

## **Compressed Air System**

### **Screen 1:**

#### **Welcome Screen:**

Welcome to the Compressed Air System module of the ES44AC/DC Mechanical Systems Advanced course.

### **Screen 2:**

#### **Introduction to Compressed Air System:**

In this module, you will learn how to inspect and maintain the components of the compressed air system on an ES44AC/DC locomotive in a running repair environment.

At the end of this module, you will be able to:

- State the purpose and location of the compressed air system.
- State the purpose and location of the major components of the compressed air system.
- State the purpose and location of the compressed air system instrumentation devices.
- Describe how the compressed air system operates.
- Describe how to perform running maintenance related to the compressed air system.

### **Screen 3:**

#### **Disclaimer:**

This module is for training use only. For complete details of inspecting and maintaining the components of the compressed air system on an ES44AC/DC locomotive in a running repair environment, refer to customer-specific drawings, manuals, and procedures.

### **Screen 4:**

#### **System Overview:**

The compressed air system provides compressed air to the air brake system and the auxiliary air-operated devices on the locomotive, such as the horn and windshield wipers and, on earlier GEVO locomotives, a pneumatic crossing bell. The compressed air system and all its components, except the air compressor, are attached to or located under the platform. The air compressor is located in the radiator cab.

### **Screen 5:**

#### **Components of the Compressed Air System:**

The compressed air system on an ES44AC/DC locomotive includes several major components, including the air compressor and the safety valve.

### **Screen 6:**

#### **Air Compressor:**

Located in the radiator cab, the air compressor compresses ambient air and provides pressurized air to the system.

**Screen 7:****Safety Valve:**

Located between the two main air reservoirs on the Engineer's side of the locomotive, the J1 safety valve protects the air compressor and the rest of the compressed air system from an overpressure condition.

**Screen 8:****Components of the Compressed Air System:**

Other major components of the compressed air system include the main air reservoirs, air dryer, and final air filters.

**Screen 9:****Main Air Reservoirs:**

Located on the Engineer's side of the locomotive in a notched area of the fuel tank, the main air reservoirs store compressed air for later use by other components of the locomotive.

**Screen 10:****Air Dryer:**

Located on the Engineer's side of the locomotive between the fuel tank and the number 2 truck, the air dryer removes moisture from the compressed air.

**Screen 11:****Final Air Filters:**

Located on the Engineer's side of the locomotive between the fuel tank and the number 1 truck under the walkway, the final air filters filter contaminants from the compressed air before it is distributed to the controlled components.

**Screen 15:****System Instrumentation:**

A locomotive's instrumentation provides feedback for diagnostics, control, and protection.

**Screen 16:****Air Reservoir Pressure Sensor (ARPS):**

The Air Reservoir Pressure Sensor (ARPS) measures the pressure of the air that is at the output of the first main air reservoir. The locomotive control system uses this information to turn the air compressor motor on and off and to control when the compressor is to load or unload. The end result is to regulate the air pressure in the system. This information is also presented on the smart displays for operator use. The ARPS is located on the air compressor control panel, which is in the radiator cab. Access to the panel is from the Engineer's side of the locomotive near the air compressor.

**Screen 17:****Air Compressor Speed Sensor (ACS):**

The Air Compressor Speed Sensor (ACS) is used to detect the air compressor motor speed and send this information (a frequency) to the locomotive control system. The control system takes this information and uses it to determine if the compressor motor is operating at the correct speed. The ACS sensor is located at the end of the air compressor motor.

## **Screen 18:**

### **Operation of the Compressed Air System – Compression:**

The typical compressed air system utilizes a WABCO 3CDCLAT air-cooled compressor to provide the main source of compressed air for the locomotive. The compressed air system has four basic functions: compression, storage, filtration, and distribution. During compression, the outside air passes through two paper air filters and enters the air compressor. The air compressor is an AC motor-driven, two-stage air compressor that provides regulated compressed air to the first main reservoir. The locomotive's control system regulates the compressed air from the air compressor by controlling the following:

- When the air compressor motor turns on and off,
- The motor's speed when operating, and
- When the compressor loads (compresses air) or unloads (stops compressing air).

## **Screen 19:**

### **Operation of the Compressed Air System – Storage:**

From the air compressor, the compressed air enters the first main reservoir where cooling and moisture condensation take place. The main reservoir is tilted so that water collects at one end, where a drain valve drains any accumulated condensation from moisture in the air. A safety valve is connected to the outlet of the first main reservoir. If air pressure exceeds 150 psi, the valve will open. This is to protect the air compressor and the rest of the system from an overpressure condition. Compressed air from the first main reservoir flows in two ways. One path is to the main air reservoir pressure sensor (ARPS), which provides a feedback signal of the air pressure to the locomotive's control system. The other path is to the second main air reservoir, with or without an air dryer, based on customer requirements.

## **Screen 20:**

### **Operation of the Compressed Air System – Storage:**

For customer locomotives without an air dryer, compressed air from the main reservoir flows to the second main air reservoir and to the auxiliary air filter. A check valve between the output of the first main reservoir and the MR equalizing pipe allows consist air from another locomotive to enter this locomotive's air system.

## **Screen 21:**

### **Operation of the Compressed Air System – Storage (Cont'd):**

For customer locomotives with an air dryer, the air flows through the air dryer, where moisture is removed, and then continues to the second main air reservoir and to the auxiliary air filter. From the air dryer, the air flows to the second main air reservoir and to the auxiliary air filter. A check valve is connected between the output of the first main reservoir and the MR equalizing pipe. This check valve allows consist air from another locomotive to enter this locomotive's air system. A second check valve is connected between the output of the air dryer and the MR equalizing pipe, allowing air to flow to another locomotive in the consist. This path ensures that the air has passed through the dryer before being made available to another unit. Air enters the second main reservoir through a check valve and then flows to the MR air filter. The check valve prevents air from flowing backwards to the first main reservoir. This ensures that if the first main reservoir loses air, the second air reservoir will maintain enough supply air for the

brake system to be able to provide one emergency air brake application.

#### **Screen 22:**

##### **Operation of the Compressed Air System – Filtration and Distribution:**

The MR air filter and the auxiliary air filter are also known as final air filters.

These devices filter the air before being distributed to the air brake system and the auxiliary air devices. Each filter is equipped with a drain valve that may be used to drain any accumulated condensation. During distribution, the filtered air from the auxiliary air filter (that is, the auxiliary supply air) is distributed to the horn, bell, windshield wipers, and sanding valves. Filtered air from the MR air filter (that is, the MR supply air) is distributed to the air brake system, shutter control magnet valves, univalve control magnet valves, and the compressor magnet valve.

#### **Screen 25:**

##### **Operational Details:**

You can test the air compressor from any of the Smart Displays using Self-Tests 401, 402, and 403. These self-tests are used to test the operation of the Compressor Drive Contactors (CDC1, CDC2, and CDC2A) and the Compressor Magnet Valve (CMV), all of which will be discussed later. The Smart Display software controls when the air compressor motor turns on or off and at what speed by energizing the correct compressor drive contactors and when to load or unload the air compressor. To protect the air compressor motor from high startup currents, the motor is turned on first, and then the air compressor is loaded. Typically, the air compressor starts loading when the main reservoir pressure, as read by the ARPS sensor, drops below 128 psi and stops loading when the pressure rises above 141 psi. These values may vary depending on the railroad's compressed air requirements.

#### **Screen 26:**

##### **Running Maintenance Schedule:**

The table displays the recommended scheduled maintenance recommendations for the compressed air system and its major components.

#### **Screen 29:**

##### **Air Compressor:**

The air compressor is a three-cylinder, two-stage, air-cooled machine with two low-pressure cylinders and one high-pressure cylinder. The high-pressure and low-pressure pistons are driven by connecting rods that rotate about a common crankshaft crankpin. The air compressor is driven by an electric motor, which is mounted directly to the compressor crankcase. Running maintenance for the air compressor involves checking the oil level, draining and filling the oil, taking an oil sample, testing the load/unload operation, and removing and installing the air compressor.

**Warning:** When performing running maintenance, the air compressor motor could start at any time. Disable the compressor drive contactors by placing the Local Control Circuit Breaker (LCCB) on the Engine Control Panel in the OFF position before servicing the air compressor.

#### **Screen 30:**

##### **Running Maintenance for Air Compressor – Checking the Air Compressor Oil Level:**

Typical steps to check the air compressor oil level are as follows:

1. Place the LCCB in the OFF position to prevent the air compressor from running.
2. Check the air compressor oil level using the oil dipstick or oil level gauge located on the air compressor and add oil, if needed.

**Note:** When using the dipstick to take an oil level reading, the dipstick should first be removed and wiped clean, and then re-inserted. Ensure that the dipstick is fully seated, and then remove it and take the reading. Add oil as indicated on the dipstick or gauge.

3. Open the aftercooler petcocks each time the oil level is checked to allow accumulated moisture and small amounts of lubricant to be exhausted.
4. Close the petcocks when the moisture has been drained.

### **Screen 31:**

#### **Running Maintenance for Air Compressor – Draining Air Compressor Oil:**

Typical steps to drain the air compressor oil are as follows:

1. Place the LCCB in the OFF position to prevent the air compressor from running.
2. Place a receptacle of sufficient capacity under the air compressor drain pipe to collect the oil.

**Note:** The WABCO Model 3CDCLAT air compressor has a lubricating oil capacity of 16 gallons (60.56 liters). The drain pipe is located on the Helper's side of the locomotive under the platform.

3. Open the two drain valves — one located near the base of the air compressor on the Helper's side, which should be tagged open, and the other located under the platform on the Helper's side of the locomotive.

**Caution:** When changing the air compressor oil, thoroughly clean the crankcase. Any dirt and sludge remaining in the crankcase could be picked up by the pump and, if allowed to accumulate, could eventually plug the pump suction. If such blockage occurs, the flow of lubricating oil will be obstructed, resulting in possible damage to the compressor's moving parts.

4. Wipe the air compressor crankcase using a railroad-approved solvent and clean, lint-free cloth.
5. Close the drain valve near the base of the air compressor and the drain valve under the platform.

### **Screen 32:**

#### **Running Maintenance for Air Compressor – Filling the Air Compressor with Oil:**

Typical steps to fill the air compressor with oil are as follows:

1. Open the air compressor fill cap.
2. Fill the crankcase with the approved lubricating oil.

**Note:** The oil capacity of the air compressor is 16 gallons.

3. Check the crankcase lube oil level on the dipstick or gauge and add oil if needed.

**Screen 33:**

**Running Maintenance for Air Compressor – Collecting Oil Samples for Laboratory Analysis:**

Engineering recommends that oil samples be collected for analysis at a minimum frequency of 7 to 10 days. Have the sample analyzed by a qualified laboratory, and then take the appropriate action based on the analysis. Prior to taking an oil sample, run the air compressor to mix the oil in the crankcase. Some air compressors are equipped with a Test pushbutton located near the air compressor on the Engineer's side of the locomotive that when pushed will cause the air compressor motor to turn on for four minutes. After the air compressor motor turns off, place the LCCB in the OFF position to prevent the air compressor from turning back on. Next, write all pertinent information (such as road number, date, etc.) on the sampling bottle. Print the information clearly and keep the label clean so that a lab technician can read it. Connect an oil-sampling valve to the quick-disconnect fitting located on the air compressor. The oil sample bottle should be filled two-thirds to three-quarters full.

**Screen 34:**

**Running Maintenance for Air Compressor – Compressor Loading and Unloading:**

The air compressor must be manually loaded and unloaded to check the operation of the compressor load/unload system. When loaded, the compressor motor is running and the compressor is compressing air. When unloaded, the compressor motor is running but the compressor is not compressing air. This change from loading to unloading is accomplished through the operation of the Compressor Magnet Valve (CMV) and compressor unloader valves. Let's look at the role of the compressor magnet valve and the unloader valves during the process of loading and unloading.

**Screen 35:**

**Air Compressor Loading Operation:**

During compressor loading, the CMV is de-energized and opens, venting the air pressure supply to the unloader valves. The unloader valves then open, allowing the compressor intake valves to operate normally. When operating normally, air enters the compressor cylinders through the intake valves during the intake stroke, the intake valves then close, the compressor's pistons compress the air, exhausting the high-pressure air into the receiver, the compressor exhaust valves close and the process is repeated. With the compressor drive motor running and the compressor building air pressure, the compressor is operating in a "loaded" condition.

**Screen 36:**

**Air Compressor Unloading Operation:**

During compressor unloading, the CMV, which is a solenoid-operated valve, is energized and closes to force air pressure to act on the compressor unloader valves. The unloader valves physically force the compressor intake valves to remain open, preventing the compressor from building pressure. Although the compressor drive motor may be running, since the compressor cannot build air pressure, the compressor is operating in an unloaded condition.

**Note:** For normal automatic operation of the air compressor, the compressor cut-out valve

must be open, allowing air to flow to the ARPS, the CMV must be unlatched (that is, not locked in an energized position), and the governor test probe must be installed.

**Screen 37:**

**Running Maintenance for Air Compressor – Checking Air Compressor Loading Operation:**

To check the air compressor loading operation, the air compressor must be loaded manually. To manually load the air compressor, remove the governor test probe and leave the CMV unlatched.

**Warning:** Do not allow the air compressor to operate in this mode unattended. The ARPS will sense the low air pressure and the control system will continuously cause the air compressor to load. The J1 safety valve will open when pressure reaches 150 psi, but no other device will keep the main reservoir pressure within safe limits.

When the governor test probe is removed, the line to the ARPS is vented. The ARPS will indicate lower air pressure, the control system will cause the motor to start, and two seconds later, the CMV will de-energize, exhausting air. This action will cause the air compressor to load (i.e., the intake valves will close and the compressor will pump air, thus building air pressure). Ensure that the test probe is re-installed when testing is complete.

**Screen 38:**

**Running Maintenance for Air Compressor – Checking Air Compressor Unloading Operation:**

To check the air compressor unloading operation, the air compressor must be unloaded manually. To manually unload the air compressor, remove the governor test probe, allowing the line to the ARPS to be vented. Then, latch (that is, energize) the CMV. With the CMV energized, pressure acts on the compressor unloader valves, and the unloader valves physically force the compressor intake valves to remain open, preventing the compressor from building pressure. Return the CMV to the unlatched position. Fit the test probe before returning the locomotive to service.

**Screen 39:**

**Running Maintenance for Air Compressor – Replacing Air Inlet Filters:**

Proper air filtration is important to the life of the air compressor. When replacing the air inlet filters, ensure that the filters are properly seated and the mounting nuts are securely tightened so that all air entering the compressor is filtered.

**Screen 41:**

**Running Maintenance for Air Compressor – Air Compressor Removal:**

Typical steps to remove the air compressor from the locomotive are as follows:

**Note:** Some Evolution Series locomotives are equipped with an oil free air compressor. If removing oil free air compressor, disregard steps 1 and 2.

1. Open the drain cock at the side of the locomotive to drain the lubricating oil from the air compressor.

**Note:** The end of the drainpipe is capped. Remove the cap to drain the oil into a suitable

container. Refer to the appropriate air compressor publication for air compressor lubricating oil capacity.

2. Near the base of the air compressor, disconnect the lubricating oil drain piping at the pipe union.
3. Remove the channel section from the radiator cab structure at the end of the air compressor removal slides on the A side of the locomotive.
4. Remove the two bolts securing the door catch and remove the door catch.
5. Disconnect the air compressor motor power cables.
6. Disconnect the air compressor motor speed sensor.

#### **Screen 42:**

##### **Running Maintenance for Air Compressor – Air Compressor Removal (Cont'd):**

7. Disconnect the air compressor discharge piping at the aftercooler outlet flange.
8. Exhaust the unloader piping, and remove the unloader hose from the air compressor.

**Warning:** Reaching the air compressor base bolts is difficult. lb.-ft. Exercise caution when removing the air compressor base bolts. Failure to do so may result in sprains, strains, or personal injury.

**Note:** It is possible to remove the air compressor base bolts if the access door below the manual handbrake wheel is removed. A long extension may be necessary to access base bolts.

9. Remove the air compressor hold-down bolts at the four corners of the air compressor base.

**Warning:** The air compressor weighs approximately 2550 lbs. (1157 kg). Ensure the lifting device, cables, and straps are adequate. Failure to do so may result in personal injury or death.

10. Use a come-along to move the air compressor to the walkway along the Engineer's side of the locomotive. Carefully lift the air compressor with a crane and set it on the shop floor.

#### **Screen 43:**

##### **Running Maintenance for Air Compressor – Air Compressor Installation:**

Typical steps to install the air compressor into the locomotive are as follows:

**Note:** Some Evolution Series locomotives are equipped with an oil free air compressor. If installing an oil free air compressor, disregard steps 10 and 11.

**Warning:** The air compressor weighs approximately 2550 lbs. (1157 kg). Ensure the lifting device, cables, and straps are adequate. Failure to do so may result in personal injury or death.

1. Carefully lift the air compressor with a crane and set the compressor on the air compressor slides, then use a come-along to move the air compressor into position in the locomotive.



**Note:** Check for flatness by rocking the air compressor. Shim one corner if the gap exceeds 0.015 inches (0.38 mm).

**Warning:** Reaching the air compressor base bolts is difficult. Exercise caution when removing the air compressor base bolts. Failure to do so may result in sprains, strains, or personal injury.

2. Install and tighten the air compressor hold-down bolts at the four corners of the air compressor base, then torque the bolts to 440-490 lb.-ft. (597-665 Nm).

**Note:** It is possible to install the air compressor base bolts if the access door below the manual handbrake wheel is removed. A long extension may be necessary to access base bolts.

3. Connect the unloader hose to the air compressor unloader lines.
4. Bolt the air compressor discharge piping to the aftercooler outlet flange.

#### **Screen 44:**

##### **Running Maintenance for Air Compressor – Air Compressor Installation (Cont'd):**

5. Install the air compressor motor speed sensor.

**Note:** The speed sensor gap should be 0.030-0.040 inches (0.76-1.02 mm). This gap is set at the factory and normally does not need to be readjusted.

**Caution:** When the power leads to the air compressor motor have been disconnected for any reason, it is possible to incorrectly connect the leads at re-installation. If any two power leads are swapped, the motor may still operate, but will rotate backwards. Prolonged backward running of the motor may cause damage to the compressor. To check rotation, with the engine at IDLE, place the air compressor to manual run – loaded operation. Next, verify that the air from the fan blades is flowing toward the air compressor.

6. Connect the air compressor motor power cables.
7. If the fan guard has been removed for any reason, it should be re-installed.
8. Reposition the door catch and secure with two bolts.
9. Install the channel section from the radiator cab structure at the end of the air compressor removal slides on the A side of the locomotive.
10. Connect the lubricating oil drain piping at the pipe union and close the drain cock, then fill the air compressor with oil.

#### **Screen 45:**

##### **Main Air Reservoirs:**

The main air reservoirs store compressed air for later use by the locomotive. The locomotive has two 22.5-inch diameter x 78-inch long reservoirs. The two reservoirs store about 56,000 cubic inches of air at main reservoir pressure. Each reservoir is tilted to allow moisture to accumulate at one end. An automatic or manual, customer-specific, blow-down device ("spitter" type drain valve) is installed at the low end of each reservoir to expel the moisture.

**Screen 46:****Running Maintenance for Main Air Reservoirs:**

Each main reservoir is supplied with telltale holes predrilled from the outside of the reservoir as specified by government regulation. The purpose of the telltale holes is to indicate the condition of the interior surface of the reservoir. The holes are drilled to a depth considered to be the minimum wall thickness. As corrosion inside the reservoir occurs and consumes the corrosion allowance material, a “weep” occurs at the predrilled area. This weep, which may be observed as air leakage or moisture droplets, provides an advance warning of the loss of the reservoir interior surface thickness.

**Warning:** The main air reservoirs are compressed air devices. Compressed air is extremely dangerous if not handled correctly. Do not attempt to service, repair, or break any connections or air lines without bleeding all pressure from this device.

If leakage is detected, check for a break in the reservoir shell at one of the holes. Replace the reservoir as needed.

**Screen 49:****Air Dryer (Customer Option):**

The air dryer removes moisture from the compressed air. Moisture could cause rust or freeze and can damage air-controlled components. The Graham-White (GW) 994-100 Air Dryer System utilizes a modular design incorporating a coalescing filter, a remote liquid drain, an auto-adjust purge valve, an inlet diverter/exhaust valve, an outlet shuttle/purge check valve, a control box, and twin desiccant towers. The dryer is installed in a mounting bracket, which is permanently attached to the locomotive platform and air piping. Running maintenance for air dryers includes removing and installing the coalescer element.

**Warning:** This is a compressed air device. Compressed air is extremely dangerous if not handled carefully. Do not attempt to service, repair or break any connections or air lines without bleeding all pressure from this device.

**Screen 50:****Running Maintenance for Air Dryer – Removing the Coalescer Element:**

Typical steps to remove the coalescer element from the air dryer are as follows:

1. Remove the eight cap screws from the bottom of the air dryer.
2. Remove the coalescer cap.
3. Remove and discard the O-ring.
4. Remove and discard the coalescer element.

**Screen 51:****Running Maintenance for Air Dryer – Installing the Coalescer Element:**

Typical steps to install the coalescer element into the air dryer are as follows:

1. Lubricate a new O-ring with Dow Corning 55M lubricant and install it on the cap.
2. Install the new coalescer element and cap, then secure the cap with the eight cap screws.

3. Torque the screws to 20-26 lb.-ft. (28-36 Nm).

### **Screen 53:**

#### **Final Air Filters:**

The final air filters remove contaminants from the compressed air before it is distributed to the air-controlled components. The final air filters are located on the Engineer's side of the locomotive between the fuel tank and the number 1 truck, just under the walkway. The auxiliary air supply filter is on the outside and the MR air supply filter is located on the inside. Two types of final air filters may be used: Salem 975 and Salem 824. Running maintenance for the Salem 975 filter includes removing and installing its filter element. Running maintenance for the Salem 824 filter includes removing and installing its coalescer element.

### **Screen 54:**

#### **Running Maintenance for Salem 975 – Removing the Filter Element:**

Typical steps to remove the filter element in the Salem 975 filter are as follows:

1. Remove the six hex nuts and lockwashers.

**Note:** The bottom cap and drain valve will drop down with the gasket.

2. Remove the wing nut and filter retainer.
3. Remove the filter element. Inspect and replace any damaged component as necessary.

### **Screen 55:**

#### **Running Maintenance for Salem 975 – Installing the Filter Element:**

Typical steps to install the filter element in the Salem 975 filter are as follows:

1. Clean the inside of the filter body and bottom cap with solvent.

**Note:** When installing a filter element, lubricate the sealing surface at both ends of the element with Dow Corning M55 or equivalent.

2. Carefully install the filter element on the filter retaining device in the filter body assembly followed by the filter retainer and wing nut.
3. Install a gasket on the bottom cap and assemble it to the filter body.

**Note:** Assemble the gasket with the sealing bead on top.

4. Secure the bottom cap to the filter body assembly using six lockwashers and hex nuts.

### **Screen 56:**

#### **Running Maintenance for Salem 824 – Removing the Coalescer Element:**

Typical steps to remove the coalescer element in the Salem 824 filter are as follows:

1. Disconnect the actuating air line to the drain valve.
2. Remove the eight hex nuts and lockwashers.
3. Use the screwdriver slots to loosen and remove the sump bowl and drain valve.

4. Remove the wing nut and seat washer from the tube assembly.
5. Remove the coalescer retainer, then remove the coalescer element and discard.

#### **Screen 57:**

##### **Running Maintenance for Salem 824 – Installing the Coalescer Element:**

Typical steps to install the coalescer element in the Salem 824 filter are as follows:

1. Carefully insert the new coalescer element into the filter body followed by the coalescer retainer and wing nut.

**Note:** Ensure that the guide pin on the coalescer retainer is inserted properly into the guide pin receptacle on the coalescer deflector, then tighten the wing nut securely.

2. Inspect the sump bowl gasket for damage and replace as required.
3. Wipe any debris from the sump bowl before reassembling the repaired drain valve to the sump bowl and then the sump bowl to the filter body.
4. Reconnect the actuating air line to the drain valve.

#### **Screen 59:**

##### **Summary:**

You have reached the end of this module!

In this module, you learned to:

- State the purpose and location of the compressed air system.
  - The compressed air system provides compressed air to the air brake system and to the auxiliary air-operated devices on the locomotive, including the horn and windshield wipers.
  - The compressed air system and all its components, are attached to or located under the platform. The air compressor is located in the radiator cab.
- State the purpose and location of the major components of the compressed air system.
  - The major components of the compressed air system include the air compressor, main air reservoirs, air dryer, final air filters, and safety valve.
  - Air Compressor: Located in the radiator cab, the air compressor compresses ambient air and provides pressurized air to the system.
  - Main Air Reservoirs: The main air reservoirs are located on the Engineer's side of the locomotive in a notched area of the fuel tank. The main air reservoirs store compressed air for use by other components of the locomotive.
  - Air Dryer: The air dryer is located on the Engineer's side of the locomotive between the fuel tank and the number 2 truck. The air dryer removes moisture from the compressed air.
  - Final Air Filters: The final air filters are located on the Engineer's side of the locomotive between the fuel tank and the number 1 truck, under the walkway. The final air filters remove contaminants from the compressed air before it is distributed to the controlled components.
  - Safety Valve: The safety valve is located between the two main reservoirs on the

Engineer's side of the locomotive. The J1 safety valve protects the air compressor and the rest of the compressed air system from an overpressure condition.

- State the purpose and location of the compressed air system instrumentation devices.
  - The Air Reservoir Pressure Sensor (ARPS) measures the pressure of the air that is at the output of the first main air reservoir. The locomotive control system uses this information to turn the air compressor motor on and off and to control when the compressor is to load or unload. The ARPS is located on the air compressor control panel, which is in the radiator cab. Access to the panel is from the Engineer's side of the locomotive near the air compressor.
  - The Air Compressor Speed Sensor (ACS) is used to detect the air compressor motor speed and send this information (a frequency) to the locomotive control system. The control system takes this information and uses it to determine if the compressor motor is operating at the correct speed. The ACS sensor is located on the end of the air compressor motor.
- Describe how the compressed air system operates.
  - The compressed air system has four basic functions: compression, storage, filtration, and distribution.
  - During compression, the outside air passes through two paper air filters and enters the air compressor.
  - From the air compressor, the compressed air enters the first main reservoir, where cooling and moisture condensation take place.
  - If air pressure exceeds 150 psi, a safety valve connected to the outlet of the first main reservoir opens. This protects the air compressor and the rest of the system from an overpressure condition.
  - Compressed air from the first main reservoir flows in two ways. One path is to the main reservoir pressure sensor, which provides a feedback signal of the air pressure to the locomotive's control system, and the other path is to the second main reservoir and auxiliary air filter. The path to the second main reservoir may or may not have an air dryer, depending on customer requirements.
  - In systems without an air dryer, a check valve connected between the output of the first main reservoir and the MR equalizing pipe allows consist air from another locomotive to enter this locomotive's air system.
  - In systems with an air dryer, there are two check valves: one connected between the output of the first main reservoir and the MR equalizing pipe, which allows consist air from another locomotive to enter this locomotive's air system, and another connected between the output of the air dryer and the MR equalizing pipe, which allows air to flow to another locomotive in the consist.
  - Air enters the second main reservoir through a check valve and then flows to the MR air filter.
  - The check valve prevents air from flowing backwards to the first main reservoir. This ensures that if the first main reservoir loses air, the second air reservoir maintains enough supply air for one emergency air brake application.
  - The final air filters filter the air before distributing it to the air brake system and the auxiliary air devices.

- Describe how to perform running maintenance related to the compressed air system.
  - Daily or every trip, test the operation of the horn, bell, and wipers. Ensure proper operation of the air dryers, if equipped. Ensure the main reservoir condensate drain valves are in the automatic position and operating properly. Check the sand box for the level of sand and refill as necessary.
  - Daily or every trip, exhaust accumulated moisture and small amounts of lubricant through the aftercooler petcocks each time the oil level is checked.
  - Daily or every trip, check the air dryer humidity indicator. A blue color indicates that the dryer is functioning properly. Lavender, white, yellow, or brown indicates possible dryer damage and that further inspection is required.
  - Every seven to ten days, perform a complete laboratory analysis to determine if the oil is suitable for continued use. If acceptable, fill the oil to the FULL mark on the dipstick or gauge with an approved lubricating oil, else change the oil.
  - At 92 days, check the operation of the compressor load/unload system.
  - Every year, replace the air inlet filters, clean the exterior of the intercooler and inspect it for leakage, check the operation of the load/unload system, drain the oil and replace with new, replace the oil strainer, and clean the oil sump screen.
  - Every year, check the operation of the J1 safety valve, verifying it opens at 150 psi.
  - Every year, replace/renew the air compressor magnet valve and gasket on the magnet valve panel.
  - Every year, change the final air filters.
  - Every year, change the coalescer element of the air dryer (if equipped).
  - Every year, change the direct line air filters to the univalve, shutter control magnet valves, and the CMV.
  - Every year, replace the vent valve with a reconditioned valve.
  - Every 3 years, replace the tinsel, brass, and valve located in the crankcase breather of the air compressor.

## **Screen 60:**

### **Summary (Cont'd):**

- Describe compressor loading and unloading.
  - When loaded, the compressor motor is running and the compressor is compressing air. When unloaded, the compressor motor is running but the compressor is not compressing air. This change from loading to unloading is accomplished through the operation of the CMV and compressor unloader valves.
  - The CMV is a solenoid operated valve that, when energized, closes to force air pressure to act on the compressor unloader valves. The unloader valves physically force the compressor intake valves to remain open, preventing the compressor from building pressure. Although the compressor drive motor may be running, since the compressor cannot build air pressure, the compressor is operating in an unloaded condition.
  - When de-energized, the CMV opens, venting the air pressure supply to the unloader valves. The unloader valves then open, allowing the compressor intake valves to operate normally. With the compressor drive motor running and the compressor building air pressure, the compressor is operating in a "loaded" condition.

- Air Compressor Removal
  1. Open the drain cock at the side of the locomotive to drain the lubricating oil from the air compressor.
  2. Disconnect the lubricating oil drain piping at the pipe union.
  3. Remove the channel section from the radiator cab structure at the end of the air compressor removal slides on the A side of the locomotive.
  4. Remove the two bolts securing the door catch and remove the door catch.
  5. Disconnect air compressor motor power cables, speed sensor, and discharge piping at the aftercooler outlet flange.
  6. Exhaust the unloader piping, and remove the unloader hose from the air compressor.
  7. Remove the four air compressor hold-down bolts.
  8. Pull the air compressor to the walkway using a come-along and set it on the shop floor with a crane.
- Air Compressor Installation
  1. Carefully lift the air compressor with a crane and set the compressor on the air compressor slides, then use a come-along to move the air compressor into position in the locomotive.
  2. Install and tighten the four air compressor hold-down bolts.
  3. Install the unloader hose, air compressor discharge piping, motor speed sensor, motor power cables.
  4. Reposition the door catch and secure with two bolts.
  5. Install channel section from the radiator cab structure at the end of the air compressor removal slides on the A side of the locomotive.
  6. Connect the lubricating oil drain piping at the pipe union and close the drain cock, then fill the air compressor with oil.
- Coalescer Element Removal from the Air Dryer
  1. Remove the eight cap screws from the bottom of the air dryer and the coalescer cap.
  2. Remove and discard the O-ring and the coalescer element.
- Coalescer Element Installation in the Air Dryer
  1. Lubricate and install a new O-ring on the cap.
  2. Install the new coalescer element, then secure the cap with the eight cap screws.
- Filter Element Removal from the Salem 975 Filter
  1. Remove the six hex nuts and lock washers securing the bottom cap and drain valve.
  2. Remove the bottom cap, drain valve, wing nut, filter retainer, and filter element.
- Filter Element Installation into the Salem 975 Filter
  1. Clean the inside of the filter body and bottom cap with solvent.
  2. Carefully install the filter element on the filter retaining device in the filter body assembly, followed by the filter retainer and wing nut.
  3. Install a gasket on the bottom cap and assemble it to the filter body.
  4. Secure the bottom cap to the filter body assembly using six lock washers and hex nuts.
- Filter Element Removal from the Salem 824 Filter
  1. Disconnect the actuating air line to the drain valve.
  2. Remove the eight hex nuts and lock washers securing the sump bowl and drain

valve.

3. Remove the sump bowl and drain valve, wing nut and seat washer, and coalescer retainer, then remove the coalescer element and discard.
- Filter Element Installation into the Salem 824 Filter
    1. Carefully insert the new coalescer element into the filter body, followed by the coalescer retainer and wing nut.
    2. Reassemble the repaired drain valve to the sump bowl and the sump bowl to the filter body.
    3. Reconnect the actuating air supply line to the drain valve.