SEMEM378

Testing and calibrating instrumentation and control equipment and circuits

Overview

This standard identifies the competences you need to 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 a good 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.

Performance criteria

You must be able to:

1. work safely at all times, complying with health and safety legislation and other relevant regulations, directives and guidelines
2. follow the appropriate procedures for use of tools and equipment to carry out the required tests
3. set up and carry out the tests using the correct procedures and within agreed timescales
4. complete and store all relevant documentation of the test outcome in accordance with organisational requirements
5. review the results and carry out further tests if necessary
6. dispose of waste materials in accordance with safe working practices and approved procedures and leave the work area in a safe condition

Knowledge and understanding

You need to know and understand:

1. the health and safety requirements of the area in which the testing and calibrating activity is to take place, and the responsibility these requirements place on you
2. your responsibilities under regulations relevant to the instrumentation and control equipment and circuit testing activities being undertaken
3. 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
4. the specific safety precautions to be taken when carrying out instrument and circuit testing and calibration activities
5. 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
6. what constitutes a hazardous voltage and how to recognise victims of electric shock
7. how to reduce the risks of a phase to earth shock (such as insulated tools, rubber matting and isolating transformers)
8. the importance of wearing protective clothing, and other appropriate safety equipment (PPE) during the testing and calibrating activities
9. 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
10. the procedures and precautions to be adopted to eliminate/protect against electrostatic discharge (ESD)
11. 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
12. 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

13. 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
14. the identification of instrument sensors (including how to identify their markings, calibration information, component values, operating parameters and working range)
15. methods of checking and calibrating instruments, and the type and range of equipment that can be used
16. how to set up and apply the appropriate test and calibration equipment (such as pressure testing in incremental stages)
17. 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
18. how to analyse the test and calibration results, and how to use comparison and sequential techniques
19. the environmental control requirements and organisational operating procedures relating to the testing and calibrating activities
20. the documentation required, and the procedures to be followed, at the conclusion of the testing and calibrating
21. what to do if instruments or control circuits do not meet the required calibration parameters
22. the extent of your own authority and to whom you should report if you have problems that you cannot resolve

Scope/range

1.

Carry out all of the following during the testing and calibration activities:

1.1 obtain and use the correct issue of organisational and/or manufacturers' drawings and testing/calibration documentation
1.2 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
1.3 where appropriate, ensure the insertion of any relevant system trip defeats (such as fire extinguishant, emergency shutdown)
1.4 ensure the safe isolation of instruments (such as process, electrical, hydraulic, pneumatic, mechanical)
1.5 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
1.6 provide and maintain safe access and working arrangements for the testing and calibration area
1.7 carry out the testing and calibration activities, using appropriate techniques and procedures
1.8 where applicable, take electrostatic (ESD) precautions when handling sensitive components and circuit boards
1.9 re-connect and return the equipment to service on completion of the testing and calibration activities
1.10 dispose of waste materials in accordance with safe working practices and approved procedures, and leave the work area in a safe condition

2.

Carry out tests and calibration on four of the following types of instrumentation and control equipment and circuit:

2.1 pressure (such as absolute, gauge, vacuum)
2.2 flow (such as orifice plate, venturi tube, electromagnetic, ultrasonic, differential pressure cell, positive displacement)
2.3 level (such as floats, displacer, differential pressure cells, load cells, ultrasonic, conductivity)
2.4 temperature (such as bi-metallic, thermocouples, resistance, infra-red, thermal imaging)
2.5 weight (such as mechanical systems, load cells/strain gauges, transducers)
2.6 fiscal metering (such as gas, electricity, water, fuel)
2.7 detection and alarm (such as smoke, heat, gas, chemical, water, metal)
2.8 speed measurement (such as mechanical, electrical, stroboscopic)
2.9 emergency shutdown
2.10 speed control (such as mechanical governors, electrical governors, DC speed controller, AC motor control systems, stepper motors, invertors)
2.11 vibration monitoring (such as vibration switches, proximity probes, seismic velocity transducer, linear variable differential transformers, portable data collectors)

2.12 nucleonic and radiation (such as Geiger-Muller tube, neutron counter, photomultiplier tube, proportional counter, ionising radiation monitors)
2.13 analysers (such as gas detection, spectroscopy, oxygen analyser, water analysis, moisture measurement, density)
2.14 recorders and indicators
2.15 telemetry systems (such as master station, outstation, stand alone systems)
2.16 valves and valve mechanisms (such as control valves, valve actuators and positioners)
2.17 other specific instrumentation or control equipment

3.

Carry out tests and calibration using a range of tools and test equipment, to include six of the following:

3.1 analogue or digital multimeter
3.2 insulation testers
3.3 temperature baths
3.4 signal sources
3.5 standard test gauges
3.6 calibrated weights
3.7 current injection devices
3.8 pressure sources
3.9 comparators
3.10 analogue and digital meters
3.11 digital pressure indicators
3.12 dead weight tester
3.13 logic probes
3.14 calibrated flow meters
3.15 special purpose test equipment
3.16 workshop potentiometers

4.

Carry out all of the following during the testing/calibrating activities:

4.1 obtaining calibration parameters from data records
4.2 installing alarm defeat keys or program overrides (where appropriate)
4.3 connecting up supplies, test and calibration equipment
4.4 carrying out the tests and calibration to manufacturers' procedures
4.5 setting, adjusting and calibrating the equipment and control circuit to the required specification parameters
4.6 recording the test and calibration results in the appropriate formats/documentation
4.7 dealing with instruments and control circuits that do not meet specification requirements

5.

Carry out six of the following tests and calibrations:

5.1 visual inspection of the instrument for completeness and freedom from damage or foreign objects

5.2 standard serviceability test/calibration
5.3 equipment self-diagnostics
5.4 leak/pressure test
5.5 signal injection tests
5.6 soak test
5.7 special-to-type tests
5.8 signal measurement and transmission
5.9 operational/function checks
5.10 five-point calibration
5.11 unit substitution

6.

Test and calibrate instrumentation and control equipment and circuits, in compliance with one of the following

6.1 organisational standards and procedures
6.2 BS, ISO and/or BSEN standards
6.3 customer standards and requirements
6.4 instrument manufacturer's requirements

7.

Complete and store all relevant documentation of the test outcome in accordance with organisational requirements, using one of the following:

7.1 calibration log or report
7.2 organisational-specific documentation
7.3 job cards
7.4 electronic reports

SEMEM378

Testing and calibrating instrumentation and control equipment and circuits

Developed by	Enginuity
Version Number	3
Date Approved	30 Mar 2021
Indicative Review Date	01 Mar 2024
Validity	Current
Status	Original
Originating Organisation	Enginuity
Original URN	SEMEM378
Relevant Occupations	Maintenance Engineer
Suite	Engineering Maintenance Suite 3
Keywords	Instrumentation; control equipment; control circuits; engineering; repair equipment; testing/calibrating equipment; maintenance/manufacturers documentation; testing/calibrating activities;