

Certification Services Division  
Newton Building, St George's Avenue  
Northampton NN2 6JB  
United Kingdom

Tel: +44(0)1604-893-811.  
Fax: +44(0)1604-893-868.  
E-mail: pcn@bindt.org



**PCN/GEN APPENDIX B2 ISSUE 6 REV C**

**CERTIFICATION OF PERSONNEL FOR RADIOGRAPHIC TESTING OF CASTINGS**

**ASSOCIATED DOCUMENTS:**

- Appendix E3 to PCN/GEN (Requirements for the Certification of Personnel in Radiation Safety)
- Annex Z1 to PCN/GEN (examination syllabus compendium)
- Annex Z2 to PCN/GEN (specimen examination questions compendium)

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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

This document prescribes the specific requirements and procedures by which personnel may be examined and, if successful, certificated for the radiographic testing of castings. Requirements contained in this document are supplementary to those contained in PCN General Requirements for Certification of Personnel engaged in Non-Destructive Testing.

## 2. EXAMINATION CONTENT

The examination format is described in PCN General Requirements. This Appendix amplifies the provisions of that document only where necessary.

### 2.1 Level 1

Except where exemptions apply (refer to PCN General Requirements), all candidates will be required to attempt an examination comprised of the following parts:

2.1.1 General Theory of the radiographic NDT method. 2.1.2 Sector Specific Theory of the application of the radiographic NDT method to castings.

2.1.2 Basic Radiation Safety (PCN radiography certification is valid only so long as the holder holds any other level of PCN radiation protection certification, or valid radiation safety certification recognised by the British Institute of NDT). For details of this examination see Appendix E3.1 to PCN/GEN.

2.1.3 Radiation Protection to Supervisor standard (optional). For details of this examination see Appendix E3.1 to PCN/GEN.

2.1.4 Sector Specific Practical examination comprised of:

- (i) preparation and calibration of testing equipment for use (this may involve system sensitivity and control checks).
- (ii) testing two castings using X and/or  $\gamma$  radiation techniques on samples selected by the examiner from light and/or dense metals appropriate to the category of certification sought (refer to Clause 3).
- (iii) examination and evaluation of the suitability for interpretation of radiographs produced, and reporting of the results in a prescribed manner on proforma report sheets provided.

The total time allowed for the practical examination is six hours. The minimum pass mark for the practical part is 70% in each sample tested and radiograph interpreted.

**NOTE:** PCN radiography certificates are valid only so long as the holder holds any other level of PCN radiation protection certification, or valid radiation safety certification recognised by the British Institute of NDT. For initial radiography candidates, the basic radiation safety examination may be taken at the same time as the radiography examination.

### 2.2 Level 2

Except where exemptions apply (refer to PCN General Requirements), all candidates will be required to attempt an examination comprised of the following parts:

2.2.1 General Theory of the radiographic NDT method.

2.2.2 Sector Specific Theory of the application of the radiographic NDT method to the testing of castings, including questions on the basic casting process and associated defects.

2.2.3 Basic Radiation Safety (PCN radiography certification is valid only so long as the holder holds any other level of PCN radiation protection certification, or valid radiation safety certification recognised by the British Institute of NDT). For details of this examination see Appendix E3.1 to PCN/GEN.

2.2.4 Radiation Protection to Supervisor standard (optional). For details of this examination see Appendix E3.1 to PCN/GEN.

### 2.2.5 Sector Specific Practical examination comprising:

- (i) preparation and calibration of testing equipment for use (this may involve system sensitivity and control checks).
- (ii) testing two castings using X and/or  $\gamma$  radiation techniques on samples selected by the examiner from light and/or dense metals appropriate to the category of certification sought (refer to Clause 3.2), in accordance with NDT procedures or instructions (one to be provided by the test centre, and one to be generated by the candidate (see (iv) below).
- (iii) processing and interpretation of the resultant radiographs in a prescribed manner on proforma report sheets provided.
- (iv) preparation of a detailed NDT instruction (suitable for level 1 personnel to follow) for the testing of one of the above samples to a provided procedure, code, standard or specification, and to prove the instruction by application. The instruction shall include any calculations necessary for determining inspection sensitivities and film density.
- (v) interpretation, marking up and reporting on a total of 12 radiographs representative of the categories of certification sought (the candidate will read and report on 12 radiographs regardless of the categories attempted).

The total time allowed for the sector specific practical examination is eight hours. The minimum pass mark for the practical part is 70% in each sample tested and radiograph interpreted.

<i>Category</i>	<i>Light</i>	<i>Dense</i>	<i>Combined</i>
<i>No of samples</i>	12	12	12 (6 Light + 6 Dense)

### 2.3 Level 3

Except where exemptions apply (refer to PCN General Requirements), all candidates will be required to attempt an examination comprising a Basic examination and a Main Method examination. Information on the content and grading of PCN level 3 examinations is provided in PCN General Requirements for Certification of Personnel engaged in Non-Destructive Testing.

2.3.1 Level 3 candidates who do not hold PCN level 2 certification for the radiographic testing of castings are required to successfully complete the examination described in Clause 2.2.5 (excepting clause (iv)).

### 2.4 Radiographic Interpreter (Castings)

Except where exemptions apply (refer to PCN General Requirements), all candidates will be required to attempt an examination comprised of the following parts:

2.4.1 General Theory of the radiographic NDT method.

2.4.2 Sector Specific Theory of the application of the radiographic NDT method to the testing of castings, including questions on the basic casting process and associated defects.

2.4.3 Sector Specific Practical examination requiring the candidate to read, mark up and report on a total of 12 radiographs representative of the categories of certification sought (the candidate will read and report on 12 radiographs regardless of the categories attempted). Maximum time allowed: three hours per Category. The pass mark is 70% for each radiograph interpreted.

<i>Category</i>	<i>Light</i>	<i>Dense</i>	<i>Combined</i>
<i>No of samples</i>	12	12	12 (6 Light + 6 Dense)

## 3. CERTIFICATION AVAILABLE

### 3.1 Level 1

3.1.1 X-Radiography of Light Metal Castings.

3.1.2 X-Radiography of Dense Metal Castings.

3.1.3 Gamma Radiography of Dense Metal Castings.

3.1.4 X-Radiography and Gamma Radiography of Dense Metal Castings.

3.1.5 X-Radiography of Light and Dense Metal Castings and Gamma Radiography of Dense Metal Castings.

### **3.2 Level 2**

3.2.1 X-Radiography of Light Metal Castings.

3.2.2 X-Radiography of Dense Metal Castings.

3.2.3 Gamma Radiography of Dense Metal Castings.

3.2.4 X-Radiography and Gamma Radiography of Dense Metal Castings.

3.2.5 X-Radiography of Light and Dense Metal Castings and Gamma Radiography of Dense Metal Castings.

### **3.3 Level 3**

3.3.1 Radiographer (Castings).

### **3.4 Radiographic Interpreter (Castings).**

This will cover casting radiographs from either or both of the following groups:

3.4.1 'Dense metal castings' comprising of Ferritic steels, Austenitic steels and high nickel alloys (excluding Monel), Copper, Copper alloys, Monel and Titanium.

3.4.2 'Light metal castings' comprising of Aluminium, Magnesium and their alloys.

Candidates who achieve an overall score of 80% or more for Level 1, 2 and 3 examinations shall be awarded with the distinction level 'D' excluding BRS/RPS certificates (refer to PCN GEN – Grading of Examinations).

## **4. RENEWAL AND RECERTIFICATION**

4.1. The general rules for level 1 and level 2 renewal and recertification are fully described in PCN document CP16, and the rules for level 3 recertification are detailed in PCN document CP17.

4.2. Level 1 certificate holders seeking recertification will be required to undertake the practical examination detailed at Clause 2.1.5 above. The minimum pass mark for the practical part is 70% per sample tested (failure to detect and report a reportable discontinuity in any one sample will result in failure of this examination part).

4.3. Level 2 certificate holders seeking recertification will be required to undertake the practical examination detailed in Clause 2.2.5 above, except they will read, interpret and report on only two radiographs from each metal group they hold certification for (groups are detailed in Clause 3.4), and the Basic Radiation Safety examination detailed in Appendix E3.1 to PCN/GEN. The minimum pass mark for the practical part is 70% per sample tested and 70% for the NDT instruction (failure to detect and report a reportable discontinuity in any one sample, or failure to produce an acceptable NDT instruction, will result in failure of this examination part).

4.4. Level 2 radiographers who fail parts (i), (ii), (iii), and (iv) of the Sector Specific Practical examination detailed at 2.2.5 may, if successful in all other parts of the recertification examination, be issued Radiographic Interpreter certification.

4.5. Level 2 radiographer attaining a Sector Specific Practical examination part (v) grade equal to or greater than 70% in any one or more metal groups, with not less than 70% in any other groups attempted, may be awarded certification for the groups in which 70% or more was attained. Such candidates may subsequently attempt supplementary examinations as described in Clause 5 below.

4.6. Radiographic Interpreters seeking recertification will be required to read, interpret and report upon two radiographs from each metal group they hold certification for (groups are detailed in Clause 3.4).

## 5. SUPPLEMENTARY EXAMINATION CONTENT

5.1 Existing PCN level 1 or level 2 Radiography of Castings certificate holders wishing to be certificated for additional metal groups or an alternative radiation source will be required to pass a further sector specific practical examination comprised of samples and/or a radiation source, appropriate to the group in which certification is sought (see Clause 3 above).

## 6. GRADING

General information on the grading of examinations will be as specified in the current edition of PCN General Requirements, and information on the grading of practical examinations is provided in PCN document CP22.

## 7. REFERENCE LITERATURE

### Essential Reading - Radiographic Theory and Practical

- ❑ BS 2737: Terminology of internal defects in Castings as revealed by radiography.
- ❑ ISO 3999: Radiation protection -- Apparatus for industrial gamma radiography -- Specifications for performance, design and tests
- ❑ BS EN 444: Industrial Radiography-General principles for radiographic examination of metallic materials using X and Gamma rays
- ❑ BS EN ISO 11699-1: Non-destructive testing. Industrial Radiographic Film. Classification of film systems for industrial radiography
- ❑ 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 19232-5: Non-destructive testing. Image quality of radiographs. Determination of image unsharpness value using duplex wire-type image quality indicators.
- ❑ BS EN ISO 11699-2: Non-destructive testing. Industrial radiographic film. Control of film processing by means of reference values.
- ❑ BS EN 1330-1: Non-destructive testing-Terminology – Part 1 List of general terms
- ❑ BS EN 1330-2: Non-destructive testing-Terminology – Part 2 Terms common to the non-destructive testing methods
- ❑ BS EN 1330-3: Non-destructive testing-Terminology - Part 3 Terms used in industrial radiographic testing.
- ❑ BS EN 12543-1: Non-destructive testing. Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing. Scanning method.
- ❑ BS EN 12543-2: Non-destructive testing. Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing. Pinhole camera radiographic method
- ❑ BS EN 12543-3: Non-destructive testing. Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing. Slit camera radiographic method
- ❑ BS EN 12543-4: Non-destructive testing. Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing. Edge method
- ❑ BS EN 12543-5: Non-destructive testing. Characteristics of focal spots in industrial X-ray systems for use in non-destructive testing. Measurement of the effective focal spot size of mini and micro focus X-ray tubes
- ❑ BS EN 25580: Minimum requirements for industrial radiographic illuminators for non-destructive testing
- ❑ BS ISO 9000: Series of quality management and quality assurance standards.

NOTE. National or international standards equivalent to the above may be used as alternatives.

## Training Course Notes

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

### Essential Reading - Safety Aspects

- ❑ 1999 No.3232: The Ionising Radiation Regulations 1999. HMSO.
- ❑ The Protection of Persons against Ionising Radiation arising from any Work Activity. Approved Code of Practice.
- ❑ Recommendations of the International Commission on Radiological Protection. ICRP Publication 9.
- ❑ Hazards by Road 1994.
- ❑ Ionising Radiations: Precautions for Industrial Users (New Series No 13). HMSO.
- ❑ Factory Form 324: Precautions in the use of Ionising Radiations in Industry.
- ❑ ISO 361: Basic ionising radiation symbol.
- ❑ BS 4094: Recommendations for data on shielding from ionising radiation:  
Part 1 Shielding from Gamma radiation  
Part 2 Shielding from X-radiation

### Recommended Reading

- ❑ Non-Destructive Testing Handbook, edited by Robert C McMaster. The Ronald Press, New York.
- ❑ An Introduction to Industrial Radiology Techniques by R Halmshaw. Wykeham Publications.
- ❑ The Physics of Industrial Radiography by R Halmshaw. Heywood.
- ❑ Industrial Radiography. Kodak Limited, London.
- ❑ Data Sheets for Industrial Radiography. Kodak Limited, London.
- ❑ Industrial Radiography. Agfa-Gevaert Limited, Brentford, Middlesex.
- ❑ Recent Developments in Non-Destructive Testing. The Welding Institute.
- ❑ Radiation Safety for Site Radiography. Kluwer Publishing Limited.
- ❑ Basic Metallurgy for NDT. The British Institute of Non-Destructive Testing, Newton Building, St George's Avenue, Northampton NN2 6JB.
- ❑ BS 3146: Investment castings in metal.  
Part 1 Specification for investment castings in metal. Carbon and low alloy steels  
Part 2 Specification for investment castings in metal. Corrosion and heat resisting steels, nickel and cobalt base alloys
- ❑ BS 4570: Fusion welding of steel castings. (current/obsolescent)
- ❑ BS EN 1011-8: Welding. Recommendations for welding of metallic materials. Welding of cast irons. (Partially replaces BS 4570)
- ❑ ASNT Classroom Training Handbook. (originally published by General Dynamics).
- ❑ ASNT Self Study Handbook. (originally published by General Dynamics).
- ❑ ASNT Question and Answer Book.
- ❑ ASNT Level III Study Guide.
- ❑ NDT Handbook, second edition, volume 3 (1985).
- ❑ ASNT Student Package.
- ❑ ASNT Instructor Package (overheads for training).

NOTE. Some of the above are available only in reference libraries. For information on sources of the above recommended reading contact The British Institute of Non-Destructive Testing, Newton Building, St George's Avenue, Northampton, NN2 6JB.