

SEMEM4-44

Carrying out maintenance activities on instrumentation and control equipment



Overview

This standard identifies the competences you need to lead maintenance activities by carrying out corrective maintenance activities on instrumentation and control equipment, in accordance with approved procedures. You will be required to maintain a range of instrumentation and control 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. This will involve dismantling, removing and replacing a range of instruments and faulty peripheral components down to unit and component level, as appropriate.

You will also be required to identify and implement a systematic approach to improving the equipment maintenance activities undertaken and ensure that the maintenance team have to appropriate skills, knowledge and understanding to maintain the equipment efficiently, effectively and safely.

Your responsibilities will require you to comply with organisational policy and procedures for the maintenance activities undertaken, and to report any problems with the activities, instrument system, tools or equipment used, that you cannot personally resolve, or that are outside your permitted authority, to the relevant people. You will be expected to work with a minimum of 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 your work, and will provide an informed approach to applying maintenance procedures to instrumentation and control equipment and circuits. You will understand the maintenance methods and procedures used, and their application, and will know about the various instrumentation units and peripheral components, their functions and associated defects, in adequate depth to provide a sound basis for carrying out the maintenance activities, correcting faults and ensuring that the equipment operates to the required specification and remains compliant with all standards and regulations. You will also know about the interaction of the other associated integrated technologies, and will have sufficient knowledge to carry out the dismantling and reassembly of the instrumentation system safely and effectively.

You will understand the safety precautions required when carrying out the maintenance 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.

SEMEM4-44

Carrying out maintenance activities on instrumentation and control equipment

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 maintenance schedules and plans
- P3 lead maintenance activities within the limits of your personal authority
- P4 carry out the maintenance activities in the specified sequence and in an agreed timescale
- P5 report any instances where the maintenance activities cannot be fully met or where there are identified defects outside the planned schedule
- P6 complete relevant maintenance documentation accurately
- P7 dispose of waste materials in accordance with safe working practices and approved procedures
- P8 identify and lead on making improvements to maintenance processes and procedures
- P9 update management information and systems to support the activities of the maintenance department

SEMEM4-44

Carrying out maintenance activities on instrumentation and control equipment

Knowledge and understanding

You need to know and understand:

- K1 the health and safety requirements of the area in which the maintenance 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 procedures or permit-to-work procedure that applies
- K8 the specific health and safety precautions to be applied during the maintenance procedure, and their effects on others
- K9 hazards associated with carrying out mechanical maintenance activities (such as handling oils, greases, stored pressure/force, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise these and reduce any risks
- K10 the importance of wearing protective clothing and other appropriate safety equipment during maintenance process
- K11 how to obtain and interpret drawings, specifications, manufacturers' manuals and other documents needed in the maintenance process
- K12 the procedure to be adopted to establish the background of the fault
- K13 how to evaluate the various types of information available for fault diagnosis
- K14 how to use the various aids and reports available for fault diagnosis
- K15 how to use various types of fault diagnostic equipment needed to investigate the problem
- K16 the various fault finding techniques that can be used (such as half-split, input-to-output, emergent problem sequence, six point technique, function testing, unit substitution, injection and sampling techniques and equipment self-diagnostics) and how they are applied
- K17 how to evaluate sensory conditions (by sight, sound, smell, touch)
- K18 how to analyse evidence and evaluate possible characteristics and causes of specific faults/problems
- K19 how to relate previous reports/records of similar fault conditions
- K20 how to evaluate the likely risk of running the equipment with the

SEMEM4-44

Carrying out maintenance activities on instrumentation and control equipment

- displayed fault, and the effects the fault could have on health and safety, and on the overall process or system
- K21 the care, handling and application of instrumentation test instruments (such as multimeters, logic probes, oscilloscopes, signal tracers, signal generators)
 - K22 how to check that test instruments are within current calibration dates, and that they are free from damage and defects
 - K23 the precautions to be taken to prevent electrostatic discharge (ESD) damage to electronic circuits and components
 - K24 the basic principles of operation of the instrumentation and control equipment being maintained, how the system functions, its operating sequence, the working purpose of individual units/components and how they interact
 - K25 the reasons for making sure that control systems are isolated or put into manual control, and appropriate trip locks, keys or program overrides are inserted, before removing any sensors or instruments from the system
 - K26 the identification and selection of instrument sensors (including how to identify their markings, calibration information, component values, operating parameters and working range)
 - K27 the correct way of fitting instruments to avoid faulty readings (caused by head correction, poor flow past sensor, blockages, incorrect wiring, poor insulation or incorrect materials)
 - K28 the correct and tidy installation and connection of external wiring and components, to avoid electronic interference or mechanical damage
 - K29 how to carry out visual checks of the instruments (such as checking for leaks, security of joints and physical damage)
 - K30 the procedure for obtaining replacement parts, materials and other consumables necessary for the maintenance process
 - K31 company policy on the repair/replacement of components during the maintenance process
 - K32 the techniques used to dismantle/assemble integrated equipment (such as release of pressures/force, proof marking to aid reassembly, plugging exposed pipe/component openings, dealing with soldered joints, screwed, clamped and crimped connections)
 - K33 methods of attaching identification marks/labels to removed components or cables, to assist with reassembly
 - K34 methods of checking that components are fit for purpose, and the need to replace electronic modules, sensors, transmitters, transducers, electronic boards and other failed items
 - K35 how to check that tools and equipment are free from damage or defects, are in a safe and usable condition, and are configured correctly for their intended purpose
 - K36 the generation of appropriate documentation and/or reports following the maintenance activity

SEMEM4-44

Carrying out maintenance activities on instrumentation and control equipment

- K37 the equipment operating and control procedures to be applied during the maintenance activity
- K38 the problems that can occur during the maintenance of the instrumentation and control system, and how they can be overcome
- K39 the organisational procedure to be adopted for the safe disposal of waste of all types of material
- K40 how to conduct a systematic plan, do, check, act (PDCA) approach to problem-solving and business improvement
- K41 how to evaluate improvement ideas in order to select those that are to be pursued
- K42 how improvements to the process are achieved by engaging the knowledge and experience of the people working on the process
- K43 how to create or update Standard Operating Procedures (SOP's) maintenance schedules and plans.
- K44 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)
- K45 the extent of your own authority and to whom you should report if you have problems that you cannot resolve

SEMEM4-44

Carrying out maintenance activities on instrumentation and control equipment

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 maintenance activities to the team
 - 1.2. involve the team in planning how the maintenance activities will be undertaken
 - 1.3. allocate specific maintenance activities to each team member
 - 1.4. involve the team in identifying improvements that could be made to the maintenance 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 maintenance (routine inspections, and adjustments)
 - 2.2. corrective maintenance (activities identified from preventative maintenance activities)
 - 2.3. predictive maintenance (analysis of the equipment's condition)
 - 2.4. reactive maintenance (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. operator manuals/working instructions
 - 2.14. regulatory compliance
 3. Collect fault diagnostic evidence from four of the following sources:
 - 3.1. the person or operator who reported the fault
 - 3.2. equipment self-diagnosis
 - 3.3. test instrument measurements (such as multimeter, oscilloscope, logic probe, signal tracer, signal generator)
 - 3.4. recording devices
 - 3.5. plant/equipment records
 - 3.6. circuit outputs/computer display (such as pressure, flow, temperature)
 - 3.7. equipment outputs
 - 3.8. sensory input (sight, sound, smell, touch)
 4. Use a range of fault diagnostic techniques, to include two of the following:

SEMEM4-44

Carrying out maintenance activities on instrumentation and control equipment

- 4.1. half-split technique
- 4.2. input/output technique
- 4.3. injection and sampling
- 4.4. six point technique
- 4.5. emergent sequence
- 4.6. unit substitution
- 4.7. function/performance testing
- 4.8. equipment self-diagnostics
5. Use a variety of diagnostic aids, to include two of the following:
 - 5.1. logic diagrams
 - 5.2. fault analysis charts (such as fault trees)
 - 5.3. flow charts or algorithms
 - 5.4. manufacturers' manuals
 - 5.5. probability charts/reports
 - 5.6. troubleshooting guides
 - 5.7. computer-aided test equipment
 - 5.8. electronic aids
6. Use all of the following fault diagnostic procedures:
 - 6.1. inspection (such as breakages, wear/deterioration, signs of overheating, loose connections/fittings)
 - 6.2. operation (such as manual switching off and on, automatic switching/timing/sequencing, outputs)
 - 6.3. measurement (such as voltage, current, continuity, logic state, noise, frequency, signal shape, level)
7. Use four of the following types of test equipment to aid fault diagnosis:
 - 7.1. multimeter
 - 7.2. pressure sources
 - 7.3. oscilloscope
 - 7.4. digital pressure indicators
 - 7.5. signal sources/generator
 - 7.6. standard test gauges
 - 7.7. current injection devices
 - 7.8. special purpose test equipment
 - 7.9. logic probe
 - 7.10. signal tracer
 - 7.11. other specific test equipment
8. Find faults that have resulted in two of the following breakdown categories:
 - 8.1. intermittent problem
 - 8.2. partial failure/out-of-specification output
 - 8.3. complete breakdowns
9. Carry out all of the following during the maintenance activity:
 - 9.1. obtain and use the correct issue of company and/or manufacturer's drawings and maintenance documentation
 - 9.2. adhere to procedures or systems in place for risk assessment, COSHH,

SEMEM4-44

Carrying out maintenance activities on instrumentation and control equipment

- personal protective equipment and other relevant safety regulations and procedures to realise a safe system of work
- 9.3. ensure the safe isolation of equipment (such as mechanical, electricity, gas, air or fluids)
- 9.4. provide and maintain safe access and working arrangements for the maintenance area
- 9.5. carry out the maintenance activities using appropriate techniques and procedures
- 9.6. re-connect and return the system to service on completion of activities
- 9.7. dispose of waste items in a safe and environmentally acceptable manner and leave the work area in a safe condition
- 10. Carry out maintenance activities on three of the following types of instrumentation and control equipment:
 - 10.1. pressure (such as absolute, gauge, vacuum)
 - 10.2. flow (such as orifice plate, venturi tube, electromagnetic, ultrasonic, differential pressure cell, positive displacement)
 - 10.3. level (such as floats, displacer, differential pressure cells, load cells, ultrasonic, conductivity)
 - 10.4. temperature (such as bi-metallic, thermocouples, resistance, infra-red, thermal imaging)
 - 10.5. weight (such as mechanical systems, load cells/strain gauges, transducers)
 - 10.6. fiscal metering (such as gas, electricity, water, fuel)
 - 10.7. detection and alarm (such as smoke, heat, gas, chemical, water, metal)
 - 10.8. speed measurement (such as mechanical, electrical, stroboscopic)
 - 10.9. emergency shutdown
 - 10.10. speed control (such as mechanical governors, electrical governors, DC speed controller, AC motor control systems, stepper motors, invertors)
 - 10.11. vibration monitoring (such as vibration switches, proximity probes, seismic velocity transducer, linear variable differential transformers, portable data collectors)
 - 10.12. nucleonic and radiation (such as Geiger-Muller tube, neutron counter, photomultiplier tube, proportional counter)
 - 10.13. analysers (such as gas detection, spectroscopy, oxygen analyser, water analysis, moisture measurement, density)
 - 10.14. recorders and indicators
 - 10.15. telemetry systems (such as master station, outstation, stand alone systems)
 - 10.16. valves and valve mechanisms (such as control valves, valve actuators and positioners)
 - 10.17. other specific instrumentation
- 11. Carry out ten of the following maintenance activities, as appropriate to the equipment being maintained:
 - 11.1. disconnecting electrical/pneumatic supply
 - 11.2. replacing mechanical components

SEMEM4-44

Carrying out maintenance activities on instrumentation and control equipment

- 11.3. disconnecting signal transmission
- 11.4. replacing electrical components
- 11.5. disconnecting process pipework
- 11.6. replacing complete instruments
- 11.7. removing instruments from the system
- 11.8. tightening fastenings to the required torque
- 11.9. replacing peripherals (such as sensors, actuators, relays, switches)
- 11.10. replacing 'lived' items (such as seals, gaskets, batteries)
- 11.11. proof marking/labelling of removed wires or components
- 11.12. taking electrostatic discharge (ESD) precautions when handling components and circuit boards
- 11.13. setting, aligning and adjusting replaced instruments
12. Use four of the following types of test equipment:
 - 12.1. analogue or digital meters
 - 12.2. oscilloscope
 - 12.3. signal sources/generator
 - 12.4. standard test gauges
 - 12.5. current injection devices
 - 12.6. pressure sources
 - 12.7. logic probes
 - 12.8. digital pressure indicators
 - 12.9. signal tracer
 - 12.10. special purpose test equipment
13. Return instruments and systems to service, to include carrying out all of the following:
 - 13.1. connecting up process impulse pipework
 - 13.2. connecting up electrical/pneumatic supply
 - 13.3. connecting up signal transmission (such as electrical, electronic, pneumatic, mechanical)
 - 13.4. confirming that signal measurement and transmission are satisfactory
 - 13.5. final re-commissioning of the system and removal of any trip defeats
14. Maintain equipment which complies with three of the following:
 - 14.1. organisational guidelines and procedures
 - 14.2. equipment manufacturer's operating specification/range
 - 14.3. British, European or International standards or directives
 - 14.4. recognised compliance agency/body standards or directives
 - 14.5. health, safety and environmental requirements
 - 14.6. customer standards and requirements
15. Complete the relevant maintenance documentation to include one from the following:
 - 15.1. job cards
 - 15.2. permit to work/formal risk assessment and/or sign-on/off procedures
 - 15.3. maintenance log or report
 - 15.4. company-specific recording system

SEMEM4-44

Carrying out maintenance activities on instrumentation and control equipment

SEMEM4-44

Carrying out maintenance activities on instrumentation and control equipment

Developed by SEMTA

Version number 1

Date approved February 2013

Indicative review date February 2016

Validity Current

Status Original

Originating organisation SEMTA

Original URN SEMEM4-44

Relevant occupations Corporate managers and senior officials; Engineering and Manufacturing technologies; Engineering; Functional managers

Suite Engineering and Manufacture Suite 4

Key words Engineering; leading; design; process; maintenance; quality; customer; function; features; objectives; manufacturing; installation; commissioning; testing; carrying out; problems; specifications; quality; research; evaluate; instrumentation; control; equipment