Chapter 4

Fluid Power Standards and Symbols

Language of the Industry
Objectives

- Describe the meaning of a standard and the importance of standardization in an industry.
- Identify the primary groups that provide standards for the fluid power industry and describe the standards information maintained by each group.
- Provide specific examples of standards from standardizing groups involved in the fluid power industry.

Objectives

- Identify and explain the parts of circuit diagrams typically used with fluid power equipment.
- Explain the symbols used to designate components in fluid power circuit diagrams.
Standardization

- **Standards** affect our daily activities:
  - Health and safety issues
  - Quality of manufactured goods
  - Service industry
- Standards can be defined in many ways.

Standardization

- In manufacturing, a standard is usually a set of specifications that define a procedure or product
Standardization

Standards are established using a variety of procedures:
- Societal customs (*de facto*)
- General consent of the involved group
- Legal regulation based on laws

In the United States, the standardizing process is carried on by:
- Trade and business associations
- Scientific and professional societies
- General membership associations
- Testing and certifying groups
- Consortia with a common interest
- Government
Standardization

- Domestic and international standards-coordinating organizations exist to assist the many groups involved in standards development
  - American National Standards Institute (ANSI) is the primary domestic coordinating group
  - International Organization for Standardization (ISO) is the international coordinating group

Standardization

- Professional organizations provide related services to the fluid power and other industries
- They provide:
  - Technical information
  - Training
  - Standardization
  - Product testing services
Examples of professional organizations include:

- American Petroleum Institute (API)
- ASTM International
- ASME
- Underwriters Laboratories, Inc. (UL)

Standards from the American Petroleum Institute affect common items such as motor oil.
Standardization

- In fluid power, four professional organizations act in the areas of:
  - Manufacturers and distributors association activities
  - Standards development
  - Professional society functions
  - Educational promotion

Standardization

- The four professional organizations in the fluid power area are:
  - National Fluid Power Association (NFPA)
  - Fluid Power Distributors Association (FPDA)
  - International Fluid Power Society (IFPS)
  - Fluid Power Educational Foundation (FPEF)
Standardization

- Fluid power professional organizations promote education in the fluid power area

Standardization

- Organizations involved in the standards-development process follow a carefully outlined set of written procedures to assure adequate due process for those affected by the standards.
- The content of standards vary considerably in both technical complexity and detail.
Standardization

- Typical standards include information on:
  - Scope
  - Purpose
  - References
  - Definitions
  - Identification statements
  - General rules of the standard
  - Appendices

Fluid Power Symbols and Circuit Diagrams

- **Symbols** are used in all parts of the world for designating components in fluid power circuits

![Symbols Diagram](image-url)
Fluid Power Symbols and Circuit Diagrams

- Knowledge of common symbols is considered a valuable tool for anyone working in the fluid power field.
- The types of symbols most often encountered in the fluid power field are:
  - Graphic
  - Pictorial
  - Cutaway
  - Combination

Fluid Power Symbols and Circuit Diagrams

- **Graphic symbols** are the most common symbol type
  - Relatively simple to draw
  - More easily standardized than other types

![Graphic Symbol Example](image.png)
Fluid Power Symbols and Circuit Diagrams

- The intent of a graphic symbol is to represent the:
  - Type
  - Functions
  - Operation
  - External connections
  - Does not show the actual construction of the unit

Fluid Power Symbols and Circuit Diagrams

- Fluid power graphic symbols consist of basic figures:
  - Lines
  - Circles
  - Squares
  - Triangles
  - Dots
  - Arrows
For example:

- Circles are used to represent components such as pumps, motors, and pressure gauges
- Squares depict valves and conditioning units
Fluid Power Symbols and Circuit Diagrams

- Other graphic elements designate the operating medium of the system, direction of movement, or the source of system energy.

For example, a small, equilateral triangle shows the type of fluid and the direction of energy flow.
A number of mechanisms are used to control the valves in a fluid power system:
- Muscular
- Mechanical
- Electrical
- Pressure
- Feedback

Control mechanisms are shown on the end of the general valve graphic symbol
- Pilot (pressure) and solenoid (electrical) control symbols usually are shown in boxes
- Muscular and mechanical control devices have separate symbols attached to the valve symbol
Fluid Power Symbols and Circuit Diagrams

- Example control mechanism symbols

- Pictorial symbols consist of line drawings of the exterior shapes of fluid power components
Fluid Power Symbols and Circuit Diagrams

- **Cutaway symbols** are miniature section drawings of the components.

Fluid Power Symbols and Circuit Diagrams

- Pictorial symbols and cutaway symbols are very useful in training and other applications.
- Pictorial symbols and cutaway symbols do not adapt well to standardization.
Fluid Power Symbols and Circuit Diagrams

- Joining of lines in a circuit is represented by a graphic symbol, which is a dot.
- Lines that cross without joining are shown as an arc crossing without a dot.

![T-type connection](image1.png)  
![Nonjoining lines](image2.png)

Fluid Power Symbols and Circuit Diagrams

- Basic graphic symbols for energy conversion devices are the circle and the rectangle.
  - Pumps, compressors, and motors are depicted by circles.
  - Cylinders are represented by rectangles.
Fluid Power Symbols and Circuit Diagrams

- A capsule is the symbol used to show energy storage devices in both hydraulic and pneumatic systems
  - **Accumulators** are the storage devices found in hydraulic systems
  - **Air receivers** are the primary pneumatic storage devices

Fluid Power Symbols and Circuit Diagrams

- One or more box shapes serve as the basic symbol for control valves
  - Each box represents a single valve position.
  - Boxes are drawn with contiguous sides when the symbol depicts a multiple-position valve
Fluid Power Symbols and Circuit Diagrams

- Basic valve graphic symbols.

- Symbols for pressure control valves are shown as normally open or normally closed
  - Normally open valve is open at rest, allowing flow through the valve
  - Normally closed valve is closed at rest, blocking flow through the valve
Fluid Power Symbols and Circuit Diagrams

- Symbols for normally open and normally closed pressure control valves

![Diagram of normally open valve](symbol)

![Diagram of normally closed valve](symbol)

Fluid Power Symbols and Circuit Diagrams

- Simplified symbol for an adjustable flow control valve shows an orifice with an arrow drawn diagonally across it.
  - Arrow indicates the orifice is adjustable
  - When appropriate, symbols also indicate pressure and temperature compensation
Fluid Power Symbols and Circuit Diagrams

- Symbol for an adjustable flow control valve

Fluid Power Symbols and Circuit Diagrams

- Symbols for pressure- and temperature-compensated flow control valves; symbols may be combined
Fluid Power Symbols and Circuit Diagrams

- A number of reservoir symbols are shown in a typical circuit diagram
  - Only one reservoir exists in most systems
  - Using multiple reservoir symbols reduces the complexity of a diagram by eliminating the return lines extending from the components to the reservoir

Fluid Power Symbols and Circuit Diagrams

- Lines returning to the reservoir

![Diagram of lines returning to the reservoir](image)
Fluid Power Symbols and Circuit Diagrams

- Fluid-conditioning devices include filters, separators, air dryers, lubricators and heat exchangers
- Basic graphic symbol for fluid conditioning devices is a square shown resting on one corner

Symbols for basic fluid-conditioning devices:

- Filter
- Manually drained separator
- Lubricator
- Heat exchanger
Fluid Power Symbols and Circuit Diagrams

- A number of measuring instruments and specialized electrical switches are represented by individual symbols
  - Basic graphic symbol for measuring instruments is a circle
  - Basic graphic symbol for switches is a square

Fluid Power Symbols and Circuit Diagrams

- Graphic symbols for basic measuring devices

- Pressure indicator
- Flowmeter
- Liquid level indicator
- Tachometer
- Temperature indicator
- Torque meter
Fluid Power Symbols and Circuit Diagrams

- **Circuit diagrams** provide a variety of information about fluid power systems for use during system assembly, operation, and testing.
  - Schematic diagrams
  - Component lists
  - Sequence of operation

Fluid Power Symbols and Circuit Diagrams

- Circuit diagram schematics must:
  - Include all components and connections
  - Be logically arranged so it is possible to easily follow the operating cycle of the system
Fluid Power Symbols and Circuit Diagrams

- All system components in a circuit diagram should be identified with a code number to allow easy identification
- ISO standards provide a four-element coding system to provide a logical, easily applied identification system

Fluid Power Symbols and Circuit Diagrams

- A wide variety of technical information can be included in a circuit diagram
  - System prime mover information
  - Flow rating of pumps
  - Level of filtration
  - Conductor sizes and weights
  - Actuator sizes
  - Pressure settings of valves
  - Other appropriate information
Review Question

Standards are established using one of three processes. List these processes.

A. Custom or de facto, B. general consent, and C. legal regulation

Review Question

Standardization groups (committees) should include members of at least three groups. List these three groups.

A. Product producers, B. users, and C. those interested in the product.
Review Question

A number of organizations from outside the fluid power industry provide information and standards on items that support the hydraulic and pneumatic fields. List three items that this type of information or standardization may relate to in the fluid power field.

(any three; other answers possible) A. Composition of materials, B. generic parts like bolts and other fasteners, C. commonly used materials, D. component parts, E. lubricants, F. seals, and G. electrical solenoids.

Review Question

Graphic symbols are not intended to show the:

A. Function of the component.
B. Location of the component.
C. Appearance of the component.
D. Type of fluid.

C. Appearance of the component.
Review Question

List the three items that fluid power symbols are used to communicate.

A. Component design features, B. system construction, and C. system operation.

Glossary

- Accumulator
  - A hydraulic component in which system liquid is stored under pressure using a mechanical device, compressed gas, or weight to maintain pressure.

- Air receiver
  - A tank used for the storage of compressed air in a pneumatic system. Also assists in the control of air temperature and water vapor.
American National Standards Institute (ANSI)
- The primary standards coordinating group in the United States. The group consists of numerous professional, technical, trade, labor, consumer, and governmental organizations and agencies. It is also the United States member of the International Organization for Standardization (ISO).

American Petroleum Institute (API)
- An organization consisting of corporations from the petroleum and allied industries. The group includes petroleum producers, refiners, marketers, and transporters. Activities include providing information to the general public as well as advocacy, research, and technical services for members.
Glossary

- **American Society of Mechanical Engineers (ASME)**
  - A technical society organized to promote mechanical engineering and its associated arts and sciences. The group participates in international standardization activities.

- **Circuit diagram**
  - A group of symbols combined to represent the components and interconnecting lines in a fluid power system.

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Glossary

- **Control mechanism**
  - A device used to control the operation of a control valve. This may include mechanically, pilot-, solenoid-, and manually operated devices.

- **Cutaway symbol**
  - Represent fluid power components in schematics using miniature cutaway drawings of the basic internal structure of valves and other parts.
Glossary

- **De facto standard**
  - A standard that has become generally accepted without specific government or industry endorsement.

- **Electrical controls**
  - Control of a variety of fluid power component and system functions ranging from simple manual on/off switches to complex servomechanisms.

Glossary

- **Energy conversion device**
  - A device that has the ability to convert energy from potential to kinetic or kinetic to potential.

- **Feedback control**
  - A control system that uses information from system output to vary the input function to maximize performance.
Fluid Power Distributors Association (FPDA)
- An organization of companies primarily involved in the distribution of fluid power products. The organization promotes the industry through trade shows, brochures, and numerous educational programs.

Fluid Power Educational Foundation (FPEF)
- An organization that coordinates, supports, and promotes education in fluid power. The foundation works closely with the NFPA, the FPDA, and the IFPS.
Glossary

- **Graphic symbols**
  - The most common symbols used to represent component features, system construction, and system operation in fluid power diagrams. Consist of a series of lines and shapes that represent specific components or features.

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Glossary

- **International Fluid Power Society (IFPS)**
  - A group of individuals concerned with fluid power in a wide variety of technical fields. Operates a certification process requiring both a written and hands-on test.
Glossary

- International Organization for Standardization (ISO)
  - An international agency for standardization located in Geneva, Switzerland. It includes the recognized national standards bodies of approximately 110 countries of the world.

- Mechanical control
  - Mechanical mechanisms to operate control valves, including levers and ramps (inclined planes).

- Muscular control
  - A valve-control element that depends on manually applied force to shift the valve into a desired operating position.
Glossary

- National Fluid Power Association (NFPA)
  - A nonprofit trade association and standards developer serving manufacturers of fluid power products, including both hydraulics and pneumatics.

Glossary

- Pictorial symbol
  - A symbol often used to depict a component in a fluid power circuit. The symbols often represent the external shape of components, but no standardized shapes have been identified.
Glossary

- **Pressure controls**
  - A variety of components designed to limit maximum system pressure (relief), sequence actuator movement (sequence), restrain movement (counterbalance), unload pump output (unloading), and provide reduced pressure (pressure reducing).

- **Standard**
  - In industry, a standard is usually a set of specifications that define a process, product, or part.

- **Symbols**
  - Figures used on a diagram to represent fluid power components and features of those components.
Glossary

- **Underwriters Laboratories Inc. (UL)**
  - An equipment testing and certifying organization that has also developed standards for use in the industry. It tests and certifies many of the electrical components used in fluid power equipment.