

## Hydraulic Technology Training Course Overview

### Module 1 – Principles of Hydraulics

***Description:***

This lesson discusses several concepts such as force, pressure, work, friction, resistance, horsepower, energy, incompressibility, Pascal's Law, fluid power transmission, and properties of hydraulic fluids.

***Learning Objectives:***

- Explain basic fluidic principles.
- Explain Pascal's Law.
- Describe the difference between laminar and turbulent flow.
- Explain flow rate and flow velocity.
- Demonstrate the relationship between pressure, area, and force.
- Explain and demonstrate the FPA Triangle.
- Important properties of hydraulic fluids Fluid viscosity.
- Causes of corrosion and fluid oxidation.
- Describe the effect of fluid temperature on viscosity.

### Module 2 – Hydraulic System Operation

***Description:***

This lesson discusses the components of hydraulic systems and explains how these components function together to operate a hydraulic system. Explanation of series and parallel circuits, hydraulic schematics, and how to use system pressure to troubleshoot.

***Learning Objectives:***

- Name the main components of a hydraulic system.
- Visually identify and describe the function of hydraulic components.
- Interpret hydraulic schematics and components.
- Identify transmission of power and flow path through the system.
- Understand the stages of power transmission through a hydraulic system.
- Identify and describe the function(s) of hydraulic reservoirs and their components.
- Identify common indications of malfunctions in hydraulic piping and connectors.

## Module 3 – Hydraulic Safety

### ***Description:***

This lesson discusses safe habits working around hydraulic systems and common hydraulic equipment hazards.

### ***Learning Objectives:***

- Identify safety considerations for working with system hydraulics.
- Understanding common hazards such as heat, flammability and pinch points.
- Hydraulic fluid injection injury hazards.
- Hose and fitting failures.
- System adjustments and unexpected motion.
- Importance of verifying zero energy state in a hydraulic system.

## Module 4 – Cylinders

### ***Description:***

This lesson discusses double-acting and single-acting cylinders, plus various other types of actuators; anatomy of a cylinder, mounting and seal selection considerations, flow capacity, cushioning, stop tube, cylinder position sensing, and troubleshooting.

### ***Learning Objectives:***

- Describe the purpose of a hydraulic cylinder, and explain how a double-acting cylinder and single-acting cylinder function.
- Explain the difference between "pull-type" and "push-type" cylinder applications and considerations.
- Demonstrate how to calculate area, force, volume and speed of a hydraulic cylinder.
- Explain how changing flow rate affects the performance of the cylinder.
- Describe the construction of a hydraulic cylinder and schematic symbols.
- Explain the various methods of mounting cylinders.
- Explain ISO and NFPA industry standards.
- Concept of cylinder intensification and cavitation.
- Cylinder drift, synchronization and regen basics.
- Ways to increase a cylinder's reliability.

## Module 5 – Flow Control Valves

### ***Description:***

This lesson discusses various flow control valves types and the relationship between flow verses speed in a hydraulic system.

### ***Learning Objectives:***

- Understand and demonstrate the relationship between flow and speed.
- Principles behind flow control valve operation.
- Identify various flow control valve schematic symbols in a hydraulic circuit.
- Understand operation and use of an orifice, needle valve, check valve, and flow control valve.
- Understand operation and use of a pilot-operated check valve and pressure-compensated flow controls.
- Explain how pressure differential affects flow.
- Describe the operation of meter-in and meter-out circuits.

## Module 6 – Pressure Controls Valves

### ***Description:***

This lesson discusses several different pressure control valves, their functions in hydraulic systems and some of their applications. Basic principles, valve operation and schematic symbols are covered with specific applications for relief valves, direct-acting valves, pilot operated valves, normally-open valves, unloading valves, counterbalance valves, sequence valves, and pressure reducing valves.

### ***Learning Objectives:***

- Understand operation and use of pilot-operated pressure control valves.
- Explain the functions of a pressure-control valve, a pressure-relief valve, pressure-reducing valve and sequence valve
- Understand operation and use of normally-open pressure control valves and unloading valves.
- Explain function and uses of a counterbalance valve with an internal pilot, external pilot and both internal/external pilot.
- Identify various pressure controls valve schematic symbols in a hydraulic circuit.

## Module 7 – Directional Control Valves

### **Description:**

This lesson discusses types of directional control valves, their functions in a hydraulic system, and some of their applications. This lesson explains four-way, three-position directional control valves and explains different ways they can be centered, actuated, piloted, and drained. Basic introduction on proportional, servo, and Din cartridge valves.

### **Objectives:**

- Explain industry classification of directional control valves.
- Identify functions of ports on a directional control valve
- Trace various flow paths through a directional control valve on a system schematic
- Describe the type of actuators used with directional control valves
- Explain the difference between direct-acting and pilot-operated valves.
- Describe how manual and solenoid operated valves work.
- Describe the operation a spool valve, a three-way valve, and four-way valves.
- Explain the difference between normally closed and normally open valves.
- Be able to identify schematic symbols and directional controls valve functions.

## Module 8 – Hydraulic Pumps

### **Description:**

This lesson discusses types of positive-displacement hydraulic pumps such as gear, vane and piston. The lesson shows and explains the functions of pumps in hydraulic systems and the operating principles of different types of pumps; distinguishing between open-loop and closed-loop pumps, identifying common pump controls. Explanation of basic troubleshooting and maintenance methodology. Review of common pump specification and sizing calculations.

### **Learning Objectives:**

- Identify the most common types of positive-displacement pumps, describe their operation; differentiating between fixed and variable displacement pumps.
- Identify the components and principles of operation for variable-volume axial piston pumps during pressure compensation.
- Recognize symptoms of pump malfunction, aeration and cavitation.
- Identify factors affecting pump selection and pump performance.
- Define volumetric efficiency and overall efficiency
- Identify hydraulic pump schematic symbols.
- Determine pump flow rate, input horsepower and displacement.

## Module 8 – Hydraulic Motors

### ***Description:***

This lesson discusses the operating principles and construction of a gear motor, a vane motor, and a piston motor. Performance specifications such as starting, running, and stalling torque.

### ***Learning Objectives:***

- Explain the classification of hydraulic motors.
- Demonstrate how the torque of a hydraulic motor is calculated.
- Calculate the horsepower output of a hydraulic motor.
- Discuss cost factors and other considerations affecting motor selection.
- Describe the operation of unidirectional and bidirectional motors.
- Identify schematic symbols
- Explain braking circuits, and meter-in circuits.

## Module 9 – Hydraulic Accessories

### ***Description:***

This lesson explains the purpose and operation of several hydraulic components such as heat exchangers, filters, strainers, reservoir breathers, accumulators and measurement devices.

### ***Learning Objectives:***

- Describes the use and operation of various hydraulic accessory components.
- Explain the different types of accumulators and reasons for them.
- Explain accumulator precharge rule-of-thumb.
- Safety factors and considerations when working with accumulators.
- Identify various accessory component schematic symbols.

## Module 10 – Troubleshooting and Filtration

### ***Description:***

This lesson reviews hydraulic troubleshooting methodology and filtration anatomy.

### ***Learning Objectives:***

- Common sense approach to hydraulic system troubleshooting.
- Explain hydraulic filtration standard and component requirements.
- Explain the primary reasons for hydraulic system failures.

## Hands-On Lab Trainer Exercises

- Maximum Relief Pressure
- Flow Rate of Pump
- Standard Closed Center Circuit
- Setting Flow Rate Through a Flow Control Valve
- Cylinder Leak Test
- Regeneration
- Measuring Flow Out of a Cylinder
- Meter-In and Meter-Out
- Meter-Out With Pressure Compensated Control Valve
- Pressure Reducing Valve Adjustment
- Pressure Reducing Circuit
- Standard Open Center Circuit
- Closed Center Pressure Buildup
- Regeneration Without Full Flow Through Directional Valve
- Synchronize on Extend Only
- Synchronize Both Ways Without Flow Control
- Hydraulic Motor Meter-In Flow Circuit
- Hydraulic Motor Meter-Out Flow Circuit
- Counterbalance
- Counterbalancing a Hydraulic Motor
- Sequence Valve Adjustment
- Sequencing Cylinders
- Sequencing Cylinder and Motor
- Sequencing and Pressure Reducing

## Hands-On Tear-Down and Assembly Exercises

- Hydraulic Cylinder
- Gear Pump
- Vane Pump
- Solenoid Directional Control Valve
- Proportional Relief Valve