

# **W-11**

**STUDY MATERIALS FOR THE  
CERTIFICATE OF FITNESS EXAMINATION FOR  
TESTING AIR RECEIVERS**

This study material contains the information you will need to prepare for the examination for the Certificate of Fitness for Testing Air Receivers. The study material includes information taken from relevant sections of Fire Prevention Directives, the Fire Prevention Code and the Building Code of New York.

All questions on the Certificate of Fitness examination are multiple choice, with four alternative answers to each question. Only one answer is correct for each question. If you do not answer a question, or if you mark more than one alternative your answer will be scored as incorrect. A score of 70% correct is required on the examination in order to qualify for the Certificate of Fitness. Read each question carefully before marking your answer. There is no penalty for guessing.

### **Sample questions**

1. An air compressor system is primarily used for:
  - (a) fire fighting operations
  - (b) storing pressurized air
  - (c) forcing water through fire sprinklers in a building
  - (d) running elevators in a high rise apartment building

The correct answer is "b". You would tap "b" on your touch screen monitor.

2. When air is pressurized by an air compressor it:
  - (a) collects water from the surrounding air
  - (b) becomes cold
  - (c) becomes hot
  - (d) forces dirt out of the storage tank

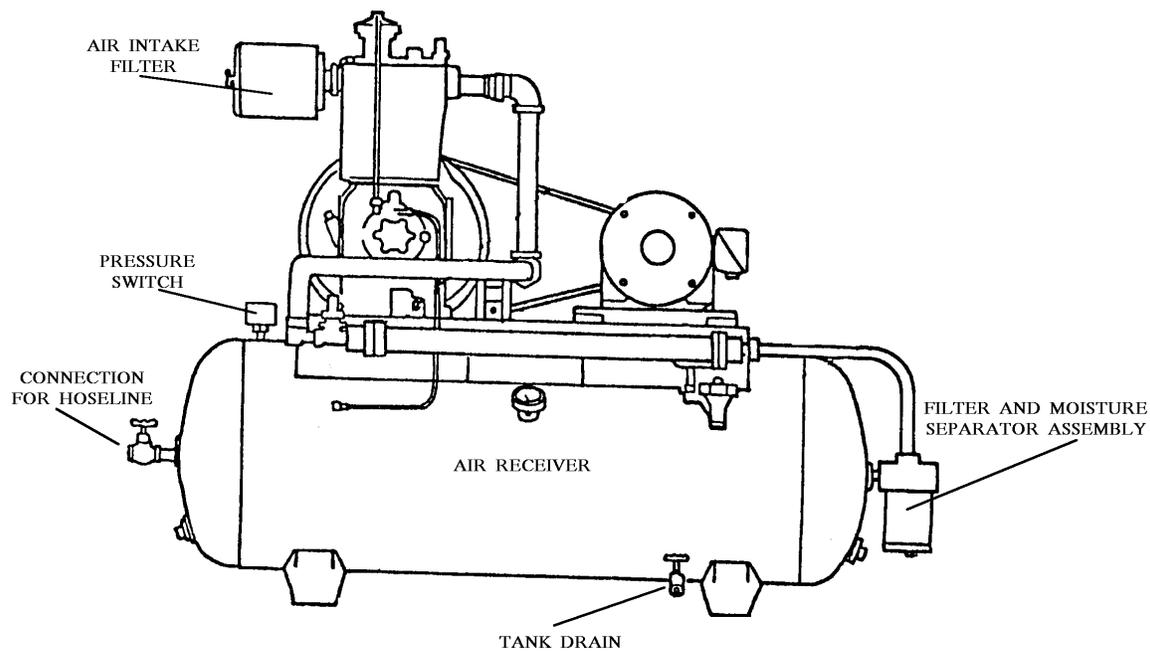
The correct answer is "c". You would tap "c" on your touch screen monitor.

## AIR COMPRESSORS

An air compressor takes the air in a room and forces it into a container under pressure. The more air forced into the container the greater the air pressure that builds up inside. The compressed air can be discharged from the container at a controlled rate. The compressed air is used to power a variety of tools and machinery. For example, compressed air is used to power pneumatic wrenches and lifts in automobile service stations. Compressed air is also used for heavy machinery and paint spray booths in industrial plants.

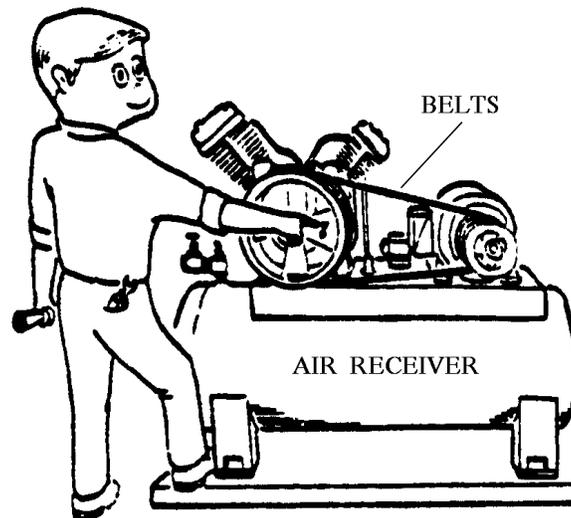
There are several types of air compressors. The different types include the reciprocating, centrifugal and rotary compressors. The only real difference between these compressors is the way in which they compress the air. The most commonly used air compressor is the reciprocating air compressor. Air compressors are sometimes called air pumps.

The air compressors can be powered by electric motors, internal combustion engines or steam turbines. The most common power source is an electric motor. A typical air compressor is shown below.



## BASIC OPERATION OF AN AIR COMPRESSOR

The operating principles of an air compressor are very simple. The entire unit is driven by an electric motor. This motor then activates a series of drive belts. The belts on the air compressor serve to power the moving parts of the unit. These belts are very similar to the belts that drive the power steering and alternator in an automobile. The belts on a typical air compressor are shown below.



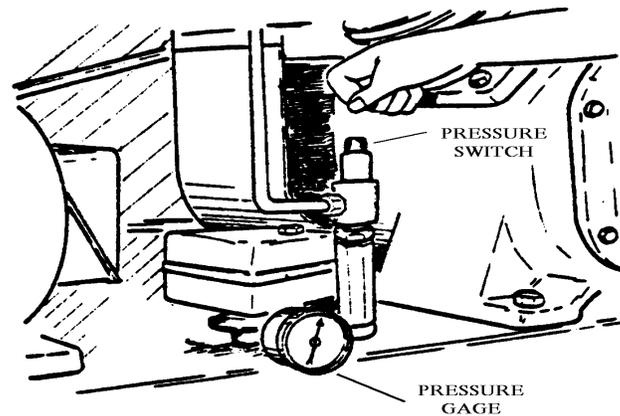
The air is compressed in a compression chamber. The compression chamber consists of a piston inside a cylinder. The piston moves up and down. When the piston moves downward it draws air into the cylinder. The air is drawn in through an intake valve. The intake valve automatically opens when the piston moves downward. When the piston reaches the bottom of the cylinder it changes direction. As the piston moves upward the intake valve is automatically closed. The closed intake valve prevents the air from escaping from the cylinder.

The upward stroke of the piston compresses the air. When air pressure reaches a certain level it forces open a discharge valve. The discharge valve is spring loaded. When the discharge valve opens the compressed air is released into an air receiver. The air receiver is sometimes called an air tank. The compressed air is then taken from the air receiver when it is needed to supply the tools or machinery.

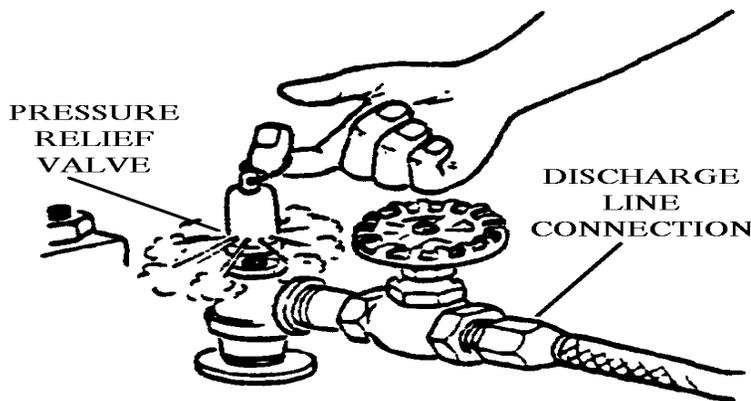
## SAFETY COMPONENTS OF THE AIR COMPRESSOR

The air compressor is fitted with several safety components. These components are briefly described below. The first is an UNLOADING VALVE. The unloading valve allows the air to escape from the compression chamber when there is a strain on the electrical motor. The strain usually occurs when the electric motor running the compressor is first started. After a few cycles of the motor the valve is closed. In most air compressors the unloading valve operates automatically. However in older compressors it may need to be manually operated. The manufacturer's instruction manual should be followed when starting an older compressor. A PRESSURE GAGE is installed as part of the compression unit. It indicates the pressure inside the air receiver. The Certificate of Fitness holder should pay close attention to the

reading on the pressure gage. The pressure inside the air receiver must never exceed the manufacturer's recommendations. If the pressure is greater than the recommended level it may cause an explosion. The pressure in the air receiver is controlled by the pressure switch. To adjust the pressure simply turn the switch in the desired direction.



PRESSURE RELIEF VALVES are also installed on the system. These valves allow air to escape from the system when the pressure is too great. The valves operate automatically. They may also be operated manually by pulling on the ring attached to the pressure relief valves. An example of a pressure relief valve is shown below.



The AIR INTAKE VALVE is fitted with an air filter. The filter prevents dust from being drawn into the compression cylinder. If dust enters the compressor it may result in a fire inside the cylinder. The heat inside the cylinder can cause the dust to catch fire. A fire inside the cylinder may cause damage to the air compressor. For this reason it is important make sure that the air filter is clean and securely connected to the compressor.

Moisture can cause problems when using an air compressor to power machinery. For this reason another filter must be installed to take out the moisture out of the compressed air. The moisture is usually removed using a FILTER AND MOISTURE SEPARATOR ASSEMBLY (FMSA). The FMSA is installed between the air compressor and the air receiver. It removes

the moisture and dust from the compressed air before it enters the air receiver. A drain cock is attached to the FMSA. It is used to drain the water and dirt from the FMSA.

An AUTOMATIC CONTROL DEVICE is attached to the air receiver. It controls the starting and stopping of the air compressor. It shuts down the compressor when the air pressure in the air receiver is adequate. It then restarts the air compressor when there is a need for more pressure.

Sometimes a CONSTANT SPEED CONTROL SWITCH is installed on the system. This is used when there is a steady or constant demand for compressed air. The switch allows the air compressor to run continuously. The compressor runs at a safe speed while supplying the desired amount of compressed air. If the demand drops the excess compressed air is simply allowed to escape into the atmosphere. The unneeded compressed air is released through the pressure release valve.

A COOLING SYSTEM is installed in each air compression unit. The compression chamber and the compressed air must be cooled. Small compressors are usually air cooled. The air is circulated around the compressor by a fan. Large air compressors are usually water cooled. Cold water is pumped throughout the compressor. Both the air and water cooling systems prevent the compressors from overheating and causing serious damage.

The air compressor is also fitted with a LOW OIL LEVEL INDICATOR SWITCH. This indicator switch will automatically shut down the air compressor if the oil level is low. The compressor should not be operated if the oil is low. This can cause serious damage to the compressor. Do not attempt to run the air compressor until the oil is replaced.

### **SAFETY PRECAUTIONS**

All hose connections on the air compressor should be checked frequently to make sure that they are tight. The safety valves and gages should be regularly to make sure that they are in good working order.

Make sure that the air compressor is operated at safe speeds. Do not run the compressor a speeds above its safe recommended operating range. The operating range is indicated in the manufacturer's manual.

The air intake filter should be visually inspected and cleaned on a regular basis. The filter should be replaced every six months.

Never place any combustible materials on the air compressor. These materials may be ignited by the high operating temperatures of the air compressor.

Use a soap and water solution when cleaning the air compressor and its storage tanks. Never use benzene, kerosene or other light oils for this purpose. These oils may cause an explosion if mixed with air under pressure.

Never make repairs to the compressor while it is running. The compressor must always be turned off when making repairs. As an added precaution shutdown the electrical supply to the machine. Compressed air should also be drained from the compressor before starting any work.

## PERMITS

A permit is require for any air compressor that compresses air at pressures above 100 pounds per square inch (psi). A permit is also required for all air compressors that have total air receiver capacity of 30 cubic feet or more. These permits are issued by the Bureau of Fire Prevention.

## TESTING

The air compressor must be tested regularly to make sure that it is working safely. Most of the air compressor system must be tested a least once every 90 days. These inspections must be conducted by a Certificate of Fitness holder. All inspections must be recorded in the inspection log and posted near the air compressor. The air compressor and its parts are tested by following the procedures outlined below.

### Air Receivers

All air receivers must be constructed of rolled, drawn or forged steel. The air receiver must meet specifications of the American Society of Mechanical Engineers (ASME). A hydrostatic test is used to test air receivers. This test examines the structural soundness of the air receiver tank. The test steps are as follows:

1. Disconnect the power supply. Then open the drain valve and discharge all air from the tank. The air is discharged by opening the tank drain. Then close the drain valve.
2. Remove or plug the pressure relief valve. The pressure relief valve must be removed using an approved wrench. Then fill the air receiver with water.
3. Using a suitable hand pump increase the hydrostatic pressure in the receiver tank. The pump has a special connection device installed on the end of its hose. This device is screwed into the threads that held the pressure relief valve.
4. Increase the water pressure in the tank until it reaches twice the normal working pressure. If the testing pressure would be greater than 300 psi increase the pressure to  $1 \frac{2}{3}$  the normal working pressure.
5. Hold this pressure constant for about 20 minutes. During this time look for leaks in the receiver. If no leak is discovered the tank is in good condition. If the tank passes the test drain the water from the tank. The replace the pressure relief valve. Be careful to make sure that the relief valve is securely connected to the tank.
6. If a leak is discovered the air receiver should be condemned and replaced. No attempt should be made to use a tank with a leak. A leaking receiver tank is dangerous and may cause an explosion.

Normally the hydrostatic test must be conducted every 5 years. However, fully automatic air receivers may be tested annually by the Certificate of Fitness holder. If the compressor is tested annually, an affidavit must be filed with the Division of Fire Prevention after each inspection. This affidavit must be on an approved form. The affidavit must certify that the air compressor is in first class operating condition.

If the receiver meets the requirement of the test several of the automatic devices must be inspected.

### **Pressure Switch**

The pressure switch is a pressure regulating device. It shuts down the air compressor when pressure in the air receiver reaches a certain preset level. Then it restarts the compressor when the pressure falls below a certain level. The shut down and restart levels depend on the size of the compressor and the demand for compressed air. The pressure switch prevents the air pressure inside the tank from reaching dangerous levels. Dangerously high pressure levels may cause the tank to explode. It is therefore essential that the pressure switch is working correctly. The steps to test the pressure switch are as follows:

1. Start the air compressor. Allow the pressure in the air receiver to build up to normal operating levels. Pay close attention to the pressure gage.
2. When the gage indicates that the pressure is above normal operating levels the pressure switch should shut down the compressor automatically. If the compressor does not shut down automatically the pressure switch may be adjusted. If the adjustment does not correct the problem the switch is defective. A defective pressure switch must be replaced before the compressor may be restarted.

Some air compressors are designed to operate continuously. They have a different pressure switch device. This device does not shut down the entire air compressor. Rather it allows the compressor to run but prevents the compressor from compressing air. The testing procedures should check that air is no longer compressed when the preset level is reached.

### **Pressure Relief Valve**

The pressure relief valve acts as a backup safety device to the pressure switch. It is designed to automatically open when the pressure in the receiver reaches dangerous levels. The pressure relief valve is tested by running the air compressor with the pressure switch fully open. When the pressure switch is fully open it cannot shut down the compressor.

The pressure relief valve should open automatically when the pressure reaches 25 psi above the normal operating pressure. If the pressure relief valve does not open it may be defective. The valve may also be defective if it opens before the receiver reaches normal operating pressure. Defective relief valves must be replaced before the compressor is restarted. The Certificate of Fitness holder must also check to make sure that the pressure relief valve is of the correct size. The pressure relief valves must meet the manufacturer's specifications. These specifications are outlined in the air compressor maintenance manual.

### **Belts**

The belts must be inspected to make sure that the air compressor is running at the correct speed. First turn off the compressor and disconnect the power supply. If the belts are covered by a protective guard remove the guard. If the belts are frayed or visibly damaged they must be replaced. To test the belt tension firmly press down on the belt. If the belt moves more than

one the inch flywheel may need to be adjusted. Make the adjustments as needed. If the adjustment does not work replace the belts with the belts specified by the manufacturer.

### **Operating Temperature**

The air compressor must be tested to make sure that it is running within normal operating temperature ranges. Guidelines for acceptable operating temperatures are specified in the maintenance manual. This test reduces the likelihood of the air compressor overheating. Overheating may cause irreparable damage to the compressor. An overheating air compressor is a potential fire hazard. If an overheating problem is discovered the water cooling mechanisms must be checked. The cooling mechanism is tested to make sure that an adequate water supply is reaching the air compressor. Any blockages, leaks or other defects must be repaired or defective parts replaced.

### **Electrical Connections**

All electrical connections, fuses, and cables must be visually inspected by the Certificate of Fitness holder. A qualified electrician must be notified if there is evidence of any defective parts. The electrician must pay close attention to the motor starter. The motor starter protects the compressor against thermal overload. Thermal overload is caused by excessive electrical currents.

### **Maintenance Procedures**

The Certificate of Fitness holder should make sure that the air compressor is properly maintained. Sometimes the air compressor is not maintained correctly. The operator must know how to check, and when to check the lube oil. The operator should also know how to replace the belts and air filter etc. An incorrectly maintained air compressor is a potential fire hazard.