

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 - please refer to entry requirements.

BASIC HYDRAULIC DESIGN TRAINING COURSE (3 Day) TYPICAL CONTENT

- 1. Determining the Load**
 - size, volume, density, and mass
 - calculating force and acceleration
 - effects of gravity
 - effects of static and sliding friction
 - calculating torque
 - calculating rotational speed

- 2. Sizing the Actuator**
 - cylinder sizing
 - rod buckling load calculation
 - motor sizing
 - use of step-up and step-down gearboxes

- 3. Planning and Duty Cycle**
 - flow-time graphical representation
 - pressure-time graphical representation

- 4. Control Valve Selection**
 - directional valve selection from graphical characteristic curves
 - open-centre and closed centre 'mobile' multi-function valves
 - PO Check valve pilot pressure calculation
 - counterbalance and overcentre valve selection and pilot pressure calculation
 - logic valve sizing (including area ratios) and pilot pressure calculations

- 5. Sizing the Power-Pack (Pump, Prime Mover and Reservoir)**
 - pump sizing and selection
 - prime mover selection (electric motors & diesel engines)
 - reservoir sizing
 - reservoir layout and internal construction

- 6. Throttling**
 - orifice calculation
 - calculating intensification for meter-out throttling applications
 - proportional/mobile valve spool selection from graphical performance curves

- 7. Heating and Cooling**
 - Fluid selection (choosing viscosity grade for ambient temperature)
 - Cooling calculations (including ambient radiation from reservoirs)
 - Heating calculations

- 8. Sizing Pipework and Hoses**
 - Calculating pipe & hose internal diameter
 - Calculating change of pressure drop due to changes in flowrate

- 9. Turbulent Flow Flushing**
 - calculating turbulent flowrate for flushing

- 10. Tips and Tricks to Improve Machine Performance**
 - accumulator sizing calculations
 - use of 2-stage relief valve for unloading and multiple pressure selection
 - use of externally piloted 'unloader' valve for Hi-Lo pump systems and accumulator charging applications
 - calculating cylinder regenerative ('regen') extension flow/speed

- 11. Filter Placement**
 - use of BFPA 'P5' process to determine filter placement

- 12. Case Study**
 - attendees will carry out a case study to design a typical hydraulic system incorporating the above topics

Level 2 Training

- Fault Finding
- Accumulator Competence
- Proportional Hydraulics
- Basic Hydraulic Design

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.