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*The Voice of the European Fluid Power Industry*

# *EDUCATION RECOMMENDATIONS*

★**PNEUMATICS PROGRAMME P2**

**CETOP Passport Occupational Level 2**



***RE 2025/01.01 - P2***

# *PNEUMATICS PROGRAMME (P2):*
# *RE 2025/01.01 - P2*
# *CETOP (Passport) Occupational Level 2*

## *INTRODUCTION*

This is a LEVEL 2 Pneumatics (P2) Programme, forming the start of a series of competence-based qualifications designed around CETOP occupational levels.

It combines the necessary knowledge and competence based skills for those people on route to a higher level qualification at level 3, involving the maintenance and management of pneumatic systems.

*Note: In all cases, each programme represents a "stand-alone" qualification but can also be a progressive route to a higher level.*

## *CETOP OCCUPATIONAL LEVELS*

LEVEL (2) This person will perform a variety of activities needing some understanding of the technical factors involved. The activities may require the interpretation and application of varied and non-routine specifications. Activities will involve the use of simple diagnostic checks and ability to make a positive response to deviations. Co-operation with others in team or work groups may be required.

Throughout the programme, emphasis will be placed upon the development of knowledge relating to "FUNCTION", "OPERATION" and "APPLICATION".

The knowledge-based section will support the development and effective application of Practical Skills necessary to carry out in a safe and effective manner that of:

- INSTALLATION
- COMMISSIONING
- PERFORMANCE TESTING
- PREDICTIVE MAINTENANCE AND MACHINE MANAGEMENT
- SERVICING
- COMPONENT REMOVAL AND EPLACEMENT

The development of Planning and Preparatory Skills, the use of technical information and specifications and the formulation and implementation of safe working procedures will be emphasized throughout all aspects of this programme.

## *METHODOLOGY AND ASSESSMENT*

The programme can be offered via a range of learning modes devised by the Approved Centres but it is envisaged that distance learning support- ed by a series of centre-based modules will be the normal system used.

Candidates will be expected to complete a series of assignments throughout the programme of study to reinforce the learning process and
attend the programme of centre-based modules.

Final assessment for the knowledge-- based units will be by means of a written examination of 2 hours duration. These will be prepared and offered at approved centres or at an engaged external examination centre. The pass mark for the written examination will be 60%.

The expected completion time for this competence based programme is 1–2 years and will require a high level of personal commitment to study and research the subjects within the syllabus.

Practical task preparation and competence based unit assessment will be carried out by arrangement with the approved centre during the year. Final assessment will be carried out on a "one to one" basis or in groups, candidate to tutor, and the outcome will be pass or fail.

Successful completion of both the knowledge based and competence based units will result in the award of a CETOP Level 2 Pneumatics Qualification Certificate (P2). Candidates successfully completing only one unit will receive a CETOP Unit Certificate.

## *PRACTICAL TASK ASSESSMENT (P2)*

***Assessment Requirements***
In practical tasks, candidates must on at least two occasions, prove their ability to carry out the following:

***Assessed Ability***
P 2.1 Interpret pneumatic/Electro- Pneumatic circuit diagrams.

P 2.1.1 Components correctly identified.
P 2.1.2 Application of components identified.
P 2.1.3 Operation of pneumatic/Electro-Pneumatic system relating to control input and machines output identified.

***Assessed Ability***
P 2.2 Design pneumatic/Electro-Pneumatic systems from given information.

***Evidence Required***
P 2.2.1 Appropriate components selected and adjusted as necessary.
P 2.2.2 System assembled in safe and efficient.
P2.2.3 Start-up and commissioning procedures correctly specified and followed.
P 2.2.4 System operates according to requirements.
P 2.2.5 Safe working practice and statutory regulations followed at all times.

***Assessed Ability***
P 2.3 Identify and rectify faults in pneumatic/ Electro-Pneumatic systems.

***Evidence Required***
P 2.3.1 Nature of faults correctly identified.
P2.3.2 Fault finding check list prepared.
P 2.3.3 Diagnostics used to locate fault, ensuring safety at all stages.
P 2.3.4 Machine/system shut down safely in correct sequence as necessary.
P 2.3.5 Faulty component repaired/replaced/ adjusted as necessary.
P 2.3.6 Cause and effect of faults accurately assessed.
P 2.3.7 Machine/system re-commissioned in accordance with set procedures.
P 2.3.8 Machine/system operates according to requirements.
P 2.3.9 Safe working practice and statutory regulations followed at all times.

***Assessed Ability***
P 2.4 Carry out routine maintenance on pneumatic/Electro-Pneumatic systems.

***Evidence Required***
P2.4.1 Service/maintenance requirements, establish schedule.
P2.4.2 Service/maintenance undertaken as per schedule, in safe and efficient manner.
P2.4.3 Faulty component, replaced, adjusted or repaired in line with planned procedures.
P2.4.4 System tested after maintenance to ensure efficient working.
P2.4.5 Safe working practice and statutory regulations followed at all times.

## *KNOWLEDGE BASED UNIT (P2)*

## *CONTENTS*

P 2.5.1 Fundamental and Scientific Principles.
P 2.5.2 Application of Fundamental Principles.
P 2.5.3 Compressed Air Installations.
P2.5.4 Legal Regulations (The Pressure Systems Safety Regulations).
P 2.5.5 Pneumatic Circuit Components.
P 2.5.6 Fundamental Electrical Principles.
P 2.5.7 Electro-Pneumatic Circuit Components.
P 2.5.8 Hydro-Pneumatic Components.
P 2.5.9 Pipe-work and Connectors.
P 2.5.10 Seals.
P 2.5.11 Circuit and Control Features (Recognition and use of pneumatic and electrical component symbols).
P 2.5.12 Emergency Fail-safe and Safety Systems.
P 2.5.13 Installation and Commissioning Procedures.
P 2.5.14 Maintenance, Monitoring and Fault Finding Procedures.

## *KNOWLEDGE BASED UNIT – WRITTEN EXAMINATION SPECIFICATION*

The examination paper will contain 8 questions from the 14 sections.

- Examination duration of a minimum of 2 consecutive hours
- Candidates will be expected to attempt 5 questions
- Each question will have equal weighting (20%)
- Questions may be single subject or integrated
- Pass mark will be 60%

Where calculations and formulae are involved, all progressive stages of the calculation together with the corresponding units must be shown.

## *PNEUMATICS - (Knowledge Based Unit)*

### *P2.5.1 Fundamental and Scientific Principles*

Describe the fundamental principles of power transmission by pneumatics and associated scientific principles underlying their use.

a) List the basic components and describe their function:
- prime movers, compressor, coolers, air receiver, dryers and pipe-work

b) Know the quantities and units:
- pressure, force, area, air consumption, flow rate, speed/velocity, torque and power

c) Know the formulae relating to:
- pressure, force, area, air consumption, flow rate, speed/velocity, torque and power

d) State and use the relationship between:
- pressure, force and area

e) List the advantages and disadvantages of pneumatic systems compared to:
- mechanical systems
- electrical systems
- hydraulic systems

### *P2.5.2 Application of the Fundamental Principles*

Describe the application of the fundamental principles relating to:

a) Relationship between flow rate, pressure drop, pipe size and length

b) Control of Pressure
- distinguish between gauge pressure and absolute pressure
- compression ratio
- pressure relief
- pressure reduction

c) Control of Flow
- directional
- soft start/dump
- flow control, bi-directional
- flow control with by-pass
- non-return

d) Control of movement
- speed
- stopping or preventing movement
- changing direction

### *P2.5.3 Compressed Air Installations*

Describe compressed air installations.

a) draw a typical compressed air installation system block diagram showing the relative position of the following components:
- compressors
- coolers
- air receiver
- relief valves
- dryers
- filters
- water traps
- service units

b) state the function of the components listed in a) above

c) describe air compressor systems:
- list air compressor types in common use: reciprocating, rotary and axial types – single and multistage
- list the factors influencing the choice of compressor type for a particular compressed air installation

d) describe the need for drying compressed air
- the purpose of drying
- differences in principle of absorption, absorption and low temperature drying methods

e) describe the layout and installation of pipe-work for main line systems
- state the requirements for pipeline gradient (fall) and method of support
- distinguish between dead-end and ring main systems, state the advantages of each system
- sketch typical methods of tapping air lines for power supplies and for draining

f) state the function of the airline components
- shut off valve
- soft start/dump valve
- filter
- pressure regulator
- pressure gauge
- lubricator

### *P2.5.4 Legal Regulations (The Pressure Systems Safety Regulations)*

State the legal regulations for pressure systems (The Pressure Systems Safety Regulations, PED)

***P2.5.5 Pneumatic Circuit Components***

Describe pneumatic circuit components.

a) air cylinders, motors and semi-rotary actuators
- state that air cylinders and motors convert fluid energy into work
- calculate the static force developed by an air cylinder, state the effect of the piston rod on the force developed
- state the need to increase theoretical static force by a minimum of 30% for dynamic applications
- list the factors that affect piston speed
- state the difficulties associated with slow speed control of an air cylinder
- identify the main features and state typical applications of the following types of cylinder
    - single-acting
    - double-acting
    - diaphragm
    - rod-less
    - non-rotating
- state the main reasons for the following special features in cylinders
    - cushioning
    - magnetic piston
    - piston rod locking mechanisms
    - piston rod guidance and anti-rotation
- identify the main features and state typical applications of rotary air motors and semi-rotary actuators

b) vacuum components
- vacuum generators
- suction cups
- holding valves

c) control valves
- identify the need in a circuit for directional control, soft start/dump, flow regulation, non-return, shuttle and proof of position valves
- identify the main features of 2/2, 3/2, 4/2, 5/2, 3/3, 4/3, 5/3 spool and poppet valves
- identify the different methods of valve actuation
    - manual
    - mechanical
    - electrical
    - pneumatic
- distinguish between the centre condition of three position valves
    - all ports closed
    - service ports open to exhaust
    - service ports open to supply ports
- identify unidirectional and bi-directional flow restrictors
- outline how logic functions NOT, AND, OR are achieved using
    - conventional valves
    - moving part logic valves
- state the principle and purpose of silencers and reclassifiers
- state the functions of a reservoir in the circuit
- state the function of 'blocking' and 'unloading' valves

***P2.5.6 Fundamental Electrical Principles***

Describe the fundamental principles and control, applicable to the use and application of electrical/electronic technology:

- state and use the relationship between voltage, current value, resistance and power
- state the relationship between movement, magnetism and current
- meaning of the term inductance and its effect upon DC circuits
- meaning of the term capacitance and its effect upon DC circuits
- meaning of the terms amplitude, frequency, periodic time and RMS
- define the terms digital and analogue associated with control systems
- describe the fundamental principles of open and closed loop control

***P2.5.7 Electro-Pneumatic Components***

a) state the function of the listed components
- solenoids
    - types of solenoid
    - switching ('ac' and 'dc')
    - direct acting
    - solenoid pilot operated
    - manual override
    - intrinsically safe
    - explosion proof
- reed switches
- proximity sensors
- micro switches
- pressure switches
- light sensitive devices
- relays
- stepping relays

***P2.5.8 Hydro-pneumatic Components***

a) list the uses of hydro-pneumatic components
- air/oil cylinders
- intensifiers
- hydro-checks

b) state the advantages of hydro-pneumatic systems

***P2.5.9 Pipe-work and Connectors***

a) distinguish between types of pipes and hoses

b) identify couplings and connectors for components listed in a)

c) state materials of construction of pipes and hoses and give examples of their application

***P2.5.10 Seals***

a) identify static and dynamic seals installation procedures

b) state materials of construction and give examples of their application

***P2.5.11 Circuit and Control Features Recognition and Use of Pneumatic and Electrical Component Symbols)***

a) recognize and use ISO standard graphical pneumatic symbols and IEC standard

b) sketch single cylinder circuit diagrams to control piston movements
- single cycle and reciprocating action using proof of position and pressure operating valves
- dwell control by restrictors/reservoirs and timers
- speed control by flow regulators

c) recognize the numerical system ISO standard by means of identifying valve ports

d) state other methods of identifying ports
- alphabetical

e) state method of specifying cylinder movement by
- ISO standard
- alphabetical method

f) describe multi-cylinder pneumatic circuits (Note: restrict to 3 cylinders only)
- sketch circuit diagrams using proof of position valves as interlocks
- define the terms 'pulsed signal', 'maintained signal', 'trapped signal'
- illustrate methods of avoiding trapped signals
  - cascade system
  - logic step sequencer

g) describe multi-cylinder Electro-pneumatic circuits (Note: restrict to 3 cylinders only)
- sketch circuit diagrams using solenoid valves and reed switches/proximity sensors
- multi-cylinder circuits using relay control

h) sketch circuit diagrams with shuttle, differential pilot and quick exhaust valves

i) describe hydro-pneumatic circuits for
- precision movement control
- pressure intensification
- hydraulic locking

***P2.5.12 Emergency Fail-safe and Safety Systems***

In accordance with the Machinery Directive, describe emergency fail-safe and safety systems.

a) differentiate between 'emergency' and 'fail-safe'

b) outline emergency stop procedures using
- interlocks
- fail-safe systems

***P2.5.13 Installation and Commissioning Procedures***

Describe installation and commissioning procedures to be followed:
- planning work to be done and listing necessary resources
- checking component conformance against technical specification
- following manufacturer's recommendations for installation of a particular component/s
- outline commissioning procedures to be followed, taking into consideration: safety/risk assessment; operational specification; technical specification and start up procedures
- outline the procedures to be followed to ensure that system/components/s operates at a satisfactory level of performance
- outline the procedure to be followed to ensure that the work place is re-established 'fit for purpose'
- completion of all necessary reports/documentation

***P2.5.14 Maintenance, Monitoring and Fault Finding Procedures***

Describe maintenance, monitoring and fault-finding procedure:

a) Outline the maintenance scheme, involving performance and health monitoring in terms of:
- maintaining cleanliness standard
- regular use of diagnostic and test equipment

- analysis of results and actions to be taken (prognosis)
- keeping up to date records and information systems
- establishing safe working practices and step by step procedures when dealing with system breakdowns/component failures/replacement/ re-commissioning start up and testing

b) List the common faults encountered in Electro-Pneumatic systems and associated components and state possible causes and effects on system performance relating to:
- incorrect sequence of operations
- incorrect sensor setting
- low air supply pressure
- air starvation
- incorrect air preparation
- erratic operation
- loads lowering/failure to hold position

c) Describe procedures to follow when carrying out fault finding, in terms of:
- identifying and determining the nature of the fault
- planning stages
- safe working practices to be followed and associated risk assessment
- information necessary to effectively carry out fault diagnosis and rectification process
- application of FAULT-CAUSE-REMEDY procedures
- use of diagnostic equipment and recording results
- procedures to follow to rectify problems (adjustments, replacements, repair and re-commissioning)
- establishing system re-start procedures
- re-establish work place- 'fit for purpose'
- completion of all necessary reports/ documentation.