

Level 1 Training:

**BASIC HYDRAULICS TRAINING COURSE (3 days): Typical Content**

1. **Self-Assessment Questionnaire**
  - used to support the introduction to hydraulics and identify levels of previous knowledge and understanding
2. **Introduction to the basic principles of Fluid Power Systems**
  - what is a hydraulic system?
  - important characteristics of hydraulic systems
  - where do we use hydraulics?
  - 7 basic principles that underpin hydraulic systems
  - Pascal's Law, Force Transmission, Pressure Transmission
3. **Introduction to Circuit Symbols (to current ISO standards)**
  - hydraulic symbols, shape and recognition
  - how to read hydraulic circuit diagrams
  - open and closed loop circuits
4. **Pumps**
  - different pump types and basic principal of operation (gear, vane, piston)
  - shaft input power and hydraulic output power
  - suction performance, cavitation, aeration, causes of failure
  - installation and commissioning
5. **Pressure Control Devices – function, operation and circuit application**
  - pressure relief valves – direct and pilot operated (including unloading)
  - pressure reducing valves
  - sequence valves
6. **Directional Control Valves – function, operation and circuit application**
  - direct operated and pilot operated
  - valve sizes and nominal flow rates
  - poppet valves
7. **Load Holding and Motion Control – function, operation and circuit application**
  - standard check valves
  - pilot operated check valves
  - counter balance valves
8. **Flow Control Valves – function, operation and circuit application**
  - simple throttle valves
  - viscosity compensated valves
  - pressure compensated valves
  - meter in / meter out flow control
9. **Pipes, Hoses and Fittings**
  - compression joints - establishing the perfect connection
  - knowing the parts and application
  - hose construction and selection
  - hose failures and correct installation
  - safety
10. **Motors**
  - different motor types and basic principal of operation (axial piston, radial piston, fixed and variable displacement)
  - shaft speed, displacement, input flow-rate, torque.

11. **Cylinders**
  - different types, basic construction / operation
  - force, effective area, flow rate and velocity
  - intensification
  - regeneration
12. **Accumulators**
  - different types (piston, diaphragm, bladder)
  - Basic principal of operation
  - applications
  - safety and legislation
13. **Hydraulic Oil**
  - important characteristics and different types
  - additives
  - viscosity
  - management control
14. **Contamination Control**
  - origin and nature of contaminants
  - particle sizes and typical component clearances
  - establishing target cleanliness levels
  - monitoring and maintaining cleanliness standards (measurement)
  - sampling methods
15. **Fault Finding**
  - fault diagnosis, start point and procedures to follow
  - health and safety and establishing safe working practices
  - planning and preparation
  - application of 'fault-cause-remedy' techniques
16. **Practical Exercises (in-house training rigs)**
  - performance testing a pump
  - comparing the performance of a simple throttle valve to a pressure compensated flow control valve
  - to observe and understand pressure intensification
  - to prepare a set up procedure for three different pressure control valves with different settings
  - to build and understand a simple accumulator circuit
17. **Hydraulic Safety**
  - general safety, personal hygiene and handling of oils

Level 2 training - please refer to entry requirements.

### **FAULT FINDING TRAINING COURSE (2 Days): Typical Content**

1. **Review of the basic principles of Fluid Power**
  - fundamental principles that underpin hydraulic systems
  - Pascal's Law, transmission of force, power
  - formulae used to calculate flow, pressure, power, torque and force
2. **Maintenance and Fault Finding**
  - maintenance strategies
  - planning and fault finding techniques
  - system monitoring
  - fluid condition
  - tools and measuring equipment
  - use of technical reference information
3. **Circuits and Symbols**
  - review of circuit symbols and circuit diagrams
  - examples of different circuit diagrams
  - circuit errors
  - 'truth tables' / 'solenoid charts'
4. **Accumulators**
  - basic principal of operation
  - back up bottles
  - safety and legislation
5. **Logic Elements**
  - basic function
  - different types (direction and pressure)
  - applications
6. **Proportional Valves**
  - basic function
  - command and feedback signals
  - diagnostic equipment
7. **Faults and Failures**
  - installation problems
  - cavitation and aeration
  - effects of temperature
  - causes of failures
8. **Hydraulic Oil**
  - contamination control
  - condition monitoring
  - sampling methods
9. **Practical Exercises (in-house training rigs)**
  - practical exercises to identify and rectify faults
  - practise fault finding techniques
  - use of measuring equipment
10. **Safety**
  - general safety, personal hygiene and handling of oils
  - risk assessments
  - safe systems of work

Level 2 training - please refer to entry requirements.

### **ACCUMULATOR COMPETENCE TRAINING COURSE (1 DAY): Typical Content**

1. **Introduction - Review of the basic principles of Fluid Power Systems**
  - important characteristics of hydraulic systems
  - basic principles that underpin hydraulic systems
  - the importance of fluid cleanliness
  - Pascal's Law, useful formulas
  
2. **Introduction to accumulators**
  - history and developments
  - basic operating principles
  
3. **Gas charged accumulators**
  - gas laws and operating principles
  - nitrogen
  - compressibility
  - gas cylinder - supply options
  - safe working with Nitrogen
  
4. **Gas charged accumulator types**
  - understanding common terms
  - details of operation of - Diaphragm, Bladder and Piston accumulators
  - back-up gas bottles
  - safety equipment associated with accumulator systems
  - charging kit
  - the gas charging process
  - sources of information
  
5. **The Pressure System Safety Regulations**
  - the responsibility of users and owners of systems
  - the written scheme of examination
  - drawing up a written scheme of examination
  
6. **Application examples**
  - various examples
  
7. **Practical exercises**
  - practical exercises to support the topics
  - practice gas charging
  - build accumulator circuits

Level 2 training - please refer to entry requirements.

**PROPORTIONAL HYDRAULICS TRAINING COURSE (3 Day)**  
**TYPICAL CONTENT**

A copy of the Bosch Rexroth Vol 2 Training Manual, R900018626, Proportional and Servo Valve Technology, is included as part of the course material.

- 1. Proportional Hydraulics – An Introduction**
  - overview of 'on-off' control and its limitations
  - introduction to a 'proportional' alternative
- 2. How Proportional Valves control flow**
  - the proportional DCV spool
  - spool characteristics (flow rate, symmetry and notch shape)
  - symbol recognition
- 3. Proportional DCV's**
  - direct operated and pilot operated DCV's
  - feedback and non-feedback valves
  - describing valve performance in graphical form
- 4. Other Proportional Valves and Servo Valves**
  - proportional relief valves and proportional reducing valves
  - proportional flow control valves
  - pump and motor displacement controls
  - overview of high response proportional and servo valves
- 5. Control Systems, Input and Output Signals**
  - construction and characteristics of a proportional solenoid
  - role of the amplifier (deadband compensation, ramp and dither)
  - input signals and gain control
  - valve spool feedback transducers and 'internal closed loop' control
  - PID control
  - overview of pulse width modulation
  - valves with integral amplifiers
- 6. Proportional Valves used in real circuits**
  - oil cleanliness requirements
  - using pressure compensators
  - solenoid air bleeds
  - effect of proportional valves on load control valves
- 7. Practical Work**
  - proportional and bang-bang solenoid characteristics
  - force control, stroke control and hysteresis
  - proportionality/ramps with DCV and motor circuit
  - proportional relief valve performance
  - deadband compensation and gain control
  - cylinder velocity profile control with 4/3 proportional DCV

## **Level 2 Training**

- Fault Finding
- Accumulator Competence
- Proportional Hydraulics

## **Entry Requirements**

Completion of the Basic Hydraulics course is strongly recommended prior to attending a Level 2 course. Alternatively, attendees must have sound knowledge/experience of:

- the basic principles that underpin all hydraulic systems (relationship between, pressure, flow, force, torque, speed, power);
- reading and interpreting circuit diagrams using current symbols;
- the function and operation of relief, sequence and pressure reducing valves;
- the principle of pressure compensation relating to flow control; operation of spool valves; gear, vane and piston pumps;
- characteristics of oils and contamination control;
- accumulators and their use, safety and legislation.