

Split Cooling Water System

Screen 1:

Welcome Screen:

Welcome to the Split Cooling Water System module of the ES44AC/DC Mechanical Systems Advanced course. The split cooling water system is also referred to as the cooling water system.

Screen 2:

Introduction to Split Cooling Water System

In this module, you will learn how to inspect and maintain the components of the split cooling water system in a running repair environment.

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

- State the purpose and location of the major components of the split cooling water system.
- Describe how water flows through the split cooling water system.
- Describe the protection strategies used with the split cooling water system.
- Describe the running maintenance required for the split cooling water system.
- Summarize the steps to remove and install the major components of the split cooling water system.

Screen 3:

Disclaimer:

Please note that this module is for training use only. For complete details of inspecting and maintaining the components of the split cooling water system in a running repair environment, refer to customer-specific drawings, manuals, and procedures.

Screen 4:

Overview of the Split Cooling Water System:

The split cooling water system maintains a nearly constant engine operating temperature throughout the load range of the engine, even with wide variations in outside temperature and throttle call. The split cooling water system also provides additional cooling for the water-based intercooler and the oil cooler at higher load conditions. Additional cooling of the water-based intercooler helps reduce the temperature of the intake manifold air that enters the engine cylinders. The reduced manifold air temperature decreases the amount of harmful emissions from the exhaust stack and decreases fuel consumption. Increased cooling of the oil cooler in higher load conditions helps improve the life of the engine's bearings.

Screen 5:

Major Components of the Split Cooling Water System:

The major components of the split cooling water system are displayed.

Screen 6:**Water Storage Tank:**

Located in the radiator cab directly below the air-based intercooler assembly, the water storage tank is a round flow-through tank that holds the majority of water for the cooling water system. The water tank allows for thermal expansion of water in the system during operation.

Screen 7:**Water Pump:**

Located on the Integrated Front End (IFE) cover of the engine, the water pump circulates water throughout the cooling water system.

Screen 8:**Lubricating Oil Cooler:**

Located in the radiator cab on the B-side (left side) of the locomotive just aft of the engine, the lubricating oil cooler removes heat from the lubricating oil and transfers it to the cooling water.

Screen 9:**Major Components of the Split Cooling Water System (Cont'd):**

Additional components of the split cooling water system are displayed.

Screen 10:**Water-Based Intercooler:**

Located in the upper section of the radiator cab, adjacent to the turbocharger, the water-based intercooler provides the first stage of cooling for the air discharged from the turbocharger.

Screen 11:**Univalve:**

Located in the upper section of the radiator cab, above the water-based intercooler, the univalve directs water flow through the cooling system to maintain system temperature during different operating conditions.

Screen 12:**Univalve Control Magnet Valves:**

Located in the combustion air filter compartment on the A-side (right side) of the locomotive, the univalve control magnet valves control the air that switches the univalve from one mode position to another.

Screen 13:**Radiators:**

Located on the top of the radiator cab, at the back end of the locomotive, the radiators transfer heat from the cooling water to the ambient air.

Screen 14:**Radiator Fan:**

Located directly below the radiators, the radiator fan cools the cooling water in the radiators by forcing air across the radiator sections.

Screen 15:**Fuel Manifold:**

Located in the radiator cab, mounted to the back of the fuel filter assembly, the fuel manifold contains a heater that heats the fuel when its temperature is below 85°F. The fuel heater uses the warmer cooling water as the source of heat.

Screen 16:**Automatic Water Drain Valve:**

Located in the engine cab, below the water pump, the automatic water drain valve provides freeze protection for the cooling water system components. If the engine is shut down, the automatic water drain valve opens to empty the cooling water system when the water temperature reaches a preset value, typically around 40°F.

Screen 17:**Sensors of the Split Cooling Water System:**

The split cooling water system also includes several sensors that provide feedback for diagnostics, control, and protection.

Screen 18:**EWIT Sensor:**

Located in the water pipe that connects the IFE cover of the engine and the water pump, the Engine Water In Temperature (EWIT) sensor measures the temperature of the cooling water entering the engine and provides this information to the Engine Control Unit (ECU).

Screen 19:**EWOT Sensor:**

Located in the water pipe that connects the engine and the univalve, the Engine Water Out Temperature (EWOT) sensor measures the temperature of the cooling water exiting the engine and provides this information to the ECU.

Screen 20:**EWIP Sensor:**

Located on the rear of the engine crankcase just behind the left-6 power assembly, the Engine Water In Pressure (EWIP) sensor measures the pressure of the cooling water at the left-6 power assembly of the engine and provides this information to the ECU.

Screen 21:**MAT Sensor:**

Located at the end of the engine's intake air manifold, the Manifold Air Temperature (MAT) sensor measures the temperature of the air in the intake manifold and provides this information to the ECU.

Screen 22:**Sensors of the Split Cooling Water System (Cont'd):**

Additional sensors of the split cooling water system are displayed.

Screen 23:**ATT Sensor:**

Located in the combustion air filter compartment wall, the Ambient True Temperature (ATT) sensor measures the temperature of the air entering the turbocharger and provides this information to the ECU.

Screen 24:**BAP Sensor:**

Located on the wall of Control Area 4 (CA4) in the auxiliary cab, the Barometric Air Pressure (BAP) sensor measures the pressure of the atmosphere and provides this information to the ECU.

Screen 25:**ELIT Sensor:**

Located in the IFE cover next to the oil inlet to the engine, the Engine Lube In Temperature (ELIT) sensor measures the temperature of the lube oil entering the engine and provides this information to the ECU.

Screen 28:**Operation of the Split Cooling Water System:**

The split cooling water system uses a pressurized, wet-dry radiator system. The amount of heat transferred from the engine and other components to the cooling water is regulated by changing the flow of the cooling water through the cooling water system and by changing the speed of the radiator fan. The cooling water system operates within established conditions referred to as Modes:

- Mode 3,
- Mode 2, and
- Mode 1.

The mode determines the path of the cooling water through the system, the radiator fan speed, and the strategies that protect the engine when abnormal operating conditions occur.

Screen 29:**Cooling Water Flow Paths – Mode 3:**

Mode 3 is utilized during low load or low ambient operating conditions. Usually, Mode 3 is entered immediately after starting the engine. Mode 3 operation heats the engine water, lubricating oil, and intake manifold air. During Mode 3 operation, the engine water pump draws water from the water storage tank and forces it through the turbocharger and engine. The combustion process in the engine heats the water. The heated water exits the engine and flows to the univalve.

Screen 30:**Cooling Water Flow Paths – Mode 3 (Cont'd):**

The univalve directs the heated water from the engine through two paths. The first path is through the oil cooler and the water-based intercooler and back to the storage tank, and the second path is directly to the water storage tank. The water that flows through the oil cooler and the water-based intercooler heats the lube oil and intake manifold air, respectively.

Screen 31:**Cooling Water Flow Paths – Mode 2:**

Mode 2 cools the engine water and provides a small temperature adjustment to the lubricating oil and intake manifold air. During Mode 2 operation, the engine water pump draws water from the water storage tank and forces it through the turbocharger and engine. From the engine, the heated water flows to the univalve. The univalve directs the heated water from the engine through two paths.

Screen 32:**Cooling Water Flow Paths – Mode 2 (Cont'd):**

The first path is through the oil cooler and the water-based intercooler, and then back to the water storage tank. This path either warms or cools the lubricating oil and intake manifold air. The second path is through the radiator and its sub-coolers, and then back to the water storage tank. A motor-driven radiator fan pushes air through the radiator to cool the engine water. Varying the fan motor speed from off to 1/4, 1/2, or full engine speed controls the amount of cooling that occurs. For more information on manifold air temperature control, refer to the Combustion Air System module.

Screen 33:**Cooling Water Flow Paths – Mode 1:**

Mode 1 is utilized during high load or high ambient operating conditions. Mode 1 provides maximum cooling for the engine water, lubricating oil, and intake manifold air. During Mode 1 operation, the engine water pump draws water from the water storage tank and forces it through the turbocharger and engine. From the engine, the water flows to the univalve. The univalve directs all of the water from the engine to the radiator. The radiator has two sections: main and sub-cooler. The majority of the water flows through the "one-pass" main section back to the water storage tank.

Screen 34:**Cooling Water Flow Paths – Mode 1 (Cont'd):**

The remaining water continues through the "two-pass" sub-cooler section for further cooling. Water from the sub-cooler section is then channeled by the univalve to flow through the oil cooler and the water-based intercooler to provide additional cooling. A motor-driven radiator fan pushes air through the radiator to cool the engine water. Varying the fan motor speed from off to 1/4, 1/2, or full engine speed controls the amount of cooling that occurs. For more information on manifold air temperature control, refer to the Combustion Air System module.

Screen 35:**Conditions that Determine Mode Selection and Radiator Fan Speed:**

The split cooling water system maintains the cooling water within a certain range of temperatures. To accomplish this, the water temperature (as read by the EWIT sensor) and lube oil temperature (as read by the ELIT sensor) are monitored, and then the water flow path or the radiator fan speed is changed accordingly. Changing the flow path for the cooling water is accomplished with the univalve and can be thought of as making a course adjustment (or Mode selection) to the cooling process. Changing the radiator fan speed is done within a course adjustment, or Mode. This can be thought of as making a fine adjustment to the cooling process.

Screen 36:**Conditions that Determine Mode Selection and Radiator Fan Speed (Cont'd):**

Because ambient temperature and engine horsepower production can radically affect the cooling requirements, the following temperature set points or triggers are used to determine when switching of the univalve or radiator fan speed needs to be adjusted upward or downward to account for these conditions:

- Ambient Temperature Adjustment Strategy
- Horsepower (HP) Adjustment Strategy
- Mode (or Univalve) Switching Control
- Radiator Fan Speed Switching Control

Screen 37:**Ambient Temperature Adjustment Strategy:**

Ambient temperature affects how much heat can be transferred to the atmosphere and the rate at which that heat transfer can occur. Adjustments to the cooling process are divided into two regions, low and high ambient. Transition between regions is based on the True Ambient Temperature as read by the ATT sensor. For example, the strategy switches from Low Ambient Strategy to High Ambient Strategy when the temperature rises above 48°F.

Screen 38:**Horsepower Adjustment Strategy:**

The amount of horsepower (HP) produced by the engine affects how much heat is generated and the rate at which that heat is generated. Horsepower is a computed value and is divided into three regions: low horsepower, medium horsepower, and high horsepower. Transition between regions is based on set values of horsepower. Note that there are different transition times for the univalve and radiator fan.

Screen 39:**Mode (or Univalve) Switching Control:**

Transition between Mode 3 and Mode 2 is based on the temperature of the water entering the engine (as read by the EWIT sensor). Transition between Mode 2 and Mode 1 is based on the temperature of the lube oil entering the engine (as read by the ELIT sensor). In addition to the EWIT and ELIT temperature set points or triggers, transition from Mode 2 is also dependent on a minimum dwell time.

Screen 40:**Mode (or Univalve) Switching Control (Cont'd):**

A minimum dwell time is required for two reasons. The first is to ensure continuous water flow through the lubricating oil cooler and water-based intercooler. The second is to ensure that the radiator is approximately the same temperature as the fluid flowing inside. This minimizes the possibility of the radiator freezing when switching from Mode 2 to Mode 3 (radiator draining).

Screen 41:**Mode (or Univalve) Switching Control (Cont'd):**

When the radiator is not flooded and water is not flowing through it for an extended period of time (i.e., ambient temperature dependent), the radiator metal temperature approaches the ambient temperature. When water is again diverted to the radiator, especially during low ambient operation, the temperature difference induces significant heat transfer from the water to the radiator. The temperature of the water at the exit of the radiator is low enough that, even after mixing with the water in the tank, it is still below the Mode 2 to Mode 3 transition temperature set point. An immediate transition would stop the flow of water to the radiator.

Screen 42:**Mode (or Univalve) Switching Control (Cont'd):**

Although the radiator is warmer because of the energy transfer from the water, the temperature difference between the water and the metal is still large enough that the rate of heat transfer from the water to the metal may cause the water to freeze while the radiator is draining. When the computer software adjusts the cooling process to account for ambient temperature and horsepower, the following flow control strategies are used:

- Low Ambient Flow Control Using Water Temperature Set Points
- High Ambient Flow Control Using Water Temperature Set Points
- Flow Control Using Lube Oil Temperature Set Points

Screen 43:

Radiator Fan Speed Switching Control:

Radiator fan speed transition is based on the temperature of the water entering the engine (as read by the EWIT sensor).

Note: There is a minimum dwell time before the speed changes. This prevents unnecessary cycling of the radiator fan speed, which would cause the radiator fan assembly to wear faster.

When the computer software adjusts the cooling process to account for ambient temperature and horsepower, the following radiator fan control strategies are used:

- Low Ambient Radiator Fan Control and
- High Ambient Radiator Fan Control.

Screen 44:

Protection Strategies:

The following protection functions protect the diesel engine from damage that could be caused by operating at the extremes of the operating range or by abnormal conditions. Appropriate derations or restrictions are applied by each function as necessary.

Screen 45:

Low Water Pressure Protection:

The Engine Management System (EMS) software uses water pressure information (as read by the EWIP sensor) to prevent damage to the engine caused by a low water pressure condition. If water pressure is below a threshold value for 10 seconds at a given engine notch speed, a 20-second timer is started. If the water pressure continues to stay below the threshold value for the 20-second duration, the engine notch speed decreases by one notch. This action occurs every 20 seconds until the engine goes to IDLE. If at any point the water pressure increases to above the threshold value for 10 seconds, the engine notch speed restriction is removed. The table displays the water pressure thresholds for each engine notch speed. To prevent nuisance faults, low water pressure protection is inactive for engine speeds below 400 RPM.

Screen 46:

Cold Engine Protection:

When the engine is cold, such as immediately after starting and in extremely cold ambient temperatures, engine speed is limited as a function of the lubricating oil outlet temperature (as read by the ELOT sensor). This protection prevents damage to the engine, the lube oil pump, and external oil piping. If the engine was just started, the

engine speed is limited to 795 RPM or less until the lubricating oil outlet temperature is 140°F or greater for three minutes.

Screen 47:

Hot Water Protection:

When the engine inlet water temperature (as read by the EWIT sensor) is hot, the available horsepower from the engine is reduced to protect the engine from damage. At the same time, the engine speed increases to 1050 RPM to provide the highest radiator fan speed and maximum cooling. When the engine inlet water temperature exceeds 230°F for two seconds, the engine speed increases to 1050 RPM (an EMS_HOT_ENGINE_1050_INC is logged) and the available horsepower is modulated to hold the engine inlet water temperature at 230°F. If the available horsepower has been reduced to 80% or less for one minute, an EMS_HOT_WATER_DERATION_INC is logged. If the attempt to control the water temperature fails, and the available horsepower has been reduced to 0% for five minutes, the engine shuts down and an EMS_HOT_WATER_SHUTDOWN_INC will be logged.

Screen 48:

Cannot Cool Protection:

If the radiator fan is unable to run, the engine is limited to Notch 2. This protects the engine from overheating.

Screen 49:

Engine Water Inlet Temperature and Engine Lube Oil Outlet Temperature ΔT Protection:

The engine horsepower derates or shuts down if the delta temperature (ΔT) between the engine water inlet (as read by the EWIT sensor) and the engine lube oil outlet (as read by the ELOT sensor) exceeds an allowable limit. The allowable ΔT limit is dependent on the engine lube oil outlet temperature as displayed in the table.

Screen 50:

Engine Water Inlet Temperature and Engine Lube Oil Outlet Temperature ΔT Protection (Cont'd):

If the maximum allowable ΔT limit is exceeded, the engine horsepower will be derated as displayed in the table. If the ΔT is not within the limit five minutes after the initial violation, the engine goes to IDLE. If the ΔT is not within the limit 10 minutes after the initial violation, the engine is shut down. If at any time the ΔT returns to an allowable limit, the engine horsepower is restored to 100%.

Screen 51:

Loss of Both Engine Water Temperature Sensors Protection:

If both engine water temperature sensors (EWIT and EWOT) are bad, the engine shuts down. If one of the two sensors is bad, the ECU models the good sensor to provide a substitute value for the bad sensor. If the EWIT sensor is bad, the substitute value is

EWIT = EWOT - 6°F. If the EWOT sensor is bad, the substitute value is EWOT = EWIT + 10°F.

Screen 55:

System Capacities:

It is important to know where to find operational data about the split cooling water system, any pertinent self-tests, and normal operating temperatures and pressures. Knowing how the system normally operates can be a very valuable tool when trying to diagnose problems. The split cooling water system holds 430 gallons of treated water. The bulk of the water, which is approximately 327 gallons, fills the water storage tank.

Screen 56:

Monitor Parameters:

The following monitor parameters are available on a Smart Display (in Level 3 access) to aid maintenance personnel in monitoring the split cooling water system.

Screen 57:

Normal Operating Temperatures and Pressures:

The table displays normal expected operating temperatures and pressures for the water flowing in and out of the engine.

Screen 58:

Operational Details:

Self-Test 309, initiated by means of a Smart Display, can be used to test the green LED. When illuminated, the green LED normally indicates that the water is out of the radiators and is in the water storage tank. Self-Test 309 is used to test that the computer system can turn on and off the green LED only. This self-test does not test the operation of the water flow control magnet valves. Self-Test 320, initiated by means of a Smart Display, can be used to test the univalve and water flow control magnet valves (WV1, WV2, and WV3). This self-test is used to place the split cooling water system in a Mode of operation (Mode 1, 2, or 3) and then verify that the proper switching has occurred. In Mode 1, the univalve mode indicator should be in the 12 o'clock position, and WV1, WV2, and WV3 should be energized. In Mode 2, the univalve mode indicator should be in the 2 o'clock position, and WV2 should be energized. In Mode 3, the univalve mode indicator should be in the 4 o'clock position, and all WV's should be de-energized. Self-Test 404, initiated by means of a Smart Display, can be used to test the radiator fan operation.

Screen 59:

Running Maintenance Schedule:

The table displays the recommended running maintenance schedule associated with the cooling water system and its major components.

Screen 62:**System Checks and Adjustments:**

Check the cooling water level by using the water sight glass, but only after the engine has been idling for at least ten minutes with the green LED on. This delay ensures that all water has drained from the radiators back into the water storage tank. At IDLE, the correct water level is between the FULL AT IDLE and LOW AT IDLE marks on the water sight glass.

Note: It is recommended to fill the cooling system with pretreated water at the supplied water fill pipe connection. It is not recommended to remove the pressure cap or blanking plate from the fill pipe. Follow all Railroad Regulations and Rules concerning the addition of cooling water and water treatment compound.

Screen 63:**Filling the Cooling Water System:**

Typical steps to fill the cooling water system with pretreated water are as follows:

Caution: Do not check or add cooling water until the engine has been idling for at least ten minutes with the green LED on. Do not fill the cooling water system above the FULL AT IDLE mark, because the system may run cold, causing serious engine damage and possibly frozen radiators. Do not allow the level to go below the LOW AT IDLE mark, because water pump cavitation will take place, resulting in low water pressure, poor cooling, and a hot engine.

1. Attach the water supply hose to the water fill pipe connection.
2. Turn on the water supply.
3. Vent pressure from the system by holding the flag vent valve down for at least 60 seconds.

Screen 64:**Filling the Cooling Water System (Cont'd):**

4. Pull down and hold the spring-loaded handle of the water fill valve until the sight glass water level is at the FULL AT IDLE mark.
5. Slowly return the spring-loaded handle of the water fill valve to its normal closed position.
6. Shut off the water supply.
7. Remove the water supply hose from the water fill pipe connection.

Screen 65:**Draining the Cooling Water System and Taking Cooling Water Samples:**

To drain the cooling water system, first, shut down the engine. Then, open the manual water drain valve located by the water pump.

Warning: To prevent personal injury and potential equipment damage, ensure that the engine cannot be started before removing, installing, or adjusting any components. Open the Battery Switch (BS) to prevent starting attempts. Also, place the Fuel Pump Circuit Breaker (FPB) and the Local Control Circuit Breaker (LCCB) in the OFF position. Apply a warning tag to the Engine Control (EC) switch.

It is recommended to collect water samples for analysis at a minimum frequency of seven to ten days. Have the sample analyzed by a qualified laboratory, and then take the appropriate action based on the analysis. Before taking a water sample, write all pertinent information on the sampling bottle. Print the information clearly and keep the label clean so that a lab technician can read it. Collect the water sample by using one of the water-sampling valves on the water sight glass housing. Fill the water sample bottle 2/3 to 3/4 full.

Screen 66:

Water Pump:

The centrifugal water pump, mounted on the engine's IFE cover, circulates water through the cooling water system. The pump, gear-driven from the engine crankshaft by means of an auxiliary drive gear, draws water directly from the water storage tank and moves approximately 545 GPM of water at Notch 8 engine speed.

Screen 67:

Running Maintenance for Water Pump:

During daily inspections of the diesel engine, visually inspect the water pump for any leaks or cracks. Closely check around the joint areas, such as the water pump suction and discharge lines. If any leaks are found in the piping joints, try tightening the joint first. If this fails to stop a leak, remove the pump and replace the gaskets. Listen for any unusual noises coming from the pump, and correct as needed. For removal and installation of the water pump, refer to the Diesel Engine Advanced course for instructions.

Screen 68:

Lubricating Oil Cooler:

The lubricating oil cooler removes heat produced in the engine by combustion and friction from the lubricating oil. The lubricating oil cooler is a plate heat exchanger design, with metal plates separating the oil, flowing in one direction, from the cooling water, which flows in the opposite direction. The plates not only separate the two fluids but also form the medium to transfer heat from the oil to the cooling water.

Screen 69:

Running Maintenance for Lubricating Oil Cooler:

Visually inspect the oil cooler and the piping connections to the cooler for any leaks. Repair any leaks in the piping system as necessary. Any leaks in the oil cooler require that the oil cooler be replaced. If lube oil is visible in the water sight glass, an internal

leak probably exists in the oil cooler. Because the oil pressure in the lube oil system is higher than the cooling water pressure in the split cooling water system, leaks between the two systems usually appear first in the cooling water system. For removal and installation of the oil cooler, refer to the Lubricating Oil System module of this course.

Screen 70:

Water-Based Intercooler:

As part of a two-stage manifold air-cooling process, the water-based intercooler (WBIC) provides the first stage of cooling. The WBIC cools the air discharged from the turbocharger. At Notch 8 engine speed, the outlet air temperature from the WBIC is typically around 200°F. Factors such as engine load, altitude, and ambient air temperature can significantly affect this value. The WBIC is made up of a core and an outer shell. The core is a mechanically bonded tube-and-fin design. The cooling water flows inside the tubes and makes two passes through the shell before exiting. The turbocharger discharge air flows over the tubes and fins in one pass. The outer shell, which may be either fabricated or cast, provides the rigid frame for mounting the intercooler core. To distinguish between the two designs, which are referred to as the fabricated WBIC and the cast WBIC, consider the following:

- For the fabricated WBIC design, the outside diameter of the water inlet and outlet pipes is 3.5 inches (88.9 mm). It has a B-side rectangular cover casing door that is secured using hex bolts.
- In the cast WBIC design, the outside diameter of the water inlet and outlet pipes is 2.8 inches (71.12 mm). It has a B-side rectangular cover casing door that is secured using socket (Allen) head screws.

Screen 71:

Fabricated WBIC Core Removal:

Note: This demonstration displays the steps to remove a core from a fabricated WBIC. For details of removing the core from a cast WBIC, refer to the Cast WBIC Core Removal section of this module.

Typical steps to remove the fabricated WBIC core are as follows:

Warning: To prevent personal injury and potential equipment damage, ensure that the engine cannot be started before removing, installing, or adjusting any components. Open the BS to prevent starting attempts. Also, place the FPB and the LCCB in the OFF position. Apply a warning tag to the EC switch.

Warning: If the locomotive is equipped with Auto Engine Start/Stop (AESS), the diesel engine may start without operator action. Exercise caution when working around the radiator cab. Ensure that AESS is disabled before performing any maintenance procedures on the locomotive. Failure to do so may result in death or serious personal injury.

1. Shut down the diesel engine.
2. Depressurize the cooling water system by holding the water fill assembly vent valve open for approximately one minute.
3. With the engine shutdown and the cooling water system depressurized, ensure the radiators contain no water.
4. Drain the water from the cooling water system below the level of the water-based intercooler.
5. From the A-side (right side) of the locomotive:
 - a. Open, but do not remove, the access door.
 - b. Remove the drain line and fitting from the drain pipe.
 - c. Remove the two 5/8-inch hex bolts and washers near the top of the cover.
 - d. Remove the 20, 3/8-inch hex bolts holding the A-side (right side) cover.
 - e. Remove the four 3/8-inch hex bolts and seal plate surrounding the drain fitting and save all hardware for re-use.

Screen 72:

Fabricated WBIC Core Removal (Cont'd):

6. From the B-side (left side) of the locomotive:
 - a. Remove the maintenance access panel from underneath the wing of the radiator cab, then set the panel aside and save all hardware for re-use.
 - b. Disassemble and remove the Victaulic couplings securing the piping to the water-based intercooler.

Note: For additional information on disassembly and removal of the Victaulic couplings, refer to the Victaulic Coupling Removal section of this module.

- c. Disconnect the vent fitting.
- d. Loosen and remove the 10 hex bolts and washers that secure the core access plate to the intercooler shell, then set aside the plate and all related hardware for re-use.

Note: Depending on the fabricated WBIC shell design, it may also be necessary to remove Allen bolts from the front end of the intercooler shell in order to remove the intercooler core.

Screen 73:

Fabricated WBIC Core Removal (Cont'd):

Warning: The WBIC core weighs approximately 550 lbs. (250 kg). Ensure that the lifting device is adequate. Failure to do so may result in personal injury or death.

7. Install the puller tool (PSB P5205) onto the B-side of the locomotive for removing the intercooler core, as follows:
 - a. Install the support plate to the locomotive carbody.
 - b. Set the support stand on the handrail allowing it to sit on the catwalk.

Warning: The intercooler core cradle support weighs approximately 100 lbs. (45 kg). Ensure that the lifting device, cables, and straps are adequate. Failure to do so may result in personal injury or death.

- c. Install the cradle support legs using ball lock pins.
- d. Install the cradle support using ball lock pins, then adjust the support so it is level with the bottom of the intercooler core.
- e. Install the puller tool puller bar onto the end of the intercooler core.

Screen 74:

Fabricated WBIC Core Removal (Cont'd):

8. Using a 1/2-inch air ratchet with a 3/4-inch socket, turn the worm gear and remove the core attached to the puller tool puller bar.
9. After the core has fully cleared the wing of the radiator cab and is stationary on the cradle support, install the four, ½-inch lifting eye bolts.
10. Lift the core off the cradle.

Note: Ensure that the movement of the core is away from the radiator cab. Do not simply lift the core straight up.

11. Place the core on a stable work surface.

Screen 75:

Fabricated WBIC Core Installation:

Note: This demonstration displays the steps to install a fabricated WBIC core. For details of installing a cast WBIC core, refer to the Cast WBIC Core Installation section of this module.

Typical steps to install the fabricated WBIC core are as follows:

Note: After the fabricated WBIC core has been placed in the locomotive, re-install the A-side covers using new O-rings as applicable.

Warning: The fabricated WBIC core weighs approximately 550 lbs. (250 kg). Ensure that the lifting device is adequate. Failure to do so may result in personal injury or death.

1. Ensure that the fabricated WBIC core is being installed by confirming the water inlet and outlet pipe outside diameter measurements are 3.5 inches (88.9 mm) and the B-side rectangular cover casing door is attached with hex bolts.
2. If required, install the puller tool (PSB P5205) onto the B-side of the locomotive for installing the intercooler core as discussed in the Fabricated WBIC Core Removal section of this module.
3. Install the four ½-inch lifting eye bolts on the intercooler core.

4. Using a suitable lifting device, slowly lift the core and place it on the puller tool cradle, ensuring the core does not impact the side of the radiator cab while lifting.
5. Using the attached puller tool puller bar and a 1/2-inch air ratchet with 3/4-inch socket, turn the worm gear and install the intercooler core in position in the radiator cab.

Screen 76:

Fabricated WBIC Core Installation (Cont'd):

6. After the intercooler core has been placed in the radiator cab, install the rectangular cover using the 20, 3/8-inch hex bolts, then torque the bolts to 22-24 lb.-ft. (30-33 Nm).
7. Install the seal plate around the drain fitting using the four 3/8-inch hex bolts, then torque the bolts to 22-24 lb.-ft. (30-33 Nm).
8. Install the two bolts and washers near the top of the cover, then torque the bolts to 110-120 lb.-ft. (149-163 Nm).
9. Attach the drain hose and fitting and close the access door.
10. Remove and disassemble the puller tool (PSB P5205) from the B-side of the locomotive.

Screen 77:

Fabricated WBIC Core Installation (Cont'd):

11. Install the B-side access plate cover with a new air side O-ring.
12. Torque the 10, 1/2-inch hex bolts to 55-62 lb.-ft. (75-84 Nm).

Note: Depending on the fabricated WBIC shell design, it may also be necessary to install Allen bolts that were previously removed from the front end of the intercooler shell in order to remove the intercooler core. If so, install and torque the Allen bolts to 31-33 lb.-ft. (42-45 Nm).

13. Using new gaskets, re-install the Victaulic couplings that secure the piping to the intercooler on the B-side.

Note: For additional information on assembly and installation of the Victaulic couplings, refer to the Victaulic Coupling Installation section of this module.

14. Reconnect the vent fitting.
15. Refill the cooling water system, if required as discussed in the Filling the Cooling Water System section of this module, and visually inspect the intercooler and associated piping for signs of leakage or damage.
16. Re-install the maintenance access panel underneath the wing of the radiator cab.

Screen 78:

Cast WBIC Core Removal:

Note: This demonstration displays the steps to remove a core from a cast WBIC. For details of removing the core from a fabricated WBIC, refer to the Fabricated WBIC Core Removal section of this module. Before replacing the core, check for leaks from the tell-tale holes to ensure that there is no water leak.

Typical steps to remove the cast WBIC core are as follows:

Warning: To prevent personal injury and potential equipment damage, ensure that the engine cannot be started before removing, installing, or adjusting any components. Open the BS to prevent starting attempts. Also, place the FPB and the LCCB in the OFF position. Apply a warning tag to the EC switch.

Warning: If the locomotive is equipped with AESS, the diesel engine may start without operator action. Exercise caution when working around the radiator cab. Ensure that AESS is disabled before performing any maintenance procedures on the locomotive. Failure to do so may result in death or serious personal injury.

1. Shut down the diesel engine.
2. De-pressurize the cooling water system by holding the water fill assembly vent valve open for approximately one minute.
3. Remove the maintenance access panel underneath the wing of the radiator cab, then set the panel aside and retain the hardware.

Note: Ensure that the radiators contain no water.

4. Drain the water from the cooling system, below the level of the cast WBIC.
5. From the A-side (right side) of the locomotive:
 - a. Open, but do not remove, the access door.
 - b. Remove the drain line and the fitting from the drain pipe.
 - c. Remove the 28, 3/8-inch hex bolts from the outer end fastening plate that secures the intercooler core and attached end cover to the shell, and save all hardware for re-use.
 - d. Remove the outer end fastening plate and discard the O-ring.

Note: If desired, the intercooler core end cover may also be removed by removing the 16 Allen bolts; however, the cover may remain attached during the cast WBIC core removal and installation.

Screen 79:

Cast WBIC Core Removal (Cont'd):

6. From the B-side (left side) of the locomotive:
 - a. Disassemble and remove the couplings securing the piping to the cast WBIC.

Note: For additional information on disassembly and removal of the Victaulic couplings, refer to the Victaulic Coupling Removal section of this module.

- b. Disconnect the vent fitting and discard the gaskets.
- c. Loosen and remove the 16 Allen bolts that secure the core access plate with end tank to the outer end fastening plate.

Note: Depending on the cast WBIC B-side end plate design, M10 bolts either with or without hard lock (Nord-Lock) washers may have been used instead of Allen bolts to secure the core access plate with end tank to the outer end fastening plate.

- d. Set the core access plate with end tank aside and save all hardware for re-use.
- e. Discard the O-ring.
- f. Loosen and remove the 16, 1/2-inch hex bolts and washers that secure the outer end fastening plate to the intercooler shell.
- g. Remove the outer end fastening plate and save all hardware for re-use.

Screen 80:

Cast WBIC Core Removal (Cont'd):

Warning: The approximate nominal weight of the cast WBIC core is 1428 lbs. (648 kg) and the approximate dry core weight is 518 lbs. (235 kg). Ensure that the lifting device, cables, and straps are adequate. Failure to do so may result in personal injury or death.

Caution: While lifting the core, ensure that the movement of the core is away from the radiator cab. Do not simply lift the core straight up. Failure to do so may result in damage to the components.

- 7. Install the cast WBIC core removal tool (TESCO T85373) onto the B-side (left side) of the locomotive.
- 8. Install a lifting eye bolt on the B-side outer end fastening plate.
- 9. Attach a sling to the B-side eye bolt to pull the core out from the radiator cab and onto the cast WBIC core removal tool (TESCO T85373).
- 10. After the core has fully cleared the wing of the radiator cab and is stationary on the cast WBIC core removal tool (TESCO T85373), install the other lifting eye bolt on the A-side outer end fastening plate or the intercooler core end cover, if still installed.
- 11. Attach lifting slings to the two eye bolts, then lift the core and place it on a stable (level) work surface.

Screen 81:

Cast WBIC Core Installation:

Note: This demonstration displays the steps to install a cast WBIC core. For details of installing a fabricated WBIC core, refer to the Fabricated WBIC Core Installation section of this module.

Typical steps to install the cast WBIC core are as follows:

Warning: The approximate nominal weight of the cast WBIC core is 1428 lbs. (648 kg) and the approximate dry core weight is 518 lbs. (235 kg). Ensure that the lifting device, cables, and straps are adequate. Failure to do so may result in personal injury or death.

Caution: While lifting the core, ensure that the movement of the core is away from the radiator cab. Do not simply lift the core straight up. Failure to do so may result in damage to the components.

1. If required, install the cast WBIC core removal tool (TESCO T85373) onto the B-side (left side) of the locomotive.
2. Install a lifting eye bolt to the new intercooler core on the A-side outer end fastening plate or the intercooler core end cover, if installed, and another lifting eye bolt on the B-side outer end fastening plate.
3. Attach slings to the lifting eye bolts and carefully lift the core from the stable work surface.
4. Place the intercooler core on the cast WBIC core removal tool (TESCO T85373), then remove the slings and lifting eye bolts from the sides of the core.
5. Using the cast WBIC core removal tool (TESCO T85373), install the intercooler core into the radiator cab, sliding the core through the wing and into the intercooler shell.
6. After the core is properly positioned in the intercooler shell, perform the following on the B-side (left side) of the locomotive:
 - a. Remove the cast WBIC core removal tool (TESCO T85373).
 - b. Install the outer end fastening plate with the 16, 1/2-inch hex bolts and washers, then torque to 55-62 lb.-ft. (75-84 Nm).
 - c. Re-install the core access plate with end tank to the outer end fastening plate with a new O-ring and the 16 Allen bolts, then torque to 31-33 lb.-ft. (42-45 Nm).

Note: Depending on the cast WBIC B-side end plate design, M10 bolts either with or without hard lock (Nord-Lock) washers may have been used instead of Allen bolts to secure the core access plate with end tank to the outer end fastening plate. If so, install and torque the M10 bolts with hard washers to 36 lb.-ft. (49 Nm) or, for M10 bolts without hard washers, to 31 lb.-ft. (42 Nm).

- d. Re-install the vent fitting with a new gasket.
- e. Re-install the couplings to secure the piping to the intercooler on the B-side (left side).

Note: For additional information on assembly and installation of the Victaulic couplings, refer to the Victaulic Coupling Installation section of this module.

Screen 82:**Cast WBIC Core Installation (Cont'd):**

7. On the A-side (right side) of the locomotive:
 - a. Re-install the outer end fastening plate and, if required, the intercooler core end cover using new O-rings as applicable.
 - b. If required, secure the intercooler core end cover with the 16 Allen bolts, then torque to 31-33 lb.-ft. (42-45 Nm).
 - c. Secure the outer end fastening plate to the shell using the 28, 3/8-inch hex bolts, then torque to 29.5 lb.-ft. (40 Nm).

Caution: Torque the side plate bolts in a star pattern to prevent side loading and possible O-ring damage.

- d. Re-attach the drain hose and fitting to the drain pipe.
 - e. Close the access door.
8. Refill the water in the cooling system as discussed in the Filling the Cooling Water System section of this module.
9. Visually inspect the intercooler and the associated piping for signs of leakage or damage.
10. Re-install the maintenance access panel underneath the radiator cab wing.

Screen 83:**WBIC Core, Seal, and O-Ring Inspection:**

Inspect the intercooler core for signs of damage, including the core, water seals, and O-rings. If found, replace the applicable components, as necessary, in accordance with site specific locomotive maintenance instructions. If the water seals are damaged, corrosion will be found on the outside of the core. Clean the corrosion from the sides of the core using pressurized water.

Screen 84:**Univalve Assembly:**

Note: Not all Evolution Series locomotives are equipped with a univalve assembly.

The univalve assembly changes the cooling water flow paths through the cooling system to regulate the water temperature during different operating conditions. The univalve assembly consists of a rotary flow control valve assembly shafted to a three-position pneumatic actuator. The three univalve control magnet valves (WV1, WV2, and WV3) are used to switch the actuator. To troubleshoot the univalve, an indicator on the actuator provides a visual indication of what mode of operation the assembly is in.

Screen 85:**Univalve Assembly (Cont'd):**

In Mode 1, the univalve mode indicator should be in the 12 o'clock position, and WFV1, WFV2, and WFV3 should be energized. In Mode 2, the univalve mode indicator should be in the 2 o'clock position, and WFV2 should be energized. In Mode 3, the univalve mode indicator should be in the 4 o'clock position, and all WFVs should be de-energized. In addition, the solenoid on each univalve control magnet valve can be manually overridden. The magnet valve picks up when the manual override plunger is pressed down. The illustration indicates which magnet valve needs to be on or off to switch the univalve to a particular mode.

Screen 86:**Univalve Assembly Removal:**

Typical steps to remove the univalve assembly are as follows:

Note: Not all Evolution Series locomotives are equipped with a univalve assembly.

Warning: To prevent personal injury and potential equipment damage, ensure that the engine cannot be started before removing, installing, or adjusting any components. Open the BS to prevent starting attempts. Also, place the FPB and the LCCB in the OFF position. Apply a warning tag to the EC switch.

Warning: If the locomotive is equipped with AESS, the diesel engine may start without operator action. Exercise caution when working around the radiator cab. Ensure that AESS is disabled before performing any maintenance on the locomotive. Failure to do so may result in death or serious personal injury.

Note: To ensure successful univalve maintenance, note the pin position on the valve. The replacement valve must be inserted in the same configuration as the removed valve. Also, mark the ports of the copper air tubing that supply operating air to the univalve's rotary actuator. The tubing will be removed and must be reattached to the correct ports.

1. Shut down the diesel engine.
2. Depressurize the cooling water system by holding the water fill assembly vent valve open for approximately one minute.
3. With the engine shutdown and the cooling water system depressurized, ensure the radiators contain no water.
4. Remove the bulkhead and radiator cab top covers to allow access to the univalve.

Note: Steps 5 through 8 are applicable only for univalve model 84D709452G1RSM and do not specifically apply to univalve models 84A214652ABP2 and 84A214652ABP3, which may or may not include a vent manifold assembly. Refer to customer-specific

drawings, manuals, and procedures for removal and installation of these models, which include a newly designed mounting bracket and may or may not include the necessary mounting brackets for the vent manifold assembly.

5. Disconnect the three copper air tubes that supply actuating air to the univalve rotary actuator.

Screen 87:

Univalve Assembly Removal (Cont'd):

6. Remove the Victaulic couplings that connect the various water flowpaths to the univalve.

Note: For additional information on disassembly and removal of the Victaulic couplings, refer to the Victaulic Coupling Removal section of this module.

7. Remove and save the four bolts, washers, and lockwashers that secure the univalve mounting clamps.
8. Remove and save the two univalve mounting clamps and cushion inserts.

Warning: The univalve assembly weighs approximately 250 lbs. (113 kg). Ensure the lifting device is adequate. Failure to do so may result in personal injury or death.

9. Remove the univalve assembly with an appropriate lifting device.

Screen 88:

Univalve Assembly Installation:

Typical steps to install the univalve assembly are as follows:

Note: Not all Evolution Series locomotives are equipped with a univalve assembly.

Warning: To prevent personal injury and potential equipment damage, ensure that the engine cannot be started before removing, installing, or adjusting any components. Open the BS to prevent starting attempts. Also, place the FPB and the LCCB in the OFF position. Apply a warning tag to the EC switch.

Warning: If the locomotive is equipped with AESS, the diesel engine may start without operator action. Exercise caution when working around the radiator cab. Ensure that AESS is disabled before performing any maintenance on the locomotive. Failure to do so may result in death or serious personal injury.

Note: To ensure successful univalve maintenance, note the pin position on the valve. The replacement valve must be inserted in the same configuration as the removed valve. Also, mark the ports of the copper air tubing that supply operating air to the

univalve's rotary actuator. The tubing will be removed and must be reattached to the correct ports.

Warning: The univalve assembly weighs approximately 250 lbs. (113 Kg). Ensure the lifting device is adequate. Failure to do so may result in personal injury or death.

1. Use an appropriate lifting device and place the univalve assembly in position on the radiator cab.

Note: Steps 2 through 5 are applicable only for univalve model 84D709452G1RSM and do not specifically apply to univalve models 84A214652ABP2 and 84A214652ABP3, which may or may not include a vent manifold assembly. Refer to customer-specific drawings, manuals, and procedures for removal and installation of these models, which include a newly designed mounting bracket and may or may not include the necessary mounting brackets for the vent manifold assembly.

2. Install the two univalve mounting clamps and cushion inserts.
3. Install the four bolts, washers, and lockwashers that were removed during removal to secure the univalve mounting clamps.
4. Install the Victaulic couplings that connect the various water flowpaths to the univalve and torque the bolts to 70-80 lb.-ft. (95-108 Nm).

Note: For additional information on assembly and Installation of the Victaulic couplings, refer to the Victaulic Coupling Installation section of this module.

5. Connect the three copper air tubes that supply actuating air to the univalve rotary actuator.
6. Install the bulkhead and radiator cab top covers.

Screen 89:

Radiators:

The mechanically bonded radiators have been specially designed to maximize the transfer of heat from the cooling water to the ambient air. Heat transfer can occur by natural convection or by forcing air across sections of the radiators. There are two radiators: one forms the left bank and the other forms the right bank. Each bank consists of a main section and a sub-cooler section. When the cooling system is in Mode 3 operation, the water in the radiators automatically drains back to the water storage tank by gravity.

Screen 90:

Cleaning Radiators:

Steam Jet Cleaner or Locomotive Wash Facility and Radiator Lifting Fixture TESCO 58901 (upgraded version used on the Dash 9/AC4400) are required to clean, remove, and install the radiators.

Warning: Before cleaning, removing, and installing radiators, shut down the diesel engine, depressurize the cooling water system, and ensure the radiators contain no water.

Warning: Comply with all Railroad safety procedures before proceeding to the top of the radiator cab. The radiator rock guards were not designed to be walked on by more than one person. Use the supplied walkway cover. Failure to do so could result in serious personal injury.

Screen 91:

Cleaning Radiators (Cont'd):

Typical steps to clean the radiators are as follows:

1. Standing on the walkway cover, clean any dirt accumulation or debris on the cores of the radiators by directing pressurized air from the top down.

Note: If the cores have grease deposits, use a steam jet to clean.

Caution: Ensure that the fins or tubes are not damaged from rough brushing or excessive jet pressure of either steam or air.

Warning: Always use extreme caution when working with compressed air or steam. Do not direct the flow of compressed air or steam at any human being. Discharge compressed air or steam only toward areas to be cleaned.

2. Clean the radiator inlet V-screens from the inside out and remove all visible debris using pressurized air.

Screen 92:

Cleaning Radiators (Cont'd):

3. Force out any remaining debris in the radiator cab.
4. If required, clean the radiators and the inlet screens by running the locomotive through a high-pressure washer with appropriate cleaning agents.
5. If rust has developed on the steel frame, clean and repaint as necessary.

Screen 93:

Radiator Bank Removal:

Typical steps to remove one of the radiator banks from the locomotive are as follows:

Warning: To prevent personal injury and potential equipment damage, ensure that the engine cannot be started before removing, installing, or adjusting any components. Open the BS to prevent starting attempts. Also, place the FPB and the LCCB in the OFF position. Apply a warning tag to the EC switch.

Warning: If the locomotive is equipped with AESS, the diesel engine may start without operator action. Exercise caution when working around the radiator cab. Ensure that AESS is disabled before performing any maintenance on the locomotive. Failure to do so may result in death or serious personal injury.

Warning: Before removing the radiators, shut down the diesel engine, depressurize the cooling water system and ensure the radiators contain no water.

Warning: Comply with all Railroad safety procedures before proceeding to the top of the radiator cab. The radiator rock guards were not designed to be walked on by more than one person. Use the supplied walkway cover. Failure to do so could result in serious personal injury.

1. Ensure that the radiator assembly has been fully drained and is cool to the touch before attempting to remove the radiator bank.
2. Remove and save the hex-head bolts, washers, and lockwashers, and remove the walkway cover, then place the walkway cover in an area where it will not be damaged.
3. Remove and save the four hold-down hex-head bolts, washers, and plates from the center-vee mounting channel.
4. Remove and save the hex-head bolts, washers, and lockwashers, and remove the short-hood end covers, then place the end covers in an area where they will not be damaged.

Screen 94:

Radiator Bank Removal (Cont'd):

5. Remove the outboard Victaulic couplings and disconnect the outlet pipe from the radiator bank to be removed.

Note: For additional information on disassembly and removal of the Victaulic couplings, refer to the Victaulic Coupling Removal section of this module.

6. Disconnect the short-hood vent lines of the radiator bank to be removed.

Note: The air lines should be labeled before they are removed from the shutter cylinders so that they will not be reversed when re-installing the shutters.

7. Disconnect the air lines, two per shutter, attached to the shutter cylinders.

Note: All Evolution Series locomotives are not equipped with the radiator shutter assembly. Some, in place of the radiator shutter assembly, have a covering grate. For these locomotives, remove all sets of clamps, lockwashers, washers, and bolts that secure the grate to the assembly.

8. Remove and save the hex-head bolts, washers, and lockwashers, and remove the long-hood end covers, then place the end covers in an area where they will not be damaged.
9. Remove the two outboard Victaulic couplings to disconnect the inlet pipes from the radiator bank to be removed.

Note: For additional information on disassembly and removal of the Victaulic couplings, refer to the Victaulic Coupling Removal section of this module.

Screen 95:

Radiator Bank Removal (Cont'd):

10. While standing on the locomotive walkway, remove the radiator access plates from the underside of the wing.
11. Remove and save the eight hex-head bolts, washers, and plates that fasten the radiators to the radiator cab frame.

Warning: A radiator bank with shutter mounted to it weighs approximately 2355 lbs. (1070 kg). Ensure that the lifting device is adequate. Failure to do so may result in personal injury or death.

12. Attach the lifting device to the two lifting lugs. Carefully remove the radiator bank from the radiator cab.

Screen 96:

Radiator Bank Installation:

Typical steps to install one of the radiator banks on the locomotive are as follows:

Warning: To prevent personal injury and potential equipment damage, ensure that the engine cannot be started before removing, installing, or adjusting any components. Open the BS to prevent starting attempts. Also, place the FPB and the LCCB in the OFF position. Apply a warning tag to the EC switch.

Warning: A radiator bank with the shutter assembly mounted to it weighs approximately 2355 lbs. (1070 kg). Ensure that the lifting device is adequate. Failure to do so may result in personal injury or death.

1. Attach the lifting device to the two lifting lugs, then carefully lift the radiator bank and place it into the radiator cab.
2. Install and align the Victaulic couplings and pipes in the inlet and discharge headers.

Note: For additional information on assembly and installation of the Victaulic couplings, refer to the Victaulic Coupling Installation section of this module.

3. Connect the short-hood vent lines.
4. Reconnect the air lines, two per shutter, attached to the shutter cylinders.

Note: All Evolution Series locomotives are not equipped with the radiator shutter assembly. Some, in place of the radiator shutter assembly, have a covering grate. For these locomotives, remove all sets of clamps, lockwashers, washers, and bolts that secure the grate to the assembly.

5. Using the four previously removed and saved hold-down hex-head bolts, washers, and plates, fasten the radiator bank to the center-vee mounting channel, then tighten the bolts to 110-120 lb.-ft. (150-162 Nm).

Screen 97:

Radiator Bank Installation (Cont'd):

6. From the outside of the radiator cab, install the previously removed and saved radiator hold-down hex-head bolts, washers, and plates, then tighten the bolts to 110-120 lb.-ft. (150-162 Nm).
7. Install the access plates on the radiator cab.
8. Using the previously removed and saved hex-head bolts, washers, and lockwashers, install the end covers to the radiator cab frame.
9. Using the previously removed and saved hex-head bolts, washers, and lockwashers, install and fasten the walkway covers.
10. Fill the cooling water system, if required as discussed in the Filling the Cooling Water System section of this module.

Screen 98:

Radiator Shutter Removal:

Typical steps to remove the radiator shutter are as follows:

Warning: To prevent personal injury and potential equipment damage, ensure that the engine cannot be started before removing, installing, or adjusting any components. Open the BS to prevent starting attempts. Also, place the FPB, the LCCB in the OFF position. Apply a warning tag to the EC switch.

Warning: If the locomotive is equipped with AESS, the diesel engine may start without operator action. Exercise caution when working around the radiator cab. Ensure that AESS is disabled before performing any maintenance procedures on the locomotive. Failure to do so may result in death or serious personal injury.

1. Remove and save the hex-head bolts, washers, and lockwashers, then remove the walkway cover.
2. Place the walkway cover in an area where it will not be damaged.

Note: The air lines should be labeled before they are removed from the shutter cylinders. This will ensure that they will not be reversed when re-installing the shutters.

3. Disconnect the air lines, two per shutter, attached to the shutter cylinders.
4. Remove and save all bolts, washers, and lockwashers that hold the shutter to the radiator.
5. Attach a proper lifting device to the attachment holes located on the end plates, then carefully remove the shutter.

Screen 99:

Radiator Shutter Installation:

Typical steps to install the radiator shutter are as follows:

Warning: To prevent personal injury and potential equipment damage, ensure that the engine cannot be started before removing, installing, or adjusting any components. Open the BS to prevent starting attempts. Also, place the FPB, the LCCB in the OFF position. Apply a warning tag to the EC switch.

1. Attach a proper lifting device to the attachment holes located on the end plates, then carefully lift the shutter and set it in place.
2. Install and fasten the shutter to the radiator using the previously removed and saved bolts, washers, and lockwashers.
3. Connect the air lines attached to the shutter cylinders following the labels applied at the time of removal.

Note: Check the radiator shutter air lines to ensure the proper tap blocks are installed. If the radiator tap blocks are missing, install the two shutter airline brackets, then install the radiator shutter air lines such that the air lines are at a downward angle. Refer to site specific maintenance instructions for specific details and part numbers.

4. Install and fasten the walkway cover using the previously removed and saved hex-head bolts, washers, and lockwashers.

Screen 102:

Radiator Fan:

The radiator fan cools the engine cooling water flowing through the radiators by forcing air across the radiator sections. The radiator fan assembly consists of an AC motor and a fan blade assembly. The radiator fan motor is controlled by a solid-state regulator, which controls the fan speed (i.e., off, 1/4, 1/2, or full engine speed). The engine cooling water temperature, detected by the EWIT sensor, is the primary input used to control the radiator fan speed.

Screen 103:**Running Maintenance for Radiator Fan:**

A Radiator Fan Lifting Fixture is required to remove and install the radiator fan. The radiator fan bearings should be lubricated on a yearly basis. The upper bearing requires 4.5 oz. (128 g) of grease, and the lower bearing requires 1.3 oz. (37 g) of grease.

Bearings should be lubricated with a grease meeting D6A2C10.

Screen 104:**Radiator Fan Removal:**

Typical steps to remove the radiator fan are as follows:

Warning: To prevent personal injury and potential equipment damage, ensure that the engine cannot be started before removing, installing, or adjusting any components. Open the BS to prevent starting attempts. Also, place the FPB and the LCCB in the OFF position. Apply a warning tag to the EC switch.

Warning: If the locomotive is equipped with AESS, the diesel engine may start without operator action. Exercise caution when working around the radiator cab. Ensure that AESS is disabled before performing any maintenance on the locomotive. Failure to do so may result in death or serious personal injury.

1. Remove and save the eight bolts that hold the large screen on the left side of the radiator cab.
2. Carefully, remove the large cab screen assembly and set it aside.
3. Disconnect the three lead wires from the terminal block located on the underside of the radiator fan motor.
4. Note carefully the identification of the lead on each terminal for subsequent reassembly, then install the hardware back on the terminal block studs.

Screen 105:**Radiator Fan Removal (Cont'd):**

Note: Both halves of the radiator fan shroud can be removed to facilitate the radiator fan removal, but it is only necessary to remove the half on the side from which the fan will be removed.

5. Remove and save the two bolts holding the two halves of the fiberglass radiator fan shroud together at the front and rear of the shroud.
6. Remove and save the eight bolts holding the shroud half and metal pan to the cover plate on the side from which the radiator fan and motor are to be removed.
7. Set the shroud half and metal pan aside.

Screen 106:**Radiator Fan Removal (Cont'd):**

8. Remove and save the two long bolts holding the radiator fan and motor and the radiator fan support to the radiator cab structure.

Warning: The radiator fan weighs approximately 1,645 lbs. (746 kg). Ensure that the lifting device is adequate.

Caution: Use extreme care when removing the radiator fan assembly to prevent damaging the fan blades and the shroud.

9. With a forklift or a lifting fixture suspended from a crane, reach into the side of the radiator cab structure through the opening from where the screens and shroud were removed.
10. Insert the forks into the two hollow box sections across the bottom of the radiator fan motor.

Screen 107:**Radiator Fan Removal (Cont'd):**

11. If using a crane and lifting fixture, switch the crane hook from the empty lifting location to the loaded lifting location.
12. Remove and save the two remaining mounting bolts.
13. Lift the radiator fan and motor and remove it from the side of the cab.
14. Set the fan and motor down on wooden blocks; ensure that enough clearance exists under the motor to protect the terminal block and the bottom bearing cap.

Screen 108:**Radiator Fan Installation:**

Typical steps to install the radiator fan are as follows:

Warning: To prevent personal injury and potential equipment damage, ensure that the engine cannot be started before removing, installing, or adjusting any components. Open the BS to prevent starting attempts. Also, place the FPB and the LCCB in the OFF position. Apply a warning tag to the EC switch.

Warning: The radiator fan weighs approximately 1,645 lbs. (746 kg). Ensure that the lifting device is adequate.

Caution: Use extreme care when removing the radiator fan assembly to prevent damaging the fan blades and the shroud.

1. Place the forks of a forklift or a lifting fixture suspended from a crane into the two hollow box sections across the bottom of the radiator fan motor.

2. Lift the fan and motor, and insert it through the opening from where the screens and shroud were removed in the side of the radiator cab structure.
3. Lower the motor onto the support, aligning the fan and support with the mounting bolt holes in the radiator cab structure.

Screen 109:

Radiator Fan Installation (Cont'd):

Note: If using a crane and lifting fixture, switch the crane hook from the loaded lifting location to the empty lifting location.

4. Carefully remove the forks from the radiator fan motor box sections, preventing the radiator fan and motor or radiator fan support from shifting position.
5. Install the previously removed and saved four long mounting bolts with a lockwasher under each head through the radiator fan motor box sections and the radiator fan support into the radiator cab structure.
6. Torque the four bolts to 440-490 lb.-ft. (597-665 Nm).

Screen 110:

Radiator Fan Installation (Cont'd):

7. Ensure that the fan tips have clearance around the shroud; if they do not, adjust as necessary.
8. Rotate the fan.

Note: The fan motor must rotate freely with no rubbing sounds.

9. Install the shroud half and metal pan on the side from which the radiator fan and motor was installed, and bolt it to the cover plate with the eight previously removed and saved bolts.
10. Install the two previously removed and saved bolts holding the two halves of the fiberglass radiator fan shroud together at the front and the rear of the shroud, then tighten all ten bolts.

Screen 111:

Radiator Fan Installation (Cont'd):

11. Connect the three lead wires on the terminal block located on the underside of the radiator fan motor, ensuring that each lead is on the correct terminal, then tighten the nuts on the terminal block studs.

Caution: When the power leads to the radiator fan motor or the Radiator Fan Motor Controller (RFC) have been disconnected at either end, it is very important to reconnect the leads correctly at re-installation. If any two power leads are swapped at either end, the fan may still operate, but it will rotate backwards. Running the radiator fan backwards greatly decreases the air flow. This reduced air flow can allow the diesel

engine cooling water to become excessively hot, causing the locomotive to gradually derate until the engine goes to IDLE.

12. Install the large screen on the left side of the radiator cab.
13. Install and tighten the eight previously removed and saved bolts to hold the screen in place.

Screen 112:

Running Maintenance for the Automatic Water Drain Valve:

Note: The automatic water drain valve hex body and cartridge (actuating portion) can be inspected, tested, and replaced without disconnecting any pipe connections.

When replacing the automatic water drain valve cartridge and the associated hex nut, ensure that the color of the installed automatic water drain valve cartridge handle and hex nut stripe match the color code for the year. If the entire flanged valve body with the tee fitting is to be removed from the piping, the engine cooling water system must be drained. For more information on replacing the valve along with the tee fitting, refer to the Automatic Water Drain Valve Assembly Replacement section of this module. The table displays the color of the automatic water drain valve cartridge handle and the hex nut stripe for the years 2022-2036.

Screen 113:

Automatic Water Drain Valve Actuating Portion Removal and Testing:

Typical steps to remove and test the actuating portion of the automatic water drain valve are as follows:

Warning: To avoid personal injury from engine cooling water burns, do NOT attempt to service the automatic water drain valve when the water temperature is over 100 °F (37.7 °C). Perform maintenance only when the engine cooling water system is cooled down.

1. Carefully loosen and remove the hex body and cartridge from the pipe tee, using a 1-7/8-inch wrench.

Note: The internal check valve closes, keeping water from draining from the cooling water system; however, with the hex body and cartridge removed, it is normal for a small amount of water to continue to leak from the pipe tee.

Note: The hex nut and valve cartridge must be changed out together. Changing only the cartridge can result in debris accumulation in the hex nut and deterioration of the cartridge O-ring nose seal. This results in a leak path where water can freeze prohibiting the cartridge from dropping out when required.

2. With the hex body and cartridge removed, the functionality of the actuating portion may be tested, if desired, as follows:
 - a. Intermittently spray canned coolant (available from Therm-O-Tech, Part Number MS-242N) onto the brass sensor at the cartridge tip, keeping a layer of frost on the metal surface.

Note: The cartridge should release from the hex body in less than one minute; if not, replace the entire unit as discussed in the Automatic Water Drain Valve Assembly Replacement section of this module.

- b. Reinstall the cartridge in the hex body after reheating to above 40 °F (4.4 °C).

Screen 114:

Automatic Water Drain Valve Actuating Portion Installation:

Typical steps to install the actuating portion of the automatic water drain valve are as follows:

Caution: Failure to install the hex body and cartridge properly will cause insufficient opening of the internal check valve, resulting in little or no drainage from the valve.

1. Chase the internal threads of the pipe tee to remove any rust or debris.
2. Using an approved low strength thread sealant (Loctite®567), screw the new hex body and cartridge into the leg of the pipe tee.
3. Tighten the hex body into the pipe tee to a torque value of 80 lb.-ft. (108 Nm).

Screen 115:

Automatic Water Drain Valve Assembly Replacement:

Typical steps to replace the automatic water drain valve assembly are as follows:

1. Drain the locomotive cooling water system.
2. Remove the two screws, lockwashers, and nuts from each connecting flange and remove the entire automatic water drain valve body from the piping.
3. Discard the O-ring seals and replace with new O-rings.

Note: When reassembling, apply a small amount of grease (Dow Corning 55M or equivalent) to the O-ring seals.

4. Install the replacement water drain valve assembly to the connecting flanges by securing with screws, lockwashers, and nuts.

Screen 116:

Victaulic Couplings:

Pipes between the major components of the cooling water system are joined together by Victaulic couplings. Victaulic couplings reduce pipe stress by absorbing vibration

and allowing for minor pipe-to-pipe misalignment. Victaulic couplings also make it easier for maintenance personnel to remove and install components in the system. The Victaulic coupling consists of two outer steel coupling halves, which are held together by bolts and gaskets. The gasket material is selected to withstand the effects of the liquids passing through the piping. The pipes that the Victaulic couplings connect to are machined to accept the lip of the Victaulic coupling. No running maintenance is required on the piping system. However, any time a component of the system is removed, Victaulic couplings must be disassembled.

Note: Victaulic couplings must be properly installed to ensure reliability.

Screen 117:

Victaulic Coupling Removal:

Typical steps to remove a Victaulic coupling on the cooling water system are as follows:

Warning: To prevent personal injury and potential equipment damage, ensure that the engine cannot be started before removing, installing, or adjusting any engine component. Place the BS in the OFF position to prevent starting attempts. Also, place the FPB and the LCCB in the OFF position. Also, apply a warning tag on the EC switch.

Warning: If the locomotive is equipped with AESS, the diesel engine may start without operator action. Exercise caution when working around the radiator cab. Ensure that AESS is disabled before performing any maintenance on the locomotive. Failure to do so may result in death or serious personal injury.

Note: When replacing a leaking or defective Victaulic coupling, depending on the location of the leaking or defective coupling, it may be necessary to drain the cooling water system to ensure water is removed from the section of piping containing the leaking or defective coupling.

1. If required, drain the cooling water system as discussed in the Draining the Cooling Water System and Taking Cooling Water Samples section of this module.
2. After the water from the cooling water system is drained or the pipe from which the Victaulic coupling is to be removed is empty, remove the bolts and nuts that hold the coupling halves together and remove the coupling.
3. While supporting the pipe with one hand, slide the gaskets (one on each end of the pipe) onto the removable pipe.

Note: After the gaskets and the body of the coupling have cleared the fixed pipe, the pipe can be removed to allow gasket removal.

4. Remove the gaskets from the pipe.
5. Protect the pipe ends after disassembly.

Screen 118:

Victaulic Coupling Installation:

Typical steps to install a Victaulic coupling on the cooling water system are as follows:

Warning: To prevent personal injury and potential equipment damage, ensure that the engine cannot be started before removing, installing, or adjusting any engine component. Place the BS in the OFF position to prevent starting attempts. Also, place the FPB and the LCCB in the OFF position. Also, apply a warning tag on the EC switch.

Note: Couplings used in the cooling water system have a seal made of EPDM rubber. EPDM rubber is indicated by a green mark on the inside of the gasket. Couplings used in the lubricating oil system are indicated by a blue mark on the inside of the gasket. Couplings used in the compressed air system are completely red and made from silicon gasket.

1. Inspect the gaskets for cuts, holes, or embedded foreign material.
2. Inspect the sealing surfaces of the pipe.

Note: Rough or non-machined surfaces do not indicate a defective pipe. However, there must not be scratches or gouges that cross more than 50% of the sealing surface. If scratches or gouges are present, use sandpaper or a fine file to dress the pipe surfaces. If defects cannot be removed without excessive sanding, the pipe should be replaced.

3. Inspect the cleanliness of the pipe and ensure it is clean and free of debris.

Note: Coupling seals used in both oil and water systems should be thoroughly lubricated. This prevents tearing or cutting the gasket when it is assembled.

4. Slide both gaskets onto the fixed end of the pipe ensuring that each gasket is flush with the end.

Screen 119:

Victaulic Coupling Installation (Cont'd):

5. Insert the pipe with one person holding the pipe in position while another person carefully slides the gasket into place.

Note: To ensure that the gasket is properly located on the pipe, both corners of the gasket's sealing surface must be exposed.

Note: There should be approximately a 0.125-inch (3.18 mm) gap between the pipe ends to allow for expansion. The gap between the piping lengths can be adjusted by loosening the four 0.5-inch (12.7 mm) bolts at the flange at one end of the pipe, moving the pipe into the desired location, then retightening the bolts to seal the pipe.

6. Install the coupling halves, then install the bolts and nuts ensuring that the oval under each bolt head is mated into the recessed oval in the coupling half.
7. Tighten the nuts until there is a metal-to-metal contact between the coupling halves.
8. Check the system for leaks.
9. Torque the Victaulic coupling bolts to 70-80 lb.-ft. (95-108 Nm).
10. Ensure that the Victaulic couplings are pointed out, mounted horizontally with respect to the split line of the coupling.

Note: Some dripping of lubricant from pipe joints may occur as the engine and piping warms up. This should not cause a concern unless you see evidence of joint leakage.

Screen 120:

Summary:

You have reached the end of this module!

In this module, you learned to:

- State the purpose and location of the major components of the split cooling water system.
 - The split cooling water system maintains a nearly constant engine operating temperature throughout the load range of the engine, even with wide variations in outside temperature and throttle call.
 - The split cooling water system provides additional cooling for the water-based intercooler and oil cooler at higher load conditions. The additional cooling of the water-based intercooler helps reduce the intake manifold air temperature into the engine cylinders, which in turn decreases the amount of harmful emissions from the exhaust stack and fuel consumption. The added cooling of the oil cooler in higher load conditions helps improve the life of the engine's bearings.
 - The major components of the split cooling water system are the water storage tank, water pump, lubricating oil cooler, water-based intercooler, univalve, univalve control magnet valves, radiator, radiator fan, fuel manifold, and automatic and manual water drain valves.
 - The split cooling water system also includes several sensors: Engine Water In Temperature, Engine Water Out Temperature, Engine Water In Pressure, Manifold Air Temperature, Ambient True Temperature, Barometric Air Pressure, and Engine Lube In Temperature.

Screen 121:

Summary (Cont'd):

- Describe how water flows through the split cooling water system.
 - The split cooling water system operates within established conditions referred to as Modes.

- During Mode 3 operation, the engine water pump draws water from the water storage tank and forces it through the turbocharger and engine. The combustion process in the engine heats the water. The heated water exits the engine and flows to the univalve. The univalve directs the heated water from the engine through two paths. The first path is through the oil cooler and the water-based intercooler, and then back to the storage tank, and the second path is directly to the water storage tank. The water through the oil cooler and the water-based intercooler heats the lube oil and intake manifold air, respectively.
- During Mode 2 operation, the engine water pump draws water from the water storage tank and forces it through the turbocharger and engine. From the engine, the heated water flows to the univalve. The univalve directs the heated water from the engine through two paths. The first path is through the oil cooler and the water-based intercooler, and then back to the water storage tank. This path either warms or cools the lubricating oil and intake manifold air. The second path is through the radiator and its sub-coolers, and then back to the water storage tank. A motor-driven radiator fan pushes air through the radiator to cool the engine water. Varying the fan motor speed from off to 1/4, 1/2, or full engine speed controls the actual amount of cooling that occurs.
- During Mode 1 operation, the engine water pump draws water from the water storage tank and forces it through the turbocharger and engine. From the engine, the water flows to the univalve. The univalve directs water from the engine to the radiator. The radiator has two sections: main and sub-cooler. The majority of the water flows through the "one-pass" main section back to the water storage tank. The remaining water continues through the "two-pass" sub-cooler section for further cooling. Water from the sub-cooler section is then channeled by the univalve to flow through the oil cooler and the water-based intercooler to provide additional cooling. A motor-driven radiator fan pushes air through the radiator to cool the engine water. Varying the fan motor speed from off to 1/4, 1/2, or full engine speed controls the amount of cooling.

Screen 122:

Summary (Cont'd):

- Describe the protection strategies used with the split cooling water system.
 - Low Water Pressure Protection: The Engine Management System (EMS) software uses water pressure information (as read by the EWIP sensor) to prevent damage to the engine caused by a low water pressure condition.
 - Low Water Pressure Thresholds: This strategy prevents damage to the engine when the water pressure drops below the specified threshold value for each engine notch speed.

- Cold Engine Protection: When the engine is cold, engine speed is limited as a function of lubricating oil outlet temperature (as read by the ELOT sensor). This prevents damage to the engine, lube oil pump, and external oil piping.
- Hot Water Protection: When the engine inlet water (as read by the EWIT sensor) is hot, the available horsepower from the engine is reduced to protect the engine from damage. At the same time, the engine speed increases to 1050 RPM to provide the highest radiator fan speed and maximum cooling.
- Cannot Cool Protection: If the radiator fan is unable to run, the engine is limited to Notch 2, thereby protecting the engine from overheating.
- Engine Water Inlet Temperature and Engine Lube Oil Outlet Temperature ΔT Protection: The engine horsepower derates or shuts down if the delta temperature (ΔT) between the engine water inlet (as read by the EWIT sensor) and the engine lube oil outlet (as read by the ELOT sensor) exceeds an allowable limit.
- Loss of Both Engine Water Temperature Sensors Protection: If both engine oil temperature sensors (ELIT and ELOT) are bad, the engine shuts down.
- Describe the running maintenance required for the split cooling water system.
 - Split Cooling Water System: Visually inspect the engine, water pump, oil cooler, water-based intercooler, fuel manifold, univalve, radiators, and all system piping for water leaks and correct as needed.
 - Cooling Water: Check the cooling water level after the engine has been idling for at least ten minutes with the green LED on.
 - Radiators: Clean as necessary. Run the radiator fan backwards to clean debris from screens every 184 days.
 - Univalve: Inspect for any water leakage. Run Self-Test 320 and observe that the univalve switches correctly for each mode of operation every 184 days.
 - Water-Based Intercooler: Every 184 days, inspect for any water (or oil) leakage at the weep holes at each end of the intercooler and check the two weep holes in the engine IFE cover.
 - Radiator Fan: Lubricate the bearings every year. Clean radiator fan blades and closely inspect the blades for cracks every two years. If any cracks are found, replace the radiator fan.
 - Victaulic Coupling: No routine running maintenance on the piping system is required.

Screen 123:

Summary (Cont'd):

- Summarize the steps to remove and install the major components of the split cooling water system.
 - Water Pump Removal and Installation

- For instructions on water pump removal and installation, refer to the Water Pump Removal and Installation module of the Diesel Engine Advanced course.
- Lubricating Oil Cooler Removal and Installation
 - For instructions on lubricating oil cooler removal and installation, refer to the Lubricating Oil System module of the Mechanical Systems Advanced course.
- Fabricated WBIC Removal
 1. Shut down the diesel engine.
 2. Depressurize the cooling water system.
 3. Ensure the radiators contain no water.
 4. Drain the water from the cooling water system below the level of the water-based intercooler.
 5. From the A-side (right side) of the locomotive:
 - a. Open, but do not remove, the access door.
 - b. Remove the drain line and fitting from the drain pipe.
 - c. Remove the two 5/8 inch hex bolts and washers near the top of the cover.
 - d. Remove the 20, 3/8 inch hex bolts holding the A-side (right side) cover.
 - e. Remove the four 3/8 inch hex bolts and seal plate surrounding the drain fitting and save all hardware for re-use.
 6. From the B-side (left side) of the locomotive:
 - a. Remove the maintenance access panel from underneath the wing of the radiator cab, then set the panel aside and save all hardware for re-use.
 - b. Disassemble and remove the Victaulic couplings securing the piping to the water-based intercooler.
 - c. Disconnect the vent fitting.
 - d. Loosen and remove the hex bolts and washers that secure the core access plate to the intercooler shell, then set aside the plate and all related hardware for re-use.
 - e. Using an appropriate tool (Grainger Part 5MK13), remove all Allen bolts from the front end of the intercooler shell.
 7. Install the puller tool (PSB P5205) onto the B-side of the locomotive for removing the intercooler core, as follows:
 - a. Install the support plate to the locomotive carbody.
 - b. Set the support stand on the handrail allowing it to sit on the catwalk.
 - c. Install the cradle support legs using ball lock pins.
 - d. Install the cradle support using ball lock pins, then adjust the support so it is level with the bottom of the intercooler core.
 - e. Install the puller tool puller bar onto the end of the intercooler core.
 8. Using a ½-inch air ratchet with a 3/4 inch socket, turn the worm gear and remove the core attached to the puller tool puller bar.
 9. After the core has fully cleared the wing of the radiator cab and is stationary on the cradle support, install the four, 1/2 inch lifting eye bolts.

10. Lift the core off the cradle.
11. Place the core on a stable work surface.

Screen 124:

Summary (Cont'd):

- Fabricated Water-Based Intercooler Seal Inspection and Replacement
 1. Ensure that the fabricated WBIC core is being installed by confirming the water inlet and outlet pipe outside diameter measurements are 3.5 inches (88.9 mm) and the B-side rectangular cover casing door is attached with hex bolts.
 2. If required, install the puller tool (PSB P5205) onto the B-side of the locomotive for installing the intercooler core.
 3. Install the four ½-inch lifting eye bolts on the intercooler core.
 4. Using a suitable lifting device, slowly lift the core and place it on the puller tool cradle, ensuring the core does not impact the side of the radiator cab while lifting.
 5. Using the attached puller tool puller bar and a 1/2-inch air ratchet with 3/4-inch socket, turn the worm gear and install the intercooler core in position in the radiator cab.
 6. After the intercooler core has been placed in the radiator cab, install the rectangular cover using the 20, 3/8-inch hex bolts, then torque the bolts to 22-24 lb.-ft. (30-33 Nm).
 7. Install the seal plate around the drain fitting using the four 3/8-inch hex bolts, then torque the bolts to 22-24 lb.-ft. (30-33 Nm).
 8. Install the two bolts and washers near the top of the cover, then torque the bolts to 110-120 lb.-ft. (149-163 Nm).
 9. Attach the drain hose and fitting, and close the access door.
 10. Remove and disassemble the puller tool (PSB P5205) from the B-side of the locomotive.
 11. Install the B-side access plate cover with a new air side O-ring.
 12. Torque the 10, 1/2-inch hex bolts to 55-62 lb.-ft. (75-84 Nm).
 13. Using new gaskets, re-install the Victaulic couplings that secure the piping to the intercooler on the B-side.
 14. Reconnect the vent fitting.
 15. Refill the cooling water system and visually inspect the intercooler and associated piping for signs of leakage or damage.
 16. Re-install the maintenance access panel underneath the wing of the radiator cab.
- Cast Water-Based Intercooler Core Removal
 1. Shut down the diesel engine.
 2. De-pressurize the cooling water system by holding the water fill assembly vent valve open for approximately one minute.
 3. Remove the maintenance access panel underneath the wing of the radiator cab, then set the panel aside and retain the hardware.

4. Drain the water from the cooling system, below the level of the cast WBIC.
5. From the A-side (right side) of the locomotive:
 - a. Open, but do not remove, the access door.
 - b. Remove the drain line and the fitting from the drain pipe.
 - c. Remove the 28, 3/8-inch hex bolts from the outer end fastening plate that secures the intercooler core and attached end cover to the shell, and save all hardware for re-use.
 - d. Remove the outer end fastening plate and discard the O-ring.
6. From the B-side (left side) of the locomotive:
 - a. Disassemble and remove the couplings securing the piping to the cast WBIC.
 - b. Disconnect the vent fitting and discard the gaskets.
 - c. Loosen and remove the 16 Allen bolts that secure the core access plate with end tank to the outer end fastening plate.
 - d. Set the core access plate with end tank aside and save all hardware for re-use.
 - e. Discard the O-ring.
 - f. Loosen and remove the 16, 1/2-inch hex bolts and washers that secure the outer end fastening plate to the intercooler shell.
 - g. Remove the outer end fastening plate and save all hardware for re-use.
7. Install the cast WBIC core removal tool (TESCO T85373) onto the B-side (left side) of the locomotive and install the lifting eye bolt on the header plate.
8. Install a lifting eye bolt on the B-side outer end fastening plate.
9. Attach a sling to the B-side eye bolt to pull the core out from the radiator cab and onto the cast WBIC core removal tool (TESCO T85373).
10. After the core has fully cleared the wing of the radiator cab and is stationary on the cast WBIC core removal tool (TESCO T85373), install the other lifting eye bolt on the A-side outer end fastening plate or the intercooler core end cover, if still installed.
11. Attach lifting slings to the two eye bolts, then lift the core and place it on a stable (level) work surface.

Screen 125:

Summary (Cont'd):

- Cast Water-Based Intercooler Core Installation
 1. If required, install the cast WBIC core removal tool (TESCO T85373) onto the B-side (left side) of the locomotive.
 2. Install a lifting eye bolt to the new intercooler core on the A-side outer end fastening plate or the intercooler core end cover, if installed, and another lifting eye bolt on the B-side outer end fastening plate.
 3. Attach slings to the lifting eye bolts and carefully lift the core from the stable work surface.

4. Place the intercooler core on the cast WBIC core removal tool (TESCO T85373), then remove the slings and lifting eye bolts from the sides of the core.
 5. Using the cast WBIC core removal tool (TESCO T85373), install the intercooler core into the radiator cab, sliding the core through the wing and into the intercooler shell.
 6. After the core is properly positioned in the intercooler shell, perform the following on the B-side (left side) of the locomotive:
 - a. Remove the cast WBIC core removal tool (TESCO T85373).
 - b. Install the outer end fastening plate with the 16, 1/2-inch hex bolts and washers, then torque to 55-62 lb.-ft. (75-84 Nm).
 - c. Re-install the core access plate with end tank to the outer end fastening plate with a new O-ring and the 16 Allen bolts, then torque to 31-33 lb.-ft. (42-45 Nm).
 - d. Re-install the vent fitting with a new gasket.
 - e. Re-install the couplings to secure the piping to the intercooler on the B-side (left side).
 7. To the A-side (right side) of the locomotive:
 - a. Re-install the outer end fastening plate and, if required, the intercooler core end cover using new O-rings as applicable.
 - b. If required, secure the intercooler core end cover with the 16 Allen bolts, then torque to 31-33 lb.-ft. (42-45 Nm).
 - c. Secure the outer end fastening plate to the shell using the 28, 3/8-inch hex bolts, then torque to 29.5 lb.-ft. (40 Nm).
 - d. Re-attach the drain hose and fitting to the drain pipe.
 - e. Close the access door.
 8. Refill the water to the cooling system.
 9. Visually inspect the intercooler and the associated piping for signs of leakage or damage.
 10. Re-install the maintenance access panel underneath the radiator cab wing.
- Cast Water-Based Intercooler Core Seals and O-Rings Inspection
 - Inspect the intercooler core for signs of damage, including the core, water seals, and O-rings. If found, replace the applicable components, as necessary, in accordance with site specific locomotive maintenance instructions. If the water seals are damaged, corrosion will be found on the outside of the core. Clean the corrosion from the sides of the core using pressurized water.

Screen 126:

Summary (Cont'd):

- Univalve Assembly Removal
 1. Shut down the diesel engine.
 2. Depressurize the cooling water system.
 3. Ensure the radiators contain no water.

4. Remove the bulkhead and radiator cab top covers to allow access to the univalve.
5. Disconnect the three air supply tubes from the univalve rotary actuator.
6. Remove the Victaulic couplings connected to the univalve.
7. Remove and save the four bolts, washers, and lockwashers that secure the univalve mounting clamps.
8. Remove and save the two univalve mounting clamps and cushion inserts.
9. Remove the univalve assembly with an appropriate lifting device.
- Univalve Assembly Installation
 1. Use an appropriate lifting device and place the univalve assembly in position on the radiator cab.
 2. Install the two univalve mounting clamps and cushion inserts.
 3. Install the four bolts, washers, and lockwashers that were removed during removal to secure the univalve mounting clamps.
 4. Install the Victaulic couplings that connect the various water flowpaths to the univalve and torque the bolts to 70-80 lb.-ft. (95-108 Nm).
 5. Connect the three copper air tubes that supply actuating air to the univalve rotary actuator.
 6. Install the bulkhead and radiator cab top covers.
- Radiator Bank Removal
 1. Ensure that the radiator assembly has been fully drained and is cool to the touch before attempting to remove the radiator bank.
 2. Remove and save the hex-head bolts, washers, and lockwashers, and remove the walkway cover, then place walkway cover in an area where it will not be damaged.
 3. Remove and save the four hold-down hex-head bolts, washers, and plates from the center-vee mounting channel.
 4. Remove and save the hex-head bolts, washers, and lockwashers, and remove the short-hood end covers, then place the end covers in an area where they will not be damaged.
 5. Remove the outboard Victaulic couplings and disconnect the outlet pipe from the radiator bank to be removed.
 6. Disconnect the short-hood vent lines of the radiator bank to be removed.
 7. Disconnect the air lines, two per shutter, attached to the shutter cylinders.
 8. Remove and save the hex-head bolts, washers, and lockwashers, and remove the long-hood end covers, then place the end covers in an area where they will not be damaged.
 9. Remove the two outboard Victaulic couplings to disconnect the inlet pipes from the radiator bank to be removed.
 10. While standing on the locomotive walkway, remove the radiator access plates from the underside of the wing.
 11. Remove and save the eight hex-head bolts, washers, and plates that fasten the radiators to the radiator cab frame.

12. Attach the lifting device to the two lifting lugs, then carefully remove the radiator bank from the radiator cab.
- Radiator Bank Installation
 1. Attach the lifting device to the two lifting lugs, then carefully lift the radiator bank and place it into the radiator cab.
 2. Install and align the Victaulic couplings and pipes in the inlet and discharge headers. Refer to the Victaulic couplings section for more information.
 3. Connect the short-hood vent lines.
 4. Reconnect the air lines, two per shutter, attached to the shutter cylinders.
 5. Using the four hold-down hex-head bolts, washers, and plates, fasten the radiator bank to the center-vee mounting channel, then tighten the bolts to 110-120 lb.-ft. (150-162 Nm).
 6. From the outside of the radiator cab, install the radiator hold-down hex-head bolts, washers, and plates, then tighten the bolts to 110-120 lb.-ft. (150-162 Nm).
 7. Install the access plates on the radiator cab.
 8. Using the hex-head bolts, washers, and lockwashers, install the end covers to the radiator cab frame.
 9. Using the hex-head bolts, washers, and lockwashers, install and fasten the walkway covers.
 10. Fill the cooling water system.
- Radiator Shutter Removal
 1. Remove and save the hex-head bolts, washers, and lockwashers, then remove the walkway cover.
 2. Place the walkway cover in an area where it will not be damaged.
 3. Disconnect the air lines, two per shutter, attached to the shutter cylinders.
 4. Remove and save all bolts, washers, and lockwashers that hold the shutter to the radiator.
 5. Attach a proper lifting device to the attachment holes located on the end plates, then carefully remove the shutter.
- Radiator Shutter Installation
 1. Attach a proper lifting device to the attachment holes located on the end plates, then carefully, lift the shutter and set it in place.
 2. Install and fasten the shutter to the radiator using the bolts, washers, and lockwashers.
 3. Connect the air lines attached to the shutter cylinders following the labels applied at the time of removal.
 4. Install and fasten the walkway cover using the hex-head bolts, washers, and lockwashers.

Screen 127:

Summary (Cont'd):

- Radiator Fan Removal
 1. Remove and save the eight bolts that hold the large screen on the left side of the radiator cab.
 2. Carefully, remove the large cab screen assembly and set it aside.
 3. Disconnect the three lead wires from the terminal block located on the underside of the radiator fan motor.
 4. Note carefully the identification of the lead on each terminal for subsequent reassembly, then install the hardware back on the terminal block studs.
 5. Remove and save the two bolts holding the two halves of the fiberglass radiator fan shroud together at the front and rear of the shroud.
 6. Remove and save the eight bolts holding the shroud half and metal pan to the cover plate on the side from which the radiator fan and motor are to be removed.
 7. Set the shroud half and metal pan aside.
 8. Remove and save the two long bolts holding the radiator fan and motor and the radiator fan support to the radiator cab structure.
 9. With a forklift or a lifting fixture suspended from a crane, reach into the side of the radiator cab structure through the opening from where the screens and shroud were removed.
 10. Insert the forks into the two hollow box sections across the bottom of the radiator fan motor.
 11. If using a crane and lifting fixture, switch the crane hook from the empty lifting location to the loaded lifting location.
 12. Remove and save the two remaining mounting bolts.
 13. Lift the radiator fan and motor and remove it from the side of the cab.
 14. Set the fan and motor down on wooden blocks; ensure that enough clearance exists under the motor to protect the terminal block and the bottom bearing cap.
- Radiator Fan Installation
 1. Place the forks of a forklift or a lifting fixture suspended from a crane into the two hollow box sections across the bottom of the radiator fan motor.
 2. Lift the fan and motor, and insert it through the opening from where the screens and shroud were removed in the side of the radiator cab structure.
 3. Lower the motor onto the support, aligning the fan and support with the mounting bolt holes in the radiator cab structure.
 4. Carefully remove the forks from the radiator fan motor box sections, preventing the radiator fan and motor or radiator fan support from shifting position.

5. Install the four long mounting bolts with a lockwasher under each head through the radiator fan motor box sections and the radiator fan support into the radiator cab structure.
6. Torque the four bolts to 440-490 lb.-ft. (597-665 Nm).
7. Ensure that the fan tips have clearance around the shroud; if they do not, adjust as necessary.
8. Rotate the fan. The fan motor must rotate freely with no rubbing sounds.
9. Install the shroud half and metal pan on the side from which the radiator fan and motor was installed, and bolt it to the cover plate with the eight bolts.
10. Install the two bolts holding the two halves of the fiberglass radiator fan shroud together at the front and the rear of the shroud, then tighten all ten bolts.
11. Connect the three lead wires on the terminal block located on the underside of the radiator fan motor, ensuring that each lead is on the correct terminal, then tighten the nuts on the terminal block studs.
12. Install the large screen on the left side of the radiator cab.
13. Install and tighten the eight bolts to hold the screen in place.

Screen 128:

Summary (Cont'd):

- Running Maintenance for the Automatic Water Drain Valve Actuating Portion
 - When replacing the automatic water drain valve cartridge and the associated hex nut, ensure that the color of the installed automatic water drain valve cartridge handle and hex nut stripe match the color code for the year. If the entire flanged valve body with the tee fitting is to be removed from the piping, the engine cooling water system must be drained.
- Automatic Water Drain Valve Actuating Portion Removal and Testing
 1. Carefully loosen and remove the hex body and cartridge from the pipe tee, using a 1-7/8-inch wrench.
 2. With the hex body and cartridge removed, the functionality of the actuating portion may be tested, if desired, as follows:
 - a. Intermittently spray canned coolant (available from Therm-O-Tech, Part Number MS-242N) onto the brass sensor at the cartridge tip, keeping a layer of frost on the metal surface.
 - b. Reinstall the cartridge in the hex body after reheating to above 40 °F (4.4 °C).
- Automatic Water Drain Valve Installation
 1. Chase the internal threads of the pipe tee to remove any rust or debris.
 2. Using an approved low strength thread sealant (Loctite® 567), screw the new hex body and cartridge into the leg of the pipe tee.
 3. Tighten the hex body into the pipe tee to a torque value of 80 lb.-ft. (108 Nm).

- Automatic Water Drain Valve Assembly Replacement
 1. Drain the locomotive cooling water system.
 2. Remove the two screws, lockwashers, and nuts from each connecting flange and remove the entire automatic water drain valve body from the piping.
 3. Discard the O-ring seals and replace with new O-rings.
 4. Install the replacement water drain valve assembly to the connecting flanges by securing with screws, lockwashers, and nuts.
- Victaulic Coupling Removal
 1. Drain the cooling water system.
 2. Remove the bolts and nuts that hold the coupling halves together and remove the coupling.
 3. Slide the gaskets onto the removable pipe, then remove the pipe to allow gasket removal.
 4. Remove the gaskets from the pipe.
 5. Protect the pipe ends after disassembly.
- Victaulic Coupling Installation
 1. Inspect the gaskets.
 2. Inspect the sealing surfaces of the pipe.
 3. Inspect the cleanliness of the pipe and ensure it is clean and free of debris.
 4. Slide both gaskets onto the fixed end of the pipe ensuring that each gasket is flush with the end.
 5. Insert the pipe with one person holding the pipe in position while another person carefully slides the gasket into place.
 6. Install the coupling halves, then install the bolts and nuts ensuring that the oval under each bolt head is mated into the recessed oval in the coupling half.
 7. Tighten the nuts until there is a metal-to-metal contact between the coupling halves.
 8. Check the system for leaks.
 9. Torque the Victaulic coupling bolts to 70-80 lb.-ft. (95-108 Nm).
 10. Ensure that the Victaulic couplings are pointed out, mounted horizontally with respect to the split line of the coupling.