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

Tel: +44(0) 1604-893811
Fax: +44(0) 1604-893868
E-mail: pcn@bindt.org

PCN/GEN APPENDIX E3 ISSUE 7 Rev B dated 1st October 2011

Further information concerning the content of PCN documents is available from the PCN Scheme Manager at the above address.

CERTIFICATION OF PERSONNEL IN RADIATION SAFETY AND PROTECTION

CONTENTS **Page**

1. SCOPE

1.1 This document prescribes procedures by which personnel may be assessed and certificated for competence in Radiation Safety and/or Radiation Protection. Requirements contained in this document are supplementary to those contained in PCN General Requirements for PCN Certification of NDT Personnel. There are specific requirements detailed within relating to training and experience in terms of eligibility for certification.

1.2 The assessments detailed within are designed to test the candidate's underpinning knowledge of the subject and an understanding of the operations he or she performs.

1.3 Candidates for PCN Industrial Radiography certification who hold existing valid PCN certification in Radiation Safety or Radiation Protection will be exempt any further safety examinations when seeking PCN certification of competence for Industrial Radiography.

2. INTRODUCTION

The PCN Scheme recognises two levels of competence in radiation safety:

2.1 **Basic Radiation Safety** (BRS) certification should be held by any person who is practising industrial radiography and has been adequately trained in the hazards associated with ionising radiations, the precautions to be taken when employing inonising radiation, and the methods of protection. He or she will be aware of the content of and importance of complying with any special requirements for permanent facility or site operations, as well as possible accident or emergency situations which can arise, and the actions to be taken in the event of such occurrences.

2.2 **Radiation Protection Supervisor** (RPS) level is an optional level of certification for holders of PCN level 1, level 2 and level 3 certification of competence for industrial radiography. In addition, it is made available for those appointed by an employer in accordance with regulation 17(4) of the United Kingdom Ionising Radiation Regulations (1999) to supervise work with radiation. A candidate for this PCN certification will have been adequately trained in the requirements for Radiation Protection Supervisors and, in addition, will be assessed for knowledge and understanding of the requirements to assess doses, carry out hazard assessments, implement contingency plans and emergency procedures, and arrange for the provision of dosemeters and the keeping of dose records.

3. ELIGIBILITY FOR ASSESSMENT AND CERTIFICATION

3.1 All candidates must have successfully completed a PCN approved scheme of training and accumulated experience as defined below:

3.2.1 Basic Radiation Safety (BRS). Candidates shall have successfully completed a PCN approved course comprising of 16 hours formal training to the appropriate part of the syllabus outlined in the current edition of PCN/GEN Appendix Z1.

3.2.2 Radiation Protection to Supervisor Level (RPS). Candidates for this examination must:

i) Hold a current PCN BRS certificate or an alternative acceptable to BINDT.

ii) Have successfully completed a PCN approved course comprising of 24 hours of formal training to RPS level as outlined in the current edition of PCN/GEN Appendix Z1.

iii) Provide evidence of nine months relevant experience as a holder of a PCN Basic Radiation Safety certificate or an alternative recognised by BINDT.

NOTE: The responsibility for appointment of a Radiation Protection Supervisor rests with the employer, whose attention is drawn to regulation 13 of the IRR 99 regarding the duty to consult one or more Radiation Protection Advisers.

4. ASSESSMENT OF CANDIDATES

4.1 Due to the variation in the industrial application of radiography, it is impossible to differentiate between the requirements of a site radiographer and an operator concerned with only one specific task in an exposure bay with mechanical/electronic safety controls. Therefore the safety aspects must apply to all personnel and basic radiation safety and radiation protection supervisor assessments include competence for laboratory, site and workshop conditions.

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

4.2.1 Basic Radiation Safety (Applications for certification on form PSL/57 are to be submitted directly to a PCN Authorised Qualifying Body.)

- Thirty multiple choice questions. Time allowed: 60 minutes.

4.2.2 Radiation Protection to Supervisor level (Applications for certification on form PSL/57 are to be submitted directly to a PCN Authorised Qualifying Body.)

- Twenty multiple choice questions at RPS standard (not BRS).
- One mandatory calculation question. Passmark 100%.
- Three further questions requiring narrative answers. (out of a choice of four)

  Total time allowed: 2½ hours. Overall passmark 70%. Failure in the mandatory calculation or failing to achieve the overall required passing grade of 70% will result in the candidate being considered an initial candidate for certification at RPS level.

5. CERTIFICATION AVAILABLE

5.1 Basic Radiation Safety

5.2 Radiation Protection to Supervisor level.

6. PROCEDURE FOR RECERTIFICATION

6.1 There is no recertification for radiation safety or radiation protection to supervisor level, without a further full assessment.

6.2 Personnel whose PCN radiation safety or radiation protection to supervisor level certification expires at the end of the maximum five year period of validity shall undergo a recertification process comprised of:

6.2.1 Basic Radiation Safety:

A written examination comprising thirty multi-choice questions. Time allowed: 45 minutes. Applications for recertification on form PSL/57 are to be submitted directly to a PCN Authorised Qualifying Body.

6.2.2 Radiation Protection to Supervisor level:

A written examination comprising of twenty multiple choice questions, three narrative answer questions and one mandatory calculation. Time allowed: 2½ hours. Pass mark 70%. Applications for recertification on form PSL/57 are to be submitted directly to a PCN Authorised Qualifying Body.

6.3 Where there has been a significant change in radiation safety regulations or legislation since issue of the expiring PCN certificate, candidates will be required to demonstrate they have undertaken additional and relevant training covering the new legislation or regulations prior to applying for recertification.

7. COMPLAINTS AND APPEALS

7.1 An aggrieved party in a dispute which considers itself to have reasonable grounds for questioning the competency of a PCN certificated individual may petition for withdrawal or cancellation of certification. Such a petition must be accompanied by all relevant facts and, if it is established that an adequate case has been presented, a full investigation of the circumstances under dispute will be initiated.

7.2 If the petition is substantiated to the satisfaction of the PCN Certification Management Committee (or a committee to which the CMC has assigned responsibility for such matters), the certification may be cancelled, or renewal or recertification may be refused, for such period as the CMC may decide, unless the holder of certification is successful in a further examination or assessment, the content of which will be decided by the CMC at an ordinary meeting.

7.3 Appeals against certificate cancellation, failure to certify or recertify may be made in accordance with the guidance in document reference CP21 by the candidate or certificate holder upon application in writing to the PCN Scheme Manager.

7.4 The CMC may delegate the process of dealing with complaints and appeals to a properly constituted sub-committee.

8. REFERENCE LITERATURE

Textual references are essential reading. Recommended reading references given below but not mentioned in the syllabus are recommended reading.

Essential Reading

Statutory Instrument No. 3232. The Ionising Radiation Regulations, 1999 - HMSO.
ISBN 0 11 085614 7

Approved Code of Practice and Guidance - HSE Books, 2000 (L121). ISBN 0 77176 17467

Radiation Safety for Site Radiography, ECIA, London.

Statutory Instrument 1998 No. 543 : Health and Safety - The Control of Lead at Work Regulation 2002

Recommended Reading

Any relevant British, European or international standards

IRID: Ionising Radiation Incident Database. First review of cases reported and operation of the database - NRPB. ISBN 0 85951 436 6

NRPB Website: www.hpa.org.uk (NRPB joined hpa on 01 April 2005)

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

Tel: +44(0) 1604-893811
Fax: +44(0) 1604-893868
E-mail: pcn@bindt.org

PCN/GEN Appendix E3

Further information concerning the content of PCN documents is available from the PCN Scheme Manager at the above address.

EXAMINATION SYLLABUS FOR THE CERTIFICATION OF PERSONNEL IN RADIATION SAFETY AND PROTECTION

ASSOCIATED DOCUMENTS:

Appendix E3.1 to PCN/GEN:

Specific Requirements for the Certification of Personnel in Radiation Safety and Protection.

Appendix E3.3 to PCN/GEN:

Specimen Examination Questions for the Certification of Personnel in Basic Radiation Safety and Radiation Protection (to supervisor level).

CONTENTS

INTRODUCTION

Unless otherwise stated all examinations are 'closed book'. Although the syllabi for some parts of each available level of certification are the same, the degree of difficulty and therefore depth of knowledge required increases from basic radiation safety to supervisor level.

Candidates for the Basic Radiation Safety (BRS) examination should have a general knowledge of the subjects listed and an awareness of the contents of the documents indicated.

Candidates for the Radiation Protection to Supervisor (RPS) examination would be expected to have an in depth knowledge of all aspects of radiation safety.

The recommended minimum time to be devoted to each subject area during a structured classroom based training course is given in brackets following each subject heading. Training hours are included only for guidance purposes and are not intended to prevent the training establishment adopting alternative training hours for each subject area.

BASIC RADIATION SAFETY

Candidates will have attended a structured course of classroom training for personnel requiring a thorough understanding of basic radiation safety. At the end of the course candidates should:

a) Have an understanding of the basic concepts of ionising radiations.

b) Be familiar with the terminology used in radiation protection.

c) Be familiar with the main requirements of the following:

- The Ionising Radiations Regulations 1999
- The Approved Code of Practice
- Associated Guidance Notes

d) Have an understanding of the potential hazards (health effects) associated with the use of ionising radiation.

e) Have an understanding of the principles of practical protection to minimise exposure to ionising radiation.

f) Have an understanding of the good working practices required to keep radiation doses as low as reasonably practicable, for both site and compound radiography.

g) Be able to calculate source intensity and dose rates, and have an understanding of the inverse square law.

h) Be aware of the appropriate action to take in emergency situations.

BASIC RADIATION SAFETY SYLLABUS

1.1 Basic Concepts (1¼ hours)

Matter, molecules, elements, atoms, fundamental particles, atomic number, mass number, isotopes, radionuclides. Types of radiation: α, β, and γ. Radiation energies (eV). Production of X-rays. Activity, decay, half-life. Sealed and unsealed sources. Contamination. Ionisation.

1.2 Equipment (1 hour)

Gamma radiography: Remote exposure containers; Collimators. X-ray generators. High energy X-ray generators. X and γ-ray compounds. Site radiography.

1.3 Radiation Units and Dose Limitation (2 to 3 hours)

1.3.1 Quantities and units

Activity (Bq). Absorbed dose (Gy). Equivalent dose and effective dose (Sv). Dose rate (uSv/hr). Conversion from old to SI units. Commonly used prefixes.

1.3.2 A brief summary of legislation

- Radioactive Substances Act 1993
- Ionising Radiations Regulations 1999.
- Approved Code of Practice, parts 1,2 and 4.
- Guidance Notes : "Radiation Safety for Site Radiography" (RSSR).
- Transport regulations.

1.3.3 Dose limitation

Justification, optimisation, dose limits. Regulatory Dose Limits. Reference levels: 7.5 µSv/hr

1.4 Biological Effects (½ hour)

Cell, nucleus, DNA, chromosomes. Cellular damage, varying radiosensitivity. Acute macroscopic effects: stochastic and deterministic effects. The effects of chronic exposure.

1.5 Principles of Protection from External Radiation (1½ to 2 hours)

Basic parameters: time, distance, shielding, source outputs. Half value and tenth value thickness.

Practical aspects:

- The use of enclosures versus site radiography
- Wind-out containers, X-ray sets, collimators
- Safety and warning systems
- Radiography compounds
- Required interlock systems for compounds
- Communication between radiographers
- Methods and equipment for minimising the size of the controlled area

1.6 Shielding Calculations (2 hours)

Exercise on manipulation of radiation units.

Exercises on the following:

Calculating source and X-ray intensity; Calculating dose from dose-rate, use of inverse square law, use of half value and tenth value thickness for calculating shielding.

1.7 Personal Dosimetry (1 to 1½ hours)

Classification - medical surveillance, dose assessment, ADS dose record keeping. Types of dosemeter - film badges, TLDs, personal alarm monitors. ALARP - investigation. Exposure - investigation. Over-exposure - investigation, notification. Use of the Radiation Passbook for outside workers.

1.8 Radiation Monitoring (½ hour)

Types of monitor (direct, indirect reading) correct use. Correction factors. Testing and calibration. Frequency of monitoring. Record keeping.

1.9 Specific Requirements of Regulations (1½ hours)

Source accountancy. Controlled and Supervised Areas. RPA and RPS. Local Rules. Transportation of sources.

1.10 Accidents and Hazards in Perspective (¾ hour)

Accident case histories. Effects of low radiation doses, sources of information on radiation risks. Risk estimates and comparison with other risks.

1.11 Emergency Procedures (1 hour)

Case studies of incidents related to industrial radiography. Transport incidents. Emergency equipment. Actions to take in event of emergency. Contingency plans.

RADIATION PROTECTION TO SUPERVISOR LEVEL

Candidates for this examination will already have completed the training course for Basic Radiation Safety and hold Basic Radiation Safety certification.

Radiation Protection Supervisor certification is intended for personnel who may be appointed as radiation protection supervisors for site radiography or compound facilities.

The regulations require that an RPS knows and understands the requirements of the Regulations and local rules as they effect the work he or she supervises, and understands the necessary precautions to be taken in the work which is being done and the extent to which these precautions will restrict exposures.

At the end of the course, candidates should:

a) Have an understanding of the basic concepts of ionising radiations.

b) Be familiar with the terminology used in radiation protection.

c) Have a detailed understanding of the main requirements of the following:

- The Radioactive Substances Act 1993
- The Ionising Radiations Regulations 1999
- The Approved Code of Practice
- Associated Guidance Notes
- The Transport Regulations

d) Have an understanding of the potential hazards (health effects) associated with the use of ionising radiation.

e) Have an understanding of the principles of practical protection to minimise exposure to ionising radiation.

f) Have an understanding of the good working practices required to keep radiation doses as low as reasonably practicable, for both site and compound radiography.

g) Understand the role of the RPS and be aware of the various records that need to be maintained.

h) Be able to calculate source intensity and dose rates, and carry out inverse square law and shielding calculations.

i) Have a detailed understanding of emergency procedures.

NOTE: The recommended minimum time to be devoted to each subject area during a structured classroom based training course is given in brackets following each subject heading. The total recommended lecture time required to cover this syllabus is 12 hours. Additional time will also be required for practical exercises, group work and demonstrations. Training hours are included only for guidance purposes and are not intended to prevent the training establishment adopting alternative training hours for each subject area.

RADIATION PROTECTION SUPERVISOR SYLLABUS

2.1 The Legislative Structure (½ hour)

The development of legislation. The Radioactive Substances Act 1993. The Health and Safety at Work Act 1974. The Ionising Radiations Regulations 1999. The Approved Code of Practice. Guidance Notes: “Radiation Safety for Site Radiography”. The Management of Health and Safety at Work Regulations 1999. Transport regulations.

2.2 Biological Effects (½ hour)

Cellular radiation damage, effects of dose rate, repair mechanisms, radiosensitivity.

Macroscopic effects: stochastic and deterministic effects, hereditary effects. Chronic and acute exposure.

2.3 The Radioactive Substances Act 1993 (¼ hour)

Registrations. Authorisation for disposal of radioactive waste.

2.4 Dose Limitation (¾ hour)

The setting of investigation levels. Dose quantities: equivalent dose, effective dose. The ICRP principles of: justification, optimisation, dose limits. Regulatory dose limits. Reference levels: 7.5 µSv/hr.

2.5 The Control of Work with Radiation (1¼ hours)

Prior authorization. Prior risk assessment. Controlled and supervised areas. Classified persons. Role of RPA.

2.6 Role of The Radiation Protection Supervisor (1 hour)

Co-operation. Record Keeping. Notification. Training. Local Rules. Critical examinations.

2.7 Principles of Protection from External Radiation (2½ hours)

Basic parameters: source activity, time, distance, shielding. Exercise on the manipulation of radiation units and on the following: calculating intensities from y sources and X-ray sets, calculating dose from dose rate, use of inverse square law, shielding and thicknesses, Half Value Thickness, Tenth Value Thickness.

2.8 Practical Protection from External Radiation (1 hour)

Adequate shielding - safety and warning systems. Application of ACOP and guidance to industrial radiography. Storage of sources. Wind-out containers, X-ray generators, collimation. Safety and warning systems. Radiography compounds. The interlocks required for radiography compounds. Methods and equipment for minimising the size of the controlled area. The use of enclosures versus site radiography. The correct choice of equipment. Communication between radiographers.

2.9 Radiation Monitoring (1 hour)

Routine monitoring. Instrument Testing. Correct choice of instrument. Record keeping. Types of monitor: ionisation chamber, Geiger muller tube, compensated GM, scintillation detector. Energy response, response time, interpretation, calibration factors.

2.10 Transport (¾ hour)

Current legislative situation. IAEA Regulations. Types A and B containers. Labelling - transport index. Excepted packages. Documentation. UN Numbers. Responsibilities of: consignor, carrier, driver. Training of drivers.

2.11 Personal Dosimetry (1 hour)

Dose surveillance. Classified persons. Classification - ADS, dose record keeping. ALARP investigation. Exposure - investigation. Over-exposure - investigation, notification. Medical surveillance. Types of dosemeter - film, badge, TLD, electronic dosemeter. Biological Dosimetry. The Outside Undertaking.

2.12 Emergency Procedures (1 hour)

Case studies of incidents related to industrial radiography. Hazard assessments and contingency plans. Emergency equipment - prevention by training. National Arrangements for Incidents Involving Radioactivity (NAIR).

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

Tel: +44(0) 1604-893811
Fax: +44(0) 1604-893868
E-mail: pcn@bindt.org

PCN/GEN Appendix E3

Further information concerning the content of PCN documents is available from the PCN Scheme Manager at the above address.

SPECIMEN EXAMINATION QUESTIONS FOR THE CERTIFICATION OF PERSONNEL IN RADIATION SAFETY AND PROTECTION

ASSOCIATED DOCUMENTS:

Appendix E3.1 to PCN/GEN:

Specific Requirements for the Certification of Personnel in Radiation Safety and Protection.

Appendix E3.2 to PCN/GEN:

Examination Syllabus for the Certification of Personnel in Radiation Safety and Protection.

CONTENTS

GENERAL

1.1 To avoid confusion any source activities or dose rates are given in dual units on the paper. e.g.:

- 740 GBq ^{60}Co (20 Ci ^{60}Co)
- 185 GBq^{192}Ir (5 Ci ^{192}Ir)

1.2 In order to offer a variety of questions, various sources will be referenced and various shielding materials e.g. concrete, steel or lead and the relevant half or tenth value thickness given.

BASIC RADIATION SAFETY

The candidate will be required to achieve a pass mark of 70% in an examination comprising 30 multiple choice questions, including at least one question involving a calculation. A period of 45 minutes is allowed for the examination.

1. Atoms of a single element which have different numbers of neutrons in the nucleus are:

a) radioactive

b) unstable

c) isotopes

d) beta emitters

2. The Quality Factor of different forms of ionising radiation is a measure of their relative:

a) wavelength

b) biological effect

c) electrical charge

d) penetrating ability

3. The radiation intensity 1 metre from a source is 10 µSv/hour. The distance required to reduce this to 2.5 µSv/hr is:

a) 2 metres

b) 5 metres

c) 10 metres

d) 20 metres

4. The thickness of a specified material necessary to reduce the exposure rate to 25% of the initial value is the:

a) two half value thicknesses

b) tenth value layer

c) attenuation coefficient

d) inverse square law factor

5. A controlled area is an area where workers are likely to receive an effective dose rate greater than:

a) 50 mSv/yr

b) 15 mSv/yr

c) 6 mSv/yr

d) 20 mSv/Yr

6. A 370 GBq (10 Ci) source of Iridium is being used on a panoramic shot inside an open-ended pipe with a wall thickness of 39mm and outside diameter of 2 metres. If the barrier is only 25 metres away from the source at the open end of the pipe, how far back must the barrier be moved to achieve a dose rate at the barrier of 7.5 µSv/hr?

a) 80 metres

b) 55 metres

c) 8.0 metres

d) 3.28 metres

RADIATION PROTECTION (to Supervisor level)

Candidates will be required to achieve a pass mark of 70% in an examination comprising of twenty multiple choice questions, one mandatory calculation and three from four narrative answer questions. Examples of these are given below. The total time allowed will be 2½ hours.

1. Every employer shall designate as a controlled area, any area under his control which has been identified as an area in which:

a) special procedures have to be adopted to restrict significant exposure

b) any person working in the area is likely to receive an effective dose greater than 6 mSv per year

c) any person working in the area is likely to receive an equivalent dose greater than three tenths of any relevant dose limit

d) both A and C

2. Every employer shall ensure that an investigation is carried out when the effective dose of ionising radiation received by any of his employees for the first time in any calendar year exceeds:

a) 1 mSv

b) 2 mSv

c) 6 mSv

d) 15 mSv

3. You are required to carry out on-site radiography from the centre of a 20 metre long x 4 metre diameter 45 mm WT steel pipe using a panoramic technique with an Iridium 192 isotope of 700 GBq (19 Curie). At what distance from the pipe would you need to set barriers for a maximum dose rate of 7.5µSv/hr? (Source output = 130 µSv/hr/GBq)

4. List the requirements of LOCAL RULES and state how they should be controlled.

5. Detail the procedure to be followed when an employee of a company reports that he has reasonable cause to believe he has received excessive exposure to radiation.

DATA TO BE USED IN CALCULATIONS

The following data will be used with all calculation questions:

Half value thicknesses:

Steel (Iridium)	= 13 mm
Steel (Cobalt)	= 20 mm
Steel (250 kV x-rays)	= 12 mm
Steel (200 kV x-rays)	= 6 mm
Lead (Cobalt)	= 11 mm
Lead (Iridium)	= 5.5 mm
Concrete (Iridium)	= 43 mm
Concrete (Cobalt)	= 63 mm
Lead (Selenium)	= 1.5 mm

Dose rates at 1 metre:

Iridium	µSv/hr/GBq	= 130
Iridium	rem/hr/Ci	= 0.48
Cobalt	µSv/hr/GBq	= 357
Cobalt	rem/hr/Ci	= 1.32
Ytterbium	µSv/hr/GBq	= 33.8
Ytterbium	rem/hr/Ci	= 0.125
Thulium	µSv/hr/GBq	= 0.676
Thulium	rem/hr/Ci	= 0.0025
Selenium	µSv/hr/GBq	= 55