

STUDY MATERIAL FOR THE  
CERTIFICATE OF FITNESS FOR:

**G-35**

**TO OPERATE AIR COMPRESSORS**

ALSO INCLUDED IN THIS BOOKLET YOU WILL  
FIND THE FOLLOWING:

**1. NOTICE OF EXAMINATION (NOE)**

This study material contains the information you will need to prepare for the examination for the Certificate of Fitness To Operate Air Compressors. The study material includes information taken from relevant sections of the Fire Prevention Code and the Building Code of New York. The study material does not contain all of the information you need to know in order to perform the job at your work location. It is your responsibility to learn whatever else you need to know to do your job.

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 press "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.

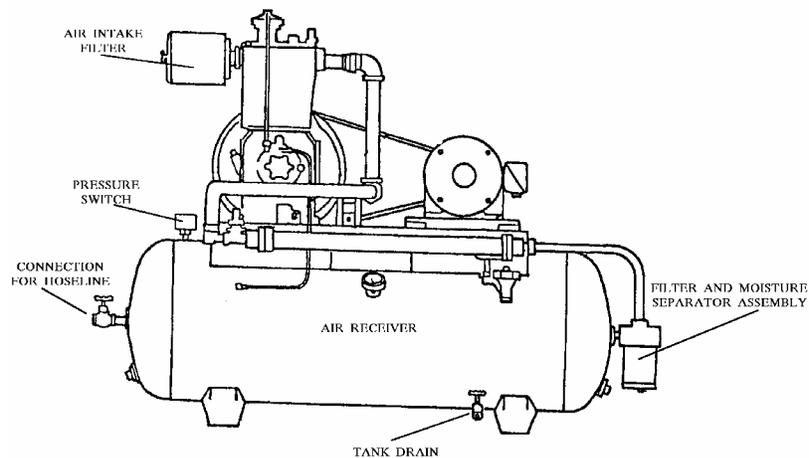
The correct answer is "C". You would mark "C" on your touch screen monitor.

## 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.

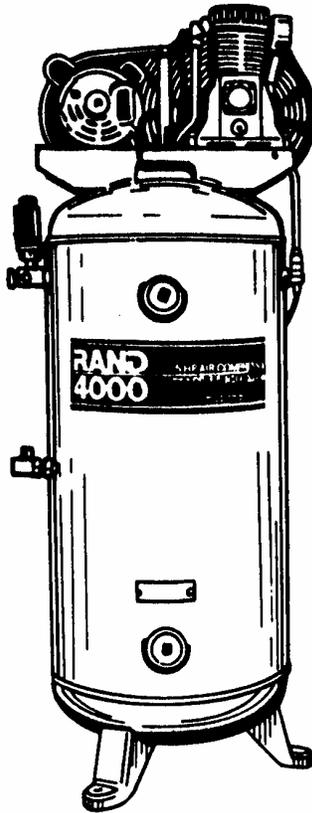
There are several types of air compressors. The different types include the reciprocating, centrifugal and rotary compressors. The only real difference between these compressors is the way in which they compress the air. The most commonly used air compressor is the reciprocating air compressor. Air compressors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



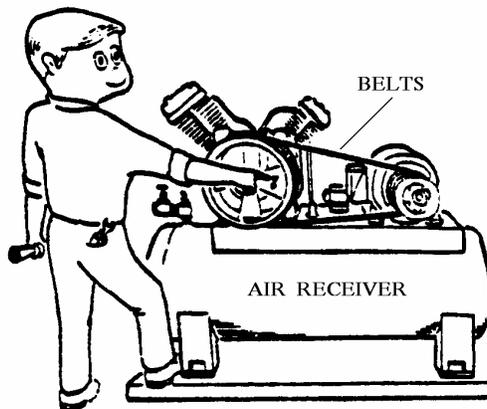
In some locations there may be a build up of flammable gases. For example, there may be a build up of flammable gases in service stations and workshops. Flammable gases are usually heavier than air and fall to the floor before spreading outward. The flammable gases are easily ignited by sparks and high temperatures. They may be ignited by the heat generated by the air compressor. If the flammable gases are ignited inside the compressor it will cause an explosion.

For this reason steps must be taken to make sure that no flammable gases are drawn into the air compressor. This is done by raising the air compressor at least 5 feet above ground level. The raised air compressor is less likely to ignite the flammable gases. Meeting this height requirement may be done in several ways. For example, the compressor may be placed on a shelf or a bench. Or the air receiver tank may be turned and stood on end. Then the air compressor is bolted to the top of the air receiver.



### 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.

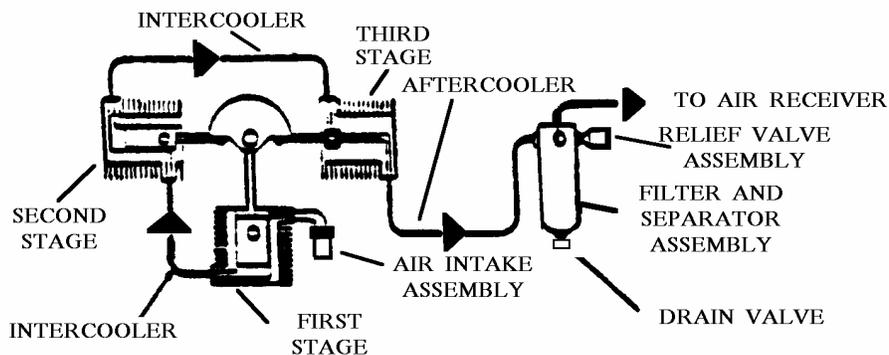


The air is compressed in a compression chamber. The compression chamber consists of a piston inside a cylinder. The piston moves up and down. When the piston moves downward it draws air

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.

An air compressor with one cylinder and one piston is called a single stage air compressor. Some air compressors may have more than one cylinder and piston installed. These compressors can supply greater pressure than the single stage compressor. For each additional cylinder and piston the number of stages increases by one. For example, a compressor with three cylinders and three pistons is called a three-stage air compressor. When air is compressed it becomes heated. An intercooler is installed between the stages of the air compressor. The intercooler cools the air as it travels between the compression stages. A diagram of a three-stage air compressor is shown below.



In some systems the compressed air is forced from the air receiver into storage containers. These containers allow the compressed air to be used later as needed.

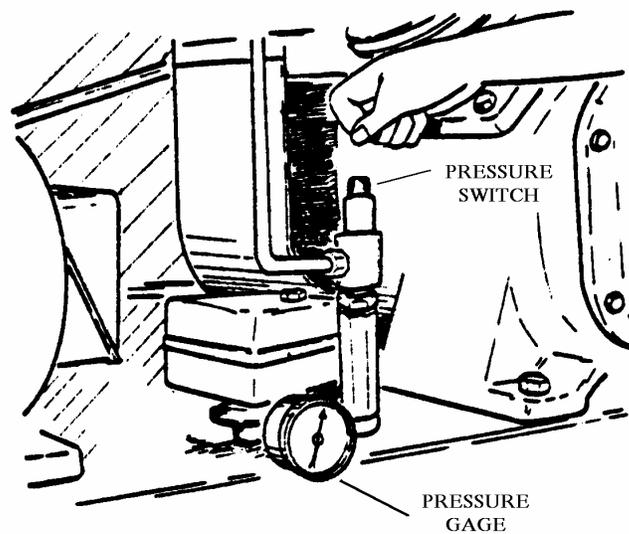
Some systems may use several connected air compressors. The air is drawn into the first compressor and then forced into the second compressor. The second compressor then forces the compressed air into the next compressor. This occurs until the air has passed through all of the connected compressors. Each time the air passes through a compressor the air pressure is increased. Finally the compressed air is forced into the hose line or a storage container. This systems is used when there is a need for air under very high pressure.

### **SAFETY COMPONENTS OF THE AIR COMPRESSOR**

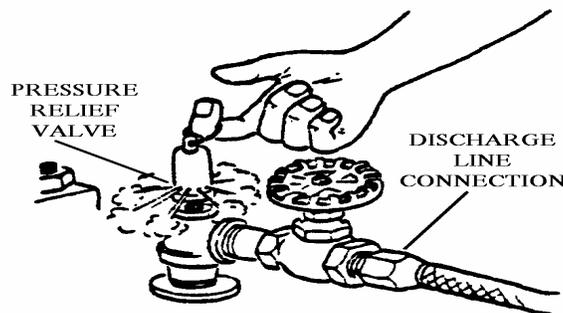
The air compressor is fitted with several safety components. These components are briefly described below. The first is an UNLOADING VALVE. The unloading valve allows the air to escape from the compression chamber when there is a strain on the electrical motor. The strain

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 checked 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 at 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.

## OPERATION INSPECTION AND MAINTENANCE

Before the air compressor is started the entire system must be visually inspected by the Certificate of Fitness holder. This visual inspection should make sure that the following components are correctly installed and in good working order.

- (a) The unloading system
- (b) The pressure relief valves
- (c) The filter and moisture separator assembly
- (d) The air receiver
- (e) The air filter
- (f) The drain valve
- (g) The gages

When starting the compressors be sure to follow the guidelines outlined by the manufacturer. The certificate of Fitness holder should remain in the area for a few minutes after the air compressor has been started. This is to make sure that the compression unit is operating safely.

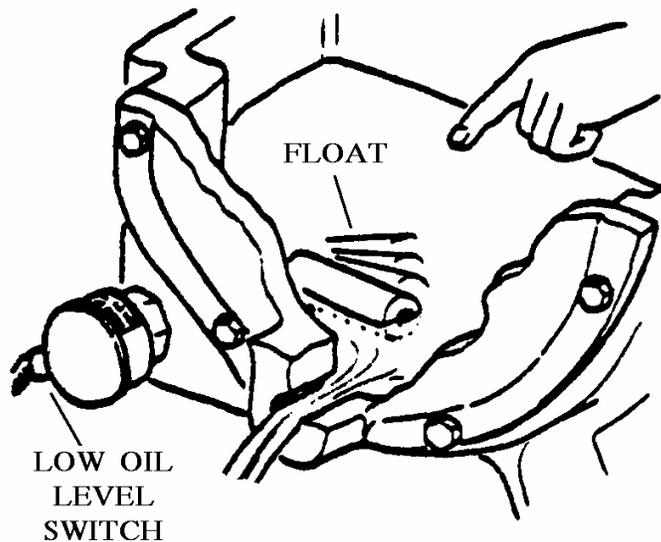
The cooling system should be tested every 6 months to make sure that it is working correctly. The water supply control valves should always be open when the air compressor is in operation.

The air intake filter should be inspected and cleaned weekly. It should be replaced every 6 months. If at any time the filter is damaged it should be replaced.

The Certificate of Fitness holder should refer to the manufacturer's manual to determine the safe operating temperatures of the water, oil and compressed air.

The level of the lubricating oil (lube oil) should be checked weekly using the dipstick. The lube oil is designed to lubricate the moving parts on the air compressor. The oil used must be of the grade specified by the compressor manufacturer. The lube oil should be replaced every six months.

The automatic low-level oil indicator switch should be tested every 3 months. This is tested by manually draining the oil from the air compressor when it is running. The indicator switch will shut down the air compressor within a few minutes if it is working correctly. When testing the compressor in this way do not run the air compressor for a long period of time. If the switch is defective it should be repaired or replaced. The air compressor should be refilled with oil before it is used again. The oil drain valve is shown in the figure below.



Water builds up in the moisture separator assembly and the air receiver must be drained daily. This is done by opening the drain valve and draining off the excess water.

All safety valves should be manually operated every week. This is to ensure that they will function correctly in case of an emergency. The air receiver tank must be tested every 5 years by a qualified technician.

The air compressor should be serviced and repaired by a qualified repair technician. All major repairs must be made by a qualified technician. However, the Certificate of Fitness holder may make minor repairs and perform maintenance on the air compressor. For example, the Certificate of Fitness holder may change the oil and the air filter. The manufacturer's manual should be consulted when performing maintenance or making repairs.