SEMEM4-40
Carrying out the testing and calibration of instrumentation control equipment and circuits

Overview

This standard identifies the competences you need to lead and carry out tests and calibration of instrumentation and control equipment and circuits, in accordance with approved procedures. You will be required to carry out the various tests and calibration on a range of instrumentation equipment, such as pressure, flow, level and temperature instruments; fiscal monitoring equipment; smoke, heat, gas, water, chemical and metal detection and alarm systems; industrial weighing systems; linear and rotational speed measurement and control; vibration monitoring equipment; photo-optic instruments; nucleonic and radiation measurement; analysers recorders and indicators; telemetry systems; emergency shutdown systems and other specific instrumentation, to establish that they are functioning at optimal level and to specification.

You will be required to carry out tests and calibration which will include voltage and current levels, resistance values, waveform, open/short circuit, signal injection, logic state, pressure/leak tests, signal measurement and transmission and other specific or special-to-type tests.

Your responsibilities will require you to comply with organisational policy and procedures for carrying out the testing and calibration activities, and to report any problems with these activities that you cannot personally resolve, or that are outside your permitted authority, to the relevant people. You will be expected to work with minimal supervision, taking personal responsibility for your own actions, and for the quality and accuracy of the work that you carry out.

Your underpinning knowledge will provide an in depth understanding of the procedures for carrying out the required tests and calibration, and will provide an informed approach to applying the necessary testing and calibrating procedures. You will understand the equipment being worked on, the test and calibration equipment being used, and the various testing/calibrating procedures and their application, in adequate depth to provide a sound basis for carrying out the activities to the required specification and remains compliant with all standards and regulations. In addition, you will be expected to review the outcome of the tests/calibration, to compare the results with appropriate specifications, to determine the action required, and to record/report the results in the appropriate format.

You will understand the safety precautions required when carrying out the testing and calibrating activities, especially those for isolating the equipment. You will be required to demonstrate safe working practices throughout, and will understand your responsibility for taking the necessary safeguards to protect yourself and others in the workplace.

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Performance criteria

You must be able to:

P1 work safely at all times, complying with health and safety and other relevant regulations, directives and guidelines
P2 produce and update relevant testing/calibration schedules and plans
P3 lead testing/calibration activities within the limits of your personal authority
P4 carry out the testing/calibration activities in the specified sequence and in an agreed timescale
P5 report any instances where the testing/calibration activities cannot be fully met or where there are identified defects outside the planned schedule
P6 complete relevant testing/calibration documentation accurately
P7 dispose of waste materials in accordance with safe working practices and approved procedures
P8 identify and lead on making improvements to testing/calibration processes and procedures
P9 update management information and systems to support the activities of the maintenance department

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Knowledge and understanding

You need to know and understand:

K1 the health and safety requirements of the area in which the testing/calibration activity is to take place, and the responsibility these requirements place on you

K2 how to prioritise your own and your team's workload to ensure that targets are met

K3 how to communicate effectively, listen, question, support and coach others to work towards the departmental targets

K4 the importance of ensuring that teams have the required skills, knowledge and understanding in order to maintain equipment to the required standards

K5 how to complete a skills audit of team members

K6 how maintenance teams can access the appropriate training and development programmes once a need training need has been identified

K7 the isolation and lock-off procedure or permit-to-work procedure that applies to the system and instruments being worked on, and how to check that any stored energy in pipework and instruments has been released

K8 the specific safety precautions to be taken when carrying out instrument and circuit testing and calibration activities

K9 hazards associated with carrying out testing and calibrating activities on instrumentation and control systems (such as stored pressure/force, electrical supplies, process controller interface, using damaged or badly maintained tools and equipment, not following laid-down testing and calibration procedures) and how to minimise them and reduce any risks

K10 the importance of wearing protective clothing and other appropriate safety equipment, during the testing and calibrating activities

K11 how the testing and calibrating activities may affect the work of others and the procedure for informing them of the work to be carried out

K12 the procedures and precautions to be adopted to eliminate/protect against electrostatic discharge (ESD)

K13 how to obtain and interpret circuit drawings, calibration data, instrument specifications, manufacturers' manuals, history/maintenance reports, symbols used on instrumentation and control documents, and other documents needed in the testing and calibration process

K14 the basic principles of operation of the instrumentation and control equipment being tested/calibrated, how the system functions, its operating sequence, the working purpose of individual units/components and how they interact

K15 the reasons for making sure that control systems are isolated or put into manual control, and appropriate trip locks or keys are inserted, before removing any sensors or instruments from the system

K16 the identification of instrument sensors (including how to identify their markings, calibration information, component values, operating parameters and working range)
K17 methods of checking and calibrating instruments, and the type and range of equipment that can be used
K18 how to set up and apply the appropriate test and calibration equipment (such as pressure testing in incremental stages)
K19 how to check that the test and calibration equipment is free from damage or defects, is in a safe and usable condition, and is configured correctly for the intended purpose
K20 how to analyse the test and calibration results, and how to use comparison and sequential techniques
K21 the environmental control requirements and company operating procedures relating to the testing and calibrating activities
K22 the documentation required, and the procedures to be followed, at the conclusion of the testing and calibrating
K23 what to do if instruments or control circuits do not meet the required calibration parameters
K24 how to conduct a systematic plan, do, check, act (PDCA) approach to problem-solving and business improvement
K25 how to evaluate improvement ideas in order to select those that are to be pursued
K26 how improvements to the process are achieved by engaging the knowledge and experience of the people working on the process
K27 how to create or update Standard Operating Procedures (SOP's) maintenance schedules and plans
K28 the techniques required to communicate information using visual control systems (such as card systems, colour coding, floor footprints, graphs and charts, team boards, tool/equipment shadow boards)
K29 the extent of your own authority and to whom you should report if you have problems that you cannot resolve

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Additional Information

Scope/range related to performance criteria

You must be able to:

1. Lead a maintenance team by carrying out all the following:
   - 1.1 communicate the testing/calibration activities to the team
   - 1.2 involve the team in planning how the testing/calibration activities will be undertaken
   - 1.3 allocate specific testing/calibration activities to each team member
   - 1.4 involve the team in identifying improvements that could be made to the testing/calibration process and/or procedures
   - 1.5 encourage the team and/or individuals to take the lead where appropriate
2. Review and update maintenance procedures and plans to include three the following:
   - 2.1 preventive testing/calibration (routine inspections, and adjustments)
   - 2.2 corrective testing/calibration (activities identified from preventative maintenance activities)
   - 2.3 predictive testing/calibration (analysis of the equipment's condition)
   - 2.4 reactive testing/calibration (unexpected equipment/component failure)
   - 2.5 maintenance prevention (equipment/component design and development)

   plus supporting documentation associated with two of the following
   - 2.6 equipment performance
   - 2.7 equipment downtime/failure
   - 2.8 overall equipment effectiveness (OEE)
   - 2.9 maintenance costs
   - 2.10 health and safety
   - 2.11 staff development and training
   - 2.12 maintenance procedures/instructions
   - 2.13 testing/calibration processes
   - 2.14 operator manuals/working instructions
   - 2.15 regulatory compliance
3. Carry out all of the following during the testing and calibration activities:
   - 3.1 obtain and use the correct issue of company and/or manufacturers' drawings and testing/calibration documentation
   - 3.2 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
   - 3.3 where appropriate, ensure the insertion of any relevant system trip defeats (such as fire extinguishant, emergency shutdown)

3.4 ensure the safe isolation of instruments (such as process, electrical, hydraulic, pneumatic, mechanical)
3.5 ensure that test equipment used is appropriate for the tests being carried out, is within current calibration dates and is used within its specified range
3.6 provide and maintain safe access and working arrangements for the testing and calibration area
3.7 carry out the testing and calibration activities, using appropriate techniques and procedures
3.8 where applicable, take electrostatic discharge (ESD) precautions when handling sensitive components and circuit boards
3.9 re-connect and return the equipment to service on completion of the testing and calibration activities
3.10 dispose of waste items in a safe and environmentally acceptable manner, and leave the work area in a safe condition

4. Carry out tests and calibration on four of the following types of instrumentation control equipment and circuits:
4.1 pressure (such as absolute, gauge, vacuum)
4.2 flow (such as orifice plate, venturi tube, electromagnetic, ultrasonic, differential pressure cell, positive displacement)
4.3 level (such as floats, displacer, differential pressure cells, load cells, ultrasonic, conductivity)
4.4 temperature (such as bi-metallic, thermocouples, resistance, infra-red, thermal imaging)
4.5 weight (such as mechanical systems, load cells/strain gauges, transducers)
4.6 fiscal metering (such as gas, electricity, water, fuel)
4.7 detection and alarm (such as smoke, heat, gas, chemical, water, metal)
4.8 speed measurement (such as mechanical, electrical, stroboscopic)
4.9 emergency shutdown
4.10 speed control (such as mechanical governors, electrical governors, DC speed controller, AC motor control systems, stepper motors, invertors)
4.11 vibration monitoring (such as vibration switches, proximity probes, seismic velocity transducer, linear variable differential transformers, portable data collectors)
4.12 nucleonic and radiation (such as Geiger-Muller tube, neutron counter, photomultiplier tube, proportional counter, ionising radiation monitors)
4.13 analysers (such as gas detection, spectroscopy, oxygen analyser, water analysis, moisture measurement, density)
4.14 recorders and indicators
4.15 telemetry systems (such as master station, outstation, stand alone

systems)
4.16 valves and valve mechanisms (such as control valves, valve actuators and positioners)
4.17 other specific instrumentation

5. Carry out tests and calibration using a range of tools and test equipment, to include six of the following:
   5.1 multimeter
   5.2 insulation testers
   5.3 temperature baths
   5.4 signal sources
   5.5 standard test gauges
   5.6 calibrated weights
   5.7 current injection devices
   5.8 pressure sources
   5.9 comparators
   5.10 analogue and digital meters
   5.11 digital pressure indicators
   5.12 dead weight tester
   5.13 logic probes
   5.14 calibrated flow meters
   5.15 special purpose test equipment
   5.16 workshop potentiometers
6. Carry out all of the following during the testing/calibrating activities:
   6.1 obtaining calibration parameters from data records
   6.2 installing alarm defeat keys or program overrides (where appropriate)
   6.3 connecting up supplies, test and calibration equipment
   6.4 carrying out the tests and calibration to manufacturers' procedures
   6.5 setting, adjusting and calibrating the equipment and control circuit to the required specification parameters
   6.6 recording the test and calibration results in the appropriate formats/documentation
   6.7 dealing with instruments and control circuits that do not meet specification requirements
7. Carry out six of the following tests and calibrations:
   7.1 visual inspection of the instrument for completeness and freedom from damage or foreign objects
   7.2 standard serviceability test/calibration
   7.3 equipment self-diagnostics
   7.4 leak/pressure test
   7.5 signal injection tests
   7.6 soak test
   7.7 special-to-type tests
   7.8 signal measurement and transmission

7.9 operational/function checks
7.10 five point calibration
7.11 unit substitution

8. Identify and implement improvements in the services provided by the maintenance team to include two of the following:
   8.1 equipment downtime during maintenance
   8.2 equipment performance monitoring systems
   8.3 overall equipment effectiveness (OEE)
   8.4 maintenance procedures
   8.5 testing/calibration processes
   8.6 operator instructions
   8.7 visual management systems/documentation
   8.8 resource planning
   8.9 costs
   8.10 staff development and training
   8.11 health and safety
   8.12 procurement
   8.13 other (to be specified)
9. Test and calibrate instrumentation control equipment and circuits, in compliance with three of the following
   9.1 organisational guidelines and procedures
   9.2 equipment manufacturer's operating specification/range
   9.3 British, European or International standards or directives
   9.4 recognised compliance agency/body standards or directives
   9.5 health, safety and environmental requirements
   9.6 customer standards and requirements
10. Complete the relevant testing/calibration documentation to include one from the following:
   10.1 job cards
   10.2 testing/calibration log or report
   10.3 company-specific recording system

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