BRITISH FLUID POWER ASSOCIATION QUALIFICATIONS

PNEUMATICS (P2)

CETOP (PASSPORT) OCCUPATIONAL LEVEL 2

Issue 2
2003

FOREWORD

Developed by the BFPA Education and Training Committee, this programme represents one of a range of new competence-based qualifications launched in 2001.

They are intended for those personnel involved in the maintenance and management of pneumatic systems and associated controls who require knowledge and competence based skills to support such work based activities as: planning and preparation, interpreting and using technical information, devising and following sound procedures associated with the operation, installation, commissioning, testing, fault diagnosis, rectification, maintenance, servicing and re-establishing a machine "fit for purpose".

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
PROACTIVE 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 emphasised 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 ranging from that of short courses to distance learning and centre based modules. The timescale can also be flexibly managed by the approved centres.

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 via a written examination of 2 hours duration.

This will be prepared by BFPA and offered at approved centres in June each year. (Approved Centres can apply to BFPA to request additional examination dates).

The pass mark for the written examination will be 60%.

The expected completion time for this competence base 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, candidate to tutor, and the outcome will be pass or fail.

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

Reference should be made to the Guideline Document to Qualifications BFPA/Q1 for further details.

Further copies of this document can be obtained from British Fluid Power Association, Cromwell Park, Chipping Norton, Oxon OX7 5SR. Tel: 01608 647900. Fax: 01608 647919.

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

P2.1 Interpret pneumatic/electro-pneumatic circuit diagrams.

Evidence Required

P2.1.1 Components correctly identified.
P2.1.2 Application of components identified.
P2.1.3 Operation of pneumatic/electro-pneumatic system relating to control input and machines output identified.

Assessed Ability

P2.2 Construct pneumatic/electro-pneumatic systems from given information.

Evidence Required

P2.2.1 Appropriate components selected and adjusted as necessary.
P2.2.2 System assembled in safe and efficient.
P2.2.3 Start-up and commissioning procedures correctly specified and followed.
P2.2.4 System operates according to requirements.
P2.2.5 Safe working practice and statutory regulations followed at all times.

Assessed Ability

P2.3 Identify and rectify faults in pneumatic/electro-pneumatic systems.

Evidence Required

P2.3.1 Nature of faults correctly identified.
P2.3.2 Fault finding check list prepared.
P2.3.3 Diagnostics used to locate fault, ensuring safety at all stages.
P2.3.4 Machine/system shut down safely in correct sequence as necessary.
P2.3.5 Faulty component repaired/ replaced/ adjusted as necessary.
P2.3.6 Cause and effect of faults accurately assessed.
P2.3.7 Machine/system re-commissioned in accordance with set procedures.
P2.3.8 Machine/system operates according to requirements.
P2.3.9 Safe working practice and statutory regulations followed at all times.

Assessed Ability

P2.4 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

KNOWLEDGE BASED UNIT - WRITTEN EXAMINATION SPECIFICATION

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

- Examination duration 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:
   i) prime movers, compressor, coolers, air receiver, dryers and pipework

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

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

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

e) List the advantages and disadvantages of pneumatic systems compared to:
   i) mechanical systems
   ii) electrical systems
   iii) 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
   i) compressors
   ii) coolers
   iii) air receiver
   iv) relief valves
   v) dryers
   vi) filters
   vii) water traps
   viii) service units

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

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

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

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

f) state the function of the airline components
   i) shut off valve
   ii) soft start/dump valve
   iii) filter
   iv) pressure regulator
   v) pressure gauge
   vi) lubricator

P2.5.4 Legal Regulations (The Pressure Systems Safety Regulations 2000)

State the legal regulations for pressure systems (The Pressure Systems Safety Regulations 2000)

P2.5.5 Pneumatic Circuit Components

Describe pneumatic circuit components.

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

b) vacuum components
   i) vacuum generators
   ii) suction cups
   iii) holding valves

c) control valves
   i) identify the need in a circuit for directional control, soft start/dump, flow regulation, non-return, shuttle and proof of position valves
   ii) identify the main features of 2/2, 3/2, 4/2, 5/2, 3/3, 4/3, 5/3 spool and poppet valves
   iii) identify the different methods of valve actuation
      A) manual
      B) mechanical
      C) electrical
      D) pneumatic
   iv) distinguish between the centre condition of three position valves
      A) all ports closed
      B) service ports open to exhaust
      C) service ports open to supply ports
   v) identify unidirectional and bidirectional flow restrictors
   vi) outline how logic functions NOT, AND, OR are achieved using
      A) conventional valves
      B) moving part logic valves

vii) state the principle and purpose of silencers and reclassifiers
viii) state the functions of a reservoir in the circuit
ix) 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, 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
  i) solenoids
    A) types of solenoid
    B) switching ('ac' and 'dc')
    C) direct acting
    D) solenoid-pilot operated
    E) manual override
    F) intrinsically safe
    G) explosion proof
  ii) reed switches
  iii) proximity sensors
  iv) micro switches
  v) pressure switches
  vi) light sensitive devices
  vii) relays
  viii) stepping relays

P2.5.8 Hydro-pneumatic Components

a) list the uses of hydro-pneumatic components
  i) air/oil cylinders
  ii) intensifiers
  iii) hydrochecks

b) state the advantages of hydro-pneumatic systems

P2.5.9 Pipework 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) recognise and use ISO1219-1 graphical pneumatic symbols and DIN 40713 (BS3939)

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

c) recognise the numerical system ISO5599/3 and CETOP RP68Prev. means of identifying valve ports

d) state other methods of identifying ports
   i) alphabetical

e) state method of specifying cylinder movement by
   i) ISO1219-2
   ii) alphabetical method

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

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

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

i) describe hydro-pneumatic circuits for
   A) precision movement control
   B) pressure intensification
   C) 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
   i) interlocks
   ii) 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