Employer's Unit of Competence – **Infrared thermography (active) testing of materials, products and plant**

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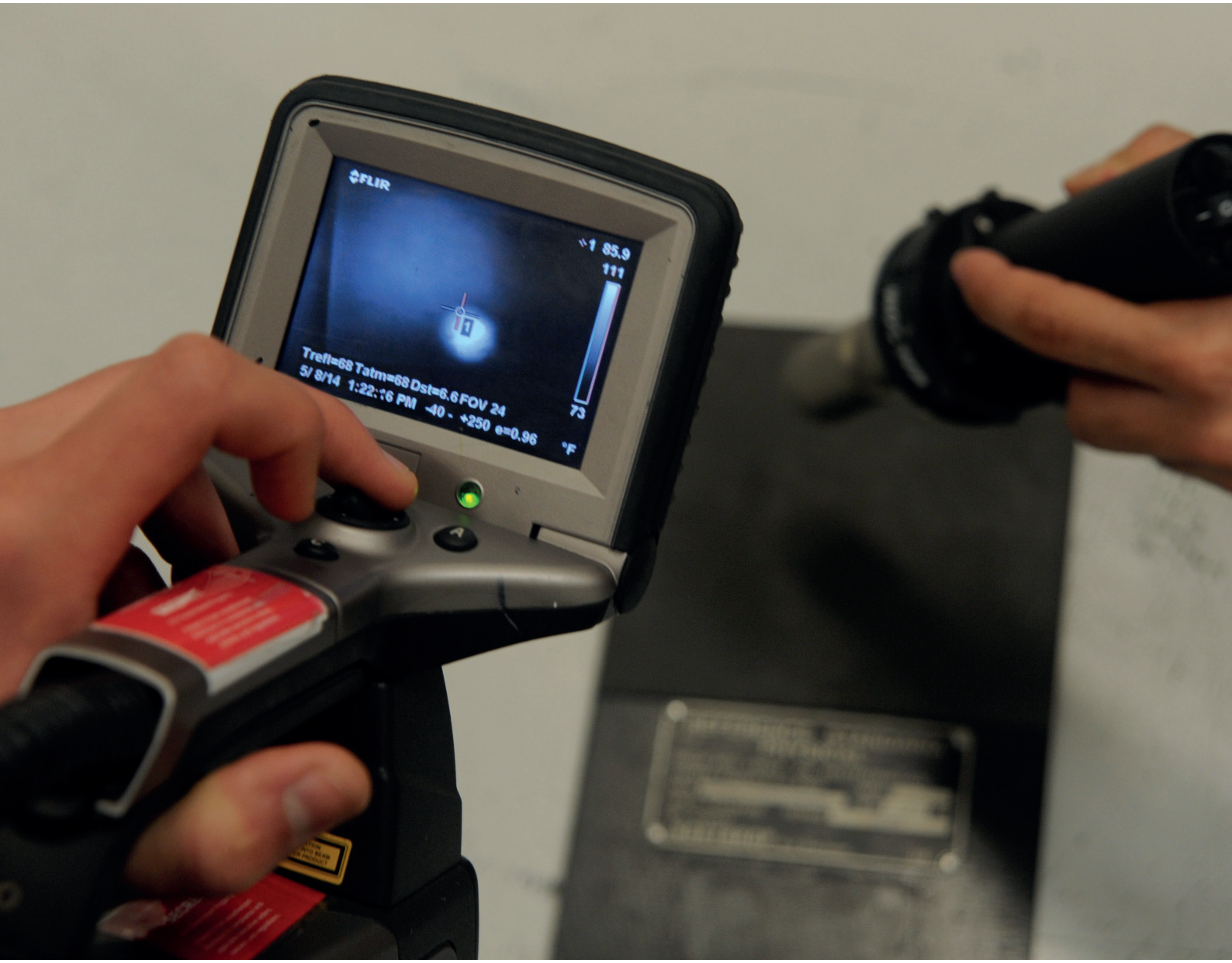

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Overview

This unit identifies the competencies required to carry out stimulated thermography testing (ST) inspection activities, using manual, semi-automatic or fully automatic equipment on engineering materials, products and plant, in accordance with approved procedures. This includes active optically-stimulated thermographic techniques, such as flash and laser spot, in addition to acoustic and electromagnetic stimulation.

The apprentice will be required to check that the ST inspection equipment complies with the specification requirements, is safe to use, fit for purpose and has been correctly calibrated. They will prepare the products for inspection, identifying the test area for future reference and checking the environmental conditions, material properties and surface conditions to which stimulated thermography testing is sensitive. They will set up and adjust the equipment, carry out the specified inspection using the correct procedures/techniques, according to the ST testing instructions and requirements, and observe and record the test indications.

They will be expected to interpret ST equipment displays, recognise changes in the equipment response and draw conclusions about the probable cause of these changes. They will complete the inspection by preparing/completing an ST test report containing the required test information, the values assigned to key inspection parameters and an accurate map of the position, type, severity and distribution of any flaws detected. If appropriate and safe to do so, they may be expected to mark up the products, objects or structures to identify areas of interest and digital information of the signals produced. The completed inspection report will be passed to the appropriate people, in accordance with procedures.

The apprentice's responsibilities will require them to comply with organisational policy and procedures for the ST inspection activities undertaken. Any problems with the activities or equipment in use that they cannot personally resolve, or are outside their permitted authority, are to 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 their work and will provide an informed approach to the ST inspection of engineering materials, products and plant or structures and the process or product technology associated with each.

They will have a working knowledge of the principles and common techniques of optically-stimulated thermography and they will understand different heat mechanisms and data analysis techniques, such as those utilised in flash thermography, long-pulse thermography and lock-in thermography.

They will have a detailed knowledge of good inspection practice, including equipment calibration requirements, the selection of appropriate calibration pieces, test-blocks and reference discontinuities befitting the specific ST inspection task.

They will become aware of the factors that determine the sensitivity and reliability of the inspection and the appropriate corrective or compensating measures required to negate their effects.

They will have knowledge of capability demonstration techniques and methods to measure the inspection capability, including probability of detection studies.

They will have a working knowledge of the principles of heat and temperature, convection, conduction and radiation energy exchange. They will be able to apply these principles to a host of potential applications, including flaw detection, material degradation assessment and measurement of thickness and surface coatings thickness, across a range of products.

They will also have detailed knowledge of 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 materials at a high temperature during manufacture, a temperature increase due to cold working, working with electrical equipment, active plant and associated material, equipment or vehicular movements.

They will have good knowledge of defect types in engineering materials, composites, metals and surface coatings.

They will, by virtue of the training and supervised experience that they receive, become keenly aware of the potential consequences of component failure. The importance of compiling accurate and legible reports will also be a key issue in completing this unit.

They will understand the safety precautions required when carrying out the ST inspection 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 and the anticipated locations and orientation of flaws

P3 Use the appropriate equipment configuration to achieve specific inspection requirements

P4 Identify and, where possible, control potential sources of inspection uncertainty

P5 Carry out all required ST inspections as specified

P6 Identify any regions where a thermal behaviour, likely to be attributed to some definite material change, anomaly or flaw, requires further investigation, which may include the application of complementary NDT methods

P7 Undertake analysis and interpretation of signal displays or inspection charts

P8 Record the results of the ST inspections 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 ST activities on engineering materials, products and plant

K2 The hazards associated with carrying out the ST activities (such as electrical contact, moving mechanical parts and high temperatures) and how the risks associated with these hazards 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 and ST testing specifications and how to interpret this information

K5 The relative strengths and weaknesses of each technique used in stimulated thermography testing and the range of materials and products to which it is usefully applied

K6 Why products may need to be tested by a range of different non-destructive testing methods (such as magnetic particle inspection, penetrant flaw detection, ultrasonics and radiography)

K7 Heat and temperature – temperature, heat, absolute and relative temperature scales, heat transfer via conduction, convection and radiation

K8 Application of heat and temperature theory to detect flaws in engineering materials

K9 Infrared thermographic equipment – the history of infrared systems, infrared thermal imagers, waveband selection, lens design, instantaneous field of view, digital *versus* optical zoom, IRT detector performance, camera operation and features, sensitivity, noise equivalent temperature difference, minimum resolvable difference

K10 Different types of thermal stimulation, including optical, induction and ultrasonic vibration. Different methods of heating, including flash, long-pulse and lock-in

K11 The common signal evaluation techniques, including videos, images, temperature-time transients, time differential techniques, logarithmic temperature-time plots and pulse-phase

K12 Factors that influence the inspection sensitivity, including emissivity, variation of emissivity with angle, excitation energy or power, environmental factors, camera sensitivity and external heat sources

K13 Heat flow within a solid, including conductivity and diffusivity

K14 Coverage, field of view and resolution

K15 Accessibility and line of sight

K16 Flaw orientation and flaw size

K17 Component geometry, proximity of the flaw to part edges

K18 How the properties of the products to be tested will affect the way the equipment performs (such as thermal conductivity, diffusivity and emissivity)

K19 How to set up and calibrate stimulated thermography inspection equipment using specified calibration blocks, setting the test sensitivity as appropriate to the product being inspected, and the effect of any differences in material properties between the calibration block and the material of the inspected products

K20 How to carry out the stimulated thermography testing activities by selection of the appropriate technique, equipment or test configurations and the use of appropriate scanning and image resolution to assure the detection of flaws of the specified size

K21 How to interpret the various signals from the equipment, in terms of defect/flaw identification and defect/flaw sizing

K22 The types of defect/flaws that are detectable using specific techniques of the stimulated thermography test method

K23 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

K24 The system of quality control within the company and who is responsible for it

K25 Why it is critical that records of ST inspections of the products are accurate, comprehensive and maintained legibly

K26 The person/s that the inspection records need to be passed to

K27 In the case of digital data, how to facilitate automatic storage and/or transfer to a more publicly-accessible server

K28 Care and control of the equipment (to include checking the condition of insulation, all electrical cables and connections, equipment operating controls and displays)

K29 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:

1. Carry out **all** of the following during the ST inspections:

   - Obtain the required equipment and ensure that it is in a safe and usable condition
   - Use appropriate personal protective equipment
   - Use appropriate screening of any high-energy light source to ensure the safety of all personnel in the vicinity of the inspection
   - Comply with job instructions, NDT testing inspection procedures, 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.

2. Obtain the correct configuration of equipment, as required by the ST procedures/techniques or work Instructions, to include **all** of the following:

   - Camera
   - Heat excitation equipment (for example a flash lamp)
   - Reference pieces or blocks.

3. Prior to undertaking an ST Inspection, carry out and record the following equipment parameters (where appropriate) that could influence the outcome from the inspection:

   - Image resolution/image size
   - Recording frame rate
   - Number of images obtained/length of time images are recorded
   - Heating excitation energy.

4. Preparation prior to commencing an inspection, to include carrying out the following as appropriate:

   - Identify the inspection areas
   - Check that the test areas are correctly prepared for testing
   - Check for key reference (datum) markings
   - Recognise and deal with material condition, coatings, heat-treated condition, corrosion and contamination
   - Check for surface roughness, scuffing, scratching or marking, which may generate unwanted signals.

5. Carry out the specified tests, using **all** of the following:

   - The appropriate procedure and technique
   - The specified equipment
   - The correct flaw size measurement technique.

6. Carry out ST Inspection on **one** of the following:

   - Composite material
   - Thermal barrier coating
   - Other specific products.

7. Complete an ST inspection report, to include recording **all** of the following:

   - Equipment used
   - Equipment settings
   - Area of inspection
   - Calibration standards
   - Test configuration
   - Material type, dimensions and condition
   - Name of inspector, qualification and signature
   - Reference drawings or sketches as appropriate
   - Datums used
   - Flaw response thresholds
   - Defect/flaw type
   - Defect/flaw length and depth
   - Defect/flaw location
   - Summary of inspection results including a conclusion.

8. Follow the correct procedure to deal with products that fall into one or more 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.

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

- Marking up defective products, plant, materials or structures with all relevant information
- Handing over the inspection report to the appropriate people.

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