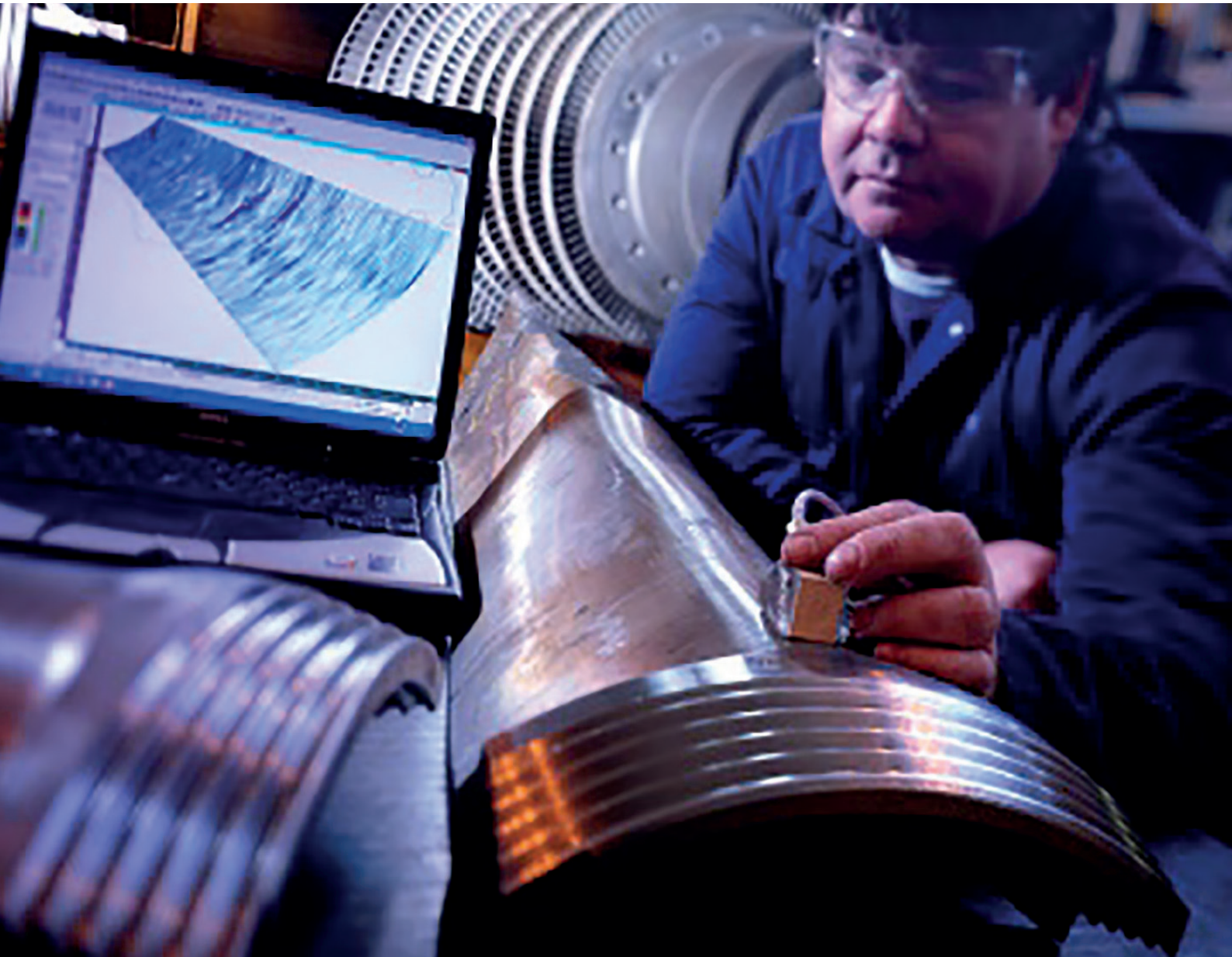


Employer's Unit of Competence – **Ultrasonic testing of materials, products and plant**



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Rolls-Royce



Overview

This standard identifies the competencies required to carry out ultrasonic testing activities using manual, semi-automatic or fully automatic equipment, in accordance with approved procedures. The use of both contact and non-contact ultrasonic flaw detector equipment is covered in this standard.

The apprentice will be required to check that the ultrasonic test equipment complies with the specification requirements, is safe to use, fit for purpose and has been correctly calibrated. They will prepare the products for testing, identifying the test area for future reference, and check the material of the product for features that might interfere with the ultrasonic tests. They will set up and adjust the equipment, carry out the specified tests using the correct procedures/techniques, according to the non-destructive testing (NDT) instructions and requirements, and observe and record the test indications.

They will be aware of the limitations of the most appropriate technique employed and refer to them within their inspection report.

They will be expected to draw conclusions about the type of defect/flaw present and its location and size. They will complete the tests by preparing/completing an NDT test report containing the required test information and data, along with their interpretation of the test indications. They will be expected to mark up the products, materials or structures to show where there are indications of defects/flaws. The completed inspection report will be passed to the appropriate person, in accordance with procedures.

The apprentice's responsibilities will require them to comply with organisational policy and procedures for the ultrasonic testing activities undertaken. Any problems with the activities or equipment in use that they cannot personally resolve, or are outside their permitted authority, will be reported to the relevant people. They will be expected to work with minimal supervision, taking personal responsibility for their actions and for the quality and accuracy of the work they carry out.

The apprentice's underpinning knowledge will demonstrate a good understanding of the work and will provide an informed approach to the inspection of engineering products, materials or structures by using ultrasonic flaw detection/testing techniques. They will have a working knowledge of the principles of ultrasonic testing using the pulse-echo system and through-transmission and will understand the functions and characteristics of the flaw detector, its performance requirements and the different types of probe available.

They will have a detailed knowledge of testing practice, including the equipment calibration requirements, defect/flaw measurement techniques, equipment performance checks and routine care of the equipment. Their knowledge will include an appreciation of hazards and safe working practices and they will understand the risks posed by material/structure defects/flaws and the consequences of component failure. The importance of compiling accurate and legible reports will also be a key issue in completing this standard.

They will understand the safety precautions required when carrying out the ultrasonic testing activities and when using the associated tools and equipment. They will be required to demonstrate safe working practices throughout and will understand the responsibility they owe to themselves and others in the workplace.

Performance criteria

The apprentice must be able to:

- P1 Work safely at all times, complying with health & safety and other relevant regulations, directives and guidelines
- P2 Follow the correct specification/technique for the product or equipment being inspected
- P3 Interpret drawings required for the inspection
- P4 Identify/use the correct equipment to carry out the inspection
- P5 Identify and confirm the inspection checks to be made and acceptance criteria to be used
- P6 Carry out all required inspections as specified
- P7 Identify any defects/flaws or variations from the specification
- P8 Record the results of the inspection in the appropriate format
- P9 Deal promptly and effectively with problems within their control and report those that cannot be solved.

Knowledge and Understanding

The apprentice must know and understand:

- K1 The specific safety precautions to be taken when carrying out ultrasonic flaw detection activities
- K2 The hazards associated with carrying out the ultrasonic flaw detection activities and how they can be minimised
- K3 The type(s) of personal protective equipment (PPE) to be used and how to obtain it
- K4 How to obtain the necessary job instructions/techniques, NDT testing specifications and how to interpret this information
- K5 The reasons why it is sometimes necessary to test products using non-destructive testing methods
- K6 Why products may need to be inspected by a range of different non-destructive testing methods (such as magnetic particle inspection, penetrant flaw detection, ultrasonics and radiography) and understanding their limitations
- K7 The basic principles of ultrasonic flaw detection testing (including sound transmission and reflection, the echo principle, ultrasound, the pulse-echo system, defects as reflectors and transmission time as a measuring system)
- K8 The basic components of the ultrasonic flaw detection equipment (such as the use of pulse generators, transducers to transmit and receive ultrasound, the receiver to recognise echo signals, the amplifier and the signal display panel)
- K9 The generation of ultrasonic waves (to include the types of transducer, pulse length, frequency and bandwidth and the coupling of the transducer to the product)
- K10 The different types of ultrasonic waves (to include compression, creep, shear and surface waves, the velocity of ultrasonic waves in the materials from which the components, materials or structures are constructed, frequency and wavelength and the relationship between the parameters)
- K11 The reflection and transmission of the ultrasonic waves (such as perpendicular incidence at reflectors, acoustic impedance, reflected and transmitted energy, critical angles and the factors affecting angles of reflection, refraction of ultrasonic waves, calculations, echo signal amplitude, area/amplitude relationship and the definition of 'decibel')
- K12 The ultrasonic beam (to include beam diameter and spread, intensity *versus* radius, near-field and far-field and the influence of frequency, velocity and transducer size)
- K13 Factors that will affect the selection of suitable probes (such as type, frequency, size, angle and product to be tested and the influence of expected defects on the probe selection)
- K14 How the product properties and condition at the time of testing will affect the way the equipment performs (such as temperature, size of object, surface conditions (flat or curved, smooth or rough) and any heat treatment or repairs to the products)
- K15 How to set up and calibrate the ultrasonic flaw detection equipment using specified calibration blocks, setting the range appropriate to the product being inspected, the effect of different sound velocities on the calibration block to that of the products being inspected, the effect of product shape and surface finish on range, sensitivity and signal-to-noise ratio
- K16 How to carry out the ultrasonic testing activities (such as the role of the couplant, the use of single and tandem probes and through-transmission, the scanning pattern required to detect expected defects and the use of reference marks related to hidden features essential to probe positioning)
- K17 How to interpret the various signals from the equipment, in terms of defect/flaw identification, defect/flaw sizing and the effect of probe manipulation
- K18 The types of defects/flaws that are detectable using ultrasonic testing methods and their likely orientation to the sound path
- K19 The level of defects/flaws that are acceptable in the products and the influence of the defects on the service/performance of the products, materials or structures
- K20 The system of quality control within the company and who is responsible for it
- K21 Why it is critical that records of ultrasonic flaw detection on the products are accurate, comprehensive and legible
- K22 The person that the inspection records need to be passed to
- K23 Care and control of the equipment (to include checking the condition of insulation, all electrical cables and connections, equipment operating controls and displays, mechanical functions and probes)
- K24 The extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Skills

The apprentice must be able to:

- S1 Carry out **all** of the following during the ultrasonic testing activities:
- Obtain the required ultrasonic testing equipment and ensure that it is in a safe and usable condition
 - Use appropriate personal protective equipment
 - Comply with job instructions, NDT testing inspection specifications, relevant COSHH sheets and risk assessment documentation
 - Follow the defined testing procedures/techniques and apply safe working practices and procedures at all times
 - Leave the work area in a safe condition on completion of the activities.
- S2 Obtain the correct type of equipment, as required by the NDT instructions/techniques, to include **all** of the following:
- The flaw detector (such as analogue or digital)
 - Calibration blocks
 - Specified probes (and leads)
 - Couplant (as appropriate).
- S3 Carry out ultrasonic testing activities using **one** of the following types of equipment:
- Manual
 - Semi-automatic
 - Fully automatic.
- S4 Prepare the products, materials or structures for testing, to include carrying out **all** of the following:
- Identifying and marking the test areas
 - Checking that the test areas are correctly prepared for testing
 - Checking for key reference (datum) markings indicating the location of product features
 - Marking the scanning limits on the surface of the test areas
 - Checking the products, when appropriate, for internal features that may interfere with the wave propagation and flaw detection.
- S5 Carry out the specified tests, using **all** of the following:
- The specified type of scan
 - The appropriate scanning procedure and technique
 - The specified probes (correct type, size and frequency)
 - The correct flaw size measurement technique.
- S6 Carry out ultrasonic testing on **one or more** of the following:
- Welded joints
 - Castings
 - Wrought products/materials (such as forged, rolled or extruded)
 - Cold-formed products (formed, for example, by bending, pressing or rolling)
 - Heat-treated components

- Structures (such as airframes, lifting beams or pressure vessels)
- Composite
- Other specific products.

S7 Record the test indications and conclusions, including **all** of the following:

- Defect/flaw type
- Defect/flaw size
- Defect/flaw location
- Test area identification
- Thickness readings if required.

S8 Follow the correct procedure to deal with products that fall into any of the following categories:

- Components, materials or structures that meet the specification
- Components, materials or structures with identified defects
- Components, materials or structures requiring further investigation
- Components, materials or structures requiring other inspection methods
- Components, materials or structures that meet the required thickness.

S9 Complete an NDT report, to include recording **all** of the following:

- Product identification
- Geometry, thickness and surface condition of identified test areas where defect indications were found
- Test information (specified flaw detector, probe data, scan type and procedure, size measurement technique, sensitivity and other parameters relevant to the test)
- Test indications and interpretation
- Flaw classification/type
- Flaw severity/dimensions
- Comparison of flaw data with acceptance criteria
- Extent of compliance with criteria
- Conclusions and sentencing (accept or reject)
- Personal data.

S10 Complete the inspection activities, to include carrying out **all** of the following:

- Marking up defective products, materials or structures with all relevant information
- Recording all the required details of the inspection in the appropriate format
- Communication of the results to the appropriate people.

