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SPECIFIC REQUIREMENTS FOR THE CERTIFICATION OF PERSONNEL FOR WELD INSPECTION

CONTENTS

1. SCOPE

1.1. This document prescribes the specific requirements and procedures by which personnel may be examined and, if successful, certificated for Welding Inspection at three levels covering welds. (Level 1, Level 2 and Level 3 see Certification Available). It includes requirements for certification, examination syllabus, specimen examination questions, and a bibliography.

1.2. Each candidate is responsible for bringing a copy of a suitable **Code of Practice** or **Application Standard** relevant to the application. Authorised Training Organisations (ATO's) may be able to advise on such documentation.

1.3. This document update is intended to bring the Welding Inspector training & examination process in line with the best practice's adopted by PCN

1.4. This document incorporates the requirements of **ISO 17637 "Non-Destructive testing of welds – Visual testing of fusion-welded joints**" and much of the Annex B of **ISO 14731:2006 "Welding coordination – Tasks and responsibilities"** and specifically welding inspection into this qualification.

1.5. 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) 438300, or email questions to pcn@bindt.org.

1.6. Copies of PCN documents are available free of charge from BINDT Certification Services Division at Midsummer House, Riverside Way, Bedford Road, Northampton, NN1 5NX, 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. ELIGIBILITY FOR EXAMINATION

2.1 Weld Inspection Level 1 candidates will have successfully completed a BINDT recognised course of training for Level 1 Welding Inspection. (20 hours **minimum** duration)

2.2 Weld Inspection level 2 candidates will have successfully completed a BINDT recognised course of training* for Welding Inspection. (50 hours **minimum** duration, **20% of this maybe accrued by self-study prior to the start of a course).

2.3 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.*

*** The ATO shall supply training material to the candidate prior to attending the course, this shall be considered 'self-study'.*

2.4 The PCN requirements for colour perception and acuity of vision, together with the qualifications of those administering the vision tests, are fully defined in PCN document PSL/44, which includes a form for recording the results of vision tests. The requirements are reproduced below for ease of information.

2.5 Candidates for PCN examinations will be required, on the day of the examination, to provide proof of a satisfactory vision test conducted within the 12 months preceding the examination.

2.5.1 Near vision acuity shall permit reading a minimum of Jaeger number 1 or Times Roman N 4.5 or equivalent letters (having a height of 1,6 mm) at not less than 30 cm with one or both eyes, either corrected or uncorrected;

2.5.2 Colour vision shall be sufficient that the candidate can distinguish and differentiate contrast between the colours or shades of grey used in the NDT method concerned as specified by the employer.

NOTE: Subsequent to certification, the documented tests of visual acuity shall be carried out at least every twelve months and verified by the employer

3 EXAMINATION CONTENT

3.1 The principles of mastering specimens shall be in line with PCN documents CP8 for training specimens and CP9 (appendix 13) for examination specimens.

3.2 Weld Inspection Level 1

3.2.1 The theoretical examination is designed to assess candidate knowledge and understanding of the syllabus. The theoretical examination comprises one section:

3.2.1.1 30 multiple choice questions on basic welding theory, weld inspection and product technology. Time allowed 45 minutes.

3.2.2 The practical examination, shall not include plastics, it is designed to test the practical competence of the candidate and comprises of:

3.2.2.1 Assessment of a Weld – Fit-up to a specified WPS. Time allowed: 30 minutes

3.2.2.2 Assessment of a completed Fillet Weld. Time allowed: 1 hour

3.2.2.3 Assessment of a completed Plate Weld. Time allowed: 1 hour

3.2.2.4 Reporting the results in a prescribed manner in accordance with the instructions provided

Total Time allowed 2.5 hours.

3.3 Weld Inspection level 2

3.3.1 The narrative examination is designed to assess the candidate's knowledge and understanding of the key syllabus parts. The written examination part comprises two sections:

3.3.1.1 30 questions on general welding theory, welding inspection and product technology. Time allowed: 45 minutes.

3.3.1.2 4 narrative questions selected by the candidate from 6 provided, covering specific welding technology. Time allowed: 1.5 hours.

For direct access to Level 2 the candidate must complete the examination at 3.2.2.2

3.3.2 The practical examination, shall not include plastics, it is designed to test the practical competence of the candidate and comprises three parts:

3.3.2.1 Assessment of a joint preparation/joint fit-up to a specified Welding Procedure Specification. *(**This would be exempt if the PCN Level 1 Weld Inspection certificate was current).* Time allowed: 30 minutes.

3.3.2.2 Assessment of a Plate AND Pipe Weld to a provided Code of Practice or Application standard. *(**Plate would be exempt if the PCN Level 1 Welding Inspection certificate was current).* Time allowed: Plate = 1 hour, Pipe = 1.5 hours (2.5 hours total)

3.3.2.3 Report on 2 destructive specimens to a provided imperfection acceptance standard. This would be a macroscopic test and either a bend test or fracture test of a fillet welded specimen. Time allowed: 30 minutes.

Maximum total time allowed: 3.5 hours

3.4 Weld Inspection Level 3

3.4.1 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.

3.4.2 The written examination part comprises:

3.4.2.1 4 narrative questions selected by the candidate from 6 provided, covering specific welding technology. Time allowed: 1½ hours.

3.4.2.2 30 multiple-choice general theory questions at Level 2 standard demonstrating the basic understanding of conventional and advanced NDT methods that a Level 3 Welding Inspector may encounter. Time allowed: 1 hour.

3.4.3 The practical examination, shall not include plastics, the exam comprises four parts :

3.4.3.1 Scrutinise and comment on three inspection related documents. Time allowed: 1 hour.

3.4.3.2 Inspection of two separate weld failures associated with defects producing a report on the proforma provided. Time allowed: 1 hour.

3.4.3.3 Understanding of welding fabrication drawing symbols. Time allowed: 1 hour.

3.4.3.4 Interpretation of six radiographs of welds. The welds will have been produced by MMA, MIG, TIG or any other standard welding technology. (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.

4 EXAMINATION GRADING

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

5 RETESTS

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

6 ELIGIBILITY FOR CERTIFICATION

6.1 Level 1 candidates will have successfully completed a PCN examination for Weld Inspection Level 1 and:

6.1.1. Have a minimum of one month experience under supervision acceptable to BINDT in the syllabus areas given in section 2.1

6.2 Level 2 candidates will have successfully completed a PCN examination for Welding Inspection Level 2, and:

6.2.1 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 Annex B, **or**

6.2.2 Have held certification, acceptable to BINDT, covering non-destructive testing of welds for at least 12 months and have a minimum of 6 months experience under qualified supervision acceptable to BINDT as a certificated or uncertificated Weld Inspector Level 2 carrying out the work activities listed in Annex B, **or**

6.2.3 Provide verifiable evidence of having been a welding instructor or welding foreman/supervisor for a minimum of 12 months, or provide verifiable evidence of having been trained through a structured training programme such as a Welding Technician or Welding Craftsperson from a formal apprenticeship for a minimum of 24 months and have a minimum of 12 months experience under qualified supervision acceptable to BINDT as a certificated or uncertificated Welding Inspector Level 2 carrying out the work activities listed in Annex B.

6.3 Level 3 candidates will have successfully completed a PCN examination for Weld Inspection Level 3 and:

6.3.1 Have held BINDT recognised Weld Inspector Level 2 certification for at least two years, **or**

6.3.2 Provide verifiable evidence of having typical job responsibilities of a Weld Inspection Level 3 for at least five years.

7 VALIDITY OF CERTIFICATION

7.1 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.

8 REVALIDATION UPON EXPIRY

8.1 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.

8.2 Renewal

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

8.3 Recertification

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

8.3.1 Weld Inspector Level 1 - All the practical elements given in section 4.1.2.1.

8.3.2 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.

8.3.3 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.

9 CERTIFICATION AVAILABLE

9.1 The following certification is available:

9.1.1 Weld Inspection Level 1

9.1.2 Weld Inspection Level 2

9.1.3 Weld Inspection Level 3

10 TRANSITION

10.1 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.

10.2 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.

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ANNEX A. SYLLABUS & EXAMINATION CRITERIA

It is intended that the Level 1 welding inspector practitioner will hold a basic knowledge of all aspects of welding inspection indicated below, the level 2 welding inspector will have an in-depth understanding. The level 3 welding inspector is required to demonstrate full knowledge & understanding of the requirements and processes involved with this certification, and also have the knowledge, experience and ability to be able to organize and manage an inspection team.

For ease of understanding the following table has been created.

For Reference and in the context of Weld Inspection:

B = Basic Knowledge.

- Inspector shall have a basic knowledge of the subject.
- Inspector shall be able to perform the basic task required.
- Inspector shall be able to report results in an agreed/approved manner.

I = Intermediate knowledge. (As for "B" plus)

- Inspector shall have intermediate knowledge of the subject.
- Inspector shall be able to perform all of the listed tasks for weld inspection and related activities as detailed within table A1.
- Inspector shall be able to report and interpret results of the test/method undertaken (Pass/fail)

F = Further knowledge. (As For "I" plus).

- Inspector shall have a better understanding of the subject.
- Inspector shall be able to co-ordinate and assume responsibility for weld inspection and related activities as detailed within table A1.
- Inspector shall be able to report and interpret results & give informed opinion on the results.

TABLE A1.

1	Principals of Welding Inspection.	Level 1.	Level 2.	Level 3.
1.1	**Introduction**.			
	• Essential duties of welding inspection.	B	I	F
	• Duties of a Level 1 Welding Inspector.	B	I	F
	• Duties of a Level 2 Welding Inspector.		I	F
	• Duties of a Level 3 Welding Inspector.			F
	• Supervision.		I	F
	• Codes, Standards & workmanship. (Both national and international. (EN, ISO, AWS, ASME, etc).	B	I	F
	• Material types properties & weldability.	B	I	F
	• Basic knowledge of Quality Assurance &Quality Control.	B	I	I
	• Knowledge of NDT methods.	B	I	F
	• Understanding of residual stress and distortion.		I	F
	• Health & Safety related to welding and welding environments.	B	I	
1.2.	**Duties prior to welding**.			
	• Checking of Materials. Size, type and condition.	B	I	F

	• Separation of materials during welding and minimizing cross contamination. (E.g. Carbon Steel / Stainless steels).	B	F	F
	• Checking welding processes for conformity.	B	I	F
	• Checking welding consumables for conformity.	B	I	F
	• Checking welding consumable for correct storage and handling.	B	I	F
	• Consumable designation and classification.			
	• Checking Correct WPS is applicable.	B	I	F
	• Checking of edge preparation type, method and joint set up	B	I	F
	• Checking of joint alignment is in use and correct process and method is used for tacking etc. if required.	B B	I I	F F
	• Application and control of pre-heat, measurement and method used.	B	I	F
	• Control of inter-pass temperature			
	• Qualification of welders.	B	I	F
	• Validation and verification of equipment and tools used. (Volt/Amp meter, temperature gauge etc.).	B	I I	F F
1.3.	**Duties during welding**.			
	• Checking correct process in use per weld run as per WPS. (e.g.TIG/GTAW – root & subsequent passes, MMA/SMAW – fill & capping passes).	B	I	F
	• Checking heat input during welding. (VoltsxAmps/Travel Speed x k factor).	B	I	F
	• Checking correct technique in use during welding, (Weave, or Stringerbead).	B	I	I
	• Checking correct direction of welding and position. (E.g. Leftward, rightward and vertical up – down.).	B	I	I
	• Checking correct weld run sequence is used during welding.	B	I	I
	• Checking of inter-pass temperature.	B	I	I
	• Checking of method of inter-pass cleaning.	B	I	I
1.4.	**Duties after welding**.			
	• Ensure that the weldface is completed to specification.	B	I	I
	• Ensure any remedial work is carried out while the weld is still adequate in temperature as per the WPS if applicable	B	I	I
	• Check the weld is adequately post cleaned.	B	I	I
	• Visual assessment of completed weld.	B	I	F
	• Ensure the weld is covered if required by the appropriate WPS with heat insulated blankets to retard cooling rate.	B	I	F
	• Check post weld heat treatment is carried out as per the WPS or procedure where specified.	B	I	F
1.5.	**Visual testing of finished weld.**			
	• Factors affecting the visual inspection, lighting levels etc.	B	I	F
	• Material under inspection and its properties.	B	I	F
	• Preparation of area for test.	B	I	F
	• Dimensional check of weld.	B	I	F
	• Visual check of weld face & root against acceptance criteria.	B	I	F
	• Influence of geometry on weld imperfection detectability.	B	I	F
	• Surface conditions.	B	I	F
1.6	**Reporting of Weld.**			
	• Reporting on and completion of report of completed welds.	B	I	F
	• Minimum Information requiring recording is stated in EN ISO 17637 Section 5 “Test records”	B	I	F
	• Releasing weld for NDT.		I	F
	• Acceptance/Rejection of Weld		I	F
1.7	**Monitoring of any weld repairs required**.			
	• Correct WPS is used.	B	I	F
	• Correct consumables are used as per WPS.	B	I	F
	• Correct process used as per WPS	B	I	F
	• Correct pre-heat used as per WPS.	B	I	F
	• Correct depth of repair excavation and length are made as per NDT results.	B	I	F
	• Correct NDT applied to repair area as per WPS – work instructions – Quality plan.	B	I	F

	• Qualification of Welder for Repair Welding.	B	I	F
2	**Welding Equipment.**	**Level 1.**	**Level 2.**	**Level 3.**
2.1	**Construction and mode of operation of welding equipment.**			
	• MMA/SMAW (111)	B	I	F
	• TIG/GTAW (141).	B	I	F
	• MIG/GMAW (131).	B	I	F
	• MAG/GMAW (135).	B	I	F
	• FCAW (136)	B	I	F
	• SAW (12).	B	I	F
	• PAW (15).	B	B	B
2.2	**Block Diagram of Welding Processes**.			
	• Control and function of equipment including inverter systems.		I	F
	• Manual/semi-automatic/mechanized/automated processes		I	F
	• Significance of drooping characteristic.(Constant Current)		I	F
	• Significance of flat characteristic (Constant Voltage)		I	F
2.3	**Welding Current and type of polarity.**			
	• AC sine and square wave types	B	I	I
	• DC Electrode Positive.(DCEP)	B	I	I
	• DC Electrode Negative.(DCEN)	B	I	I
	• Pulsed arc processes		I	I
2.4	**Calibration & Validation of equipment.**			
	• Use of measuring equipment for weld inspection.	I	I	I
	• Welding Gauges, rules, Go / No-go gauges, Fillet Gauges, Boro-scopes, magnifiers etc.	B	I	I
	• Equipment Calibration.	B	I	F
	• Volt/Amp meter calibration.	B	I	F
	• Digital Thermometers / pyrometers etc.	B	I	F
	• Heat indicating temperature crayons etc.	B	I	F
	• Illumination.	B	I	F
2.5.	**Health and safety of equipment.**			
	• Hazards of working with welding equipment.	B	I	F
	• Hazards of different welding processes.	B	I	F
3	**Welding imperfections.**	**Level 1.**	**Level 2.**	**Level 3.**
3.1	**Imperfection Acceptance Levels.**			
	• Classification of imperfections.	B	I	F
	• Acceptance to “Code” or “Standard”.		I	F
3.2.	**Planar imperfections.**			
	• Lack of side wall fusion.	B	I	F
	• Lack of inter-run fusion	B	I	F
	• Lack of root penetration	B	I	F
	• Lack of root fusion	B	I	F
	• Cracks	B	I	F
	• Tears	B	I	F
3.3	**Gas Inclusions**.			
	• Gas pore	B	I	F
	• Elongated gas cavities (Worm holes)	B	I	F
	• Porosity	B	I	F
3.4	**Solid Inclusions.**			
	• Copper.	B	I	F
	• Tungsten.	B	I	F
	• Slag.	B	I	F
	• Silica.	B	I	F
3.5	**Workmanship imperfections.**			
	• Incomplete filled grove.	B	I	F
	• Arc Strikes/Stray arcs.	B	I	F
	• Root concavity (Suck Back).	B	I	F
	• Burn Through	B	I	F

	• Overlap	B	I	F
	• Spatter	B	I	F
	• Poor Profile.	B	I	F
	• Undercut.	B	I	F
3.6.	**In-Service Imperfections**			
	• Fatigue		I	F
	• Stress Corrosion Cracking		I	F
	• Brittle fracture.		I	F
3.7	**Cracks.**			
	• Solidification cracks.	B	I	F
	• Cracking mechanisms.		I	F
	• HAZ Cracks (hydrogen induced)		I	F
	• Chevron cracks.		I	F
4	**Weld Joint Design**	**Level 1.**	**Level 2.**	**Level 3.**
4.1	**Weld Joint Terminology**.			
	• Bevel angle.	B	I	I
	• Included Angle	B	I	I
	• Root Face.	B	I	I
	• Root Gap.	B	I	I
4.2.	**Type of Joint.**			
	• Butt Weld	B	I	I
	• Fillet Weld.	B	I	I
	• Cruciform	B	I	I
	• Edge, lap and corner joints	B	I	I
	• Spot, seam, projection and slot welds	B	I	I
	• Compounded welded joints	B	I	I
4.3	**Weld Zone Terms**.			
	• Heat affected Zone (HAZ).	B	I	I
	• Weld root.	B	I	I
	• Weld face (Cap).	B	I	I
	• Fusion boundary, fusion faces and sidewall	B	I	I
	• Leg Length (z)	B	I	I
	• Throat thickness (a and s details)	B	I	I
4.4	**Welding Position.**			
	• Slope.	B	I	I
	• Rotation.	B	I	I
	• Position. PA, PB, PC, PDetc	B	I	I
4.5	**Weld Symbols.**			
	• Weld symbols on drawings.	B	I	F
	• EN ISO 2553, AWS		I	F
5.	**Welder Testing.**	**Level 1.**	**Level 2.**	**Level 3.**
5.1	**Witness welder qualification testing**.			
	• Monitor a welder test.	B	I	F
	• Record/report all variables and parameters.	B	I	F
	• Visual acceptance or rejection of welder test.	B	I	F
	• Sign off Welder as approved/qualified as per standard / specification / code.		I	F
6.	**Welding Procedure Qualification.**	**Level 1.**	**Level 2.**	**Level 3.**
	Witness of welding procedure qualification test.			
	• Witness of all material/consumable certification		I	F
	• Monitor & record all parameters. (WPQR.)	B	I	F
	• Ensure all required NDT is carried out as per Specification / Code / Standard applicable.		I	F
	• Witness all mechanical testing carried out on WPQR and report all		I	F

	findings as applicable • Signing off WPQR as a "true record".			 F
7.	**Mechanical Testing.**	**Level 1.**	**Level 2.**	**Level 3.**
7.1	**Definitions**. • Brittle. • Ductile. • Elasticity. • Toughness. • Hardness.	 B B B B B	 I I I I I	 F F F F F
7.2.	**Typical test carried out on welds**. (Usually as part of weld procedure qualification). • Tensile. • Bend. • Fracture. • Impact. (Charpy, IZOD). • Hardness. (Vickers, Brinell). • Macro/microscopic. • CTOD. • Fatigue.	 B B B B B B	 I I I I I I I I	 F F F F F F F F
7.3	**Stress – Strain**. • Stress-strain relationship diagram		 I	 F
7.4	**Ultimate Tensile Strength**. • Calculation		 I	 F
7.5.	**Elongation**. • Calculation.		 I	 F
8.	**Materials. Properties and Weld-ability.**	**Level 1.**	**Level 2.**	**Level 3.**
8.1	**Typical "Steel" composition. Elements & Properties**. • Carbon. • Manganese • Silicon • Aluminum • Molybdenum. • Chromium. • Vanadium • Nickel. • Copper • Sulphur • Phosphorus	 B B B B B B B B B B B	 I I I I I I I I I I I	 I I I I I I I I I I I
8.2	**Grain Structures**. • Austenite • Ferrite • Pearlite • Bainite • Martensite.		 B B B B B	 B B B B B
8.3	**Heat Affected Zone** • Heat Input Formula (EN 1011) versus arc energy	 B	 I	 F
8.4	**Hydrogen**. • Effects of Hydrogen in Steel • Hydrogen Scales	 B B	 I I	 F F
8.5	**Carbon Equivalent** • IIW Formula • Need for Pre-Heat	 B	 I I	 F F
8.6	**Heat Treatments.** • Post weld stress relieving • Post weld heating techniques • Annealing.	 B B	 I I I	 F F F

	• Normalizing.		I	F
	• Hardening/quenching.		I	F
	• Tempering.		I	F
	• Thermo-mechanical treatments		I	F
	• Hydrogen Release.		I	F
8.7	**Various Metals,** Steel types. (+Guide to weldability)			
	• Low carbon steel	B	I	F
	• Fine grained steels	B	I	F
	• Medium carbon steel.		I	F
	• High carbon steel.		I	F
	• Low temperature steel. (Cryogenic).		I	F
	• High temperature steel. (Creep Resistant).	B	I	F
	• Micro-alloyed steel.		I	F
	• Austenitic stainless steel.		I	F
	• Ferritic stainless steel	B	I	F
	• Martensitic stainless steel.		I	F
	• Duplex and super duplex stainless steel.		I	F
	• Nickel – Nickel Alloys.		I	F
	• Copper		I	F
	• Light metal alloys including aluminium and associated alloys		I	F
			I	F
8.8	**Residual stress & distortion.**			
	• Stress & distortion caused by welding.		I	F
	• Effects of residual stress and distortion & distortion control.		I	F
9.	**Welding Consumables.**	**Level 1.**	**Level 2.**	**Level 3.**
9.1	**Applicable Codes & Standards.**			
	• International (EN – ISO).	B	I	F
	• National (AWS/DIN etc.).	B	I	F
9.2	**Consumable by Process. SMAW.**			
	• Type of Flux Covering.	B	I	F
	• Basic.	B	I	F
	• Rutile.	B	I	F
	• Cellulosic.	B	I	F
	• Key constituents		I	F
9.3.	**Classification of consumables**			
	• EN ISO 2560 e.g. E 46 3 1Ni B 5 4 H5	B	I	F
	• AWS. D5.1. e.g. E7018	B	I	F
9.4	**Storage & Handling.**			
	• The correct storage and handling of consumables, as specified in the manufacturers recommendations.	B	I	F
10.	**Thermal Cutting**	**Level 1.**	**Level 2.**	**Level 3.**
10.1.	**Flame cutting processes and their effects**			
	• Flame cutting – manual and mechanised	B	I	F
	• Gas types used	B	I	F
	• Special applications		I	F
10.2	**Electric Arc Cutting Processes**			
	• Plasma Arc Cutting	B	I	F
	• Oxy Arc Gouging	B	I	F
	• Arc-Air.	B	I	F
10.3	**Non thermal cutting methods and effects**			
	• Shearing	B	I	I
	• Machining	B	I	I
	• Shaping	B	I	I
	• Water jet	B	I	I
11.	**NDT.**	**Level 1.**	**Level 2.**	**Level 3.**
11.1	**Understanding of main NDT methods.**			

	(Testing of Welds).			
	• Penetrant Testing (PT)	B	I	I
	• Magnetic Particle Testing (MT)	B	I	I
	• Ultrasonic Testing (UT)	B	I	I
	• Automatic ultrasonic testing (AUT).		I	I
	• Radiographic testing. (RT)	B	I	I
	• Radiographic Interpretation (RI)		I	I
	• Eddy Current Testing.(ET)		I	I
	• Phased Array	B	B	I
	• Time of flight diffraction	B	B	I
12.	**Quality Control / Quality Assurance.**	**Level 1.**	**Level 2.**	**Level 3.**
12.1	**Quality Assurance.**			
	• Aims of Quality Assurance.		I	F
	• Benefits of adopting a Quality Assurance System.		I	F
	• What is Definition of Quality Assurance	B	I	F
12.2	**Scope of Quality Assurance.**			
	• Inspection versus Quality Control.		I	F
	• Inspection versus Quality Assurance		I	F
	• Quality Assurance versus Quality Control.		I	F
	• Quality Standards.		I	F
12.3	**Normative Documentation.**			
	• Standard.	B	I	F
	• Code of Practice	B	I	F
	• Specification.	B	I	F
	• NDT Procedure.		B	F
	• NDT Instruction.		B	F
	• Inspection and Test Plan.	B	I	F
13.	**Safety.**	**Level 1.**	**Level 2.**	**Level 3.**
13.1.	As well as having a general understanding of safety in the workplace inspectors are required to have specific knowledge related to the risks and hazards associated with welding and welding plant.	B	I	F
13.2.	Protection against heat & light			
	• Protection from burns.	B	I	F
	• Laser welding and cutting.		I	F
	• Arc radiation.		I	F
13.3.	Protection against electrical shock.			
	• Electrical risks & magnetic fields.	B	I	F
	• Effects of volts and amperage		I	I
13.4.	Protection against fumes & gases.			
	• Metal Fume Fever.	B	I	F
	• Cadmium Exposure.	B	I	F
	• Oxy-Fuel Safety.	B	I	F
	• Confined Space.	B	I	F
	• Ventilation.	B	I	F
13.5.	Ergonomics in the welding environment.		B	F
13.6.	Tungsten Electrodes.	B	I	F

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ANNEX B. CORE COMPETENCIES.

INTRODUCTION

Since the inception over 40 years ago, welding inspection is a fundamental part of the manufacture of fabricated products to ensure consistent performance and reliability.

The purpose of this document is to communicate to employers, candidates, PCN Authorised Training Organisations and PCN Authorised Qualification Bodies the core competencies required for PCN welding inspection personnel to ensure candidates and employers are fully aware of the requirements for each level.

This document, along with its counterparts has been generated by an industry PCN Welding Inspector Working Group made up of personnel who work in the field of Welding Inspection, Quality Assurance and Quality Control.

The Level 1 Welding Inspector

The level 1 welding inspector is aimed at personnel coming into welding inspection for the first time with a limited scope of work and being supervised by a Level 2 or Level 3 welding inspector. It is the intention of this certification that the Level 1 will assess and visually accept or reject welded joints. The Level 1 inspector would however have limited exposure to before and during welding activities and will report their findings to the level 2 or Level 3 for sentencing. A significant part of this level concentrates on aspects of visual testing of welds in accordance to BS EN ISO 17637 requirements.

The Level 2 Welding Inspector

The Level 2 welding inspector has an increased scope of duties and competencies compared to a Level 1 welding inspector but until recently, the syllabus and examination scope has stayed unchanged for many years. The revised syllabus contained within this and other related documents now reflects an improved scope of work with a greater emphasis on pre weld inspection of joints and their correct fit up against the welding procedure specification. The examination has also been changed to reflect what is regarded as more important aspects of welding inspection and the visual testing of welded joints.

The Level 3 Welding Inspector

The Level 3 Welding Inspector shall be able to perform, and more importantly, manage, supervise and when required, coach, Level 1 and Level 2 welding inspectors as part of a continuous improvement philosophy. This is as well as overseeing the correct application of NDT by competent inspection personnel involved in the project. The level 3 inspector shall also prepare inspection procedures and test plans, review and interpret welding procedures as required, whilst working closely with the welding engineer or welding coordinator. The level 3 welding inspector shall also be involved with the conduct of audits of vendors and/or organizations providing services or materials to the project and shall ensure that the work performed, and the records kept are in accordance with both the contract documentation and in accordance with the applicable standards or codes of practice.

Table B1 below sets out the core competences of the 3 levels of welding inspection personnel.

TABLE B1.

1.	Basic Knowledge	Level 1.	Level 2.	Level 3.
1.1	**Preparation of reports**	B	I	F
1.2	**Understand & be able to communicate both orally & in writing using the correct technical terms.**	B	I	F
1.3	**Basic use of weld inspection equipment**	B	I	I
1.4	**Basic Welding equipment & Set Up.**	B	I	I
1.5	**Knowledge of Welding Related Standards & Specifications**	B	I	I
1.6	**Welding Procedure**			
	• Essential Features of a WPS.	B	I	F
	• Oversee a Welder Test Under Supervision.	B	I	F
	• Oversee a Welder Test.		I	F
	• Oversee a WPS (WPQR) under Supervision, and witness mechanical testing		I	F
	• Oversee a WPS (WPQR) and witness mechanical testing.		I	F
1.7	**Design of reporting Matrix and formats.*****			F
1.8	**Understand fundamentals of the main welding & cutting processes used and recognize the main inspection points.**	B	I	F
1.9	**Weld Imperfections.**			
	• An understanding of common welding imperfections & their key inspection points.	B	I	F
	• Classification of imperfection and knowledge of their effect on the weld, including the basic understanding of the causes and avoidances.	B	I	F
1.10	**Heat Treatment.**			
	• Understand the difference between material heat treatment and welding heat treatments	B	I	F
	• Understand the need for pre-heat as required by the WPS & be able to monitor correctly (under supervision for Level 1).	B	I	F
	• Understand the need for Post Weld Heat treatment and be able to monitor correctly under supervision	B	I	F
	• Accept/reject heat treatment reports.		I	F
1.11	**Understand the application and interpretation of weld symbols on drawings.**	B	I	F
1.12	**Interpret engineering & welding drawings**	B	I	F
1.13	**Understand the fundamentals of the common NDT methods.**	B	B	F
1.14	**Understand common steel types and their inspection points.**	B	I	F
1.15	**Understand the fundamentals of weld ability concepts.**	B	I	F
1.16	**Arc Welding Safety.**			
	• Appreciate common risk associated with welding & cutting in an engineering environment.	B	I	F
2.	**Inspection and testing.**	**Level 1.**	**Level 2.**	**Level 3.**
2.1	**Perform visual testing of welds.**	B	I	F
2.2	**Review Weld Inspection Reports. (Accept/Reject).**		I	F
2.3	**Devise Weld Inspection Procedures**			
	• Before Welding.		I	F
	• During Welding.		I	F
	• Post Welding.		I	F
2.4	**Verify NDT is in line with Contract requirements.**			F
2.5	**Review NDT Inspection Reports. (Accept/Reject).**			I
3.	**Quality Assurance**	**Level 1.**	**Level 2.**	**Level 3.**
3.1	**Understand Quality Control Documentation Requirements.**			
	• Ensure all records are kept for the works / services provided as per the contract / specification requirements.			F
	• Ensure all documents are signed and approved for insertion into the final documentation and that the personnel carrying out the			F

	inspection are fully qualified for the work/service.			
3.2	**Review Quality & Inspection and Test Plans.** • Work out an inspection schedule based on an ITP. • Ensure all personnel are qualified for the task they are to perform. • Ensure all NDT procedures are signed off by the relevant NDT level 3 or as specified in the contract requirements.			F F F
3.3	**Welder Qualification Test Records.** • Ensure that the Welder qualification test record is kept up to date at all times. • Ensure that sufficiently qualified welders are available to cover all the WPS on the contract		I	F F
3.4	**Welding Procedure Specification.** • Be able to understand the contents of a WPS • Ensure the WPS is valid & satisfies the range of qualification • Confirm that all WPS have been approved and signed by the relevant Welding Engineer. • Ensure that the WPS log is kept up-to-date at all times. • Ensure that sufficient WPS's are available for the materials and positions in which they are to be performed are available at all times.	 B B	 I I	 F F F F F
3.5	**Perform routine assessment and audits.** • Audit of Vendors. • Audit of service suppliers. • Audit of Contract Materials. • Audit of Welding Consumable & storage facilities. • Audit of material documentation. • Audit of Consumable documentation. • Issue and close out NCR's where required.		 I I I I I I	 F F F F F F F
3.6	**Design Reporting Formats and matrix documentation as required by the contract.*** **			F
4.	**Contract Documentation**	**Level 1.**	**Level 2.**	**Level 3.**
4.1	**Review Contract Documentation.** • Confirm all standards available. • Confirm all material in agreement with contract specification • Confirm all consumables are in compliance with WPS.		 I I I	 F F F
4.2	**Final Documentation**. • Confirm all Inspection points have been covered and reports signed off as Accept. • Confirm that no NCR's are still outstanding. • Confirm all contract documentation; reports etc. are in line with the contract requirements and sign off the final package.			 F F F

***NOTE: A Senior Level 3 Inspector should have a good understanding of computerised "Office" based programs, and can often be called upon to design reporting templates and formats for use in the "Field" by inspection personnel. The use of word, excel, power point etc. type programs are often utilized for this process.

RECOMMENDED READING LIST.

The candidate (or employer) will be supplied with an Application Standard or Specification for use in the PCN welding inspector training &examinations for level 2 and 3 only. This is used in some of the examination modules as appropriate.

A clean, unmarked and up to date copy of the Specification is required for the examination. This specification has been developed by PCN for use in the training and examinations only.

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.

Codes of Practice, Application Standards and Specifications

NGAS T/SP/P2 Specification for pipeline construction

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

BS 4515-2: Specification for welding of steel pipelines on land and offshore. Duplex stainless steel pipelines

API STD 1104 Welding of Pipelines and Related Facilities

PD 5500 Specification for unfired fusion welded pressure vessels

National Structural Steelwork Specification (NSSS)

BS EN 1090-1: Execution of steel structures and aluminium structures. Requirements for conformity assessment of structural components

BS EN 1090-2: Execution of steel structures and aluminium structures. Technical requirements for steel structures

BS EN 1090-3: Execution of steel structures and aluminium structures. Technical requirements for aluminium structures

BS EN 1011-1: Welding. Recommendations for welding of metallic materials. General guidance for arc welding.

BS EN 1011-2: Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels

BS EN 1011-3: Welding. Recommendations for welding of metallic materials. Arc welding of stainless steels (in conjunction with BS EN ISO 5817: Welding. Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded). Quality levels for imperfections)

BS EN 1011-4: Welding. Recommendations for welding of metallic materials. Arc welding of aluminium and aluminium alloys

BS EN 1011-5: Welding. Recommendations for welding of metallic materials. Welding of clad steel

BS EN 1011-6: Welding. Recommendations for welding of metallic materials. Laser beam welding

BS EN 1011-7: Welding. Recommendations for welding of metallic materials. Electron beam welding

BS EN 1011-8: Welding. Recommendations for welding of metallic materials. Welding of cast irons

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

ASME B31.3: Chemical Plant and Petroleum Refinery Piping

AWS. D1.1 Structural steel welding code

AWS. Z49.1. Safety in Welding, Cutting & Allied Processes

OTHER STANDARDS

General

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

BS 499-1: Supplement: 1992: Welding terms and symbols. Supplement. Definitions for electric welding equipment

BS EN ISO 4063: Nomenclature of processes and reference numbers

BS EN ISO 2553: Welded, brazed and soldered joints-symbolic representation on drawings. Welded joints.

Qualification of welders and procedures

BS EN ISO 9606-1: Qualification testing of welders. Fusion welding. Steels.

BS EN ISO 9606-2: Qualification test of welders. Fusion welding. Aluminium and aluminium alloys

BS EN ISO 9606-3: Approval testing of welders. Fusion welding. Copper and copper alloys

BS EN ISO 9606-4: Approval testing of welders. Fusion welding. Nickel and nickel alloys

BS EN ISO 9606-5: Approval testing of welders. Fusion welding. Titanium and titanium alloys, zirconium and zirconium alloys

BS EN ISO 15614-1: 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. Welding procedure test. Arc welding of aluminium and its alloys

BS EN ISO 15614-3: Specification and qualification of welding procedures for metallic materials. Welding procedure test. Fusion welding of non-alloyed and low-alloyed cast irons

BS EN ISO 15614-4: Specification and qualification of welding procedures for metallic materials. Welding procedure test. Finishing welding of aluminium castings

BS EN ISO 15614-5: Specification and qualification of welding procedures for metallic materials. Welding procedure test. Arc welding of titanium, zirconium and their alloys

BS EN ISO 15614-6: Specification and qualification of welding procedures for metallic materials. Welding procedure test. Arc and gas welding of copper and its alloys

BS EN ISO 15614-7: Specification and qualification of welding procedures for metallic materials. Welding procedure test. Overlay welding

BS EN ISO 15614-8: Specification and qualification of welding procedures for metallic materials. Welding procedure test. Welding of tubes to tube-plate joints

BS EN ISO 15614-10: Specification and qualification of welding procedures for metallic materials. Welding procedure test. Hyperbaric dry welding

BS EN ISO 15614-11: Specification and qualification of welding procedures for metallic materials. Welding procedure test. Electron and laser beam welding

BS EN ISO 15614-12: Specification and qualification of welding procedures for metallic materials. Welding procedure test. Spot, seam and projection welding

BS EN ISO 15614-13: Specification and qualification of welding procedures for metallic materials. Welding procedure test. Upset (resistance butt) and flash welding

BS EN ISO 15614-14: Specification and qualification of welding procedures for metallic materials. Welding procedure test. Laser-arc hybrid welding of steels, nickel and nickel alloys

ASME IX: Welding and brazing qualifications.

Materials and weldability

BS EN 10025-1: Hot rolled products of structural steels. General technical delivery conditions

BS EN 10025-2: Hot rolled products of structural steels. Technical delivery conditions for non-alloy structural steels

BS EN 10025-3: Hot rolled products of structural steels. Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels

BS EN 10025-4: Hot rolled products of structural steels. Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels

BS EN 10025-5:2004, Hot rolled products of structural steels. Technical delivery conditions for structural steels with improved atmospheric corrosion resistance

BS EN 10025-6:2004 + A1:2009, Hot rolled products of structural steels. Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition

BS EN 1011 parts 1-8: Welding – Recommendations for welding of metallic materials

Welding consumables

BS EN ISO 2560: A Welding Consumables. Covered electrodes for manual metal arc welding of non-alloy and fine grain steels.

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

BS EN ISO 14341: Wire electrodes and deposits for gas shielded metal arc welding of non alloy and fine grain steels. Classification

BS EN ISO 14175: Welding consumables. Gases and gas mixtures for fusion welding and allied processes

Quality assurance, quality control and inspection

ISO 14731:2006 "Welding coordination – Tasks and responsibilities"

BS EN ISO 17637: Non-destructive testing of welds. Visual testing of fusion-welded joints.

BS EN ISO 3452-1: Non-destructive testing. Penetrant testing. General principles

ISO 3834-2:2005, Quality requirements for fusion welding of metallic materials -- Part 2: Comprehensive quality requirements

ISO 3834-3:2005, Quality requirements for fusion welding of metallic materials -- Part 3: Standard quality requirements

ISO 3834-4:2005, Quality requirements for fusion welding of metallic materials -- Part 4: Elementary quality requirements

ISO 3834-5:2015, Quality requirements for fusion welding of metallic materials

BS EN ISO 17638: Non-Destructive testing of welds. Magnetic Particle testing

BS EN ISO 17636-1: Non-Destructive testing of welds. Radiographic testing. X- and gamma-ray techniques with film

BS EN ISO 19232-1: Non-Destructive testing. Image quality of radiographs. Determination of the image quality value using wire-type image quality indicators

BS EN ISO 19232-2: Non-destructive testing. Image quality of radiographs. Determination of the image quality value using step/hole-type image quality indicators

BS EN ISO 17639: Destructive tests on welds in metallic materials. Macroscopic and microscopic examination of welds

BS EN ISO 5173+A1: 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

ISO 3834: Quality requirements for welding. (all parts)

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

BS EN 10204: Metallic Products – Types of Inspection Documents.

ISO 19011: Guidelines for Quality and/or environmental management systems auditing

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

OTHER READING SOURCES

- A Quick Guide to Welding and Weld Inspection. By Steven E Hughes ISBN 13: 9780791859506 Publisher: ASME www.asme.org
- Product Technology Classroom Training Handbook. BINDT/PCN Publication. Contact: The British Institute of NDT
- PCN Classroom Training Handbook on the Visual Non-Destructive Testing of Metallic Materials in General Engineering use. BINDT/PCN Publication. Contact: The British Institute of NDT
- Welders Handbook; A Complete Guide to MIG, TIG, Manual Metal 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

Summary of changes

Issue	Issue date	Summary of changes
4 rev 2	01.01.2018	Implementation date extended from 1st April 2018 to 1st May 2018 Changes to exam content requirements for Levels 1-3 Amendment to eligibility for certification and direct access to level 2 New clause added for principles of mastering specimens