

#### **Job Responsibilities - Hydraulic Symbols**

- Identifies pressure source graphic symbols.
- Identifies hydraulic graphic symbols that describe flow lines and connections.
- Identifies directional control valve symbols.
- Associates directional valve center position with actuator control.
- Identifies hydraulic pressure control valves from detailed symbols.
- Associates simplified flow control valve symbols with component function.
- Identifies flow control valves from both simplified and detailed symbols.
- Associates detailed flow control symbols with component function.
- Identifies symbols for hydraulic pumps and motors.

#### **Job Responsibilities - Statics**

- Understands the relationship between height of a liquid and the gauge pressure reading in psi.
- Understands the relationship between height of a liquid and gauge pressure reading in inches of mercury (in-Hg).
- Understands that hydraulic pressure results from load resistance.
- Uses cylinder bores and rod diameters to figure static pressures.
- Relates resistive and overrunning loads to static pressures in cylinders.
- Understands that cylinder movement is caused by sufficient pressure against a movable area.

#### **Job Responsibilities - Components**

- Determines hydraulic flow capacity from conductor sizes.
- Calculates speeds and forces associated with single rod cylinders.
- Understands how hydraulic flow rate and cylinder rod velocity are used to determine volumetric efficiency.
- Distinguishes between operation of a pressure relief, pressure reducing, unloading, sequence, counterbalance, and brake valves.
- Understands that load holding valves are required on truck mounted aerial lift cylinders.
- Understands the characteristics of hydraulic pressure relief valve and unloading relief valve circuits.
- Understands that hydraulic pressure compensated flow control valves maintain constant actuator speed regardless of load.
- Understands that hydraulic pressure compensated flow control valves maintain constant pressure across a variable orifice.

- Understands that flow through a sharp edged orifice is less affected by change in fluid temperature than other types of restrictions.
- Understands functions, porting, and purpose of differential areas in pilot operated hydraulic check valves.
- Understands that load holding, pilot operated to-open, check valves require an open center or float center directional control valve.
- Understands that thermal expansion of fluid can cause high pressure and thermal lock in cylinders equipped with pilot operated check valves.
- Distinguishes between the operation of a counterbalance valve and pilot operated to-open check valve.
- Determines the pressure required to shift a pilot operated check valve.
- Interprets hydraulic pump specifications from performance curves.
- Predicts directional control valve operation from performance curves.
- Understands that pilot drains on directional control valves should have separate lines where the system experiences high return line pressure.
- Understands the purpose and operation of priority flow divider valves, bypass flow regulators, and proportional flow divider valves.
- Calculates fill times, oil capacities, and charge pressures for hydro-pneumatic accumulators.

<b>Job Responsibilities - Controls</b>
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- Identifies limit switch positions.
- Identifies single-phase two-speed, and three-phase AC motor symbols.
- Understands forward and reverse rotation wiring diagrams for singlephase and three-phase AC electric motors.
- Identifies basic electrical symbols from ladder diagrams.
- Understands the basics of hydraulic system electrical controls.
- Distinguishes between ladder diagram elements: Electrical contacts (push button switches, sensors, and relay contacts), and output elements (resistance loads, such as relays, solenoids, lamps, and motors).
- Understands that electrical contacts have negligible resistance, whereas output elements have appreciable electrical resistance.
- Understands that in a ladder diagram, the voltage drops across the switch if it is open or across the load if it is closed.
- Understands the interaction between a ladder diagram and directional control valves.
- Identifies the function of electrical components in a circuit.
- Understands that solenoid coil hum is caused by alternating current and the bias spring.
- Understands that a solenoid shading ring helps hold the armature in place as the main magnetic coil attraction drops to zero.
- Understands that the shading ring in AC directional control valve solenoids minimizes hum by providing an induced current that lags the applied current.
- Associates AC solenoid failures with failure of the armature, or failure of the plunger to seat.
- Understands the relationship given by Ohm's law.

## Job Responsibilities - Basic Circuits

- Understands the function of a Graetz rectifier.
- Understands that system pressure in a series hydraulic circuit results from the combined load on all actuators.
- Understands that pressure in a parallel hydraulic circuit results from the load on the actuator with least resistance.
- Understands that the pressure relief valve diverts unneeded flow to the reservoir when a fixed displacement pump is used.
- Recognizes basic hydraulic circuits from circuit schematics.
- Identifies purposes for hydraulic meter-in, meter-out, bleed-off, brake, sequence, and counterbalance circuits.
- Recognizes the characteristics of meter-in, meter-out, and bleed-off circuits.
- Recognizes the limitations of meter-in, meter-out, and bleed-off circuits.
- Identifies circuits that match applications.
- Understands that hydraulic regenerative cylinder circuits increase cylinder rod velocity.
- Understands that regenerative hydraulic circuits require adding rod end flow to cap end flow on the extension stroke.
- Understands how components interact in a hydraulic regenerative circuit.
- Calculates the cylinder rod force, cylinder rod velocity, and flow rate in various lines in a hydraulic regenerative cylinder circuit.
- Distinguishes hydraulic accumulator circuit purposes from circuit schematics.
- Understands that hydraulic system heat generation in aerial trucks is caused by boom actuation and portable hydraulic tool usage.
- Understands that a variable displacement, pressure compensated pump reduces energy loss by avoiding relief valve operation at full pump pressure during holding or clamping.
- Understands that load sensing circuits with variable displacement, pressure compensated, pumps maintain pressure approximately at load pressure.
- Understands that hydraulic circuit synchronization can be achieved by mechanical tying, metering, flow dividers, two equal displacement pumps, or replenishing circuits.