cetop

The Voice of the European Fluid Power Industry

EDUCATION RECOMMENDATIONS

- ★ *QUALIFICATIONS ASSOCIATED WITH FLUID POWER SYSTEMS*
- ★ *IMPLEMENTATION OF CETOP EDUCATION RECOMMENDATIONS IN EUROPE*
- ★ *CETOP QUALIFICATIONS APPROVED CENTRES GUIDELINE*
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- ★ *HYDRAULICS PROGRAMMES (H1), (H2, MH2, IH2), (H3, MH3, IH3)*
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QUALIFICATIONS
ASSOCIATED WITH FLUID POWER SYSTEMS
RE 2015/06.02- H/P

1. INTRODUCTION

1.1 What is CETOP?

Founded in 1962, CETOP is the European Oil Hydraulics and Pneumatics Committee and represents the National Fluid Power Associations within the seventeen European countries, inturn representing some 1,000 companies throughout Europe.

CETOP supports, promotes and provides aid to the fluid power industry and prepares standards and guidelines in co-operation with the technical committees of ISO (International Organization for Standardization), CEN (European Committee of Standardization) and the various National Standards Organizations.

More detailed information may be obtained by visiting the CETOP web-site at www.cetop.org.

1.2 Education and Training Proposal and Harmonization initiative for Europe

With the ever-growing need throughout Europe and the world for a COMPETENT, WELL EDUCATED WORKFORCE, able to maintain and manage fluid power systems; CETOP have developed a programme that harmonies to the qualifications of such a workforce.

1.3 The Aim

The aim is to develop an acceptable and agreed structure of "Competence Based Qualifications" reflecting the needs of those people who fall into the categories covered by OCCUPATIONAL LEVELS 1, 2 and 3 (see 2.1). Such a structure will reflect the needs of those people in employment or being prepared for a particular level of employment.

1.4 What are COMPETENCE BASED QUALIFICATIONS?

Historically, many people have achieved a qualification that represents a "level of academic attainment" and does not always relate to that person's ability to apply their knowledge to a "real life situation".
The real life skills associated with Maintenance and Management of fluid power systems are work related and are as follows:

- PLANNING AND PREPARING
- INSTALLING
- COMMISSIONING
- TESTING
- MAINTAINING
- FAULT DIAGNOSIS AND RECTIFICATION
- REMOVAL AND REPLACEMENT
- DISMANTLING AND REASSEMBLING

To carry out these tasks at the various "occupational levels" and achieve a level of performance and repeatability within a given time will require that person to be COMPETENT.

A "Competence Based Qualification" will therefore consist of a combination of both knowledge and application of the knowledge, supported by practical experience in the workplace.

1.5 OCCUPATIONAL LEVELS - VS KNOWLEDGE BASED/COMPETENCE BASED PROGRAMMES OF STUDY TO MEET THE OCCUPATIONAL NEEDS

The following provides an example to enable the reader to clearly see the difference in knowledge based levels under consideration.

A relief valve is used as the example and this ANOLOGY outlines the difference in knowledge requirements at the various levels and clearly indicates where training and experience plays its part.

RELIEF VALVE

At Level 1- the candidate needs to know what a relief valve is, what it does and why. (Basic Function.)

At Level 2 - the candidate needs to know in addition to the above, how the relief works. (Function and Operation.)

At Level 3 - the candidate also needs to know the different applications that a relief valve can be used for (unloading, proportional control) and what can go wrong. (Function, Operation, Application and Technical Specification.)

From base level to Level 1 requires only education and training, work-based activities will be repetitive, following established procedures and requires very little experience and knowledge of other areas.

From Level 1 to Level 2 requires education and training with an acquired level of competency allied to experience to meet Level 2 Occupational requirements.

From Level 2 to Level 3, a greater depth and breadth of knowledge is required compared to level 2, with a knowledge of other subject areas complementary to fluid power. At level 3, the competence-based skills should clearly reflect a level of experience able to deal with the broader and more complex range of activities required to fulfil this occupational level.

2. COMPETENCE IN FLUID POWER SYSTEMS

2.1 OCCUPATIONAL LEVELS

LEVEL 1	This person will perform activities that follow an established procedure. Activities will be recurring and of a short term nature. The reaction to most problems will be to summon help or follow a predefined set of actions.
LEVEL 2	This person will perform a variety of activities and needs 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.
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.

2.2 Knowledge based and competence based skills

	KB	CB	KB	CB	KB	CB	
COMPONENTS	L1		L2		L3		
• types	●		●		●		
• construction			●		●		
• function	●		●		●		
• operation			●		●		
• application			●		●		
• performance/characteristics			●		●		
• selection/recommendations			●	●	●	●	
• sizing			●	●	●	●	
• mounting/interface			●	●	●	●	
• control systems/interface	●		●		●		WSD
• installation	●	●	●	●	●	●	
• commissioning/setting up	●	●	●	●	●	●	WSD
• malfunction and effects	●		●		●		
• testing			●	●	●	●	WSD
• fault diagnosis			●	●	●	●	
• removal and replacement	●	●	●	●	●	●	
• dismantle			●	●	●	●	
• re-assemble			●	●	●	●	
• contamination tolerance/awareness	●		●		●		
• technical data			●		●		
• use of formulae/calculations			●		●		
• system design/compatibility					●		
• safety precautions/features	●		●		●		
• risk assessment/use			●		●	●	
• physical attributes (noise etc.)	●		●		●		
• legislation/directives/standards			●		●		

KNOWLEDGE BASED = KB · COMPETENCE BASED = CB · WITHIN THE SCOPE OF THEIR DUTIES = WSD

NOTE- although the O may appear in a number of levels, the breadth and depth of the subjects differ from level to level

	KB	CB	KB	CB	KB	CB	
SYSTEMS	***L1***		***L2***		***L3***		
• planning- projects/actions					●	●	
• technical data/specifications			●	●	●	●	
• circuit diagrams	●		●	●	●	●	WSD
• control systems/options			●		●		
• control system interfaces			●		●		
• configuration	●		●		●		
• operation	●		●		●		
• application	●		●		●		
• installation (parts and whole)			●	●	●	●	
• commissioning			●		●	●	
• modifications						●	
• recommendations for improvement			●		●		
• health monitoring (con: monitoring)			●	●	●	●	
• performance monitoring (ditto) (procedures and use of diagnostics)			●	●	●	●	
• interpretation of results					●		
• routine maintenance	●	●	●	●	●	●	
• proactive/predictive maintenance			●	●	●	●	
• contamination management/control	●		●	●	●	●	WSD
• fault diagnosis			●	●	●	●	
• fault rectification			●	●	●	●	
• fault-cause analysis	●		●		●	●	WSD
• corrective actions			●	●	●	●	
• safe working procedures	●	●	●	●	●	●	
• re-commissioning procedures			●	●	●	●	
• hydraulic and compressed air fluid (management/selection)	●		●	●	●	●	
• risk management					●	●	
• legislation/directives/standards			●		●		

KNOWLEDGE BASED = KB · COMPETENCE BASED = CB · WITHIN THE SCOPE OF THEIR DUTIES = WSD

NOTE- although the O may appear in a number of levels, the breadth and depth of the subjects differ from level to level

	KB	CB	KB	CB	KB	CB	
CORE SKILLS/Knowledge	***L1***		***L2***		***L3***		
• fundamental PRINCIPLES	●		●		●		
• use of formulae and calculations			●		●		
• technical report writing			●	●	●	●	WSD
• communications	●	●	●	●	●	●	WSD
• information technology	●	●	●	●	●	●	WSD
• presentation skills					●	●	
• planning skills	●	●	●	●	●	●	WSD
• preparing procedures/work instructions					●	●	
• reading and interpretation technical data/ circuit diagrams	●	●	●	●	●	●	WSD
• translation of information			●	●	●	●	WSD
• analysis of facts	●		●		●		
• organizational management	●		●		●		
• quality management	●		●		●		
• safety management	●		●		●		
• power and motion control interfaces	●		●		●		WSD

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NOTE- although the O may appear in a number of levels, the breadth and depth of the subjects differ from level to level

2.3 TECHNICAL TERMS USED Relating to COMPONENTS

Type	Different components used within a system, e.g. gear pumps, vane pumps, piston pumps, screw compressor, vane compressor, lubricators, dryers, coolers etc.
Construction	Individual design attributes, e.g. a pump may have a splined shaft, a relief valve may be sub-plate mounted, compressors fully packaged, cushioned cylinders
Function	Purpose or specific activity, e.g. the function of a relief valve is to limit the pressure to a particular level, 3port-2position valve to operate single acting cylinder.
Operation	Specific performance, e.g. a relief valve poppet lifts off its seat when the system pressure creates a force upwards, greater than that of the downward force of the opposing spring.
Application	Relates to the function of a component within a circuit or system, e.g. a pressure reducing valve may be used to specifically limit the pushing force on a small press cylinder.
Performance/ characteristic	Refers to the dynamic operation of a component, e.g. pressure override of a pressure control valve, slippage rate of a pump, pressure drop across a proportional directional control valve. FAD for a compressor, pressure drop in pipes.
Selection/ recommendation	Types and choice available and why a particular component would be selected in preference to another.
Sizing	Relating to range and capacity, e.g. flow and pressure range to meet a specific requirement.
Mounting/interface	Refers to ISO/NG/CETOP/SAE, pipe mounted, flange mounted, screw in, etc.
Control System/ Interface	Pilot operation solenoid operation, 'on-off' or interface proportional, digital or analogue, solenoid/pilot, detent.
Installation	Procedures to be followed when fitting a component into a system or part of a system, new or replacement.
Commissioning /setting up	Procedures to follow to meet a required performance specification, e.g. setting up of a compensator on a pump to 150 bar. Speed of a cylinder and cushioning
Malfunction and effects	Refers to deviation in performance, possible causes and the effect on the system.
Testing	Checking the settings of a component meet a specific performance (involving diagnostic equipment).
Fault diagnosis	Following procedures to identify a fault against specific symptoms, evaluation of the facts to identify a cause and implementation of a solution to rectify and pre-vent a re-occurrence.
Removal/ replacement	Procedures to be followed, including safe working practices and the correct use of tools and equipment. Compliance with all specifications and manufacturer recommendations.
Dismantle	Procedures to be followed, including the correct use of tools and equipment, following safe working practices and compliance with manufactures recommendations and specifications.

Re-assemble	Procedures to be followed, including the correct use of tools and equipment, following safe working practices and compliance with manufactures recommendations and specifications.
Contamination tolerance/ awareness	Refers to manufacturers cleanliness recommendations for components to effectively perform, plus knowledge of target cleanliness levels and methods of achieving and maintaining them.
Technical data	Refers to manufacturers catalogue information and recommendations specific to a particular component.
Use of formulae/ calculations	Refers to fundamental formulae to determine information specific to component size, performance, flow rate, pressure drop, etc.
System design/ compatibility	Refers to a component's performance characteristics, size, construction, etc. to meet a system specification in conjunction with other components.
Safety precautions/ features	Refers to specific component safety features and/or the safety precautions to be taken when a particular component becomes part of a system.
Risk assessment/use	Refers to the investigation of a component within a system to identify any possible safety hazards during use and the necessary recommendations/precautions to be implemented.
Physical attributes	Refers to noise, heat generation, vibration (belonging to or caused by).
Legislation/ directives/ standards	European Standards, ISO Standards, Health & Safety requirements and directives, Machinery Directive. Specific links to component application in a particular system.

TECHNICAL TERMS USED Relating to SYSTEMS

Planning - projects/ actions	Preparing a documented plan of actions relating to a specific task involving: • Procurement • Compliance • Staffi ng/resourcing • Time-based action plan • Review/ evaluation • Installation/commissioning • Hand-over/declaration of conformance
Technical data/ specification	Use of manufacturers catalogues and data sheets with reference to recommendations for 'setting up', installation and testing.
Circuit diagrams	Symbolic representation of components and systems to meet the required ISO specification.
Control systems/ options	Open and closed loop (continuous and discontinuous), digital and/or analogue options, pump control system options.
Control system Interfaces	Digital and analogue systems (use of PLC's and bus systems, pilot control).
Configuration	Open systems, closed hydrostatic transmission system. (List of specific circuits relating to a particular application).
Operation	Specific performance at system level (involving a number of components).
Application	Specific system function (operational specification).

Installation	Procedures to be followed when configuring a system from individual components (involving planning and preparation).
Commissioning	Preparing a system for 'active duty', setting up of the component parts to meet a performance specification.
Modification	Procedures to be followed when alterations are made to a system for example, the need to update technical documentation and the performance specification to ensure that any modifications are in compliance with the manufacturers specification and all requirements to health and safety.
Recommendations for improvement	Reports relating to system improvements specific to a particular aspect of its performance, maintenance safety and operational management.
Health (condition) Monitoring	Procedures set up to determine system and component performance that meets the operation of the specification with reference to: • Fluid condition to meet target cleanliness levels • Noise and vibration • Temperature • General leakage • Documentation & report
Performance Monitoring	Procedures set up to determine that system and component performance meets the required operation specification with reference to: • Pumps – Q/P testing • Actuator speeds • Operational pressures • Documentation & report
Interpretation of results	Referring to health and performance monitoring, translating results into an action plan with clear 'outcome objectives' as part of the proactive maintenance programme.
Routine maintenance	Maintenance activities that are time based – daily, weekly, monthly etc. and follow a 'set checklist' approach.
Pro-active/predictive maintenance	Maintenance activities carried out as part of a plan for continued improvement and/or relating to specific condition monitoring.
Contamination management/ control	Refers to that of maintaining cleanliness levels that meet the TARGET CLEANLINESS LEVEL and ensuring that procedures are in place to achieve and maintain this at all times. Where a non-compliance is identified, procedures should be in place to enable remedial action to be taken and cause to be evaluated.
Fault diagnosis	Procedures to be followed, to effectively diagnose a fault within a system.
Fault rectification	Procedures to be followed, to effectively rectify a fault with a system and to re-establish the system to a fully operational status.
Fault-Cause-Analysis	Management procedures in place to investigate the cause of a fault and the necessary steps to implement preventative measures against a re-occurrence.
Corrective actions	A report outlining actions to be taken to overcome and prevent the re-occurrence of a fault or that of fault prevention identified as part of the programme for continued improvement.
Re-commissioning Procedures	Plan of action inline with manufacturers recommendations and operational/ technical specifications for the system to become fully operational.
Fluid Management/ Selection and Treatment	Refers to control procedures relating to: • Oil procurement, storage, transportation, filling and dispensing systems whilst in use in the machine to final disposal with regard to all aspects of health and safety. • Compressed air, contaminants and purity classes with regard to all aspects.
Risk	Refers to the investigation of a system by a competent person to identify any possible hazards during use and the necessary recommendations/precautions to be implemented to prevent danger to all
Legislation/ directives/standards	European Standards, ISO Standards, Health & Safety requirements and directives, Machinery Directive. Specific links to systems and their application.

IMPLEMENTATION OF CETOP EDUCATION RECOMMENDATIONS IN EUROPE CETOP RE 2015/06.02 - H/P

1. THE OUTCOME

This initiative will enable employers to identify the levels of competence, skills and knowledge achieved by a person holding a CETOP Qualification and will provide a greater guarantee of quality assurance throughout.

The proposal is for CETOP Qualifications to become the “bench mark” for fluid power education and training throughout Europe; whilst at the same time providing greater opportunities for employment and skills transfer within Europe.

2. HOW WILL THIS BE MANAGED?

The responsibility to implement and manage this harmonization programme will be that of the individual CETOP ASSOCIATION MEMBERS.

It is recommended that each member works closely with the various education and training organizations within their respective countries to ensure that all aspects of scheme quality assurance, validation and verification are maintained against CETOP RECOMMENDATIONS.

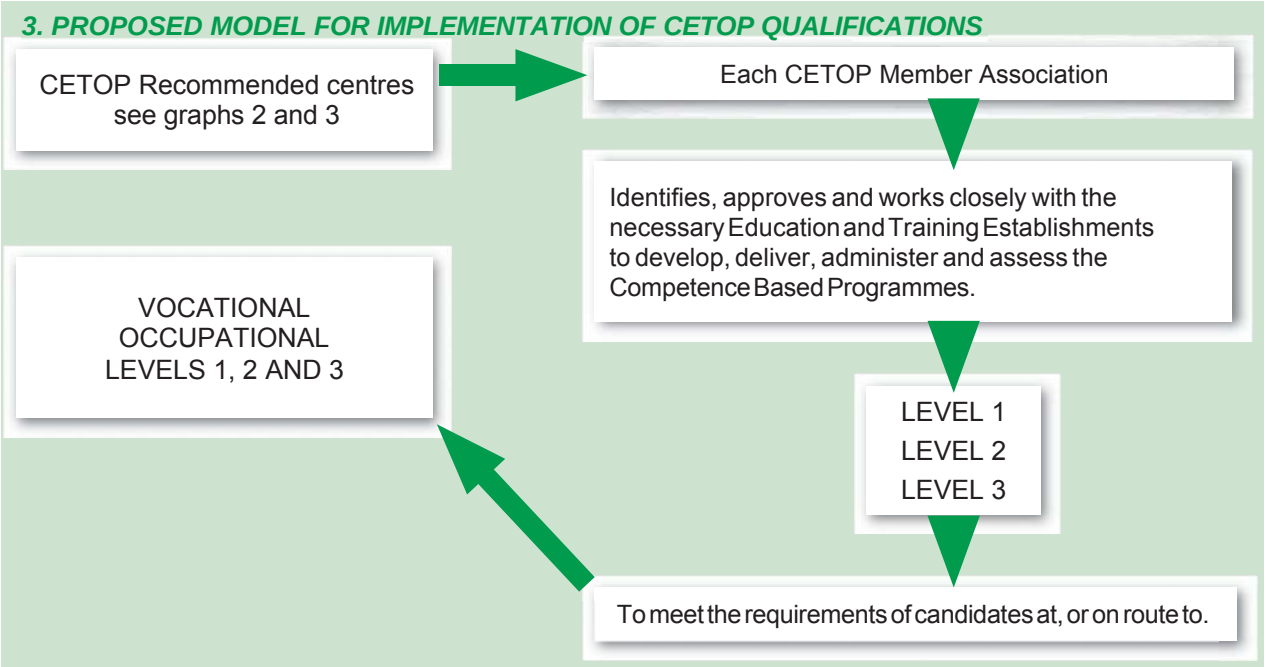
This guideline provides recommendations for achieving CETOP Qualifications including an explanation of competence based qualifications and the methodology associated with their acquisition.

The intention is for each CETOP ASSOCIATION MEMBER to achieve within their own educational systems the required outcomes, giving each organization total flexibility and freedom to develop and implement the necessary routes for achievement.

Association members will also be responsible for recommending and endorsing training organizations to deliver this proposal and assist through their member companies in providing and supporting the necessary resource.

Each CETOP ASSOCIATION MEMBER will award the necessary certificates recognizing an “individual’s level of achievement”.

3. PROPOSED MODEL FOR IMPLEMENTATION OF CETOP QUALIFICATIONS



Note: CETOP fully support and encourage practical work based assessments assuming all necessary evidence criteria can be met.

The certificate will then be endorsed by a clear indication of the respective CETOP QUALIFICATION LEVEL achieved. This certificate will then represent a recognized qualification throughout Europe.

4. INDIVIDUAL RECORDS OF ACHIEVEMENT

Through their period of study and acquisition of competence based skills, all candidates will be expected to maintain their own individual RECORDS OF ACHIEVEMENT. This should form a portfolio of evidence covering both knowledge and competence based skills achieved, appertaining to their particular occupation level. All such records must carry a signature of authenticity and become the basis for "continued professional development".

5. PROVIDING THE CORRECT LEVELS OF EDUCATION AND TRAINING TO MEET BOTH INDIVIDUAL AND ORGANISATIONAL NEEDS

It will be the responsibility of the "Recommended Centeres" to provide advice and direction relating to individual needs, whilst taking into consideration their prior knowledge and experience.
It does not always follow, for example, that an "occupational level 3 person" is capable of dealing with a level 3 programme of study. Consideration should be given to "programme profiling" to enable candidates to proceed successfully to the required levels. Different people will require different breadths and depth of knowledge and associated competence based skills depending upon:

a) their present knowledge, skills, experience and whether employed or unemployed
b) the expectations of their employer relating to their position of employment or specialized skills level required (Example, a University graduate electronic person may only need to know a little about hydraulics and a level 1 programme may satisfy his or her needs)

Recognized Centres must provide equal opportunities to candidates at all levels and provide a variety of learning opportunities, ranging from that of:

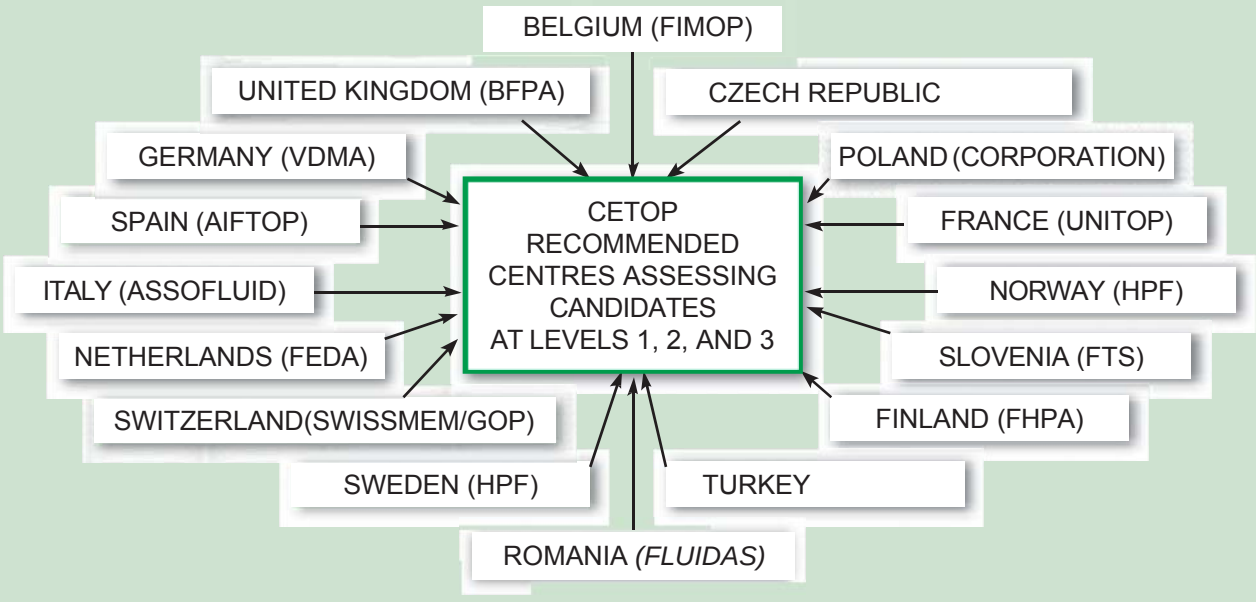
- Short Courses and Modules
- Flexible Distance Learning Programmes
- Personal Study

6. CONCLUSION

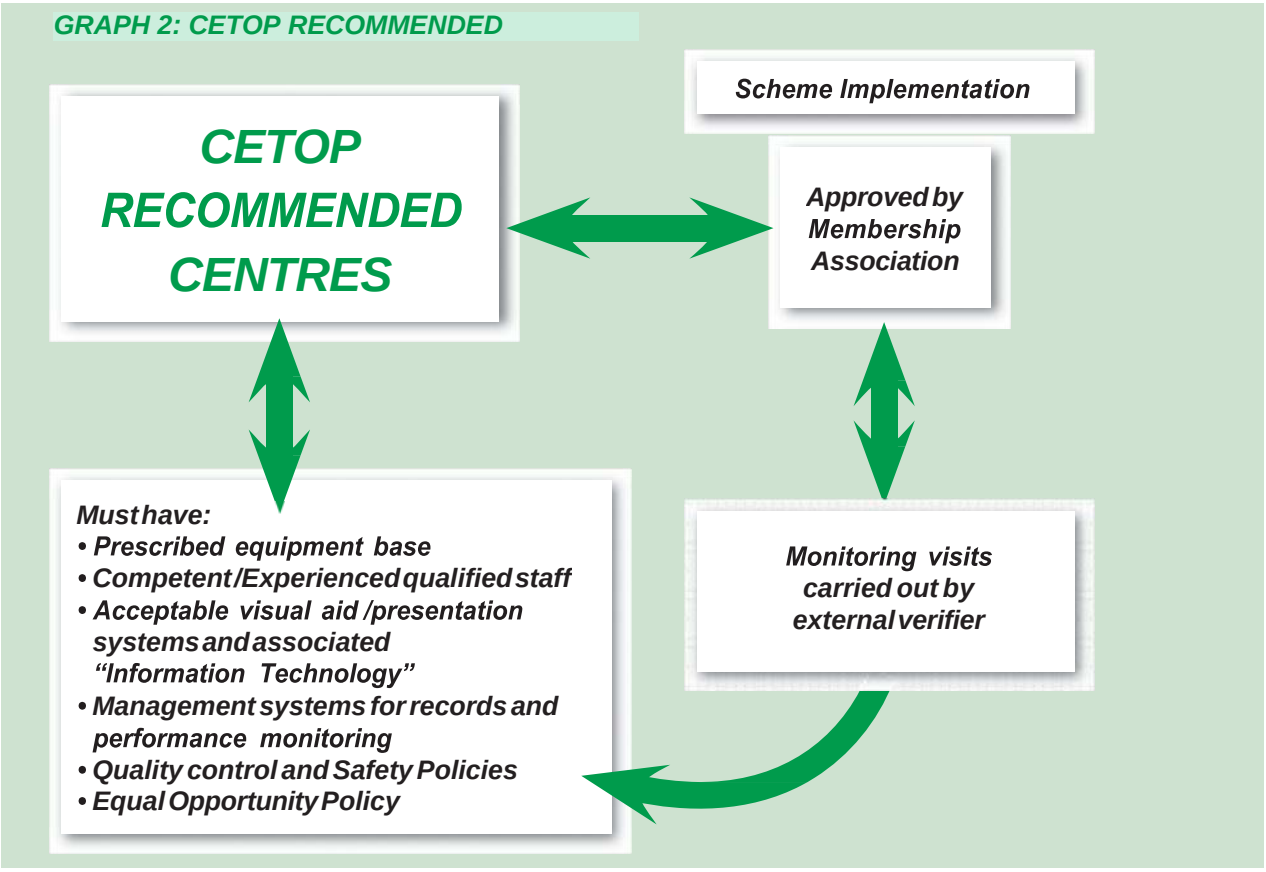
For this "Harmonization Initiative" to be successfully implemented and to be successful and effective, it is necessary for all CETOP ASSOCIATE MEMBERS to establish within their own countries, a series of competence based programmes, covering the various levels and associated subjects. They must work closely with educational establishments, industry lead bodies, OEM's and end users to ensure that the content continuously meets their needs, in light of changes in occupational standards and ever changing technology.

Relating to "Recommended Centres", CETOP Member Associations must play an active role in establishing, implementing and verifying all quality assurance procedures necessary to ensure "Parity" and standardization throughout.

GRAPH 1: COMMON ACCORD (EUROPEAN NETWORK)



GRAPH 2: CETOP RECOMMENDED



GRAPH 3: RECOMMENDED ASSESSMENT METHODS

ASSESSMENT METHODS FOR COMPETENCE BASED QUALIFICATIONS

"Knowledge and understanding" is assessed through a series of written assignments leading to a WRITTEN EXAMINATION.

"Knowledge, understanding and APPLICATION" is assessed via a series of COMPETENCE BASED TASKS relating to a specific "key function" eg. installation, commissioning, fault diagnosis. This is performed on an INDIVIDUAL basis with the approved assessor. Success is based upon a minimum of two performances under different conditions and criteria.

Evidence will include direct observation by the assessor, questioning and written reports/data. Success is based upon a satisfactory performance by the candidate being ASSESSED OBJECTIVELY.

Programmes can be NON-TIME based, or follow a TRADITIONAL EDUCATIONAL SYSTEM. PRIOR KNOWLEDGE and EXPERIENCE should also be taken into account. Assessment is only carried out when the candidate is ready and the tutor/assessor is satisfied that sufficient knowledge and understanding of the subjects have been gained to ensure success.

CETOP QUALIFICATIONS
APPROVED CENTRES GUIDELINE
RELATING TO CETOP OCCUPATIONAL LEVELS
RE 2015/06.02 – H/P

1. INTRODUCTION

The purpose of this paper is to provide a specific informative guideline to “Approved Centres” and the processes associated with quality assurance and quality control of competence based qualifications.

2. APPROVED CENTRES

If a person is presented with a competence based qualification, the certificate should clearly state:

- The level of competence
- The range of skills covered
- The specific area covered by these skills
- The Approved Centre at which the qualification was obtained
- The name of the controlling organization (Qualifying Body) and associated signature of authority.

The Approved Centre must be itself assessed by a representative of the Qualifying Body, to guarantee that it can effectively and continue-oily meet the criteria necessary to develop The knowledge and skills of personnel to a level at which they are deemed competent.

A major concern is that once a person has been certified competent he or she “must be” competent and there must be no doubt placed upon that person’s capability within the range of skills covered by the certificate.

Approved Centres are the responsible body for ensuring quality and consistency of performance and should therefore guarantee these levels of candidate knowledge and competence based skills.

It is the responsibility of the Qualifying Body to establish a guideline document clearly explaining to educational establishments and training organizations their commitment to achieving and maintaining “Approved Centre Status”.

Before applying for Approved Centre status, organizations must fully understand that competence can only be achieved through “real hands on experience”. It is therefore necessary for centres to have, or have access to, an extensive range of fully operational equipment, which clearly represents present day technology and which is able to meet the criteria laid down for knowledge and skills development followed by competence-based assessment.

To ensure candidate performance levels, it is necessary for centres to have technically competent tutors and assessors, with field experience in fluid power and associated engineering tech nologies as well as good academic qualifications.

To effectively educate, train and carry out competence based assessment, staff themselves should, through their own work-based experiences, have a range of practical skills involving the maintenance and management of fluid power systems.

Other important issues are the centre’s ability to:

a) Interpret the competence-based programme(s) and effectively integrate the knowledge-based sections with the development of practical skills.

b) Establish individual candidate “action plans” against prior knowledge and experience.

c) Maintain candidate progress records, providing evidence of feedback, evaluation and confidentiality.

d) Establish a series of written assignments to support the knowledge-based sections.

e) Establish a series of competence-based tasks to meet the evidence criteria - to be carried out on a “one to one” basis or in groups.

f) Establish a Management Control System, covering all aspects of document control,

including Tutors, Assessors and Internal Verifiers, involving regular documented management review meetings.

g) Provide quality tuition through an extensive range of visual aids, computer-based presentations, etc. in lecture rooms conducive to learning.

h) Provide good library facilities, including where possible, access to Internet-based information.

Further to these requirements, centres must have in place, an active Health and Safety and Equal Opportunities Policy. ISO 9000 or ISO Approval 14000 would be seen as most supportive when the Qualifying Body makes the final consideration for Approved Centre Status.
Note: Centres approved at Level 3 are automatically approved for Levels 1 and 2.

2.1 CETOP Approved Centres' duties
Approved by the CETOP National Associations, all centres must have in place the following:

a) A suitable quality control/management system to effectively manage the scheme covering all aspects of registration, induction, review and evaluation of individual needs, continuous assessment, performance monitoring, final assessment, examinations, validation and the provision for effective feedback
b) A system for maintaining records in a confidential and secure manner

c) Technical/competent staff, with experience in the field of hydraulic systems, pneumatic systems and control as applicable to the programmes to be delivered

d) Experienced staff to carry out both knowledge-based and competence-based assessments to meet the scheme requirements, with reference to assessment and internal verification
e) An implemented policy covering Health and Safety and Equal Opportunities

f) An equipment base to support the tutor in the presentation of the knowledge-based section, whilst at the same time providing adequate support for candidates to practice and develop their skills for the final competence-based assessment (See 2.6 relating to Centre Equipment Provision)

g) A technical library containing an adequate supply of current:

a. Manufacturers' catalogues and technical data
b. Access to the internet as required to provide current technical data
c. Fluid power Guidelines
d.Training Manuals
e. Health and Safety Documentation

Note: All current issue dates should be recorded and documentation kept at the current level.

h) Suitable lecture rooms with appropriate visual aids to support and present the programmes. These should include:
a. Computer-aided presentations
b. Projection Systems

On application to the CETOP Member Association for centre approval using the prescribed form, an approval visit will be arranged. A member appointed by the CETOP Member Association will carry out a site visit on a mutually agreed date to assess the centre, its staff, its equipment base and overall organizational capability to effectively manage and deliver the programme/s indicated by the application. Both parties will agree all arrangements in writing.

Centres are advised to contact their CETOP National Association for an outline of all current costs and for:
• Centre Approval visit
• CETOP National Association Verification visit
• Candidate examination registration

2.2 Centre verification and validation of standards

Approved Centres will be visited by an external verifier (appointed by their CETOP national association). The verifier will, in conjunction with the centre, agree upon a date and visit time to suit both parties. Centres will be informed, in writing, at least one month before the verifier's visit and all procedures, processes and documentation will be agreed upon prior to the visit.

The verifier will submit a report to the centre within 14 days of the visit, plus a copy to the national fluid power association. The verifier's report will include:

a) Acceptance of existing systems and continued approval

b) Recommendations for improvements and agreed action plan and time scale

c) Date of next meeting

d) Update on any current changes to the programme and approval/verification processes

2.3 Recommendations

Throughout the programme, both Tutor and Candidates are expected to use and apply:

a) Hydraulic symbols to current issue level ISO standard

b) Electrical/electronic symbols to current issue level EN standard

Throughout the delivery of the programme, Tutors will be expected to use a variety of system circuits to support and reinforce the learning process. Candidates should be encouraged to use their own circuitry applicable to the type of machines and systems for which they are currently involved as part of their employment (where applicable). The tutor will in conjunction with individual candidates, review all circuitry and identify its suitability.

2.4 Centre programme delivery/methodology

The delivery of these programme/s should include practical „Hands On“ activities throughout to reinforce the learning experience.

Emphasis must be placed on ensuring candidates receive and achieve a thorough understanding of the core subjects: fundamental principles, the ability to read and interpret circuit diagrams in symbol form, contamination control and the application of safe working practices.

2.5 Examination/assessment control procedures

Examination papers and marking schemes will be prepared by the CETOP national fluid power association and dispatched to respective centres or institute. Dispatch will take place by registered mail at least 2 working days before the designated examination date. They will be dispatched to the designated examinations control officer.

He or she will be responsible for the control of all aspects of confidentiality, administration and invigilation and in turn the dispatch of the transmittal notice “send back” to the CETOP national Member Association on receiving the pack by registered mail.

The CETOP national Member Association will notify centres of the designated examination in due time, together with any further details considered necessary to ensure effective management and control of the examination process.

On completion of the written examination, candidate’s scripts will be returned to the examinations officer who will then arrange for them to be marked by the nominated person against the supplied marking scheme.

Successful candidates should be reported to the CETOP national Member Association within one month of the examination date using the prescribed form (Examination Report Form) for knowledge-based units.

Note: Centres will receive one extra copy of the examination paper for reference during invigilation and marking. The Marking Scheme provided must be returned to the CETOP national Member Association together with the Examination Report Form. Under no circumstances must this be copied.

Where candidates fail to meet the required pass mark and are planning to resit the examination at the next available date, the CETOP national Member Association must be notified by completion of the respective Examination Entry Form.

2.6 Information relating to specific programs

Approved Centres must have or have access to the following equipment to:

a) provide support for knowledgebased learning

b) provide for effective tutor demonstrations

c) provide adequate hands on experience during skills development and competence-based assessment

2.6.1 Mobile Hydraulics Programmes

Centres must have the ability to:

1) Demonstrate cavitation and aeration on the suction side of pump

2) Operate a fixed displacement pump system with a variety of pressure and flow control devices covering:
- single stage relief valves
- pilot operated relief valves with vent control unloaded valves
- Electro-Hydraulic pressure switches and transducers
- accumulators
(including provision for charging)
Flow control should include simple throttle valves and pressure compensated flow control valves, covering meter-in, meter-out and by-pass operations and should be investigated under
load and non-load conditions

3) Operate and control a variable displacement pump system incorporating:
- pressure compensation (constant pressure control)
- load sensing
- remote pressure control (including the application of electrical and proportional control)

4) Show the effects of engine speed and pump displacement on pump flow rates

5) Carry out pump performance testing and establish the relationship between Q and P under load and non-load conditions

6) Investigate the performance of:
- priority flow control valves
- spool flow dividers
- rotary flow dividers under load and non-load conditions

7) Distinguish the difference between mounted valves, screw-in cartridge, slip-in cartridge and pipe mounted arrangements, through practical hands on experience

8) Operate a variety of multifunction mobile valves covering:
- open centre applications
- flow/pressure compensation
- inlet and service port provisions (including the operation via manual control, oil pilot joystick and electrical proportional control)

9) Investigate the performance of pilot operated check valves and external piloted counterbal- ance valves for load holding and motion control involving cylinder systems

10) Investigate the operation of a closed hydro-static system incorporating the basic control functions

11) Investigate the performance of two-way and three-way pressure reducing valves

12) Demonstrate the procedures to follow to assess the contamination level of hydraulic fluid using a patch test kit

13) Investigate the performance of hydraulic steering systems and associated priority valves

14) Investigate hydraulic motor performances associated with displacement, speed and slippage rates

2.6.2 Industrial Hydraulics and Control

Centres must have the ability to:

1) Demonstrate cavitation and aeration on the suction side of pump

2) Operate a fixed displacement pump system with a variety of pressure, flow and associated control devices covering:
- single stage relief valves
- pilot operated relief valves with vent-control
- unloaded systems
- Electro-Hydraulic pressure switches and transducers
- accumulators (including provision for charging)
Flow control should include simple throttle valves and pressure compensated flow control valves, covering meter-in, meter-out and by-pass operations plus the application of flow divider
and should be investigated under load and non- load conditions

3) Operate and control a variable displacement pump system incorporating:
- pressure compensation (constant pressure control)
- load sensing
- remote pressure control (including the application of electrical and proportional control)

4) Demonstrate and investigate load holding and motion control via pilot operated check valves and over-centre counterbalance valves

5) Incorporate and apply both on-off solenoid operated valves and proportional control

6) Build circuitry involving switches, relays and amplifier card systems
7) Carry out pump performance testing and establish the relationship between Q and P under load and non-load conditions

8) Demonstrate the procedures to follow to assess the contamination level of hydraulic fluid using a patch test kit

9) Investigate the performance of hydraulic cylinders operating in a regenerative mode

10) Investigate hydraulic motor performances associated with displacement, speed and slippage rates

11) Investigate the performance of two-way and three-way pressure reducing valves

12) Distinguish the difference between mounted valves, screw-in cartridge, slip- in cartridge and pipe mounted arrangements, through practical hands-on experience

2.6.3 Power Pneumatics and Control

Centres must have the ability to:

1) Build a range of pneumatic circuitry from simple to complex involving air pilot and solenoid pilot control

2) Build Electro-Pneumatic circuits incorporating relays and a variety of switching devices

3) Incorporate the application of PLC's to initiate control of pneumatic circuitry

4) Demonstrate the performance of cylinders with and without cushioning

5) Incorporate into circuitry, safety systems, interlocks, two hand starts and emergency stops

6) Investigate the operation of air compressors and ancillary equipment, receivers, coolers and dryers

7) Investigate the performance of a variety and combinations of FRL units

8) Investigate different pipe-work and sealing systems in current use

3. EDUCATIONAL ESTABLISHMENTS/ TRAINING ORGANISATIONS

Before applying for centre approval, Educational Establishments/Training Organization must be conversant with:

a) The content of the programme for which they are applying to run.

b) The guideline document outlining the center's specific commitment and requirement to run the scheme.

Note: The Guideline Document will contain the necessary forms for application for centre approval, candidate registration and examination entry.

4. QUALIFYING BODY/EXTERNAL VERIFIERS

On receiving the application form for centre approval, the Qualifying Body will arrange a centre visit by one of its elected "External Verifiers"(EV). The EV will communicate with the centre and finalise a date and time for the visit. The EV will notify the centre in writing of all the necessary arrangements for the visit, clearly outlining all areas to be checked and discussed as part of the approval process and the necessary personnel to be present.

Centres would be advised to forward to the EV, current copies of CV's for all personnel involved in the scheme, prior to the visit.

The EV will normally work from a checklist system and a copy of this can be forwarded to the respective centre prior to the approval visit (See appendix RE 2015/06.01 - H/P).

During the visit to the centre the EV will provide:

a) Advice and guidance to the centre, to help them meet the Qualifying Body's criteria for centre approval.

b) Advice and guidance regarding the delivery, management and assessment processes required to effectively run the scheme.

On completion of the centre approval visit, the EV will notify there whether or not they have met the necessary criteria to become officially approved.

If so, the EV will officially notify the Qualifying Body, forwarding all the necessary approval docu- mentation. The Qualifying Body will then award the centre with its Approved Centre Certificate.

Should a centre fail to meet the approval criteria, the EV will discuss a timescale with the centre and the necessary remedial actions to be taken.

The Qualifying Body may grant conditional approval, for a period of up to six months. At this stage, full approval will be granted if the centre can present the necessary evidence showing that it has clearly met the criteria. This may involve a re-visit by the EV and this will incur additional costs.

The Qualifying Body will normally approve a centre for a period of six years, subject to the EV's visit and report.

The EV, on behalf of the Qualifying Body, will be responsible for developing a close communication link with the centre. It will be the responsibility of the Qualifying Body to provide specimen practical competence based tasks, including respective marking schemes, ensuring that Approved Centres adopt a style and content acceptable to the qualification level.

The Qualifying Body will be responsible for setting examinations and establishing the necessary marking schemes, on an agreed time-scale. The approved centre will be responsible for the administration, invigilation, marking and confidentiality.

Note: Where Qualifying Bodies in Europe do not have the resources to set and administer examination papers, etc., the alternative is to establish an acceptable set of examination papers and marking schemes, through the various education and training establishments, allowing them to administer and control them accordingly. However, the Qualifying Body must agree the standard, whilst ensuring the content meets the programme and qualifications level.

5. EXTERNAL VERIFIER /VERIFICATION VISITS TO APPROVED CENTRES

During such visits, the EV will:

a) Verify the centre against its original centre approval documentation, systems and management control.

b) Review candidate records of achievement.

c) Observe competence based practical task assessments, where possible.

d) Discuss with Centre Tutors, Assessors and Internal Verifiers, any problems associated with the management and daily running of the scheme.

e) Receive from centre staff any objective feedback regarding the scheme and proposed improvements.

f) Provide the centre with any updated information from the Qualifying Body, which they may not yet have received.

Note: It is the responsibility of the Qualifying Body to have in place a programme for scheme/ qualification review and improvements. This will normally be a three year process.
The Qualifying Body will notify Approved Centres in writing through established "Information Updates". These will include recommendations to Approved Centres and dates for implementation where necessary.
It will be the responsibility of the Approved Center's Management Team to meet these requirements.

On completion of the centre visit by the EV, a full report will be submitted to the Qualifying Body and a copy sent to the respective centre, outlining any agreed improvements, actions or observations, which need attention. The EV will discuss the outline of his or her report with the centre at the end of the visit.

6. SUCCESSFUL CANDIDATES

On successful completion of the scheme, the approved centre will, through the necessary documented systems, inform the Qualifying Body of the candidates' success.

It will be the responsibility of the Qualifying Body to award the respective certificate, showing the competence base level of achievement signed by an authorized representative of the Qualifying Body.

APPENDIX: CETOP QUALIFICATIONS APPROVED CENTRES GUIDELINE

APPENDIX CETOP RE 2015/06.02 - H/P

For example that can be modified by the CETOP Member Associations

Appendices:
Typical Centre Approval Report Forms given for example that can be modified by the CETOP Member Associations.

- ★ ***CENTRE APPROVAL REPORT FORM***
- ★ ***CENTRE APPROVAL APPLICATION (CETOP/CA/1)***
- ★ ***CANDIDATE REGISTRATION (CETOP/CR/1)***
- ★ ***APPROVED CENTRE: EXAMINATION ENTRY (CETOP/EE/1)***
- ★ ***EXTERNAL VERIFIER'S VISIT REPORT (CETOP/EV/1)***
- ★ ***INTERNAL VERIFIER'S REPORT (CETOP/IV/1)***
- ★ ***WORK EXPERIENCE VERIFICATION (HYDRAULICS EXAMPLE)***

CENTRE APPROVAL REPORT FORM

1	CENTRE DETAILS	2	RECOMMENDATIONS	
	Centre Name:		Full Approval	Tick
	Address:			
	Centre Contact:		Conditional Approval	
	Tel. No. Fax No.			
	E-mail:		Period of Months	
	External Verifier's Name:			
	Date/Time/Visit:		Rejection	

3	CENTRE APPROVAL SOUGHT FOR	CODE	LEVELS			
			1	2	3	
•	Hydraulics and Control	H				
•	Industrial Hydraulics and Control	IH				
•	Mobile Hydraulics and Control	MH				
•	Power Pneumatics and Control	PP				

Please tick the appropriate box.

4	*ACCOMMODATION/FACILITIES (Brief Report)*
a)	Lecture Room Facilities/Layout
b)	Visual Aids/Presentation Methods
c)	Programme Notes/Support Materials/Software
d)	Manufactures Catalogues/CDs/Access to Web Sites/Library
e)	Fluidpower Publications and Relevant Standards
	Recommendations/Comments

5	PRACTICAL FACILITIES/EQUIPMENT AVAILABILITY/ACCESS
At this stage the External Verifier will make reference to “2.6” (pages 17–19) of Guideline Document relating to the equipment necessary to effectively deliver competence based programmes Report on the acceptability of the centre’s resources to effectively deliver the programme	
Comments	
Quality of Equipment	
Range of Equipment	
Age/Current	
Recommendations/Comments	

6	***CENTRE PROGRAMME DELIVERY AND MANAGEMENT***	YES	NO
•	Tutor Names: CVs Checked Comments		
•	Assessor Names: CVs Checked Comments		
•	Internal Verifier: CV Checked Comments		
	LEARNING METHODS TO BE USED		
Recommendations/Comments			

7	***SCHEME ADMINISTRATION***	YES	NO
•	Candidate Training Plans Established (Format) Comments		
•	Candidate Personal Development Plans Established (Format) Comments		
•	Systems for Progress Monitoring/Maintaining/Confidential – Secure Records 1. Assignments 2. Practical Task Preparation 3. Practical Task Assessment 4. Written Examinations		
	RESPONSIBILITY/CONTROLLED BY – (name)		
	Name of Examinations Officer Met during visit Tel No. Fax No. E-mail		
	Recommendations/Comments		

8	***HEALTH AND SAFETY/HYGIENE***	YES	NO
	• Health and Safety Policy Operational • Relevant Safety Notices in place • Risk Assessment carried out and recorded		
	Recommendations/Comments		
9	***EQUAL OPPORTUNITIES POLICY IMPLEMENTED***		
	Comments		
10	***EXTERNAL VERIFIER'S SUMMARY/RECOMMENDATIONS***		

EVs Signature	Date
Technical Manager National Fluid power Association	Date

CETOP APPLICATION FOR CENTRE APPROVAL

Form CETOP/CA/1 *Copy form as required*

Send Back to national CETOP Member Association

Programme for Approval (name)

Name of Organization Full

Address Contact Name

Tel No Position

Fax No

E-mail Web

I have thoroughly read the CETOP Guideline Documents & Recommendations and I am fully aware of the necessary organizational commitment and equipment base required for Centre Approval.

I am aware of the associated costs for centre visits and would like you to arrange a visit to our organization to carry out a Centre Approval investigation.

	tick as applicable
We will forward to the national CETOP Member Association: Payment via Purchase order	[ ]
	[ ]

Date Signed

For official use by CETOP Member Association staff

Date Application Received

Actioned by

Name of ET Member carrying out Centre Approval

Visit Date Planned

Outcome of visit

Financial Transactions completed

Date completed

Any other info:

CETOP INDUSTRY STANDARD QUALIFICATIONS

Candidate Registration

Form CETOP/CR/1 *Copy form as required*

This form must be completed by the Candidate and Approved Centre and returned to the National CETOP Member Association within 14 days of the date on which candidates are initially enrolled on to the prescribed CETOP programme.
The Centre will receive a Registration No. for each candidate from the CETOP Member Association, and all correspondence associated with the candidate should include this number. Once registered, this number is for life.

Personal Details (To be completed by the Candidate - BLOCK CAPITALS)

Full Name

Position

Employer's Name

Employer's Address

Contact Address (Home)

Tel No Date of Birth

Fax No E-mail

Programme Details

(To be completed by the Approved Centre - BLOCK CAPITALS)

Centre

Programme

Date of Enrolment

Signed Date

CETOP M. A. REGISTRATION NUMBER :

Internal Record

(For Centre use)

Examination (written)

Practical Task Assessments

CETOP APPROVED CENTRE: Examination Entry

Form CETOP/EE/1 *Copy form as required*

This form must be completed by the Approved Centre and returned to the CETOP M. A. at least 2 months before the examination date. Centres will be charged based upon the number of candidates recorded and examination scripts will be sent to the centre accordingly.

Prescribed Programme/Scheme

Written Examination Date

Name of Organization

Full Address

Contact Name Position

Tel No Fax No

E-mail Web

Signature Date

The listed candidates will be sitting the written examination on the above date.

NOTE: This same form will also be used to record PASS or FAIL. From this information CETOP M. A. will send the respective Candidates' Qualification Certificates to the Approved Centres for dispatch.

No	*Candidates Name*	*CETOP M. A.* Registration No.	*Examination Results* P= Passed F= Fail	*Competence-based-Units* P= Passed	*CETOP M. A.* official use: Certificate Dispatched/Date
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

CETOP EXTERNAL VERIFIER'S VISIT REPORT

Form CETOP/EV/1 *Copy form as required*

External Verifier's Date:

Name: Approved Schemes

Centre: Approved:

Centre Contact Person/IV: Approval:

STANDARDS – (Tick a necessary)

	AUDIT CHECKS CARRIED OUT	*UNSATISFACTORY*	*MEETING SCHEME REQUIREMENT*
1	Overall Management Including:		
	• Scheme Management Candidate		
	• Systems for Tracking Progress		
	• Areas of Responsibility		
	• Document Control System		
	• Health and Safety Policy		
	• Quality Systems		
	• Internal Verifier Reports		
2	Individual Candidate Records (Random Check)		
3	Inspection of Candidate Assignments		
4	Inspection of Practical Task Assessments		
5	Inspection of Candidate Individual Portfolios		
6	Inspection of Completed Examination Scripts		

ANY ADDITIONAL CHECKS CARRIED OUT

External Verifier's Comments:

Actions to be taken:

	Tick	
Copy Sent to Approved Centre	[ ]	Date:
Copy Sent to CETOP M. A.	[ ]	Date:
Copy to File	[ ]	Date:

CETOP INTERNAL VERIFIER'S REPORT

Form CETOP/IV/1 *Copy form as required*

Internal Verifier's Name: _____

Approved Centre: _____

Qualifications Under Review: _____

Candidate Start Date: _____

Date of Verification: _____ Report No: _____

Initial Information Required

(Answer or Tick Box)

1 Number of candidates enrolled and registered with CETOP M. A.:

2 Number of candidates active on scheme to date:

3 Number of candidates taking next written examination:

4 Number of candidates successfully completed written examination:

5 Number of candidates preparing to resit examinations:

6 Number of candidates completed/part completed practical task:

Verification

(Organizational and Quality Control)

		CHECKED Yes	No
I	Candidate individual record folders – content against checklist	[ ]	[ ]
II	Candidate assignment progress records	[ ]	[ ]
III	Register for candidates attending modules	[ ]	[ ]
IV	Course feedback reports from candidates (4 monthly)	[ ]	[ ]
V	Completed practical task assessment profiles	[ ]	[ ]

Please tick the appropriate box.

Verification

(Assessment Process)

	Yes	No
Discussed candidate progress with assessor/s	[ ]	[ ]

Please tick the appropriate box.

Assessor/s Name/s: _____

Comments:

Final Remarks

Overall performance of Centre to meet the scheme requirements as laid down by the national CETOP Member Association and meeting requirements of the External Verifier.

…….. Acting as Internal Verifier on behalf of this Centre I am Satisfied/Not Satisfied with the scheme management, records and methodology.

Actions/Recommendations:

	Tick	
Copy Sent to External Verifier	[ ]	Date: _____
Copy to File	[ ]	Date: _____

WORK EXPERIENCE VERIFICATION
Candidate Registration

Form CETOP/WE/1 *Copy form as required*

This form must be completed by the Candidate and the employer and returned to the National Fluid power Association (CETOP M.A.).

Personal Details (To be completed by the Candidate - BLOCK CAPITALS)

Full Name

Position

Employer's Name

Employer's Address

Contact Address (Home)

Tel No Date of Birth (Civil reg. no.)

Fax No E-mail

.....

EMPLOYER WORK EXPERIENCE: Verification Entry

Form CETOP/VE/1 *Copy form as required*

This form must be completed by the Employer of the candidate and returned to the CETOP M. A. by the candidate.

Employer Programme/Scheme

Personal Details (To be completed by the Employer representative - BLOCK CAPITALS)

Verification Date

Name of Organization Full

Address

Contact Name Position

Tel No Fax No

E-mail Web

Signature Date

Practical task assessments to verify competency about:

- INSTALLATION
- COMMISSIONING
- PERFORMANCE TESTING
- PROACTIVE MAINTENANCE AND MACHINE MANAGEMENT
- SERVICING
- COMPONENT REMOVAL AND REPLACEMENT

Verified by employer, system related, work based experience

Instruction:
Describe what type of work the candidates have been done within:

- *INSTALLATION*

Describe experience in reading hydraulic diagram for assembly

Describe experience of assembly based on cleanliness, security and quality.

- *COMMISSIONING and PERFORMANCE TESTING*

Describe experience of commissioning in respect by person, component, system security and cleanliness.

Describe experience of system functional testing

- *PREDICTIVE MAINTENANCE AND MACHINE MAINTENANCE PLUS SERVICE*

Describe experience of predictive maintenance

Describe experience of fault finding and repair (dis-assembly and assembly of existing system)

Appendix 1. Certification of practical experience

1: Control and adjustment:	If experienced, tick with an **X**
Flow	
Speed on certain movements	
Temperature	
Accumulator pressure/pre-charge pressure	
Fluid cleanliness according to ISO classification system	
Sensors and switches for fluid system	
2: Fault finding in systems:	
From diagram and symptom	
With test equipment	
Without test equipment. Feel, smell, listen	
By phone description	
3: Understand security and environmental issues at dis-assembly of complete or part of fluid systems and machines:	
Read and understand maintenance and security instructions	
What means by Lockout and Tag out instructions	
Secure movements with plunge or similar equipment	
Check and dis-charge trapped pressure within pipes	
Dis-charge accumulators	
Without maintenance and safety instructions, from diagram and machine structure, analyze actions to be done to be able to work safe	
Cleanliness at dis-assembly of system.	
Understand the importance of managing waste fluids in a safe manner due to environmental issues	
Understand the importance of using relevant personal protection	
4: Maintain and repair fluid power systems:	
Maintaining systems:	
Exchange sealing's	
Check mounting surfaces	
Couplings	
Flanges	
Valves	
Empty and refill fluid in systems	
Inside cleaning	
Cleaning coolers	
Exchange filter cartridges	
Exchange components:	
Pumps	
Valves	

Fluid motors	
Electric motors	
Accumulator piston and bladder	
Cylinders	
Hoses	
Other components	
Repair of components, dis-assemble, analyze status, exchange wear parts and re-mount:	
Pumps	
Motors	
Valves	
Cylinders	
Accumulators	
5: Start-up of fluid power systems after maintenance work / exchange of component:	
Flushing	
De-aeration	
Adjust pressure and flow	
Leakage control	
Control of cleanliness level according to ISO code system	
Cleaning of workplace	
Documentation	

For approved practical experience shall the candidate have practical experience of at least 50% of above listed.

Comments about experiences.

cetop

The Voice of the European Fluid Power Industry

EDUCATION RECOMMENDATIONS

HYDRAULICS PROGRAMMES

★ **POWER HYDRAULICS PROGRAMME (H1): RE 2015/06.01 – H**
CETOP (Passport) Occupational Level 1

★ **HYDRAULICS & ASSOCIATED CONTROL PROGRAMME (H2): RE 2015/06.01 – H**
CETOP (Passport) Occupational Level 2

★ **MOBILE HYDRAULICS & ASSOCIATED CONTROL PROGRAMME (MH2): RE 2015/06.01 – H**
CETOP (Passport) Occupational Level 2

★ **INDUSTRIAL HYDRAULICS & ASSOCIATED CONTROL PROGRAMME (IH2): RE 2015/06.01 – H**
CETOP (Passport) Occupational Level 2

★ **HYDRAULICS & ASSOCIATED CONTROL PROGRAMME (H3): RE 2015/06.01 – H**
CETOP (Passport) Occupational Level 3

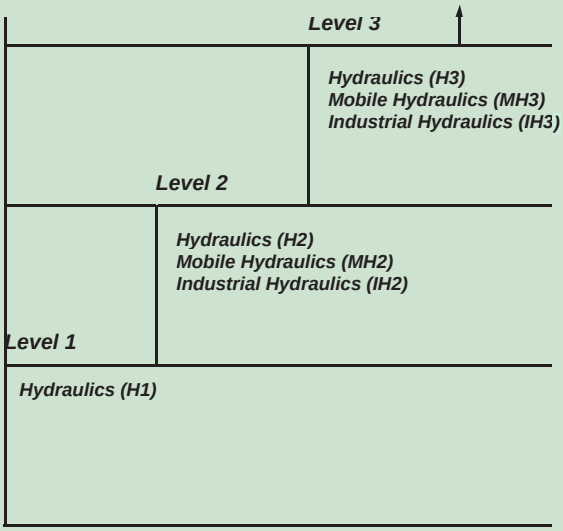
★ **MOBILE HYDRAULICS & ASSOCIATED CONTROL PROGRAMME (MH3): RE 2015/06.01 – H**
CETOP (Passport) Occupational Level 3

★ **INDUSTRIAL HYDRAULICS & ASSOCIATED CONTROL PROGRAMME (IH3): RE 2015/06.01 – H**
CETOP (Passport) Occupational Level

FOREWORD

These Competence Based Qualifications have been developed by CETOP to meet the occupational levels of those people involved in the maintenance and management of fluid power systems and cover the specific subjects of mobile hydraulics, industrial hydraulics, power pneumatics and associated control systems. They form a structure for progressive learning and the acquisition of a range of competence assessed skills. They have now been accepted by CETOP as industry standard qualifications forming part the harmonization programme and the proposed passport for Europe within this sector of engineering.

Relating to CETOP Occupational Levels



Each level can be considered as a stand-alone qualification and level of achievement. However, each level progresses to a higher level of knowledge, understanding and application.
In all cases candidates should ensure that they have the appropriate knowledge and experience to commence the qualification level chosen. Level 1 programmes provide a foundation of knowledge with emphasis placed upon fundamental principles, component functionality, operation and recognition together with an understanding of fluid power systems at a basic level.
The level 2 programmes ensure component functionality, operation and application are fully understood. These programmes have a higher technical content than the level 1 programmes and provide a more in-depth approach to function, operation, application and the interpretation of circuitry.

The level 3 programmes place emphasis on complex systems, integrated operations and their associated controls including the electrical / electronic interface. They involve technical specifications and the development of greater in-depth know ledge associated with component characteristics, system performance and interpretation. Each level involves calculations and the use of formulae, emphasis is also placed upon the ability to read and interpret circuit diagrams. The development of diagnostic skills and the ability to act accordingly is involved at every level thereby applying a fault-cause-remedy approach throughout.

Where the same subjects appear at more than one level they are dealt with at the appropriate depth and in a manner that meets the requirements of that level.

It is advisable in all cases to study the content of the previous levels before taking a higher level. This will ensure that your prior theoretical know ledge and application experience is sufficient for you to proceed. You should seek advice from your nearest Approved Centre and if in doubt arrange a formal meeting with a tutor to carryout an analysis to identify your strengths and weakness and jointly establish a plan for your progression.
For further details of these industry standard qualifications and Approved Centres visit the web-site: www.cetop.org.

Developed on behalf of the CETOP Education Commission, representatives from CETOP member associations, this programme represents one of a range of new competence based qualifications recommended by CETOP. It is intended for those personnel involved in the maintenance and management of hydraulic systems used in mobile applications and who require knowledge and competence based skills to support work based activities such as: planning and preparation, interpreting and using technical information, devising and following sound procedures associated with installation, commissioning, testing, fault diagnosis, rectification, maintenance, servicing and re-establishing a machine "fit for purpose".

HYDRAULICS PROGRAMME (H1):

RE 2015/06.01 – H

CETOP (Passport) Occupational Level 1

INTRODUCTION

This is the LEVEL 1 Hydraulics 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 levels 2 and 3, involving the maintenance and management of both Industrial and Mobile hydraulic 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 LEVEL 1

LEVEL (1) This person will perform activities that follow an established procedure. Activities will be recurring and of a short-term nature. The reaction to most problems will be to summon help or follow a predefined set of actions.

This level 1 programme provides an excellent introduction to power hydraulics and places great emphasis on the understanding of fundamental principles, component functionality and principles of operation.

Emphasis upon health and safety and that of developing safe working practices is applied throughout, as a CORE ELEMENT within the scheme. CORE ELEMENTS are not necessarily taught as specific subject areas but integrated within the scheme.

Throughout the programme, emphasis is 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:

- 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 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 ranging from that of short courses to distance learning and centre based modules. The time scale can also be flexibly managed by the Approved Centres.

Candidates will be expected to complete a series of written assignments throughout the programme of study to reinforce the learning process. These can be supportive to the final marks for the knowledgebased section.

- 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%.

- Practical task competence based unit assessment will be carried out on a "one to one" basis or in groups, candidate to tutor, on a pass/fail basis, against agreed evidence of performance.

PRACTICAL TASK ASSESSMENT (H1)

When assessing competence, the following processes must be followed:

- Relating to the occupational level, a series of Assessed Abilities are identified. These represent the ”DOING PART” of a person’s job and requires a combination of both practical skills and applied knowledge.
- For each Assessed Ability, evidence of performance is then established and shown as EVIDENCE REQUIRED (sometimes termed performance criteria).

In all cases candidates must meet the requirements of each Assessed Ability.

During practical task assessment, the ASSESSOR will agree the ”type of evidence” to be obtained and this can range from:

- Direct Observation
- Verbal Questioning/Candidate Commentary
- Written Report

and may include all types.

ASSESSMENT REQUIREMENTS

Assessed Ability

H1.1 Recognize the component parts of a selected machine and their functionality, linked to system and circuit diagram.

Evidence Required

H1.1.1 Reservoir and associated parts identified including functionality.

H1.1.2 Pump type identified and associated connections.

H1.1.3 Method used for controlling pressure identified.

H1.1.4 Method used for controlling flow identified. H1.1.5 Actuator type identified.

H1.1.6 Filter location identified and associated filter performance indicator.

Assessed Ability

H1.2 From circuit diagram provided and associated system, check operating pressures at strategic points and record.

Evidence Required

H1.2.1 Safety checks carried out before pressure checks commence and working environment assessed.

H1.2.2 Test points identified on circuit diagram and machine system, check list established.

H1.2.3 Correct range of pressure gauges and connections used at all times.

H1.2.4 Pressure readings taken and recorded.

H1.2.5 Safe working practices followed at all times.

H1.2.6 Written report completed covering all findings.

Assessed Ability

H1.3 Change filter element on a system.

Evidence Required

H1.3.1 Risk assessment check carried out and working procedures established.

H1.3.2 Specification of new element (element checked against machine specification part number type and size).

H1.3.3 Correct isolation procedures followed before dismantling process commenced.

H1.3.4 Correct tools used at all times.

H1.3.5 Cleanliness control procedures followed and spillage of oil prevented at all times.

H1.3.6 Filter disposal procedures established.

H1.3.7 Operational checks carried out after installation (system ”fit for purpose”).

Assessed Ability

H1.4 Check accumulator pre-charge pressure and establish level against specification.

Evidence Required

H1.4.1 Established procedures followed at all times.

H1.4.2 Safe working practices followed at all times.

H1.4.3 Correct tools and test equipment used.

H1.4.4 Written report completed covering all actions taken.

KNOWLEDGE BASED UNIT (H1)

H1.5 *Contents*

H1.5.1 Fundamental Principles.

H1.5.2 Hydraulic System Construction (BASIC BUILDING BLOCKS).

H1.5.3 Components – Function and Operation.

H1.5.4 Hydraulic Fluids.

H1.5.5 Cleanliness Control.

H1.5.6 First Line Management.

H1.5.7 Maintenance Procedures.

Health and Safety CORE ELEMENT

- Do's and Don'ts
- Good/Safe Working Practices/Risk Assessments

Literacy and Numeracy CORE ELEMENT

- Use of Basic Formula
- Application of Simple Calculations and Associated Units
- Terminology

KNOWLEDGE BASED UNIT – WRITTEN EXAMINATION SPECIFICATION

The examination paper will contain questions from the 7 sections of this programme and core elements will be integrated as necessary.

- Examination minimum duration 2 consecutive hours
- Pass mark 60%
- Question style may be single subject, multiple subject, short answer and multiple choice

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

HYDRAULICS - (Knowledge Based Unit)

H1.5.1 Fundamental Hydraulic Principles

a) Know the fundamental principles that underpin the operation of all hydraulic systems and how they affect performance:

- flow makes it go
- pressure provides the pushing force
- oil in a system always takes the path of least resistance
- pressure is a measure of the resistance to flow
- for oil to flow in any system, there has to be a pressure difference
- the greater the pressure drop the greater the flow potential
- when fluid flows from a high pressure level to a lower pressure level and no work is carried out, then heat is generated

b) State and use the relationship between:

- pressure, area and the force transmitted by a cylinder
- flow rate, cylinder dimensions and piston velocity
- pressure, displacement and hydraulic motor torque
- flow rate, displacement and motor speed
- pump displacement, shaft speed and flow rate
- pump flow rate, operating pressure and hydraulic power volumetric efficiency, mechanical efficiency and overall efficiency of pumps and motors
- pipe diameters, flow rates, fluid viscosity and pressure losses

c) Know the units and terminology relating to:

- flow rate
- speed
- pressure
- temperature
- power
- torque
- motor and pump sizes

H1.5.2 Hydraulic System Construction and Symbolic Representation

a) Know the component parts used to construct a hydraulic system and the basic layout (basic building blocks).

b) Outline the function of the component parts used to design a hydraulic system relating to:

- prime mover
- coupling and bell housing
- pumps
- reservoir
- filters
- pipes – rigid and flexible
- relief valves
- pressure reducing valves
- direction control valves
- flow control valves
- hydraulic motors
- hydraulic cylinders
- pressure gauges
- flow meter
- check valves- inline and pilot operated
- bladder accumulator

c) Recognize and use current graphical hydraulic symbols to represent the component parts of a hydraulic system. (ISO standards).

H1.5.3 Operation of the Major Components used to design a Hydraulic System

Describe the operating principles of the following components:

- gear pump (external)
- vane pump (cartridge type)

- piston pump (swash plate – pressure compen- sated)
- relief valve (direct and pilot operated)
- pressure reducing valve
- direction control valves (lever operated and solenoid operated)
- pilot operated check valve
- throttle valve (with and without free flow check valve)
- pressure compensated flow control valve
- filter with bypass and differential indicator
- hydraulic motor (piston and orbit)
- cylinders (tie rod and screwed body types)
- cylinder cushioning
- accumulator and safety block

H1.5.4 Hydraulic Fluids and their Characteristics

a) Know the meaning of the following terms:
- viscosity
- ISO viscosity grade
- viscosity index

b) Know the function of the hydraulic fluid:
- power transmission
- lubrication
- cooling
- carrying contaminants to the nearest filter

c) Outline the effect of system temperature on:
- oil viscosity and system performance

d) Know the factors that affect the life of the hydraulic fluid and their effect upon system performance:
- contamination
- heat
- moisture

H1.5.5 Contamination Control

a) Know the origin of contamination and ways in which it enters a system.

b) Outline procedures to follow to reduce contamination ingression.

c) Know the effects of contaminants on the life and performance of component parts.

d) Know the locations of filters within a system.

e) Outline the performance of a filter, including by-pass and indicator.

f) Know the importance of regular fluid contami- nation analysis and the correct interpretation of the results.

H1.5.6 First Line Management of Hydraulic Systems

a) Know the points of inspection and the observations to be made:
- Power unit and prime mover:
- Stop – Start – Isolation
- general external cleanliness
- position and security of all guards
- relevance of all notices – risk assessment noise level and general temperature hydraulic oil level and color at sight glass
- suction hose connections and hose conditions
- pressure gauge readings
- signs of leakage
- security of fittings – pipes and hoses
- filter indicator status
- reservoir access points and sealing arrangements
- accumulator inspection and associated safety block (pre-charge pressure checks)
- general structure of power unit (steel work)
- Hydraulic System:
- operation of services (feedback from operator)
- leakage (cylinders, motors, hoses, sub-plates and stacks) view topping up record
- pressure readings inline with operating specification
- noise and vibration
- system filter and indicator status

b) Know how to effectively complete a written report covering:
- non compliances
- actions taken
- request for further investigation

H1.5.7 Maintenance Procedures

a) Know the requirements of a pro-active maintenance programme with reference to health and performance monitoring and relating to:
- pump performance testing (QP)
- periodically taking pressure readings under vary- ing operational conditions
- taking regular oil samples to enable cleanliness level to be assessed
- taking regular oil samples to determine oil life expectancy
- checking systems temperatures
- checking working performance (time based op- erations)

b) Know how to effectively complete a written report covering:
- non compliances
- results identified
- actions taken
- request for further investigation

HYDRAULICS & ASSOCIATED CONTROL PROGRAMME (H2) CETOP RE 2015/06.01 - H
CETOP (Passport) Occupational Level 2

INTRODUCTION

This is a LEVEL 2 Hydraulics Programme, forming the start of a series of competency-based qualifications designed around CETOP occupational levels.

It combines the necessary knowledge and competency based skills for those people on route to a higher level qualification at level 3, involving the maintenance and management of hydraulic 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 LEVEL 2

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 is 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:

- 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 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 ranging from that of short courses to distance learning and centre based modules. The time scale 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 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 competency based programme is 1-2 years but this does depend upon previous experience and the learning mode devised by the centre and will require a high level of personal commitment to study and research the subjects within the syllabus.

Practical task preparation and competency-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 competency-based units will result in the award of a CETOP Level 2 Hydraulics Qualification Certificate. (Candidates successfully completing only one unit might receive a CETOP Unit Certificate).

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e-mail: education@cetop.org

PRACTICAL TASK ASSESSMENT

When assessing competency based skills, the following processes must be followed:

- Relating to the occupational level, a series of Assessed Abilities are identified. These represent the ”DOING PART” of a person’s job and requires a combination of both practical skills and applied knowledge.
- For each Assessed Ability, evidence of performance is then established and shown as EVIDENCE REQUIRED (sometimes termed performance criteria).

In all cases, candidates must meet the requirements of each Assessed Ability on at least two occasions.

During practical task assessment, the ASSESSOR will agree the ”type of evidence” to be obtained and this can range from:

- Direct Observation
- Verbal Questioning/Candidate Commentary
- Written Report

and may include all types.

Assessment Requirements

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

Assessed Ability

H2.1 Interpret hydraulic circuit diagrams applicable to selected systems.

Evidence Required

H2.1.1 Machine function and operation correctly identified.
H2.1.2 Components named and function identified.
H2.1.3 Component control methods identified.

Assessed Ability

H2.2 Assemble a hydraulic system from given information and carry out effective fault diagnosis.

Evidence Required

H2.2.1 Components selected and checked against specification.
H 2.2.2 Installation plan prepared (order of actions to be taken).
H2.2.3 Safe working practices followed at all times.
H2.2.4 Components commissioned by following prescribed procedures.
H2.2.5 Start-up procedures followed.
H2.2.6 System operational checks carried out and results recorded.
H2.2.7 System operates according to specification.
H2.2.8 System fails to operate according to specification – ”Fault, Cause, Remedy” Approach to fault diagnosis is effectively applied to re-establish

Assessed Ability

H2.3 Pump performance test carried out to assess Q/P relationship under load conditions.

Evidence Required

H2.3.1 Correct diagnostic equipment selected.
H2.3.2 Establish test procedures followed.
H2.3.3 Safe working practices followed at all times.
H2.3.4 Pump specification checked.
H2.3.5 Performance results recorded and written report completed covering all actions taken.

Assessed Ability

H2.4 System contamination levels assessed against established target cleanliness levels.

Evidence Required

H2.4.1 Established oil sampling procedures followed.
H2.4.2 Cleanliness control procedures followed to ensure representative sample is taken.
H2.4.3 Sample identification procedures followed.
H2.4.4 Safe working practices followed at all times.
H2.4.5 Sample analysis procedures followed and comparison checks made to determine cleanliness level.
H2.4.6 Written report completed.

HYDRAULICS PROGRAMME KNOWLEDGE BASED UNIT

CONTENTS

KNOWLEDGE BASED UNIT – WRITTEN EXAMINATION SPECIFICATION

The examination paper will contain questions from all sections of the programme.

- Examination minimum duration 2 consecutive hours
- Pass mark 60%
- Question style may be single subject, multiple subject, short answer, multiple choice
- All questions will carry equal marks

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

HYDRAULICS PROGRAMME - (Knowledge Based Unit)

H 2.5.1 Fundamental Hydraulic Principles

State and use the fundamental principles underpinning the operation of Hydraulic systems and know how they affect performance:

a) Pascal's Law (static and dynamic pressure).

b) Know the cause and effect of pressure generation, pressure losses, heat generation, fluid leakage, cavitation, aeration, noise and vibration.

c) State and use the relationship between:
• pressure, area and the force transmitted by a cylinder
• flow rate, cylinder dimensions and cylinder velocity
• pressure, displacement and hydraulic motor torque
• flow rate, displacement and motor speed
• pump displacement, shaft speed and flow rate
• pump flow rate, operating pressure and hydraulic power
• motors and actuators
• filters and coolers
• pipe work, rigid and flexible

H 2.5.2 Hydraulic System Components

Describe the function and operation of control valves and recognize their graphical symbols on associated circuitry.

a) Flow control:
• flow control devices both fixed and adjustable
• pressure and temperature compensated flow control devices
• flow dividers – spool, rotary and priority

b) Pressure control:
• relief valves – single and two stage
• vented vent control and unloading principles

• pressure reducing – single and two stage (two way and three way operations)
• counterbalance with remote pilot
• joystick control
• sequence valves

c) Load Holding and Motion Control:
• pilot operated check valves
• counterbalance with remote pilot
• hose burst valves

d) Directional Control devices and methods of control:
• check valves
• pilot operated check valves
• spool valves – including two stage
• multiple port mobile valve (open and closed center including load sensing arrangements, involving pre-compensation)
• control methods including manual, oil pilot and Electro-Hydraulic
• poppet valves
• rotary valves
• manual/pilot/on-off solenoid operation
• introduction to proportional control

H 2.5.3 Pumps and Associated Control Systems Describe the function and operation of Hydraulic pumps and listed control systems, plus set up pro- cedures as prescribed.

a) Pumps:
- external gear
- internal gear
- gerotor
- vane (fixed and variable)
- axial piston (fixed and variable)
- bent axis (fixed and variable)
- radial piston (fixed and variable)

b) Control features:
- fixed pumps with relief valve involving vent control
- unloading (two pump system)
- pressure compensation with and without load sensing
- manual displacement control
- constant power control

c) Pump relationship between pressure and flow (Q/P) characteristics.

d) Compensator setting up procedures involving standby and pressure limiting compensators.

e) Effects of electric motor/engine speed on pump performance.

H 2.5.4 Hydraulic Actuators
Describe function and operation of hydraulic actuators.

a) Motor types:
- gear
- gerotor/orbit
- vane
- radial piston – single and two speed
- axial piston – fixed and variable displacement
- bent axis – fixed and variable displacement

b) Motor performance:
- series circuitry
- parallel circuitry

c) Cylinders, types, construction, sealing and mounting arrangements:
- single acting
- double acting
- through rod
- sealing
- mounting arrangements
- cushioning

d) Semi-rotary actuators:
- rack and pinion type
- vane type
- others

H 2.5.5 Circuitry and Control Features
Interpret listed circuitry, including basic electrical symbols and circuits.

a) counterbalance and load holding

b) closed hydrostatic circuitry including:
- pump control features
- motor control features

c) two pump unloaded valve circuit

d) pump control circuit including pressure compensation, load sensing and constant pow- er/torque

e) hydrostatic steering circuitry (non-dynamic) including:
- open center
- closed center

f) mobile valve circuitry involving joystick pilot oil control, including:
- open center valve spool arrangements
- closed center valve spool arrangements

g) braking circuitry involving:
- parking brakes
- service brakes

h) regenerative circuitry

i) power take off arrangements for pump trans- mission applying step up/step down gearbox

j) Electrical symbols and associated circuitry:
- NO and NC contacts
- solenoids (AC and DC)
- relays

H 2.5.6 Hydraulic Fluids
Describe the functions and characteristics of hydraulic fluids.

a) Functions:
- power transmission
- lubrication
- cooling
- sealing
- carrier for contaminants

b) Characteristics and properties and their effect on system performance:
- viscosity
- viscosity index
- lubricity
- oxidation
- pour point
- demulsibility
- material compatibility

c) Oil types and application:
- mineral oil
- emulsions
- glycols
- bio-degradable fluids
- engine oils (SAE grades)
- transmission fluids

d) Storage, handling and transfer:
- explain the need for correct storage, handling, transfer systems and associated cleanliness control
- regulations and requirements relating to safe handling and disposal

H 2.5.7 Reservoirs and Conditioning Equipment

Describe the function of a reservoir and associated fluid conditioning equipment.

a) Describe a typical reservoir with respect to:
- size (relate to pump capacity) with reference to open and closed systems
- general construction
- return line arrangements
- filling arrangements
- level/temperature indication
- contamination control

b) Describe methods of fluid cooling:
- reservoir (size, siting)
- air blast coolers
- water cooled coolers

H2.5.8 Hydraulic pressure equipment and safety components

Describe function, operation and typical applications of accumulator installation.

Describe
- bladder type
- piston type
- diaphragm type
- safety components
- safety and control features to PED
- pre-charge procedures

H 2.5.9 Contamination Control

Describe contamination control methods.

- origins of contamination
- cleanliness targets – achieving and maintaining
- monitoring fluid condition (sampling and measurement)
- preventive/correction actions
- filter performance and ratings
- filter types
- locations and performance

H 2.5.10 Maintenance, Monitoring and Fault Finding Procedures

Describe maintenance, Monitoring and fault finding procedures.

a) Know the importance of RISK MANAGEMENT:
- safe working practices (risk assessment)
- following established procedures
- regular use of diagnostic and test equipment
- analysis of results
- record keeping

b) List common faults and possible causes and effects on system performance:
- high noise level
- vibration
- system/component temperature high
- erratic operations (stick-slip, air inclusion, cavitation, aeration, dieseling)
- incorrect pressure
- incorrect actuator speed
- failing to work within component manufacturers' recommendations
- failure to hold position/load
- leakage

c) Describe procedures that should be followed when carrying out fault diagnosis and rectification:
- safe working practices and associated risk assessments
- identifying the nature of the fault
- identify and remove the cause of the fault and take steps to prevent re- occurrence
- identify information required for effective fault diagnosis and rectification
- use of test equipment and diagnostic techniques
- use of FCR (fault, cause, remedy) procedures
- importance of accurate record keeping
- establishing system restart procedures and emergency stop procedures
- re-establishing the workplace "fit for purpose"
- know the difference between preventive action versus corrective action

MOBILE HYDRAULICS & ASSOCIATED CONTROL PROGRAMME (MH2): RE 2015/06.01 - H

CETOP (Passport) Occupational Level 2

INTRODUCTION

This is a LEVEL 2 Hydraulics 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 both Industrial and Mobile hydraulic 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 LEVEL 2

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 is 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:

- 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 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 ranging from that of short courses to distance learning and centre based modules. The time scale 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 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 but this does depend upon previous experience and the learning mode devised by the centre and will require a high level of personal commitment to study and research the subjects within the syllabus.

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

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PRACTICAL TASK ASSESSMENT (MH2)

When assessing competence, the following processes must be followed:

- Relating to the occupational level, a series of Assessed Abilities are identified. These represent the ”DOING PART” of a person’s job and requires a combination of both practical skills and applied knowledge.

- For each Assessed Ability, evidence of performance is then established and shown as EVIDENCE REQUIRED (sometimes termed performance criteria).

Practical task assessments to verify competency against the agreed performance criteria will be carried out at the approved centre during the education programme period. It could be arranged on one to one base or in groups, candidate/ candidates to tutor.

During practical task assessment, the ASSESSOR will agree the ”type of evidence” to be obtained and this can range from:

- Direct Observation
- Verbal Questioning/Candidate Commentary
- Written Report

and may include all types.

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

Assessed Ability
MH2.1 Interpret hydraulic circuit diagrams applicable to selected systems.

Evidence Required
MH2.1.1 Machine function and operation correctly identified.
MH2.1.2 Components named and function identified.
MH2.1.3 Component control methods identified.

Assessed Ability
MH 2.2 Assemble a hydraulic system from given information and carry out effective fault diagnosis.

Evidence Required
MH 2.2.1 Components selected and checked against specification.
MH 2.2.2 Installation plan prepared (order of actions to be taken).
MH 2.2.3 Safe working practices followed at all times.
MH 2.2.4 Components commissioned by following prescribed procedures.
MH 2.2.5 Start up procedures followed.
MH 2.2.6 System operational checks carried out and results recorded.
MH 2.2.7 System operates according to specification.
MH 2.2.8 System fails to operate according to specification – ”Fault, Cause, Remedy” Approach to fault diagnosis is effectively applied to re-establish 2.2.7.

Assessed Ability
MH 2.3 Pump performance test carried out to assess Q/P relationship under load conditions.

Evidence Required
MH 2.3.1 Correct diagnostic equipment selected.
MH 2.3.2 Establish test procedures followed.
MH 2.3.3 Safe working practices followed at all times.
MH 2.3.4 Pump specification checked.
MH 2.3.5 Engine speed for test established.
MH 2.3.6 Performance results recorded and written report completed covering all actions taken.

Assessed Ability

MH 2.4 System contamination levels assessed against established target cleanliness levels.

Evidence Required

MH 2.4.1 Established oil sampling procedures followed.
MH 2.4.2 Cleanliness control procedures followed to ensure representative sample is taken.
MH 2.4.3 Sample identification procedures followed.
MH 2.4.4 Safe working practices followed at all times.
MH 2.4.5 Sample analysis procedures followed and comparison checks made to determine cleanliness level.
MH 2.4.6 Written report completed.

MOBILE HYDRAULICS PROGRAMME KNOWLEDGE BASED UNIT (MH2)

CONTENTS

KNOWLEDGE BASED UNIT – WRITTEN EXAMINATION SPECIFICATION

The examination paper will contain questions from all sections of the programme.

- Examination minimum duration 2 consecutive hours
- Pass mark 60%
- Question style may be single subject, multiple subject, short answer and multiple choice
- All questions will carry equal marks

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

MOBILE HYDRAULICS PROGRAMME - (Knowledge Based Unit)

MH2.5.1 Fundamental Hydraulic Principles and Basic Circuit Configuration

State and use the fundamental principles underpinning the operation of Hydraulic systems and know how they affect performance:

a) Pascal's Law (static and dynamic pressure).

b) Know the cause and effect of pressure generation, pressure losses, heat generation, fluid leakage, cavitation, aeration, noise and vibration.

c) State and use the relationship between:
- pressure, area and the force transmitted by a cylinder
- flow rate, cylinder dimensions and cylinder velocity
- pressure, displacement and hydraulic motor torque
- flow rate, displacement and motor speed
- pump displacement, shaft speed and flow rate
- pump flow rate, operating pressure and hydraulic power
- volumetric efficiency, mechanical efficiency and overall efficiency of pumps and motors
- pipe diameters, flow rates, fluid viscosity and pressure losses

d) Outline the basic building blocks and circuit configuration for a typical mobile machine:
- engine
- main and auxiliary pumps
- reservoir and fluid
- steering and braking systems
- valve control systems
- motors and actuators
- filters and coolers
- pipe work, rigid and flexible

MH 2.5.2 Hydraulic System Components

Describe the function and operation of control valves and recognize their graphical symbols on associated circuitry.

a) Flow control:
- flow control devices both fixed and adjustable
- pressure and temperature compensated flow control devices
- flow dividers – spool, rotary and priority

b) Pressure control:
- relief valves – single and two stage
- vented vent control and unloading principles

• pressure reducing (two way and three way operations)
• joystick control
• sequence valves

c) Load Holding and Motion Control:
• pilot operated check valves
• counterbalance with remote pilot
• hose burst valves

d) Directional Control devices and methods of control (including proportional control):
• multiple port mobile valve (open and closed center including load sensing arrangements, involving pre-compensation)
• control methods including manual, oil pilot and Electro-Hydraulic
• spool valves – including two stage configurations to ISO standards
• poppet valves
• rotary valves
• manual/pilot/on-off solenoid operation and proportional control

MH 2.5.3 Pumps and Associated Control Systems
Describe the function and operation of Hydraulic pumps and listed control systems, plus set up procedures as prescribed.

a) Pumps:
• external gear
• internal gear
• gerotor
• vane (fixed and variable)
• axial piston (fixed and variable)
• bent axis (fixed and variable)

b) Control features:
• fixed pumps with relief valve involving vent control
• unloading (two pump system)
• pressure compensation with and without load sensing
• manual displacement control
• constant power control

c) Pump relationship between pressure and flow (Q/P) characteristics.

d) Compensator setting up procedures involving standby and pressure limiting compensators.

e) Effects of engine speed on pump performance.

MH 2.5.4 Hydraulic Actuators
Describe function and operation of Hydraulic actuators.

a) Motor types:
• gear
• gerotor/orbit
• vane
• radial piston – single and two speed
• axial piston – fixed and variable displacement
• bent axis – fixed and variable displacement

b) Motor performance:
• series circuitry
• parallel circuitry

c) Cylinders, types, construction, sealing and mounting arrangements:
• single acting
• double acting
• telescopic
• sealing
• mounting arrangements
• cushioning

d) Semi-rotary actuators:
• rack and pinion type
• vane type

MH 2.5.5 Circuitry and Control Features
Interpret listed circuitry and associated drive systems.

a) counterbalance and load holding

b) closed hydrostatic circuitry including:
• pump control features
• motor control features

c) two pump unloaded valve circuit

d)pump control circuit including pressure compensation, load sensing and constant power/torque

e) hydrostatic steering circuitry (non-dynamic) including:
• open center
• closed center

f) mobile valve circuitry involving joystick pilot oil control, including:
• open center valve spool arrangements
• closed center valve spool arrangements

g) braking circuitry involving:
• parking brakes
• service brakes

h) regenerative circuitry

i) power take off arrangements for pump transmission applying step up/step down gearbox

MH 2.5.6 Hydraulic Fluids
Describe the functions and characteristics of hydraulic fluids.

a) Functions:
• power transmission
• lubrication
• cooling
• sealing
• carrier for contaminants

b) Characteristics and properties and their effect on system performance:
• viscosity
• viscosity index
• lubricity
• oxidation
• pour point
• demulsibility
• material compatibility

c) Oil types and application:
• mineral oil
• glycols
• bio-degradable fluids
• engine oils (SAE grades)
• transmission fluids

d) Storage, handling and transfer:
• explain the need for correct storage, handling, transfer systems and associated cleanliness control
• COSHH regulations and requirements relating to unsafe handling and disposal

MH 2.5.7 Reservoirs and Auxiliary Equipment
Describe the function of a reservoir and associated fluid conditioning equipment and auxiliary components.

a) Describe a typical reservoir with respect to:
• size (relate to pump capacity) with reference to open and closed systems
• general construction
• return line arrangements
• filling arrangements
• level/temperature indication
• contamination control

b) Describe methods of fluid cooling:
• reservoir (size, siting)
• air blast coolers
• water cooled coolers

c) Describe function, operation and typical applications of Accumulators:
• bladder type
• piston type
• diaphragm type
• safety and control features
• pre-charge procedures

MH 2.5.8 Contamination Control
Describe contamination control methods.

• origins of contamination
• cleanliness targets – achieving and maintaining
• monitoring fluid condition (sampling and measurement)
• preventive/correction actions
• filter performance and ratings
• filter types
• locations and performance

MH 2.5.9 Maintenance, Monitoring and Fault Finding Procedures
Describe maintenance, monitoring and fault finding procedures.

a) Know the importance of RISK MANAGEMENT:
• safe working practices (risk assessment)
• following established procedures
• regular use of diagnostic and test equipment
• analysis of results
• record keeping

b) List common faults and possible causes and effects on system performance:
• high noise level
• vibration
• system/component temperature high
• erratic operations (stick-slip, air inclusion, cavitation, aeration, dieseling)
• incorrect pressure
• incorrect actuator speed
• failing to work within component manufacturers' recommendations
• failure to hold position/load
• leakage

c) Describe procedures that should be followed when carrying out fault diagnosis and rectification:

• safe working practices and associated risk assessments
• identifying the nature of the fault

- identify and remove the cause of the fault and take steps to prevent re-occurrence
- identify information required for effective fault diagnosis and rectification
- use of test equipment and diagnostic techniques
- use of *FCR* (fault, cause, remedy) procedures
- importance of accurate record keeping
- establishing system restart procedures and emergency stop procedures
- re-establishing the workplace ”fit for purpose”
- know the difference between preventive action versus corrective action

INDUSTRIAL HYDRAULICS & ASSOCIATED CONTROL PROGRAMME (IH2) CETOP RE 2015/06.01 - H

CETOP (Passport) Occupational Level 2

INTRODUCTION

This is a LEVEL 2 Hydraulics 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 both Industrial and Mobile hydraulic 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 LEVEL 2

LEVEL (2) This person will perform a variety of activities needing some understanding of the technical factors involved. The activities may re- quire 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 is 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:

- 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 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 ranging from that of short courses to distance learning and centre based modules. The time scale 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 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 but this does de-pend upon previous experience and the learning mode devised by the centre and will require a high level of personal commitment to study and re-search the subjects within the syllabus.

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

PDF version of this document can be obtained on the CETOP web-site: www.cetop.org
e-mail: education@cetop.org

PRACTICAL TASK ASSESSMENT (IH2)

When assessing competence, the following processes must be followed:

- Relating to the occupational level, a series of Assessed Abilities are identified. These represent the ”DOING PART” of a person’s job and requires a combination of both practical skills and applied knowledge.
- For each Assessed Ability, evidence of perform- ance is then established and shown as EVIDENCE REQUIRED (sometimes termed performance criteria).

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.

During practical task assessment, the ASSESSOR will agree the ”type of evidence” to be obtained and this can range from:

- Direct Observation
- Verbal Questioning/Candidate Commentary
- Written Report

and may include all types.

Assessment Requirements

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

Assessed Ability

IH2.1 Interpret hydraulic circuit diagrams applicable to selected systems.

Evidence Required

IH 2.1.1 Machine function and operation correctly identified.
IH 2.1.2 Components named and function identified.
IH2.1.3 Component control methods identified.

Assessed Ability

IH2.2 Assemble a hydraulic system from given information and carry out effective fault diagnosis.

Evidence Required

IH 2.2.1 Components selected and checked against specification.
IH 2.2.2 Installation plan prepared (order of actions to be taken).
IH 2.2.3 Safe working practices followed at all times.
IH 2.2.4 Components commissioned by following prescribed procedures.
IH 2.2.5 Start up procedures followed.
IH 2.2.6 System operational checks carried out and results recorded.
IH 2.2.7 System operates according to specification.
IH 2.2.8 System fails to operate according to specification – ”Fault, Cause, Remedy” Approach to fault diagnosis is effectively applied to re-establish 2.2.7.

Assessed Ability

IH2.3 Pump performance test carried out to assess Q/P relationship under load conditions.

Evidence Required

IH 2.3.1 Correct diagnostic equipment selected.
IH 2.3.2 Establish test procedures followed.
IH 2.3.3 Safe working practices followed at all times.
IH 2.3.4 Pump specification checked.

IH 2.3.5 Performance results recorded and written report completed covering all actions taken.

Assessed Ability

IH 2.4 System contamination levels assessed against established target cleanliness levels.

Evidence Required

IH2.4.1 Established oil sampling procedures followed.
IH2.4.2 Cleanliness control procedures followed to ensure representative sample is taken.
IH2.4.3 Sample identification procedures followed.
IH2.4.4 Safe working practices followed at all times.
IH2.4.5 Sample analysis procedures followed and comparison checks made to determine cleanliness level.
IH2.4.6 Written report completed.

INDUSTRIAL HYDRAULICS PROGRAMME KNOWLEDGE BASED UNIT (IH2)

CONTENTS

KNOWLEDGE BASED UNIT – WRITTEN EXAMINATION SPECIFICATION

The examination paper will contain questions from all sections of the programme.

- Examination minimum duration 2 consecutive hours
- Pass mark 60%
- Question style may be single subject, multiple subject, short answer, multiple choice
- All questions will carry equal marks

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

INDUSTRIAL HYDRAULICS PROGRAMME - (Knowledge Based Unit)

IH 2.5.1 Fundamental Hydraulic Principles

State and use the fundamental principles underpinning the operation of Hydraulic systems and know how they affect performance:

a) Pascal's Law (static and dynamic pressure).

b) Know the cause and effect of pressure generation, pressure losses, heat generation, fluid leakage, cavitation, aeration, noise and vibration.

c) State and use the relationship between:
- pressure, area and the force transmitted by a cylinder
- flow rate, cylinder dimensions and cylinder velocity
- pressure, displacement and hydraulic motor torque
- flow rate, displacement and motor speed
- pump displacement, shaft speed and flow rate
- pump flow rate, operating pressure and hydraulic power
- volumetric efficiency, mechanical efficiency and overall efficiency of pumps and motors
- pipe diameters, flow rates, fluid viscosity and pressure losses

IH 2.5.2 Hydraulic System Components

Describe the function and operation of control valves and recognize their graphical symbols on associated circuitry.

a) Flow control:
- flow control devices both fixed and adjustable
- pressure and temperature compensated flow control devices
- flow dividers – spool, rotary and priority

b) Pressure control:
- relief valves – single and two stage
- vented vent control and unloading principles
- pressure reducing – single and two stage (two way and three way operations)
- counterbalance with remote pilot
- sequence valves

c) Directional Control devices and methods of control:
- check valves
- pilot operated check valves
- spool valves – including two stage
- poppet valves
- rotary valves

• manual/pilot/on-off solenoid operation
• introduction to proportional control

IH 2.5.3 Pumps and Associated Control Systems

Describe the function and operation of Hydraulic pumps and listed control systems, plus set up pro-cedures as prescribed.

a) Pumps:
• external gear
• internal gear
• gerotor
• vane (fixed and variable)
• axial piston (fixed and variable)
• bent axis (fixed and variable)
• radial piston (fixed and variable)

b) Control features:
• fixed pumps with relief valve involving vent control
• unloading (two pump system)
• pressure compensation with and without load sensing
• manual displacement control

c) Pump relationship between pressure and flow (Q/P) characteristics.

d) Compensator setting up procedures involving standby and pressure limiting compensators.

IH 2.5.4 Hydraulic Actuators

Describe function and operation of hydraulic actuators.

a) Motor types:
• gear
• gerotor/orbit
• vane
• radial piston – single and two speed
• axial piston – fixed and variable displacement
• bent axis – fixed and variable displacement

b) Motor performance:
• series circuitry
• parallel circuitry

c) Cylinders, types, construction, sealing and mounting arrangements:
• single acting
• double acting
• through rod
• sealing
• mounting arrangements
• cushioning

d) Semi-rotary actuators:
• rack and pinion type
• vane type
• others

IH 2.5.5 Circuitry and Control Features

Interpret listed circuitry, including basic electrical symbols and circuits.

• counterbalance
• regenerative circuit
• two pump (Hi-Lo) circuits
• sequence valve circuitry
• P O checks. (Load holding, pre-fill/decompression)
• closed hydrostatic circuitry

a) Electrical symbols and associated circuitry:
• NO and NC contacts
• solenoids (AC and DC)
• relays

IH 2.5.6 Hydraulic Fluids

Describe the functions and characteristics of hydraulic fluids.

a) Functions:
• power transmission
• lubrication
• cooling
• sealing
• carrier for contaminants

b) Characteristics and properties and their effect on system performance:
• viscosity
• viscosity index
• lubricity
• oxidation
• pour point
• demulsibility
• material compatibility

c) Oil types and application:
• mineral oil
• emulsions
• glycols
• bio-degradable fluids

d) Storage, handling and transfer:
• explain the need for correct storage, handling, transfer systems and associated cleanliness control
• regulations and requirements relating to safe handling and disposal

IH 2.5.7 Reservoirs and Auxiliary Equipment
Describe the function of a reservoir and associated fluid conditioning equipment and auxiliary components.

a) Describe a typical reservoir with respect to:
• size (relate to pump capacity)
• general construction
• return line arrangements
• filling arrangements
• level/temperature indication
• contamination control

b) Describe methods of fluid cooling:
• reservoir (size, siting)
• air blast coolers
• water cooled coolers

c) Describe function, operation and typical applications of accumulators:
• bladder type
• piston type
• diaphragm type
• safety and control features
• pre-charge procedures

IH 2.5.8 Contamination Control
Describe contamination control methods.

• origins of contamination
• cleanliness targets – achieving and maintaining
• monitoring fluid condition (sampling and measurement)
• preventive/correction actions
• filter performance and ratings
• filter types
• locations and performance

IH 2.5.9 Maintenance, Monitoring and Fault Finding Procedures
Describe maintenance, Monitoring and fault finding procedures.

a) Know the importance of RISK MANAGEMENT:
• safe working practices (risk assessment)
• following established procedures
• regular use of diagnostic and test equipment
• analysis of results
• record keeping

b) List common faults and possible causes and effects on system performance:
• high noise level
• vibration
• system/component temperature high
• erratic operations (stick-slip, air inclusion, cavitation, aeration, dieseling)
• incorrect pressure
• incorrect actuator speed
• failing to work within component manufacturers' recommendations
• failure to hold position/load
• leakage

c) Describe procedures that should be followed when carrying out fault diagnosis and rectification:
• safe working practices and associated risk assessments
• identifying the nature of the fault
• identify and remove the cause of the fault and take steps to prevent re-occurrence
• identify information required for effective fault diagnosis and rectification
• use of test equipment and diagnostic techniques
• use of FCR (fault, cause, remedy) procedures
• importance of accurate record keeping
• establishing system restart procedures
• re-establishing the workplace "fit for purpose"
• preventive versus corrective action

HYDRAULICS & ASSOCIATED CONTROL PROGRAMME (H3): RE 2015/06.01 - H

CETOP (Passport) Occupational Level 3

INTRODUCTION

This is a LEVEL 3 Hydraulics Programme, forming the start of a series of competency-based qualifications designed around CETOP occupational levels.
It combines the necessary knowledge and competency based skills for those people on route to this high level of qualification, involving the maintenance and management of both Industrial and Mobile hydraulic 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 is 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:

- 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 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 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 a competency based programme is one to three years depending on work experience within hydraulics and will require a high level of personal commitment to study and research the subjects within the syllabus.

Practical task assessments to verify competency against the agreed performance criteria will be carried out at the approved centre during the education programme period. It could be arranged on one to one base or in groups, candidate/ candidates to tutor.

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 competency based units will result in the award of a CETOP Level 3 Hydraulics Qualification Certificate. Candidates successfully completing only one unit will receive a CETOP Unit Certificate.

PRACTICAL TASK ASSESSMENT (H3)

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

Assessed Ability

H3.1 Interpret hydraulic and Electro-Hydraulic circuit diagrams applicable to selected systems (against recommended specification) and prepare a schematic representation of the system.

Evidence Required

H3.1.1 Machine function and operating principles identified.
H3.1.2 Components correctly identified.
H3.1.3 Function and operation of individual sub-circuits correctly identified.
H3.1.4 Machine control inputs and outputs identified.

Assessed Ability

H3.2 Assemble a hydraulic system from given information and establish suit- able maintenance procedures.

Evidence Required

H3.2.1 Components selected and conformance checked against system specification.
H 3.2.2 Installation plan prepared.
H3.2.3 System assembled in a safe and efficient manner.
H3.2.4 Commissioning procedures followed in accordance with technical specification.
H 3.2.5 Startup procedures correctly specified and followed.
H3.2.6 System operated according to specification.
H3.2.7 Establish predictive maintenance procedures to be followed, including:
- component performance testing
- fluid sampling and assessment of contamination level against target level.
- electrical input and output signals involving on/off and proportional control systems

Assessed Ability

H3.3 Carry out effective fault diagnosis and rectification.

Evidence Required

H3.3.1 Nature of fault correctly identified.
H3.3.2 Fault, cause, remedy checklist prepared.
H3.3.3 Diagnostics used to locate fault.
H3.3.4 Safe working practices followed at all times.
H3.3.5 Faulty components replaced.
H3.3.6 Cause and effect of faults assessed.
H3.3.7 System re-commissioned in accordance with set procedures.
H3.3.8 System operated according to machine specification.

Assessed Ability

H3.4 Designated or faulty component replacement carried out in accordance with given information.

Evidence Required

H3.4 Establish documented procedures and carry out proactive maintenance and monitoring of Electro-Hydraulic systems.

Evidence Required

H3.4.1 System assessed to determine service/maintenance schedule requirements.
H3.4.2 System assessed to determine routine monitoring requirements.
H3.4.3 Documented system established including safety requirements/risk assessment.
H3.4.4 Performance testing carried out and results recorded.
H3.4.5 Electrical input and output signals involving on-off and proportional control systems checked and recorded.
H3.4.6 Fluid sampling carried out and contamination levels assessed against target cleanliness and result recorded.
H3.4.7 Manufacturers recommendations and specifications checked against results.
H 3.4.8 Safe working practices followed at all times.
H3.4.9 Work place re-established to required levels of tidiness and cleanliness.

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

KNOWLEDGE BASED SECTION (H3) CONTENTS

KNOWLEDGE BASED UNIT – WRITTEN EXAMINATION SPECIFICATION

The examination paper will contain 8 questions integrating the above 22 sections

- Examination duration will be 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

HYDRAULICS PROGRAMME (Knowledge Based Section)

In addition to demonstrating an understanding of Hydraulic Systems and Associated Control, candidates must prove ability to:

H 3.5.1 Fundamental and Scientific Principles

Describe the fundamental principles of power transmission by hydraulics and associated scientific principles underlying its use.

a) List the basic building blocks and describe their function with reference to:
prime movers, pumps, reservoirs, fluids, control valves, filters, coolers, pipe work and manifold blocks.

b) Know the cause and effect of pressure generation, pressure losses, heat generation, fluid leakage, cavitation, aeration, noise and vibration.

c) Know the difference between laminar and turbulent flow and their effect on system performance.

d) Know the meaning of the term Reynolds Number and use the associated formula.

e) Know the difference between static and dynamic pressure.

f) Know the quantities and units:
pressure, force, area, displacement, flow rate, speed/velocity, torque and power.

g) Know the formulae relating to:
pressure, force, area, displacement, flow rate, speed/velocity, torque and power.

h) Know the principles of heat dissipation and temperature control:
heat sinks within a system (reservoirs, pipe work and coolers) and effects of ambient conditions and working cycle.

i) State and use the relationship between: pressure, force and area for cylinders and pressure, torque and displacement per revolution for pumps and motors.

j) State and use the relationship between:
flow, area and velocity for cylinders, and flow, displacement per revolution and shaft speeds for pumps and motors.

k) Know the relationship between:
input and output powers of pumps and motors and the causes of volumetric and mechanical inefficiencies.

H 3.5.2 Application and Fundamental Principles

Describe the application of the fundamental principles with regard to:

a) Relationship between flow rate, pressure drop, restriction, power and heat.

b) Control of pressure
- pressure generation
- pressure limiting
- pressure unloading
- pressure reducing
- pressure intensification

c) Control of flow
- non-compensated flow control
- pressure compensated flow control
- temperature compensated flow control
- flow dividing
- regenerative flow
- damping
- meter-in, meter-out and by-pass flow control

d) Control of movement
- acceleration and deceleration control
- stopping or preventing movement
- changing direction

H 3.5.3 Hydraulic Fluids

Describe the application and selection of fluids for use in hydraulic systems relating to:

a) Functions
- power transmission
- lubrication
- cooling

b) Characteristics and properties (behavior and effect on system performance):
- viscosity
- viscosity index
- lubrication
- thermal stability (oxidation)
- pour point
- remissibility
- shear stability
- compressibility
- material compatibility
- foaming and aeration resistance
- filterability
- specific gravity
- fire-resistance

c) Types of fluids in common use in hydraulic applications
- ISO/SAE viscosity grades
- classifications to ISO standards

d) Fluid selection for typical applications (factors to be considered):
- environmental considerations
- fire resistance
- toxicity
- water separation
- filterability

e) Fluid storage, handling and transfer:
- explain the need for correct storage, handling, cleanliness control and transfer systems to be in place and controlled by working procedures

f) Explain the need for cleanliness control systems to be in place and associated fluid analysis procedures and monitoring

H 3.5.4 Valve Mounting Styles/Configurations

Describe valve mounting styles, standardized interfaces, sizes, flow rates, port layouts and sealing arrangements, relating to:

- pipe mounting/line mounting
- sub-plate mounting
- manifold mounting
- stack, mounting
- flange mounted valves
- screw in cartridge
- slip in cartridge
- ISO interface valves

H 3.5.5 Control Valves

Describe the function, operation and application of control valves and interpret their graphical symbols.

a) Flow control devices (fixed and adjustable:
- non-compensated flow control devices (orifices and throttle valves)
- pressure and temperature compensated flow control valves
- hydrostatics and applications with proportional controls
- priority valves
- spool flow dividers
- rotary flow dividers
- differential lock units

b) Pressure control devices:
- pressure limiting
- single stage, relief valves
- two stage, pilot operated relief valves
- unloading valves
- control features
- vent
- remote control (manual/proportional)
- load sensing
- pressure sensing (application of pressure switches)

- pressure reducing
- single stage and two stage pressure reducing valves
- two way and three way configuration

c) Load Holding and Motion Control:
- pilot operated check valves
- counterbalance with internal and external pilot control (including the effect of pilot ratios)
- hose burst control devices

d) Direction control devices:
- check valves
- pilot operated check valves
- spool valves
- ball valves
- poppet valves
- sequence valves

e) Control features to include simple on-off and proportional control)

H 3.5.6 Mobile multifunction Valves

Describe the function, operation, application and control features of mobile multifunction control valves and interpret their graphical symbols.

a) Mobile spool direction control valves:
- layout/construction (monoblock/sandwich)
- spool configurations (single and multiple) series
- flow paths - parallel, series and tandem arrangements including carry-over and alternative inlet sections
- open centre, closed center, single acting, double-acting motor half motor, regeneration and float arrangements

b) Inlet sections:
- pressure control/unloading facilities/priority
- load sensing connections
- pilot fluid supply

c) Controls:
- manual - spring cantered, mechanical hydraulic and electrical detent
- solenoid and solenoid pilot
- proportional control (with and without spool position monitoring)
- remote control [Joystick], (hydraulic and pneumatic)
- remote control - electrical [Joystick]

d) Special features (including inlet, outlet and service ports):
- flow sharing (pre and post compensation)
- load sensing, pressure limiting and vent control
- load holding
- anti-cavitation
- pressure limiting

e) Valve characteristics:
- valve sizes, flow rates and associated pressure drops
- operating performance (under conditions of closed, partially open and fully open)

H3.5.7 Hydrostatic Steering Systems

Describe the function, operation and application of hydrostatic steering systems and associated control features:

a) Rotary servo steering units:
- open center
- closed center
- reaction and non-reaction types
- load sensing systems
- steer units for electric motor applications
- steer units with 'power beyond' facilities
- flow amplifiers
- dual displacement steer units

b) Priority valves:
- non dynamic types
- dynamic types

c) Steering systems, modes:
- single ram single rod, single ram double rod, double rams single rods
- methods of switching between steering modes

d) Emergency steering systems (manual and powered)

H 3.5.8 Slip-in Logic Cartridge Valves

Describe the function, operation and application Slip-in (logic) cartridge elements

- construction and manifold assembly
- sizes and associated flow rates
- operating principles
- application for pressure, flow and direction control including associated control methods

H 3.5.9 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

H 3.5.10 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
- tacho-generator
- frequency control of electric motor speed

H 3.5.11 Proportional Valve Technology

Describe the principles of proportional valve technology

- list the potential benefits compared to application of “on-off“ operated systems
- describe the difference in performance of a proportional solenoid to that of a standard solenoid
- describe the application of proportional control to pressure, flow and direction control (including feedback and non-feedback valves, direct and two stage versions)
- describe, in block diagram form the control components of a typical proportional valve electronic amplifier
- explain the meaning of the terms: gain adjustment, dead band compensation, ramp control, dither and pulse width modulation and demonstrate an understanding of their effects on system performance
- explain the recommended practices for installing proportional electronic control in terms of: power supply requirements, enable signals, input signal generation, cable shielding, earthling and interface with PLC’s

H 3.5.12 Electronic controls and sensors

Describe and interpret electronic controls and sensor signals including functional safety standards:

Recognize different control signals and functions that will be used in industrial machines

- Types and use of digital BUS systems
- Types and use of different control signals (analog, digital)
- Types and use of different sensor signals
- Functional Safety standards:
  Know the requirements aim of IEC and EN standards

H 3.5.13 Pumps and Associated Control Systems

Describe the function and operation of hydraulic open loop pumps and associated control features:

a) Pumps:
- external gear
- internal gear
- vane (fixed and variable)
- radial piston (fixed and variable)
- axial piston (fixed and variable)
- bent axis piston (fixed and variable)
- multiple pumps

b) Know the power - torque relationship between the prime mover and pump with reference to electric motor/engine speed.

c) Control features:
- fixed pumps with integral pressure and flow control
- fixed pumps with unloaded valve systems
- mechanical/hydraulic servo displacement
- Electro-Hydraulic proportional displacement
- pressure compensation/limiting
- load sensing (constant flow/variable speed)
- constant power
- torque summation control, including prime mover characteristics
- pumps with frequency control of electric motor speed and features

d) Link to prime mover:
- power take off arrangements
- splitter gearbox
- step up and step down gearbox arrangements
- belt drives and clutch arrangements

H 3.5.14 Hydraulic Actuators (Motors and Cylinders)
Describe the function, operation and application of hydraulic actuators, including control features:

a) Motors:
- gear
- gerotor/orbit
- vane
- radial piston
  Including variable and dual displacement control features and associated torque speed characteristics
- axial piston (swash plate)
  Including variable and dual displacement control features and associated torque speed characteristics
- bent axis
  Including variable and dual displacement control features and associated torque speed characteristics
- cam/roller types
  Including variable and dual displacement control features and associated torque speed characteristics

b) Motor features:
- pressure control (pressure compensation)
- displacement (torque/speed control)
- parking brake
- dynamic braking (use of counterbalance valves)

c) Motor performance:
- series circuitry
- parallel circuitry

d) Cylinders, mounting arrangements and construction:
- telescopic
- single acting
- double acting
- sealing
- cushioning
- mounting arrangements
- position monitoring

e) Semi-rotary actuators:
- rack and pinion type
- vane type

H 3.5.15 Closed Loop Hydrostatic Transmissions
Describe the function, operation and application of hydraulic components associated with closed loop hydrostatic transmission systems:

a) Basic configuration:
- close coupled (motor and pump back to back units)

b) Over center piston pumps:
- basic construction (axial, bent axis and radial)
- control methods
- mechanical
- mechanical servo
- pilot pressure
- electronic servo
- pressure/limitation and displacement control
- automotive control

c) Charge pump:
- construction
- charge pump circuitry
- case flushing (including cooling and heating functions)

d) Control valves:
- hot oil shuttle valves
- cross-line relief valves
- counterbalance valves
- free-wheel by-pass valves
- differential lock valves
- parking brake systems

e) Special control features:
- inch control
- creep speed
- brake defeat function
- hydrostatic braking

H 3.5.16 Reservoirs, Conditioning and Auxiliary Components
Describe the purpose of the system reservoir and associated fluid conditioning equipment and auxiliary components.

a) Outline a typical system reservoir in terms of:
- size, with reference to oil and air space and changes in level
- general construction (internal/external), incl. return line and port arrangements to minimize aeration)
- level/temperature indication
- filling connections
- sampling points
- level/temperature indication
- air and oil filtration
- pressurized reservoirs
- use of bladder and diaphragms separators

b) Describe the use of hydraulic fluid systems:
- cooling
- reservoirs (size, siting and layout)
- air blast coolers
- water coolers

H 3.5.17 Hydraulic pressure equipment and safety components

Describe the function, operation and application of hydraulic accumulators, associated safety components and associated selection process and sizing relating to application:

a) Accumulator:
- piston
- bladder
- diaphragm

b) Associated Safety component and control features
Fluid side:
- pressure relief valve
- safety block
- pressure switches

Gas side:
- pressure relief valve
- temperature fuse
- burst disc
- pressure switches

Describe the pressure terms:
- pre-charge pressure (p_0) and control
- working pressure (p_1)
- max. pressure (p_2)

c) Have full knowledge about the fundamental rules of European Pressure Equipment Directive:
- PED

H 3.5.18 Pipes and Hoses – Installation and Commissioning Procedures

Describe installation and commissioning procedures for pipes hoses and seals, and associated selection process and sizing relating to application:

a) Determine from pipe sizing charts and manufacturers' catalogues, suitable pipe/hose diameters associated with flow rates, velocities and acceptable pressure drops.

b) Describe the types and application of seals used in hydraulic systems, with specific reference to:
- static and dynamic seals,
- cylinder seals
- pump and motor shaft seals
- seal materials, selection and compatibility
- replacement methods and care to be taken during installation

c) State the factors that affect system pressure drop:
- pipe/hose dimensions
- pipe work/manifold block configuration
- flow rate
- fluid viscosity and density
- component size/design

d) Hoses types and application:
- wire braided
- 2-wire braided
- spiral wire
- thermoplastic
- high temperature and protective sleeved (abrasion resistant)
- low temperature

e) Hose/pipe fitting and assembly procedures:
- use of adapters and unions,
- use of bite compression fittings
- use of 'O-Ring' fittings
- use of flange type fittings
- use of formed fittings
- use of welded connections

f) Hydraulic hose failures relating to:
- poor installation procedures
- failure to meet required working specification
- system performance
- pipe-work installations
- layout fastenings
- leakage prevention

H 3.5.19 Contamination Control

Describe contamination control methods associated with:

- ingression of contamination and the nature of the contaminant
- preventative measures to reduce ingression to an acceptable level
- establishing a suitable cleanliness target
- achieving and maintaining a cleanliness target (ISO and AS standards)
- measuring and monitoring cleanliness levels
- remedial actions
- filter types, rating, location and performance

H 3.5.20 Machine Circuitry and Control Features (Recognition and use of hydraulics and electrical symbols)

Describe and interpret hydraulic circuits and associated methods of control, including failsafe methods:

Recognize and use current graphical hydraulic and electrical symbols relating to hydraulic systems.

H3.5.21 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 manufacturers' 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/component/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

H 3.5.22 Maintenance, Monitoring and Fault Finding Procedures

Describe maintenance, monitoring and fault-finding procedures:

a) Outline a maintenance scheme, involving per- formance and health monitoring, in terms of:

- maintaining cleanliness standard
- regular use of diagnostic and test equipment
- continuous condition monitoring systems
- analysis of results and actions to be taken
- 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
- leakage detection methods

b) List the common faults encountered in hydraulic systems and associated components and state the possible causes and effects on system performance:

- excessive noise
- vibration
- high system/component temperature
- erratic operation
- leakage
- pressure too high
- pressure too low
- incorrect actuator speed
- incorrect pump flow rate
- incorrect sequence of operations
- loads lowering/failure to hold position
- hose and pipe failure (Section H3.5.18 f)
- contamination level too high

c) Describe procedures to follow when carrying out fault finding, including:

- 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-establishing work place "fit for purpose"
- completion of all necessary reports/documentation

MOBILE HYDRAULICS & ASSOCIATED CONTROL PROGRAMME (MH3): RE 2015/06.01 - H

CETOP (Passport) Occupational Level 3

INTRODUCTION

This is a LEVEL 3 Hydraulics 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 this high level of qualification, involving the maintenance and management of both Industrial and Mobile hydraulic 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 is 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:

- 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 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 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 center-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 a competency based programme is one to three years depending on work experience within hydraulics and will require a high level of personal commitment to study and research the subjects within the syllabus.

Practical task assessments to verify competency against the agreed performance criteria will be carried out at the approved centre during the education programme period. It could be arranged on one to one base or in groups, candidate/ candidates to tutor.

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 competency based units will result in the award of a CETOP Level 3 Mobile Hydraulics Qualification Certificate. Candidates successfully completing only one unit will receive a CETOP Unit Certificate.

PRACTICAL TASK ASSESSMENT (MH3)

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

Assessed Ability

MH 3.1 Interpret hydraulic circuit diagrams applicable to a selected machine and prepare a schematic representation of the system.

Evidence Required

MH3.1.1 Machine function and operating principles identified.
MH3.1.2 Components correctly identified.
MH3.1.3 Function and operation of individual sub-circuits correctly identified.
MH3.1.4 Machine control inputs and outputs identified.

Assessed Ability

MH 3.2 Assemble a hydraulic system from given information and establish suitable maintenance procedures.

Evidence Required

MH3.2.1 Components selected and conformance checked against system specification.
MH 3.2.2 Installation plan prepared.
MH3.2.3 System assembled in a safe and efficient manner.
MH3.2.4 Commissioning procedures followed in accordance with technical specification.
MH3.2.5 Start up procedures correctly specified and followed.
MH3.2.6 System operated according to specification.
MH3.2.7 Establish predictive maintenance procedures to be followed, including:
- component performance testing
- fluid sampling and assessment of contamination level against target level.

Assessed Ability

MH 3.3 Carry out effective fault diagnosis.

Evidence Required

MH3.3.1 Nature of fault correctly identified.
MH3.3.2 Fault, cause, remedy checklist prepared.
MH3.3.3 Diagnostics used to locate fault.
MH3.3.4 Safe working practices followed at all times.
MH 3.3.5 Faulty components replaced.
MH 3.3.6 Cause and effect of faults assessed.
MH 3.3.7 System re-commissioned in accordance with set procedures.
MH3.3.8 System operated according to machine specification.

Assessed Ability

MH 3.4 Designated or faulty component replacement carried out in accordance with given information.

Evidence Required

MH3.4.1 Component checked against technical specification.
MH3.4.2 Action plan procedures prepared.
MH3.4.3 Safe working practices determined and adhered to at all times.
MH3.4.4 Cleanliness control procedures followed at all times.
MH3.4.5 Component removed following recommended procedures and correct tools used at all times.
MH3.4.6 Replacement component installed effectively in accordance with procedures and respective technical data sheets.
MH3.4.7 Commissioning procedures followed and adjustments carried out using correct instrumentation where necessary.
MH3.4.8 Start up procedures correctly specified and followed.
MH3.4.9 System operated according to specification.
MH 3.4.10 Work place re-established to required levels of tidiness and cleanliness.

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

KNOWLEDGE BASED SECTION (MH3)

CONTENTS

KNOWLEDGE BASED UNIT – WRITTEN EXAMINATION SPECIFICATION

The examination paper will contain 8 questions integrating the above 16 sections

- Examination duration will be 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

MOBILE HYDRAULICS PROGRAMME (Knowledge Based Section)

MH3.5.1 Fundamental and Scientific Principles

Describe the fundamental principles of power transmission by hydraulics and associated scientific principles underlying its use.

a) List the basic building blocks and describe their function with reference to: prime movers, pumps, reservoirs, fluids, control valves, filters, coolers, pipe work and manifold blocks.

b) Know the cause and effect of pressure generation, pressure losses, heat generation, fluid leakage, cavitation, aeration, noise and vibration.

c) Know the difference between laminar and turbulent flow and their effect on system performance.

d) Know the meaning of the term Reynolds Number and use the associated formula.

e) Know the difference between static and dynamic pressure.

f) Know the quantities and units: pressure, force, area, displacement, flow rate, speed/velocity, torque and power.

g) Know the formulae relating to: pressure, force, area, displacement, flow rate, speed/velocity, torque and power.

h) Know the principles of heat dissipation and temperature control: heat sinks within a system (reservoirs, pipe work and coolers) and effects of ambient conditions and working cycle.

i) State and use the relationship between: pressure, force and area for cylinders and pressure, torque and displacement per revolution for pumps and motors.

j) State and use the relationship between: flow, area and velocity for cylinders, and flow, displacement per revolution and shaft speeds for pumps and motors.

k) Know the relationship between: input and output powers of pumps and motors and the causes of volumetric and mechanical inefficiencies.

MH3.5.2 Application and Fundamental Principles

Describe the application of the fundamental principles with regard to the:

a) Relationship between flow rate, pressure drop, restriction, power and heat.

b) Control of pressure
- pressure generation
- pressure limiting
- pressure unloading
- pressure reducing
- pressure intensification

c) Control of flow
- non-compensated flow control
- pressure compensated flow control
- temperature compensated flow control
- flow dividing
- regenerative flow
- damping
- meter-in, meter-out and by-pass flow control

d) Control of movement
- acceleration and deceleration control
- stopping or preventing movement
- changing direction

MH3.5.3 Hydraulic Fluids

Describe the application and selection of fluids for use in mobile hydraulic systems relating to:

a) Functions
- power transmission
- lubrication
- cooling

b) Characteristics and properties (behavior and effect on system performance):
- viscosity
- viscosity index
- lubrication
- thermal stability (oxidation)
- pour point
- remissibility
- shear stability
- compressibility
- material compatibility
- foaming and aeration resistance
- filterability
- fire-resistance

c) Types of fluids used in mobile machinery:
- hydraulic fluid
- engine oil
- transmission fluid
- universal oil
- biodegradable fluid
- fire-resistant fluid

d) ISO/SAE viscosity grades

e) Fluid selection for typical applications (factors to be considered):
- environmental considerations
- fire resistance
- toxicity
- water separation
- filterability

f) Fluid storage, handling and transfer:
- explain the need for correct storage, handling, cleanliness control and transfer systems to be in place and controlled by working procedures
- know the requirements associated with COSHH regulations
- explain the need for cleanliness control systems to be in place and associated fluid analysis procedures and monitoring

(ISO and AS standards) see section MH3.5.15

MH3.5.4 Valve Mounting Styles/ Configurations

Describe valve mounting styles, standardized interfaces, sizes, flow rates, port layouts and sealing arrangements, relating to:
- pipe mounting/line mounting
- sub-plate mounting
- manifold mounting
- stack, mounting
- flange mounted valves
- screw in cartridge
- slip in cartridge
- ISO interface valves

MH3.5.5 Control Valves

Describe the function, operation and application of control valves and interpret their graphical symbols.

a) Flow control devices (fixed and adjustable):
- non-compensated flow control devices (orifices and throttle valves)
- pressure and temperature compensated flow control valves
- hydrostatics
- priority valves
- spool flow dividers
- rotary flow dividers
- differential lock units

b) Pressure control devices:
- pressure limiting
- single stage, relief valves
- two stage, pilot operated relief valves
- unloading valves
- control features
- vent
- remote control (manual/proportional)
- load sensing
- pressure reducing
- single stage and two stage pressure reducing valves
- two way and three way configuration

c) Load Holding and Motion Control:
- pilot operated check valves
- counterbalance with internal and external pilot control (including the effect of pilot ratios)
- hose burst control devices

d) Direction control devices:
- check valves
- pilot operated checks
- spool valves
- ball valves
- poppet valves
- sequence valves

(Where appropriate, control features to include simple on-off and proportional control)

MH3.5.6 Mobile multifunction Valves

Describe the function, operation, application and control features of mobile multifunction control valves and interpret their graphical symbols.

a) Mobile spool direction control valves:
- layout/construction (mono-block/sandwich)
- spool configurations (single and multiple) services
- flow paths - parallel, series and tandem arrangements including carry-over and alternative inlet sections
- open center, closed center, single acting, double-acting motor half motor, regeneration and float arrangements

b) Inlet sections:
- pressure control/unloading facilities/priority
- load sensing connections
- pilot fluid supply

c) Controls:
- manual - spring cantered, mechanical hydraulic and electrical detent
- solenoid and solenoid pilot
- proportional control (with and without spool position monitoring)
- remote control [Joystick], (hydraulic and pneumatic)
- remote control - electrical [Joystick]

d) Special features (including inlet, outlet and service ports):
- flow sharing (pre and post compensation)
- load sensing, pressure limiting and vent control
- load holding
- anti-cavitation
- pressure limiting

e) Valve characteristics:
- valve sizes, flow rates and associated pressure drops
- operating performance (under conditions of closed, partially open and fully open)

MH3.5.7 Electrical/Electronic Components

Describe the function and application of electrical/ electronic components

- resistors
- capacitors
- potentiometers
- transformers
- diodes
- electronic switches and sensors
- pressure
- level
- temperature
- flow
- distance
- particle
- water
- proximity and limit switches
- tacho-generator
- etc.

MH3.5.8 Proportional Valve Technology

Describe the principles of proportional valve technology

- list the potential benefits compared to application of lever or “on/off” operated systems
- describe the difference in performance of a proportional solenoid to that of a standard solenoid
- describe the application of proportional control to pressure, flow and direction control describe,
- in block diagram form the control components of a typical proportional valve electronic amplifier explain the meaning of the terms: gain
- adjustment, dead band compensation, ramp control, dither and pulse width modulation and demonstrate an understanding of their effects on system performance explain the recommended practices for
- installing proportional electronic control in terms of: power supply requirements, enable signals, input signal generation, cable shielding, earthing and interface with electronic control systems.

MH3.5.9 Hydrostatic Steering Systems

Describe the function, operation and application of hydrostatic steering systems and associated control features:

a) Rotary servo steering units:
- open centre
- closed centre
- reaction and non-reaction types
- load sensing systems
- steer units for electric motor applications
- steer units with 'power beyond' facilities
- flow amplifiers
- dual displacement steer units

b) Priority valves:
- non dynamic types
- dynamic types

c) Steering systems, modes:
- single ram single rod, single ram double rod, double rams single rods
- methods of switching between steering modes

d) Emergency steering systems (manual and powered)

MH 3.5.10 Pumps and Associated Control Systems

Describe the function and operation of hydraulic open loop pumps and associated control features:

a) Pumps:
- external gear
- internal gear
- vane (fixed and variable)
- radial piston (fixed and variable)
- axial piston (fixed and variable)
- bent axis piston (fixed and variable)
- multiple pumps

b) Know the power - torque relationship between the prime mover and pump with reference to engine speed.

c) Control features:
- fixed pumps with integral pressure and flow control
- fixed pumps with unloaded valve systems
- mechanical/hydraulic servo displacement
- Electro-Hydraulic proportional displacement
- pressure compensation/limiting
- load sensing (constant flow/variable speed)
- torque summation control, including prime mover characteristics

d) Link to prime mover:
- power take off arrangements
- splitter gearbox
- step up and step down gearbox arrangements
- belt drives and clutch arrangements

MH3.5.11Hydraulic Actuators (Motors and Cylinders)

Describe the function, operation and application of hydraulic actuators, including control features:

a) Motors:
- gear
- gerotor/orbit
- vane
- radial piston
  Including variable and dual displacement control features and associated torque speed characteristics
- axial piston (swash plate)
  Including variable and dual displacement control features and associated torque speed characteristics
- bent axis
  Including variable and dual displacement control features and associated torque speed characteristics
- cam/roller types
  Including variable and dual displacement control features and associated torque speed characteristics

b) Motor features:
- pressure control (pressure compensation)
- displacement (torque/speed control)
- parking brake
- dynamic braking (use of counterbalance valves)

c) Motor performance:
- series circuitry
- parallel circuitry

d) Cylinders, mounting arrangements and construction:
- telescopic
- single acting
- double acting
- sealing
- cushioning
- mounting arrangements
- position monitoring

e) Semi-rotary actuators:
- rack and pinion type
- vane type

MH3.5.12 Closed-Loop Hydrostatic Transmissions

Describe the function, operation and application of hydraulic components associated with closed loop hydrostatic transmission systems:

a) Basic configuration:
- close coupled (motor and pump back to back units)
- split units (separate motor and pump) single and double
- multiple pump/motor layouts
- series and parallel operation

b) Over-centre piston pumps:
- basic construction (axial, bent axis and radial)
- control methods
- mechanical
- mechanical servo
- pilot pressure
- electronic servo
- pressure/limitation and displacement control
- automotive control

c) Charge pump:
- construction
- charge pump circuitry
- case flushing (including cooling and heating functions)

d) Control valves:
- hot oil shuttle valves
- cross-line relief valves
- counterbalance valves
- free-wheel by-pass valves
- differential lock valves
- parking brake systems

e) Special control features:
- inch control
- creep speed
- brake defeat function
- hydrostatic braking

MH3.5.13 Reservoirs, Conditioning and Auxiliary Components

Describe the purpose of the system reservoir and associated fluid conditioning equipment and auxiliary components.

a) Outline a typical system reservoir in terms of:
- size, with reference to oil and air space and changes in level
- general construction (internal/external), including return line and port arrangements to minimize aeration)
- filling connections
- sampling points
- level/temperature indication
- air and oil filtration
- pressurized reservoirs
- use of bladder and diaphragms separators

b) Describe the use of hydraulic fluid cooling systems:
- reservoirs (size, siting and layout)
- air blast coolers
- water coolers

c) Describe the function, operation and application of auxiliary components:
- bladder type (bag) accumulators
- piston and diaphragm accumulators
- associated safety and control features
- pressure switches

MH3.5.14 Pipes and Hoses – Installation and Commissioning Procedures

Describe installation and commissioning procedures for pipes hoses and seals, and associated selection process and sizing relating to application:

a) Determine from pipe sizing charts and manufacturers' catalogues, suitable pipe/hose diameters associated with flow rates, velocities and acceptable pressure drops.

b) Describe the types and application of seals used in hydraulic systems, with specific reference to:
- static and dynamic seals,
- cylinder seals
- pump and motor shaft seals
- seal materials, selection and compatibility
- replacement methods and care to be taken dur- ing installation

c) State the factors that affect system pressure drop:
- pipe/hose dimensions
- pipe work/manifold block configuration
- flow rate
- fluid viscosity and density
- component size/design

d) Hoses types and application:
- wire braided
- 2-wire braided
- spiral wire
- thermoplastic
- high temperature and protective sleeved (abrasion resistant)
- low temperature

e) Hose/pipe fitting and assembly procedures:
- use of adapters and unions,
- use of bite compression fittings
- use of 'O-Ring' fittings
- use of flange type fittings
- use of formed fittings
- use of welded connections

f) Hydraulic hose failures relating to:
- poor installation procedures
- failure to meet required working specification
- system performance
- pipe-work installations
- layout fastenings
- leakage prevention

MH3.5.15 Contamination Control

Describe contamination control methods associated with:

- ingression of contamination and the nature of the contaminant (particles, water, gasses)
- preventative measures to reduce ingression to an acceptable level
- establishing a suitable cleanliness target
- achieving and maintaining a cleanliness target (ISO and AS standards)
- measuring and monitoring cleanliness levels (particles and level of water ingression/saturation)
- remedial actions
- filter types, rating, location and performance

MH3.5.16 Machine Circuitry and Control Features (Recognition and Use of Symbols)

Describe and interpret hydraulic circuits and associated methods of control, including failsafe methods:

Recognize and use current graphical hydraulic and electrical symbols relating to mobile hydraulic systems.

Suggested Systems:
- Excavators
- Wheeled loader
- Backhoe loaders
- Forklifts
- Man lifts/access platforms Sweeper
- Telescopic handlers
- Mobile cranes
- Agricultural tractors
- Agricultural harvesters/viners

MH 3.5.17 Electronic controls and sensors

Describe and interpret electronic controls and sensor signals including functional safety standards:

Recognize different control signals and functions that will be used in mobile machines
- Types and use of digital BUS systems
- Types and use of different control signals (analog, digital)
- Types and use of different sensor signals
- Functional Safety standards:
- Know the requirements aim of IEC and EN standards

MH3.5.18 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 manufacturers' 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/component/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

MH3.5.19 Maintenance, Monitoring and Fault Finding Procedures

Describe maintenance, monitoring and fault-finding procedures:

a) Outline a 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
- 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
- leakage detection methods

b) List the common faults encountered in hydraulic systems and associated components and state the possible causes and effects on system performance:

- excessive noise
- vibration
- high system/component temperature
- erratic operation
- leakage
- pressure too high
- pressure too low
- incorrect actuator speed
- incorrect pump flow rate
- incorrect sequence of operations
- loads lowering/failure to hold position
- hose and pipe failure (Section MH3.5.14(f))
- contamination level too high

c) Describe procedures to follow when carrying out fault finding, including:

- 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-establishing work place ”fit for purpose” completion of all necessary reports/document

INDUSTRIAL HYDRAULICS & ASSOCIATED CONTROL PROGRAMME (IH3): RE 2015/06.01 - H

CETOP (Passport) Occupational Level 3

INTRODUCTION

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It combines the necessary knowledge and competence based skills for those people on route to this high level of qualification, involving the maintenance and management of both Industrial and Mobile hydraulic systems.

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- COMMISSIONING
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- 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 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 supported by a series of centre based modules will be the normal system used.

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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 a competency based programme is one to three years depending on work experience within hydraulics and will require a high level of personal commitment to study and research the subjects within the syllabus.

Practical task assessments to verify competency against the agreed performance criteria will be carried out at the approved centre during the education programme period. It could be arranged on one to one base or in groups, candidate/ candidates to tutor.

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 competency based units will result in the award of a CETOP Level 3 Industrial Hydraulics Qualification Certificate. Candidates successfully completing only one unit will receive a CETOP Unit Certificate.

PRACTICAL TASK ASSESSMENT (IH3)

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

Assessed Ability

IH3.1 Interpret hydraulic and Electro-Hydraulic circuit diagrams applicable to selected systems (against recommended specification) and prepare a schematic representation of the system.

Evidence Required

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

Assessed Ability

IH 3.2 Assemble Electro-Hydraulic system involving on-off control and proportional control from given information.

Evidence Required

IH 3.2.1 Components selected and conformance checked against system specification.
IH 3.2.2 Installation/Action plan prepared.
IH 3.2.3 System assembled in a safe and efficient manner.
IH 3.2.4 Setting up/commissioning procedures followed in accordance with technical specification.
IH 3.2.5 Start up procedures correctly specified and followed.
IH 3.2.6 System operated according to specification.
IH 3.2.7 Establish proactive maintenance procedures to be followed, including:

a) component performance testing

b) fluid sampling and assessment of contamination level against target level

c) electrical input and output signals involving on/off and proportional control systems

Assessed Ability

IH 3.3 Carry out effective fault diagnosis and rectification.

Evidence Required

IH 3.3.1 Nature of fault correctly identified.
IH 3.3.2 Fault, cause, remedy checklist prepared.
IH 3.3.3 Diagnostics used to locate fault ensuring safety at all stages.
IH 3.3.4 Safe working practices followed at all times.
IH 3.3.5 Faulty component replaced, adjusted or repaired in line with planned procedures.
IH 3.3.6 Cause and effect of faults assessed.
IH 3.3.7 System re-commissioned in accordance with set procedures.
IH 3.3.8 System operated according to machine specification.

Assessed Ability

IH3.4 Establish documented procedures and carry out proactive maintenance and monitoring of Electro-Hydraulic systems.

Evidence Required

IH 3.4.1 System assessed to determine service/ maintenance schedule requirements.
IH 3.4.2 System assessed to determine routine monitoring requirements.
IH 3.4.3 Documented system established including safety requirements/risk assessment.
IH 3.4.4 Performance testing carried out and results recorded.
IH 3.4.5 Electrical input and output signals involving on-off and proportional control systems checked and recorded.
IH 3.4.6 Fluid sampling carried out and contamination levels assessed against target cleanliness and result recorded.
IH 3.4.7 Manufacturers recommendations and specifications checked against results.
IH 3.4.8 Safe working practices followed at all times.

Note: Preparation for practical task assessment can be a group activity or it could be carried out on a "one to one" basis between the candidate and the assessor.

Evidence will be obtained by non-intrusive observation, questioning or written and verbal reports.

KNOWLEDGE BASED UNIT (IH3)

CONTENTS

KNOWLEDGE BASED UNIT – WRITTEN EXAMINATION SPECIFICATION

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

- Examination duration will be 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.

INDUSTRIAL HYDRAULICS PROGRAMME – (Knowledge Based Unit)

In addition to demonstrating an understanding of Industrial Hydraulic Systems and Associated Control, candidates must prove an ability to:

IH3.5.1 Fundamental and Scientific Principles

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

a) List the basic building blocks and describe their function:
prime movers, pumps, reservoirs, fluids, control valves, filters, coolers, pipe-work and manifold blocks.

b) Know the cause and effect of pressure generation, pressure losses, heat generation, fluid leakage, cavitation, aeration, noise and vibration.

c) Know the difference between laminar and turbulent flow, and their effect on system performance.

d) Know the meaning of the term ‘Reynolds Number’ and use the associated formula.

e) Know the difference between static and dynamic pressure.

f) Know the quantities and units: pressure, force, area, displacement, flow rate, speed/velocity, torque and power.

g) Know the formulae relating to: pressure, force, area, displacement, flow rate, speed/velocity, torque and power.

h) Know the principles of heat dissipation and temperature control:
- heatsinks within a system (reservoirs, pipe-work and coolers)
- effects of ambient conditions and working cycle

i) State and use the relationship between:
- pressure, force and area
- pressure, torque and displacement per revolution for pumps and motors

j) State and use the relationship between:
- flow, area and velocity for cylinders
- flow, displacement per revolution and shaft speeds for pumps and motors

k) Know the relationship between:
- input and output powers of pumps and motors and the causes of volumetric and mechanical inefficiencies.

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

IH3.5.2 Application of the Fundamental Principles

Describe the application of the fundamental principles relating to:

a) Relationship between flow rate, pressure drop, restriction, power and heat.

b) Control of pressure
- pressure generation
- pressure limiting
- pressure unloading
- pressure reducing
- pressure intensification

c) Control of flow
- non-compensated flow control
- pressure compensated flow control
- temperature compensated flow control
- flow dividing
- regenerative flow
- damping
- meter-in, meter-out and by-pass flow control

d) Control of movement
- acceleration and deceleration control
- stopping or preventing movement
- changing direction

IH3.5.3 Hydraulic Fluids

Describe the application and selection of fluids for use in industrial hydraulic systems relating to:

a) Functions:
- power transmission
- lubrication
- cooling

b) Characteristics and properties (behavior and effect on system performance):
- viscosity
- viscosity index
- lubricity
- thermal stability (oxidation)
- pour point
- demulsibility
- shear stability
- compressibility
- material compatibility
- foaming and aeration resistance
- filterability
- specific gravity
- fire-resistance

c) Types of fluids in common use in industrial applications
- classifications to ISO standard
- ISO viscosity grades

d) Fluid selection for typical applications (factors to be considered)
- environmental considerations
- fire resistance
- toxicity
- water separation
- filterability

e) Fluid storage, handling and transfer:
- explain the need for correct storage, handling, cleanliness control and transfer systems to be in place and controlled by working procedures
- know the requirements associated with COSHH regulations

f) Explain the need for cleanliness control systems to be in place and associated fluid analysis procedures and monitoring (ISO and AS standards)

IH3.5.4 Valve Mounting Styles/Configurations

Describe valve mounting styles, standardized interfaces, sizes, flow rates, port-layouts and sealing arrangements, relating to:

- pipe/line mounting
- sub-plate mounting
- manifold mounting
- stack, mounting
- flange mounted valves
- screw in cartridge
- slip in cartridge
- ISO interface valves

IH3.5.5 Hydraulic System Components

Describe the function, operation and application of control valves and interpret their graphical symbols (control features to include mechanical, solenoid and solenoid pilot).

a) Flow control devices: (fixed and adjustable)
- non-compensated flow control devices (orifices and throttle valves)
- pressure and temperature compensated flow control valves
- hydrostats and application with proportional control valves

- spool flow dividers
- rotary flow dividers

b) Pressure control devices:
- pressure limiting
    - single stage, relief valves
    - two stage, pilot operated relief valves
    - unloading valves
- control features
    - vent
    - remote control
    - load sensing
    - pressure sensing (application of pressure switches)
- pressure reducing
    - single stage and two stage pressure reducing valves with relieving function

c) Load Holding and Motion Control:
- pilot operated check valves
- counterbalance with internal and external pilot control (including the effect of pilot ratios)

d) Direction control devices:
- check valves
- pilot operated check
- spool valves
- ball valves
- poppet valves
- sequence valves

e) control features to include – on-off and proportional control

IH3.5.6 Slip-in Logic Cartridge Valves

Describe the function, operation and application Slip-in (logic) cartridge elements

- construction and manifold assembly
- sizes and associated flow rates
- operating principles
- application for pressure, flow and direction control including associated control methods

IH3.5.7 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

IH3.5.8 Electrical/Electronic Components

Describe the function and application of electrical/electronic components

- resistors
- capacitors
- potentiometers
- transformers
- diodes
- electronic switches and sensors
- pressure
- level
- temperature
- flow
- distance
- particle
- water
- proximity and limit switches
- tacho-generator
- etc.

IH3.5.9 Proportional Valve Technology

Describe the principles of proportional valve technology

- list the potential benefits compared to application of "on/off" operated systems
- describe the difference in performance of a proportional solenoid to that of a standard solenoid
- describe the application of proportional control to pressure, flow and direction control (including feedback and non-feedback valves, direct and two stage versions)
- describe, in block diagram form the control components of a typical proportional valve electronic amplifier
- explain the meaning of the terms: gain adjustment, dead band compensation, ramp control, dither and pulse width modulation and demonstrate an understanding of their effects on system performance
- explain the recommended practices for installing proportional electronic control in terms of: power supply requirements, enable signals, input signal generation, cable shielding, earthing and interface with PLC’s

IH 3.5.10 Electronic control and sensor signals

Describe and interpret electronic controls and sensor signals including functional safety standards:

Recognize different control signals and functions that will be used in industrial machines.

- Types and use of digital BUS systems
- Types and use of different control signals (analog, digital)
- Types and use of different sensor signals
- Functional Safety standards:
  Know the requirements aim of IEC and EN standards

IH 3.5.11 Pumps and Associated Control Systems

Describe the function and operation of hydraulic pumps and associated control features:

a) Pumps:
- external gear
- internal gear
- vane (fixed and variable)
- radial piston (fixed and variable)
- axial piston (fixed and variable)
- bent axis piston (fixed and variable)
- multiple pumps

b) Control features:
- axial piston (swash plate)
  Including variable and dual displacement control features and associated torque speed character- istics
- bent axis
  Including variable and dual displacement control features and associated torque speed characteristics
- cam/roller types
  Including variable and dual displacement control features and associated torque speed characteristics

b) Motor features:
- pressure control (pressure compensation)
- displacement (torque/speed control)
- parking brake
- dynamic braking (use of counterbalance valves)

c) Motor performance:
- series circuitry
- parallel circuitry

d) Cylinders, mounting arrangements and construction:
- single acting
- double acting
- through rod
- sealing
- cushioning
- mounting arrangements
- position monitoring

e) Semi-rotary actuators:
- fixed pumps with relief valve and unloading systems
- rack and pinion type
- vane type
- mechanical/hydraulic servo displacement
- Electro-Hydraulic proportional displacement
- pressure compensation with and without remote pressure control
- load sensing
- constant power

c) Relationship between pressure and flow (Q/P) characteristics

IH 3.5.12 Hydraulic Actuators (Motors and Cylinders)

Describe the function, operation and application of hydraulic actuators, including control features:

a) Motors:
- gear
- gerotor/orbit
- vane
- radial piston

Including variable and dual displacement control features and associated torque speed character- istics

IH 3.5.13 Close-Loop Hydrostatic Transmissions

Describe the function, operation and application of hydraulic components associated with closed loop hydrostatic transmission systems:

a) Basic configuration:
- pump and motor layout and associated control elements

b) Over-centre piston pumps:
- basic construction (axial, bent axis and radial)
- control methods
- mechanical
- mechanical servo
- pilot pressure
- electronic servo
- pressure/limitation and displacement control

c) Charge pump:
• construction
• charge pump circuitry
• case flushing (including cooling and heating functions)

d) Control valves:
• hot oil shuttle valves
• cross-line relief valves
• counterbalance valves
• free-wheel by-pass valves

IH 3.5.14 Reservoirs, Conditioning and Auxiliary Components

Describe the purpose of the system reservoir and associated fluid conditioning equipment and auxiliary components.

a) Outline a typical system reservoir in terms of:
• size, with reference to oil and air space and changes in level
• general construction (internal/external), including return line and port arrangements to minimise aeration
• filling connections
• sampling points
• level/temperature indication
• air and oil filtration
• pressurized reservoirs
• use of bladder and diaphragm separators

b) Describe the use of hydraulic fluid cooling systems:
• reservoirs (size, siting and layout)
• air blast coolers
• water coolers

c) Describe the function, operation and application of auxiliary components:
• bladder type (bag) accumulators
• piston and diaphragm accumulators
• associated safety and control features
• pressure switches

IH 3.5.15 Pipes and Hoses – Installation and Commissioning Procedures

Describe installation and commissioning procedures for pipes, hoses and seals, and associated selection process and sizing relating to application:

a) Determine from pipe sizing charts and manufacturers' catalogues, suitable pipe/hose diameters associated with flow rates, velocities and acceptable pressure drops.

b) Describe the types and application of seals used in hydraulic systems, with specific reference to:
• static and dynamic seals
• cylinder seals
• pump and motor shaft seals
• seal materials, selection and compatibility
• replacement methods and care to be taken during installation

c) State the factors that affect system pressure drop:
• pipe/hose dimensions
• pipe work/manifold block configuration
• flow rate
• fluid viscosity and density
• component size/design

d) Hoses types and application:
• wire braided
• 2-wire braided
• spiral wire
• thermoplastic
• high temperature and protective sleeved (abrasion resistant)
• low temperature

e) Hose/pipe fitting and assembly procedures:
• use of adapters and unions
• use of bite compression fittings
• use of 'O-ring' fittings
• use of flange type fittings
• use of formed fittings
• use of welded connections

f) Hydraulic hose failures relating to:
• poor installation procedures
• failure to meet required working specification
• system performance
• pipe-work installations
• layout fastenings leakage prevention

IH3.5.16 Contamination Control

Describe Contamination Control Methods associated with:

• ingression of contamination and the nature of the contaminant particles, water, gasses)
• preventative measures to reduce ingression to an acceptable level
• establishing a suitable cleanliness target,
• achieving and maintaining a cleanliness target (ISO and AS standards)
• measuring and monitoring cleanliness levels (particles and level of water ingression/saturation)
• remedial actions
• filter types, rating, location and performance

IH 3.5.17 Circuitry and Control Features (Recognition and use of symbols – hydraulic and electrical)

Describe and interpret hydraulic circuits and associated methods of control, including fail safe methods:

- Recognize and use current graphical hydraulic and electrical symbols

IH 3.5.18 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 manufacturers' recommendations for installation of a particular component(s)
- outline commissioning procedures to be fol- lowed, taking into consideration: safety/risk assessment, operational specification, technical specification and start up procedures

- outline the procedures to be followed to ensure that system/component(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

IH 3.5.19 Maintenance, Monitoring and Fault Finding Procedures

Describe maintenance, monitoring and fault finding procedures:

a) Outline a 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
- leakage detection methods

b) List the common faults encountered in hydraulic systems and associated components and state the possible causes and effects on system performance relating to:

- excessive noise
- vibration
- system temperature/component temperature high
- erratic operation
- leakage
- pressure too high
- pressure too low
- incorrect actuator speed
- incorrect pump flow rate
- incorrect sequence of operations
- loads lowering/failure to hold position
- hose and pipe failure (Section IH3.5.15(f))
- contamination level too high

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 (adjust- ments, replacements, repair and re-commissioning)
- establishing system re-start procedures
- re-establishing work place - "fit for purpose"
- completion of all necessary reports/documentation

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The Voice of the European Fluid Power Industry

EDUCATION RECOMMENDATIONS

PNEUMATICS PROGRAMMES

★ ***PNEUMATICS PROGRAMME (P1):***
RE 2015/06.01 – P
CETOP (Passport) Occupational Level 1

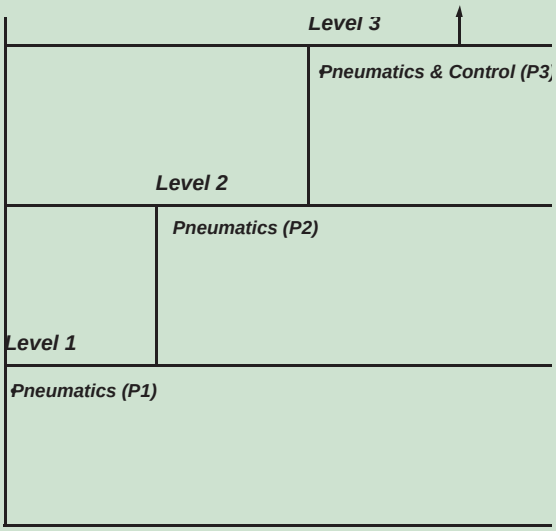
★ ***PNEUMATICS PROGRAMME (P2):***
RE 2015/06.01 – P
CETOP (Passport) Occupational Level 2

★ ***PNEUMATICS & CONTROL PROGRAMME (P3):***
RE 2015/06.01 – P
CETOP (Passport) Occupational Level 3

FOREWORD

These Competence Based Qualifications have been developed by CETOP to meet the occupational levels of those people involved in the maintenance and management of fluid power systems and cover the specific subjects of power pneumatics and associated control systems. They form a structure for progressive learning and the acquisition of a range of competence assessed skills. They have now been accepted by CETOP as industry standard qualifications forming part the harmonisation programme and the proposed passport for Europe within this sector of engineering.

Relating to CETOP Occupational Levels



Each level can be considered as a stand-alone qualification and level of achievement. However, each level progresses to a higher level of knowledge, understanding and application.
In all cases candidates should ensure that they have the appropriate knowledge and experience to commence the qualification level chosen. Level 1 programmes provide a foundation of knowledge with emphasis placed upon fundamen-tal principles, component functionality, operation and recognition together with an understanding of fluid power systems at a basic level.
The level 2 programmes ensure component functionality, operation and application are fully understood. These programmes have a higher technical content than the level 1 programmes and provide a more in-depth approach to function, operation, application and the interpretation of circuitry.

The level 3 programmes place emphasis on complex systems, integrated operations and their associated controls including the electrical / electronic interface. They involve technical specifications and the development of greater in-depth knowledge associated with component characteristics, system performance and inter-pretation.

Each level involves calculations and the use of formulae, emphasis is also placed upon the ability to read and interpret circuit diagrams. The development of diagnostic skills and the ability to act accordingly is involved at every level thereby applying a fault-cause-remedy approach throughout.

Where the same subjects appear at more than one level they are dealt with at the appropriate depth and in a manner that meets the requirements of that level.

It is advisable in all cases to study the content of the previous levels before taking a higher level. This will ensure that your prior theoretical know ledge and application experience is sufficient for you to proceed. You should seek advice from your nearest Approved Centre and if in doubt arrange a formal meeting with a tutor to carry out an analysis to identify your strengths and weakness and jointly establish a plan for your progression.

For further details of these industry standard qualifications and Approved Centres visit the web-site: www.cetop.org

Developed on behalf of the CETOP Education Commission, representatives from CETOP mem-ber Associations, this programme represents one of a range of new competence based qualifications recommended by CETOP.
It is intended for those personnel involved in the maintenance and management of pneumatic systems who require knowledge and competence based skills to support work based activities such as: planning and preparation, interpreting and using technical information, devising and follow-ing sound procedures associated with installation, commissioning, testing, fault diagnosis, rectification, maintenance, servicing and re-establishing a machine "fit for purpose".

PNEUMATICS PROGRAMME (P1):
RE 2015/06.01 - P
CETOP (Passport) Occupational Level 1

INTRODUCTION

This is the LEVEL 1 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 higher level qualification at levels 2 and 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 LEVEL 1

LEVEL (1) This person will perform activities that follow an established procedure. Activities will be recurring and of a short-term nature. The reaction to most problems will be to summon help or follow a predefined set of actions.

This level 1 programme provides an excellent introduction to power pneumatics and places great emphasis on the understanding of fundamental principles, component functionality and principles of operation.

Emphasis upon health and safety and that of developing safe working practices is applied throughout, as a CORE ELEMENT within the scheme. CORE ELEMENTS are not necessarily taught as specific subject areas but integrated within the scheme.

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.

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 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 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 1 Pneumatics Qualification Certificate (P1). Candidates successfully completing only one unit will receive a CETOP Unit Certificate.

PRACTICAL TASK ASSESSMENT (P1)

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

Assessed Ability
P 1.1 Interpret pneumatic circuit diagrams.

Evidence Required
P 1.1.1 Components correctly identified.
P 1.1.2 Application of components identified.
P 1.1.3 Operation of pneumatic system relating to control input and machine output identified.

Assessed Ability
P 1.2 Design pneumatic systems from given information.

Evidence Required
P1.2.1 Appropriate components selected and adjusted as necessary.
P1.2.2 System assembled in a safe and efficient manner.
P1.2.3 Start up and commissioning procedures correctly specified and followed.
P1.2.4 System operates according to requirements.
P1.2.5 Safe working practice and statutory regulations followed at all times.

Assessed Ability
P 1.3 Carry out routine maintenance on pneumatic systems.

Evidence Required
P1.3.1 Service/maintenance requirements, establish schedule.
P1.3.2 Service/maintenance undertaken as per schedule, in safe and efficient manner.
P1.3.3 Faulty component, replaced, adjusted or repaired in line with planned procedures.
P1.3.4 System tested after maintenance to ensure efficient working.
P1.3.5 Safe working practice and statutory regulations followed at all times.

KNOWLEDGE BASED UNIT (P1) CONTENTS

P 1.4.1 Fundamental Scientific Principles.
P 1.4.2 Application of Fundamental Principles.
P 1.4.3 Compressed Air Installations.
P1.4.4 Legal Regulations (The Pressure Systems Safety Regulations, PED).
P 1.4.5 Airline Components.
P 1.4.6 Pneumatic and Electro-Pneumatic Circuit Components.
P 1.4.7 Circuit and Control Features (Recogni- tion and use of pneumatic and electrical component symbols).
P 1.4.8 Basic Maintenance procedures.

KNOWLEDGE BASED UNIT – WRITTEN EXAMINATION SPECIFICATION

The examination paper will contain questions from 8 sections of the programme.

- Examination with a minimum duration 2 consecutive hours
- Pass mark will be 60%
- Question style may be single subject, multiple subject, short answer and multiple choice

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

PNEUMATICS - (Knowledge Based Unit)

P1.4.1 Fundamental 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) State and use the relationship between:
- pressure, force and area

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

e) State and use the relationship between voltage, current, resistance and power

P1.4.2 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

P1.4.5 Airline Components

State the function of the airline components:

a) shut off valve

b) filter

c) pressure regulator and gauge

d) soft start/dump valve

e) lubricator

P1.4.6 Pneumatic and Electro-Pneumatic Circuit Components

Describe pneumatic and Electro-Pneumatic circuit components:

a) air cylinders, motors and semi-rotary actuators
- state that air cylinders and motors convert fluid energy into work

c) Control of flow
- directional
- describe how speed can be adjusted using control valves
- identify the main features and state typical flow
- 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

P1.4.3 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
- dryers
- filters
- water traps
- service units

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

P1.4.4 Legal Regulations (The Pressure Systems Safety Regulations)

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

applications of the following types of cylinder
A) single acting
B) double acting
- state the reason for cushioning in double acting cylinders

b) control valves
- identify the need in a circuit for directional control and flow regulation valves
- identify the main features of 2/2, 3/2, 4/2, 5/2 spool and poppet valves
- identify the different methods of valve actuation
  A) manual
  B) mechanical
  C) electrical
  D) pneumatic
- state the principle and purpose of silencers and reclassifiers

c) pipe-work and connectors
- distinguish between rigid and flexible pipe-work
- identify couplings and connectors for use with above pipe-work

d) state the function of the listed components
- solenoids
  - types of solenoid
  - switching (‘ac’ and ‘dc’)
  - direct acting
  - solenoid-pilot operated
  - manual override
  - reed switches
  - proximity sensors

P1.4.7 Circuit and Control Features (Recognition and use of Pneumatic and Electrical Component Symbols)

Describe and prepare listed pneumatic circuits and associated methods of control.

a) recognize and use ISO graphical symbols for listed components
- filter
- pressure regulator and gauge
- lubricator
- single acting cylinder
- double acting cylinder
- 2/2, 3/2, 4/2, 5/2 directional control valves
- flow control valves

b) sketch single cylinder circuit diagrams to control piston movements
- manual operation of single acting cylinder
- manual operation of double acting cylinder
- manual operation of double acting cylinder with speed control

c) recognize the numerical system ISO standard

d) recognize and use IEC graphical symbols

P1.4.8 Basic Maintenance Procedures

Describe maintenance, monitoring and fault- finding 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) Checks for common faults encountered in Pneumatic systems and associated components:
- check air supply pressure indicated on pressure gauge
- check contamination level in filter bowl
- check oil level in lubricator (if fitted)
- check positional sensors
- check speed control settings

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 asso- ciated 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

PNEUMATICS PROGRAMME (P2):
RE 2015/06.01 - P
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.

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
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.
P 2.2.3 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.
P 2.3.2 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
P 2.4.1 Service/maintenance requirements, establish schedule.
P 2.4.2 Service/maintenance undertaken as per schedule, in safe and efficient manner.
P 2.4.3 Faulty component, replaced, adjusted or repaired in line with planned procedures.
P 2.4.4 System tested after maintenance to ensure efficient working.
P 2.4.5 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) recognise 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) recognise 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
- defi ne 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

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.

METHODOLOGY AND ASSESSMENT

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

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:

P3.1.1 Machine function and operating principles identified
P 3.1.2 Components correctly identified
P3.1.3 Function and operation of individual sub-circuits correctly identified
P3.1.4 Machine control inputs and outputs identified

Assessed Ability

P 3.2 Assemble pneumatic/Electro-pneumatic system from given information.be carried out at the approved centre during the education programme period. It could be arranged on one to one base or in groups, candidate/ candidates to tutor.

P3.2.1 Components selected and conformance checked against system specification
P3.2.2 Installation/Action plan prepared
P3.2.3 System assembled in safe and efficient manner and complying with European Directives and safety standards (reference P3.7.18)
P3.2.4 Setting up/commissioning procedures followed in accordance with technical specification
P3.2.5 Start up procedures correctly specified
P3.2.6 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

P3.3.2 Components correctly selected for application

P3.3.3 System assembled in safe and efficient manner

P3.3.4 Applies monitoring and editing features to correct or modify the program as necessary

P3.3.5 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
P 3.5.4 Performance testing carried out and results recorded
P 3.5.5 Pneumatic and electrical input/output signals checked and recorded
P 3.5.6 Manufacturers recommendations and specifications checked against results
P 3.5.7 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

P3.6.1 Legal Regulations: Machinery Directive (EU), EMC, ATEX...
P3.6.2 List basic safety principles and components
P3.6.3 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

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 noise/ 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
- defi ne 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

P3.7.6 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

P3.7.8 Electrical noise/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 incorporating 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 control 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)

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

d) 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

Addresses of CETOP Member Associations

CETOP has 18 member associations with more than 1,000 companies from 17 European countries.
Our member associations are:

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