

Managing competence assurance

For personnel undertaking in-service inspection of pressure equipment

PUBLICATION 193

Edition 2

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THE ENGINEERING EQUIPMENT AND MATERIALS USERS' ASSOCIATION

Managing competence assurance For personnel undertaking in-service inspection of pressure equipment

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ISBN 978-0-85931-190-8

Imprint reference 02-2013

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ENGINEERING EQUIPMENT AND MATERIALS USERS' ASSOCIATION

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Abbreviations/Acronyms

ACoP	Approved Code of Practice
ALARP	As low as is reasonably practicable
AUT	Automated ultrasonic testing
BIS	Department of Business, Innovation and Skills, UK
CAF	Compressed asbestos fibre
CDGTPER	Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations
CE	Conformité Européene
CMS	Competence management system
COMAH	Control of major accident hazards
DPI	Dye Penetrant Inspection
DTI	Department of Trade and Industry (now BIS), UK
EMAT	Electromagnetic acoustic transducer testing
EtOH	Ethanol
EU	European Union
FMECA	Failure mode and criticality analysis
FSA	Fitness for service analysis
GMAW	Gas metal arc welding
GRP	Glass reinforced plastic
GTAW	Gas tungsten arc welding
GW	Guided wave testing
HAZOP	Hazard and operability study
H and S	Health and Safety
HSE	Health and Safety Executive
IB	Inspection body
IE	Inspection engineer
IRIS	Internal Rotary Inspection System
IS	Inspection surveyor
IT	Information Technology
IVI	Internal visual inspection
LOLER	Lifting Operations and Lifting Equipment Regulations
MAG	Metal active gas welding
MeOH	Methanol
MIG	Metal inert gas welding
MMA	Manual metal arc welding
MPI	Magnetic Particle Inspection
MsS	Magnetostrictive sensor
MT	Magnetic particle inspection
NB	Notified body
NDE	Non-destructive examination
NDT	Non-destructive testing
NII	Non-intrusive inspection
NPSH	Net Positive Suction Head
NVQ	National Vocational Qualification
PAUT	Phased array ultrasonic testing

PEC	Pulsed eddy current
PED	Pressure Equipment Directive
PER	Pressure Equipment Regulations
PFEER	Prevention of Fire and Explosion and Emergency Response Regulations
PQR	Procedure Qualification Record
PRA	Process risk assessments
PSSR	Pressure Systems Safety Regulations
PSR	Pipelines Safety Regulations
PT	Dye penetrant inspection
PTFE	Polytetrafluoroethylene
PWHT	Post weld heat treatment
QC	Quality control
QRA	Quantified risk assessment
RBI	Risk based inspection
RLA	Remnant life assessment
RCA	Root cause analysis
RT	Radiographic testing
SAW	Submerged arc welding
SEP	Sound engineering practice
SHE	Safety, Health And Environment
SLOFEC	Saturated Low Frequency Eddy Current (Trademark - KontrollTechnik GmbH)
SMAW	Shielded metal arc welding
SPVD	Simple Pressure Vessels Directive
SS	Stainless steel
TIG	Tungsten inert gas welding
TOFD	Time of flight diffraction
UI	User Inspectorate
UKAS	United Kingdom Accreditation Service
UT	Ultrasonic testing
WPQR	Welding Procedure Qualification Record
WPS	Welding Procedure Specifications
WSE	Written scheme of examination

1. Introduction and Objectives

EEMUA Publication 193¹ is a recommended practice for Inspection Bodies (IBs) operating in the process, energy and related industries, whose primary responsibility is for pressure equipment. This is the revised Second Edition which incorporates changes in practice and legislation since first publication in 1998 as 'EEMUA Recommendations for the Training, Development, and Competency Assessment of Inspection Personnel'. It presents a structured training, development and competency assessment process for inspection personnel. EEMUA developed this Publication in response to:

- The increasing emphasis on the competency of individuals, for example during assessment of IBs under the accreditation process and also the general requirement to ensure competency as a part of safety management.
- The development of API certification schemes for inspectors.
- A changing relationship between IBs and inspection contractors.

1.1 Scope

Demonstration of the competence both of IBs and the individuals directly or indirectly employed in them is important in ensuring adherence to legislation and its supporting standards, especially in the EU.

The criteria for IBs are already defined, for example in the International standard ISO/IEC 17020⁽³⁹⁾ and by the United Kingdom Accreditation Service (UKAS). UKAS accredits IBs to the Standard ISO 17020. The structure of this EEMUA Publication is such that it respects the requirements of UKAS RG0⁽²⁾.

This EEMUA Publication is limited to in-service inspection of industrial pressure equipment which is taken to mean all inspections excluding new build and commissioning.

The types of equipment covered (see Appendix D – Country Specific Legislation) includes all equipment covered by:

- PSSR;
- pressure equipment subject to the COMAH Regulations;
- Pipeline Regulations;
- PFEER (offshore);
- transportable pressure equipment; and
- above ground tanks – metal and plastic.

It excludes:

- subsea equipment;
- new equipment subject to the PER; and
- below ground/buried tanks.

EEMUA Publication 193 is designed to be an authoritative statement of competency criteria for inspection personnel.

¹Contains public sector information published by the GB Health and Safety Executive and licensed under the Open Government Licence v1.0

1.2 Objectives

The main objective of this EEMUA Publication is the provision of a structure for the technical and behavioural development of Inspectors and their Technical Managers/Supervisors, as described in Appendix A - Typical Job Titles and Roles, throughout their careers. It remains the clear responsibility of local management to define the minimum competency requirements of its own staff and those of any inspection contractors. This EEMUA Publication should assist in that process whilst offering recommendations for further competency development.

2. Use of this EEMUA Publication

2.1 Recommended Use of this EEMUA Publication

It is recommended that IBs and, where appropriate, their individual organisations, identify those Units and Elements in this EEMUA Publication in which their Inspectors and their Technical Managers/Supervisors – whether permanent staff or contracted employees – would need to be fully competent in order to discharge their duties satisfactorily. The scope of these minimum requirements will be influenced by the potential hazard (e.g. the category of COMAH site (i.e. Top Tier, Lower Tier, non-COMAH)) and organisational factors such as the availability of supporting services, the accessibility of supervision, and the category of pressure equipment.

The remaining Units and Elements should then be seen to represent areas for additional training and development which would further enhance an individual's effectiveness and versatility in existing roles, would help retain or improve motivation, and would provide a structured route to career advancement in the organisation.

EEMUA Publication 193 can be used as a reference recommended practice for:

- IBs in general, for identification and definition of the technical competencies that it should have available to function in a competent manner.
- Inspection service providers, to ensure that their own training and competency assessment schemes reflect the defined minimum requirements of the Users for whom they work.
- Individuals who wish to pursue the NVQ Engineering Surveyor route and who need guidance on the development of an appropriate portfolio of evidence.
- Assessors, whether internal or external to the organisation. Formal external assessment, as part of an accreditation audit for example, should be made against the minimum competency requirements of each individual, as defined by the IB.

2.2 List of Definitions

For the purposes of this publication, the following should apply.

Assessment (of a person) – process for measuring a person's competence by one or more means such as written, oral, practical or observational.

Competence – ability to apply the necessary practical and theoretical knowledge, skills and personal attributes for the inspections to be carried out.

Competence Management System – system used to organise, monitor and develop the competence of personnel (see Chapter 3).

Experienced Inspector – a person with the qualifications of an Inspector but with several years of practical experience in the relevant activity.

In-service – equipment that has been placed in operation as opposed to new construction prior to being placed in service or retired vessels. A pressure vessel not in operation due to an outage is still considered an in-service pressure vessel. The period of time during the life of the equipment from commissioning to disposal.

In-service inspection – all inspection activities associated with a pressure vessel once it has been placed in service.

Inspection Body – organisation or part of an organisation which carries out inspection of process systems/process equipment.

Inspector – generic title for a qualified person who carries out inspection.

On-stream – a condition where equipment has not been prepared for an internal inspection.

On-stream examination – an inspection performed from the outside of equipment while it is on-stream using NDE procedures to establish the suitability of the pressure boundary for continued operation.

Out of commission – equipment that has been taken out of service until formally authorised to return to service, i.e. not temporarily to carry out a periodic examination.

Out of service – equipment that has been temporarily emptied and taken off-line but remains connected as if still in use.

Supervisor – qualified Inspector who is in the management hierarchy of an inspection department.

3. Structured Approach to Competence Management

The IB should demonstrate that it undertakes evaluations of its personnel in order to develop and maintain the competence of the inspection personnel. It should be shown that the principles discussed in Chapter 5. Identify the Competence Required for Each Activity are respected and applied and that there is a system in place for managing such issues. Suggested requirements for such a system are given here, using proposed systems from UKAS RG0⁽²⁾/RG2⁽⁸⁾ and Office of Rail Regulation publication 'Developing and Maintaining Staff Competence'⁽⁷⁾ as a basis.

The following gives the outlines for a CMS which can be used by the IB to monitor and maintain the competence of Inspectors. The purpose of the CMS is to manage and control the cycle of activities involved in assuring and developing staff competency.

3.1 Evaluations of Inspection Personnel

3.1.1 The Competence Management System Cycle

The CMS cycle seeks to put forward a system that will design, plan, implement, monitor and review competency. This is a similar process to most quality management systems. The stages are shown schematically in the diagram below.



Figure 1 Schematic representation of the Phases of the CMS cycle

As can be observed from Figure 1, the CMS cycle is broken down into phases, and within each phase are guiding principles that define the system. These are detailed in the following sections.

3.1.2 CMS Phases and Principles

Phase 1 - Establish Requirements for the CMS

- *Identify activities and assess risks.* The inspection activities and the associated risks and critical requirements should be determined. Activities or tasks that have the potential to affect or determine safe operation and continued use of equipment should be identified. This will form the core of inspector training and development.
- *Select standards.* Procedures need to be in place to ensure that training and development of inspectors is in accordance with the identified critical activities, and to ensure professional development of the individual.

Phase 2 - Design the CMS

- *Develop procedures and methods.* Competence management is part of quality assurance. The IB should ensure that procedures are developed within their organisation's Safety and Quality Assurance systems that ensure Inspector competence is monitored and controlled.
- *Decide how to meet standards established.* Find the most suitable methods for the development and assessment of inspection staff in order to meet the required levels of competence determined in Phase 1.
- *Establish requirements for training, development and assessment.* The training and development needs and competence requirements of all inspection staff, including managers and new recruits, should be established and a system put in place to ensure those needs and requirements are met.
- *Maintain Managers' competencies.* Ensure that IB managers' competence is maintained and that they have a clear understanding of their role and responsibilities.

Phase 3 - Implement the CMS

- *Select and recruit staff.* There should be systems in place to ensure that inspection staff are selected and recruited in accordance with standards that ensure minimum competency is met.
- *Train, develop and assess staff.* Ensure procedures are in place to train, develop and assess the competence of staff and recruits in accordance with the competence standards established in Phase 1.
- *Control activities undertaken.* Checks and controls should be in place to ensure that inspectors are only allowed to undertake unsupervised activities for which they have been deemed competent.

Phase 4 - Maintain and Develop Competence

- *Monitor and re-assess staff performance.* The competence of inspection staff should be monitored. IB procedures should ensure competence is reviewed on a routine basis, for example as part of the annual appraisal process, to ensure that inspection performance is consistent and is being developed.
- *Update the competence of individuals.* Where relevant changes occur this should be recorded and systems should ensure that inspectors' competencies are current.

- *Manage sub-standard performance.* Any sub-standard performance should be identified and corrective measures put in place to restore any reduced competence.
- *Keep records.* Adequate records of assessments should be maintained that are available for internal management and any outside regulatory bodies.

Phase 5 – Verify, Audit and Review the CMS

- *Verify and audit the CMS.* Have a routine audit of the CMS to ensure that any discrepancies are rectified.
- *Review and feedback.* Review and analyse relevant safety and quality data to ensure that the CMS is maintained to meet the needs of the IB and staff.

3.1.3 Developing and Maintaining the Competence of Individuals

Figure 2 below shows a suggested system for developing and maintaining individual staff competence.

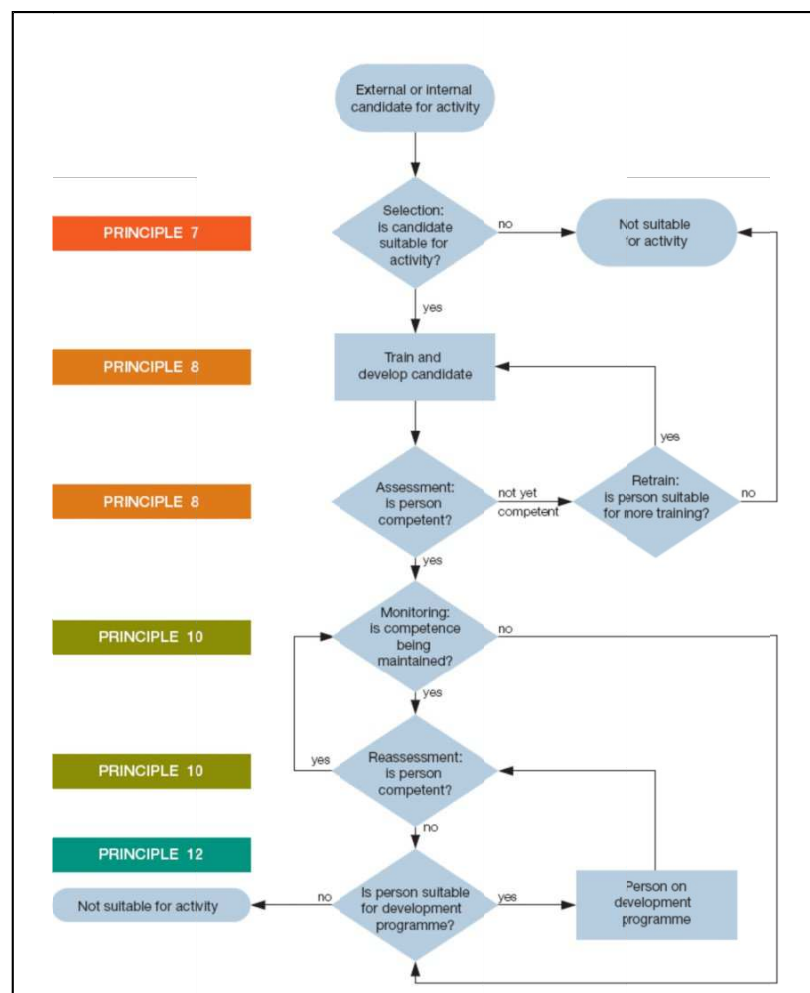


Figure 2 Proposed system for developing/maintaining staff competence

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3.2 Relevant Qualifications

UKAS RG2⁽⁸⁾ gives suggested criteria for inspection personnel qualifications which are reproduced below as Table 1 and Table 2.

Table 1 Criteria for Inspection Personnel Qualifications

Category	Description	Minimum Qualifications
1	Chartered Engineer as defined by the Engineering Council or equivalent including at least 3 years' experience within an engineering discipline associated with in-service inspection of pressure systems.	Appropriate degree with relevant experience, NVQ Level 5 Engineering Surveying, Member of Professional Engineering Institute.
2	Incorporated Engineer as defined by Engineering Council or equivalent including at least 5 years' experience within a relevant engineering discipline of which at least one year shall have been spent working within an engineering discipline associated with in-service inspection of pressure systems.	Appropriate HNC with relevant experience, NVQ Level 4 Engineering Surveying.
3	Person employed prior to the date of application for accreditation in the in-service inspection of pressure systems with less than Incorporated Engineer qualification but meeting the criteria of Category 4 below.	Approved apprenticeship scheme, Level 3 qualifications and Credit Framework*.
4	Engineering Technician, as defined by Engineering Council or Equivalent, having a minimum of 5 years' experience within a relevant discipline of which at least one year shall have been spent working within an engineering discipline associated with the in-service inspection of pressure systems or person trained in a relevant engineering discipline with a recognised and documented engineering apprenticeship with a minimum of 5 years' experience within a relevant discipline of which at least one year shall have been spent working within an engineering discipline associated with the in-service inspection of pressure systems.	Appropriate ONC with relevant experience. Approved Apprenticeship scheme.
5	Person employed prior to the date of application for accreditation in the inspection of pressure systems with less than tradesman's apprenticeship but with a minimum of 5 years spent working with or within the industry associated with pressure systems and has general knowledge of pressure systems and its operating environment. Personnel shall be placed on recognised training courses with appropriate documented tests in in-service inspection of pressure systems.	At least 21 years of age. Successful completion of recognised training courses relevant to in-service inspection of equipment.

* Which also aligns with the European Qualifications Framework, EQF

Table 2 Examples of Inspectors Qualification Criteria for Performing Inspections on Pressure Systems

Pressure System	Qualification Category	Supervision	Constraints
Major systems (including steam)	1	Occasional	Limited to inspection (or associated activities) within documented competence unless formal documented consultation undertaken.
	2	Occasional	Above limitation plus task should be limited to those within documented competencies and that follow agreed standards unless specifically approved by an appropriately qualified person (e.g. Chartered Engineer).
	3	Occasional	Limited to testing and examination to identify defects, supervised by a Category 1 or 2 person. Any decisions not incorporated in procedures need to be referred to a higher level of authority.
Intermediate systems (excluding steam)	1, 2, 3	Occasional	Same limitations as for major systems for respective categories.
	4, 5	Frequent	Limited to routine, repetitive, well defined inspections on a specific range of storage equipment.
Intermediate systems (steam only)	1, 2, 3	Occasional	Same limitations as for major systems stated above for respective categories.
Minor systems (excluding steam and pipelines)	1, 2	Occasional	Same limitations as for major systems stated above for respective categories.
	3	Occasional	Same limitations as for Category 2 person stated above under major systems.
	4	Frequent	Same limitations as for Category 3 persons stated above under major pressure systems.
	5	Frequent	Limited to routine, repetitive, well defined inspections on a specific range of storage equipment.
Minor systems (steam only)	1, 2	Occasional	Same limitations as for major systems stated above for respective categories.
	3	Occasional	Same limitations as for Category 2 person stated above under major systems.
	4	Frequent	Same limitations as for Category 3 persons stated above under major pressure systems.

Definitions

Supervision

Occasional

Annual review of work and performance with Supervisor. More frequent contact as required from performance appraisal. Access to authoritative technical support from Category 1 and 2 person readily available.

Frequent

Minimum of weekly contact with supervisor. Access to authoritative technical support from Category 1, 2 or 3 person readily available.

Pressure systems

Major, intermediate Minor Systems are defined in HSE L22 ACoP⁽⁹⁾

3.3 RG0 Illustrated Process

The competence assessment process is illustrated in Figure 3.

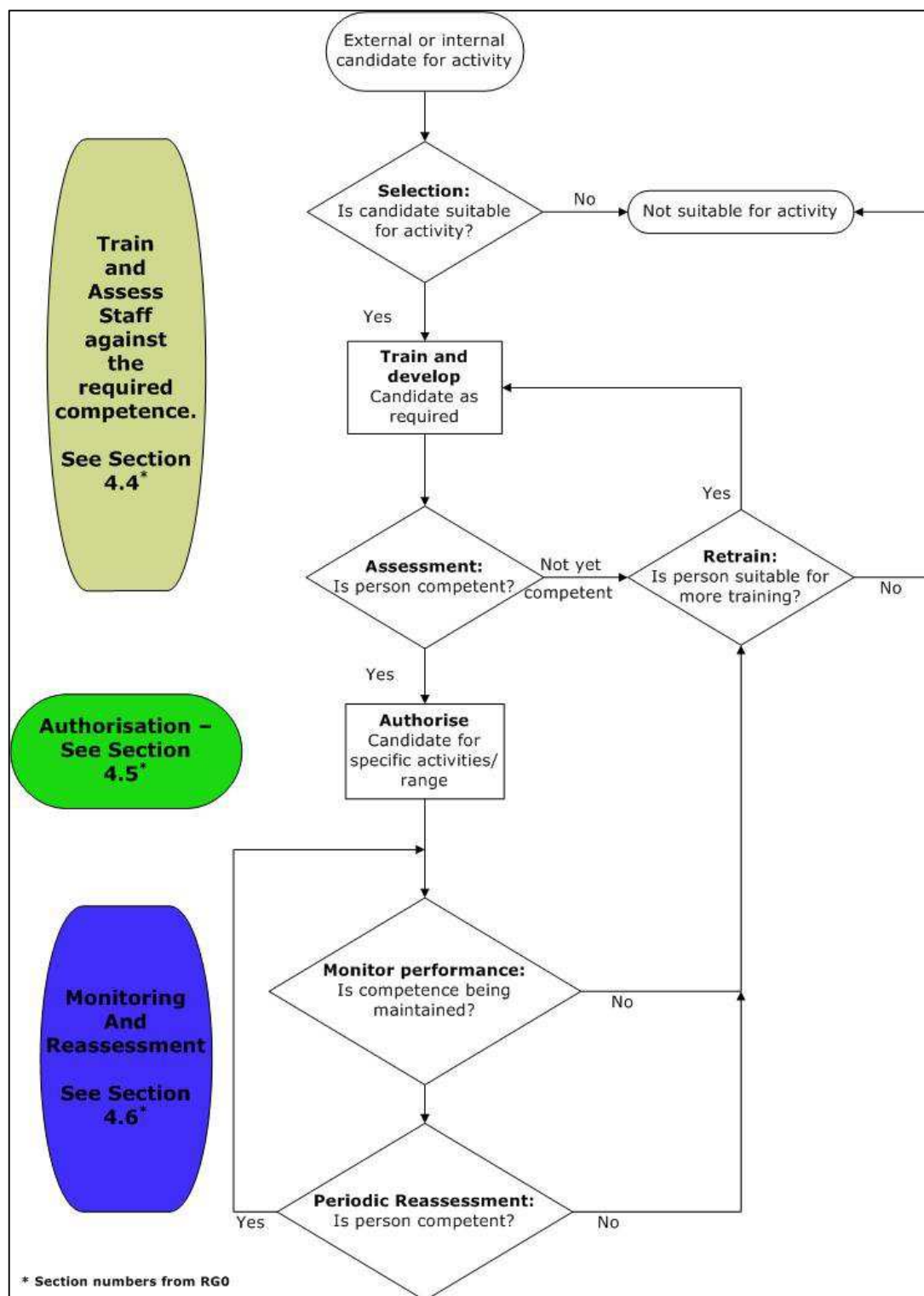


Figure 3 Diagrammatic representation of competence assessment
Copyright UKAS.

4. Identify the Range of Inspection Activities

The IB should identify each inspection activity which it performs, in order to be able to define the competence requirements, training and refresher training for each activity.

The following activities are given as examples of the range to be considered.

- Development and certification of Written Schemes of Examination.
- Examination of equipment to detect actual and potential defects and making judgments on the significance of such defects in the equipment's fitness for purpose.
- Reporting the result of examinations/inspections/tests and specifying any remedial actions and/or recommendations.
- Commenting on the suitability of and any changes necessary to the inspection methods/Written Schemes of Examination/safe operating limits.

Specific areas of inspection activity could include:

- Plant design and construction – inspection aspects.
- Knowledge and specification of properties of materials.
- Welding inspection.
- Corrosion protection and monitoring.
- Inspection and NDT technology.
- In-service inspection.
- Reporting and communication techniques.
- Inspection and risk management.
- Repairs and modifications.
- Documentation and record keeping.

These areas are discussed in more detail in Chapter 5.

5. Identify the Competence Required for Each Activity

The IB should demonstrate that it: has identified the competencies required to undertake the range of inspection activities covered by its scope; maintains and enhances those competencies; and has processes in place to train, assess and monitor staff against those competencies.

The competence required to undertake a given inspection activity will be dependent upon: the activity, range and complexity of equipment; the level of discretion, judgment and decision making required; and the extent of supervision required for the inspector in question. For example, large complex plant will require knowledge of, and consideration of, the consequences of failure such as release of flammable or toxic material.

For each inspection activity, the IB should establish guidelines to cover the competence requirements for each of the following areas:

- Personal attributes.
- Detection of defects.
- Evaluation of defects.
- Decision making.
- Identification of most suitable/capable NDE method/technique.

5.1 Personal Attributes of Inspection Personnel

The required attributes for inspection personnel are considered in the following Sections.

5.1.1 Communication Skills (Written and Verbal)

Inspectors should be competent in the following:

- Ability to read and prepare written reports for the IB and organisation inter-department use.
- Ability to read and specify amendments to engineering drawings and specifications.
- Good verbal communication abilities with all levels of personnel within the organisation and external/regulatory personnel.

5.1.2 Physical Capability to Undertake Inspection Tasks

Typical areas to be considered are:

- Physically fit for range of inspection tasks.
- Unafraid of heights.
- Unafraid of confined spaces.
- Good eyesight (assisted as necessary).
- Ensure no allergies that affect carrying out duties in the workplace.

5.1.3 Acuity of Senses

Inspection and testing personnel shall have passed a near acuity eye test and colour vision eye test (where relevant to the inspection activity) before carrying

out inspection work. Inspection and testing personnel should have a health assessment on a regular basis, which may include a hearing audiogram test.

5.1.4 Ability to Work Alone

Inspectors should satisfy the following attributes:

Thinking

- Strategic thinking (setting long term objectives).
- Analytical and logical thinking (breaking problems down to essential elements, carrying out diagnosis and developing solutions).

Self-managing

- Ability to learn (quickly understanding and applying information).
- Self-motivated.
- Flexibility (including accommodating change).
- Positive Self Image (believing in oneself).
- Self-control (performing effectively in difficult circumstances).
- Tenacity (repeated and enduring efforts to complete tasks).
- Thoroughness and accuracy (including attention to detail on routine tasks).
- Methodical.
- Independence.
- Awareness of own limitations and safety awareness.

Organisational

- Ability to organise own work and meet targets.
- Ability to lead and motivate others.
- Ability to set priorities.

Achieving

- Initiative.
- Critical information seeking (gathering key information to diagnose a problem).
- Concern for Standards (ensuring consistent application of procedures).

Others

- Safety conscious.
- Willing to work overtime, and flexibly.
- Impartiality.
- Confidentiality.
- Valid driving licence.
- Mobile elevated work platform operator (where relevant).

5.1.5 Ability to Deal with Challenging Clients

Inspectors should satisfy the following attributes:

- Rational Persuasion (building arguments based on logic).
- Communicative (including being a good listener).
- Ability to work with all levels of people.
- Customer focused.

5.1.6 Writing Skills

Inspectors should be competent in the following:

- Ability to prepare written reports for the IB and organisation inter-department use.
- Good written communication abilities with all levels of personnel within organisation and external/regulatory personnel.

See also Section 5.1.1.

5.1.7 Academic and Practical Training

Inspectors should have the requisite ability to undertake the necessary academic and practical training in order to satisfy the competence requirements of the IB.

5.1.8 Inspection Reports and Repair Recommendations

Inspectors should be adjudged competent in the preparation and issue of requisite inspection reports, together with the necessary competence, technical and practical knowledge concerning recommendations to effect repairs.

5.2 Technical Competencies

5.2.1 Detection of Defects - Practical Training

Inspectors should have satisfactorily completed a wide variety of equipment inspections and related reports appropriate to the site under the supervision of an experienced Inspector, and be able to describe the relevant inspection standards, recommended practices and procedures to detect defects in equipment.

5.2.1.1 Appropriateness of Inspection Methods/Procedures

Inspectors should have satisfactorily completed a wide variety of equipment inspections and related reports appropriate to the site under the supervision of an experienced Inspector, and be able to describe relevant inspection standards, recommended practices and procedures.

Inspectors should be capable of selecting the most appropriate NDE method and technique with the capability to detect and where possible, quantify the extent of any damage based on suitability, probability of detection, ease of use, availability and cost. Personnel employed to carry out inspection and testing should hold relevant certifications or qualifications for the specific inspection and testing activity. Typical NDE methods used and subject to certification are:

- Visual.
- Ultrasonic.
- Radiography.
- Magnetic Particle.
- Dye penetrant.
- Electromagnetic/Eddy current.
- Guided wave.

For visual examination, Inspection personnel should be familiar with the use, limitations and application of the following tools:

- Mimic/profile gauges.
- Pit depth gauges.
- Callipers.
- Mirrors.
- Magnifying lenses.
- Camera systems including image quality indicators.
- Remote visual fibrescopes/borescopes.
- Videoprobes.
- Laser profiling.

5.2.2 Use of Instruments

Inspection and testing personnel should be trained and experienced in the inspection and testing equipment that they use. Competency of inspection and testing personnel should be demonstrated using the following elements as applicable.

5.2.2.1 Performance Monitoring and Training Plan

- *Performance Monitoring.* Inspector personnel should undergo performance monitoring assessment. This competency monitoring should include witnessing of site inspection activities. The output of this assessment should be used as input to the individual's training plan.
- *Training Records.* Training record details should be maintained for all inspection and testing personnel. These records should include academic or other qualifications, training, certifications and experience.
- *Curriculum Vitae.* All inspection personnel should prepare and maintain a CV that provides information and details of general and specific training, qualification and employment history.

5.2.3 Evaluation of Defects - Practical Training

Inspectors should have satisfactorily completed a wide variety of equipment inspections and related reports appropriate to the site under the supervision of an experienced Inspector, and be able to describe the relevant inspection standards, recommended practices and procedures to assess whether defects detected in equipment would affect its suitability for on-going safe operation for a defined maximum period of operation.

5.2.3.1 Knowledge of Types of Defects

IBs should be able to identify the potential damage mechanisms, and the possible resultant defect types as part of their development and revision of inspection plans. Accordingly all Inspectors should:

- Understand the relevance and appropriateness of inspection methods to the detection of given defect types.
- Be able to relate damage mechanism to defect type and employ the most appropriate detection method.