## HYDRAULIC TRAINING DATES: May 2019 – April 2020
(Additional dates can be offered on request)

<table>
<thead>
<tr>
<th>VENUE</th>
<th>COURSE</th>
<th>2019 DATES</th>
<th>2020 DATES</th>
</tr>
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<tbody>
<tr>
<td>WAKEFIELD</td>
<td>BASIC HYDRAULICS</td>
<td>3 days</td>
<td>May 21 – 23</td>
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<tr>
<td>DUBLIN</td>
<td>PROPORTIONAL HYDRAULICS*</td>
<td>3 days</td>
<td>May 21 – 23</td>
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<tr>
<td>ST NEOTS</td>
<td>BASIC HYDRAULICS</td>
<td>3 days</td>
<td>June 3 – 5</td>
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<tr>
<td>ST NEOTS</td>
<td>FAULT FINDING* NEW</td>
<td>2 days</td>
<td>June 6 – 7</td>
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<tr>
<td>CORK</td>
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<td>3 days</td>
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<td>ST NEOTS</td>
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<td>3 days</td>
<td>August 6 – 8</td>
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<td>FAULT FINDING* NEW</td>
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<td>ST NEOTS</td>
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<td>November 4 – 6</td>
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<tr>
<td>ST NEOTS</td>
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<td>ST NEOTS</td>
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<td>3 days</td>
<td>December 11 – 13</td>
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**2020 DATES**

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<td>CORK BASIC HYDRAULICS</td>
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<tr>
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<td>3 days</td>
<td>March 3 – 5</td>
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<td>March 17 – 19</td>
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<tr>
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<td>April 21 - 23</td>
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**Venues and Pricing**

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<tr>
<th>Venues</th>
<th>Course Duration</th>
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<tr>
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<td>£918.00</td>
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<tr>
<td></td>
<td>2 days</td>
<td>£612.00</td>
</tr>
<tr>
<td>Ireland</td>
<td>Cork or Dublin</td>
<td>On request</td>
</tr>
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</table>

Quoted price per attendee, per course, excluding VAT. Course materials and lunch included.
All visa, travel, hotel and subsistence responsibility of attendee.
Written quotations available on request.
All bookings subject to receipt of official order number.

**For course bookings, please contact:**

<table>
<thead>
<tr>
<th>Venue</th>
<th>Name</th>
<th>Tel.</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>St Neots / Wakefield</td>
<td>M Morris</td>
<td>0800 1696624</td>
<td><a href="mailto:service@boschrexroth.co.uk">service@boschrexroth.co.uk</a></td>
</tr>
<tr>
<td>Cork</td>
<td>J Hickey</td>
<td>+353 21 4978787</td>
<td><a href="mailto:jhickey@phc.ie">jhickey@phc.ie</a></td>
</tr>
<tr>
<td>Dublin</td>
<td>E Ryan</td>
<td>+353 14 588880</td>
<td><a href="mailto:eryan@dphydraulics.ie">eryan@dphydraulics.ie</a></td>
</tr>
<tr>
<td><strong>We also offer (please contact us for further details):</strong></td>
<td></td>
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<td>----------------------------------------------------------</td>
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<tr>
<td><strong>• Bespoke Training</strong></td>
<td>Delivered at Bosch Rexroth St Neots or Wakefield, or customer site.</td>
<td><strong>Duration</strong></td>
<td>To suit</td>
</tr>
</tbody>
</table>
| **• Pump Control *  
   Note: This course is not limited solely to Bosch Rexroth pumps.** | Delivered at Partner site, Worksop. | **3 days** | On request |
| **• Power Pneumatics *  
   Stage 1 and 2** | Delivered at Partner site, Worksop. | **2 / 3 days** | On request |

*These are Level 2 Training Courses  
Completion of the Basic Hydraulics course is recommended prior to attending Level 2 training. 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.

Certified by the British Fluid Power Association
BASIC HYDRAULICS TRAINING COURSE (3 Day)
TYPICAL CONTENT

A copy of the Bosch Rexroth Vol 1 Training Manual, R900018614, Hydraulics, Basic Principles and Components is included as part of the course material.

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

Certified by the British Fluid Power Association

6 August 2018
PROPORTIONAL HYDRAULICS TRAINING COURSE (3 Day)
TYPICAL CONTENT

This is a Level 2 training course – please see entry requirements over.

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 – Entry Requirements

Completion of the Basic Hydraulics course is 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.
HYDRAULIC SYSTEM DESIGN TRAINING COURSE (3 Day)
TYPICAL CONTENT

This is a Level 2 training course – please see entry requirements over.

A copy of the Bosch Rexroth Training Manual, R90001854, Planning and Design of Hydraulic Power Systems is included as part of this course material.

1. Basic Hydraulic Design – An Introduction

2. Revision
   - pros and cons of 'hydraulics' as a power transmission medium
   - power transfer and generic design model
   - examples to underpin fundamental principles

3. Analysis of Load
   - positive and negative (overrunning) loads
   - understanding mass and weight
   - acceleration forces and equations of motion
   - sliding and static friction, effect of inclines, rotary systems

4. Hydraulic Actuators
   - cylinder overview
   - calculating areas, ratios, speed and forces
   - cylinder rod buckling
   - hydraulic motor overview and performance graphs
   - comparison of different types of hydraulic motors

5. Load Holding and Load Control
   - construction and application of pilot operated and overcentre valves
   - circuit design with load holding and load control valves

6. Flow Control
   - techniques, pumped flow, meter-in/out and bypass
   - throttle valve selection
   - pressure and temperature compensation
   - correct sizing of flow control valves

7. Directional Control
   - application and limitations of directed operated DCV's
   - flow forces and compensation in spool valves

8. Pressure Control
   - pressure relief and pressuring reducing valve selection

9. Hydraulic Pumps and Prime Movers
   - pump, electric motor sizing and selection
   - internal combustion engines – modifying hydraulic circuits to suit

10. Reservoirs and Cooling
    - functions of the reservoir
    - calculating and determining cooling of the reservoir
11. **Pressure Losses**  
   - sizing pipework, complicated pipe routes  
   - velocity and pressure drop nomograms; viscosity/temperature diagrams

12. **Filters and Filtration**  
   - Overview of filtration systems, media selection and filter grade  
   - target oil cleanliness, sizing and placing of filter  
   - clogging indicators, bypass valves and practical considerations in filtration systems

13. **Designer’s Checklist**  
   - common design problems  
   - understanding components, circuits and component interactions  
   - defining control to make your circuit work.

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→ characteristics of oils and contamination control;  
→ accumulators and their use, safety and legislation.
This is a Level 2 training course – please see entry requirements over.

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

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