weld fit ups and post-weld profiles.
- 2.1.3 Be able to visually inspect welded constructions and correctly identify any weld/welding imperfection present
- 2.1.4 Understand the need for specifications, codes and standards and the need for acceptance levels.
- 2.1.5 Verify that joint preparation and fit-up are in accordance with welding procedure specifications and/or work instructions.
- 2.1.6 Basic examination and evaluation of weld sequence.
- 2.1.7 Visual inspection of completed welds.

2.2 The Weld Inspection level 2 individual will:

- 2.2.1 Understand and discharge all of the responsibilities for Weld Inspection level 1
- 2.2.2 Understand the detailed requirements of relevant codes, standards and specifications;
- 2.2.3 Possess an understanding of the relationship between quality assurance, quality control and inspection procedures;
- 2.2.4 Confirm that welders have been properly qualified in accordance with applicable codes and standards, and that their certification is current and valid for the welding procedures applied;
- 2.2.5 Observe the preparation of test pieces and destructive tests, verifying compliance with relevant specifications;
- 2.2.6 Verify against specifications the correctness of base/parent material and welding consumables;
- 2.2.7 Verify that joint preparation and fit-up are in accordance with specifications;
- 2.2.8 Confirm during welding that only specified and accepted welding procedures (approved by the appropriate quality, technical or regulatory authority) are used and applied;
- 2.2.9 Examine and evaluate welds according to the prescribed inspection procedures and acceptance levels;

- 2.2.10 Review NDT reports on welding work for which the Weld Inspection level 2 is responsible;
 - 2.2.11 Record welding inspection results in a manner such that the welds inspected may subsequently be identified.
- 2.3 The Weld Inspection Level 3 individual will:
- 2.3.1 Understand and discharge all of the responsibilities for Weld Inspection level 2;
 - 2.3.2 Plan, organize and implement a system of quality control over the welding and inspection process;
 - 2.3.3 Supervise Weld Inspection Level 1 and Weld Inspection level 2 personnel;
 - 2.3.4 Confirm that welding equipment used for the work is in good order and is appropriate to the process specified in the welding procedure, such that the desired weld quality can be achieved;
 - 2.3.5 Possess an understanding of the factors influencing the formation of weld defects and their acceptability in relation to codes, specifications and standards;
 - 2.3.6 Interpret weld drawings and specifications, having a thorough understanding of weld symbols;
 - 2.3.7 Interpret weld radiographs;
 - 2.3.8 Assess NDT reports on welds, ensuring that NDT personnel are properly qualified and that certification is relevant and valid for the testing performed;
 - 2.3.9 Physically examine the finished work for conformance to the applicable codes, standards, specifications and drawings;
 - 2.3.10 Compile and maintain detailed weld inspection records;
 - 2.3.11 Provide details related to the release of a Certificate of Conformity of welded product inspected.

3. ELIGIBILITY FOR EXAMINATION

- 3.1 Weld Inspection Level 1 candidates will have successfully completed a BINDT recognised course of training for Level 1 Weld Inspectors. (12 hours minimum duration)
 - 3.2 Weld Inspection level 2 candidates will have successfully completed a BINDT recognised course of training* for Weld Inspectors. (40 hours minimum duration)
 - 3.3 Weld Inspection Level 3 candidates will have successfully completed a BINDT recognised course of training* for Weld Inspection Level 3. (40 hours minimum duration)
- * Candidates with at least 5 years documented experience without significant interruption in the discipline for which certification is sought, who can provide evidence of completion of a course of training (covering the published PCN syllabus), need not have attended a BINDT recognised course of training. Such candidates should apply to the BINDT Authorised Qualifying Body under the 'mature candidate' route. If a significant interruption in continuity in carrying out welding inspection exists, the candidate will be required to undertake further training determined by BINDT.*
- 3.4 All candidates and holders of PCN certification shall have satisfactory vision, as determined annually by an ophthalmologist, optometrist or medically recognized person. PCN document PSL/44 provides more information on the required vision standard.

4. EXAMINATION CONTENT

- 4.1 Weld Inspection Level 1
 - 4.1.1 The theoretical examination is designed to assess candidate knowledge and understanding of the syllabus. The theoretical examination comprises one section:
 - 4.1.1.1 30 multiple choice questions on basic welding theory, weld inspection and product technology. Time allowed 45 minutes.
 - 4.1.2 The practical examination is designed to test the practical competence of the candidate and comprises of:
 - 4.1.2.1 Assessment of welds for specific weld profile, weld imperfections and welding process requirements. The sample range will include a fillet weld and/or a tack welded joint and a completed butt weld. Time allowed 2 hours.
- 4.2 Weld Inspection level 2
 - 4.2.1 The written examination is designed to assess the candidate's knowledge and understanding of the syllabus. The written examination part comprises two sections:
 - 4.2.1.1 30 questions on general welding theory, welding inspection and product technology. Time allowed: 45 minutes.
 - 4.2.1.2 4 narrative questions selected by the candidate from 6 provided, covering specific welding technology. Time allowed: 1½ hours.
 - 4.2.2 The practical examination is designed to test the practical competence of the candidate and comprises three parts:
 - 4.2.2.1 inspection of two macros, and/or a bend and fractured fillet for a welder or procedure approval test against BS EN ISO 5817: Time allowed: 45 minutes
 - 4.2.2.2 inspection of a plate butt weld and reporting to a code provided by the examiner. Time allowed: 1¼ hours.
 - 4.2.2.3 inspection of a pipe butt weld and reporting to a code nominated by the candidate (which requires the prior approval of the examiner). Time allowed: 1¾ hours.
- 4.3 Weld Inspection Level 3
 - 4.3.1 Candidates not holding valid BINDT recognised Weld Inspector certification will be required to successfully complete the Weld Inspection Level 2 examination prior to attempting the examination for Weld Inspection Level 3.
 - 4.3.2 The written examination part comprises:
 - 4.3.2.1 4 narrative questions selected by the candidate from 6 provided, covering specific welding technology. Time allowed: 1½ hours.
 - 4.3.2.2 20 multiple-choice answer questions on radiographic theory and interpretation. Time allowed: 30 minutes.
 - 4.3.3 The practical examination part comprises four parts :
 - 4.3.3.1 Scrutinise and comment on three inspection related documents. Time allowed: 1 hour.
 - 4.3.3.2 Inspection of two separate weld failures associated with defects producing a report on the proforma provided. Time allowed: 1 hour.
 - 4.3.3.3 Understanding of welding fabrication drawing symbols. Time allowed: 1 hour.
 - 4.3.3.4 Interpretation of six radiographs of welds. The welds will have been produced by MMA, MIG, TIG, mechanised fusion and oxy-acetylene

welding (unless the candidate is a holder of a valid PCN certificate covering radiographic interpretation of welds). This examination part will include a requirement to comment on radiographic density and sensitivity. Time allowed: 1½ hours.

5. EXAMINATION GRADING

To be successful, candidates are required to achieve a grade of 70% in all relevant examination parts.

6. RETESTS

The conditions for retest of failed examinations are given in document entitled PCN Inspection and Testing (General).

7. CERTIFICATION AVAILABLE

- 7.1 The following certification is available:
 - 7.1.1 Weld Inspection Level 1
 - 7.1.2 Weld Inspection Level 2
 - 7.1.3 Weld Inspection Level 3

8. ELIGIBILITY FOR CERTIFICATION

- 8.1 Level 1 candidates will have successfully completed a PCN examination for Weld Inspection Level 1 and:
 - 8.1.1 had a minimum of one month experience under supervision acceptable to BINDT in the syllabus areas given in section 2.1
- 8.2 Level 2 candidates will have successfully completed a PCN examination for Welding Inspection Level 2 for ferritic steel, and:
 - 8.2.1 have a minimum of twelve months experience under qualified supervision acceptable to BINDT as a Weld Inspection Level 2 (certificated or uncertificated) carrying out the work activities listed in 2.1, or
 - 8.2.2 have held certification, acceptable to BINDT, covering non-destructive testing of welds for at least 12 months and have a minimum of six months experience under qualified supervision acceptable to BINDT as a certificated or uncertificated Weld Inspector Level 2 carrying out the work activities listed in 2.1, or
 - 8.2.3 provide verifiable evidence of having been a welding instructor or welding foreman/supervisor for a minimum of 12 months and have a minimum of six months experience under qualified supervision acceptable to BINDT as a certificated or uncertificated Weld Inspector Level 2 carrying out the work activities listed in 2.1.
- 8.3 Level 3 candidates will have successfully completed a PCN examination for Weld Inspection Level 3 and:
 - 8.3.1 have held BINDT recognised Weld Inspector Level 2 certification for at least two years, or
 - 8.3.2 provide verifiable evidence of having typical job responsibilities of a Weld Inspection Level 3 for at least five years.

9. SUPPLEMENTARY CERTIFICATION

- 9.1 Holders of valid Weld inspection level 2 or Weld Inspection Level 3 certification may apply for supplementary certification covering one or more of each of the following materials groups:
 - 9.1.1 Aluminium and its alloys (MIG and TIG welding), and magnesium and its alloys (TIG welding).
 - 9.1.2 Austenitic steels and high nickel alloys (MMA, MIG, TIG and mechanised fusion welding), and Titanium alloys (inert gas welding).
 - 9.1.3 Copper (and its alloys) and Monel (MMA, MIG and TIG welding).
- 9.2 Candidates for Weld Inspection Level 2 and/or Weld Inspection Level 3 of materials detailed above have first to gain certification for inspection of welds in ferritic steel.
- 9.3 The written examination for all candidates will comprise 10 multiple choice answer questions related to the materials technology for each of the materials groups in which certification is sought. Time allowed: 3 minutes per question.
- 9.4 For Weld Inspection Level 3, success in a practical examination will be required. This will consist of interpretation and comment on 4 weld radiographs for each material group appropriate to the scope of the supplementary certification sought (unless the candidate is a holder of a relevant valid PCN certificate covering radiographic interpretation of that group of materials). The time allowed is 15 minutes per radiograph.

10. VALIDITY OF CERTIFICATION

- 10.1 The period of validity of the certification is described in PCN document I&T (GEN) : General Requirements for the Certification of Personnel for Engineering Inspection and Testing.

11. REVALIDATION UPON EXPIRY

- 11.1 Status

Certificates have a status of either issue 01 or issue 02. Certificates bearing 01 are issued following success in an initial, supplementary or recertification examination. Certificates bearing 02 are issued following renewal after a review of satisfactory evidence of continuity in the work for which they are issued.
- 11.2 Renewal

For information on renewal, see PCN document I&T (GEN): General Requirements for the Certification of Personnel for Engineering Inspection and Testing.
- 11.3 Recertification

All issue 02 certificates are revalidated through success in a recertification examination comprising:

 - 11.3.1 Weld Inspector Level 1 - All the practical elements given in section 4.1.2.1.
 - 11.3.2 Weld Inspector Levels 2 - A multiple choice answer written paper covering those elements of the syllabus relevant to scope of the certificate and a practical visual inspection and reporting on one weld.
 - 11.3.3 Weld Inspector Level 3 - A multiple choice answer written paper covering those elements of the syllabus relevant to scope of the certificate and a practical visual inspection and reporting on one weld.

Weld Inspection Level 3 certificate holders will, in addition to the above, be required to interpret and report on a total of six radiographs relevant to the scope of the certification unless the candidate is a holder of a valid PCN certificate covering radiographic interpretation of welds.

12. TRANSITION

- 12.1 Holders of current valid weld inspection certification issued by other certification bodies (recognised by BINDT) seeking to gain PCN certification for Weld Inspection at an equivalent level will be required to be successful in the PCN recertification examination.
- 12.2 Holders of current valid weld inspection certification issued by other certification bodies (recognised by BINDT) seeking to gain PCN certification for Weld Inspection at a higher level will be required to be successful in the PCN initial examination for the level of certification sought.

ANNEX A: EXAMINATION SYLLABUS FOR WELD INSPECTION LEVEL 1, 2 AND 3

WELD INSPECTION LEVEL 1

Will have an elementary understanding of the following syllabus sections:

- A1. The role of the Weld Inspector Level 1
 - a) Specific duties and responsibilities
 - b) Basic use of welding inspection equipment
 - c) Knowledge of welding related standards and specifications
- A2. Weld terminology
 - a) Types of joint
 - b) Types of weld
 - c) Types of joint preparation
 - d) Weld zone terms
 - e) Weld positions
 - f) Welding processes
- A3. Welding procedures
 - a) The essential features of a welding procedure
 - b) Welder approvals
 - c) Welding processes: a basic understanding of recognizing
 - i) Oxy-gas welding
 - ii) Manual metal arc (MMA) welding
 - iii) Metal inert gas (MIG) and metal active gas (MAG) welding
 - iv) Tungsten inert gas (TIG) welding
 - v) Plasma arc welding
 - vi) Submerged arc welding
- A4. A basic understanding of recognizing thermal cutting
 - a) Flame cutting
 - b) Electric arc cutting
- A5. Materials
 - a) Inspection points
 - b) Size (thicknesses, lengths and diameters)
 - c) Types (grade; composition against specifications)
 - d) Cleanliness and surface condition for welding
- A6. Weld imperfections
 - a) Terminology
 - b) Weld imperfections
 - c) Correct identification of weld imperfections
 - d) Classification and significance of imperfections
 - e) Imperfections acceptance levels
 - f) Stress and distortion
- A7 Welding consumables Identification
- A8 Arc welding safety
 - g) Statutory health and safety requirement and practices
 - h) Protection against
 - i) Heat and light
 - ii) Electric shock
 - iii) Fumes and gases

WELD INSPECTION LEVEL 2 & 3

The complexity of the examination for Weld Inspection Level 3 will require a greater in-depth understanding of the subjects listed.

- A9. The role of the Weld Inspector Level 2
 - a) Specific duties
 - b) Welding inspection equipment
- A10. The role of the Weld Inspection Level 3
 - a) Supervision of Weld inspector Level 2
 - b) Auditing
 - c) Record keeping

- A11. Weld terminology
 - a) Types of joint
 - b) Types of weld
 - c) Types of joint preparation
 - d) Weld zone terms
 - e) Weld positions
- A12. Welding procedures
 - a) The essential features of a procedure
 - b) Welder approvals and their control
 - c) Welding processes
 - i) Oxy-gas welding
 - ii) Manual metal arc (MMA) Welding
 - iii) Metal inert gas (MIG) and metal active gas (MAG) welding
 - iv) Tungsten inert gas (TIG) welding
 - v) Plasma arc welding
 - vi) Submerged arc welding
- A13. Thermal cutting
 - a) Flame cutting
 - b) Electric arc cutting
- A14. Gouging processes
- A15. Materials
 - a) Inspection points
 - b) Size (thicknesses, lengths and diameters)
 - c) Types (grade; composition against specifications)
 - d) Cleanliness and surface condition for welding
- A16. Steel weldability
 - a) Steel
 - b) Grain structures
 - c) Heat affected zone (HAZ)
 - d) The effect of hydrogen in steel
 - e) The carbon equivalent of steel
 - f) Preheat, its application and control
 - g) Interpass temperature
- A17. Weldability of steels
 - a) Steel types and their weldability
 - b) Guidelines for the welding of steel
- A18. Stress and distortion
- A19. Post heat treatment
 - a) Stress relieving
 - b) Annealing
 - c) Normalising
 - d) Hardening/quenching
 - e) Tempering
 - f) Hydrogen release
- A20. Welding procedures and welder tests
- A21. Visual examination and dimensional checking before and after welding
- A22. Mechanical testing of welded joints
 - a) Tensile test
 - b) Bend test
 - c) Nick-break test
 - d) Fillet weld fracture test
 - e) Impact test
 - f) Hardness test
 - g) Macroscopic (macro) examination
 - h) Microscopic examination
 - i) Crack tip opening displacement test
- A23. Weld defects and repairs
 - a) Terminology
 - b) Weld imperfections as stated in level 1
 - c) Avoiding weld defects
 - d) Classification and significance of defects
 - e) Defect acceptance levels

- f) Repair welding
- A24. Cracking
 - a) Weld process cracks
 - b) Service induced failures
 - c) Weld decay in austenitic stainless steel
- A25. Welding consumables
 - a) Filler rods and wires
 - b) MMA consumables (electrodes)
 - c) Fusible inserts
- A26. Welding plant
 - a) Power sources
 - b) Wire feeders
 - c) Welding heads, guns and torches
 - d) Control units
 - e) Mechanised, automatic and robotic welding
- A27. Symbols for welding
 - a) Standards
 - b) Elementary symbols
 - c) Supplementary symbols
 - d) Positions for symbols
 - e) Dimensions
 - f) Complimentary indications
- A28. Arc welding safety
 - a) Statutory health and safety requirement and practices
 - b) Protection against
 - i) Heat and light
 - ii) Electric shock
 - iii) Fumes and gases
- A29. Welding related specifications and standards
- A30. Weld drawings, understanding and interpretation
- A31. Reporting
 - a) Welding inspection reports
 - b) NDT report assessment
- A32. Quality assurance
 - a) The aims, benefits and scope of QA
 - b) Comparisons of QA, quality control and inspection
 - c) QA standards
- A33. Certification
 - a) Welders
 - b) Weld Inspector Level 2
 - c) NDT personnel
- A34. Normative documents (codes)
- A35. Non-Destructive Testing (NDT)
 - a) Penetrant Testing (PT)
 - b) Magnetic Particle Testing (MT)
 - c) Radiographic Testing (RT)
 - i) Interpretation of weld radiographs (syllabus contained in PCN/GEN appendix C2.2)
 - ii) Radiation safety (syllabus contained in PCN/GEN appendix E3.2)
 - d) Ultrasonic Testing (UT)
 - e) Eddy Current Testing (ET)
 - f) Visual Testing (VT)

ANNEX B: SPECIMEN EXAMINATION QUESTIONS

MULTI-CHOICE QUESTIONS FOR WELD INSPECTION LEVEL 1

- 1) It is the duty of a Level 1 weld inspector to:
 - a) choose the welding process.
 - b) choose the welding technique.
 - c) follow the guidelines given by Level 2 and 3 weld inspectors.
 - d) Any of the above if given permission by PCN.
- 2) Which of the following usually has the most influence on imperfection types?
 - a) Weld process.
 - b) Weld position.
 - c) Parent material.
 - d) Poor welding skills.
- 3) What instrument could be used to measure the cap height on a plate butt weld?
 - a) An X-ray set
 - b) An ultrasonic set with a 0° probe.
 - c) A weld inspection gauge.
 - d) There is no need to measure the cap height.
- 4) The distance between the root and the face of a fillet weld is known as:
 - a) Mitre size
 - b) Throat thickness
 - c) Leg length
 - d) Face width

MULTI-CHOICE QUESTIONS FOR WELD INSPECTION LEVEL 2

- 1) Voltage, amperage, travel speed and pre-heat temperature are all variables which will affect :
 - a) Post weld heat treatment
 - b) Carbon content
 - c) Heat input
 - d) Melting temperature
- 2) The contour of welds forming notches at the weld toes can affect which of the following?
 - a) Fatigue
 - b) Grain structure
 - c) Low temperature properties
 - d) Both A and C
- 3) Weld metal can essentially be considered as a:
 - a) unique item
 - b) small casting
 - c) upset forging
 - d) none of the above
- 4) Annealing can be used to achieve which of the following aims?
 - a) To soften the steel
 - b) To relieve internal stresses caused by some previous treatment
 - c) To release hydrogen which may have become trapped in the HAZ
 - d) Any of the above
- 5) The Vickers Hardness Machine uses:
 - a) a diamond square based pyramid
 - b) a steel ball 1.58 mm in diameter
 - c) a hardened steel ball 10 mm in diameter
 - d) a fulcrum and jockey weight

- 6) Which of the following NDT methods would be best able to locate lack of sidewall fusion in a single vee plate weld 25 mm thick at a depth of 5-7 mm?
- a) Magnetic particle testing
 - b) Penetrant testing
 - c) Ultrasonic testing
 - d) Eddy current testing

NARRATIVE QUESTIONS FOR WELD INSPECTION LEVEL 2

- 1) Describe the duties of a Weld Inspector Level 2 . References to your chosen specification are expected in your answer (open book).
- 2) State which mechanical tests are required for a 914mm (36") diameter MMA pipe butt weld using your chosen procedure for the qualification of a welding procedure specification (WPS) qualification test. Describe the number of tests and the location of test pieces taken from the test sample. (openbook)
- 3) Explain the probable causes of tungsten inclusions in a TIG weld and what precautions can be take to prevent them.
- 4) Describe four reasons for the use of pre-heat. State the criteria which determine the pre-heat temperature.

MULTI-CHOICE RADIOGRAPHIC QUESTIONS FOR WELD INSPECTION LEVEL 3

- 1) Collimators should be selected:
 - a) by the quality control manager only.
 - b) for gamma ray sources only.
 - c) based on the film speed used.
 - d) to be of the size and shape to limit the beam only to the area of interest.
- 2) Which of the following will cause artefacts on radiographs?
 - a) Cracked lead screens.
 - b) Static electricity.
 - c) Pressure after exposure.
 - d) All of the above.
- 3) What is the one requirement that every radiographic film base must have?
 - a) Flexibility.
 - b) Transparency.
 - c) Toughness.
 - d) Fine grain.
- 4) A film being manually processed was tapped gently to remove bubbles but streakiness still occurred. This is because:
 - a) developer was spilled on the film prior to development.
 - b) developer contaminated the fixer.
 - c) the film was not agitated sufficiently during development.
 - d) water splashed on the film prior to development.
- 5) Thin sheets of lead foil in intimate contact with radiographic film increase film density because they:
 - a) fluoresce and emit visible light which helps expose the film.
 - b) absorb the scattered radiation.
 - c) prevent back-scattered radiation from fogging the film.
 - d) emit electrons which helps darken the film.
- 6) An IQI is used to determine the:
 - a) size of a discontinuity in the part.
 - b) density of the film.
 - c) radiographic contrast.
 - d) quality of the radiographic image.

NARRATIVE QUESTIONS FOR WELD INSPECTION LEVEL 3

- 1) As the Senior Welding Inspector you are required to visit a site where your Welding Inspectors and NDT Inspectors have been working. What questions would you ask them and which documents would you check as a "Final Documentation Review" before submission to the client?
- 2) Which NDT method would you expect to be used to accurately locate and size lack of sidewall fusion in a submerged arc carbon steel weld? Discuss the reasons for your choice of method over other possible NDT methods and give the advantages and disadvantages of your chosen method.
- 3) Explain how hydrogen induced cold cracking occurs in carbon steel welds and discuss methods of prevention.
- 4) A centerline crack has been detected during NDT inspection of a carbon steel weld. Give the possible reasons for its formation and discuss methods of prevention.

ANNEX C: BIBLIOGRAPHY

ESSENTIAL READING: CODES AND STANDARDS FOR WELD INSPECTION EXAMINATIONS

The candidate (or employer) has to choose a code or specification for use in the examination. This is used in two examination modules, the narrative question relating to Weld Inspector Level 2 duties and the practical pipe sample. Below is a list of possible codes and standards that can be used in the examination, this is not an exhaustive list and an examiner at the AQB will be able to advise on the suitability of any proposed alternatives. A clean unmarked copy of the standard is required for the examination, also if the standard is not on the list below a copy needs to be sent with the application to verify its suitability. It is the responsibility of the candidate to ensure they are in possession of the applicable and most up to date code or specification.

Transco T/SP/P2

BS 4515-1: Specification for process of welding of steel pipelines on land and offshore

API STD 1104 Welding of Pipelines and Related Facilities

PD 5500 Specification for unfired fusion welded pressure vessels

BS EN 1011 Welding recommendations. (In conjunction with BS EN ISO 5817 Arc Welded Joints in Steel, guidance on quality levels for imperfections).

BS 4677: Specification for arc welding of austenitic stainless steel pipe work for carrying fluids

BS 2633: Specification for class 1 arc welding of ferritic steel pipe work for carrying fluids

BS 2971: Specification for class II arc welding of carbon steel pipe work for carrying fluids

ASME VIII: Boiler & Pressure Vessel Code VIII

ANSI B31.3 : Chemical Plant and Petroleum Refinery Piping

AWS D1.1 Structural steel welding code

OTHER STANDARDS

General

BS 499, Part 1: Welding terms and symbols. Glossary for welding, brazing and thermal cutting.

BS EN 4063: Nomenclature of processes and reference numbers

BS EN 22553: Welded, brazed and soldered joints-symbolic representation on drawings.

Qualification of welders and procedures

BS EN 287, Part 1: Approval testing of welders for fusion welding - Steels.

BS EN 287, Part 2: Approval Testing of Welders for Fusion Welding of Aluminium alloys.

BS EN 15614 Part 1: Specification and approval of welding procedures for metallic materials – Steels and nickel alloys

BS EN ISO 15614-2: Specification and qualification of welding procedures for metallic materials. Aluminium and its alloys.

ASME IX: Welding and brazing qualifications

Welding consumables

BS EN 499: Welding Consumables-covered electrodes for manual metal arc welding of non-alloy and fine grain steels.

BS EN 1668: Welding Consumables - Rod Wires and Deposits for Tungsten Inert Gas Welding of Non Alloy and Fine Grain Steels-Classification.

BS EN 757: Welding Consumables-Covered Electrodes for Manual Metal Arc Welding of High Strength Steels-Classification.

BS EN 758: Welding Consumables-Tubular cored Electrodes for Metal Arc Welding with and without a Gas Shield of Non Alloy and Fine Grain Steels-Classification.

AWS A 5.1: Specification for covered carbon steel welding electrodes.

Quality assurance & quality control

BS EN 970: Non-destructive examination of fusion welds-visual examination.

BS EN 571: Penetrant testing

BS EN 1290: Magnetic Particle Inspection.

BS EN 1435: Non-destructive examination of welds: radiographic examination of welded joints.

BS EN 462, Parts 1 & 2: Image Quality of Radiographs, Wire and Step Hole Type.

BS EN 1321: Macroscopic and microscopic examination of welds

BS EN910: Destructive tests on welds in metallic materials - Bend tests

BS EN ISO 5817 Arc Welded Joints in Steel, guidance on quality levels for imperfections.

BS EN ISO 9000 : 2000 Quality Management Systems - Fundamentals and Vocabulary

BS EN ISO 9001: Quality Management Systems.- Requirements

BS EN 729/ISO 3834: Quality requirements for welding.

BS EN 473/ISO 9712: NDT and Certification/Qualification of NDT personnel

This is not an exhaustive list and local/national standards in many parts of the world will cover similar topics.

TRAINING MATERIAL

Training Course Notes.

BINDT requires candidates to have attended a recognised course of training. Training Establishments are required to provide trainees with an up-to-date set of training course notes. These are considered essential reading.

RECOMMENDED READING

- ❑ Product Technology Classroom Training Handbook. BINDT/PCN Publication, 1 Spencer Parade, Northampton, NN1 5AA.
- ❑ PCN Classroom Training Handbook on the Visual Non-Destructive Testing of Metallic Materials in General Engineering use. BINDT/PCN Publication, 1 Spencer Parade, Northampton, NN1 5AA.
- ❑ Welders Handbook; A Complete Guide to Mig, Tig, Arc and Oxyacetylene Welding. Richard Finch, HP Books, ISBN 1557882649
- ❑ Practical Welding. S W Gibbon, Macmillan Educational Ltd, ISBN 0333609573
- ❑ The Science and Practice of Welding Vol. 1, Welding Science and Technology. A C Davies, Cambridge University Press, ISBN 052143565X
- ❑ The Science and Practice of Welding Vol. 2, The Practice of Welding. A C Davies, Cambridge University Press, ISBN 0521435668
- ❑ Weld Symbols on Drawings. Welding Institute, Woodhead Publishing, ISBN 085300157X
- ❑ Welding Principles and Applications. Larry F Jeffus, Delmar Publishers ISBN 0827382405
- ❑ Metallurgy of Basic Weld Metal. G Evans, William Andrews Inc., ISBN 1855732432
- ❑ Handbook of Structural Welding, Processes, Materials and Methods used in the Welding of Major Structures, Pipelines and Process Plants. John Lancaster, Woodhead Publishing, ISBN 1855733439