cetop

The Voice of the European Fluid Power Industry

EDUCATION RECOMMENDATIONS

★ ***HYDRAULICS PROGRAMME***
Passport Occupational Level 2

HYDRAULICS & ASSOCIATED CONTROL PROGRAMME (H2) CETOP RE 2022/01.02- 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 via a written examination of a minimum of 2 hours duration. 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, 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).

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

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 subjects, 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, CONTENTS

H2.5.1 Fundamental Hydraulic Principles.
H2.5.2 Hydraulic System Components.
H2.5.3 Pumps and Associated Control Systems.
H2.5.4 Hydraulic Actuators.
H2.5.5 Circuitry and Control Features.
H2.5.6 Hydraulic Fluids.
H2.5.7 Reservoirs and Conditioning Equipment.
H2.5.8 Hydraulic pressure equipment and safety components

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
- 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 machine:
- electric motor/engine
- main and auxiliary pumps
- reservoir and fluid
- steering and braking systems

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 procedures 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.

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 arrangement for pump transmission applying step up/step down gearbox

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

FLUID POWER ELECTRONICS PROGRAMME - KNOWLEDGE BASE UNIT, CONTENTS

H 2.6.1 Electrical Components
H 2.6.2 Electronic Sensors for Control and Condition Monitoring in integrated Fluid Power Systems
H 2.6.3 Electrical/Electronic sensor signals in integrated Fluid Power Systems
H 2.6.4 Recognize and understand the application of integrated system control methods used in integrated fluid power systems.
H 2.6.5 Awareness of current Safety requirements of an integrated system
H 2.6.6 Safe working practices for an integrated system
H 2.6.7 Safety related components
H 2.6.8 Circuit and Control Features (Recognition and use of component symbols)

ELECTRONICS *PROGRAMME - (Knowledge Based Unit)*

H 2.6.1 Electrical Components

Describe the function, operation and application of electrical components used in integrated systems:

- Switches/Contacts: Normally Open (NO), Normally Closed (NC), Change Over (CO)
- Protective devices
- Lighting
- Relays
- Solenoids
- Limit switches
- Distance sensors
- Photo-electric sensors
- AC and DC Motors
- Electric Motor control technology

H 2.6.2 Electronic Sensors for Control and Condition Monitoring in integrated Fluid Power Systems

Identify sensors used in integrated Fluid Power Systems

- Pressure
- Flow
- Temperature
- Level
- Particle
- Humidity
- Viscosity
- Conductivity
- Noise
- Vibration

H 2.6.3 Electrical/Electronic sensor signals in integrated Fluid Power Systems

Describe the function, operation and application of electrical communication signals used in integrated systems:

- Digital (switching)
- Analog
- Bus
- Bi-directional communication
- Wire-less

H 2.6.4 Recognize and understand the application of integrated system control methods used in integrated fluid power systems.

- Relay control
- Power Amplifier control
- Analog and digital
- Open loop control
- Closed loop control
- Computer control

H 2.6.5 Awareness of current Safety requirements of an integrated system

Overview of relevant regulations

H 2.6.6 Safe working practices for an integrated system

- Utilize the safe working practices and procedures to be used when working on integrated systems
- Risk Assessments for the system and your workplace
- Utilize the safe working practices and procedures to be used when working on integrated systems
- Risk Assessments for the system and your workplace
- Comply with all Health and Safety requirements for the machine and your workplace
- Use the correct Personal Protection Equipment (PPE)

H 2.6.7 Safety related components

Describe the basic function and application of safety equipment and components used in integrated fluid power systems

- Personal safety
- Machine safety

H 2.6.8 Circuit and Control Features (Recognition and use of component symbols)

Identify symbols and describe common drawing practices in integrated fluid power systems

MAINTENANCE, MONITORING AND FAULTFINDING KNOWLEDGE BASE UNIT, CONTENTS

IH 2.7.1 Maintenance, Monitoring and Faultfinding Procedures
IH 2.7.2 Contamination Control

H 2.7.1 Maintenance, Monitoring and Faultfinding Procedures

Describe maintenance, monitoring, and faultfinding 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.

H 2.7.2 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