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## PCN/GEN Appendix F1 Issue 5 Rev F

# PCN CERTIFICATION OF PERSONNEL FOR ULTRASONIC TESTING OF RAILWAY AXLES

### ASSOCIATED DOCUMENTS:

#### Appendix F1 to PCN/GEN

Examination Syllabus for the Certification of Personnel in the Ultrasonic Testing of Railway Axles.

Annex Z1 to PCN/GEN (examination syllabus compendium)

Annex Z2 to PCN/GEN (example examination questions)

### CONTENTS

SPECIFIC REQUIREMENTS FOR THE CERTIFICATION OF PERSONNEL IN ULTRASONIC TESTING OF RAILWAY AXLES .....	2
1. SCOPE.....	2
2. EXAMINATION CONTENT.....	2
3. CERTIFICATION AVAILABLE .....	3
4. RENEWAL AND RECERTIFICATION.....	3
4.2 2 Level 1 and Level 2 certificate holders seeking recertification will be required to undertake the practical examination described above for their level.....	3
5. SUPPLEMENTARY EXAMINATIONS.....	3
6. GRADING .....	3
LEVEL 1 SYLLABUS .....	4
LEVEL 2 SYLLABUS .....	5
LEVEL 3 SYLLABUS .....	6
REFERENCE LITERATURE .....	6



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.



# SPECIFIC REQUIREMENTS FOR THE CERTIFICATION OF PERSONNEL IN ULTRASONIC TESTING OF RAILWAY AXLES

## 1. SCOPE

1.1 This document prescribes the specific requirements and procedures by which personnel may be examined and, if successful, certificated for the manual ultrasonic testing of railway axles (i.e. where the operator tests the axle and interprets the signal results on an ultrasonic instrument screen). Requirements contained in this document are supplementary to those contained in the current edition of PCN General Requirements for Certification of Personnel engaged in Non-Destructive Testing.

1.2 Each candidate is encouraged to bring his own equipment including probes, but test centre equipment may be hired subject to availability. The candidate's attention is drawn to Clauses 2.1.3(i) and 2.2.3(i) on calibration. Extra time will be allowed for candidates hiring test centre equipment.

## 2. EXAMINATION CONTENT

The examination content 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 comprising the following:

2.1.1 General Theory of the Ultrasonic Method.

2.1.2 Sector Specific Theory of the application of the ultrasonic method in the testing of axles including basic production processes and associated defects.

2.1.3 Sector Specific Practical. An examination comprising:

- (i) calibration of test equipment.
- (ii) testing three discreet volumes / techniques within an axle / axles (locating defects therein).
- (iii) reporting the results in a prescribed manner in accordance with the NDT instructions provided.
- (iv) producing a theoretical trace pattern prediction from a supplied drawing.

The total for the practical examination is eight hours. The minimum pass mark for the practical part is 70% per sample tested.

### 2.2 Level 2

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

2.2.1 General Theory of the Ultrasonic Method.

2.2.2 Sector Specific Theory of the application of the Ultrasonic method in the testing of railway axles, including questions on product technology, covering axle production processes, deterioration in service and associated defects.

2.2.3 Sector Specific Practical. An examination comprising :

- (i) calibration of test equipment.
- (ii) testing three discreet volumes / techniques within axle / axles (locating and characterising defects therein).
- (iii) reporting test results in a prescribed manner in accordance with the NDT instructions provided on proforma report sheets.
- (iv) producing a theoretical trace pattern prediction from the drawings provided.

2.2.4 Sector Specific Practical NDT Instruction Writing. Candidates will be required to prepare detailed NDT Instructions for each technique regarding a practical test specimen in Clause 2.2.3 (ii) above and a provided trace pattern as in 2.2.3 (iv). The instruction writing in addition to the requirements of CP25, shall include technique scanning sketches, probe angles, test sensitivities and defect reporting / rejection criteria

for each technique used. The total time allowed is eleven hours. The minimum pass mark for the practical part is 70% per sample tested.

### **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.

Level 3 candidates who do not hold PCN level 2 certification for the ultrasonic testing of railway axles will be required to successfully complete the examination described in Clause 2.2.3 except clause (iv)

## **3. CERTIFICATION AVAILABLE**

3.1 Level 1 Ultrasonic Testing of Railway Axles.

3.2 Level 2 Ultrasonic Testing of Railway Axles.

3.3 Level 3 Ultrasonic Testing of Railway Axles.

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' (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. In addition to the PCN conditions of validity of certification (refer to PCN/GEN clause 14), the requirements of GM/RT 2005 clause 3.2.5 may affect the acceptance of PCN certification by the Rail Safety and Standards Board.

**4.2 Level 1 and Level 2 certificate holders seeking recertification will be required to undertake the practical examination described above for their level.**

## **5. SUPPLEMENTARY EXAMINATIONS**

Level 1 ultrasonic testing of railway axle certificate holders wishing to upgrade to level 2 will be required to successfully complete the level 2 written and practical examination detailed in Clause 2.2 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.

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## PCN/GEN Appendix F1 Issue 5 Rev D

# EXAMINATION SYLLABUS FOR THE ULTRASONIC TESTING OF RAILWAY AXLES

### ASSOCIATED DOCUMENTS:

Specific Requirements for the Certification of Personnel in Ultrasonic Testing of railway Axles.

Annex Z1 to PCN/GEN (examination syllabus compendium)

### LEVEL 1 SYLLABUS

#### 1. General Theory

Refer to Annex Z1 of PCN/GEN (examination syllabus compendium)

#### 2. Sector Specific Theory

##### 2.1 Calibration of Testing Systems

2.1.1 Timebase calibration - normal, single, twin crystal and angle beam probes. Calibration blocks and sensitivity checks. Effect of different sound velocities in calibration block and test piece. The use of low angle probe types for the far end scan.

2.1.2 Sensitivity and signal to noise ratio.

2.1.3 Effect of finish, geometry, attenuation in specimen.

2.1.4 Control checks including probe index, beam angle, squint, resolution and pulse duration.

##### 2.2 Detectability of Defects

Advantages and limitations of the test method with regard to defect detection.

##### 2.3 Factors affecting the Performance of the Ultrasonic Test

2.3.1 Mechanical properties of the material, attenuation.

2.3.2 Sound behaviour in a shaft - classical trajectories

2.3.3 Surface condition.

2.3.4 Defect Signal type identification

##### 2.4 Codes of Practice and Standards

See essential reading list.

##### 2.5 Conducting and Recording the Test

2.5.1 Axle scanning techniques; far end, near end, high angle, surface wave.

2.5.2 Information to be recorded on the report.

2.5.3 Flaw location and reporting.



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2.5.4 Trace pattern prediction, including wheelset / axle terms / types, abbreviations and definitions.

## **LEVEL 2 SYLLABUS**

### **3. General Theory**

Refer to Annex Z1 to PCN/GEN (examination syllabus compendium)

### **4. Sector Specific Theory**

#### **4.1 Calibration of Railway Axle Testing Systems**

4.1.1 Timebase calibration - projected distance, shortened projected distance.

4.1.2 Construction of reference lines and calibration of sensitivity with reference to back wall echo and flat bottomed hole.

4.1.3 Measurement of the differences for surface condition and attenuation between test piece and reference block. Correction for attenuation depending on path length.

4.1.4 Calibration of other specialist angled probe approaches regarding the Near End, High Angle and Surface Wave techniques.

#### **4.2 Detectability of Defects**

Advantages and limitations of the test method with regard to defect detection.

#### **4.3 Factors Affecting the Performance of the Ultrasonic Test**

4.3.1 Relationship between properties of the material, condition, attenuation and sound velocity.

4.3.2 Selection of probe type, frequency and angle.

4.3.3 Preparation of test surface.

4.3.4 Selection of couplant and testing technique.

4.3.5 Influence of defect type, position and orientation on detection.

4.3.6 General knowledge of complementary techniques, radiography, eddy current, magnetic particle and liquid penetrant testing.

#### **4.4 Codes of Practice and Standards**

See essential reading list.

4.4.1 Establishing of testing instructions considering application, equipment, technique, probes, calibration, operation of test, test sensitivity, rejection criteria and recording of test results.

#### **4.5 Conducting and Recording the Test**

4.5.1 Procedure to be adopted to carry out the test.

4.5.2 Information to be recorded on the report.

4.5.3 Flaw assessment and reporting.

#### **4.6 Interpretation of Test Results**

Interpretation of test results to acceptance standards.

### **5. Product Technology Theory**

Product technology is applicable only to level 2 and level 3 candidates. Refer to **Annex Z1** to PCN/GEN (examination syllabus compendium)

#### **5.4 Visual inspection of axles**

Brand marks, surface condition, dimensional checks and protection in transit.

#### **5.5 Axle Defects Arising in Service**

Causes of defects, appropriate NDT technique required and rectification / reclamation.

## LEVEL 3 SYLLABUS

Refer to Annex Z1 to PCN/GEN (examination syllabus compendium)

### REFERENCE LITERATURE

#### Essential Reading

- ❑ 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 1330-4: Glossary of terms used in non-destructive testing. Ultrasonic flaw detection
- ❑ BS EN 10228-3: Non-destructive testing of steel forgings. Ultrasonic testing of ferritic or martensitic steel forgings
- ❑ BS EN 10228-4: Non-destructive testing of steel forgings. Ultrasonic testing of austenitic-ferritic stainless steel forgings.
- ❑ BS EN 12668-3: Non-destructive testing – Characterisation and verification of ultrasonic examination equipment – Part 3 combined equipment
- ❑ BS EN 583-1: Non-destructive testing –Ultrasonic examination – Part 1: General principles
- ❑ BS EN 583-3: Non-destructive testing –Ultrasonic examination – Part 3: Transmission technique
- ❑ BS EN 583-5: Non-destructive testing –Ultrasonic examination – Part 5: Characterisation and sizing of discontinuities
- ❑ BS EN ISO 2400:Non-destructive testing. Ultrasonic testing. Specification for calibration block No.1
- ❑ BS 5892-1: Specification for axles for traction and trailing stock.
- ❑ The current edition of the following Railway Sector Group Standards:.
- ❑ RIS 2701 RST: Rail industry standard for NDT processes on Rail Vehicles.
- ❑ GMRT 2466 Railway Wheelsets
- ❑ GM/RC2494 Recommendations for Railway Wheelset Design
- ❑ GM/RC2495 Recommendations for Railway Wheelset Manufacture
- ❑ GM/RC2496 Recommendations for Railway Wheelset Maintenance
- ❑ BS EN 13261 Railway applications- Wheelsets and bogies- Axles- Product requirements.
- ❑ BS ISO 9000 series: Quality Systems:
- ❑ 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.

**NOTE:** Other national, European or international standards equivalent to the above may be used as alternatives.

#### Recommended Reading

- ❑ Basic Metallurgy for NDT Edited by J L Taylor. British Institute of NDT, Newton Building, St George's Avenue, Northampton NN2 6JB.
- ❑ 'Guide to the Preparation of a Quality Manual'. The Institute of Quality Assurance.
- ❑ 'Ultrasonic Testing of Materials' by J and H Krautkramer. George Allen & Unwin Ltd, London.
- ❑ 'Principles and Practice of Non-Destructive Testing' edited by Dr J H Lambell. Heywood and Co London.
- ❑ Non-Destructive Testing (second edition, 1991) by R Halmshaw. Edward Arnold.

- ❑ 'Ultrasonic Flaw Detection for Technicians' by J C Drury. Obtainable from The British Institute of NDT
- ❑ ASNT Classroom Training Handbook (originally published by General Dynamics) for ultrasonic testing.
- ❑ ASNT Self Study Handbook (originally published by General Dynamics) for ultrasonic testing.
- ❑ ASNT Question and Answer Book for ultrasonic testing.
- ❑ ASNT Level III Study Guide for ultrasonic testing.
- ❑ NDT Handbook, second edition, volume 3 (1985)
- ❑ ASNT Student Package for ultrasonic testing.
- ❑ 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.