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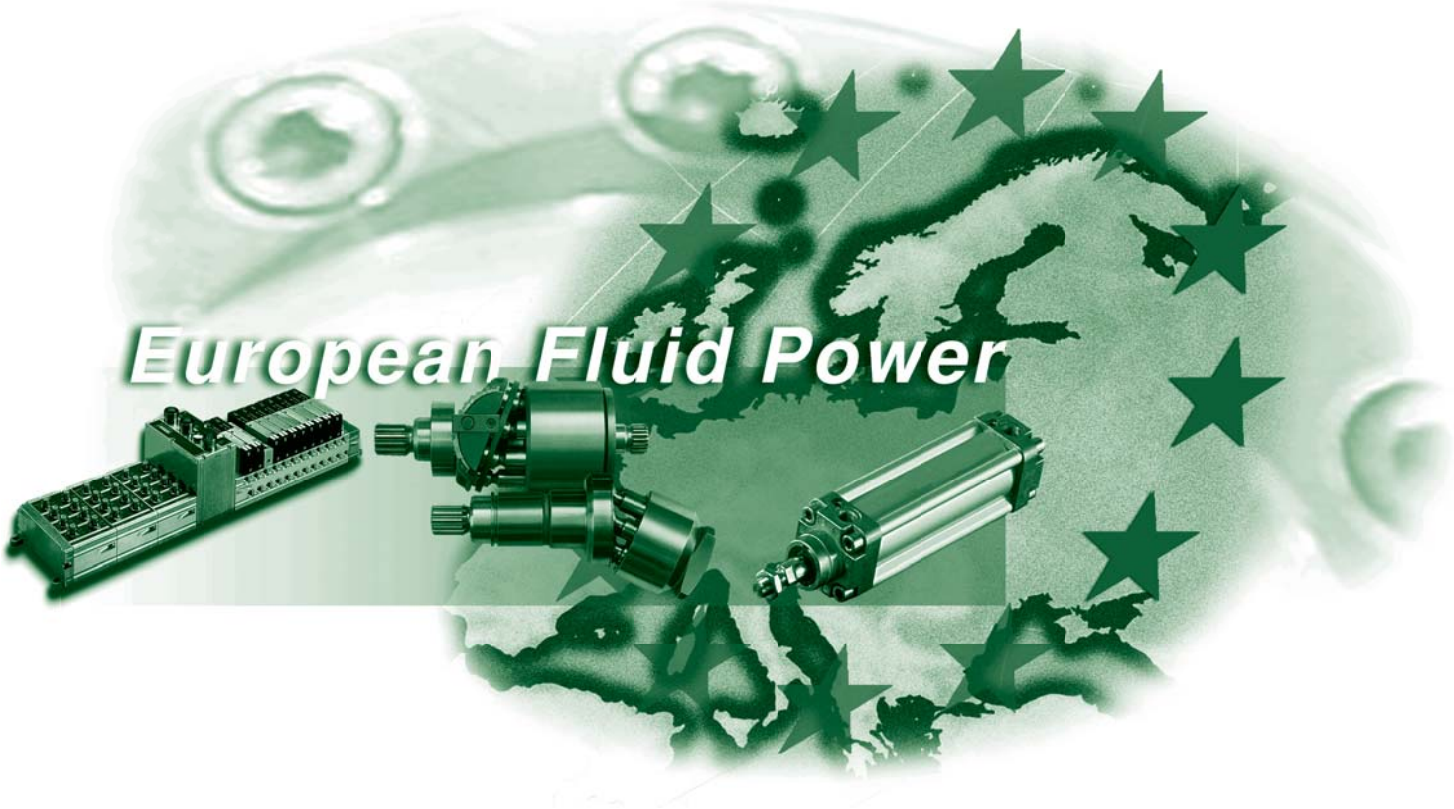
European Fluid Power

Europäisches Komitee Ölhydraulik & Pneumatik · European Oil Hydraulic & Pneumatic Committee · Comité Européen des Transmissions Oléohydrauliques & Pneumatiques

EDUCATION RECOMMENDATIONS



★ ***PNEUMATICS PROGRAMME P3***

CETOP Passport Occupational Level 3

PNEUMATICS & CONTROL PROGRAMME (P3): RE 2015/06.01 - P

CETOP (Passport) Occupational Level 3

INTRODUCTION

This is a LEVEL 3 Pneumatics 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 qualification at level 3, involving the maintenance and management of pneumatic systems.

CETOP OCCUPATIONAL LEVEL 3

LEVEL (3) This person will be involved in a broad and often complex range of activities, often requiring independent decisions to be made on technical matters concerning specifications, resources or processes. Planning of work will be a responsibility, as will the finding and rectification of faults. Responsibility for the quality of work undertaken and the required outcomes are also included.
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 REPLACEMENT

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.

The programme can be offered via a range of learning mode devised by the Approved Centres but it is envisaged that distance learning supported 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 2½ 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 70%.
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

METHODOLOGY AND ASSESSMENT

Evidence Required

Practical task assessments to verify competency against the agreed performance criteria will be

All candidates taking a level 3 qualification should have a minimum of 2 years work based experience involving hydraulics verified by their employer.

Alternative:
Where candidates do not have 2 years work based experience they can undertake the qualification but will not receive the award until they have completed two years of verified employment involving hydraulics.

Successful completion of both the knowledge based and competence based units will result in the award of a CETOP Level 3 Pneumatics & Control Qualification Certificate (P3).
Candidates successfully completing only one unit will receive a CETOP Unit Certificate.

PRACTICAL TASK ASSESSMENT (P3)

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

P 3.1.1 Machine function and operating principles identified
P 3.1.2 Components correctly identified
P 3.1.3 Function and operation of individual sub-circuits correctly identified
P 3.1.4 Machine control inputs and outputs identified

Assessed Ability
P 3.2 Assemble pneumatic/Electro-pneumatic system from given information.

Evidence Required
P 3.2.1 Components selected and conformance checked against system specification
P 3.2.2 Installation/Action plan prepared
P 3.2.3 System assembled in safe and efficient manner and complying with European Directives and safety standards (reference P 3.7.18)
P 3.2.4 Setting up/commissioning procedures followed in accordance with technical specification
P 3.2.5 Start up procedures correctly specified
P 3.2.6 System operated according to specification

Assessed Ability
P 3.3 Construct and commission 'PLC' controlled Electro-pneumatic system from given information.

Evidence Required
P 3.3.1 PLC program correctly designed
P 3.3.2 Components correctly selected for application
P 3.3.3 System assembled in safe and efficient manner
P 3.3.4 Applies monitoring and editing features to correct or modify the program as necessary
P 3.3.5 System operated according to specification

Assessed Ability
P 3.4 Identify and rectify faults in pneumatic/ Electro-pneumatic systems.

Evidence Required
P 3.4.1 Malfunction correctly identified
P 3.4.2 Correct procedures used for fault finding
P 3.4.3 Systems correctly and safely isolated
P 3.4.4 Faulty component(s) correctly identified, repaired/replaced and correctly adjusted as necessary
P 3.4.5 Cause and effect correctly assessed

Assessed Ability
P 3.5 Establish documented procedures and carry out preventative maintenance and monitoring of pneumatic/
Electro-pneumatic systems.

Evidence Required
P 3.5.1 System assessed to determine service/ maintenance schedule requirements
P 3.5.2 System assessed to determine routine monitoring requirements
P 3.5.3 Documented system established including safety requirements/risk assessment
P3.5.4 Performance testing carried out and results recorded
P3.5.5 Pneumatic and electrical input/output signals checked and recorded
P3.5.6 Manufacturers recommendations and specifications checked against results
P3.5.7 Safe working practices followed at all Times

Assessed Ability

P 3.6 Identify and apply relevant regulations for the safe installation and operation of Pneumatic/Electro-pneumatic circuits.

Evidence Required

P 3.6.1 Legal Regulations: Machinery Directive (EU), EMC, ATEX.
P 3.6.2 List basic safety principle sand components
P 3.6.3 Safety related parts of power and control systems.

Note: Preparation for practical task assessment can be a group activity or it could be carried out on a "one to one" basis or in groups between the candidate and the assessor. Evidence will be obtained by non-intrusive observation, questioning or written and verbal reports.

KNOWLEDGE BASED UNIT (P3)

CONTENTS

Assessed Ability

P 3.7.1 Fundamental and Scientific Principles
P 3.7.2 Application of Fundamental Principles
P 3.7.3 Fundamental Electrical Principles
P 3.7.4 Electrical/ Electronic Components
P 3.7.5 Solenoid Valves
P 3.7.6 Electro-pneumatic Systems
P 3.7.7 Proportional Valve Technology
P 3.7.8 Electrical noice/suppression
P 3.7.9 Pneumatic Control Systems
P 3.7.10 Digital Control Circuits
P 3.7.11 Relay Ladder Circuit Diagram
P 3.7.12 Programmable Logic Controller (PLC)
P 3.7.13 Field Bus Systems
P 3.7.14 Vacuum Technology
P 3.7.15 Systems and Control Features (Recognition and use of pneumatic, Electro-pneumatic, electrical and electronic symbols)
P 3.7.16 Installation and Commissioning Procedures
P 3.7.17 Maintenance, Monitoring and Fault Finding Procedures
P 3.7.18 Safety of Machinery, Pneumatic/Electro-pneumatic equipment used on machines conforming to European Directives & Standards

KNOWLEDGE BASED UNIT - WRITTEN EXAMINATION SPECIFICATION

The examination paper will contain 8 questions integrating the above 18 sections.

Examination duration recommended will be a minimum of 2½ consecutive hours

- Candidates will be expected to attempt 5 questions
- Each question will carry equal marks
- Pass mark will be 70%

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

POWER PNEUMATICS AND CONTROL - (Knowledge Based Unit)

P3.7.1 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.
- Conversion of units

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

P3.7.2 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
- using a P/V diagram, state the relationship between pressure, volume and temperature and work done for isothermal, polytrophic and adiabatic compression of air
- define the term relative humidity and explain the effect it has when air is compressed and when compressed air passes through a system.

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

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

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

P3.7.3 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, 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

P3.7.4 Electrical/Electronic Components

Describe the function and application of electrical/electronic components.

- resistors
- capacitors
- potentiometers
- transformers
- diodes
- switches (two way and three way)
- relays
- proximity and limit switches
- pressure switches
- position sensors

P3.7.5 Solenoid Valves

Describe the function, operating principles, application and mounting arrangements of solenoid operated valves.

a) types of solenoids
- switching (AC and DC)
- proportional

b) solenoid features
- manual override, manual reset
- explosion proof (reference to intrinsically safe)

c) types of valve
- direct operated
- internal pilot operated
- external pilot operated

d) types of solenoid suppression
- AC circuits
- DC circuits

P 3.7.6 Electro-pneumatic Systems

Describe the function, applications and mounting.

- Valve terminal
- Island

P 3.7.7 Proportional Valve Technology

Describe the fundamental principles of proportional valve technology.

a) list its potential applications compared to solenoid switching valve techniques

b) describe the operation of proportional valves
- Pressure Control
- Flow Control

c) describe in block diagram form, the components of a typical proportional valve electronic amplifier and explain the meaning of:
- gain adjustment
- deadband compensation
- ramp controls
- dither
- pulse width modulation

d) explain the recommended practices for installing proportional electronic control in terms of:
- power supply requirements
- enable signals
- input signal generation
- cable shielding
- earthing
- interfacing to PLC's

P 3.7.8 Electrical noice/suppression

a) state the causes and possible effects of electrical noise in electrical/electronic systems and identify the standard precautions for eliminating the effects.
- correct earthing and screening
- correct location of sensitive components
- use of opto-isolators
- use of filters to suppress Electro-magnetic generated noise
- effects of ground loops

b) identify the degrees of ingress protection applied to enclosures ('IP' codes)

P3.7.9 Pneumatic Control Systems

Describe the control methods and applications used to achieve sequential control.

a) Methods
- Cascade
- Pneumatic Logic
- Pneumatic Sequencer

b) Applications
- simple application
- complex application
- 'hazardous area' application

P3.7.10 Digital Control Circuits

Prepare/describe digital control circuit diagrams using graphical symbols for listed circuitry.
- manual control
- automatic control
- sequence control (time-based and feedback)
- automatic control incorporating fail safe techniques (including manual reset)

P3.7.11 Relay Ladder Circuit Diagram

Prepare/describe relay ladder circuit diagrams in-corporating the following terms:

- 'AND', 'OR', 'NOT' and 'MEMORY'
- latching and unlatching

P3.7.12 Programmable Logic Controller (PLC)

Describe the function and operating principles of a Programmable Logic Controller (PLC) in the con- trol of Electro-Pneumatic systems.

a) outline the concept of a PLC

b) list the advantages compared with relay circuits

c) describe typical PLC hardware and give examples of its use relating to:
- an installation with a simple program
- an installation with an enhanced program
- programming devices
- memory systems
- analogue to digital and digital to analogue conversion
- data acquisition
- monitoring

d) describe using block diagrams and symbols a simple PLC controlled Electro-pneumatic system including:
- power supply
- fusing
- coil suppression
- emergency stop switching

e) describe using ladder logic diagrams basic program functions:
- single and multiple 'AND' and 'NAND'
- single and multiple 'OR' and 'NOR'
- single and multiple latching
- timing
- counting
- flags/markers
- shift register
- jumps and loops

f) describe the use of a PLC used to control:
- automatic time based sequence control of two or more actuators
- automatic sequence control of two or more actuators using proof of position feedback

g) describe using block diagrams the following program types:
- alternative (stored in memory simultaneously)
- parallel
- multi-tasking

P3.7.13 Field Bus Systems

Describe the principles and characteristics of Field Bus Systems as applied to control technology:

a) outline the concept of Field Bus Systems

b) identify different methods of transmitting data (protocols)
- Profibus 'DP'
- Device Net
- ASI
- Interbus 'S'
- FIPIO
- CANopen

c) describe typical Field Bus compatible hardware
- valve islands
- valve/sensor return islands
- input/output modules, nodes
- gateways

d) describe the programming concept used with Field Bus Systems

P3.7.14 Vacuum Technology

a) Describe the fundamental and scientific principles relating to vacuum pressure.
Vacuum definition, technical data, thermodynamic topic.
Know the relating to flow rate in relation to vacuum pressure.

b) List of vacuum circuit components and describe their functions.
Vacuum generators: Venturi principle, pumps.
Vacuum actuators: Suction cups (material, shapes, size) modular vacuum grippers.
Specific components adapted for vacuum control (valves, sensors)
Piping of a vacuum circuit (diameter, length, material)

a) Applications
How can vacuum be used ? Describe applications using vacuum technology.

b) Calculation
Force on a vacuum gripper.
Force on a suction cup, friction factor.
Evacuation time, ejector pulse, air saving.
Efficiency of a vacuum generator. Energy cost.

P3.7.15 Circuit and Control Features (Recognition and use of pneumatic, Electro-pneumatic, electrical and electronic symbols)

Describe and interpret Electro-pneumatic circuits and associated methods of control, including handling systems, positioning systems, fail safe methods:

- Recognize and use current graphical pneumatic, Electro-pneumatic, electrical and electronic symbols (IEC and ISO standards)
- Use methods to describe the running: Functional diagram or function chart for sequential process (IEC standard)

P3.7.16 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

P3.7.17 Maintenance, Monitoring and Fault Finding Procedures

Describe maintenance, monitoring and faultfinding procedures:

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

P3.7.18 Safety of Machinery, Pneumatic/ Electro-pneumatic equipment on machines conforming to European Directives and Standards

Describe:

a) Safety requirements for pneumatic systems and components.

- Interpret the essential safety requirements in order to achieve conformity with European Legislation on machinery safety
- Identify and prevent hazards from pneumatic and Electro-pneumatic equipment and give the solutions for
- isolation and purging
- separation of energy sources
- reinstating of energy sources
- general stop
- emergency stop
- manual starting

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

- differentiate between 'emergency' and 'fail-safe'
- outline emergency stop procedures using
- interlocks
- fail-safe systems

c) Risk analysis in accordance with the Machinery Directive

- Compliance with ATEX Directive