

## **Steerable Truck**

### **Screen 1:**

#### **Welcome Screen:**

Welcome to the Steerable Truck module of the ES44AC/DC Mechanical Systems Advanced course.

### **Screen 2:**

#### **Introduction to Steerable Truck:**

In this module, you will learn how to inspect and maintain a three-motor, three-axle, high adhesion steerable type truck in a running repair environment.

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

- State the purpose and location of the steerable trucks.
- Describe the major components of a steerable truck.
- Describe the basic operation of a steerable truck.
- Describe how to perform running maintenance inspections related to the truck and its major components.

### **Screen 3:**

#### **Disclaimer:**

Please note that this module is for training use only. For complete details of inspection and maintenance of a steerable truck, refer to customer-specific drawings, manuals, and procedures.

### **Screen 4:**

#### **Overview of the Steerable Truck:**

The three-axle G1 model steerable truck is a three-motor, three-axle, high-adhesion, steerable type truck designed to carry one-half the weight of the locomotive. The high adhesion truck of an ES44AC/DC locomotive is designed to increase the adhesion between the wheels and the rail. Although the high adhesion truck performs as designed on a straight track, a loss of tractive effort occurs when the locomotive encounters a curve. To maximize the tractive effort on a curved track, the steerable truck was developed.

**Note:** The steerable truck can only be used on an AC locomotive.

### **Screen 5:**

#### **Overview of the Steerable Truck (Cont'd):**

The entire locomotive is supported by two steerable trucks, commonly called the front truck and the rear truck. These truck assemblies are located directly underneath the locomotive platform. Each steerable truck, designed to carry one-half of the weight of the locomotive, has three axles that are individually powered by traction motors. The

steerable trucks distribute the locomotive weight equally over the axles, and transfer the tractive effort or pulling force, and braking effort or stopping force, from the locomotive to the rails.

#### **Screen 6:**

##### **Major Components of the Steerable Truck:**

The major components of the steerable truck include:

- Truck Frame
- Wheels
- Lateral Liners
- Brake Shoes and Rigging
- Traction Motor Nose Suspension
- Side bearers
- Traction Pads
- Center Pin and Bearing Assembly
- Lateral and Yaw Dampers
- Vertical Hydraulic Dampers
- Coil Springs
- Steering Assembly and Inter-Motor Linkage Assembly
- Safety Hooks

#### **Screen 7:**

##### **Truck Frame:**

The truck frame is the backbone and foundation for the steerable truck assembly. It is a C-shaped steel casting that provides the mounting for all of the steerable truck's components.

#### **Screen 8:**

##### **Wheels:**

The wheels transfer the torque generated by the traction motor and apply it to the rails. The wheels are designed to keep the locomotive on the rails.

#### **Screen 9:**

##### **Lateral Liners:**

The lateral liners, two per axle bearing housing, provide a wear surface between the axle bearing housing and the truck frame. The axle bearing housings move vertically between nylon liners. These liners float laterally on retaining bolts that are inserted into the truck frame.

#### **Screen 10:**

##### **Brake Shoes and Rigging:**

Working together, the brake cylinders, brake rigging, and brake shoes apply stopping force to the wheels.

**Screen 11:****Traction Motor Nose Suspension:**

The traction motor nose suspension, also referred to as the dog bone or suspension link, provides support for the traction motor between the motor and the truck frame.

**Screen 12:****Side Bearers:**

The rubber side bearers, also referred to as loadbearers, consist of alternate layers of steel laminations and rubber, which are bonded together. There are four side bearers on the topside of the truck. The side bearers transmit the locomotive weight to the trucks, while permitting controlled lateral motion of the trucks relative to the locomotive platform.

**Screen 13:****Traction Pads:**

The rubber traction pads, consisting of alternate layers of steel and rubber that are bonded together, function to transmit the tractive effort from the truck to the locomotive, while permitting controlled lateral motion of the trucks relative to the locomotive platform. The traction pads also absorb the shock between the center pin bearing assembly and the truck frame during acceleration and braking.

**Screen 14:****Center Pin and Bearing Assembly:**

A center pin, located on the underside of the locomotive platform, fits into a center pin bearing assembly mounted in the truck frame. The center pin is welded to the underside of the platform and mates with the truck by way of the center block. The bearing assembly and the center pin allow the truck to pivot with respect to the locomotive platform and transmit the tractive force from the truck to the locomotive platform.

**Screen 15:****Lateral and Yaw Dampers:**

The lateral and yaw dampers are used to dampen unwanted movement and vibrations between the truck and the locomotive platform. There are two lateral and two yaw dampers per truck.

**Screen 16:****Vertical Hydraulic Dampers:**

There are four primary or vertical dampers on a steerable truck. The primary dampers are used to dampen unwanted movement and vibrations between the wheel axle assembly and the truck.

**Screen 17:****Coil Springs:**

The coil springs transfer the weight of the locomotive to the wheel and axle assembly, dampen vertical forces, and improve ride quality. There are twelve coil-compression springs, one spring located on each side of each journal bearing housing.

**Screen 18:****Safety Hooks:**

Safety hooks ensure that the truck does not become separated from the locomotive. They are located on both sides of each truck frame.

**Screen 19:****Steering Assembly:**

The steering assembly is a series of mechanical linkages that cause the axles to adjust to the curvature of the track. There are several components that make up the steering assembly. These include:

- Equalizer Bar and Equalizer Arms
- Bell Cranks
- Equalizer Bar Damper
- Reaction Arms and Wing Plate Assembly
- Traction Link and Center Link

**Screen 20:****Equalizer Bar and Equalizer Arms:**

The equalizer bar, also referred to as a "Marty" bar, and equalizer arms are attached to the open end of the bell cranks. The equalizer arms are heat-shrink fitted to the top of the bell cranks. The equalizer bar is attached to the equalizer arms by a close tolerance hardened pin with hardened bushings.

**Screen 21:****Bell Cranks:**

The bell crank is a vertically oriented shaft that rotates within the truck frame through two rubber laminated bearings. The bell crank permits the traction motor combination yaw rotation to be transmitted to the externally mounted reaction arms.

**Screen 22:****Equalizer Bar Damper:**

G1 steerable trucks have an equalizer bar damper attached between the steering arrangement and the truck frame. The damper reduces vibration induced by the steerable arrangement in the lateral direction.

**Screen 23:****Reaction Arms and Wing Plate Assembly:**

The reaction arms and wing plate assembly arrangement helps to ensure that the two axles are acting in equal and opposite direction. As the end axles rotate in equal and opposite direction in yaw, the reaction arms rotate relatively. The wing plate assembly will displace inward or outward relative to the truck frame depending upon the direction of steering. For example, if the left-side wing plate assembly displaces inward, the right-side wing plate assembly will displace outward.

**Note:** As the end axles rotate in equal and opposite direction, wheel/rail flange forces are reduced. This reduction in flange forces reduces wheel flange and rail gage face wear. Also, pulling adhesion in curves is increased.

**Screen 24:****Traction Link and Center Link:**

The traction and center links transmit and react to the tractive, braking, and steering forces from the wheel set journal box to the truck frame. Links are connected to the axle bearing housing, also known as the journal box. The other ends are attached to the truck frame through a smaller casting called a traction cap. These links have non-wearing elastomer bushings, which are securely fastened with nuts and bolts at both ends through the bushings.

**Screen 25:****Operation of Steerable Trucks:**

The 3-axled steerable truck has a series of steering linkages that force the first and third axles in equal and opposite directions, while the second axle moves laterally, towards the outside of the curve. Each set of wheels is powered by its own traction motor. The truck frame is supported by coil springs with primary dampers, which dampen vertical spring oscillations. A center pin and center pin bearing assembly transmit the tractive force from the truck to the locomotive platform. The side bearers support the vertical load and provide controlled lateral motion between the locomotive and the truck. The journal bearing housings transfer vertical loads from the frame to the axles and wheels.

**Screen 26:****Operation of Steerable Trucks (Cont'd):**

The primary, lateral, and yaw dampers reduce unwanted movement. The primary dampers reduce the motion between the truck frame and the axle. The lateral dampers reduce unwanted lateral motion of the truck as the locomotive moves along the track. The yaw dampers prevent the truck from "hunting the rail" as the locomotive moves along a straight track. Finally, brake cylinders, brake rigging, and brake shoes provide braking at each of the six truck wheels.

## **Screen 29:**

### **Wheel Inspection:**

The wheels on the steerable truck transfer the torque generated by the traction motor and apply it to the rails. The wheels are designed to keep the locomotive on the rails.

**Caution:** Shimming of truck springs to correct for differences in wheel diameters is not recommended on the steerable trucks. Shimming reduces spring travel and causes unbalanced spring loading conditions. Unbalanced loading conditions will shorten the life of other load-supporting components.

Periodically inspect the wheels for damage or excessive wear in accordance with Federal Railroad Administration (FRA) Regulations. The FRA rule for wheel inspection states, "The diameter of the wheels on the same axle shall not vary more than 0.0938 inches (2.38 mm); this is equivalent to approximately 2-1/2 tapes."

**Note:** The term "tape", as originally used in measuring locomotive wheels, is the measurement of the circumference of the wheel, where each one-eighth of an inch equals a specific number on a steel tape measure. The "tape" measurement is provided because it is easier to measure the circumference than the diameter due to the axle and bearing being located in the center of the wheel.

## **Screen 30:**

### **Wheel Inspection (Cont'd):**

FRA limits the differences in diameter between any two wheel sets in a truck to 0.75 inches (19.1 mm). However, for steerable trucks, Engineering recommends that wheels should not continue in service if the diameters in the same truck vary by more than 0.5 inches (12.7 mm) or under the same locomotive if they vary more than 1 inch (25.4 mm). These measurements are equivalent to 12-1/2 and 25 tapes, respectively.

**Note:** Engineering recommends that wheels should not vary more than 0.0188 inches (1/2 tape) on the same axle, 0.0750 inches (2 tapes) in the same truck, and 0.3002 inches (8 tapes) under the same locomotive for optimum locomotive performance.

**Note:** If the recommendations listed above are not met, excessive wear on truck components and reduced locomotive performance can result.

## **Screen 31:**

### **Wheel Repair:**

Do not attempt to repair wheels by welding. Turn or mill the wheel to restore the necessary tread and flange contour. Wheels should be removed from service and scrapped when 3 inches (76.2 mm) of material on the wheel diameter has worn off or when the rim thickness has decreased to 1 inch (25.4 mm). Ensure that the surface finish on reworked wheel flanges does not exceed 250 µin. (6.35 µm). This is important because a wheel with a rough flange surface tends to climb the rail. Refer to the WHEEL

AND AXLE manual, published by the Association of American Railroads, for further details on wheel wear tolerances and wheel turning practices.

**Screen 32:**

**Wheel Inspection and Maintenance:**

To measure wheel diameter, flange thickness, and flange height, use a wheel gauge. The wheel diameter is measured by reading the scale on the long arm of the gauge in relation to the top of the witness mark on the wheel using a conversion chart. Each mark on the scale is a one-eighth inch increase in wheel diameter. The flange thickness is measured by reading the scale on the pivot arm in relation to the 0 mark on the stationary arm. The mark on the pivot is used to determine the thickness. The flange height is measured by reading the scale on the pivot arm in relation to the marks on the bend of the gauge. The zero mark on the pivot is used to determine the height.

**Screen 33:**

**Lateral Liner Inspection:**

The lateral liners, with two liners per axle bearing housing, provide a wear surface between the axle bearing housing and the truck frame. The axle bearing housings move vertically between the lateral nylon liners. These liners float laterally on retaining bolts that are inserted into the truck frame. Using a step gauge or equivalent, measure the clearances between the lateral liners and the bearing housing tee. Ensure that the axles are aligned straight. If the lateral liner clearances exceed the maximum worn limits, replace the liners.

**Note:** The center axle has a wider clearance than the end axles. To reduce clearances, the end axles have a spacer between the truck frame and the outboard lateral liner. When replacing the lateral liner, ensure that the spacer is not placed between the liner and the tee. The wear item will always be the lateral liner.

**Screen 34:**

**Lateral Liner Replacement:**

Typical steps to replace the lateral liners are as follows:

1. At the pin retainer assembly, remove the bolts, the hardened washers, and the journal box retainer pin from the truck frame, then save the hardware for re-assembly.
2. Remove both journal box retainer pins.

**Note:** The end journal box tee pins are shorter than the center tee bolts. Do not mix them.

3. The liners should fall out but, if not, remove them with an appropriate tool.

**Note:** A hydraulic ram may be used to laterally remove the motor combo.

4. Position the new liners in place and return the correct tee bolts.

**Note:** The lateral liners on each end axle are similar on the inboard and outboard sides. The liners on the central axles are different. Do not mix them.

5. Re-install the pin retainer assembly, with the raised portion toward the truck frame, and fasten using the previously saved hardware.
6. Torque the retainer assembly bolts to  $58 \pm 3$  lb.-ft. ( $80 \pm 5$  Nm).

### **Screen 37:**

#### **Brake Shoe and Rigging Inspection:**

Working together, the brake cylinders, brake rigging, and brake shoes apply a stopping force to the wheels. The brake shoes are a high-wear item and need to be inspected on a regular schedule. This schedule varies from railroad to railroad and is based on FRA requirements.

**Caution:** Do not lubricate brake rigging pins, bushings, or wear plates. Grease or oil on exposed wear surfaces collect sand, dirt and grit, causing wear surfaces to wear faster.

**Note:** Ensure that the locomotive is on a straight, flat track before any inspection, adjustment, or replacement is made.

Inspect adjustment and condition of the brake rigging components as follows and make adjustments and repairs as required:

- Periodically check all brake shoes for wear. If the brake pad thickness is worn to less than 0.5 inches (13 mm) at any point, replace the brake shoe.
- Ensure that the brake shoes are not binding against the wheel thread surface or flange. If they are, correct this condition.
- Verify that the brake hangers are not causing misalignment of the brake shoe. Repair or replace rigging parts as needed to restore proper brake shoe alignment.

### **Screen 38:**

#### **Brake Shoe and Rigging Inspection (Cont'd):**

- Inspect brake linkage for missing, broken, or loose parts. Also, inspect for badly worn pins, bushings, or wear plates. Repair or replace parts, as necessary.
- Check the brake rigging wear plates on the hangers and the truck frame pads. Replace wear plates when the working clearance between the wear plate and the mating wear surface exceeds 0.19 inches (4.8 mm).
- Check the clearance between brake shoes and wheels. If clearance is more than 0.75 inches (19 mm), readjust the brake system as discussed in the Brake System Adjustment section of this module.

**Note:** The 0.75 inch (19 mm) clearance is needed to ensure that the brake shoes do not ride on the wheels while the truck is steering through curves.

**Note:** The maximum allowable brake-cylinder piston-rod travel is 6.5 inches (165 mm).



- Check the brake cylinder piston-rod travel that is required to engage the brake. If the piston-rod travel is 6.5 inches (165 mm) or more, readjust the brake system as discussed in the Brake System Adjustment section of this module.

### **Screen 39:**

#### **Brake Shoe Replacement:**

Typical steps to replace a brake shoe are as follows:

**Note:** Ensure that the locomotive is on a straight, flat track before any adjustment or replacement is made.

1. Chock at least two sets of truck wheels to prevent the locomotive from rolling in either direction.
2. Release the hand brake, if set, and allow time for the truck wheels to seat against the wheel chocks.

**Warning:** Ensure that the truck wheels are chocked and the hand brake is released before cutting out the air to the truck that you are going to work on. Make sure that you only cut out one truck at a time. Unexpected motion can occur if the wheels are not chocked, if the hand brake is set when brake air is released, or if the air is cut off to both trucks at the same time. Unexpected rolling of the locomotive can cause serious injury or death.

3. With the locomotive secure, locate and close the truck air cut-out cock on the underside of the locomotive frame.

**Note:** Close only the truck cut-out cock for the truck being worked on and exhaust air from the brake cylinders of that truck.

4. Move the brake shoe as far as possible from the wheel tread, then remove the retaining key and worn brake shoe from the brake head.

**Note:** Temporary removal of a pin is very helpful sometimes in securing adequate clearance. Also, the middle axle brake shoe retaining keys are installed from below for ease of maintenance.

### **Screen 40:**

#### **Brake Shoe Replacement (Cont'd):**

**Caution:** Brake shoes and the linkage design are matched for proper braking according to locomotive weight. Do not replace composition type brake shoes with cast iron shoes. Failure to use the proper replacement shoes may result in over-braking, under-braking, or an unbalanced braking condition.

5. Install a new shoe in the brake head, line-up the keyway, and then drive the retaining key to seat tight in the keyway.

6. Check the brake shoe for a tight fit in the brake head.

**Note:** If the shoe is loose with the key tight in the keyway, the brake head is probably worn and should be replaced.

**Note:** Newly installed brake shoes must hang true in the brake head. Brake head pins must be snug enough to keep the top end of the brake shoe from flopping onto the wheel, but loose enough to allow the shoe to conform to the wheel surface. The wheels should be free to move up and down in relation to the truck frame and the brake shoes.

7. Adjust the manual slack adjuster as required, then reinstall any pins that were removed and lock them into place.
8. Open the truck air cut-out cock.

#### **Screen 41:**

##### **Brake System Adjustment:**

Typical steps to adjust the brake system are as follows:

**Note:** Ensure that the locomotive is on a straight, flat track before any adjustment or replacement is made.

1. Chock at least two sets of truck wheels to prevent the locomotive from rolling in either direction.
2. Release the hand brake, if set, and allow time for the truck wheels to seat against the wheel chocks.

**Warning:** Ensure that the truck wheels are chocked and the hand brake is released before cutting out the air to the truck that you are going to work on. Make sure that you only cut out one truck at a time. Unexpected motion can occur if the wheels are not chocked, if the hand brake is set when brake air is released, or if the air is cut off to both trucks at the same time. Unexpected rolling of the locomotive can cause serious injury or death.

3. With the locomotive secure, locate and close the truck air cut-out cock on the underside of the locomotive frame.

**Note:** Close only the truck cut-out cock for the truck being worked on and exhaust air from the brake cylinders of that truck. If necessary, push the brake-cylinder piston rods back into the air brake cylinders.

4. To adjust the brake system, lift and rotate the pin retainer and remove the slack adjuster pin.

**Warning:** Do not set the slack adjuster pin in the fully extended position as doing so may cause the slack adjuster to buckle and the brake to fail.

## **Screen 42:**

### **Brake System Adjustment (Cont'd):**

**Caution:** When adjusting the tandem brake slack adjuster, ensure that there is no more than one pin hole difference between the slack adjuster settings on opposite sides of the truck. If the slack adjuster settings differ by more than the length of one pin hole, the chocked brake linkage may shorten the usable life of brake components.

5. With the piston rod fully retracted, adjust the slack adjuster to provide a minimum clearance of 0.75 inches (19 mm) between the brake shoe and the wheel.

**Note:** If adjusting tandem brakes, ensure that the slack adjusters on the opposite side of the truck are pinned to the same length, plus or minus the length of one pin hole. If settings differ by the length of two or more pin holes, replace worn shoes or linkage parts to balance out the slack adjuster settings.

6. Replace the slack adjuster pin and rotate the pin retainer in place over the pin.

**Note:** If a slack adjuster is near the adjustment limit, check for excessively worn brake shoes or brake linkage components. Replace worn or damaged parts as needed.

7. Check adjustments and the brake clearance at all other truck wheels.

**Warning:** When adjusting the brakes, check the cylinder piston rod travel required to apply the brakes. Brake cylinder piston rod travel must not exceed 6.5 inches (165 mm). Piston rod travel beyond 6.5 inches (165 mm) may cause inadequate braking force against the wheels.

8. Open the truck air cut-out cock to supply air pressure to the brake system, then check for proper operation of the adjusted air brakes.

## **Screen 43:**

### **AC Traction Motor Nose Suspension Inspection:**

The traction motor nose suspension provides support for the traction motor between the motor and the truck frame. Inspect each suspension assembly for defective rubber mounting bushings. If the mounting bushings are worn, the bushing rubber is extruded from the cast link, or appears damaged in any way, replace the suspension assembly. Also, check for loose or missing mounting hardware.

**Caution:** The suspension link is disconnected by cutting the CAMCAR bolts with a torch, a hydraulic splitter, or a removal socket. If a torch is used, form a shield to protect the rubber parts of the suspension link from heat damage, and use extreme care. Do not reuse the bolts, washers, or nuts.

**Caution:** Do not replace CAMCAR bolts and nuts with ordinary fastener bolts and nuts. Bolts and nuts may loosen during locomotive operation, and cause the traction motor to fail and/or cause other equipment damage. Refer to the applicable Parts Bulletin for recommended replacement parts.

#### **Screen 44:**

##### **Side Bearer Inspection:**

The rubber side bearers consist of alternate layers of steel laminations and rubber which are bonded together. The side bearers transmit the weight of the locomotive to the trucks, while permitting controlled lateral motion of the trucks relative to the locomotive platform. Inspect the side bearers as follows:

- Ensure that the side bearer is centered under the locomotive side bearer pad.
- Inspect for evidence of motion between the side bearer and the locomotive side bearer pad.
- Inspect the side bearers for extreme wear or severe separation of rubber and steel laminations.
- Replace any defective or displaced side bearers. Contact a Field Service representative for correct defective side bearer replacement procedures.

#### **Screen 47:**

##### **Traction Pad Inspection:**

The rubber traction pads consist of alternate layers of steel and rubber bonded together. The pads transmit the tractive effort from the truck to the locomotive and permit controlled lateral motion of the truck relative to the locomotive platform. Inspect the traction pads as follows:

- Ensure that the pads are seated in the truck frame and properly retained. In a proper installation, the pads are compressed by approximately 0.62 inches (15.7 mm), and the rubber is bulged upward by approximately 0.125 - 0.5 inches (3.18 - 12.70 mm).
- Inspect the traction pads for extreme wear or severe separation of the rubber and steel laminations.

**Note:** Cracks or unbonded rubber indicate that the pad needs to be replaced.

- Replace any defective or displaced traction pads as directed in the Backshop Manual.

#### **Screen 48:**

##### **Visual Inspection of the Dampers:**

When visually inspecting the dampers, note the following:

- Dirt and oil: Rail operations expose locomotive dampers to dirt, oil, and particulates from outside sources. The accumulation covering the outer surface of the damper is normal and has no adverse effects on the damper's performance. The damper's dust cover and rubber bellow protect the piston rod and rod seals.
- Oil leakage: New locomotive dampers will show oil loss during the first service period and, as a result, are suspected of leakage. In most cases, this is assembly lubricant, which has nothing to do with oil leakage.

#### **Screen 49:**

##### **Visual Inspection of the Dampers (Cont'd):**

- Assembly oil: Several different lubricants and fluids are used in the construction of locomotive dampers. Assembly oils or greases are yellow, black, or white in color, and can be easily distinguished from the red hydraulic damping fluid. When the damper is new, the assembly lubricant may cause a slightly moist rod or body. If this occurs, simply wipe off the excess oil and return the damper to service. If a new damper has red oil droplets, the damper should not be installed.
- Sweating: For a long service life, it is necessary for the rod oil seal to remain lubricated. The continuous inward and outward movement of the piston rod may cause oil "sweat" from the rod oil seal. This loss of oil can be recognized by the outside of the damper being slightly moist and dirty. A slight oil sweating will not affect the damping force and the damper may remain in service.
- Droplets: If red droplets of oil are clearly formed or the damper body is wet with hydraulic fluid, the damper must be replaced.

#### **Screen 50:**

##### **Visual Inspection of the Lateral and Yaw Dampers:**

The lateral and yaw dampers dampen unwanted movement and vibrations between the truck and the locomotive platform. There are two lateral and two yaw dampers per truck.

**Note:** The lateral and yaw hydraulic dampers are sealed by the manufacturer and cannot be refilled with fluid. Leaky dampers must be replaced.

#### **Screen 51:**

##### **Visual Inspection of the Lateral and Yaw Dampers (Cont'd):**

Inspect each lateral and yaw hydraulic damper for leakage or defective rubber mounting bushings. A light film of hydraulic fluid on the body is normal. If the body is wet with fluid, the mounting bushings are worn, or bindings are badly eroded or missing, replace the lateral damper.

**Note:** Refer to the applicable Parts Bulletin for the recommended replacement part number. Also, some damper manufacturers require the damper bottom end to be at a minimum of 2° below the top end for effective operation. These manufacturers mark this bottom position as "BELOW."

Ensure that "BELOW", stamped onto the body, is on the bottom side of the lowest end of the damper. If "BELOW" is at the 12 o'clock or top position, unbolt the small end of the damper and rotate the end by 180°. If it is at any other position, remove and replace the damper.

#### **Screen 52:**

##### **Vertical Hydraulic Dampers Inspection:**

The four vertical hydraulic dampers, mounted between the truck frame and the axle bearing housing, provide damping forces as a result of vertical and lateral motions between axles and the truck frame.

**Note:** The vertical hydraulic dampers are sealed by the manufacturer and cannot be refilled with fluid. Leaky vertical hydraulic dampers must be replaced. Inspect each vertical hydraulic damper for leakage or defective rubber mounting bushings.

Typical steps to inspect the vertical hydraulic dampers are as follows:

**Caution:** If one vertical hydraulic damper is found to be defective, replace both dampers on that axle as a matched set. Use only the recommended dampers on the truck to ensure a proper match with the locomotive load conditions. Replacement of only one damper or failure to use the recommended replacement dampers will create an incorrect damping condition, and may shorten the usable life of the dampers, the springs, and other load supporting the components.

1. Clean the lower body of the primary damper.
2. Visually inspect the lower body for clearly formed droplets of hydraulic fluid.
3. Clean all the dampers around the locomotive and return to the first one to begin inspection.
4. Inspect the damper mounting bushings for wear, binding, badly eroded or missing parts.
5. Inspect the structure for cracks, missing sections, or severe beating.

#### **Screen 53:**

##### **Vertical Hydraulic Dampers Replacement Criteria:**

**Note:** Normal damper operation results in a light film of hydraulic fluid on the lower body of the damper. A light film, which is not a droplet, is acceptable.

Replace the vertical hydraulic dampers, if any of the following are found during the visual inspection:

- Droplets of hydraulic fluid formed at the lower body.
- Signs of wearing, binding, or badly eroded bushings.
- Broken parts.

**Screen 54:****Vertical Hydraulic Damper Replacement:**

Typical steps to replace the vertical hydraulic dampers on the axle are as follows:

1. Remove all four bolts and washers from each set of damper mounting blocks.
2. Remove and discard both used vertical hydraulic dampers.
3. Install new dampers.

**Note:** Refer to the applicable Parts Bulletin for recommended replacement part number.

**Note:** Mating surfaces and threads of dampers must be clean and free of any oil.

4. Reinstall the bolts and washers on each set of damper mounting blocks, then torque the bolts to  $312 \pm 16$  lb.-ft. ( $422 \pm 22$  Nm).

**Screen 55:****Coil Springs: Inspection and Replacement:**

The coil springs transfer the weight of the locomotive to the wheel and axle assembly, dampen vertical forces, and improve ride quality. There are twelve coil-compression springs, one spring located on each side of each journal bearing housing.

**Note:** Removal of the coil springs requires disassembly of the steering arrangement. Obtain the correct procedures from a Field Service representative. For purposes of visual inspection, raise the weight of the locomotive and the truck from the axles to expose the springs for viewing.

Visually inspect the spring coils for breaks, cracks, vertical wear flats, deep nicks, gouges, or other signs of spring damage. If visible damage to the spring coils indicates that the useful life or performance of the springs may be limited, replace the springs.

**Screen 56:****Equalizer Bar Damper Inspection:**

The equalizer bar damper, attached between the equalizer bar damper support and the truck frame, reduces vibration induced by the steerable arrangement in a lateral direction.

Typical steps to inspect the equalizer bar damper are as follows:

1. Clean the lower body.
2. Clean all the dampers around the locomotive and return to the first one to begin inspection.
3. Perform a visual inspection of the lower body for clearly formed droplets of hydraulic fluid.
4. Inspect damper mounting bushings for wear, binding, badly eroded, or missing parts.
5. Inspect the structure for cracks, missing sections, or severe beating.

**Screen 57:****Equalizer Bar Damper Replacement Criteria:**

**Note:** Normal damper operation results in a light film of hydraulic fluid on the lower body of the damper. A light film, which is not a droplet, is acceptable.

Replace the equalizer bar dampers, if any of the following are found during the visual inspection:

- Droplets of hydraulic fluid formed at the lower body.
- Signs of wearing, binding, or badly eroded bushings.
- Broken parts.

**Screen 58:****Equalizer Bar Damper Replacement:**

Typical steps to replace the equalizer bar damper on the axle are as follows:

1. Remove the four bolts, nuts, and washers attaching the equalizer bar damper to the equalizer bar damper support bracket and the truck frame.
2. Remove and discard the equalizer bar damper.
3. Install a new damper.

**Note:** Refer to the applicable Parts Bulletin for the recommended replacement part number.

**Note:** Mating surfaces and threads of dampers must be clean and free of any oil.

4. Orient the damper correctly by ensuring that the larger diameter upper body of the damper is toward the equalizer bar damper support bracket and the smaller diameter lower body is toward the truck frame casting.
5. Ensure that "BELOW" is stamped on the bottom side of the lowest end of the damper.

**Note:** If "BELOW" is at the 12 o'clock or the top position, unbolt the small end of the damper and rotate the end by 180°. If it is in any other position, remove and replace the damper.

6. Reinstall the four bolts, nuts, and washers connecting the equalizer bar damper to the damper support bracket and the truck frame damper mounting block, then torque the mounting bolts to  $755 \pm 40$  lb.-ft. ( $1022 \pm 55$  Nm).

**Screen 59:****Bell Crank Assembly Inspection:**

Inspect the bell crank assembly for minimum clearance between the bell crank and the traction cap. Use a feeler gauge to check that there is a minimum clearance of 0.06 inches (1.5 mm) between the bell crank and the traction cap. If the clearance is less than



0.06 inches (1.5 mm), the thrust washers might be defective. Note that there are two thrust washers in the bell crank assembly, one is inside the retainer lower bearing and the other is outside of the retainer lower bearing.

**Screen 60:**

**Bell Crank Assembly Inspection: Thrust Washer Replacement:**

Typical steps to replace the thrust washer are as follows:

1. Remove the retainer thrust washer and spacer by unscrewing the four bolts and save the hardware for re-installation.
2. Remove and discard the first thrust washer.

**Note:** Do not discard the spacer. Save it for re-installation.

3. Remove the four bolts and washers from the retainer lower bearing cap and save the hardware for re-installation.
4. Replace the second thrust washer with a new thrust washer.

**Screen 61:**

**Bell Crank Assembly Inspection: Thrust Washer Replacement (Cont'd):**

5. Install the retainer lower bearing cap and the four washers and the four bolts on opposite corners, then torque the bolts to  $88 \pm 5$  lb.-ft. ( $40 \pm 2.3$  Nm).
6. Install a new thrust washer on top of the retainer lower bearing cap.
7. Install the thrust washer spacer in the center of the thrust washer.

**Note:** Ensure that both the washers are concentric.

8. Install the thrust washer retainer on top of the thrust washer spacer using four washers and four bolts, then torque the bolts to  $58 \pm 3$  lb.-ft. ( $26 \pm 1.4$  Nm).

**Screen 62:**

**Visual Inspection of the Traction Link and the Center Link:**

Visually inspect the traction link and the center link for missing nuts and bolts. Apply new fasteners if they are missing.

**Screen 63:**

**Visual Inspection of the Wing Plate Assembly:**

Typical steps to inspect the wing plate assembly are as follows:

1. Visually inspect for missing hardware fastened on links.
2. Visually inspect wing plate shear pads and rubber bushings for cracks or delamination of the bonded rubber and metal.

**Note:** No unbonded rubber or cracks are acceptable.

3. Inspect the wing plate pins for indications of wear and/or clearance.

**Note:** Pins are designed to be press fit into the reaction arm and the wing plate.

4. Ensure that the shear pad is properly seated in the wing plate, the reaction arm, and the reaction arm cover.

#### **Screen 64:**

##### **Visual Inspection of the Equalizer Arm and the Equalizer Bar:**

Typical steps to inspect the equalizer arm and equalizer bar are as follows:

1. Check the match marks on the equalizer arm to verify that the arm has NOT moved relative to the bell crank.

**Note:** Replace the equalizer arm if it has moved.

2. Visually inspect the equalizer bar rubber bushing for swelling, delamination, and wear.

**Caution:** Do not contaminate the rubber bushing with oil, paint, or grease.

3. Visually inspect the equalizer bar for any signs of wear or cracking.
4. Visually inspect the equalizer bar for missing nuts and bolts and apply new fasteners, if missing.

#### **Screen 65:**

##### **Equalizer Bar Replacement:**

Typical steps to replace the equalizer bar are as follows:

**Warning:** Ensure that the truck wheels are chocked and then release the hand brake before cutting out the brake cylinder air. Also, cut out the air to only one truck at a time. Unexpected motion can occur if the wheels are not chocked, or if the hand brake is set when the brake air is released, or if the air is cut off to both trucks at the same time. Unexpected rolling of the locomotive can cause serious personal injuries or death.

**Warning:** Ensure that the cut-out cock of the truck that is being worked is closed to eliminate air braking force.

**Warning:** To avoid pinching, be careful not to put fingers between parts.

1. Remove the equalizer bar assembly as follows:
  - a. Remove the bolts, nuts, and washers connecting the equalizer bar damper and the damper support bracket on the equalizer bar and retain the hardware for re-installation.

- b. Remove the two bolts, nuts, and washers connecting the equalizer bar and the equalizer arms and retain the hardware for re-installation.

**Warning:** Use an appropriate lifting device to handle the equalizer bar assembly that weighs approximately 160 lbs. (73 kg).

- c. Slide out the equalizer bar assembly.

#### **Screen 66:**

##### **Equalizer Bar Replacement (Cont'd):**

2. Dismantle the equalizer bar assembly as follows:
  - a. When the equalizer bar assembly is out of the truck frame, remove the damper support bracket from the equalizer bar by removing the three bracket mounting bolts, nuts, and washers.
  - b. Save the hardware and the damper support bracket for re-installation.
  - c. Save the equalizer bar for repair.
3. Assemble the subassembly by using a new equalizer bar and re-using the damper support bracket and mounting hardware.
4. Connect the damper support bracket to the new equalizer bar, then torque the three bracket mounting bolts to  $755 \pm 40$  lb.-ft. ( $1022 \pm 54$  Nm).

#### **Screen 67:**

##### **Equalizer Bar Replacement (Cont'd):**

5. Install the equalizer bar assembly as follows:

**Warning:** Use an appropriate lifting device to handle the equalizer bar assembly that weighs approximately 160 lb (73 kg).

- a. Slide the equalizer bar assembly between the truck and the platform.
- b. Connect the equalizer bar damper support bracket with the damper, then torque the two damper mounting bolts to  $175 \pm 10$  lb.-ft. ( $237 \pm 14$  Nm).
- c. Connect the equalizer bar assembly to the equalizer arms, then torque the two connecting bolts to  $312 \pm 16$  lb.-ft. ( $423 \pm 22$  Nm).

**Note:** A pinch bar might be needed to align the equalizer arm with the equalizer bar.

#### **Screen 68:**

##### **Safety Hook Inspection and Replacement:**

Safety hooks, located on each side of both trucks, ensure that the truck does not become separated from the locomotive in the event of derailment. Inspect the safety hooks for proper clearances. If the safety hooks do not meet clearances, identify and replace the defective hooks. Obtain the correct replacement procedure from a Field Service representative.

## **Screen 71:**

### **Steerable Truck Removal:**

Typical steps to remove the steerable truck from under the locomotive are as follows:

**Note:** Ensure that the locomotive is on a straight track before any adjustment or replacements are made.

1. Chock at least two sets of truck wheels on both trucks to prevent the locomotive from rolling in either direction.
2. Release the hand brake, if set, and allow time for the truck wheels to seat against the wheel chocks.

**Warning:** To eliminate air braking force, ensure that the cut-out cock of the truck that is being worked is closed.

**Warning:** Ensure that the truck wheels are chocked and release the hand brake before cutting out the brake cylinder air. Ensure that air is cut out to only one truck at a time. Unexpected motion can occur if the wheels are not chocked, if the hand brake is set when brake air is released, or if the air is cut off to both trucks at one time. Unexpected rolling of the locomotive can cause serious injury or death.

**Warning:** Follow all Railroad Operating Procedures governing compressed air and air lines.

3. With the locomotive secure, locate and close the truck air cut-out cock on the underside of the locomotive frame.

**Note:** Close only the truck cut-out cock for the truck being removed. Disconnect the hose to the brake cylinders of that truck only after all air has been exhausted from the truck air lines.

## **Screen 72:**

### **Steerable Truck Removal (Cont'd):**

**Warning:** For AC locomotives, capacitors in the inverter circuits may not be fully discharged and lethal voltages may exist. Before entering the auxiliary cab, raise and lock the barrier bar in the vertical position by securing a padlock in the supplied hole. Wait until the LEDs on the Common Power Indicator (CPI) are extinguished before entering. If the LEDs do not go off, then run the Crank Transfer Switch (CTS) self-test and move the CTS into the CENTER or propulsion position. If the LEDs remain lit, open the battery switch located in CA1 and verify that the LEDs on the CPI panel are extinguished.

4. For each traction motor, disconnect the traction motor leads, ground cable, and speed sensor cable and, if equipped, the hot bearing detector probe on the U-tube.
5. Disconnect the ground cable between the truck and the platform.

6. Disconnect the traction motor air ducts from the top of the traction motors.
7. If an axle alternator is installed on the truck being removed, disconnect the alternator cable from the junction box on the alternator, then coil and secure the cable so it will not be damaged.
8. Disconnect all sander hoses from the sander brackets on the truck.

#### **Screen 73:**

##### **Steerable Truck Removal (Cont'd):**

9. Disconnect the hoses for the flange lubricators if used, and cover the opening to prevent the entry of foreign materials.
10. Disconnect the hand brake chain if the long-hood end truck is being removed.
11. Remove the lateral and yaw dampers from the platform and save the hardware.
12. Remove both safety hooks from the truck frame, mark as right or left, and save the hardware.

**Warning:** The locomotive weighs approximately 440,000 lbs. (199581 kg) and the truck weighs approximately 62,000 lbs. (28123 kg). Ensure that the lifting or jacking device is adequate.

13. Raise the locomotive platform clear of the truck with jacks or a crane, or lower the truck on a drop table.

**Note:** Ensure that the cables, air ducts, and hoses are not damaged. If the truck is to be pulled out sideways, the locomotive platform must be raised, or the truck lowered, at least 10 inches (254 mm).

14. After the truck is removed from under the locomotive, cover the truck center pin bearing and traction motor openings to prevent contamination with dirt and other foreign materials.

#### **Screen 74:**

##### **Steerable Truck Installation:**

Typical steps to install the steerable truck under the locomotive are as follows:

1. Space the trucks for a truck center-block to center-block spacing of 50 feet and 4.24 inches (15.3477 m).

**Note:** When installed on the locomotive, the transom ends of the trucks must face each other.

2. Remove the temporary dust covers from the traction motor air duct and center pin bearing openings.
3. Inspect the traction motor air ducts between the locomotive platform and the truck and replace any air ducts that are cracked or torn.

4. Coat the center pin on the underside of the locomotive platform with grease before lowering the platform onto the truck.

**Warning:** The locomotive weighs approximately 440,000 lbs. (199581 kg) and the truck weighs approximately 62,000 lbs. (28123 kg). Ensure that the lifting or jacking device is adequate.

5. Lower the platform onto the truck or raise the truck on the drop table.

**Note:** Carefully mate the center pin with the center pin bearing. Ensure that the two tongs on top of each of the four side bearers per truck register properly in the locomotive platform.

6. Check and align the trucks, if required.
7. Install both safety hooks to the correct sides on the truck frame and torque the bolts to  $208 \pm 11$  lb.-ft. ( $282 \pm 15$  Nm).

#### **Screen 75:**

##### **Steerable Truck Installation (Cont'd):**

8. Install the lateral dampers to the platform, with the shorter bolt at the bottom, and torque the bolts to  $118 \pm 6$  lb.-ft. ( $160 \pm 8$  Nm).

**Note:** Ensure that "BELOW" stamped onto the body is on the bottom side of the lowest end of the damper.

9. Install the yaw dampers to the platform and torque the bolts to  $208 \pm 11$  lb.-ft. ( $282 \pm 15$  Nm).

**Note:** Ensure that "BELOW" stamped onto the body is on the bottom side of the lowest end of the damper.

10. If installing the long-hood end truck, connect the hand brake chain.
11. Install the hoses from the sand pipes on the platform to the sander brackets on the trucks and install the hoses for flange lubricators, if used.
12. Connect the axle alternator cable to the junction box on the alternator, if used.
13. Install the traction motor air duct to each of the traction motors and torque the bolts to  $58 \pm 3$  lb.-ft. ( $80 \pm 5$  Nm).
14. Connect the ground cable between the truck and the platform.

#### **Screen 76:**

##### **Steerable Truck Installation (Cont'd):**

**Warning:** For AC locomotives, capacitors in the inverter circuits may not be fully discharged and lethal voltages may exist. Before entering the auxiliary cab, raise and lock the barrier bar in the vertical position by securing a padlock in the supplied hole. Wait until

the LEDs on the Common Power Indicator (CPI) are extinguished before entering. If the LEDs do not go off, then run the Crank Transfer Switch (CTS) self-test and move the CTS into the CENTER or propulsion position. If the LEDs remain lit, open the battery switch located in CA1 and verify that the LEDs on the CPI panel are extinguished.

15. For each traction motor, connect the speed sensor cable, ground cable, and traction motor leads, and, if equipped, the hot bearing detection probe on the U-tube.
16. Connect the air brake hoses from the locomotive platform to the brake cylinder piping on the truck.
17. Verify that the truck cut-out cocks located under the platform are open before returning the locomotive to service.
18. Adjust the truck brake rigging.
19. Ensure that the journal bearing housings, traction motor gear cases, and traction motor support bearings have been lubricated before moving the locomotive.
20. Check the traction motor rotation.

#### **Screen 77:**

##### **Truck Alignment Verification:**

Truck alignment is required if any of the following components have been replaced:

- Traction motor assembly
- Dog bone motor nose suspension
- Inter-motor link (A-frame) assembly
- U-tube cover
- Equalizer arm
- Long bell crank
- Any bell crank bearing
- Three or more steering components

To ensure that the steerable truck is in proper alignment for operation, verify that the truck is properly aligned and check the lateral alignment of the wheel.

#### **Screen 78:**

##### **Truck Alignment Verification (Cont'd):**

Typical steps to verify truck alignment are as follows:

1. Ensure that the locomotive is on a straight, level track.
2. Release the brakes on the truck being aligned by closing the truck air brake cut-out cock and bleeding air from the brake cylinders.
3. Check the axle distance between the center and each end axle.

**Note:** Measure from the bearing seat vertical machined surface, just above the bottom cap, to the same location on the adjacent bearing housing. Ensure that the measurement is taken on the same side of the bearing housing; left side to left side, right side to right side. Take measurements on both sides of the truck. Axle center distances should be as follows:

**Note:** Because of the steering linkages, moving one wheel will move the wheels at the opposite ends of the truck.

**Screen 79:**

**Wheel Lateral Alignment Verification:**

Typical steps to check the wheel lateral alignment are as follows:

1. Align the end axle wheels with the truck frame as follows:
  - a. Install 5.125 inch (13.018 cm) blocks to the journal box tees on the non-gearcase side of both end axles.

**Note:** This provides the distance between the outside face of the journal box tee and the machined face of the truck frame between both retainer pins.

- b. Install airbags between the truck frame and the wheel on the non-gearcase side of the end wheel sets, then apply air to the airbags and move each wheel set until there is contact between the blocks and the truck frame.
2. Use wedges to block the end axles in respect to the frame and remove the airbags from the end axles.

**Screen 80:**

**Wheel Lateral Alignment Verification (Cont'd):**

3. Align the center axle wheels with the end axle wheels as follows:
  - a. Use a long straight edge or a wire stretched tight against the backside face of the non-gearcase wheels of both the end axles.

**Note:** The backside face of the wheel is the face near the wheel flange. Do not use the outside face.

- b. Use airbags to align the center axle wheel with the straight edge or wire.

**Note:** The deviation between the straight edge or wire and the exact location of the center axle wheel should not exceed 0.06 inches (0.15 cm) in either direction.

4. If the center axle wheel is not aligned with the straight edge or wire, loosen the CAMCAR bolt connections on the two inter-motor links at traction motor positions 1, 2, 5, and 6 to allow the center axle to be laterally aligned.

**Note:** There are two inter-motor links (A-frames) per truck. One side of each A-frame is connected to a suspension link (dog bone) and traction motor by two CAMCAR bolts.

5. If the CAMCAR bolts are not already loosened and hand-tightened, remove and install new CAMCAR bolts one at a time.



**Caution:** The CAMCAR bolts are removed by cutting the CAMCAR bolts with a torch or hydraulic splitter. If a torch is used, protect the rubber parts of the suspension link from heat damage.

6. Hand-tighten the nuts and tag the bolts as loose, then repeat steps 3a and 3b.

### **Screen 83:**

#### **Summary:**

You have reached the end of this module!

In this module, you learned to:

- State the purpose and location of the steerable trucks.
  - The three-axle G1 model steerable truck is a three-motor, three-axle, high-adhesion, steerable type truck designed to carry one-half the weight of the locomotive.
  - The entire locomotive is supported by two steerable trucks, commonly called the front truck and the rear truck. These truck assemblies are located directly underneath the locomotive platform. Each steerable truck, designed to carry one-half of the weight of the locomotive, has three axles that are individually powered by traction motors.
  - The steerable trucks distribute the locomotive weight equally over the axles, and transfer the tractive effort or pulling force, and braking effort or stopping force, from the locomotive to the rails.
- Describe the major components of a steerable truck.
  - The truck frame is the backbone and foundation for the steerable truck assembly. It is a C-shaped steel casting that provides the mounting for all of the steerable truck's components.
  - The wheels transfer the torque generated by the traction motor and apply it to the rails. The wheels are designed to keep the locomotive on the rails.
  - The lateral liners, two per axle bearing housing, provide a wear surface between the axle bearing housing and the truck frame.
  - Working together, the brake cylinders, brake rigging, and brake shoes apply stopping force to the wheels.
  - The traction motor nose suspension, also referred to as the dog bone or suspension link, provides support for the traction motor between the motor and the truck frame.
  - The rubber side bearers, also referred to as loadbearers, consist of alternate layers of steel laminations and rubber, which are bonded together. The side bearers, mounted on the topside of the truck, transmit the locomotive weight to the trucks, while permitting controlled lateral motion of the trucks relative to the locomotive platform.

- The rubber traction pads, consisting of alternate layers of steel and rubber that are bonded together, function to transmit the tractive effort from the truck to the locomotive, while permitting controlled lateral motion of the trucks relative to the locomotive platform. The traction pads also absorb the shock between the center pin bearing assembly and the truck frame during acceleration and braking.
- A center pin, located on the underside of the locomotive platform, fits into a center pin bearing assembly mounted in the truck frame. The center pin is welded to the underside of the platform and mates with the truck by way of the center block. The bearing assembly and the center pin allow the truck to pivot with respect to the locomotive platform and transmit the tractive force from the truck to the locomotive platform.
- The lateral and yaw dampers are used to dampen unwanted movement and vibrations between the truck and the locomotive platform. There are two lateral and two yaw dampers per truck.
- There are four primary or vertical dampers on a steerable truck. The primary dampers are used to dampen unwanted movement and vibrations between the wheel axle assembly and the truck.
- The coil springs transfer the weight of the locomotive to the wheel and axle assembly, dampen vertical forces, and improve ride quality. There are twelve coil-compression springs, one spring located on each side of each journal bearing housing.
- Safety hooks ensure that the truck does not become separated from the locomotive. They are located on both sides of each truck frame.
- The steering assembly is a series of mechanical linkages that cause the axles to adjust to the curvature of the track. There are several components that make up the steering assembly.
  - The equalizer bar, also referred to as a “Marty” bar, and equalizer arms are attached to the open end of the bell cranks. The equalizer arms are heat-shrink fitted to the top of the bell cranks. The equalizer bar is attached to the equalizer arms by a close tolerance hardened pin with hardened bushings.
  - The bell crank is a vertically oriented shaft that rotates within the truck frame through two rubber laminated bearings. The bell crank permits the traction motor combination yaw rotation to be transmitted to the externally mounted reaction arms.
  - G1 steerable trucks have an equalizer bar damper attached between the steering arrangement and the truck frame. The damper reduces vibration induced by the steerable arrangement in the lateral direction.
  - Reaction arms and wing plate assembly arrangement helps to ensure that the two axles are acting in equal and opposite direction. As the end axles rotate in equal and opposite direction in yaw, the reaction arms rotate relatively. The wing plate assembly will displace inward or outward relative to the truck frame depending upon the direction of steering.

- The traction link and the center link transmit and react to the tractive, braking, and steering forces from the wheel set journal box to the truck frame. Links are connected to the axle bearing housing, also known as the journal box. The other ends are attached to the truck frame through a smaller casting called a traction cap.

#### **Screen 84:**

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

- Describe the basic operation of a steerable truck.
  - The 3-axled steerable truck has a series of steering linkages that force the first and third axles in equal and opposite directions, while the second axle moves laterally, towards the outside of the curve. Each set of wheels is powered by its own traction motor.
  - The truck frame is supported by coil springs with primary dampers, which dampen vertical spring oscillations.
  - A center pin and center pin bearing assembly transmit the tractive force from the truck to the locomotive platform.
  - The side bearers support the vertical load and provide controlled lateral motion between the locomotive and the truck.
  - The journal bearing housings transfer vertical loads from the frame to the axles and wheels.
  - The primary, lateral, and yaw dampers reduce unwanted movement. The primary dampers reduce the motion between the truck frame and the axle. The lateral dampers reduce unwanted lateral motion of the truck as the locomotive moves along the track. The yaw dampers prevent the truck from “hunting the rail” as the locomotive moves along a straight track.
  - Finally, brake cylinders, brake rigging, and brake shoes provide braking at each of the six truck wheels.
- Describe how to perform running maintenance inspections related to the truck and its major components.
  - Wheels
    - Periodically inspect the wheels for damage or excessive wear, in accordance with Federal Railroad Administration (FRA) Regulations.
    - To measure wheel diameter, flange thickness, and flange height, use a wheel gauge.
    - The wheel diameter is measured by reading the scale on the long arm of the gauge in relation to the top of the witness mark on the wheel using a conversion chart.
    - The flange thickness is measured by reading the scale on the pivot arm in relation to the 0 mark on the stationary arm. The mark on the pivot is used to determine the thickness.
    - The flange height is measured by reading the scale on the pivot arm in relation to the marks on the bend of the gauge.

- Lateral Liners
  - If the lateral liner clearances exceed the maximum worn limits, replace them as follows:
    1. At the pin retainer assembly, remove the bolts, the hardened washers, and the journal box retainer pin from the truck frame, then save the hardware for re-assembly.
    2. Remove both journal box retainer pins.
    3. The liners should fall out but, if not, remove them with an appropriate tool.
    4. Position the new liners in place and return the correct tee bolts.
    5. Re-install the pin retainer assembly, with the raised portion toward the truck frame, and fasten using the previously saved hardware.
    6. Torque the retainer assembly bolts.
- Brake Shoes and Rigging
  - The brake shoes are a high-wear item and need to be inspected on a regular schedule.
  - Inspect adjustment and condition of the brake rigging components as follows and make adjustments and repairs as required:
    - Periodically check all brake shoes for wear.
    - Ensure that the brake shoes are not binding against the wheel thread surface or flange.
    - Verify that the brake hangers are not causing misalignment of the brake shoe.
    - Inspect brake linkage for missing, broken, or loose parts. Also, inspect for badly worn pins, bushings, or wear plates.
    - Check the brake rigging wear plates on the hangers and the truck frame pads.
    - Check the clearance between brake shoes and wheels.
    - Check the brake cylinder piston-rod travel that is required to engage the brake.

## **Screen 85:**

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

- Replace the brake shoe as follows:
  1. Chock at least two sets of truck wheels to prevent the locomotive from rolling in either direction.
  2. Release the hand brake, if set, and allow time for the truck wheels to seat against the wheel chocks.
  3. With the locomotive secure, locate and close the truck air cut-out cock on the underside of the locomotive frame.
  4. Move the brake shoe as far as possible from the wheel tread, then remove the retaining key and worn brake shoe from the brake head.
  5. Install a new shoe in the brake head, line-up the keyway, and then drive the retaining key to seat tight in the keyway.

6. Check the brake shoe for a tight fit in the brake head.
7. Adjust the manual slack adjuster as required, then reinstall any pins that were removed and lock them into place.
8. Open the truck air cut-out cock.
- Adjust the brake system as follows:
  1. Chock at least two sets of truck wheels to prevent the locomotive from rolling in either direction.
  2. Release the hand brake, if set, and allow time for the truck wheels to seat against the wheel chocks.
  3. With the locomotive secure, locate and close the truck air cut-out cock on the underside of the locomotive frame.
  4. To adjust the brake system, lift and rotate the pin retainer and remove the slack adjuster pin.
  5. With the piston rod fully retracted, adjust the slack adjuster to provide a minimum clearance of 0.75 inches (19 mm) between the brake shoe and the wheel.
  6. Replace the slack adjuster pin and rotate the pin retainer in place over the pin.
  7. Check adjustments and the brake clearance at all other truck wheels.
  8. Open the truck air cut-out cock to supply air pressure to the brake system, then check for proper operation of the adjusted air brakes.
- Traction Motor Nose Suspension
  - Inspect each suspension assembly for defective rubber mounting bushings. If the mounting bushings are worn, the bushing rubber is extruded from the cast link, or appears damaged in any way, replace the suspension assembly. Also, check for loose or missing mounting hardware.
- Side Bearer Inspection
  - Inspect the side bearers as follows:
    - Ensure that the side bearer is centered under the locomotive side bearer pad.
    - Inspect for evidence of motion between the side bearer and the locomotive side bearer pad.
    - Inspect the side bearers for extreme wear or severe separation of rubber and steel laminations.
    - Replace any defective or displaced side bearers.

## **Screen 86:**

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

- Traction Pad Inspection
  - Ensure that the pads are seated in the truck frame and properly retained. In a proper installation, the pads are compressed by approximately 0.62 inches (15.7 mm), and the rubber is bulged upward by approximately 0.125 - 0.5 inches (3.18 - 12.70 mm).

- Inspect the traction pads for extreme wear or severe separation of the rubber and steel laminations.
- Replace any defective or displaced traction pads as directed in the Backshop Manual.
- Dampers
  - Visually inspect the dampers for signs of any oil leakage, dirt or droplets, and sweating.
- Lateral and Yaw Dampers
  - Inspect each lateral and yaw hydraulic damper for leakage or defective rubber mounting bushings. A light film of hydraulic fluid on the body is normal. If the body is wet with fluid, the mounting bushings are worn, or bindings are badly eroded or missing, replace the lateral damper.
- Vertical Hydraulic Dampers Inspection
  1. Clean the lower body of the primary damper.
  2. Visually inspect the lower body for clearly formed droplets of hydraulic fluid.
  3. Clean all the dampers around the locomotive and return to the first one to begin inspection.
  4. Inspect the damper mounting bushings for wear, binding, badly eroded or missing parts.
  5. Inspect the structure for cracks, missing sections, or severe beating.
  6. Replace the vertical hydraulic dampers, if any of the following are found during the visual inspection: Droplets of hydraulic fluid formed at the lower body, signs of wearing, binding, or badly eroded bushings and broken parts.
- Vertical Hydraulic Damper Replacement
  1. Remove all four bolts and washers from each set of damper mounting blocks.
  2. Remove and discard both used vertical hydraulic dampers.
  3. Install new dampers.
  4. Reinstall the bolts and washers on each set of damper mounting blocks, then torque the bolts to  $312 \pm 16$  lb.-ft. ( $422 \pm 22$  Nm).
- Coil Springs Inspection
  - Visually inspect the spring coils for breaks, cracks, vertical wear flats, deep nicks, gouges, or other signs of spring damage. If visible damage to the spring coils indicates that the useful life or performance of the springs may be limited, replace the springs.
- Equalizer Bar Damper Inspection
  1. Clean the lower body.
  2. Clean all the dampers around the locomotive and return to the first one to begin inspection.
  3. Perform a visual inspection of the lower body for clearly formed droplets of hydraulic fluid.
  4. Inspect damper mounting bushings for wear, binding, badly eroded, or missing parts.
  5. Inspect the structure for cracks, missing sections, or severe beating.

- Equalizer Bar Damper Replacement
  1. Remove the four bolts, nuts, and washers attaching the equalizer bar damper to the equalizer bar damper support bracket and the truck frame.
  2. Remove and discard the equalizer bar damper.
  3. Install a new damper.
  4. Orient the damper correctly by ensuring that the larger diameter upper body of the damper is toward the equalizer bar damper support bracket and the smaller diameter lower body is toward the truck frame casting.
  5. Ensure that "BELOW" is stamped on the bottom side of the lowest end of the damper.
  6. Reinstall the four bolts, nuts, and washers connecting the equalizer bar damper to the damper support bracket and the truck frame damper mounting block, then torque the mounting bolts.

## **Screen 87:**

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

- Bell Crank Assembly Inspection
  - Inspect the bell crank assembly for minimum clearance between the bell crank and the traction cap. Use a feeler gauge to check that there is a minimum clearance of 0.06 inches (1.5 mm) between the bell crank and the traction cap. If the clearance is less than 0.06 inches (1.5 mm), the thrust washers might be defective.
  - Thrust Washer Replacement
    1. Remove the retainer thrust washer and spacer by unscrewing the four bolts and save the hardware for re-installation.
    2. Remove and discard the first thrust washer.
    3. Remove the four bolts and washers from the retainer lower bearing cap and save the hardware for re-installation.
    4. Replace the second thrust washer with a new thrust washer.
    5. Install the retainer lower bearing cap and the four washers and the four bolts on opposite corners, then torque the bolts to  $88 \pm 5$  lb.-ft. ( $40 \pm 2.3$  Nm).
    6. Install a new thrust washer on top of the retainer lower bearing cap.
    7. Install the thrust washer spacer in the center of the thrust washer.
    8. Install the thrust washer retainer on top of the thrust washer spacer using four washers and four bolts, then torque the bolts to  $58 \pm 3$  lb.-ft. ( $26 \pm 1.4$  Nm).
- Visual Inspection of the Traction Link and the Center Link
  - Visually inspect the traction link and the center link for missing nuts and bolts. Apply new fasteners if they are missing.
  - Visual Inspection of the Wing Plate Assembly
    1. Visually inspect the wing plate assembly for missing hardware fastened on links.

2. Visually inspect the wing plate shear pads and rubber bushings for cracks or delamination of the bonded rubber and metal.
  3. Inspect the wing plate pins for indications of wear and/or clearance.
  4. Ensure that the shear pad is properly seated in the wing plate, the reaction arm, and the reaction arm cover.
- Visual Inspection of the Equalizer Arm and the Equalizer Bar
    1. Check the match marks on the equalizer arm to verify that the arm has NOT moved relative to the bell crank.
    2. Visually inspect the equalizer bar rubber bushing for swelling, delamination, and wear.
    3. Visually inspect the equalizer bar for any signs of wear or cracking.
    4. Visually inspect the equalizer bar for missing nuts and bolts and apply new fasteners, if missing.
  - Equalizer Bar Replacement
    1. Remove the equalizer bar assembly.
    2. Dismantle the equalizer bar assembly.
    3. Assemble the subassembly by using a new equalizer bar and re-using the damper support bracket and mounting hardware.
    4. Connect the damper support bracket to the new equalizer bar, then torque the three bracket mounting bolts.
    5. Install the equalizer bar assembly.
  - Safety Hook Inspection and Replacement
    - Inspect the safety hooks for proper clearances. If the safety hooks do not meet clearances, identify and replace the defective hooks.

## **Screen 88:**

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

- Steerable Truck Removal
  1. Chock at least two sets of truck wheels on both trucks to prevent the locomotive from rolling in either direction.
  2. Release the hand brake, if set, and allow time for the truck wheels to seat against the wheel chocks.
  3. With the locomotive secure, locate and close the truck air cut-out cock on the underside of the locomotive frame.
  4. For each traction motor, disconnect the traction motor leads, ground cable, and speed sensor cable and, if equipped, the hot bearing detector probe on the U-tube.
  5. Disconnect the ground cable between the truck and the platform.
  6. Disconnect the traction motor air ducts from the top of the traction motors.
  7. If an axle alternator is installed on the truck being removed, disconnect the alternator cable from the junction box on the alternator, then coil and secure the cable so it will not be damaged.
  8. Disconnect all sander hoses from the sander brackets on the truck.



9. Disconnect the hoses for the flange lubricators if used, and cover the opening to prevent the entry of foreign materials.
10. Disconnect the hand brake chain if the long-hood end truck is being removed.
11. Remove the lateral and yaw dampers from the platform and save the hardware.
12. Remove both safety hooks from the truck frame, mark as right or left, and save the hardware.
13. Raise the locomotive platform clear of the truck with jacks or a crane, or lower the truck on a drop table.
14. After the truck is removed from under the locomotive, cover the truck center pin bearing and traction motor openings to prevent contamination with dirt and other foreign materials.
- Steerable Truck Installation
  1. Space the trucks for a truck center-block to center-block spacing.
  2. Remove the temporary dust covers from the traction motor air duct and center pin bearing openings.
  3. Inspect the traction motor air ducts between the locomotive platform and the truck and replace any air ducts that are cracked or torn.
  4. Coat the center pin on the underside of the locomotive platform with grease before lowering the platform onto the truck.
  5. Lower the platform onto the truck or raise the truck on the drop table.
  6. Check and align the trucks, if required.
  7. Install both safety hooks to the correct sides on the truck frame and torque the bolts.
  8. Install the lateral dampers to the platform, with the shorter bolt at the bottom, and torque the bolts.
  9. Install the yaw dampers to the platform and torque the bolts.
  10. If installing the long-hood end truck, connect the hand brake chain.
  11. Install the hoses from the sand pipes on the platform to the sander brackets on the trucks and install the hoses for flange lubricators, if used.
  12. Connect the axle alternator cable to the junction box on the alternator, if used.
  13. Install the traction motor air duct to each of the traction motors and torque the bolts.
  14. Connect the ground cable between the truck and the platform.
  15. For each traction motor, connect the speed sensor cable, ground cable, and traction motor leads, and, if equipped, the hot bearing detection probe on the U-tube.
  16. Connect the air brake hoses from the locomotive platform to the brake cylinder piping on the truck.
  17. Verify that the truck cut-out cocks located under the platform are open before returning the locomotive to service.
  18. Adjust the truck brake rigging.

19. Ensure that the journal bearing housings, traction motor gear cases, and traction motor support bearings have been lubricated before moving the locomotive.
20. Check the traction motor rotation.

**Screen 89:**

**Summary (Cont'd):**

- Truck Alignment Verification
  1. Ensure that the locomotive is on a straight, level track.
  2. Release the brakes on the truck being aligned by closing the truck air brake cut-out cock and bleeding air from the brake cylinders.
  3. Check the axle distance between the center and each end axle.
- Wheel Lateral Alignment Verification
  1. Align the end axle wheels with the truck frame as follows:
    - a. Install 5.125 inch (13.018 cm) blocks to the journal box tees on the non-gearcase side of both end axles.
    - b. Install airbags between the truck frame and the wheel on the non-gearcase side of the end wheel sets, then apply air to the airbags and move each wheel set until there is contact between the blocks and the truck frame.
  2. Use wedges to block the end axles in respect to the frame and remove the airbags from the end axles.
  3. Align the center axle wheels with the end axle wheels as follows:
    - a. Use a long straight edge or a wire stretched tight against the backside face of the non-gearcase wheels of both the end axles.
    - b. Use airbags to align the center axle wheel with the straight edge or wire.
  4. If the center axle wheel is not aligned with the straight edge or wire, loosen the CAMCAR bolt connections on the two inter-motor links at traction motor positions 1, 2, 5, and 6 to allow the center axle to be laterally aligned.
  5. If the CAMCAR bolts are not already loosened and hand-tightened, remove and install new CAMCAR bolts one at a time.
  6. Hand-tighten the nuts and tag the bolts as loose, then repeat steps 3a and 3b.