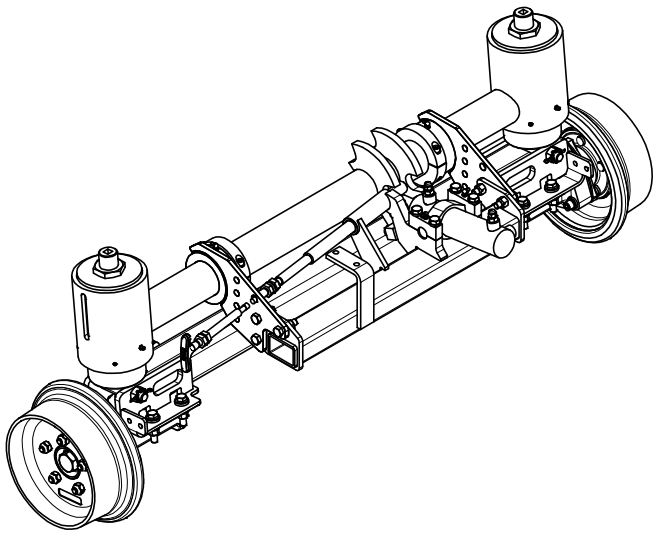
OPERATOR'S SERVICE AND PARTS MANUAL

HR1500 SERIES D
UNIVERSAL HY-RAIL®
GUIDE WHEEL EQUIPMENT
HYDRAULICALLY OPERATED



HARSCO RAIL
Enabling TECHNOLOGY IN MOTION

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■ **THIS MANUAL CONTAINS VITAL INFORMATION FOR THE SAFE USE AND EFFICIENT OPERATION OF THE VEHICLE EQUIPPED WITH HY-RAIL® GUIDE WHEEL EQUIPMENT. CAREFULLY READ THIS OPERATOR'S MANUAL BEFORE USING THE VEHICLE. FAILURE TO ADHERE TO THE INSTRUCTIONS COULD RESULT IN BODILY INJURY AND/OR PROPERTY DAMAGE.**

When this manual is received, record the guide wheel unit serial numbers in the spaces provided in the General Information and Parts Sections for future reference, in case the serial number tags ever become unreadable. A Manual must remain with the vehicle. Additional or replacement manuals may be obtained by calling or writing Harsco Rail, Harsco Corporation.

All information, illustrations and specifications in this manual are based on the latest information available at the time of publication. Harsco Rail, Harsco Corporation reserves the right to make changes at any time without notice.

www.harscorail.com

FACILITY LOCATIONS

HARSCO RAIL, LLC
306 West Fourth Street
Fairmont, MN
56031-1837
Tel: (507) 235-7376
Parts: (800) 800-6410
Fax: (507) 235-7372

HARSCO RAIL, LLC
2401 Edmund Road, Box 20
Cayce-West Columbia, SC
29171-0020
Tel: (803) 822-7420
Parts: (800) 800-6410
Fax: (803) 822-7403

HARSCO RAIL, LLC
1200 Conrad Industrial Dr.
Ludington, MI
49431
Tel: (231) 843-3431
Parts: (800) 800-6410
Fax: (231) 843-4830

HARSCO RAIL LTD
Giltway, Giltbrook
Nottingham, NG16 2GQ
England
Tel: 0115 938 7000
Fax: 0115 938 7001

HARSCO RAIL PTY LTD
4 Strathwyn Street, PO Box 5287
Brendale, Queensland 4500
Australia
Tel: 61 7 205 6500
Fax: 61 7 205 7369

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SECTION 1 - GENERAL INFORMATION
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1.1 Safety Information

1

THIS SYMBOL MEANS: ATTENTION! BECOME ALERT! YOUR SAFETY IS INVOLVED.

SAFETY IS A CRITICAL FACTOR IN THE DESIGN OF HARSCO RAIL EQUIPMENT. THE BEST SAFETY PROGRAM STARTS WITH A SAFETY CONSCIOUS OPERATOR. THE SAFETY INFORMATION HIGHLIGHTED IN THIS BULLETIN DESCRIBES SAFE OPERATING PRACTICES FOR THE BENEFIT OF THE WORKERS WHO WILL USE OUR EQUIPMENT IN THEIR DAILY JOBS.

1.1.1 Hazard Seriousness

Signal Words: DANGER, WARNING and CAUTION are used to identify levels of hazard seriousness.

DANGER

DANGER - Immediate hazards which WILL result in severe bodily injury or death.

WARNING

WARNING - Hazards or unsafe practices which COULD result in severe bodily injury or death.

CAUTION

CAUTION - Hazards or unsafe practices which COULD result in minor bodily injury and / or product or property damage.

1.1 Safety Information

- **APPLY THE VEHICLE PARKING BRAKE AND STOP THE ENGINE WHEN PERFORMING MAINTENANCE, MAKING ADJUSTMENTS, WORKING UNDER THE VEHICLE OR GUIDE WHEEL EQUIPMENT OR WHENEVER UNINTENDED MOVEMENT OF THE VEHICLE COULD OCCUR, UNLESS OTHERWISE INSTRUCTED IN THIS MANUAL.**

- **MAKE SURE ALL PERSONS ARE CLEAR OF THE VEHICLE BEFORE PERFORMING ANY OPERATING FUNCTIONS.**

- **KEEP ALL PARTS OF THE BODY AND LOOSE CLOTHING CLEAR OF ALL MOVING PARTS OF THE VEHICLE OR GUIDE WHEEL EQUIPMENT.**

- **UNDERSTAND EQUIPMENT OPERATION AND BE AWARE OF ALL PINCH POINTS BEFORE OPERATING OR MAKING ADJUSTMENTS TO THE GUIDE WHEEL EQUIPMENT.**

- **IF A DERAILMENT SHOULD OCCUR WHILE THE VEHICLE IS OPERATING IN ELECTRIFIED 3RD-RAIL TERRITORY, THE VEHICLE OR GUIDE WHEEL EQUIPMENT MIGHT BE IN ELECTRICAL CONTACT WITH THE ELECTRIFIED RAIL. DO NOT ATTEMPT TO EXIT FROM THE VEHICLE UNTIL THE ELECTRICAL POWER TO THE 3RD-RAIL HAS BEEN TURNED OFF.**

- **IF THE HY-RAIL® EQUIPPED VEHICLE IS INVOLVED IN A DERAILMENT OR HIGHWAY ACCIDENT, IT MUST BE INSPECTED AND NECESSARY REPAIRS OR ADJUSTMENTS MADE TO THE VEHICLE AND / OR HY-RAIL® EQUIPMENT PRIOR TO ITS NEXT OPERATION ON THE RAILROAD TRACK.**

- **DO NOT EXCEED 45 MPH WHEN OPERATING VEHICLE ON TRACK. RAILROAD RULES GOVERNING SPEEDS SHOULD BE OBSERVED AT ALL TIMES. REDUCE SPEED WHEN PROPELLING THE VEHICLE THROUGH SWITCHES, CROSSINGS, BRANCH LINES AND ANY SPECIAL TRACK WORKS. OPERATING THE VEHICLE AT UNSAFE SPEEDS COULD RESULT IN DERAILMENT OF VEHICLE.**

- **CHECK AND CORRECT GUIDE WHEEL EQUIPMENT ALIGNMENT PROMPTLY IF MISALIGNMENT IS INDICATED.**

1.1 Safety Information

1

- **AT MAXIMUM LOADED GROSS VEHICLE WEIGHT ON TRACK (including driver, passengers, equipment, tools, payload, etc.) DO NOT EXCEED ANY OF THE FOLLOWING:**
  - **VEHICLE'S G.V.W.R. (Gross Vehicle Weight Rating)**
  - **VEHICLE'S FRONT G.A.W.R. (Gross Axle Weight Rating) OR THE SUM OF THE FRONT UNIT GUIDE WHEEL RATED LOAD CAPACITY PLUS (+) VEHICLE'S FRONT TIRE/WHEEL RATED LOAD CAPACITY, WHICHEVER IS LOWER.**
  - **VEHICLE'S REAR G.A.W.R. (Gross Axle Weight Rating) OR THE SUM OF THE REAR GUIDE WHEEL RATED LOAD CAPACITY PLUS (+) VEHICLE'S REAR TIRE/WHEEL RATED LOAD CAPACITY, WHICHEVER IS LOWER.**
  - **COMPONENTS RATED LOAD CAPACITY:**
    A. TIRE MANUFACTURER'S RATED LOAD CAPACITY.
    B. VEHICLE'S WHEEL RATED LOAD CAPACITY.
    C. GUIDE WHEEL UNIT RATED LOAD CAPACITY:
    STEEL TREAD GUIDE WHEELS:
    1,500 lbs (680 kg) Maximum Per Guide Wheel
    RUBBER TREAD GUIDE WHEELS:
    700 lbs (318 kg) Maximum Per Guide Wheel

FAILURE TO HEED THESE WARNINGS COULD RESULT IN SEVERE BODILY INJURY.

- **OBSERVE AND FOLLOW ALL RAILROAD SAFETY RULES AND REGULATIONS.**
- **KNOW THE POSITIONS AND FUNCTIONS OF ALL CONTROLS BEFORE ATTEMPTING TO OPERATE THE VEHICLE.**
- **THIS GUIDE WHEEL EQUIPMENT IS DESIGNED WITH YOUR SAFETY IN MIND. NEVER DISCONNECT AND/OR ATTEMPT TO OVERRIDE SAFETY FEATURES.**

FAILURE TO HEED THESE PRECAUTIONS COULD RESULT IN BODILY INJURY AND/OR PROPERTY DAMAGE.

Note: To help ensure safe operation of this equipment, keep all safety decals clean and legible. Replace safety decals when necessary with new decals, listed in the Parts Section of this manual.

1.2 Description

The HR1500 Series D HY-RAIL® guide wheel equipment can be applied to various standard utility vehicles, cab chassis and pickup trucks. The vehicle's G.V.W.R. (gross vehicle weight rating) and/or G.A.W.R. (gross axle weight rating) must comply with specifications recommended by Harsco Rail. For information regarding special applications, contact Harsco Rail, Fairmont, Minnesota.

The HY-RAIL® guide wheel units are lowered and raised hydraulically. Hydraulic power may be supplied from the vehicle system or from an optional power pack. The guide wheels are locked in both the highway and rail positions with manual locks. The guide wheel units are mounted onto the vehicle frame. Load bearing guide wheel assemblies guide the vehicle during on track operation. The HY-RAIL® equipped vehicle uses the vehicle propulsion and braking systems for propelling and braking on the track.

A steering lock assembly is manually actuated during on track operation. The steering lock holds the vehicle's steering wheel in place to ensure alignment of the vehicle's front wheels with the rail.

1.3 Vehicle Orientation

Front - rear and left - right are determined from the vehicle driver's seat.

1.4 Serial Numbers

1

When this bulletin is received, complete the following record from the serial number tags on both the front and rear guide wheel units. Always provide these factory serial numbers when calling or writing about the units. The serial number tags are located on the mounting plates on both units.

FIGURE 1-1
FRONT GUIDE WHEEL UNIT SERIAL NUMBER

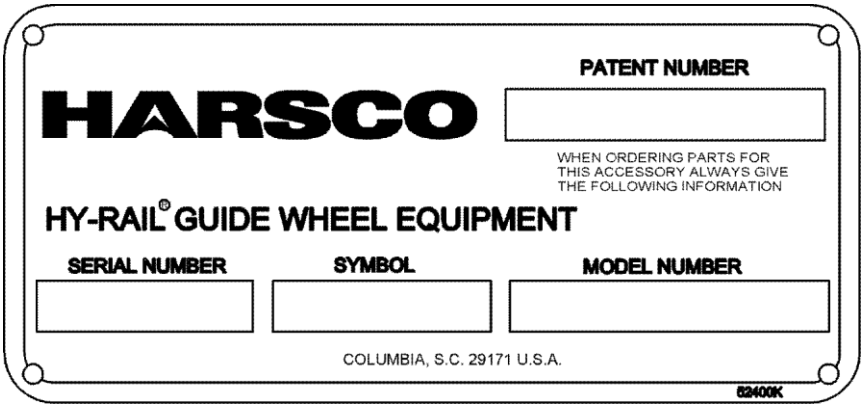
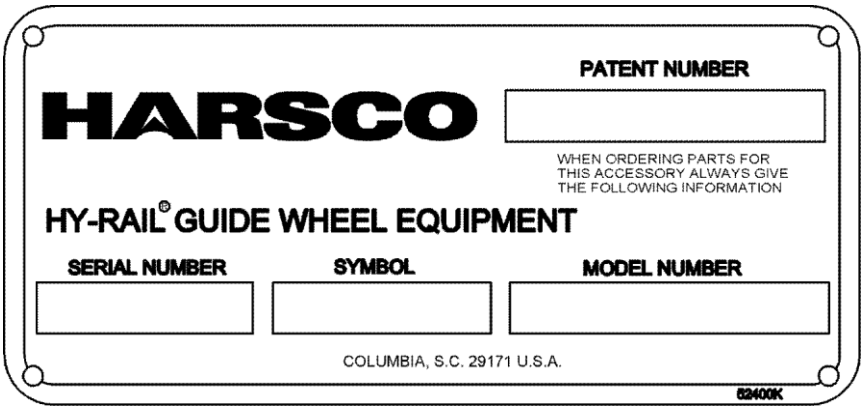


FIGURE 1-2
REAR GUIDE WHEEL UNIT SERIAL NUMBER



1.5 Specifications

1.5.1 Vehicle

The vehicle's G.V.W.R. (gross vehicle weight rating) and/or G.A.W.R. (gross axle weight rating) must comply with specifications recommended by Harsco Rail. For information regarding special applications, contact Harsco Rail, Fairmont, Minnesota.

1.5.2 Guide Wheel Unit

Track Gauge	56-1/2 in	(1435 mm)
Guide Wheels - All Tread Types - Flange Diameter	12-1/4 in	(311 mm)
- Tread Diameter	10 in	(254 mm)
Weight - Front Unit	305 lbs	(138 kg)
- Rear Unit	305 lbs	(138 kg)
Recommended Load Per Guide Wheel - All Tread Types	500 ± 25 lbs	(227 ± 11 kg)

Maximum Load Per Guide Wheel:

Steel Tread Guide Wheels	1,500 lbs	(680 kg)
Rubber Tread Guide Wheels	700 lbs	(318 kg)

NOTES

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NOTES

2.1 Speedometer

- **WHEN WHEEL/TIRE MODIFICATIONS ARE APPLIED, CHECK AND CHANGE SPEEDOMETER DRIVE RATIO IF NECESSARY. THE SPEEDOMETER DRIVE RATIO WILL INFLUENCE THE OPERATION OF THE VEHICLE'S ANTI-LOCK BRAKE SYSTEMS, ELECTRONICALLY CONTROLLED TRANSMISSION SHIFT TIMING AND SPEEDOMETER DISPLAY OF THE TRUE VEHICLE SPEED. FAILURE TO MAINTAIN CORRECT SPEEDOMETER DRIVE RATIO COULD RESULT IN SEVERE BODILY INJURY.**

Some vehicles require special larger diameter wheels and/or wheel spacers to properly space the vehicle tires for on track operation. Use of these wheel modifications may effect the speedometer drive ratio calibration. The speedometer drive ratio will influence the operation of the vehicle's anti-lock brake systems, electronically controlled transmission shift timing and speedometer display of the true vehicle speed. The vehicle speedometer must be re-calibrated when wheel modifications are applied to the vehicle. See the vehicle manufacturer or dealer for speedometer calibration information.

2.2 Preparing Vehicle For Operation

Be sure vehicle is in operating condition by checking the following:

a. Engine oil level.
b. Radiator fluid level.
c. Fuel tank level.
d. Hydraulic reservoir level.
e. Brakes work properly.
f. Parking brake works properly.
g. Head, brake and signal lights work properly.
h. Tires properly inflated: 80 PSI for Chevrolet vehicles.
   95 PSI for Ford vehicles.
I. Vehicle wheels: Lug nuts / bolts tightened to the proper torque, inspect vehicle wheels, lug bolts and lug nuts for wear or damage. For vehicle wheel, lug bolt and lug nut inspection information refer to the AMERICAN TRUCKING ASSOCIATION - TECHNOLOGY & MAINTENANCE COUNCIL - USER'S GUIDE TO WHEELS AND RIMS. To obtain this guide, contact:

   AMERICAN TRUCKING ASSOCIATION
   TECHNOLOGY & MAINTENANCE COUNCIL
   950 N Glebe Rd., Suite 210
   Arlington, VA 22203-4181
   Phone: (703) 838-1763
   Fax: (703) 838-1701
   tmc@trucking.org

j. Any other normal maintenance requirements.

2.3 Preparing Guide Wheel Equipment For Operation

Be sure the guide wheel equipment is in operating condition by checking the following:

a. Overall for damaged or worn parts.
b. Proper alignment and guide wheel loads.
c. Proper lubrication at recommended operating hourly intervals.
d. Hydraulic hoses and fittings damage, wear or leaks

2.4 Misalignment Indicators

■ **BEFORE OPERATING A VEHICLE WITH NEWLY INSTALLED GUIDE WHEEL EQUIPMENT ON TRACK, VERIFY THAT GUIDE WHEEL EQUIPMENT ALIGNMENT PROCEDURE HAS BEEN COMPLETED. CHECK AND CORRECT ALIGNMENT PROMPTLY IF MISALIGNMENT IS INDICATED. MISALIGNMENT OF GUIDE WHEEL EQUIPMENT COULD RESULT IN DERAILMENT OF VEHICLE AND SEVERE BODILY INJURY.**

The following conditions may indicate that minor adjustments to the guide wheel equipment alignment are necessary. If any of these conditions occur during operation, perform the Track Test, see Adjustment Section - Vehicle Track Test and/or complete the Alignment Procedure, see Adjustment Section - Guide Wheel Alignment Procedure.

1. Excessive flange or tread wear on any of the rail guide wheels.

2. Vehicle pulls noticeably to the left or right during track operation.

3. Vibration felt throughout the vehicle at various speeds during track operation.

2.5 Placing Vehicle on Track

- **PLACE VEHICLE AUTOMATIC TRANSMISSION IN "PARK" OR MANUAL TRANSMISSION IN "NEUTRAL". APPLY THE PARKING BRAKE.**
- **UNDERSTAND EQUIPMENT OPERATION AND BE AWARE OF ALL PINCH POINTS BEFORE OPERATING OR MAKING ADJUSTMENTS TO GUIDE WHEEL EQUIPMENT.**
- **BEFORE PROPELLING THE VEHICLE ON THE TRACK, MAKE SURE:**
  - **FRONT AND REAR GUIDE WHEELS ARE LOWERED AND LOCKED IN THE RAIL POSITION AND SECURED WITH THE LOCK PINS.**
  - **ALL GUIDE WHEEL FLANGES ARE ENGAGED ON THE INSIDE OF THE RAIL.**
  - **THE FRONT WHEELS ARE POINTED STRAIGHT AHEAD AND THE STEERING WHEEL LOCK IS ENGAGED.**

FAILURE TO HEED THESE WARNINGS COULD RESULT IN DERAILMENT OF THE VEHICLE AND SEVERE BODILY INJURY.

- **OBSERVE AND FOLLOW ALL RAILROAD SAFETY RULES AND REGULATIONS.**
- **IF THE VEHICLE IS EQUIPPED WITH A STROBE LIGHT (BEACON) AND RAILROAD RULES AND REGULATIONS REQUIRE ITS USE, THE STROBE LIGHT (BEACON) MUST BE ILLUMINATED WHEN PLACING THE VEHICLE ON TRACK AND WHEN OPERATING THE VEHICLE ON TRACK.**

FAILURE TO HEED THESE PRECAUTIONS COULD RESULT IN BODILY INJURY AND/OR PROPERTY DAMAGE.

2.5 Placing Vehicle on Track

1. Ensure that highway vehicles are not approaching the grade crossing while placing the vehicle on track. Flag the crossing per railroad rules and regulations to ensure safety.

2. At a road crossing, drive the vehicle about 25 feet (7.6 m) past the track. Back the vehicle onto the track so that the rear guide wheels are centered on rails. It may be necessary to move the vehicle back and forth several times to get the wheels centered on the rail properly.

3. Place automatic transmission in "PARK" or manual transmission in "NEUTRAL". Apply the parking brake.

4. Lower and lock the rear guide wheels first. The rear guide wheels should be lowered first so the vehicle front tires can be maneuvered to align the front guide wheels with the rails.

2.5.1 Lowering Rear Guide Wheels - See Figure 2-1

The location of the push / pull cable T-handle (1) and the control box (2) will vary depending on the application.

1. With the rear guide wheels centered over the rails, press the UP button on the control box (2) momentarily to relieve pressure from the lock pin. To disengage the lock, rotate T-handle (1), pull out and then rotate the handle to lock it in the disengaged position.

2. Press the DOWN button on control box (2) to activate the hydraulic pump and lower the guide wheels to the rail. As the guide wheels lower, ensure that the flanges of the guide wheels are on the gauge side (inside) of the rails.

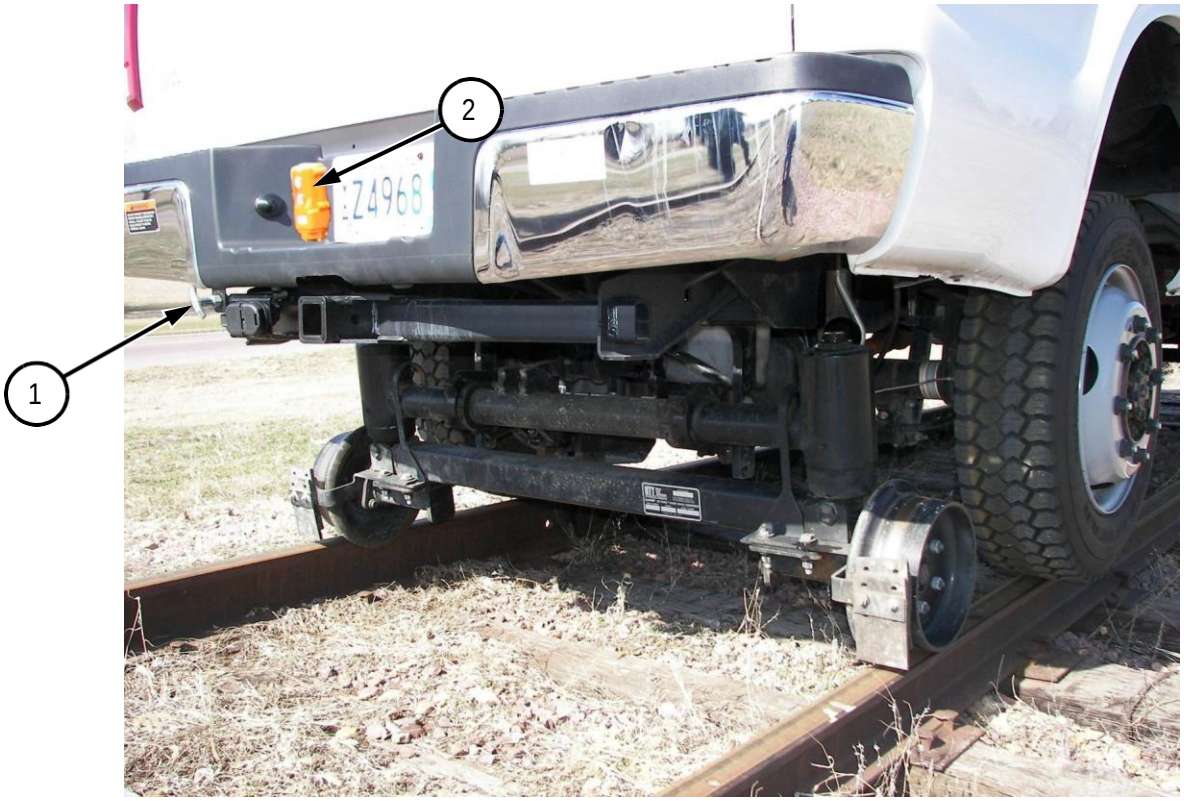
3. Continue to hold the DOWN button on control box (2) until the guide wheels are fully lowered to the "rail" position. Release the DOWN button. Rotate the T-handle to release the cable lock and then push T-handle (1) in to engage the lock. When the T-handle is fully in and the lock pin is engaged, rotate the T-handle to engage the cable lock.

4. After the rear guide wheels are locked in the "rail" position, move the vehicle so that the front guide wheels are centered on the rail.

2.5 Placing Vehicle on Track

2.5.1 Lowering Rear Guide Wheels

FIGURE 2-1
LOWERING REAR GUIDE WHEELS



2.5 Placing Vehicle on Track

2.5.2 Lowering Front Guide Wheels - See Figure 2-2

The location of the push / pull cable T-handle (1) and the control box (2) will vary depending on the application.

1. With the front guide wheels centered over the rails, press the UP button on the control box (2) momentarily to relieve pressure from the lock pin. To disengage the lock, rotate T-handle (1), pull out and then rotate the T-handle to lock it in the disengaged position.

2. Press the DOWN button on control box (2) to activate the hydraulic pump and lower the guide wheels to the rail. As the guide wheels lower, ensure that the flanges of the guide wheels are on the gauge side (inside) of the rails.

3. Continue to hold the DOWN button on control box (2) until the guide wheels are fully lowered to the "rail" position. Release the DOWN button. Rotate the T-handle to release the cable lock and then push T-handle (1) in to engage the lock. When the T-handle is fully in and the lock pin is engaged, rotate the T-handle to engage the cable lock.

FIGURE 2-2
LOWERING FRONT GUIDE WHEELS

2.5 Placing Vehicle on Track

2.5.3 Steering Lock

1. See Figures 2-3, 2-4, 2-5 and 2-6. Set the vehicle front wheels straight ahead and secure the steering wheel in that position by engaging the steering lock on the steering column. Steering locks may vary from vehicle to vehicle but will operate similarly.

   Note: Do not place your hands or any pressure on the steering wheel after the steering lock is engaged.

FIGURE 2-3
VELCRO STEERING LOCK OFF

FIGURE 2-4
VELCRO STEERING LOCK ON

FIGURE 2-5
DEAD BOLT TYPE
STEERING LOCK DISENGAGED

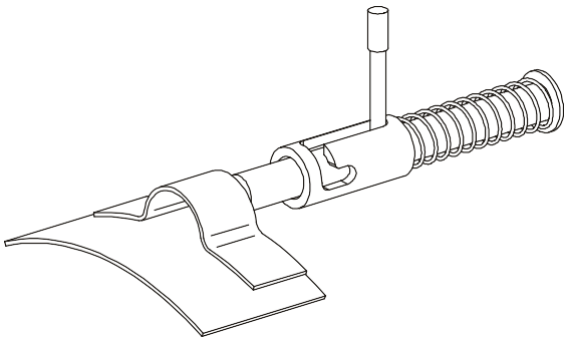
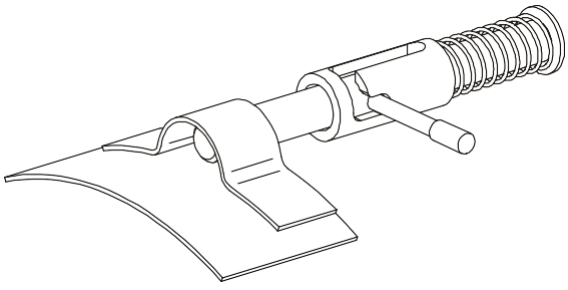


FIGURE 2-6
DEAD BOLT TYPE
STEERING LOCK ENGAGED



2.5.4 Rail Sweeps

1. The guide wheel units may be equipped with rail sweeps. The rail sweeps are positioned ahead of the front guide wheels and behind the rear guide wheels. The rail sweeps clear the rail of debris, lengthening the service life of the guide wheels.

2. The front and rear rail sweeps are attached to the axle and will lower when the guide wheels are lowered to the rail and will raise when the guide wheels are raised.

2.6 Guide Wheel Load on Track

- **IMPROPER LOADING OF GUIDE WHEEL EQUIPPED VEHICLE CAN CAUSE DERAILMENT OF VEHICLE.**
- **APPLY VEHICLE PARKING BRAKE AND STOP VEHICLE ENGINE BEFORE CHECKING GUIDE WHEEL LOAD.**
- **ALWAYS CHECK THE GUIDE WHEEL LOAD BEFORE OPERATING THE VEHICLE ON TRACK. NEVER OPERATE THE VEHICLE ON TRACK IF LOAD EXCEEDS THE MAXIMUM RATED LOAD ON THE FRONT AND/OR REAR GUIDE WHEEL UNITS. THE MAXIMUM LOAD ON THE FRONT OR REAR GUIDE WHEEL UNIT IS:**
  STEEL TREAD GUIDE WHEELS:
  1,500 lbs (680 kg) Maximum Per Guide Wheel
  RUBBER TREAD GUIDE WHEELS:
  700 lbs (318 kg) Maximum Per Guide Wheel
- **DO NOT USE ANY OTHER JACK THEN THE HARSCO RAIL WHEEL WEIGHING JACK NO. 3422565 TO CHECK THE GUIDE WHEEL LOAD. USE OF ANY OTHER JACK WILL RESULT IN INCORRECT GUIDE WHEEL LOAD INFORMATION.**
- **MISUSE OF THE WHEEL WEIGHING JACK MAY CAUSE GAUGE TO EXPLODE. READ ANSI B40.1 AND APPARATUS INSTALLATION / OPERATING INSTRUCTIONS BEFORE USE.**
- **DO NOT USE THE WHEEL WEIGHING JACK TO LIFT THE VEHICLE. EXCESSIVE WEIGHT MAY CAUSE THE JACK TO FAIL.**

FAILURE TO HEED THESE WARNINGS COULD RESULT IN DERAILMENT OF VEHICLE AND/OR SEVERE BODILY INJURY.

2.6.1 Checking Guide Wheel Load - See Figure 2-7

1. Apply the parking brake. Lower and lock the guide wheels in the rail position. Stop the vehicle's engine.

2. The guide wheel load can be checked using the HTT # 3422565 Wheel Weighing Jack. Do not use any other jack to check the guide wheel load. The use of an other jack will result in incorrect guide wheel load information.

3. Place the jack under the square tube as close to the guide wheel as possible. Jack the guide wheel up until the guide wheel just clears the top of the rail. Note the gauge reading. The gauge reading indicates the pounds of load on the guide wheel.

2.6 Guide Wheel Load on Track

2.6.1 Checking Guide Wheel Load - See Figure 2-7

Note: An easy way to tell when the guide wheel just clears the top of rail is to jack the wheel up approximately 1/4" (6.4 mm) above the top of the rail. Place a piece of paper between the rail and the guide wheel. Lower the guide wheel onto the paper. Slowly jack the guide wheel up while applying a steady pulling force on the paper until the paper can be pulled out. Note the gauge reading when the paper can be removed.

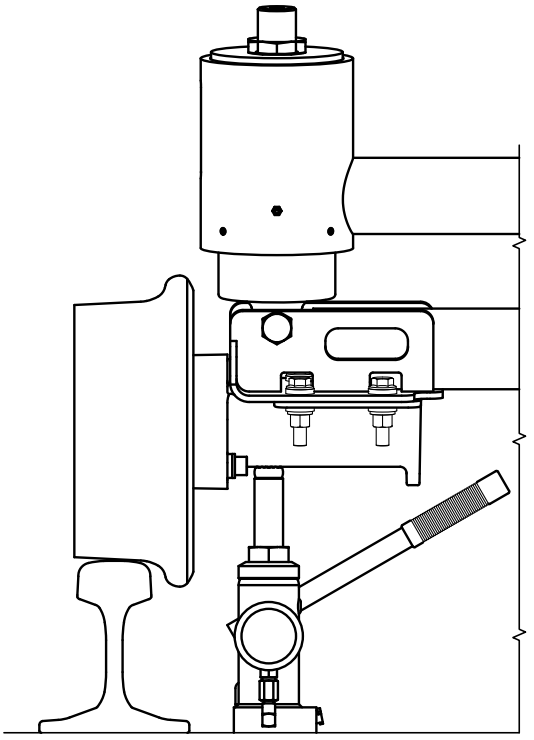
4. With the vehicle at curb weight, the recommended guide wheel load is 500 lbs ± 25 lbs (227 kg ± 11 kg) per guide wheel. The recommended guide wheel load must also be equal on the left and right sides of the front or rear guide wheel unit.

5. The maximum rated load on the front and / or rear guide wheel unit is:
   Steel Tread Guide Wheels: 1,500 lbs (680 kg) maximum per guide wheel.
   Rubber Tread Guide Wheels: 700 lbs (318 kg) maximum per guide wheel.

   The front and / or rear guide wheel unit spring cells are adjustable. See the Adjustments Section - Guide Wheel Load for the adjustment procedure.

6. If the load exceeds the maximum rated load capacity of the front and / or rear guide wheel unit or the maximum rated load capacity of any guide wheel, the load must be redistributed or some of the load removed. Never operate the vehicle on track if the load on the front and / or rear guide wheel unit exceeds the maximum rated load capacity.

FIGURE 2-7
GUIDE WHEEL LOAD



2.7 Propelling on Track

- **IMPROPER LOADING OF THE GUIDE WHEEL EQUIPPED VEHICLE CAN CAUSE DERAILMENT OF VEHICLE.**

- **ALWAYS CHECK THE GUIDE WHEEL LOAD BEFORE OPERATING THE VEHICLE ON TRACK. NEVER OPERATE THE VEHICLE ON TRACK IF LOAD EXCEEDS THE MAXIMUM RATED LOAD ON THE FRONT AND/OR REAR GUIDE WHEEL UNITS. THE MAXIMUM LOAD ON THE FRONT OR REAR GUIDE WHEEL UNIT IS:**

  STEEL TREAD GUIDE WHEELS:

  1,500 lbs (680 kg) Maximum Per Guide Wheel

  RUBBER TREAD GUIDE WHEELS:

  700 lbs (318 kg) Maximum Per Guide Wheel

  FAILURE TO HEED THESE WARNINGS COULD RESULT IN DERAILMENT OF THE VEHICLE AND/OR SEVERE BODILY INJURY.

- **BEFORE OR WHEN PROPELLING ON TRACK:**
  - **OBSERVE AND FOLLOW ALL RAILROAD SAFETY RULES AND REGULATIONS.**
  - **OPERATOR MUST LOOK ALL DIRECTIONS FOR PERSONS OR OBJECTS ON OR ADJACENT TO THE TRACK.**
  - **DO NOT ACCELERATE SUDDENLY. TRACTION IS REDUCED ON TRACK, SPINNING VEHICLE TIRES COULD DAMAGE THEM.**
  - **DO NOT EXCEED 45 MPH (72 km/h) WHEN OPERATING VEHICLE ON TRACK. RAILROAD RULES GOVERNING SPEEDS SHOULD BE OBSERVED AT ALL TIMES. REDUCE SPEED WHEN PROPELLING THE VEHICLE THROUGH SWITCHES, CROSSINGS, BRANCH LINES AND ANY SPECIAL TRACK WORKS. OPERATING VEHICLE AT UNSAFE SPEEDS COULD RESULT IN DERAILMENT OF THE VEHICLE.**
  - **STEERING LOCK MUST BE ENGAGED AT ALL TIMES WHEN OPERATING VEHICLE ON THE TRACK.**

- **IF THE VEHICLE IS EQUIPPED WITH A STROBE LIGHT (BEACON) AND RAILROAD RULES AND REGULATIONS REQUIRE ITS USE, THE STROBE LIGHT (BEACON) MUST BE ILLUMINATED WHEN OPERATING THE VEHICLE ON TRACK.**

  FAILURE TO HEED THESE PRECAUTIONS COULD RESULT IN BODILY INJURY AND/OR PROPERTY DAMAGE.

Vehicles equipped with HR1500 Series D HY-RAIL® Guide Wheel Equipment use the vehicle propulsion system for propelling on track. Do not accelerate suddenly. Traction is reduced on the track, and spinning the vehicle tires could damage them.

2.8 Braking on Track

- **PERSONS WHO OPERATE THE VEHICLE MUST BE FAMILIAR WITH TRACK AND WEATHER CONDITIONS THAT MAY AFFECT STOPPING DISTANCE. BE ALERT TO THESE CONDITIONS AND ALLOW ADEQUATE STOPPING DISTANCE.**

- **BE PREPARED TO BRAKE AT ALL HIGHWAY CROSSINGS. THIS VEHICLE WILL NOT OPERATE TRACK SIGNAL CIRCUITS, AND ONCOMING VEHICLES OR PEDESTRIANS MAY NOT YIELD THE RIGHT OF WAY.**

  FAILURE TO HEED THESE PRECAUTIONS COULD RESULT IN BODILY INJURY AND/OR PROPERTY DAMAGE.

Vehicles equipped with HR1500 Series D HY-RAIL® Guide Wheel Equipment use the vehicle brake system for braking on track. Stopping distance may be greater on track than on typical road surfaces. Apply the brakes gradually to avoid sliding the tires.

2.9 Removing Vehicle from Track

- **PLACE VEHICLE AUTOMATIC TRANSMISSION IN "PARK" OR MANUAL TRANSMISSION IN "NEUTRAL". APPLY PARKING BRAKE.**

- **UNDERSTAND EQUIPMENT OPERATION AND BE AWARE OF ALL PINCH POINTS BEFORE OPERATING OR MAKING ADJUSTMENTS TO THE GUIDE WHEEL EQUIPMENT.**

- **BEFORE PROPELLING VEHICLE OFF TRACK, MAKE SURE:**
  - **FRONT AND REAR GUIDE WHEELS ARE RAISED, LOCKED IN THE HIGHWAY POSITION, AND SECURED WITH THE LOCKING PINS.**
  - **STEERING WHEEL LOCK IS DISENGAGED.**

  FAILURE TO HEED THESE WARNINGS COULD RESULT IN SEVERE BODILY INJURY.

- **OBSERVE AND FOLLOW ALL RAILROAD SAFETY RULES AND REGULATIONS**

- **IF THE VEHICLE IS EQUIPPED WITH A STROBE LIGHT (BEACON) AND RAILROAD RULES AND REGULATIONS REQUIRE ITS USE, THE STROBE LIGHT (BEACON) MUST BE ILLUMINATED WHEN OPERATING THE VEHICLE ON TRACK AND WHEN REMOVING VEHICLE FROM TRACK.**

- **FAILURE TO HEED THESE PRECAUTIONS COULD RESULT IN BODILY INJURY AND/OR PROPERTY DAMAGE.**

2.9 Removing Vehicle from Track

1. Ensure that highway vehicles are not approaching grade crossing while removing vehicle from track. To ensure safety, flag the crossing to per railroad rules and regulations.

2. Approach a road crossing and stop with the vehicle front wheels on the crossing.

2

3. Place automatic transmission in "PARK" or manual transmission in "NEUTRAL". Apply the parking brake.

5. Raise the front guide wheels first, then the rear guide wheels.

2.9.1 Raising Front Guide Wheels - See Figure 2-8

The location of the push / pull cable T-handle (1) and the control box (2) will vary depending on the application.

1. Press the DOWN button on control box (2) momentarily to relieve pressure from the lock pin. To disengage the lock, rotate T-handle (1), pull out and then rotate the T-handle to lock it in the disengaged position.

2. Press the UP button on the control box (2) to activate the hydraulic pump and raise the guide wheels from the rail.

3. Continue to hold the UP button until the guide wheels are fully raised to the "highway" position. Release the UP button. To engage the lock, rotate T-handle (1), push in and then rotate the T-handle to lock it in the engaged position.

FIGURE 2-8
RAISING FRONT GUIDE WHEELS

2.9 Removing Vehicle from Track

2.9.2 Raising Rear Guide Wheels - See Figure 2-9

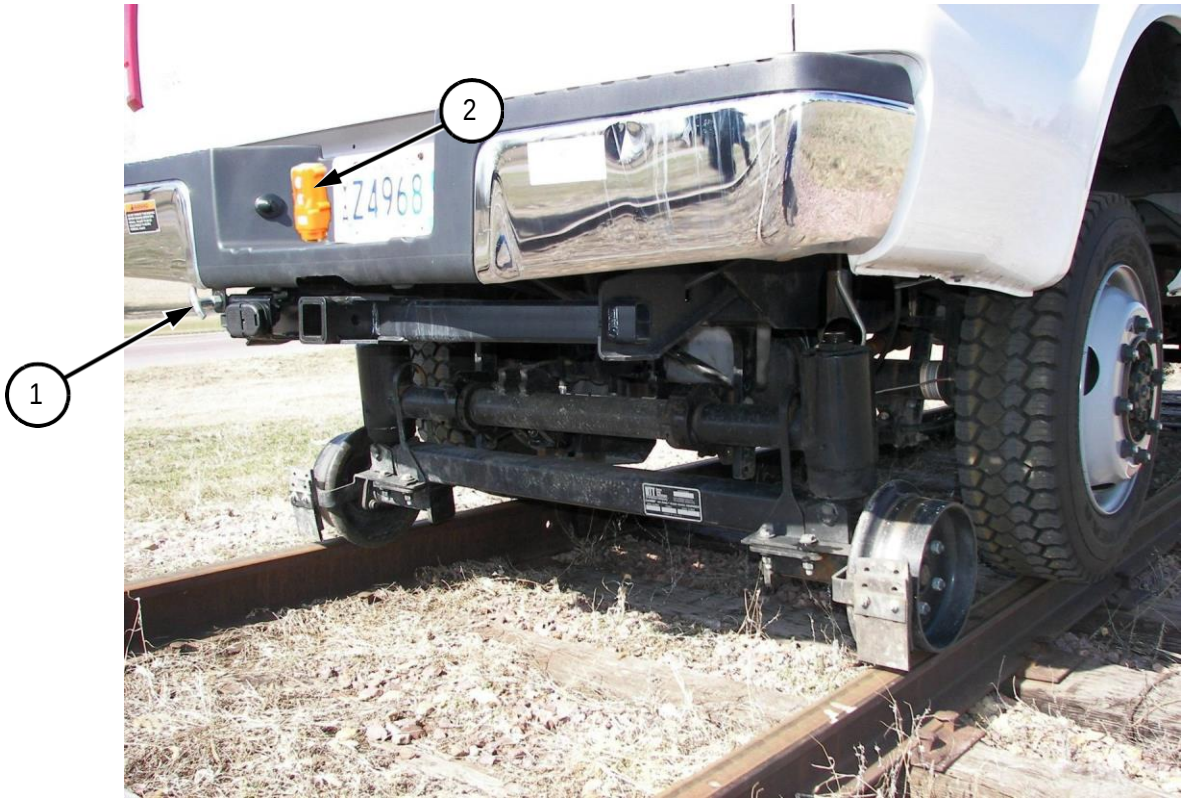
The location of the push / pull cable T-handle (1) and the control box (2) will vary depending on the application.

1. Press the DOWN button on control box (2) momentarily to relieve pressure from the lock pin. To disengage the lock, rotate T-handle (1), pull out and then rotate the T-handle to lock it in the disengaged position.

2. Press the UP button on the control box (2) to activate the hydraulic pump and raise the guide wheels from the rail.

3. Continue to hold the UP button until the guide wheels are fully raised to the "highway" position. Release the UP button. To engage the lock, rotate T-handle (1), push in and then rotate the T-handle to lock it in the engaged position.

FIGURE 2-9
RAISING REAR GUIDE WHEELS



2.9 Removing Vehicle from Track

2.9.3 Steering Lock

See Figures 2-10, 2-11, 2-12 and 2-13. Disengage the vehicle steering lock located on the steering column. Steering locks may vary from vehicle to vehicle but will operate similarly.

FIGURE 2-10
VELCRO STEERING LOCK OFF

FIGURE 2-11
VELCRO STEERING LOCK ON

FIGURE 2-12
DEAD BOLT TYPE
STEERING LOCK DISENGAGED

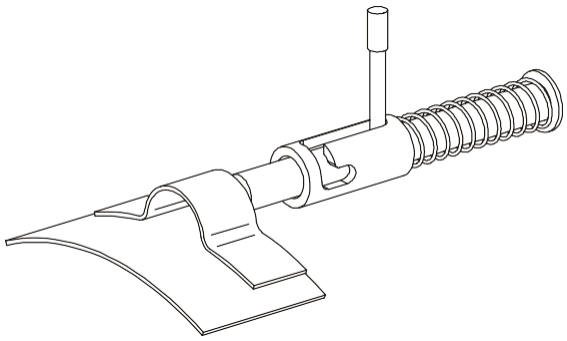
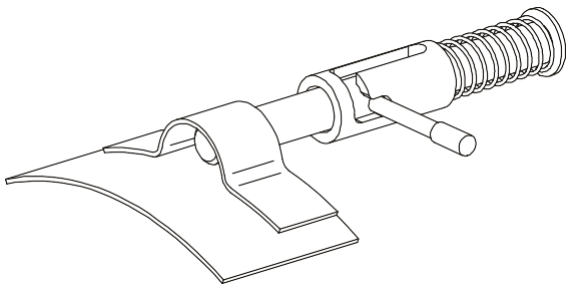


FIGURE 2-13
DEAD BOLT TYPE
STEERING LOCK ENGAGED



2.9 Removing Vehicle from Track

2.9.4 Hand Pump Operation (If Equipped) - See Figure 2-14

Note: The hand pump is only used to raise the guide wheels. It cannot be used to lower the guide wheels.

1. The location of the ball valve (1) and hand pump (2) will vary depending on the application.
2. Disengage the push / pull cable lock.
3. Rotate the ball valve handle (1) to the open position (valve handle parallel with the line).
4. Insert the provide pump handle in the hand pump. Operate the hand pump (2) to raise the guide wheels. When the guide wheels are fully raised, engage the push / pull cable lock. Rotate the ball valve handle (1) to the closed position (valve handle perpendicular to the line). Remove and store the provided pump handle.

FIGURE 2-14
RAISING GUIDE WHEELS WITH HAND PUMP

2.10 Highway Operation

CAUTION

- **THIS MULTIPURPOSE VEHICLE HAS SPECIAL DESIGN AND EQUIPMENT FEATURES FOR OFF-ROAD USE. IT HANDLES DIFFERENTLY FROM AN ORDINARY PASSENGER CAR IN DRIVING CONDITIONS WHICH MAY OCCUR ON STREETS, HIGHWAYS AND OFF-ROAD. WEIGHT AND LOCATION OF AVAILABLE PAYLOAD MAY ALSO AFFECT THE HANDLING OF THIS VEHICLE. DRIVE WITH CARE AND WEAR SAFETY BELTS AT ALL TIMES. READ VEHICLE OWNER' S MANUAL FOR ADDITIONAL PRECAUTIONS.**

2.11 Towing Trailer / Equipment With Vehicle On Track

- **VEHICLE USED FOR TOWING MUST BE RATED BY VEHICLE MANUFACTURER FOR WEIGHT OF TRAILER / EQUIPMENT TO BE TOWED. DO NOT EXCEED VEHICLE MANUFACTURER'S MAXIMUM RATED TOWING CAPACITY.**

- **TOWING VEHICLE MUST WEIGH AS MUCH OR MORE THAN TRAILER / EQUIPMENT BEING TOWED.**

- **VEHICLE USED FOR TOWING MUST HAVE AN ADEQUATE BRAKE SYSTEM TO SAFELY DECELERATE AND STOP TOWING VEHICLE AND TRAILER / EQUIPMENT BEING TOWED.**

- **TOWING TRAILER / EQUIPMENT LENGTHENS STOPPING DISTANCES. ALLOW ADEQUATE DISTANCE FOR STOPPING. ANTICIPATE STOPS SO YOU CAN BRAKE GRADUALLY.**

- **STOPPING DISTANCE IS GREATER ON TRACK THAN ON TYPICAL ROAD SURFACES. APPLY BRAKES GRADUALLY TO AVOID SLIDING VEHICLE TIRES AND GUIDE WHEELS.**

- **TOW TRAILER / EQUIPMENT AT A REASONABLE SPEED, 20 MPH (32 km/h) MAXIMUM, TAKING INTO ACCOUNT TRACK CONDITIONS, TRACK GRADE, WEATHER, VISIBILITY AND STOPPING DISTANCE TO ASSURE SAFE OPERATION. RAILROAD RULES GOVERNING SPEEDS AND RIGHT OF WAY SHOULD BE OBSERVED AT ALL TIMES.**

- **TRAILER / EQUIPMENT BEING TOWED MUST BE IN A SAFE, USABLE CONDITION TO BE TOWED.**

- **MAKE SURE THAT VEHICLE HAS:**
  - **FRONT AND REAR GUIDE WHEELS LOWERED AND LOCKED IN RAIL POSITION.**
  - **ALL FRONT AND REAR GUIDE WHEEL FLANGES ENGAGED ON INSIDE OF RAILS.**
  - **STEERING WHEEL LOCK ENGAGED WITH FRONT WHEELS STRAIGHT AHEAD.**

FAILURE TO HEED THESE WARNINGS COULD RESULT IN SEVERE BODILY INJURY.

2.11 Towing Trailer / Equipment With Vehicle On Track

- **CAREFULLY AND THOROUGHLY PREPARE VEHICLE FOR TOWING, MAKING SURE TO USE THE RIGHT TOWING EQUIPMENT AND TO ATTACH IT PROPERLY.**
- **TOWING EQUIPMENT (HITCHES, TOW BARS, ETC.) MUST BE ATTACHED TO VEHICLE FRAME. DO NOT MOUNT OR ATTACH TOWING EQUIPMENT TO VEHICLE GUIDE WHEEL UNITS.**
- **TOWING EQUIPMENT (HITCHES, TOW BARS, ETC.) MUST HAVE A RATED TOWING CAPACITY EQUAL TO OR GREATER THAN WEIGHT OF TRAILER / EQUIPMENT BEING TOWED.**
- **USE A RIGID TYPE TOW BAR WITH SAFETY LOCKING COUPLERS. DO NOT USE CHAIN, WIRE ROPE ETC.**
- **OBSERVE AND FOLLOW ALL RAILROAD SAFETY RULES AND REGULATIONS.**
- **DO NOT ACCELERATE SUDDENLY. TRACTION IS REDUCED ON RAIL, SPINNING VEHICLE TIRES COULD DAMAGE THEM.**

FAILURE TO HEED THESE PRECAUTIONS COULD RESULT IN BODILY INJURY AND/OR PROPERTY DAMAGE.

2.11 Towing Trailer / Equipment With Vehicle On Track

1. See your vehicle operator's manual for towing information.

2. Use the vehicle manufacturer's recommendations to determine the maximum weight the towing vehicle can tow. Do not exceed the vehicle manufacturer's maximum rated towing capacity.

3. The towing vehicle must have an adequate brake system to safely decelerate and stop the towing vehicle and the trailer / equipment being towed. The towing vehicle must weigh as much or more than the trailer / equipment being towed.

4. Make sure that the vehicle has:
   a. Front and rear guide wheels lowered and locked in the rail position.
   b. All front and rear guide wheel flanges engaged on the inside of the rails.
   c. Front wheels are set straight ahead and the steering wheel lock is engaged on the steering column.

5. Make sure the towing vehicle and the trailer / equipment are in good working condition (tires, brakes, lights, etc.) and that current maintenance has been performed on the vehicle and trailer / equipment.

6. The towing equipment (hitches, tow bars, etc.) on the towing vehicle must have a rating equal to or greater than the weight of the trailer / equipment being towed.

7. The towing equipment (hitches, tow bars, etc.) must be attached to the towing vehicle frame. Do not mount or attach the towing equipment to the guide wheel units.

8. Observe and follow all railroad safety rules and regulations.

9. Do not accelerate suddenly. Traction is reduced on track. Spinning the vehicle tires could damage them.

10. Stopping distance is greater on track than on typical road surfaces. Apply the vehicle brakes gradually to avoid sliding the vehicle tires and the guide wheels. Towing trailer / equipment lengthens stopping distances. Allow adequate distance for stopping. Anticipate stops so that you can brake gradually.

11. Tow the trailer / equipment on the track at a reasonable speed, 20 MPH (32 km/h) maximum, taking into account track conditions, track grade, weather, visibility and stopping distance to assure safe operation. Railroad rules and regulations governing speed limits and right of way should be observed at all times.

12. Always chock the trailer wheels before unhooking the trailer from the towing vehicle.

2.12 Towing Trailer / Equipment With Vehicle On Road

- **VEHICLE USED FOR TOWING MUST BE RATED BY VEHICLE MANUFACTURER FOR WEIGHT OF TRAILER / EQUIPMENT TO BE TOWED. DO NOT EXCEED VEHICLE MANUFACTURER'S MAXIMUM RATED TOWING CAPACITY.**

- **VEHICLE USED FOR TOWING MUST HAVE AN ADEQUATE BRAKE SYSTEM TO SAFELY DECELERATE AND STOP TOWING VEHICLE AND TRAILER / EQUIPMENT BEING TOWED.**

- **TOWING TRAILER / EQUIPMENT LENGTHENS STOPPING DISTANCES. ALLOW ADEQUATE DISTANCE FOR STOPPING. ANTICIPATE STOPS SO YOU CAN BRAKE GRADUALLY.**

- **TOW TRAILER / EQUIPMENT AT A REASONABLE SPEED TAKING INTO ACCOUNT ROAD CONDITIONS, ROAD GRADE, WEATHER, VISIBILITY AND STOPPING DISTANCE TO ASSURE SAFE OPERATION. POSTED SPEED LIMITS SHOULD BE OBSERVED AT ALL TIMES.**

- **TRAILER / EQUIPMENT BEING TOWED MUST BE IN A SAFE, USABLE CONDITION TO BE TOWED.**

- **MAKE SURE THAT VEHICLE HAS:**
  - **FRONT AND REAR GUIDE WHEEL UNITS RAISED AND LOCKED IN HIGHWAY POSITION.**
  - **STEERING WHEEL LOCK DISENGAGED.**

FAILURE TO HEED THESE WARNINGS COULD RESULT IN SEVERE BODILY INJURY.

2.12 Towing Trailer / Equipment With Vehicle On Road

- **THIS MULTIPURPOSE VEHICLE HAS SPECIAL DESIGN AND EQUIPMENT FEATURES FOR OFF-ROAD USE. IT HANDLES DIFFERENTLY FROM AN ORDINARY PASSENGER CAR IN DRIVING CONDITIONS WHICH MAY OCCUR ON STREETS, HIGHWAYS AND OFF-ROAD. WEIGHT AND LOCATION OF AVAILABLE PAYLOAD MAY ALSO AFFECT THE HANDLING OF THIS VEHICLE. DRIVE WITH CARE AND WEAR SAFETY BELTS AT ALL TIMES. READ VEHICLE OWNER' S MANUAL FOR ADDITIONAL PRECAUTIONS.**

- **OBSERVE AND FOLLOW ALL FEDERAL, STATE AND LOCAL DRIVING RULES AND REGULATIONS.**

- **STATE LAWS MAY REQUIRE TOWING VEHICLE AND TRAILER / EQUIPMENT BEING TOWED TO BE EQUIPPED WITH SPECIAL SAFETY EQUIPMENT (MIRRORS ON BOTH SIDES OF TOWING VEHICLE, TRAILER BRAKES, TRAILER LIGHTS, ETC.).**

- **CAREFULLY AND THOROUGHLY PREPARE YOUR VEHICLE FOR TOWING, MAKING SURE TO USE THE RIGHT TOWING EQUIPMENT AND TO ATTACH IT PROPERLY.**

- **TOWING EQUIPMENT (HITCHES, TOW BARS, ETC.) MUST BE ATTACHED TO VEHICLE FRAME. DO NOT MOUNT OR ATTACH TOWING EQUIPMENT TO WHEEL UNITS.**

- **TOWING EQUIPMENT (HITCH, TOW BAR, ETC.) MUST HAVE A RATED TOWING CAPACITY EQUAL TO OR GREATER THAN WEIGHT OF TRAILER / EQUIPMENT BEING TOWED.**

FAILURE TO HEED THESE PRECAUTIONS COULD RESULT IN BODILY INJURY AND/OR PROPERTY DAMAGE.

2.12 Towing Trailer / Equipment With Vehicle On Road

1. See your vehicle operator's manual for towing information.

2. Use the vehicle manufacturer's recommendations to determine the maximum weight the towing vehicle can tow. Do not exceed the vehicle manufacturer's maximum rated towing capacity.

3. The towing vehicle must have an adequate brake system to safely decelerate and stop the towing vehicle and the trailer / equipment being towed. Towing trailer / equipment lengthens stopping distances. Allow adequate distance for stopping. Anticipate stops so that you can brake gradually.

4. Make sure that the vehicle has:
   a. Front and rear guide wheel units raised and locked in the highway position.
   b. Steering wheel lock is disengaged on the steering column.

5. Make sure the towing vehicle and the trailer / equipment are in good working condition (tires, brakes, lights, etc.) and that current maintenance has been performed on the vehicle and trailer / equipment.

6. The towing equipment (hitches, tow bars, etc.) on the towing vehicle must have a rating equal to or greater than the weight of the trailer / equipment being towed.

7. The towing equipment (hitches, tow bars, etc.) must be attached to the towing vehicle frame. Do not mount or attach the towing equipment to the guide wheel units.

8. Observe and follow all federal, state and local driving rules, regulations and laws.

9. State laws may require the towing vehicle and/or the trailer / equipment being towed to be equipped with special safety equipment (mirrors on both sides of the towing vehicle, trailer brakes, trailer lights, etc.).

10. Tow the trailer / equipment on the road at a reasonable speed taking into account road conditions, road grade, weather, visibility and stopping distance to assure safe operation. Always observe posted speed limits.

11. Always chock the trailer wheels before unhooking the trailer from the towing vehicle.

2.13 Towing Disabled Vehicle On Track

- **TOWING VEHICLE / MACHINE MUST WEIGH AS MUCH OR MORE THAN DISABLED VEHICLE BEING TOWED.**
- **VEHICLE / MACHINE USED FOR TOWING MUST HAVE AN ADEQUATE BRAKE SYSTEM TO SAFELY DECELERATE AND STOP TOWING VEHICLE / MACHINE AND DISABLED VEHICLE BEING TOWED.**
- **TOWING DISABLED VEHICLE LENGTHENS STOPPING DISTANCES. ALLOW ADEQUATE DISTANCE FOR STOPPING. ANTICIPATE STOPS SO YOU CAN BRAKE GRADUALLY.**
- **TOW DISABLED VEHICLE AT A REASONABLE SPEED, 10 MPH (16 km/h) MAXIMUM, TAKING INTO ACCOUNT TRACK CONDITIONS, TRACK GRADE, WEATHER, VISIBILITY AND STOPPING DISTANCE TO ASSURE SAFE OPERATION. RAILROAD RULES GOVERNING SPEED LIMITS AND RIGHT OF WAY SHOULD BE OBSERVED AT ALL TIMES.**
- **STOPPING DISTANCE IS GREATER ON TRACK THAN ON TYPICAL ROAD SURFACES. APPLY BRAKES GRADUALLY TO AVOID SLIDING TOWING VEHICLE / MACHINE WHEELS.**
- **MAKE SURE THAT DISABLED VEHICLE HAS:**
  - **FRONT AND REAR GUIDE WHEEL UNITS LOWERED AND LOCKED IN RAIL POSITION.**
  - **ALL FRONT AND REAR GUIDE WHEEL FLANGES ENGAGED ON INSIDE OF RAILS.**
  - **STEERING WHEEL LOCK ENGAGED WITH FRONT WHEELS STRAIGHT AHEAD.**

FAILURE TO HEED THESE WARNINGS COULD RESULT IN SEVERE BODILY INJURY.

2.13 Towing Disabled Vehicle On Track

- **TOW BAR MUST BE ATTACHED TO DISABLED VEHICLE FRAME. DO NOT MOUNT OR ATTACH TOW BAR TO DISABLED VEHICLE GUIDE WHEEL UNITS.**
- **TOW BAR MUST HAVE A RATED TOWING CAPACITY EQUAL TO OR GREATER THAN WEIGHT OF DISABLED VEHICLE BEING TOWED.**
- **USE A RIGID TYPE TOW BAR WITH SAFETY LOCKING COUPLERS. DO NOT USE CHAIN, WIRE ROPE ETC.**
- **OBSERVE AND FOLLOW ALL RAILROAD SAFETY RULES AND REGULATIONS.**
- **DO NOT ACCELERATE SUDDENLY. TRACTION IS REDUCED ON TRACK, SPINNING TOWING VEHICLE / MACHINE WHEELS COULD DAMAGE THEM.**
- **TOW DISABLED VEHICLE TO NEAREST ROAD CROSSING AND REMOVE FROM TRACK.**

FAILURE TO HEED THESE PRECAUTIONS COULD RESULT IN BODILY INJURY AND/OR PROPERTY DAMAGE.

2.13 Towing Disabled Vehicle On Track

1. See your vehicle operator's manual for towing information.

2. The towing vehicle / machine must have an adequate brake system to safely decelerate and stop the towing vehicle / machine and the disabled vehicle being towed. The towing vehicle / machine must weigh as much or more than the disabled vehicle towed.

3. Make sure that the disabled vehicle has:
   a. Front and rear guide wheel units lowered and locked in the rail position.
   b. All front and rear guide wheel flanges engaged on the inside of the rails.
   c. Front wheels are set straight ahead and the steering wheel lock is engaged on the steering column.

4. Make sure the towing vehicle / machine is in good working condition (tires, brakes, lights, etc.) and that current maintenance has been performed on the vehicle / machine.

5. The towing equipment (hitches, tow bars, etc.) on the towing vehicle / machine must have a rating equal to or greater than the weight of the disabled vehicle being towed.

6. The tow bar must be mounted or attached to the disabled vehicle's frame. Do not mount or attach the tow bar to the disabled vehicle guide wheel units. Use a rigid type tow bar with safety locking couplers.

7. Observe and follow all railroad safety rules and regulations.

8. Do not accelerate suddenly. Traction is reduced on track. Spinning the towing vehicle tires / machine wheels could damage them.

9. Stopping distance is greater on track than on typical road surfaces. Apply the towing vehicle / machine brakes gradually to avoid sliding the vehicle tires / machine wheels. Towing disabled vehicle lengthens stopping distances. Allow adequate distance for stopping. Anticipate stops so that you can brake gradually.

10. Tow the disabled vehicle on the track at a reasonable speed, 10 MPH (16 km/h) maximum, taking into account track conditions, track grade, weather, visibility and stopping distance to assure safe operation. Railroad rules and regulations governing speed limits and right of way should be observed at all times.

11. Tow the disabled vehicle to the nearest road crossing and remove the vehicle from the track.

2.14 Towing Disabled Vehicle On Road

- **TOW DISABLED VEHICLE PER VEHICLE MANUFACTURER'S TOWING SPECIFICATIONS LISTED IN YOUR VEHICLE'S OPERATORS MANUAL.**
- **VEHICLE USED FOR TOWING MUST HAVE AN ADEQUATE BRAKE SYSTEM TO SAFELY DECELERATE AND STOP TOWING VEHICLE AND DISABLED VEHICLE BEING TOWED.**
- **TOW DISABLED VEHICLE AT A REASONABLE SPEED TAKING INTO ACCOUNT ROAD CONDITIONS, ROAD GRADE, WEATHER, VISIBILITY AND STOPPING DISTANCE TO ASSURE SAFE OPERATION. POSTED SPEED LIMITS SHOULD BE OBSERVED AT ALL TIMES.**
- **MAKE SURE DISABLED VEHICLE HAS:**
  - **FRONT AND REAR GUIDE WHEEL UNITS RAISED AND LOCKED IN HIGHWAY POSITION.**
  - **STEERING WHEEL LOCK DISENGAGED.**

FAILURE TO HEED THESE WARNINGS COULD RESULT IN SEVERE BODILY INJURY.

- **TOWING EQUIPMENT (TOW TRUCK, TOW BARS, ETC.) MUST BE ATTACHED TO DISABLED VEHICLE FRAME. DO NOT MOUNT OR ATTACH TOWING EQUIPMENT TO DISABLED VEHICLE GUIDE WHEEL UNITS.**
- **TOWING EQUIPMENT (TOW TRUCK, TOW BARS, ETC.) MUST HAVE A RATED TOWING CAPACITY EQUAL TO OR GREATER THAN WEIGHT OF DISABLED VEHICLE BEING TOWED.**
- **OBSERVE AND FOLLOW ALL FEDERAL, STATE AND LOCAL DRIVING RULES AND REGULATIONS.**
- **STATE LAWS MAY REQUIRE TOWING VEHICLE AND DISABLED VEHICLE TO BE EQUIPPED WITH SPECIAL SAFETY EQUIPMENT (LIGHTS, ETC.).**

FAILURE TO HEED THESE PRECAUTIONS COULD RESULT IN BODILY INJURY AND/OR PROPERTY DAMAGE.

2.14 Towing Disabled Vehicle On Road

1. See your vehicle operator's manual for towing information.

2. The towing vehicle must have an adequate brake system to safely decelerate and stop the towing vehicle and the disabled vehicle being towed.

3. Make sure that the disabled vehicle's:
   a. Front and rear guide wheel units are raised and locked in the highway position.
   b. Vehicle steering wheel lock is disengaged on the steering column.

4. Make sure the towing vehicle is in good working condition (tires, brakes, lights, etc.) and that current maintenance has been performed on the vehicle.

5. The towing equipment (tow truck, tow bars, etc.) on the towing vehicle must have a rating equal to or greater than the weight of the disabled vehicle being towed.

6. The towing equipment (tow truck, tow bars, etc.) must be mounted or attached to the disabled vehicle frame. Do not mount or attach the towing equipment to the disabled vehicle guide wheel units.

7. Observe and follow all federal, state and local driving rules, regulations and laws.

8. State laws may require the towing vehicle and disabled vehicle being towed to be equipped with special safety equipment (lights, etc.).

9. Tow the disabled vehicle on the road at a reasonable speed taking into account road conditions, road grade, weather, visibility and stopping distance to assure safe operation. Always observe posted speed limits.

SECTION 3 - ADJUSTMENTS
TABLE OF CONTENTS

3.1 Guide Wheel Equipment Alignment Procedure

- **BEFORE PERFORMING ANY ADJUSTMENTS TO THE GUIDE WHEEL UNITS OR VEHICLE, ALWAYS PLACE THE AUTOMATIC TRANSMISSION IN "PARK" OR THE MANUAL TRANSMISSION IN "NEUTRAL". APPLY THE PARKING BRAKE.**

- **UNDERSTAND EQUIPMENT OPERATION AND BE AWARE OF ALL PINCH POINTS BEFORE OPERATING OR MAKING ADJUSTMENTS TO THE GUIDE WHEEL EQUIPMENT.**

  FAILURE TO HEED THESE WARNINGS COULD RESULT IN SEVERE BODILY INJURY.

The Guide Wheel Alignment Procedure must be completed when the guide wheel equipment is applied to the vehicle, or when any of the misalignment indicators occur. See Operation Section -Misalignment Indicators.

3.1.1 Vehicle Check

1. The vehicle must be at curb weight with permanent attachments: spare tire, tool box less tools, utility box, crane, aerial lift boom, etc. and without: passengers, baggage, load, etc.

2. Weigh the entire vehicle and record this weight. Weigh both the front and rear axles of the vehicle separately and record these weights. The weight of the vehicle should not exceed the GVWR (Gross Vehicle Weight Rating) and the weight on the front and rear axles should not exceed their respective GAWR (Gross Axle Weight Rating).

3. Permanent attachments to the vehicle such as a tool box, utility box, crane aerial lift boom, etc. which could cause uneven loading on the guide wheels should be compensated for by adjusting the vehicle suspension by adding leaf springs, coil springs, torsion bars, etc.

4. Tires properly inflated: 80 PSI for Chevrolet vehicles.
   95 PSI for Ford vehicles.

5. Visually inspect the entire vehicle, especially the guide wheel equipment for loose or missing bolts and bent or damaged components. Tighten, repair or replace as necessary.

6. Verify that the vehicle that the guide wheel equipment is being mounted on is equipped correctly (springs, tires, wheels, etc.).

3.1 Guide Wheel Equipment Alignment Procedure

3.1.1 Vehicle Check

7. Check the following measurements on the vehicle that the guide wheel equipment is to be mounted on before applying the guide wheel equipment to the vehicle.

    a. Frame must be square. Diagonal measurements of frame should be equal within 1/8 inch (3.2 mm).

    b. Wheelbase (as measured on each side) must be equal within 1/16 inch (1.8 mm).

    c. Vehicle axles must be square with the frame within 1/64 inch per foot (.4 mm per 305 mm). Harsco Rail recommends that this be checked by a reputable alignment shop.

8. Follow the mounting instructions on the application drawing which is supplied with each Guide Wheel Equipment Group.

    Note: The applicator of the guide wheel equipment must make sure the application drawings remain with the vehicle for further reference. If the application drawings are not with the vehicle, contact Harsco Rail, Fairmont Minnesota Facility to obtain these drawings.

9. After mounting the guide wheel equipment, have a four point alignment completed on the vehicle including checking the caster, camber, toe-in and torsion bar specifications on the front wheels. Also, check the thrust angle of the rear axle. The thrust angle of the rear axle should be set as close to zero as possible. If necessary, adjust to vehicle manufacturer's recommendations.

10. If necessary, have the headlight aim checked and adjusted.

3.1.2 Placing Vehicle On Track

1. Place the vehicle on straight, level, tangent track or on an alignment rack constructed for guide wheel equipment alignment. If track or an alignment rack is not available, use 4 x 6 inch lumber, on a level floor, to simulate track. Space the lumber so it measures 57-1/2 inches between the inside edges. Using 4 x 6 inch lumber will allow the wheel weighing jack to fit underneath the wheel arm to weigh the guide wheel load when the guide wheels are in the "rail" position.

2. Place the automatic transmission in "Park" or manual transmission in "Neutral". Apply the parking brake. Stop the engine. Lower and lock the guide wheels in the "rail" position. See Operation Section - Placing Vehicle On Track.

3. Set the vehicle wheels straight ahead. Secure the steering wheel using the steering lock. Stop the engine.

3.1 Guide Wheel Equipment Alignment Procedure

3.1.3 Guide Wheel Back Flange Gauge - See Figure 3-1

1. Measure the back flange gauge of the front and rear guide wheel units. Measure from the back of the left wheel flange, directly below the center line of the wheel spindle, to the same point on the right wheel flange. This dimension must be 53-3/16 - 53-5/8 inches (1351 - 1362 mm).

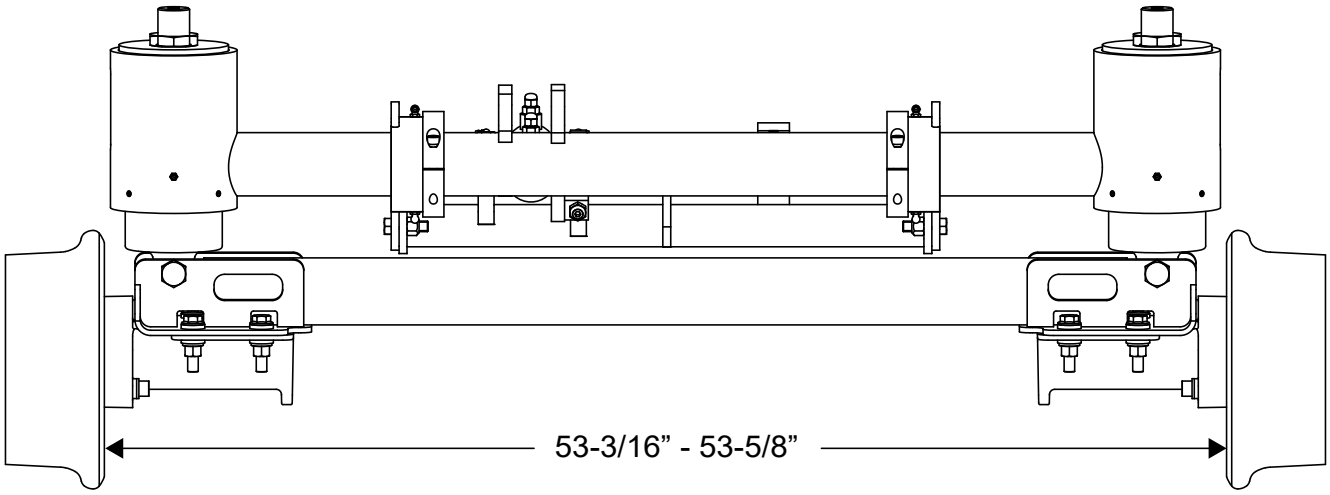
2. Although the front and rear guide wheel unit back flange gauge is preset at the factory, it is possible for the back flange gauge to change when guide wheel alignment procedures are performed on the guide wheel unit.

3. Always check the guide wheel back flange gauge after performing any guide wheel alignment procedures to ensure the back flange gauge is within the allowable limits.

3.1 Guide Wheel Equipment Alignment Procedure

3.1.3 Guide Wheel Back Flange Gauge

FIGURE 3-1
GUIDE WHEEL BACK FLANGE GAUGE



3.1 Guide Wheel Equipment Alignment Procedure

- **IMPROPER LOADING OF GUIDE WHEEL EQUIPPED VEHICLE CAN CAUSE DERAILMENT OF VEHICLE.**
- **APPLY VEHICLE PARKING BRAKE AND STOP VEHICLE ENGINE BEFORE CHECKING GUIDE WHEEL LOAD.**
- **ALWAYS CHECK THE GUIDE WHEEL LOAD BEFORE OPERATING THE VEHICLE ON TRACK. NEVER OPERATE THE VEHICLE ON TRACK IF LOAD EXCEEDS THE MAXIMUM RATED LOAD ON THE FRONT AND/OR REAR GUIDE WHEEL UNITS. THE MAXIMUM LOAD ON THE FRONT OR REAR GUIDE WHEEL UNIT IS:**
  STEEL TREAD GUIDE WHEELS:
  1,500 lbs (680 kg) Maximum Per Guide Wheel
  RUBBER TREAD GUIDE WHEELS:
  700 lbs (318 kg) Maximum Per Guide Wheel
- **DO NOT USE ANY OTHER JACK THEN THE HARSCO RAIL WHEEL WEIGHING JACK NO. 3422565 TO CHECK THE GUIDE WHEEL LOAD. USE OF ANY OTHER JACK WILL RESULT IN INCORRECT GUIDE WHEEL LOAD INFORMATION.**
- **MISUSE OF THE WHEEL WEIGHING JACK MAY CAUSE GAUGE TO EXPLODE. READ ANSI B40.1 AND APPARATUS INSTALLATION / OPERATING INSTRUCTIONS BEFORE USE.**
- **DO NOT USE THE WHEEL WEIGHING JACK TO LIFT THE VEHICLE. EXCESSIVE WEIGHT MAY CAUSE THE JACK TO FAIL.**

FAILURE TO HEED THESE WARNINGS COULD RESULT IN DERAILMENT OF VEHICLE AND/OR SEVERE BODILY INJURY.

3

3.1.4 Guide Wheel Load

3.1.4.1 Checking Guide Wheel Load

SEE SECTION 2.6.1 FOR GUIDE WHEEL LOAD CHECK

3.1 Guide Wheel Equipment Alignment Procedure

3.1.4 Guide Wheel Load

3.1.4.2 Adjusting Guide Wheel Load - See Figure 3-2 and Figure 3-3

1. With the vehicle at curb weight the spring cell must be set to the recommended guide wheel load of 500 lbs ± 25 lbs (227 kg ± 11 kg) per guide wheel. The recommended guide wheel load must also be equal on the left and right sides of the front or rear guide wheel unit.

2. See Figure 3-3. To adjust the spring cell load, raise the guide wheels and let them rest on the rails. Do not adjust the spring cell with any load on the guide wheels.

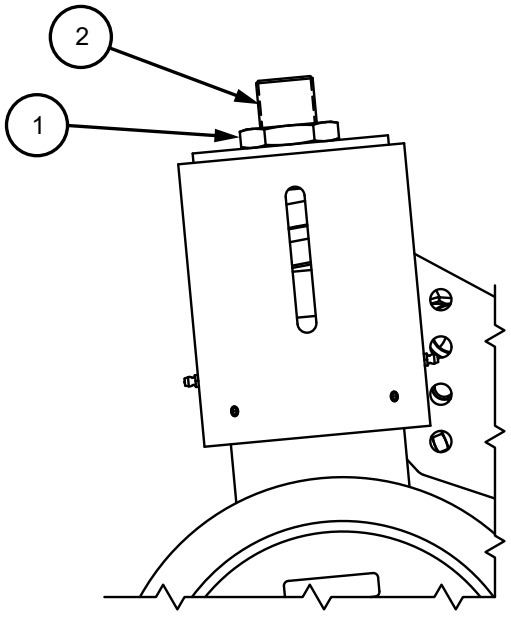
   Loosen lock nut (1). Insert a 1/2 inch drive ratchet into the 1/2 inch socket in the adjusting stud (2). Turn the adjusting stud clockwise to increase the load on the guide wheel or counter-clockwise to decrease the load on the guide wheel. Tighten lock nut (1).

3. See Figure 3-2. Lower and lock the guide wheels in the rail position. See Checking Guide Wheel Load. Use the Wheel Weighing Jack to determine the load on the guide wheel.

4. Repeat Steps 1 through 3 until the guide wheel unit is set at the recommend guide wheel load. The recommended guide wheel load must be equal on the left and right sides of the front or rear guide wheel unit.

5. If the spring cells cannot be adjusted to the recommended guide wheel load, the guide wheel unit must be repositioned in a different set of mounting holes.

FIGURE 3-3
ADJUSTING GUIDE WHEEL LOAD

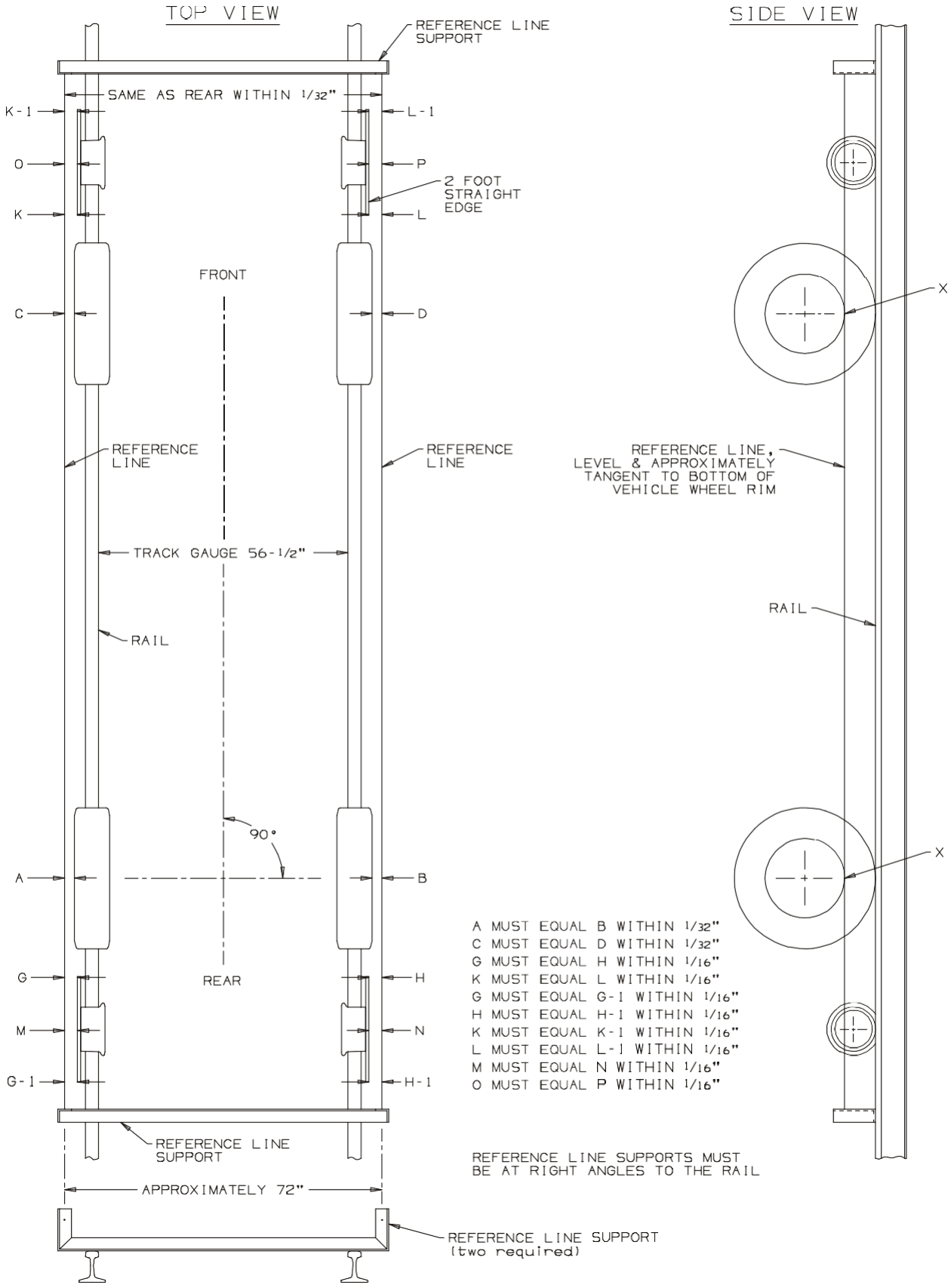


NOTES

NOTES

3.1 Guide Wheel Equipment Alignment Procedure

FIGURE 3-4
GUIDE WHEEL EQUIPMENT ALIGNMENT



3.1 Guide Wheel Equipment Alignment Procedure

3.1.5 String Lining Set-Up - See Figure 3-4

1. The string lining procedure is only a guide to check and make alignment adjustments to the guide wheel equipment. String lining the vehicle and guide wheel equipment will not guarantee that the guide wheel equipped vehicle will track properly. Harsco Rail recommends that all HY-RAIL® equipped vehicles be track tested. The vehicle should be at its normal operating load for track testing. The vehicle should be track tested when:

   a. The guide wheel equipment is installed on the vehicle.
   b. Any adjustments are made to the guide wheel equipment.
   c. The load on the vehicle is changed.
   d. Periodically to ensure that the vehicle is tracking properly.

2. Establish parallel reference lines on each side of vehicle as shown in Figure 3-4.

3. Parallel reference lines can be established by building two supports or brackets. These can be built out of scrap angle iron or other material. The supports should be approximately 6 inches high, and a few inches longer than the width of the vehicle. Wires or cords stretched between the front and rear supports will be the reference lines. The wires or cords should be spaced approximately 72 inches apart. The distance between the wires or cords must be equal or within 1/32 inch at each support.

4. Clamp the supports to the rail in front of and behind the vehicle. The supports should be at right angles to the rail. Stretch the wires or cords between the supports, level with the bottom edge of the vehicle wheel rim (point X). The reference lines must be level.

5. Shift the supports on the rail until dimensions A = B and C = D are equal or within 1/32 inch. These measurements should be taken from the bead seat of the vehicle rim directly below the axle (point X) to the reference line. When shifting the supports, keep them at right angles to the rail so the reference lines stay level and parallel to each other.

6. After the reference lines have been established, measurements can be taken from these lines to the guide wheels to ensure correct alignment.

3.1 Guide Wheel Equipment Alignment Procedure

3.1.6 Guide Wheel Unit Alignment

3.1.6.1 Checking Guide Wheel Unit Alignment - See Figures 3-4 and 3-5

1. Lower and lock the guide wheels in the "rail" position. Take measurements M, N, O & P. Measure from the outer edge of the guide wheels, directly below the center line of the wheel spindle, to the reference line. Measurements M, N, O & P must all be equal or within 1/16 inch. If not, see Adjustment.

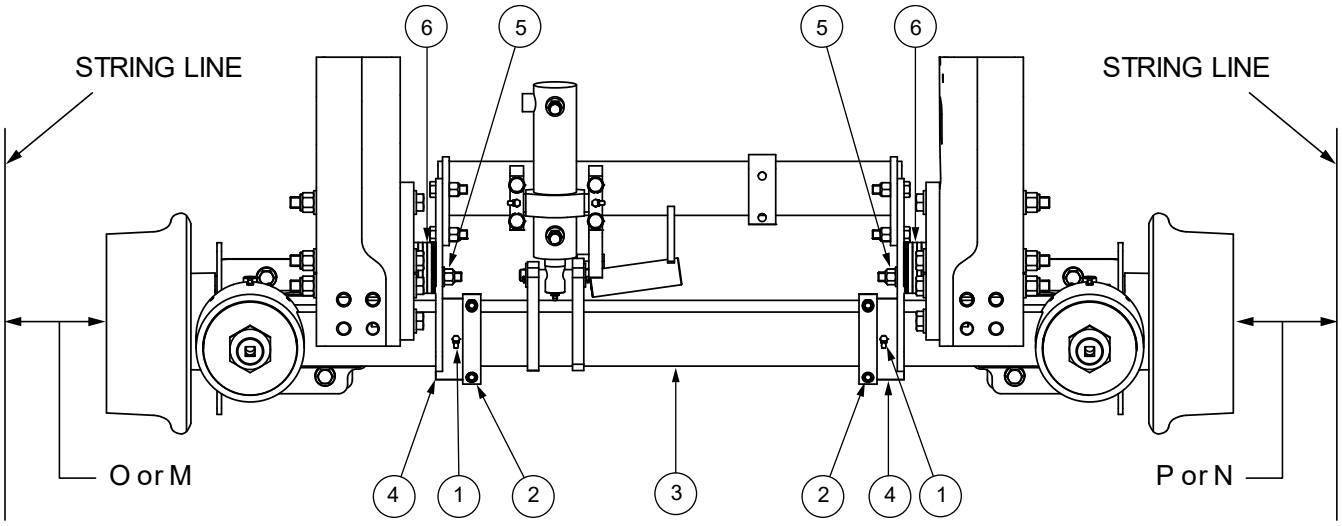
3.1.6.2 Adjusting Guide Wheels

1. Unlock and raise the front and/or rear guide wheels until they rest on the rail.
2. Loosen the four socket head cap screws (1) on collars (2).
3. Shift the entire cross tube and axle assembly (3) until measurements M & N or O & P are all equal. Make sure collars (2) are snug against the frame mounting assembly (4).
4. Re-tighten socket head cap screws (1). Torque to 35 lb-ft (47 N-m).
5. Lower and lock the guide wheels in the "rail" position. Recheck measurements M, N, O & P.
6. Repeat steps a through f until measurements M, N, O & P are all equal or within 1/16 inch.
7. If it is not possible to get enough horizontal movement of the guide wheels by moving the cross tube and axle assembly, it will be necessary to move the entire guide wheel unit in the mounting brackets.
8. Unlock and raise the front and/or rear guide wheels until they rest on the rail.
9. Loosen the six cap screws and nuts (5).
10. Remove the 1/16" or 1/4" shims (6) from one side and place on the other side between the unit and the mounting bracket.
11. Re-tighten cap screws and nuts (5). Torque to 76 lb-ft (103 N-m).
12. Lower and lock the guide wheels in the "rail" position. Recheck measurements M, N, O & P.
13. Repeat steps a through f until measurements M, N, O & P are all equal or within 1/16 inch.

3.1 Guide Wheel Equipment Alignment Procedure

3.1.6 Guide Wheel Unit Alignment

FIGURE 3-5
FRONT OR REAR GUIDE WHEEL UNIT - VIEWED FROM TOP



3.1 Guide Wheel Equipment Alignment Procedure

3.1.6 Guide Wheel Unit Alignment

3.1.6.1 Checking Guide Wheel Unit Alignment - See Figures 3-4 and 3-6

2. Lower and lock the guide wheels in the "rail" position. The guide wheels must track straight, not toed in or out. Hold a two foot long straight edge against the outer edge of the guide wheel with the straight edge centered on the guide wheel. Check that dimensions G = G-1, H = H-1, K = K-1 & L = L-1. These dimensions must be equal or within 1/16 inch. If not, see Adjustment.

Note: When verifying whether the guide wheel is toed-in or toed-out, it may be helpful to visualize the traveling direction of the vehicle when in rail position.

The guide wheel is toed-in if the front dimension of the straight edge to the reference line is larger than the rear dimension. (Example - Left Rear Guide Wheel: Dimension G is larger than dimension G-1).

The guide wheel is toed-out if the front dimension of the straight edge to the reference line is smaller than the rear dimension. (Example - Left Rear Guide Wheel: Dimension G is smaller than dimension G-1).

3.1.6.2 Adjusting Guide Wheels

14. Unlock and raise the front and/or rear guide wheels until they rest on the rail.

15. Loosen the four fasteners (1) that secure the stub axle (2) to the axle assembly (3) on the guide wheel that needs to be adjusted.

16. Holding the straight edge against the outer edge of the guide wheel, pivot the hub assembly (2) until the dimensions from both ends of the straight edge to the string line are equal or within 1/16" (dimensions G = G-1, H = H-1, K = K-1 & L = L-1).

17. Re-tighten fasteners (1). Torque to 110 lb-ft (150 N-m)

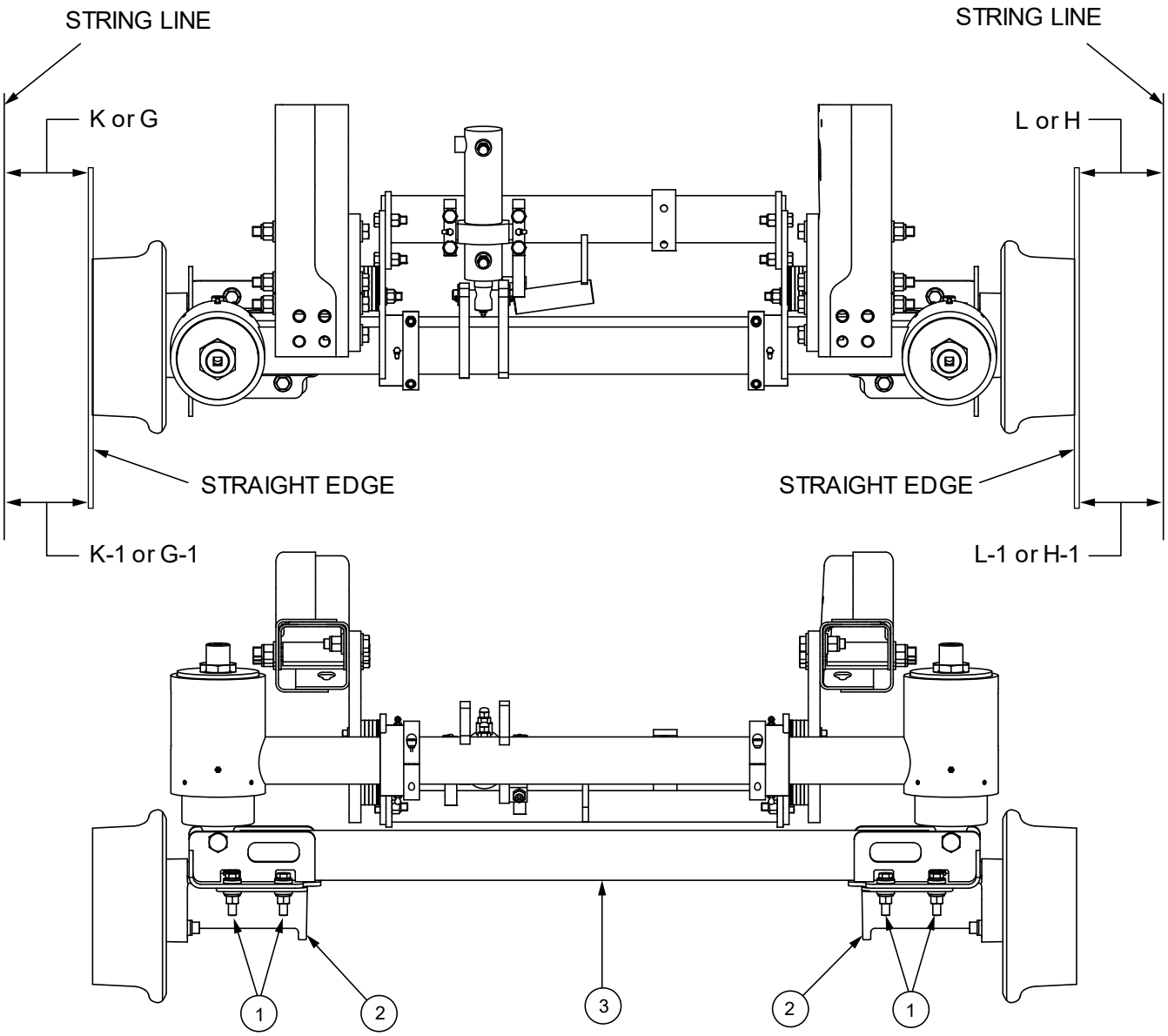
18. Lower and lock the guide wheels in the "rail" position. Recheck dimensions G = G-1, H = H-1, K = K-1 & L = L-1.

19. Repeat steps a through e until dimensions G = G-1, H = H-1, K = K-1 & L = L-1 are all equal or within 1/16 inch.

3.1 Guide Wheel Equipment Alignment Procedure

3.1.6 Guide Wheel Unit Alignment

FIGURE 3-6
FRONT OR REAR GUIDE WHEEL UNIT - VIEWED FROM TOP AND END



3.1 Guide Wheel Equipment Alignment Procedure

3.1.7 Vehicle Track Test

■ **CHECK AND CORRECT ALIGNMENT PROMPTLY IF MISALIGNMENT IS INDICATED. MISALIGNMENT OF GUIDE WHEEL EQUIPMENT COULD RESULT IN DERAILMENT OF THE VEHICLE AND SEVERE BODILY INJURY.**

1. Harsco Rail recommends that all HY-RAIL® equipped vehicles be track tested. The vehicle should be at its normal operating load for track testing. The vehicle should be track tested when:

   a. The guide wheel equipment is installed on the vehicle.
   b. Any adjustments are made to the guide wheel equipment.
   c. The load on the vehicle is changed.
   d. Periodically to ensure that the vehicle is tracking properly.

2. The vehicle must be placed on straight, level, tangent track. See Operation Section - Placing Vehicle On Track.

3. Apply spray paint to the flanges and treads of all guide wheels.

4. Lower and lock all guide wheels in the "rail" position.

5. Operate the vehicle for a short distance at a normal operating speed.

6. The paint should wear evenly around the flanges and treads of all guide wheels. If the paint is worn evenly on all guide wheels, the vehicle and guide wheel equipment is properly aligned.

7. If the paint did not wear evenly, note which guide wheels, flange and / or tread the paint is worn on.

   a. Repaint the flanges and treads on all guide wheels.
   b. Operate the vehicle in reverse for a short distance at a normal operating speed.
   c. Note which guide wheels, flange and / or tread the paint is worn on.
      If the paint wore off on the right front flange when traveling forward and then on the left rear flange when traveling in reverse, the vehicle is probably not aligned properly. Have the vehicle frame checked for proper alignment. See Vehicle Check.

8. If the vehicle pulls noticeable to the right when traveling forward, adjust the right front guide wheel to a slightly towed-in position. See Checking Guide Wheel Alignment.

9. If the vehicle pulls noticeable to the left when traveling forward, adjust the left front guide wheel to a slightly towed-in position. See Checking Guide Wheel Alignment.

10. If the vehicle continues to track improperly, repeat the String Lining and Guide Wheel Alignment Procedure.

3.2 Adjustments

3.2.1 Spring Cell Angle - See Figure 3-7

1. The guide wheel unit spring cell angle should be checked periodically and adjust if necessary.

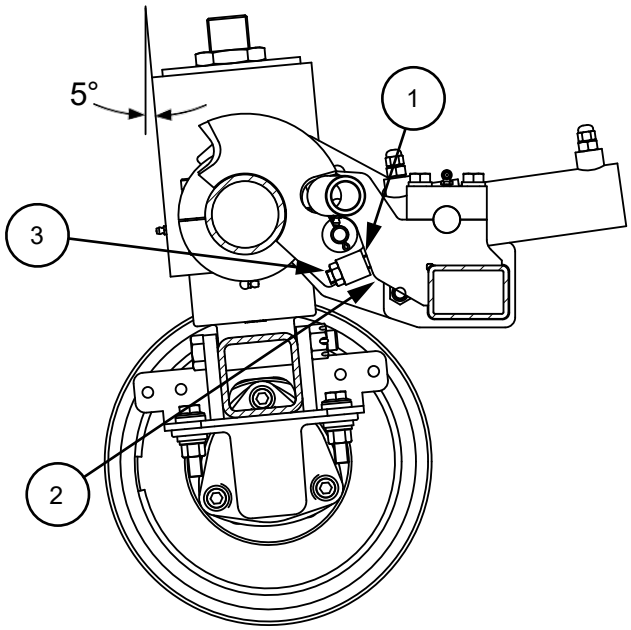
2. The spring cells should be adjusted so they are angled towards the center of the vehicle by approximately 5 degrees. Set screw (1) is used to set the angle of the spring cells when the unit is in the rail position.

3. Locate the vehicle on straight, level, tangent track. Lower the rear and front guide wheels to the rail position. Make sure the set screw (1) is against plate (2) on the guide wheel unit frame.

4. Hold and inclinometer on the front or rear of the spring cell tube. If the inclinometer indicates approximately 5 degrees, the spring cell angle is adjusted correctly. If not, the spring cell angle will need to be adjusted.

5. Raise the guide wheels. Loosen locknut (3). Rotate set screw (1) clockwise to decrease the angle or counter-clockwise to increase the angle. Tighten locknut (3). Lower the guide wheels to the rail position. Recheck the spring cell angle. Repeat adjustment procedure until the spring cell is angled approximately 5 degrees towards the center on the vehicle.

FIGURE 3-7
ADJUSTING SPRING CELL ANGLE



3.2 Adjustments

3.2.2 Rail Sweeps

3.2.2.1 Checking Rail Sweeps

1. Place the vehicle on straight, level track. Place the automatic transmission in "Park" or manual transmission in "Neutral". Apply the parking brake. Stop the engine.

2. Lower and lock the guide wheels in the "rail" position. The rear rail sweeps are mounted to the axle assembly and will lower to the rail when the guide wheels are lowered.

3. The rubber sweep (1) should clear the top of the rail by 1/4 inch (6.4 mm). If not, adjustment is necessary.

3.2.2.2 Adjusting Rail Sweeps - See Figure 3-8

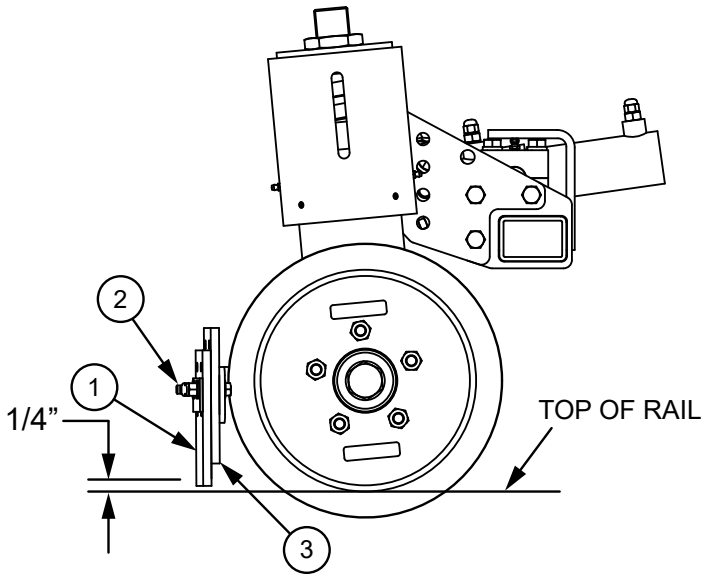
1. Loosen two fasteners (2). Adjust the rubber sweep (1) until the sweep clears the top of the rail by 1/4 inch (6.4 mm). Re-tighten the fasteners.

2. If the rubber sweep cannot be lowered because the fasteners are at the bottom of the slots in the mounting plate, remove the two fasteners. Relocate the fasteners in the next upper set of holes in the rubber sweep. Adjust the rubber sweep.

3. If the rubber sweep (1) is in the last, upper set of holes, move the rear sweep (3) to the front and the front sweep (1) to the rear as a stiffener. Adjust the rubber sweep.

4. When both rubber sweeps are worn and can not be adjusted lowered, replace both rubber sweeps.

FIGURE 3-8
CHECKING / ADJUSTING RAIL SWEEPS



SECTION 4 - MAINTENANCE
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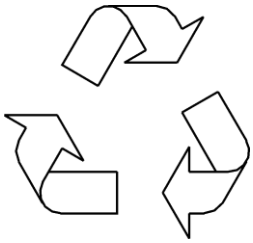
4.1 Waste Disposal



Dispose of waste properly. Improper disposal of waste can threaten the environment. The operation and maintenance of Harsco Rail equipment may involve the use of such items as hydraulic oil, engine oil, fuel, coolant, brake fluid, filters, batteries, etc.

Use leak proof containers when draining fluids. Do not pour waste onto the ground, down a drain, or into any water source. Inquire on the proper way to recycle or dispose of waste according to applicable Federal, State and/or local regulations.

4.2 Maintenance Schedule

- **RE-TORQUE VEHICLE WHEEL LUG NUTS, WHEEL SPACER LUG NUTS AND GUIDE WHEEL LUG NUTS AFTER FIRST 50 MILES OF OPERATION. THEREAFTER TORQUE WHEEL NUTS ACCORDING TO RECOMMENDED MAINTENANCE SCHEDULE. FAILURE TO HEED THIS WARNING COULD RESULT IN SEVERE BODILY INJURY.**

4.2.1 Daily:

1. Inspect both front and rear guide wheel units for damaged or missing parts.

2. Check the mechanical locks for proper operation. If the locks do not operate properly, repair or replace the lock mechanism.

3. Check the hydraulic fluid reservoir to ensure that the oil level is full. If low, fill to the proper level with the correct fluid.

4. When the vehicle is operated on the track, listen for unusual noises. Unusual noises may indicate incorrectly lowered guide wheels, or damaged or missing parts. Pay attention to the quality of the ride. Check alignment if the vehicle crowds one side of the track instead of floating from side to side. See Adjustment - Guide Wheel Equipment Alignment Procedure.

4.2 Maintenance Schedule

4.2.2 Weekly

1. Check guide wheel equipment alignment. See Adjustments Section, Guide Wheel Equipment Alignment Procedure - Vehicle Track Test.

2. Inspect guide wheel tread and flanges for wear or damage. See Maintenance - Guide Wheel Allowable Wear.

3. Spin each guide wheel by hand, checking for ease of rotation or excessive play. If the guide wheel does not rotate properly, the bearings and spindle may be damaged. Replace the bearing/spindle assembly if necessary.

4. Inspect vehicle wheels, studs, lug nuts and tires for wear, damage, cuts, etc.

5. Check that the tires are properly inflated: 80 PSI for Chevrolet vehicles.
   95 PSI for Ford vehicles.

6. Check all bolts for tightness. See Appendices, Appendix A - Bolt Torque Requirements Chart.

4.2.3 At 50 Vehicle Miles (80 Vehicle km):

1. At 50 vehicle miles (80 Km) after initial installation of vehicle wheels or when tires are rotated or new tires installed, torque wheel spacer lug nuts and vehicle wheel lug nuts to the recommended specifications. See the decal attached to the vehicle wheel for the recommended wheel bolt torque specifications. Thereafter refer to the wheel manufacturer's wheel torque specifications.

4.2.4 At 50 Track Miles (80 Vehicle km):

1. At 50 track miles (80 Km) after initial installation of the guide wheel unit, torque guide wheel lug nuts to the recommended specifications.

4.2.5 Every 2000 Track Miles (3200 Track km):

1. Lubricate the guide wheel equipment every 2000 track miles (maximum) or each time the vehicle is serviced. See Lubrication.

2. Lubricate the locking mechanism and other pivot points with light oil or a lubricating spray.

3. Torque guide wheel lug nuts to 90 lb-ft (122 N-m).

4.2.6 Annually:

1. Perform annual inspections as required by railroad rules and regulations.

4.3 Guide Wheel Unit Lubrication

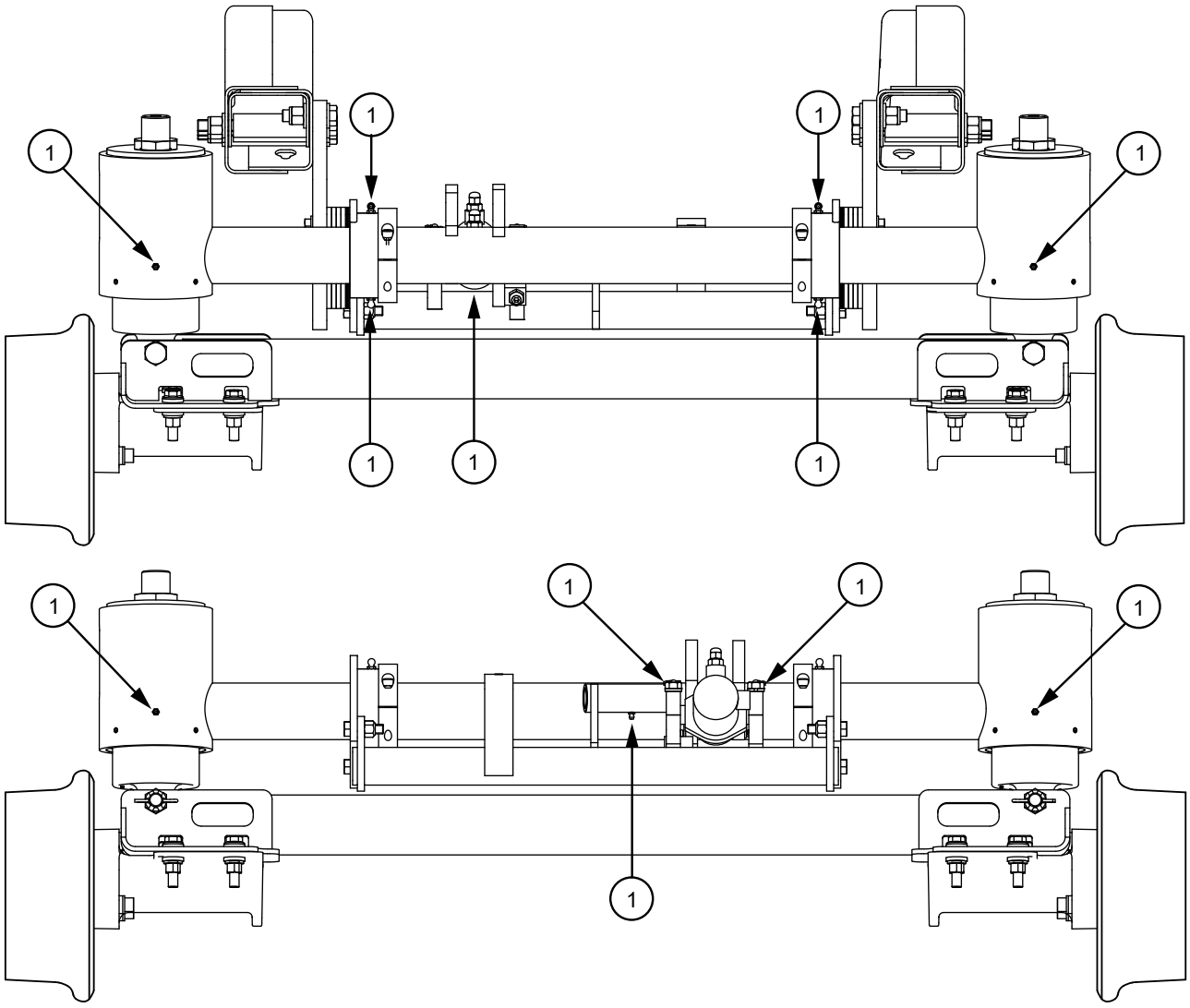
Lubricate the guide wheel equipment every 2000 track miles (3200 track km) maximum or each time the vehicle is serviced.

4.3.1 Guide Wheel Unit Lubrication - See Figure 4-1

1. Apply the vehicle parking brake. Stop the engine. Turn the vehicle's ignition switch off.
2. Lubricate all grease fittings (1) using Mobil Special Moly or equivalent.
3. Lubricate the locking mechanism and other pivot points with a light weight oil or a lubricating spray.

   Note: HR1500 Series D guide wheel equipment utilizes sealed bearings in the guide wheels. Do not re-pack the guide wheel bearings. If the bearings are worn, replace the integral spindle assembly.

FIGURE 4-1
GUIDE WHEEL UNIT LUBRICATION



4.4 Guide Wheels

4.4.1 Allowable Wear

4.4.1.1 200854 Steel Tread Guide Wheel - See Figure 4-2

WARNING

■ **REPLACE ANY GUIDE WHEEL IMMEDIATELY WHICH SHOWS DAMAGE AND/OR HAS WORN MORE THAN THE ALLOWABLE LIMITS. FAILURE TO COMPLY COULD RESULT IN DERAILMENT OF THE VEHICLE, AND SEVERE BODILY INJURY.**

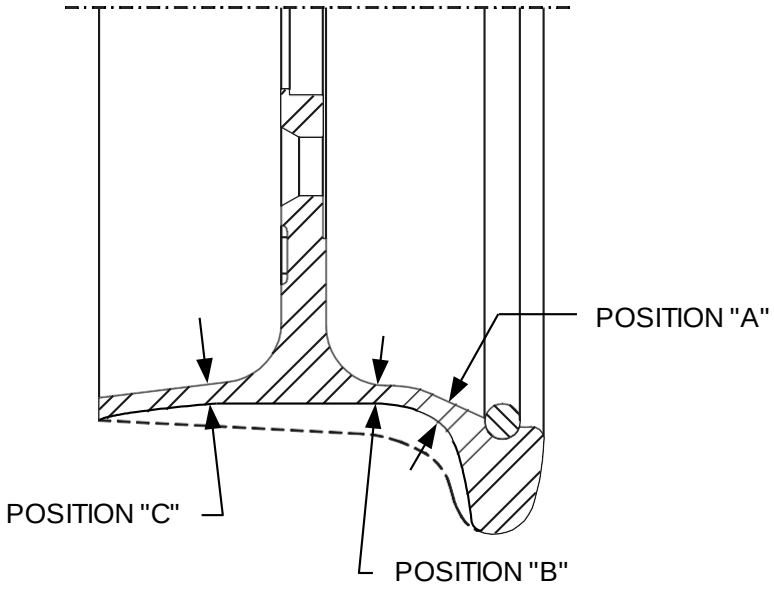
1. Tools needed: Harsco Rail wheel caliper # M019889, or equivalent.

2. Measure the guide wheel flange at position "A" with the wheel caliper. The minimum allowable flange dimension at Position "A" is 1/4 inch (6.4 mm). If the wheel flange dimension is less than the allowable limit, replace the wheel immediately.

3. Measure the wheel tread at positions "B" and "C" with the wheel caliper. The minimum allowable tread dimension at Positions "B" and "C" is 1/4 inch (6.4 mm). If any of the guide wheel tread dimensions are less than the allowable limits, replace the wheel immediately.

4. The entire wheel must not have any gouges or cracks. If any of these are evident, replace the wheel immediately.

FIGURE 4-2
ALLOWABLE WEAR - 200854 STEEL TREAD GUIDE WHEEL



4.4 Guide Wheels

4.4.1 Allowable Wear

4.4.1.2 3417921 Rubber Tread Guide Wheel - See Figure 4-3

WARNING

■ **REPLACE ANY GUIDE WHEEL IMMEDIATELY WHICH SHOWS DAMAGE AND/OR HAS WORN MORE THAN THE ALLOWABLE LIMITS. FAILURE TO COMPLY COULD RESULT IN DERAILMENT OF THE VEHICLE, AND SEVERE BODILY INJURY.**

1. Tools needed: Harsco Rail wheel caliper # M019889, or equivalent.

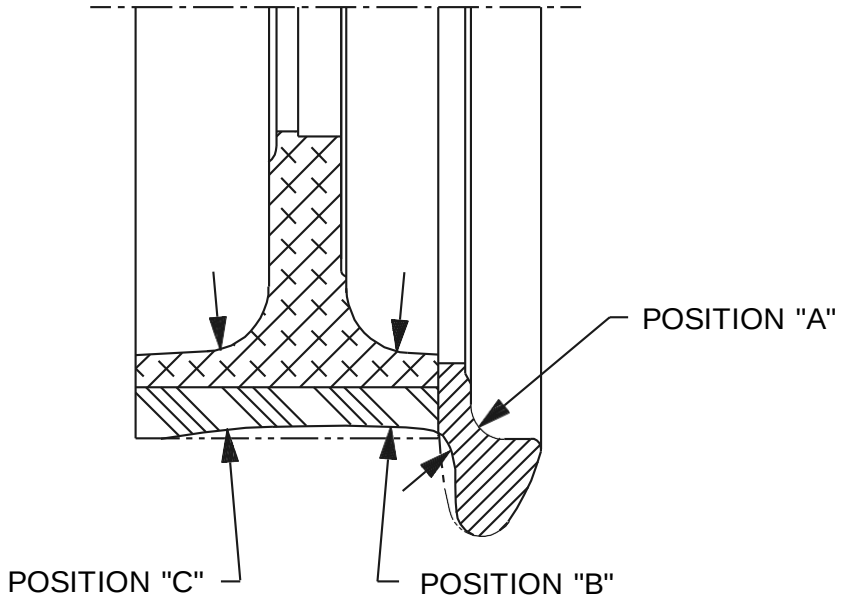
2. Measure the guide wheel flange at position "A" with the wheel caliper. The minimum allowable flange dimension at Position "A" is 1/4 inch (6.4 mm). If the guide wheel flange dimension is less than the allowable limit, replace the wheel immediately.

4

3. Measure the wheel tread at positions "B" and "C" with the wheel caliper. The minimum allowable tread dimension at Positions "B" and "C" is 11/16 inch (17.5 mm). If the guide wheel tread dimensions are less than the allowable limits, replace the wheel immediately.

4. The rubber tread must not have gouges. The aluminum wheel and/or flange must not have hairline cracks. If any of these are evident, replace the wheel immediately.

FIGURE 4-3
ALLOWABLE WEAR - 3417921 RUBBER TREAD GUIDE WHEEL



4.4 Guide Wheels

4.4.2 Guide Wheel Check

Guide wheels which do not run true on the tread and flange will vibrate and give a rough ride. If the vehicle vibrates and gives a rough ride on track, there may be foreign matter (dirt, rust, paint, etc.) between the wheel and hub, the spindle bearings may be worn, or the tread and flange of the wheel may be worn or damaged, causing a wobbling sensation. On wheels with rubber tread, there may also be foreign matter lodged between the mating surfaces of the steel flange and the aluminum wheel, giving the same sensation.

1. Verify that the five lug nuts are torqued properly to 90 lb-ft (122 N-m). Tighten if necessary.

2. Rubber Guide Wheels Only: Verify that the six 3/8 inch hex flange head cap screws securing flange to the rubber tread wheel are torqued properly to 40 lb-ft (55 N-m).

3. Track test the vehicle to verify whether the vibrations were caused by loose guide wheels or flanges.

   If track testing shows that the vibrations persist, go on to the following steps.

4. Check the spindle bearing by grasping the guide wheel and working it from side to side. If there is excessive play in the spindle, remove the guide wheel and verify that the three M12 cap screws that secure the integral spindle to the stub axle are properly torqued to 60 lb-ft (81 N-m). Re-tighten if necessary.

5. Recheck the spindle bearing by grasping the spindle and working it from side to side. If there is excessive play in the spindle bearing, the bearings are worn. Replace the integral spindle.

6. Check for foreign material on the mating surfaces of the guide wheel and the hub. Remove any foreign material on these surfaces.

7. Rubber Guide Wheels Only: Remove the flange from the guide wheel and check for foreign material on the mating surfaces of the flange and the guide wheel. Remove any foreign material on these surfaces. Reinstall the flange on the guide wheel and torque the fasteners to 40 lb-ft (55 N-m).

8. Reinstall the guide wheel onto the spindle and hub. Torque wheel nuts to 90 lb-ft 122 N-m).

9. Track test the vehicle to verify whether the vibrations were caused by worn spindle bearings or foreign material between guide wheel/flange mounting surfaces. If track testing shows that the vibrations persist, the wheel may be sprung or bent. Replace the wheel.

4.5 Vehicle Wheels

4.5.1 Wheel Replacement

■ **USE REPLACEMENT WHEEL(S) AS RECOMMENDED BY HARSCO RAIL. FAILURE TO COMPLY COULD RESULT IN BODILY INJURY AND/OR PROPERTY DAMAGE.**

Use replacement wheel rim(s) as recommended by Harsco Rail. The wheels and tires should be static balanced or balanced after installation on the vehicle for the best results. Torque vehicle wheel lug nuts to recommended specifications. See the decal attached to the vehicle wheel for the recommended wheel bolt torque specifications.

4.5.2 Tire Replacement

■ **USE REPLACEMENT TIRES WITH THE SAME ROLLING RADIUS, TREAD WIDTH, PLY RATING, AND LOAD RATING AS RECOMMENDED BY THE VEHICLE MANUFACTURER. FAILURE TO COMPLY COULD RESULT IN BODILY INJURY AND/OR PROPERTY DAMAGE.**

Replacement tires must have the same rolling radius, tread width, ply rating, and load rating as recommended by Harsco Rail. Using tires of equal diameter will help keep the speedometer reading and the guide wheel load accurate. Tires must have a minimum 5-1/2 inches of tread width. After installing new tire(s) on the vehicle, check guide wheel load. See the Adjustment Section - Guide Wheel Equipment Alignment Procedure.

Inflate tires to: 80 PSI for Chevrolet vehicles.
95 PSI for Ford vehicles.

The wheels and tires should be static balanced or balanced after installation on the vehicle for the best results. Torque vehicle wheel lug nuts to recommended specifications. See the decal attached to the vehicle wheel for the recommended wheel bolt torque specifications.

4.6 Bolt Torque Requirements

■ **CHECK ALL BOLTS AND NUTS PERIODICALLY. KEEP BOLTS AND NUTS TIGHTENED TO THE TORQUE SPECIFIED IN APPENDIX A. IF BOLT REPLACEMENT BECOMES NECESSARY, REPLACE WORN BOLT WITH EQUAL S.A.E. GRADE NUMBER BOLT. FAILURE TO COMPLY COULD RESULT IN BODILY INJURY, AND/OR PROPERTY DAMAGE.**

See Appendix A for bolt torque specification tables and grade identification markings used by manufacturers.

4.7 Hoses and Fittings

WARNING

- **ALL HOSES AND FITTINGS ON THIS EQUIPMENT MUST COMPLY WITH SAE STANDARD J1273 RECOMMENDED PRACTICE FOR SELECTION, INSTALLATION AND MAINTENANCE OF HOSE AND HOSE ASSEMBLIES. FAILURE TO COMPLY TO THIS STANDARD COULD RESULT IN SEVERE BODILY INJURY.**

4.7.1 Inspection, Maintenance, Replacement And Installation

The inspection, maintenance, replacement and installation of hydraulic hose assemblies and fittings on this equipment must conform with SAE Standard J1273. See Appendix B.

4.7.2 Hose Band - See Figure 4-4

All Harsco Rail original and replacement hose assemblies are supplied with a hose band displaying the date of manufacture and the Harsco Rail part number. The hose assembly illustrated in the example was manufactured in August 2011 and is Harsco Rail part number 188662.

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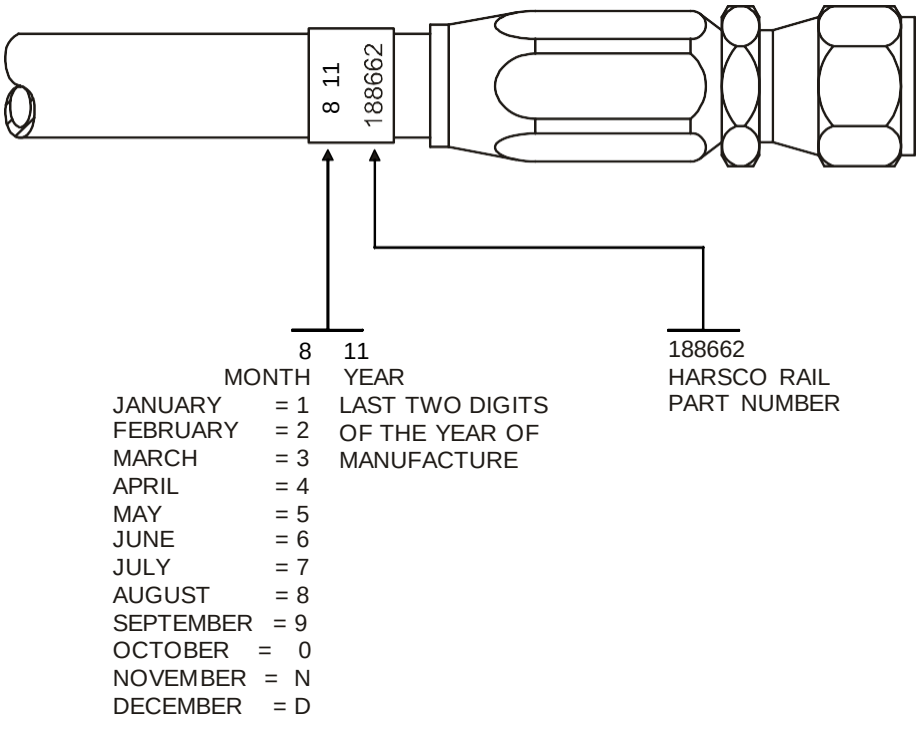
FIGURE 4-4
HOSE BAND



NOTES

SECTION 5 - TROUBLESHOOTING
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5.1 Troubleshooting Guide Wheel Equipment

PROBLEM	PROBABLE CAUSE	POSSIBLE REMEDY
Guide wheel unit does not lower or raise.	Mechanical lock engaged.	Disengage mechanical. See Operation Section - Placing Vehicle On Track or Removing Vehicle From Track.
	Hydraulic pump not operating.	Check operation of hydraulic pump.
	Hydraulic reservoir oil level low.	Fill reservoir to full level with recommended hydraulic oil.
	Components bent, broken, worn, etc.	Replace components.
	Lack of lubrication.	Lubricate front and rear guide wheel units. See Maintenance Section - Lubrication.
Guide wheel unit is difficult to lower or raise.	Vehicle over-loaded.	Remove excess load from vehicle.
	Guide wheel load adjusted incorrectly.	Re-adjust. See Adjustment Section - Guide Wheel Equipment Alignment Procedure.
	Hydraulic reservoir oil level low.	Fill reservoir to full level with recommended hydraulic oil.
	Components bent, broken, worn, etc.	Replace components.
	Lack of lubrication.	Lubricate front and rear guide wheel units. See Maintenance Section - Lubrication.
Lock mechanism not working properly.	Mud, slush, dirt, etc. in locking mechanism.	Clean foreign material from locking mechanism.
	Lack of lubrication.	Lubricate front and rear guide wheel units. See Maintenance Section - Lubrication.
	Components bent, broken, worn, etc.	Replace components.

5.1 Troubleshooting Guide Wheel Equipment

PROBLEM	PROBABLE CAUSE	POSSIBLE REMEDY
Vehicle pulls noticeably to the left or right when on track.	Vehicle loaded heavy on one side.	Move load to center of vehicle.
	Steering lock not engaged.	Engage the steering lock.
	Vehicle wheels not aligned with steering lock when engaged.	Re-align. See Adjustment Section - Guide Wheel Equipment Adjustment Procedure.
	Guide wheels are not aligned with vehicle.	Re-align. See Adjustment Section - Guide Wheel Equipment Alignment Procedure.
	Vehicle tires under inflated.	Check pressure. Inflate tires to 80 PSI for Chevrolet vehicles and 95 PSI for Ford vehicles.
	Guide wheel equipment bent, broken, etc.	Repair or replace components.
	Vehicle front tires out of alignment.	Check for pulling noticeably to the left or right when driven on the highway. Re-align front tires.
Vehicle derails.	Guide wheel units, vehicle axle(s), etc. not aligned with vehicle frame.	Check alignment. See Adjustment Section - Guide Wheel Equipment Alignment Procedure.
Unusual or excessive noise when traveling on track.	Guide wheel spindle bearings worn.	Replace bearing/spindle assembly.
	Guide wheel unit flanging hard to the right or left.	Re-align. See Adjustment Section - Guide Wheel Equipment Alignment Procedure.

5.1 Troubleshooting Guide Wheel Equipment

PROBLEM	PROBABLE CAUSE	POSSIBLE REMEDY
Vibration felt in the vehicle when traveling on track.	Guide wheel unit mounting hardware loose.	Tighten all bolts to recommended torque.
	Guide wheel spindle bearings worn.	Replace bearing/spindle assembly.
	Guide wheel worn or damaged.	Replace guide wheel.
	Vehicle rim bent.	Replace rim. See Maintenance Section - Vehicle Wheels.
	Vehicle tires out of balance.	Balance tires. See Maintenance Section - Tire Replacement.
	Wheel spacer lug nuts and or vehicle lug nuts loose.	Torque wheel spacer lug nuts and vehicle lug nuts to recommended specifications. See maintenance Section.
Vibration felt in the vehicle when traveling on road.	Guide wheel unit mounting hardware loose.	Tighten all bolts to recommended torque.
	Guide wheel units are not raised and locked in "highway" position.	STOP IMMEDIATELY. Make sure all guide wheels are locked and secured in "highway" position.
	Vehicle wheel bent.	Replace wheel. See Maintenance Section - Vehicle Wheels.
	Vehicle tires out of balance.	Balance tires. See Maintenance Section - Tire Replacement.
	Wheel spacer lug nuts and or vehicle lug nuts loose.	Torque wheel spacer lug nuts and vehicle lug nuts to recommended specifications. See maintenance Section.

SECTION 6 - PARTS
TABLE OF CONTENTS

Serial Numbers

When this manual is received, complete the following record from the serial number tag on the rear guide wheel unit. Always mention these factory serial numbers when calling or writing about the unit. The serial number tag is located on the upper structure of the unit.

FIGURE 1
FRONT UNIT SERIAL NUMBER PLATE

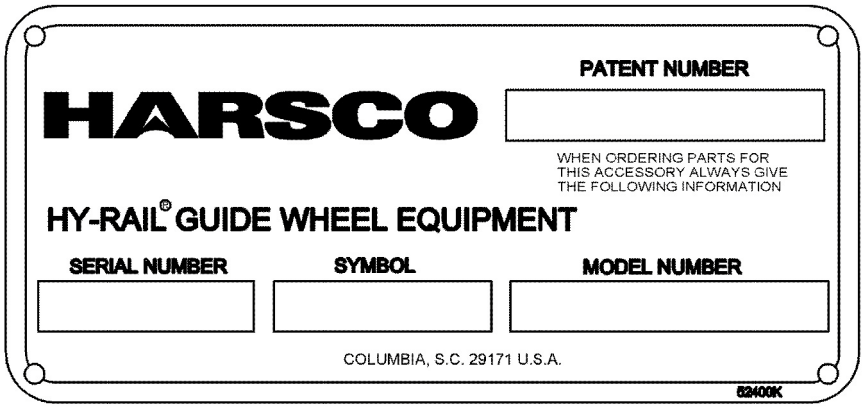
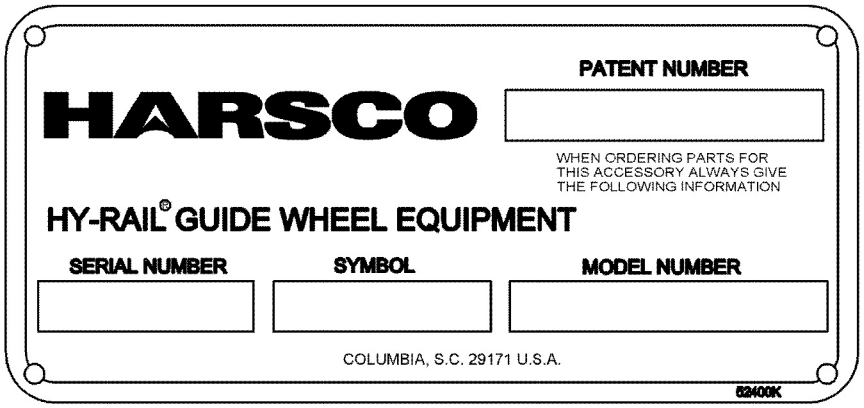


FIGURE 2
REAR UNIT SERIAL NUMBER PLATE



Instructions For Ordering Parts

1. Each application consists of required groups, optional groups required and accessory group options. These are the group numbers that were supplied with, or that were available for the unit.

2. Locate the appropriate group numbers in the Parts Section to find the individual parts required.

3. Front - rear and left - right are determined from the operator's position.

4. Assemblies: Items listed in CAPITALS are assemblies which include all parts listed immediately following and indented to the right. When assemblies can be used, always order them to save work of fitting separate parts.

5. For convenience in ordering, parts are listed by item number, part number, description, and quantity in each assembly or group. If in doubt as to any part wanted, send full description, sketch, or send the old part with the order.

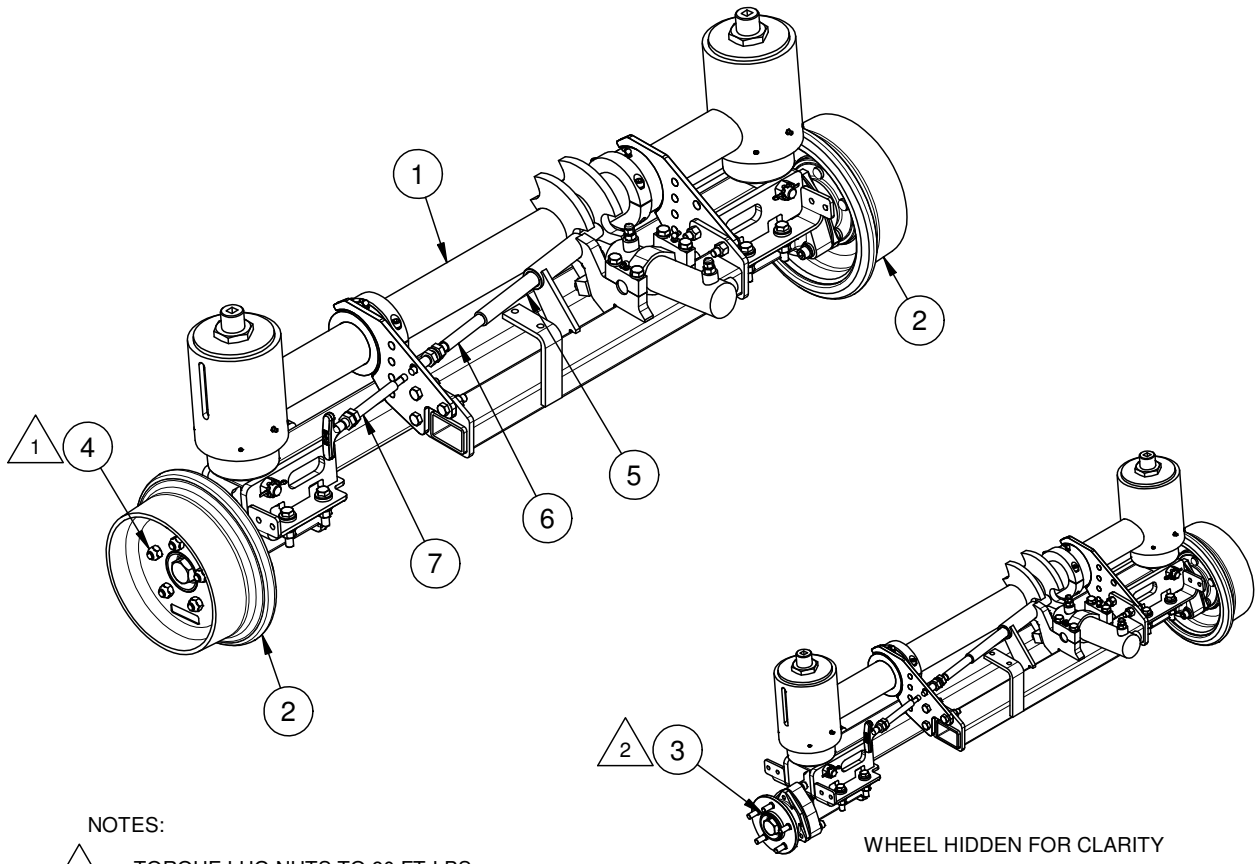
6. To insure prompt and correct shipment of parts on orders, always give:

   a. Quantity of each part wanted.
   b. Part number of each part as shown in this book. Include any prefix and suffix letters.
   c. Description of each part as shown in this book.
   d. Factory serial numbers recorded above.
   e. Purchase order number (if required).
   f. Preferred method of shipment.

7. All parts are shipped F.O.B. factory, transportation charges to be paid by customer. Terms to be determined by the Credit Department.

Notes:

5114456 - Front Guide Wheel Unit With Steel Tread And Manual Lock



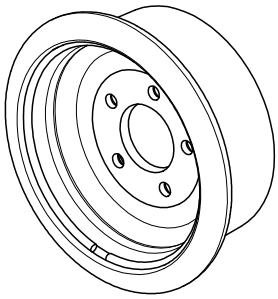
NOTES:

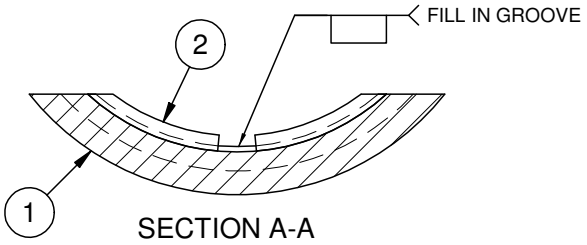
1. TORQUE LUG NUTS TO 90 FT-LBS.
2. SEAT BUSHING IT#3 (#194007) AGAINST SPINDLE SURFACE.

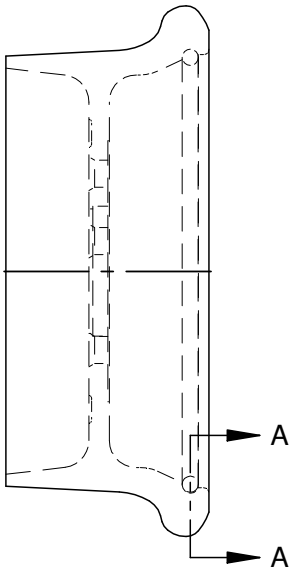
6

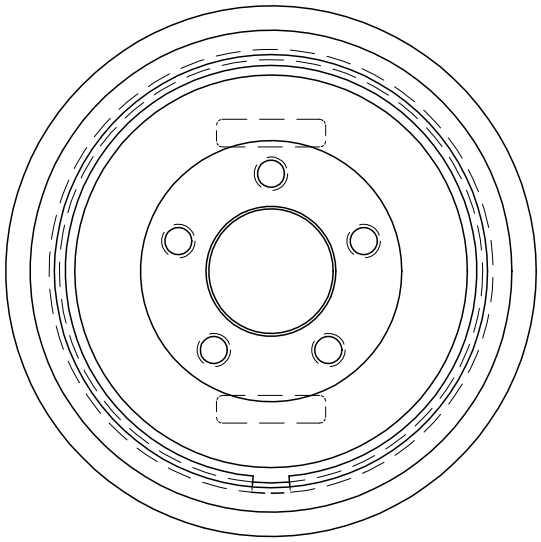
ITEM	PART NO	DESCRIPTION	QTY
1	5114186	HR1500D PILOT UNIT W/RTNR SLV	1
2	200854	WHEEL ASSEMBLY	2
3	194007	INSULATING BUSHING	2
4	F010448	WHEEL NUT, HEX 1/2-20	10
5	3421706	PIN	1
6	203253	SEAL	1
7	3421707	CONTROL CABLE 36"	1

200854 - Guide Wheel, Steel Tread









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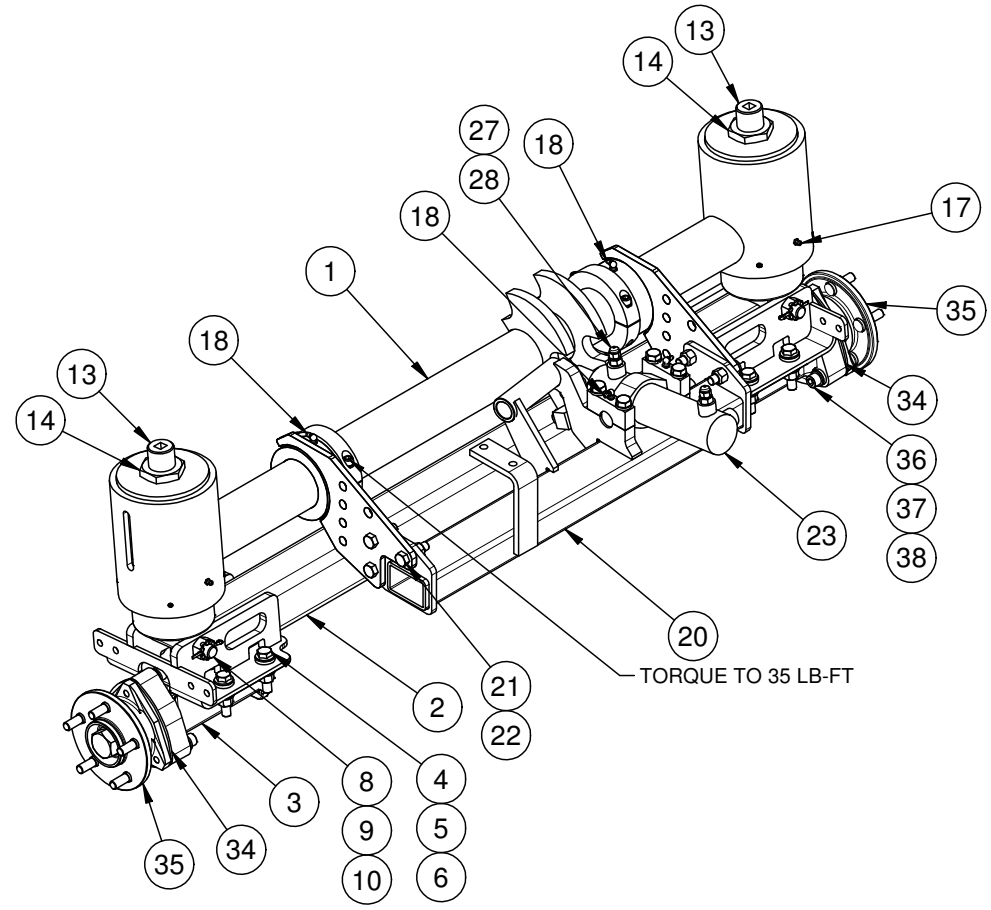
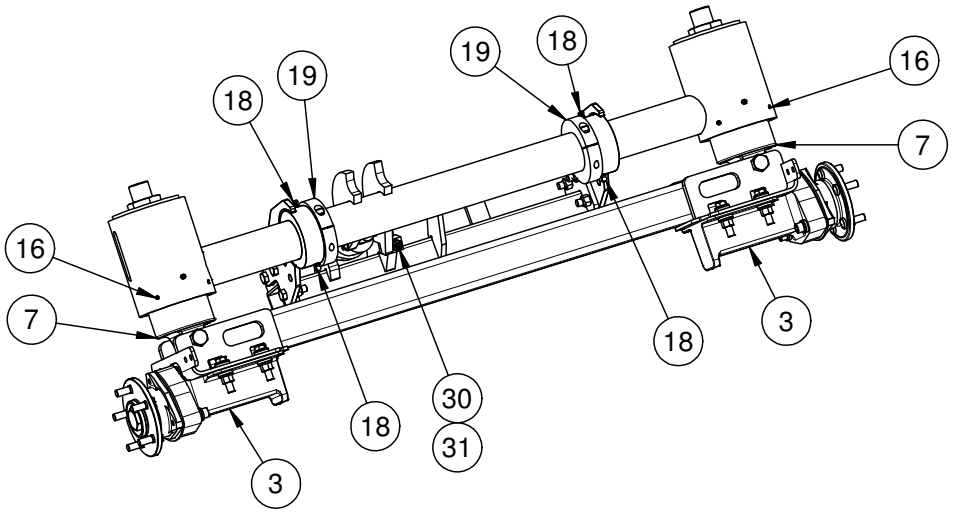
ITEM	PART NO	DESCRIPTION	QTY
1	193859	WHEEL	1
2	200853	RING	1

5114186 - HR1500D Guide Wheel Unit





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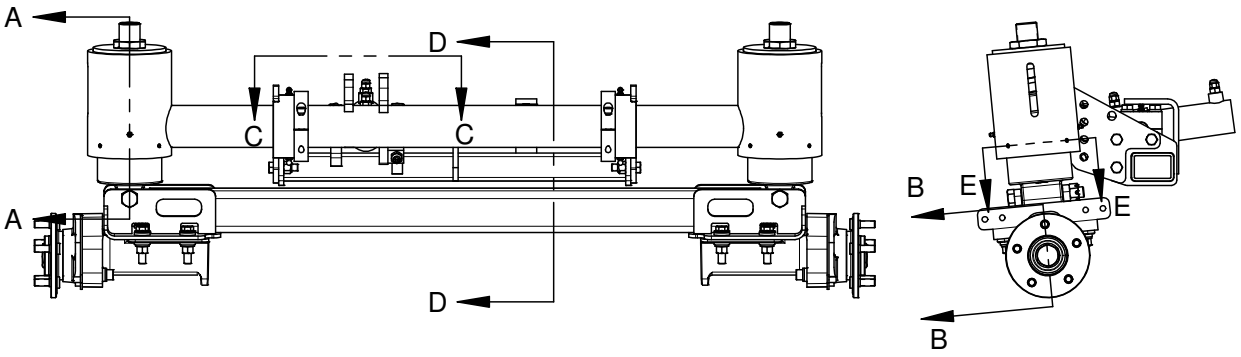
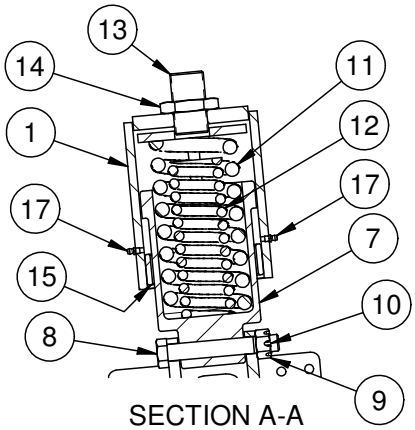
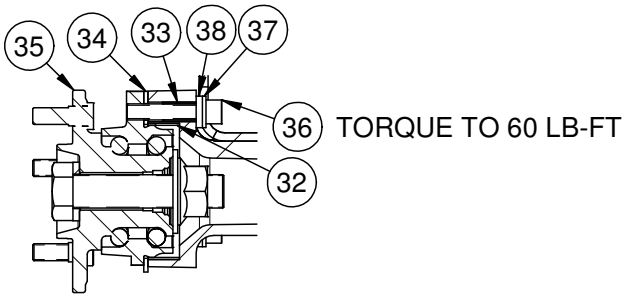
5114186 - HR1500D Guide Wheel Unit





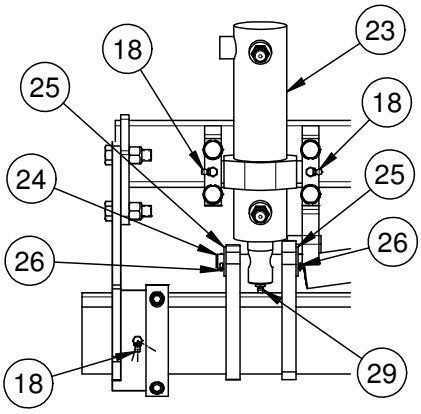
SECTION A-A



TORQUE TO 60 LB-FT

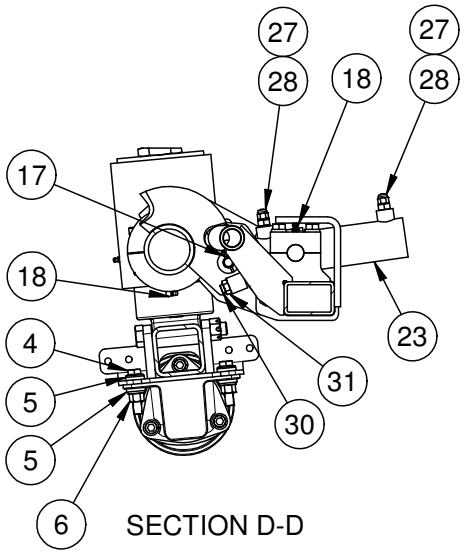
SECTION B-B

HAND TIGHTEN SLOTTED NUT UNTIL COTTER PIN CAN BE FREELY INSERTED.

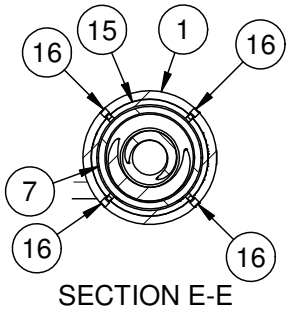


SECTION C-C

TORQUE TO 100 LB-FT



SECTION D-D



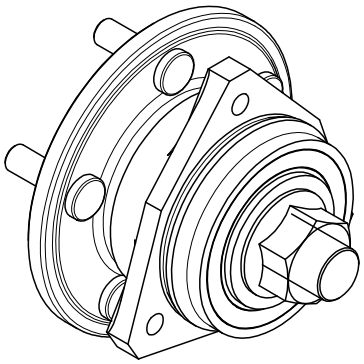
SECTION E-E

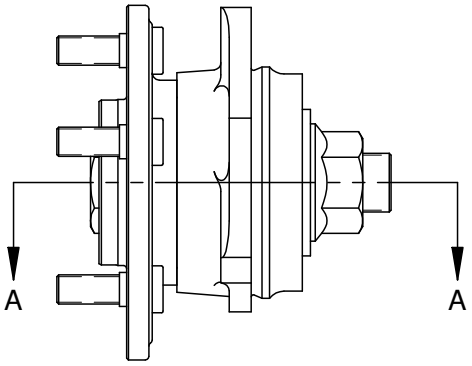
6

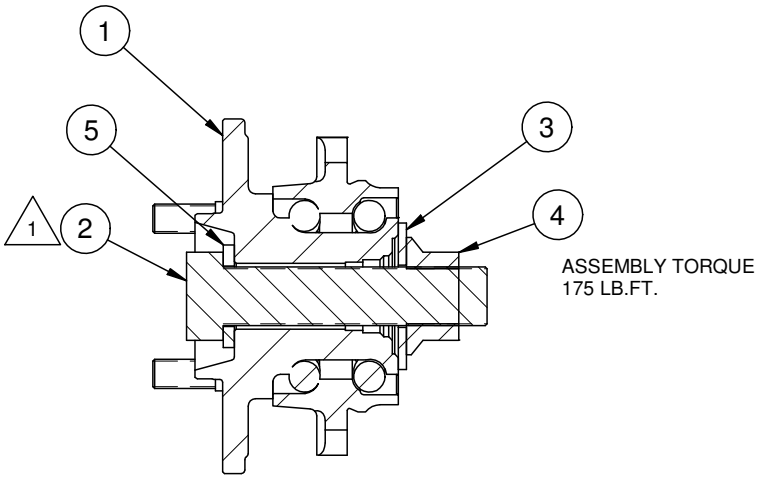
5114186 - HR1500D Guide Wheel Unit

ITEM	PART NO	DESCRIPTION	QTY
1	5116292	CROSS TUBE, 1500D, WELDMENT	1
2	5114430	AXLE WELDMENT, HR1500D	1
3	5083847	STUB AXLE, MACHINED	2
4	F021280	HHD CAP SCR1/2-20X2-1/4GR8	8
5	F024047	WASHER, FLAT, 1/2", HARDENED	16
6	201754	DISK-LOCK NUT - 1/2	8
7	5117066	LOWER SPRING CELL,MACHINING	2
8	200330	HHCS .75-10 X 5.0 LG W/CP HOLE	2
9	F002485	NUT, SLOTTED HEX, 3/4-10, GD5, ZP	2
10	F003038	5/32 X 1 3/4 COTTER PIN	2
11	204104	COIL SPRING	2
12	3423424	COIL SPRING	2
13	5116895	ADJUSTING STUD, PILOT UNIT	2
14	108560	NUT	2
15	5116291	RETAINER, SLEEVE	2
16	5117266	SET SCREW,5/16-24 X 1/2,DOG PT	8
17	F008014	HYDRAULIC FITTING	5
18	F010722	ZERK EL90 X .25-28	6
19	G8378Y03	AXLE COLLAR (2 PC)	2
20	3420896	UPPER STRUCTURE	1
21	F023674	HHD CAP SCR1/2-13X1-3/4GR8	6
22	252275-813	NUT, TOP LK, 1/2-13, GRC	6
23	193904	CYLINDER, HYD, 2.00X1.12X6.00	1
	201310	SEAL KIT	1
24	203966	PIN	1
25	F009425	WASHER, FLAT, 5/8", SAE, ZP	2
26	F001104	1/8 X 1 COTTER PIN	2
27	F022230	STR 4X6SAE	2
28	F014689	-4 JIC CAP	2
29	F004252	ZERK STR X 02NPT	1
30	5032681	1/2 -13 X 2 SKT HD CS	1
31	150964-9	NUT, JAM, 1/2-13, GD5, ZP	1
32	5114187	BUSHING, INSULATOR	2
33	3415895	BUSHING, STUB AXLE INSULATING	6
34	200415	PLATE	2
35	198689	INTEGRAL SPINDLE GROUP	2
36	5055010	SKT HD CS M12-1.75 X 60 CLASS12.9	6
37	252048-5	WASHER,FLAT,M12,DIN125,HARD	6
38	3415867	WASHER, 12MM INSULATED	6

198689 Integral Spindle Group







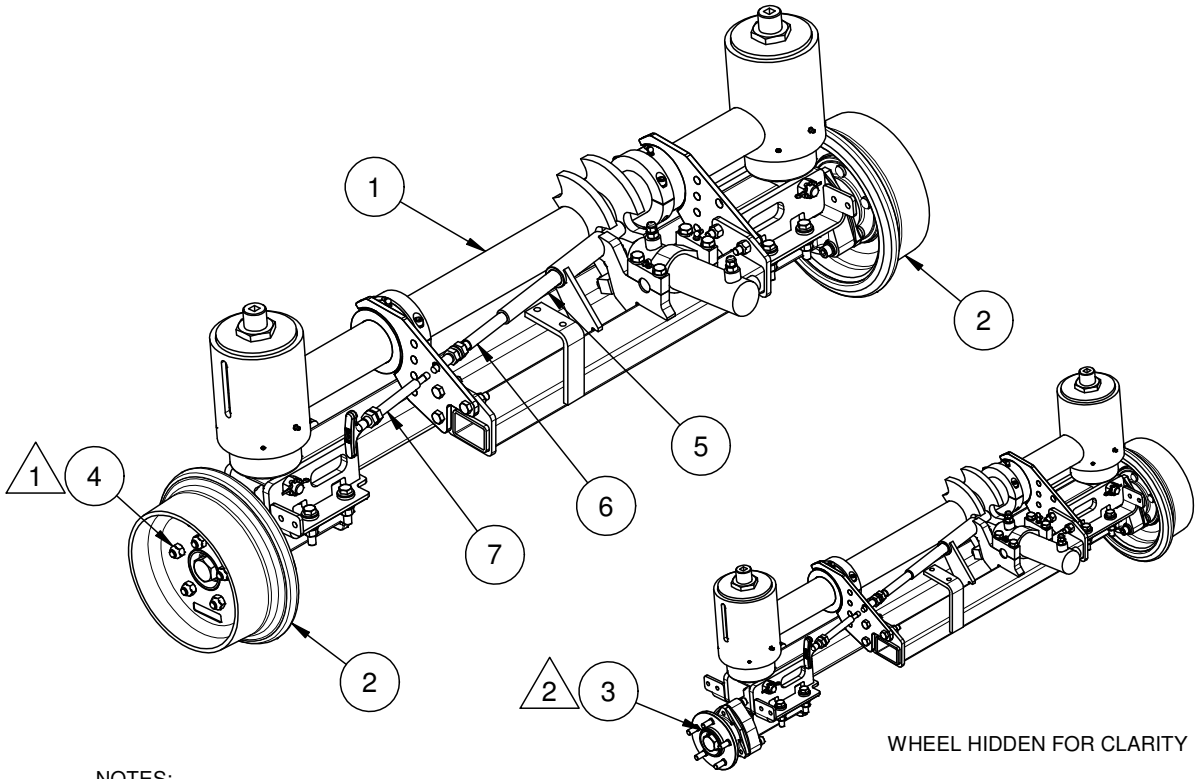
SECTION A-A

1 APPLY NO-OX-ID (200898) TO THREADS WHEN ASSEMBLING.

6

ITEM	PART NO	DESCRIPTION	QTY
1	186139	INTEGRAL SPINDLE	1
2	187193	HEX HEAD CAP SCREW	1
3	187244	1.00 WASHER, HARDENED	1
4	3419581	HEX FLG LOCK NUT 1.00-14 UNF	1
5	F008727	WASHER	1

5114457 Rear Guide Wheel Unit
With Steel Tread And Manual Lock



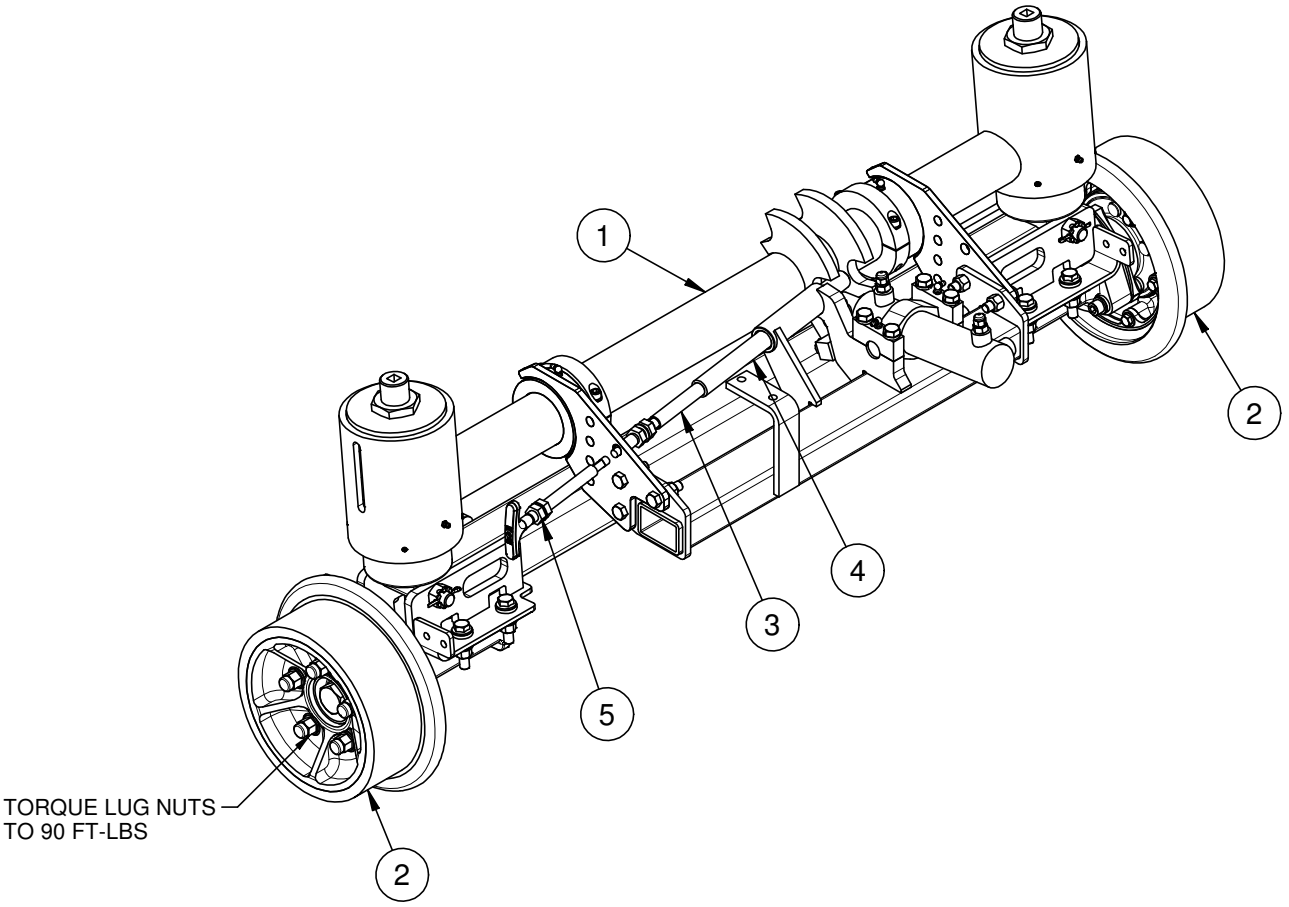
NOTES:

1. TORQUE LUG NUTS TO 90 FT-LBS.
2. SEAT BUSHING IT#3 (#194007) AGAINST SPINDLE SURFACE.

6

ITEM	PART NO	DESCRIPTION	QTY
1	5114186	HR1500D PILOT UNIT W/RTNR SLV	1
2	200854	WHEEL ASSEMBLY	2
3	194007	INSULATING BUSHING	2
4	F010448	WHEEL NUT, HEX 1/2-20	10
5	3421706	PIN	1
6	203253	SEAL	1
7	3421708	CONTROL CABLE 90"	1

5114458 Front Guide Wheel Unit
With Rubber Tread And Manual Lock



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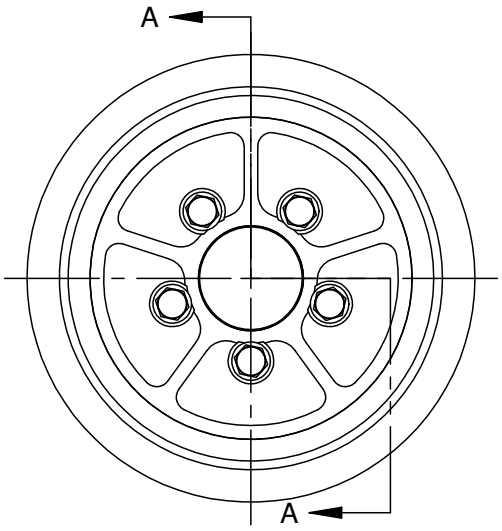
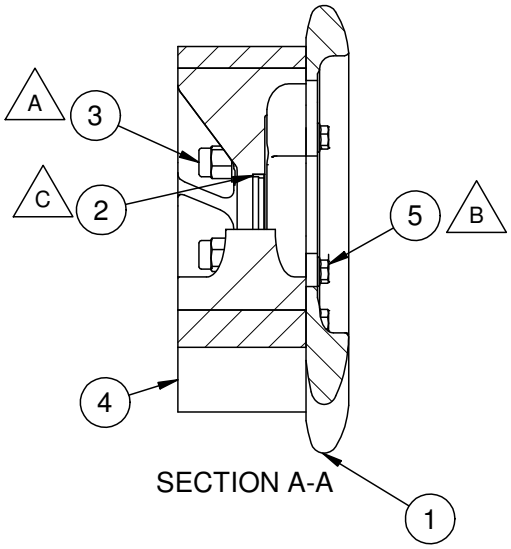
ITEM	PART NO	DESCRIPTION	QTY
1	5114186	HR1500D PILOT UNIT W/RTNR SLV	1
2	3417921	RUBBER TREAD	2
3	203253	SEAL	1
4	3421706	PIN	1
5	3421707	CONTROL CABLE 36"	1

3417921 Guide Wheel, Rubber Tread

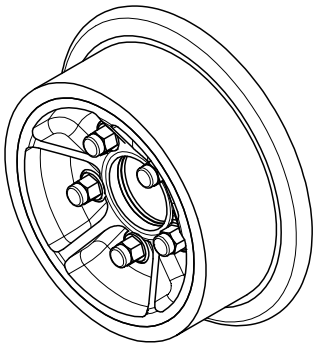




△A TORQUE TO 90 FT - LBS

△B TORQUE TO 40 FT - LBS

△C SEAT BUSHING 194007 AGAINST SPINDLE MOUNTING SURFACE.



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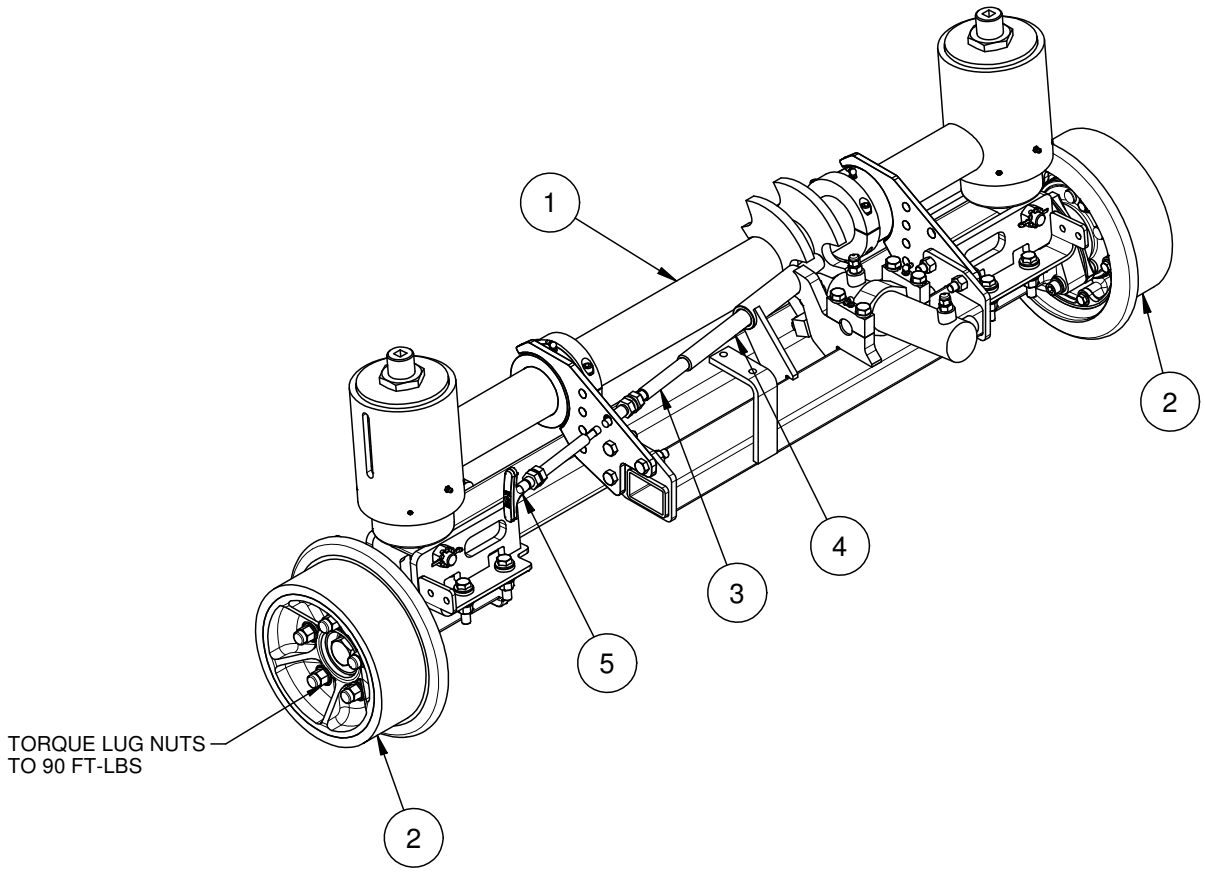
ITEM	PART NO	DESCRIPTION	QTY
1	136133	FLANGE	1
2	194007	INSULATING BUSHING	1
3	196492	LUG NUT	5
4	3411039	RUBBER TREAD	1
5	F023255	HFHCS .375-16 X 1.00 GR 5 ZP	6

5114459 Rear Guide Wheel Unit
With Rubber Tread And Manual Lock



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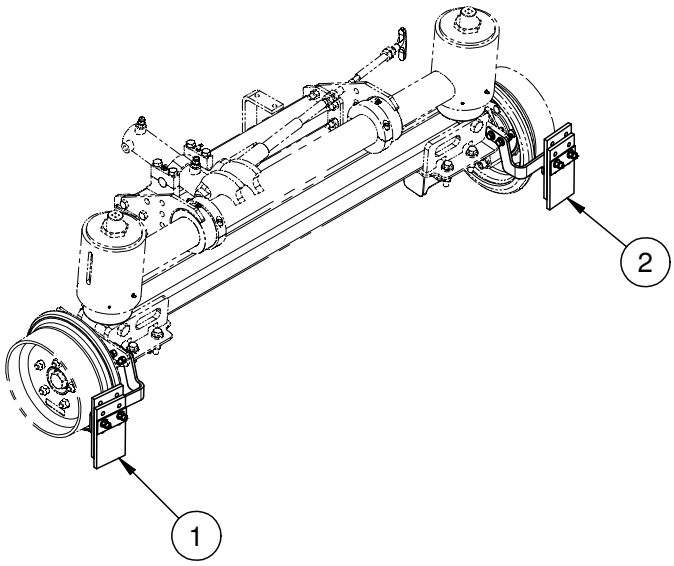
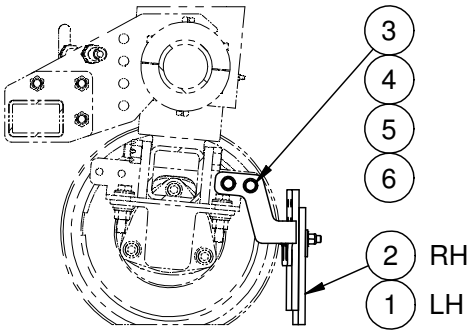
ITEM	PART NO	DESCRIPTION	QTY
1	5114186	HR1500D PILOT UNIT W/RTNR SLV	1
2	3417921	RUBBER TREAD	2
3	203253	SEAL	1
4	3421706	PIN	1
5	3421708	CONTROL CABLE 90"	1

Steering Lock Groups

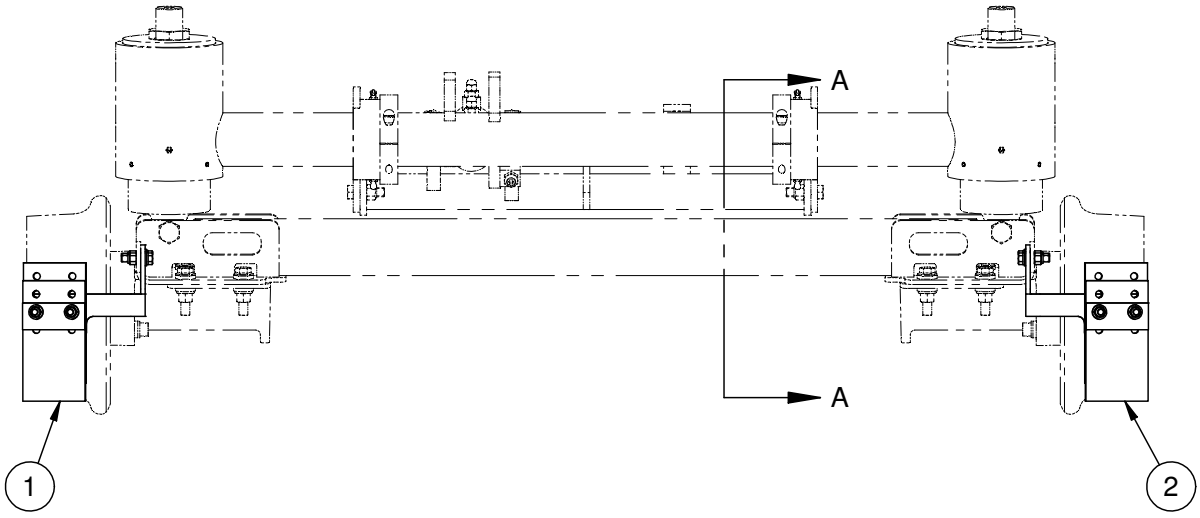
Individual steering lock components are not available as repair parts. Steering lock groups are sold as complete replacement groups only. Find the correct steering lock group applicable to your make, model and year of vehicle.

5114437 Rail Sweep



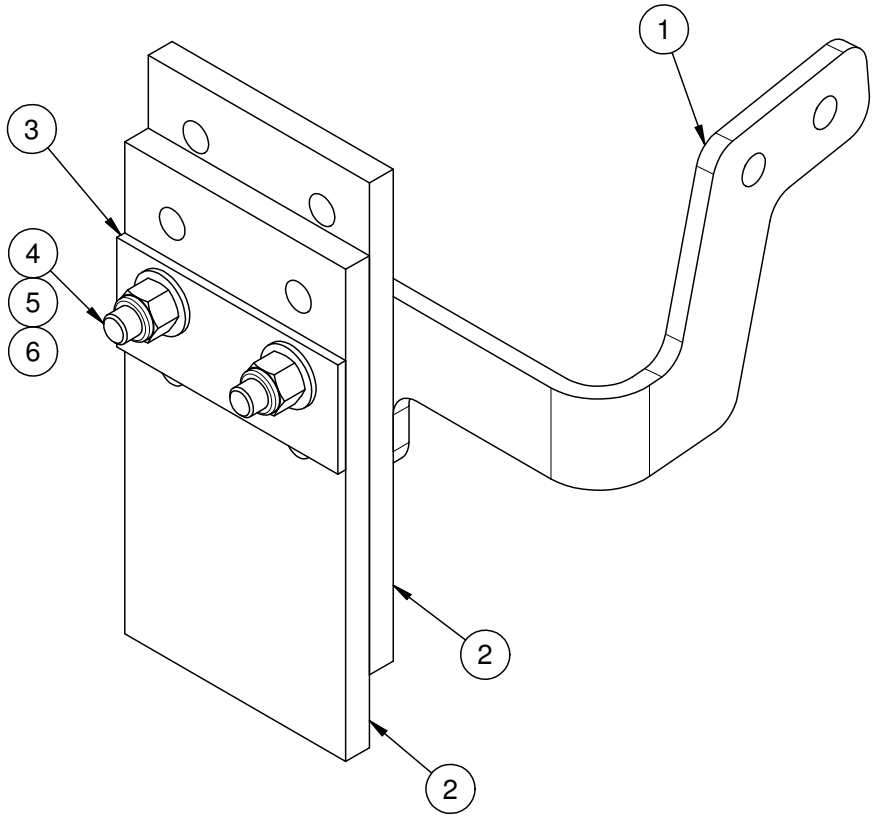


SECTION A-A



ITEM	PART NO	DESCRIPTION	QTY
1	5114425	ASSEMBLY, RAIL SWEEP RIGHT	1
2	5114426	ASSEMBLY, RAIL SWEEP LEFT	1
3	F001024	HHCS 3/8-16 X 1 1/2	4
4	F009681	FLAT WASHER. DIA 3/8. SAE. ZP	4
5	F001025	WASHER, LOCK, 3/8", MEDIUM, ZP	4
6	F011998	3/8-16 ELASTIC STOP NUT	4

5114425 Rail Sweep Assembly, Right



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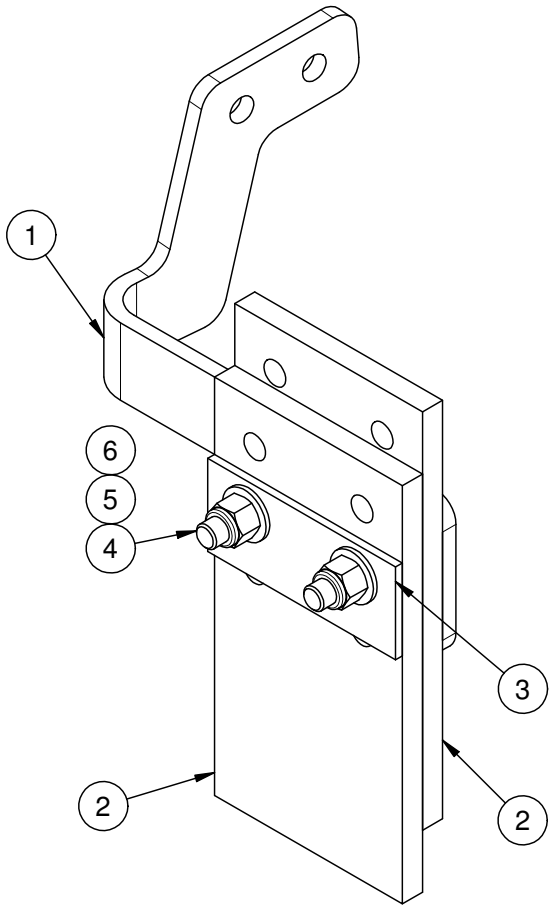
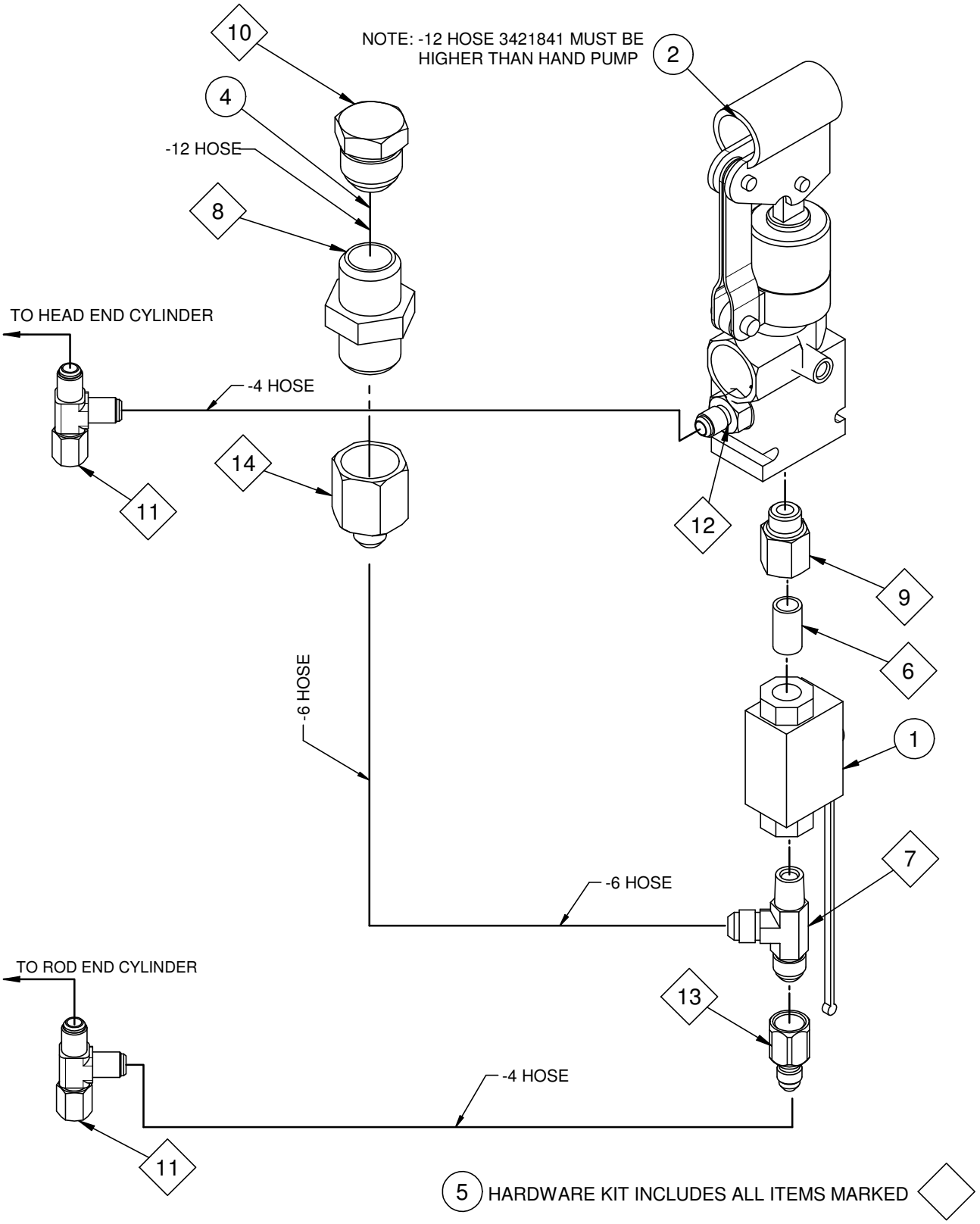
ITEM	PART NO	DESCRIPTION	QTY
1	5114281	BRACKET, RAIL SWEEP, RIGHT	1
2	3423618	RAIL SWEEP	2
3	118581	RAIL SWEEP PLATE	1
4	F001640	HHD CAP SCR 3/8-16X2 GR4	2
5	F009681	FLAT WASHER. DIA 3/8. SAE. ZP	4
6	F011998	3/8-16 ELASTIC STOP NUT	2

5114426 Rail Sweep Assembly, Left



ITEM	PART NO	DESCRIPTION	QTY
1	5114282	BRACKET, RAIL SWEEP, LEFT	1
2	3423618	RAIL SWEEP	2
3	118581	RAIL SWEEP PLATE	1
4	F001640	HHD CAP SCR 3/8-16X2 GR4	2
5	F009681	FLAT WASHER. DIA 3/8. SAE. ZP	4
6	F011998	3/8-16 ELASTIC STOP NUT	2

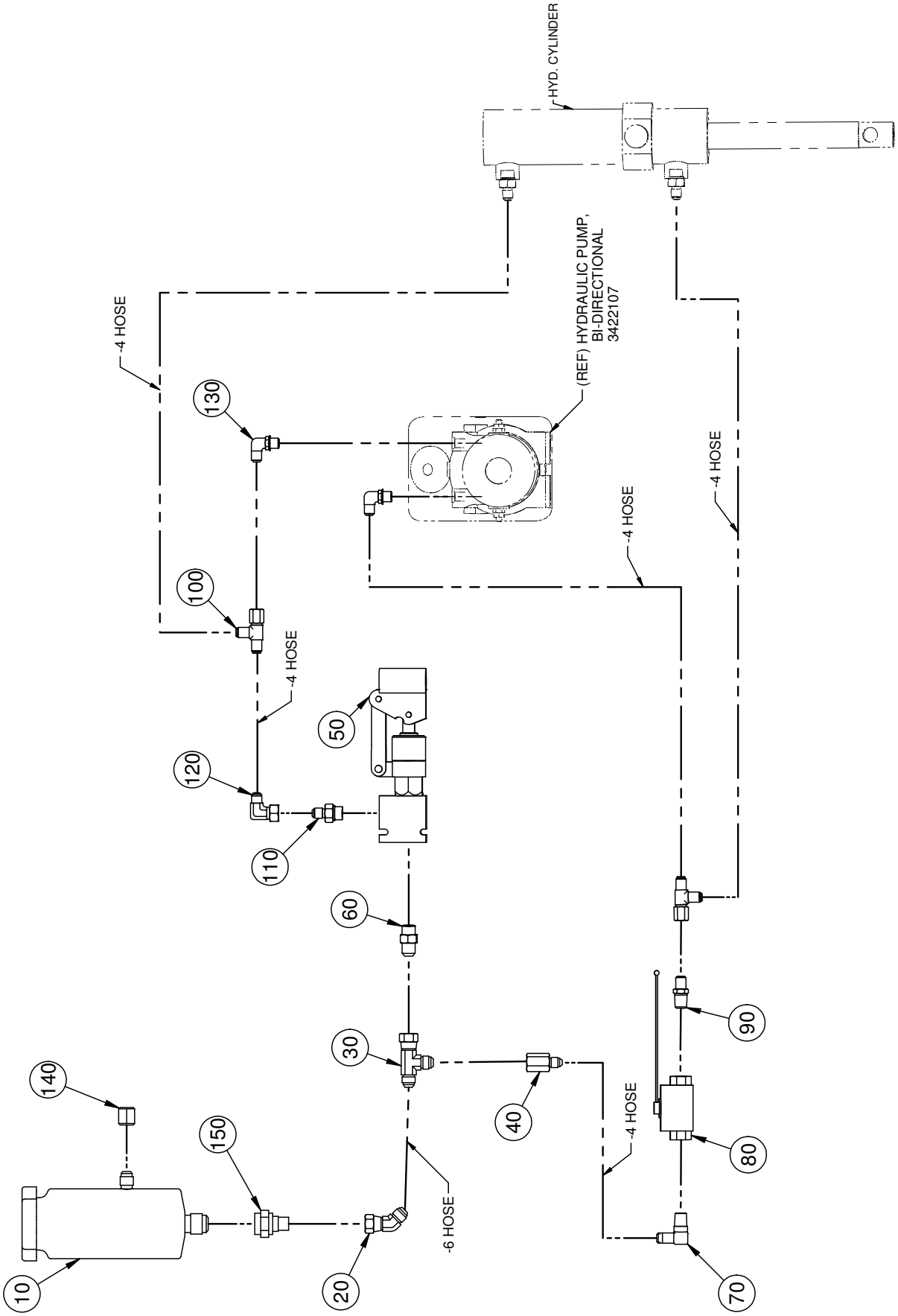
3423866 Emergency Hand Pump Group



3423866 Emergency Hand Pump Group

	PART NO	DESCRIPTION	QTY
1	0-3330040-0-04	BALL VALVE	1
2	202404	HAND PUMP	1
3	202405	HANDLE.	1
4	3421841	HOSE#12JIC STR-STRX15.00LG.	1
5	5075489	FITTINGS KIT FOR 3423866.	1
6	F008584	1/4 X 7/8 CLOSE NIPPLE.	0
7	F011239	TEE 6X4NPTX6	0
8	F012243	STR 12X12	0
9	F015501	ADAPTER - STR 4FPTX6SAE	0
10	F018553	PLG 12 HH	0
11	F021905	TEE 4FSX4X4.	0
12	F022230	STR 4X6SAE	0
13	F023087	REDUCER, -6 SW JIC X -4 JIC	0
14	F040257	ADAPTER, 12FEM-JICX06JIC	0

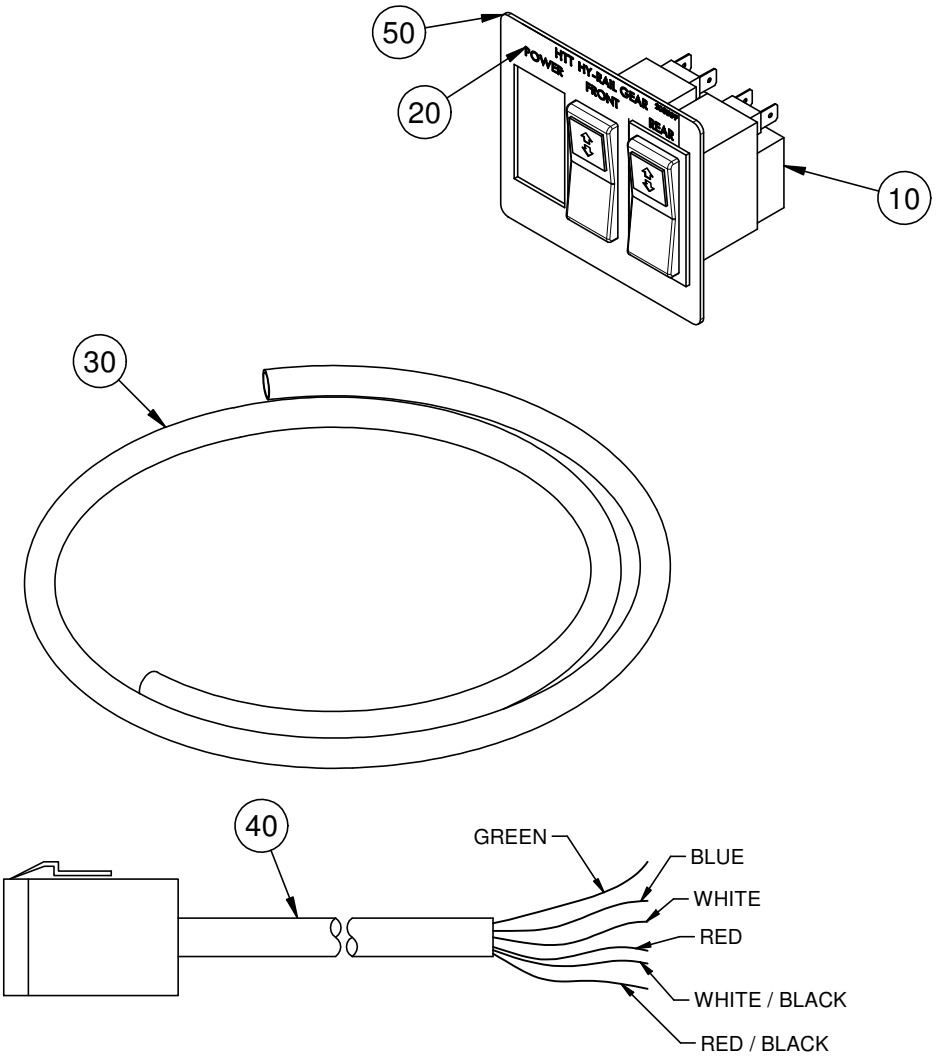
5008444 Hand Pump Group



5008444 Hand Pump Group

ITEM	PART NO	DESCRIPTION	QTY
10	5008386	RESERVOIR TANK	1
20	F014242	ELB45 6X6FS	1
30	F013627	TEE 6X6FSX6	1
40	F023087	REDUCER, -6 SW JIC X -4 JIC	1
50	202404	HAND PUMP	1
60	F013326	STR 6X6SAE	1
70	F011937	ELB90 4X4NPT	1
80	0-3330040-0-04	BALL VALVE	1
90	F012318	STR 4X4NPT	1
100	F021905	TEE 4FSX4X4	2
110	F022230	STR 4X6SAE	1
120	F015085	ELB90 4X4FS	1
130	F014734	ELB90 4X4SAE	2
140	F011529	CAP 6F	1
150	F023059	REDUCER	1

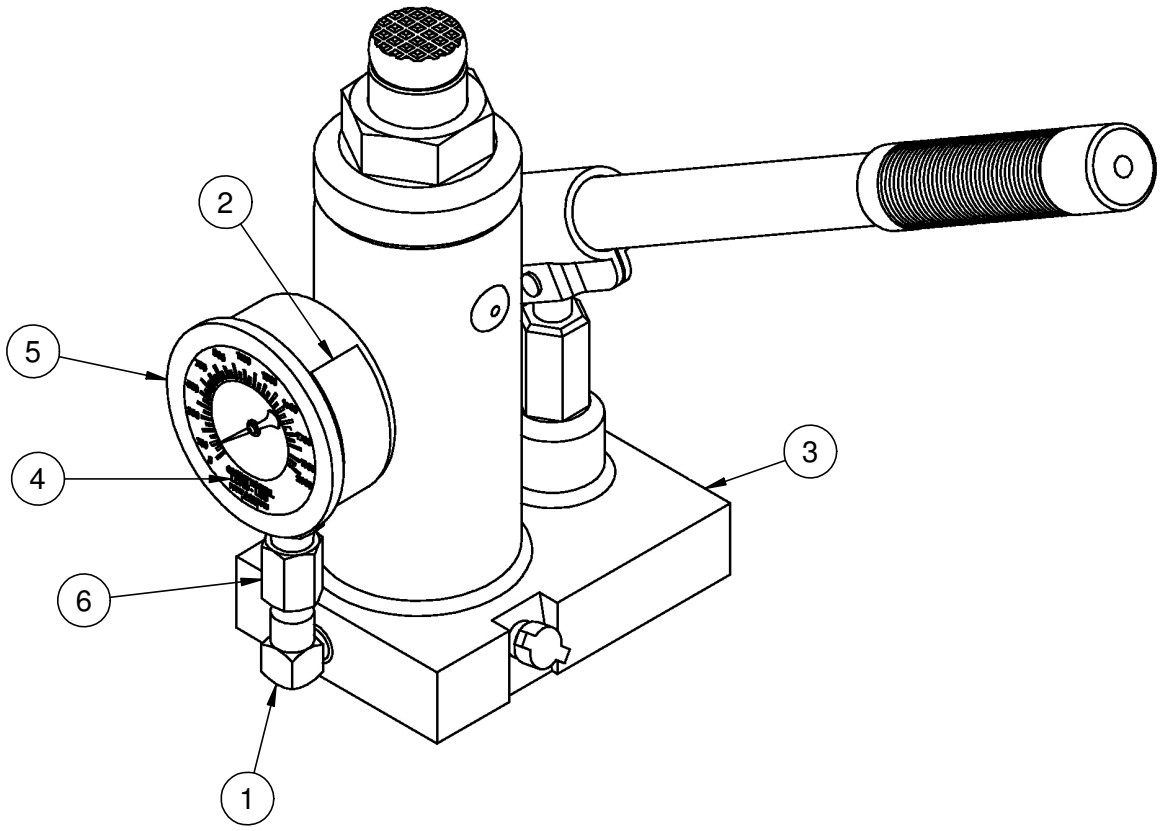
3424210 In Cab Actuation Switch Plate Kit



6

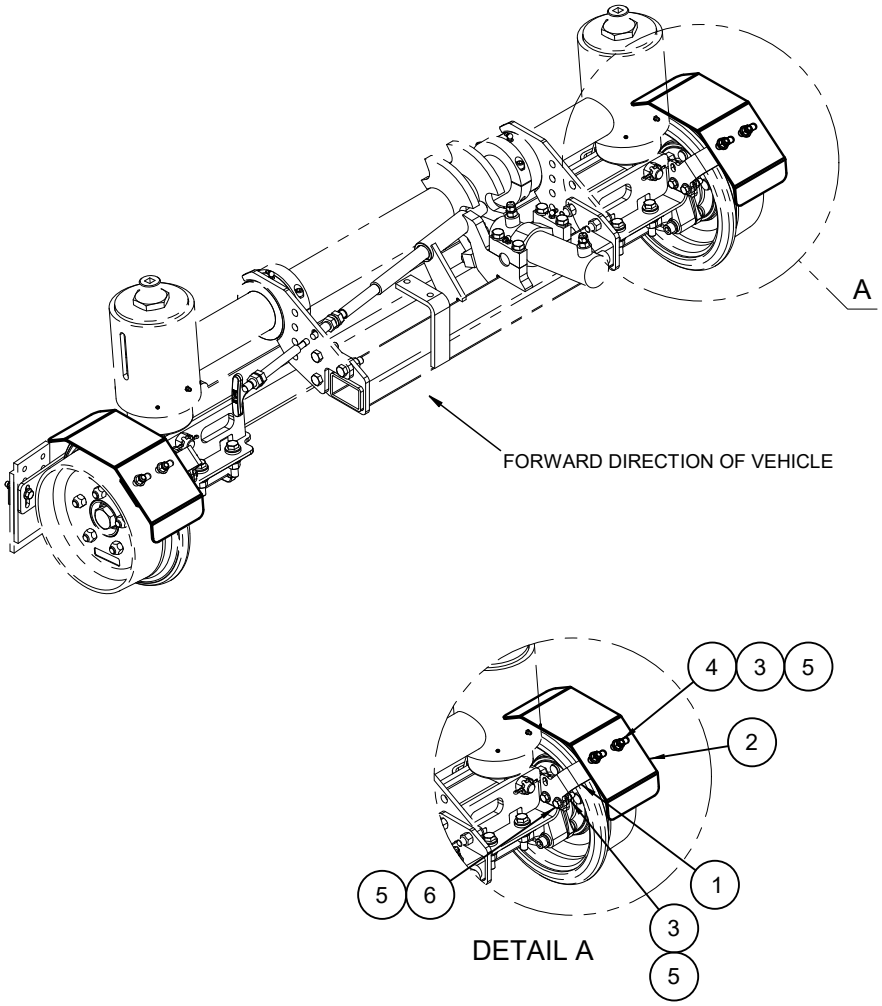
ITEM	PART NO	DESCRIPTION	QTY
10	200968	SWITCH	2
20	203559	DECAL	1
30	F024884	8,CONDUCTOR CABLE	15 ft
40	3424136	6 PIN CONNECTOR	1
50	203556	SWITCH PLATE	1

3422565 Guide Wheel Load Jack



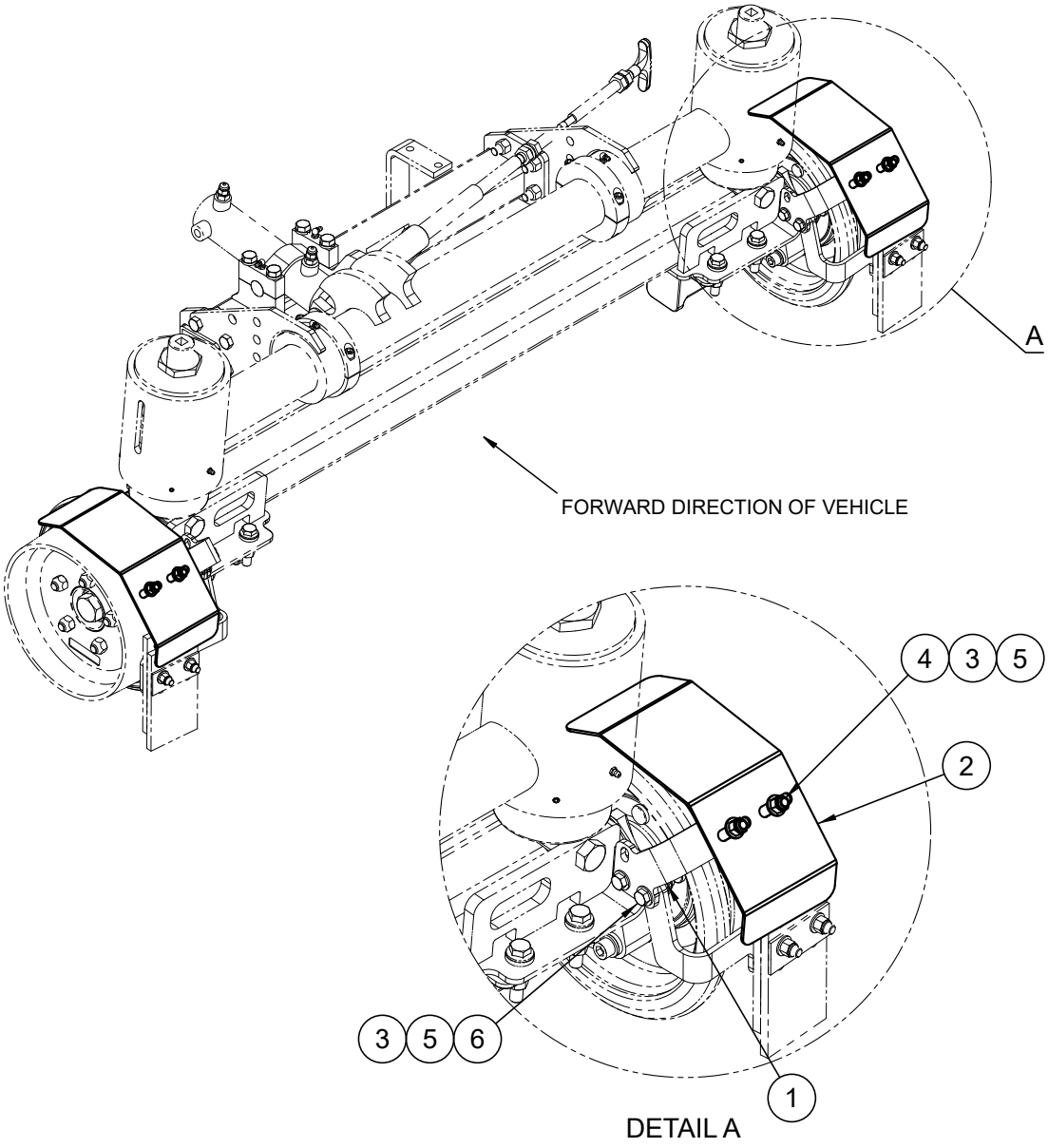
ITEM	PART NO	DESCRIPTION	QTY
1	146353	ELB90 2NPTX2FPT	1
2	156051	DECAL	1
3	3422007	HYDRAULIC JACK WITH GAUGE PORT	1
4	3422545	DECAL, HYD JACK GAUGE, 2000LB	1
5	3422563	PRESSURE GAUGE, 2000 PSI	1
6	F023088	STR 2NPTX4FPT	1
	3427481	REPLACEMENT GAUGE	1

5138613 Grease Guard - Front



ITEM	PART NO	DESCRIPTION	QTY
1	5138607	BRACKET, GREASE GUARD	2
2	3427449	GREASE GUARD - FRONT.	2
3	F011998	3/8-16 ELASTIC STOP NUT	8
4	202531	CARRIAGE BOLT .375-16 X 1.00	4
5	F009681	FLAT WASHER. DIA 3/8. SAE. ZP	12
6	F001024	HHCS 3/8-16 X 1 1/2	4

5138614 Grease Guard - Rear



DETAIL A

ITEM	PART NO	DESCRIPTION	QTY
1	5138607	BRACKET, GREASE GUARD	2
2	3427449	GREASE GUARD - FRONT	2
3	F011998	3/8-16 ELASTIC STOP NUT	8
4	202531	CARRIAGE BOLT .375-16 X 1.00	4
5	F009681	FLAT WASHER. DIA 3/8. SAE. ZP	12
6	F001024	HHCS 3/8-16 X 1 1/2	4

3421918 Decal Group

ITEM	PART NO	DESCRIPTION	QTY
1	3410918	OPERATIONAL DECAL FRONT	1
2	3410919	OPERATIONAL DECAL REAR	1
3	F018082	DECAL, STEERING LOCK	1
4	140220	DECAL - READ MANUAL	3
5	155007	DECAL,VEHICLE COMPLETION	1
6	191761	DECAL, HARSCO	2

DECAL APPLICATION INSTRUCTIONS

1. ATTACH OPERATING INSTRUCTION DECALS 3410918 AND 3410919 TO BACK SIDE OF DRIVER´S VISOR

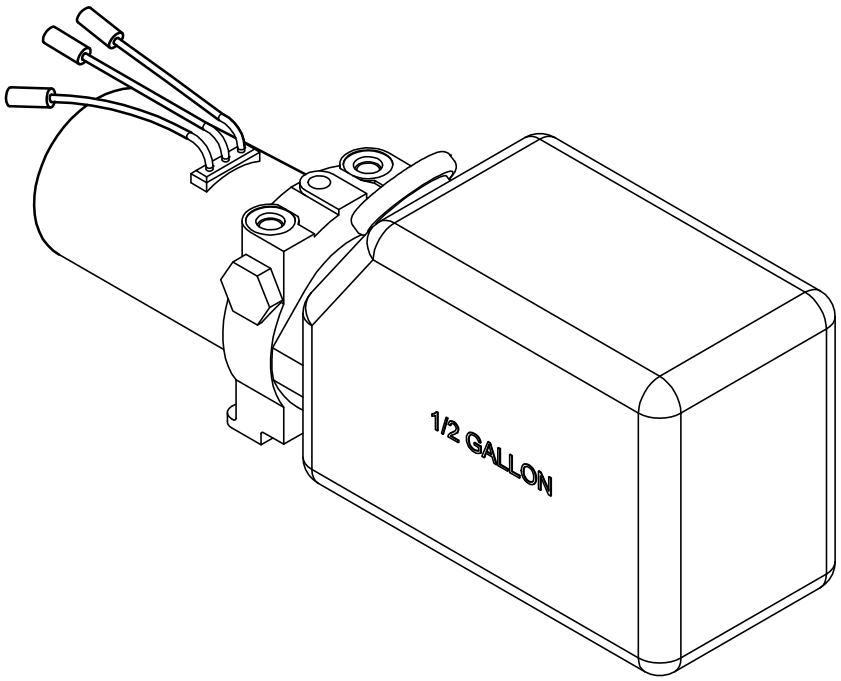
2. ATTACH SAFETY INSTRUCTIONS (LOCK FRONT WHEELS) F018082 TO STEERING WHEEL OR DASH. DO NOT PLACE DECAL OVER SEAM OF AIRBAG IN CENTER OF STEERING WHEEL.

3. ATTACH WARNING DECAL 140220 AT VISIBLE LOCATION NEAR FRONT AND REAR PILOT UNITS AND TO VEHICLE DASH IN CLEAR VIEW OF OPERATOR.

4. ATTACH CERTIFICATION DECAL 155007 TO VEHICLE DASH IN LOCATION THAT IS CLEARLY VISIBLE TO VEHICLE OPERATOR.

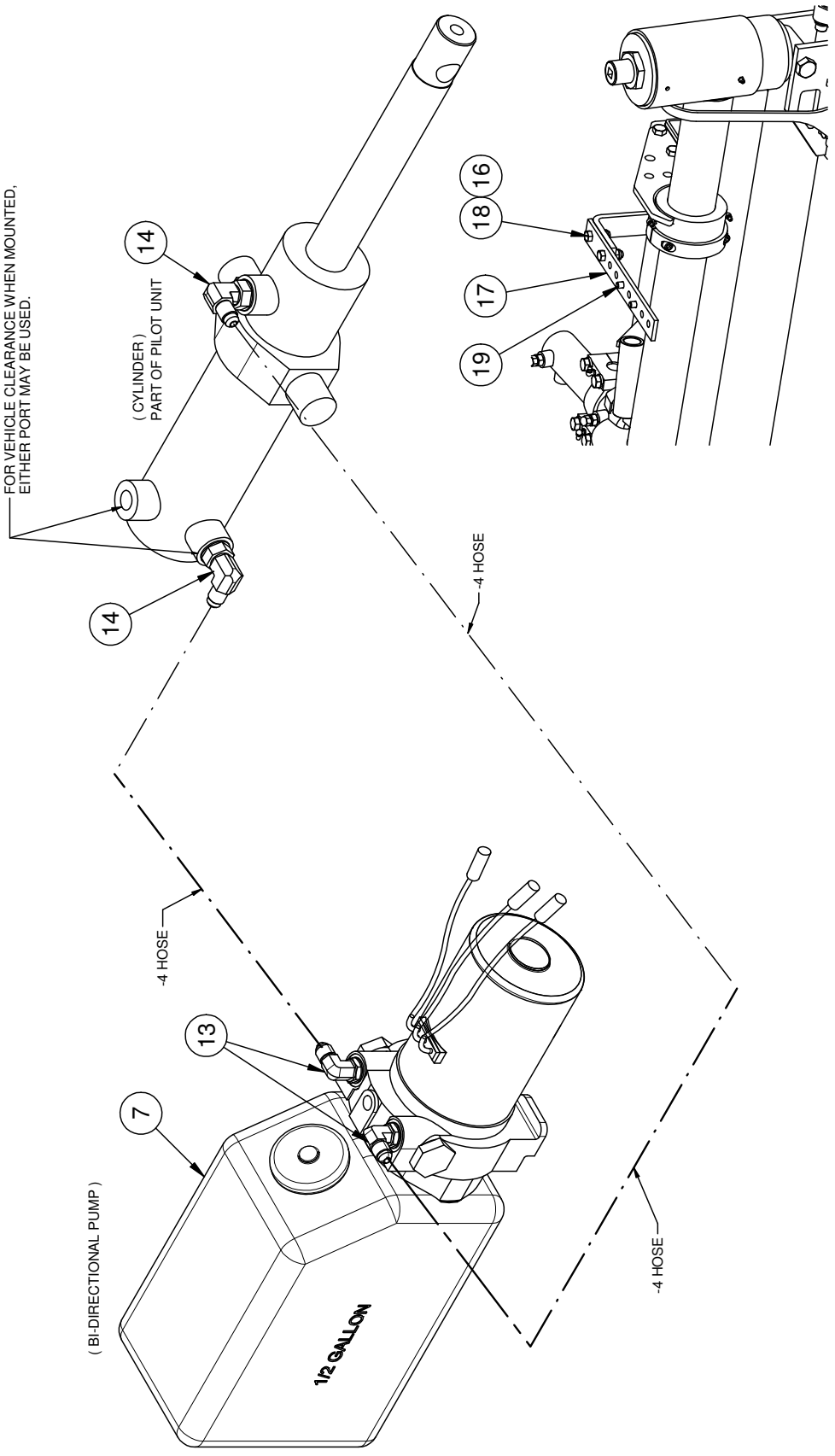
5. ATTACH HARSCO DECALS 191761 TO THE FRONT AND REAR UNIT.

3422107 Hydraulic Pump

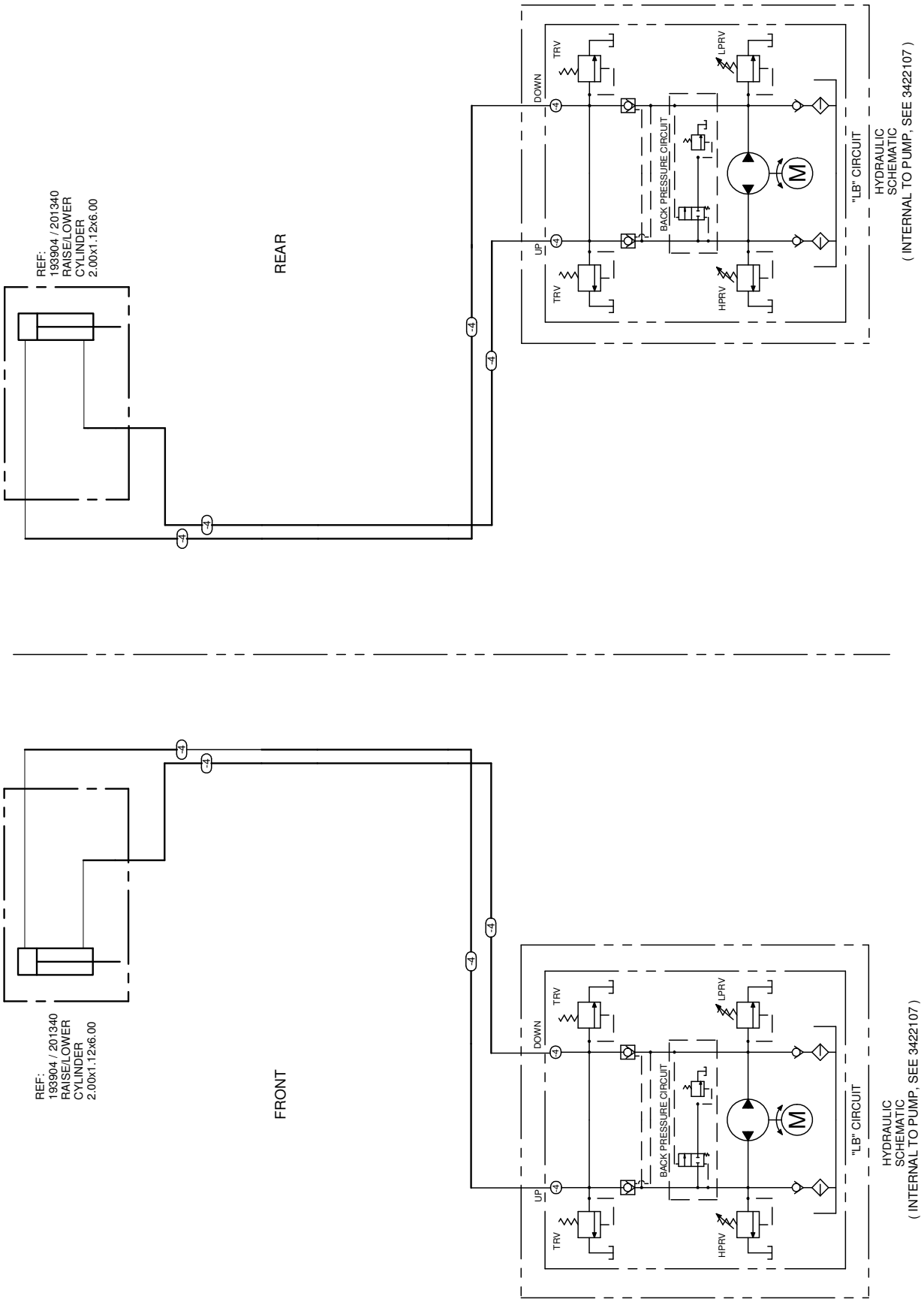


ITEM	PART NO	DESCRIPTION	QTY
-	3422107	HYDRAULIC PUMP	-
	SERVICE PARTS		
	5015971	RELIEF VALVE.	-
	3427482	CAP, REPLACEMENT	-

3423774 Hydraulic Power Pack



3423774 Hydraulic Power Pack



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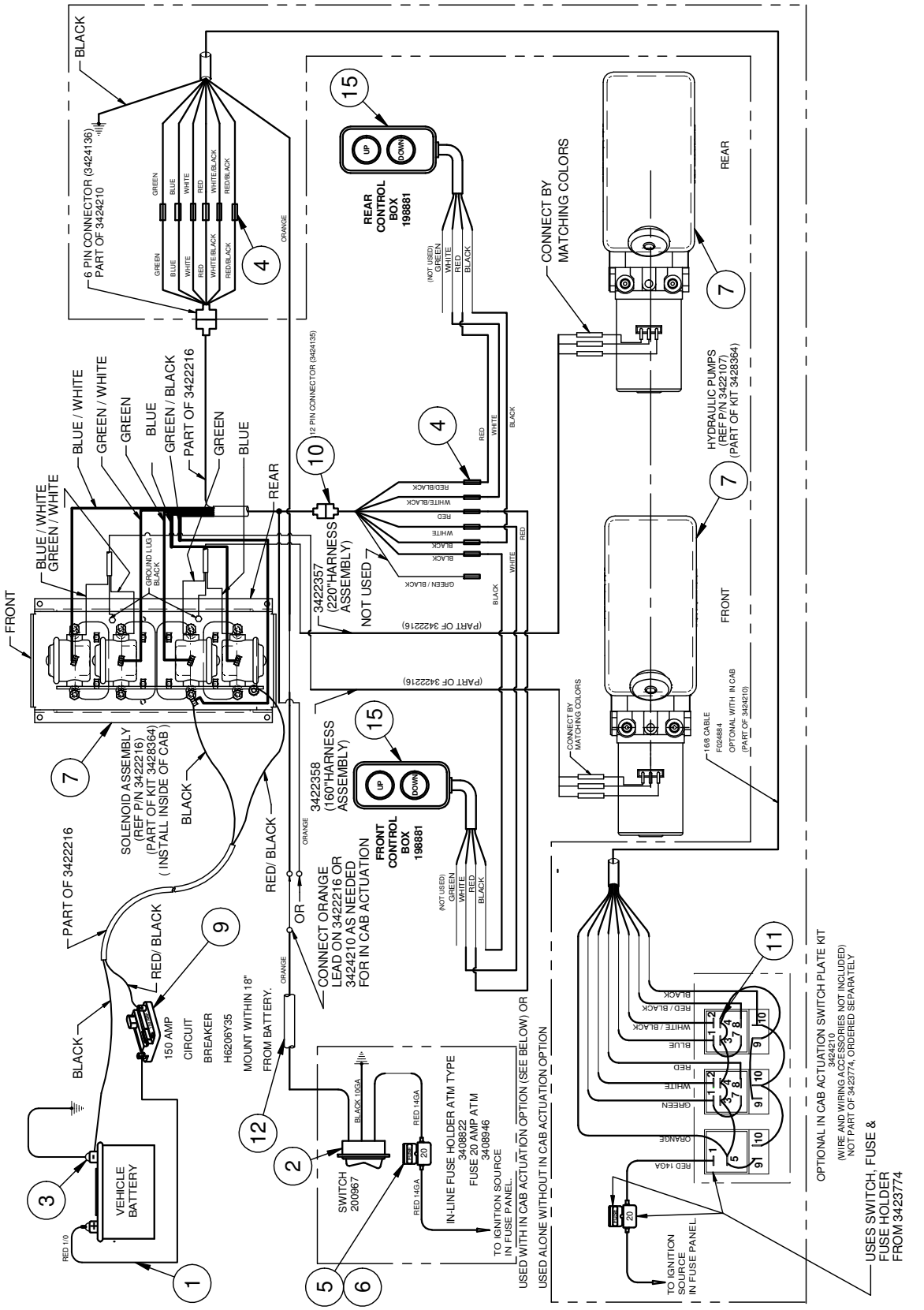
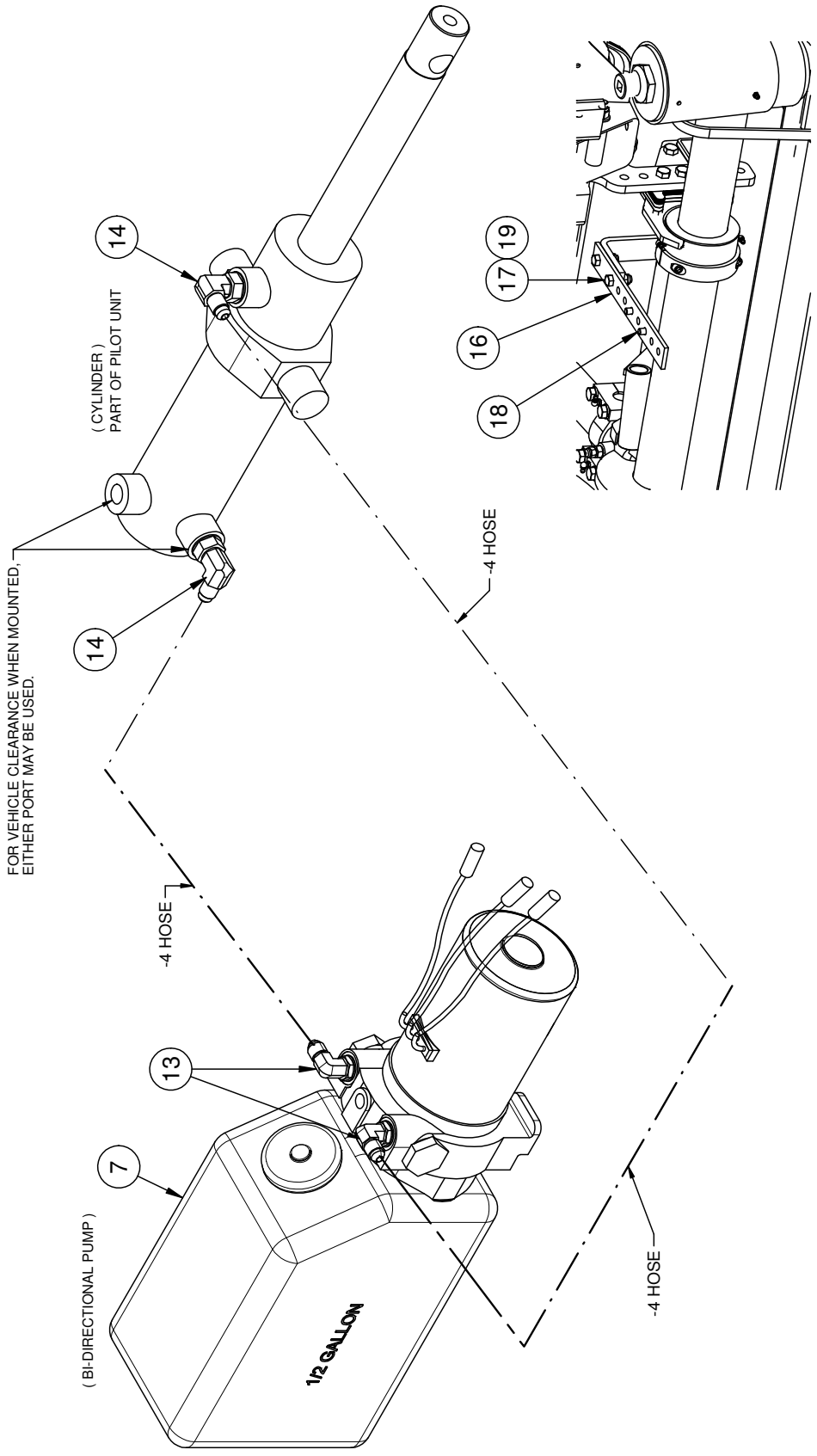
3423774 Hydraulic Power Pack



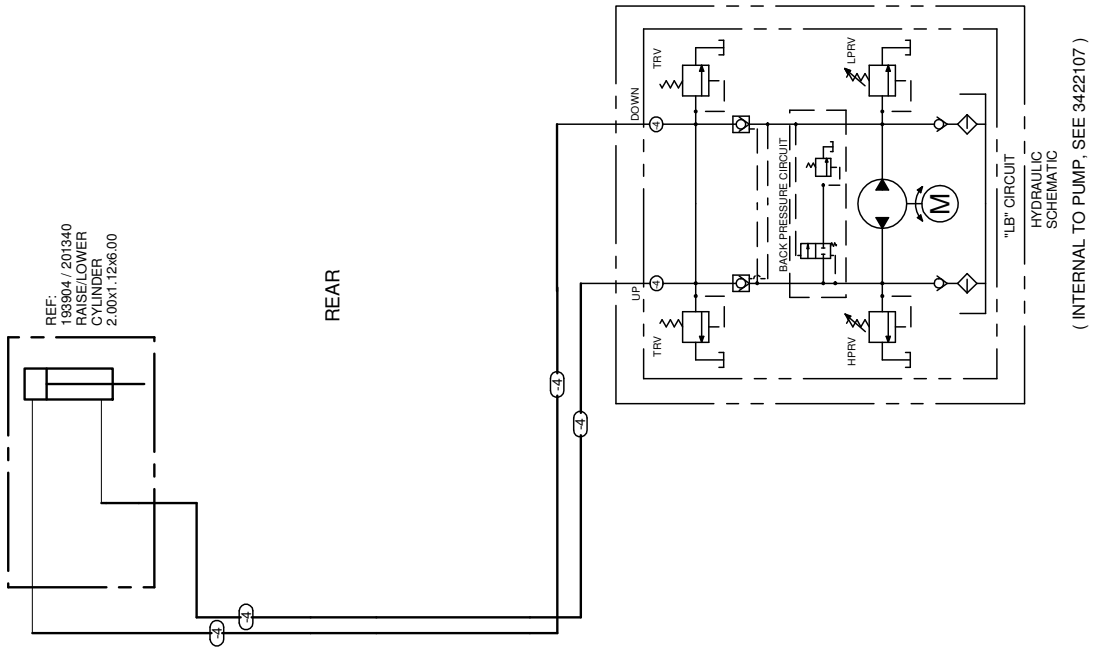
3423774 Hydraulic Power Pack

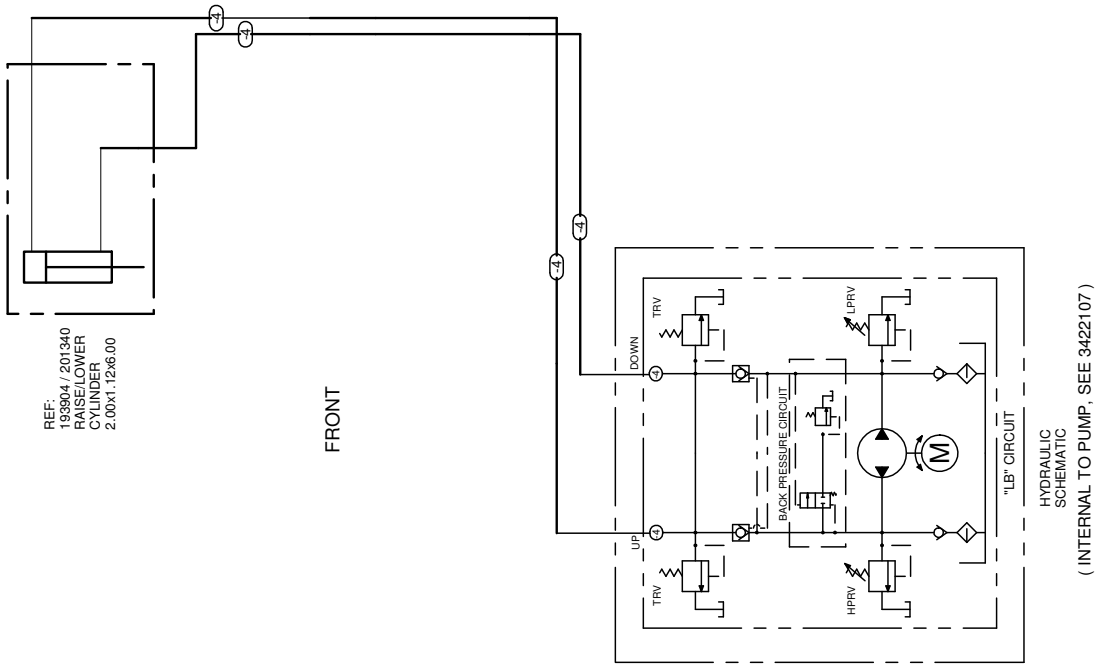
ITEM	PART NO	DESCRIPTION	QTY
1	200965	1/0 CABLE	5 ft
2	200967	SWITCH	1
3	201258	CABLE END	4
4	201260	BUTT CONNECTOR	14
5	3408822	FUSE HOLDER, IN-LINE MINI TYPE	1
6	3408946	FUSE 20 AMP - ATM BLADE TYPE	1
7	3428364	HR1500C1 PUMP/SOLENOID GROUP	1
9	H6206Y35	CIRCUIT BREAKER 150 AMP	1
10	3424135	12 PIN CONNECTOR	1
11	201270	PUSH ON CONNECTOR	22
12	701099063	AUTO-LOOM 5/8"	10 ft
13	F014734	ELB90 4X4SAE	4
14	F022262	ELB90 4X6SAE	4
15	198881	SWITCH BOX	2
16	F015718	NUT, NYLON, 7/16-14, GR 5, ZP	4
17	5077890	MOUNTING PLATE - UNIVERSAL	2
18	F003912	HEX HD CAP SCR 7/16-14X1 1/4 G	4
19	F004683	HEX HD CAP SCR 3/8-16X5/8 GR4	4

3425559 Hydraulic Power Pack, Remote



3425559 Hydraulic Power Pack, Remote





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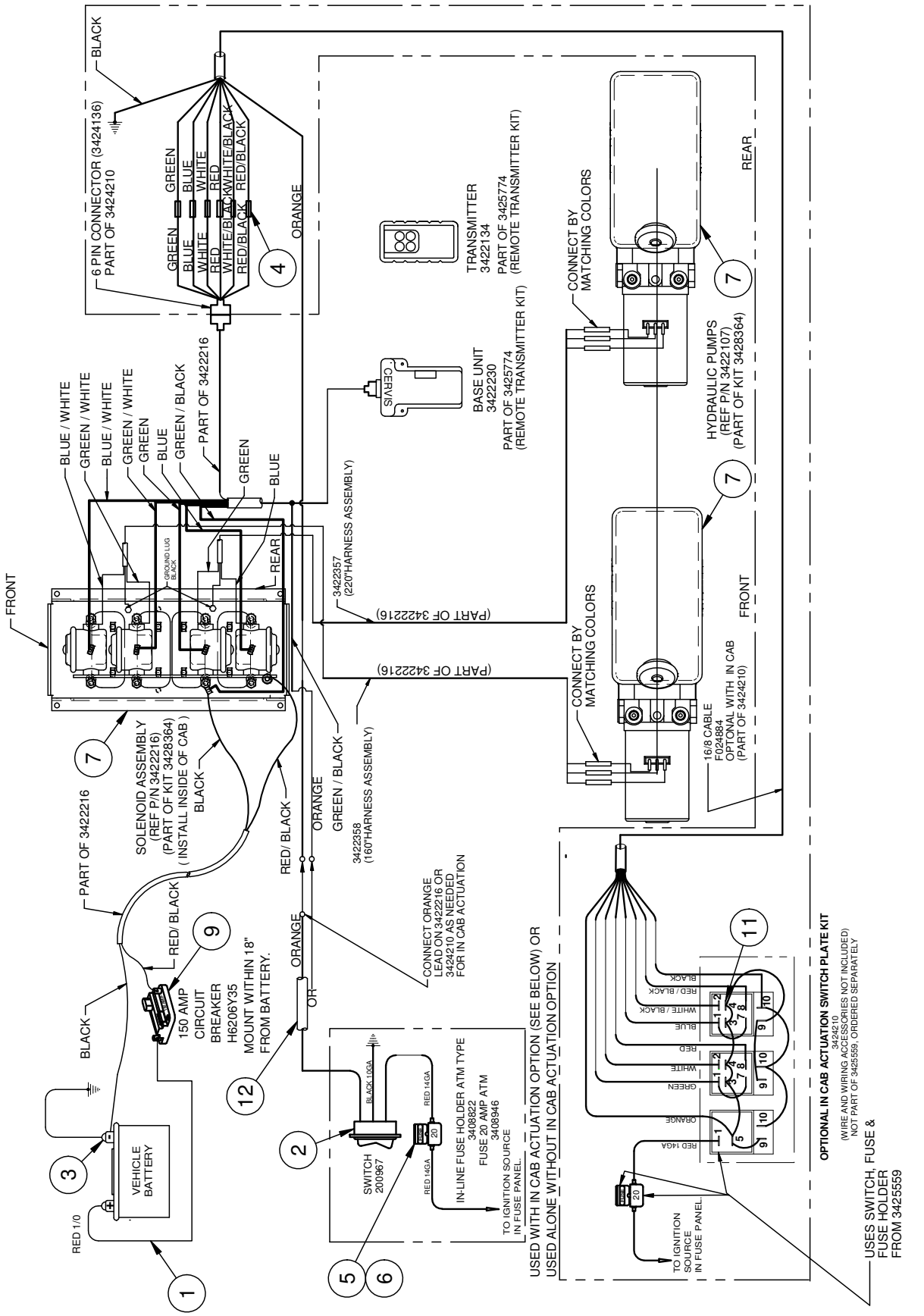
3425559 Hydraulic Power Pack, Remote



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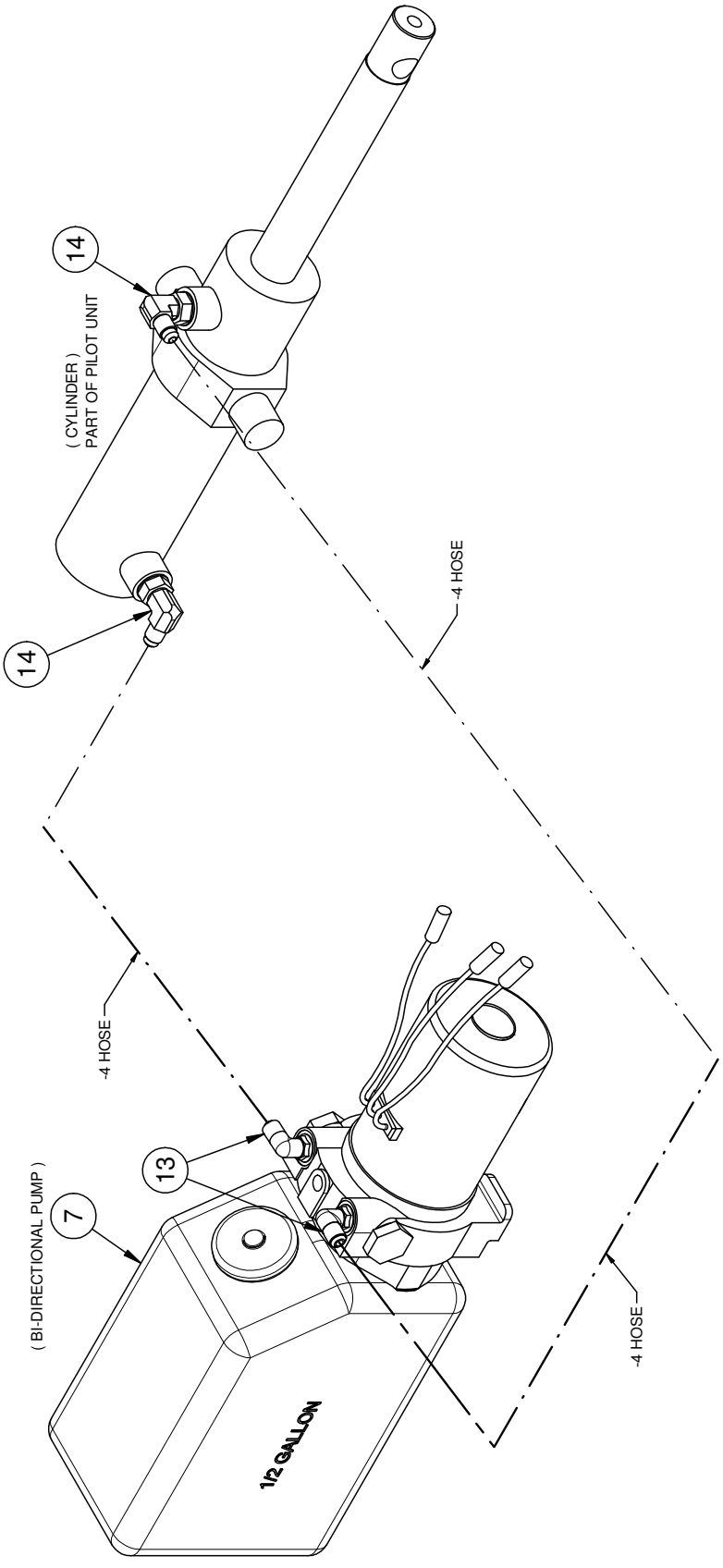
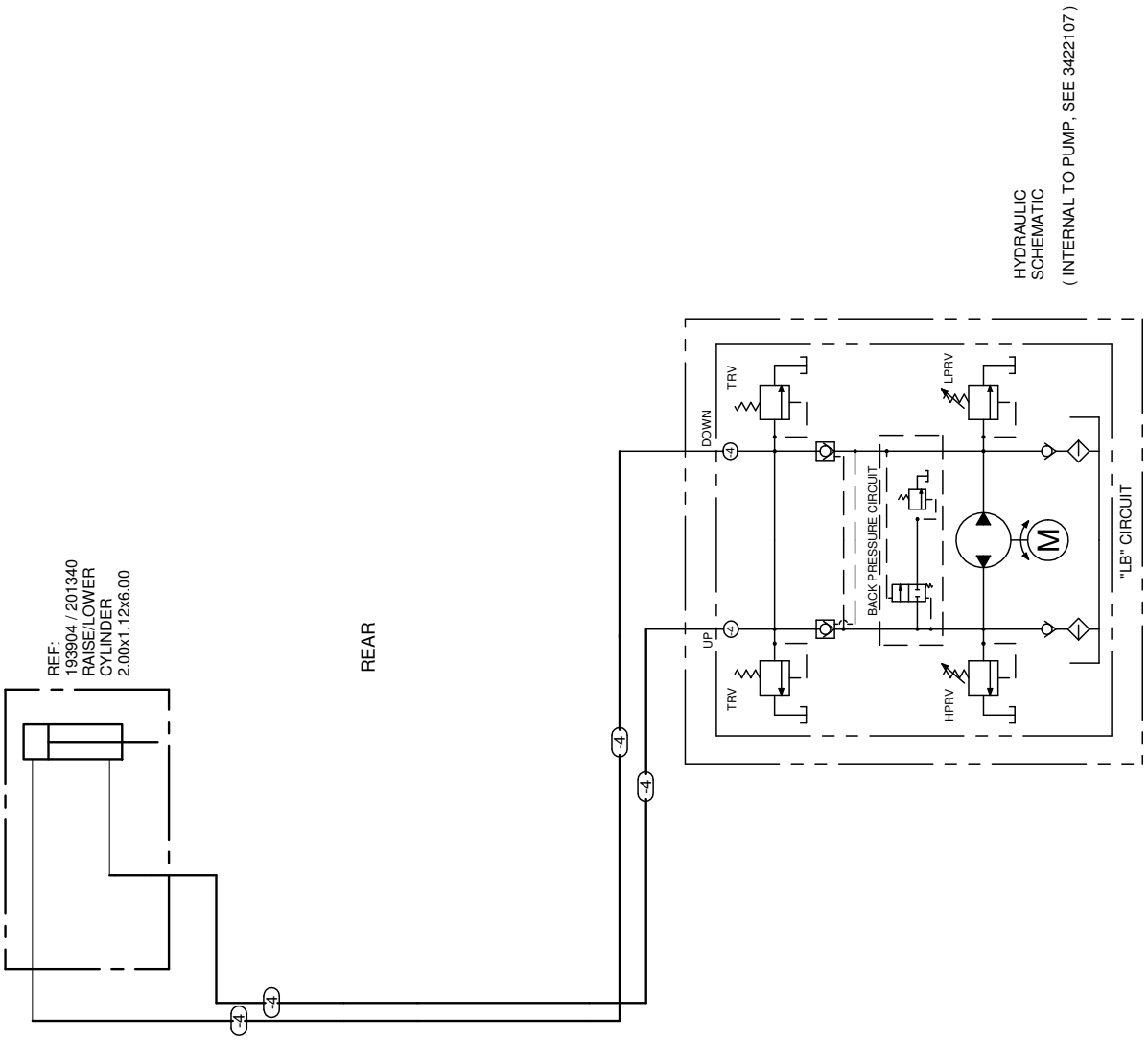
3425559 Hydraulic Power Pack, Remote

ITEM	PART NO	DESCRIPTION	QTY
1	200965	1/0 CABLE	5 ft
2	200967	SWITCH	1
3	201258	CABLE END	4
4	201260	BUTT CONNECTOR	14
5	3408822	FUSE HOLDER, IN-LINE MINI TYPE	1
6	3408946	FUSE 20 AMP - ATM BLADE TYPE	1
7	3428364	HR1500C1 PUMP/SOLENOID GROUP	1
9	H6206Y35	CIRCUIT BREAKER 150 AMP	1
11	201270	PUSH ON CONNECTOR	6
12	701099063	AUTO-LOOM 5/8"	10 ft
13	F014734	ELB90 4X4SAE	4
14	F022262	ELB90 4X6SAE	4
15	3425774	REMOTE/TRANSMITTER KIT	1
16	5077890	MOUNTING PLATE - UNIVERSAL	2
17	F003912	HEX HD CAP SCR 7/16-14X1 1/4 G	4
18	F004683	HEX HD CAP SCR 3/8-16X5/8 GR4	4
19	F015718	NUT, NYLON, 7/16-14, GR 5, ZP	4

3427543 Hydraulic Power Pack



3427543 Hydraulic Power Pack



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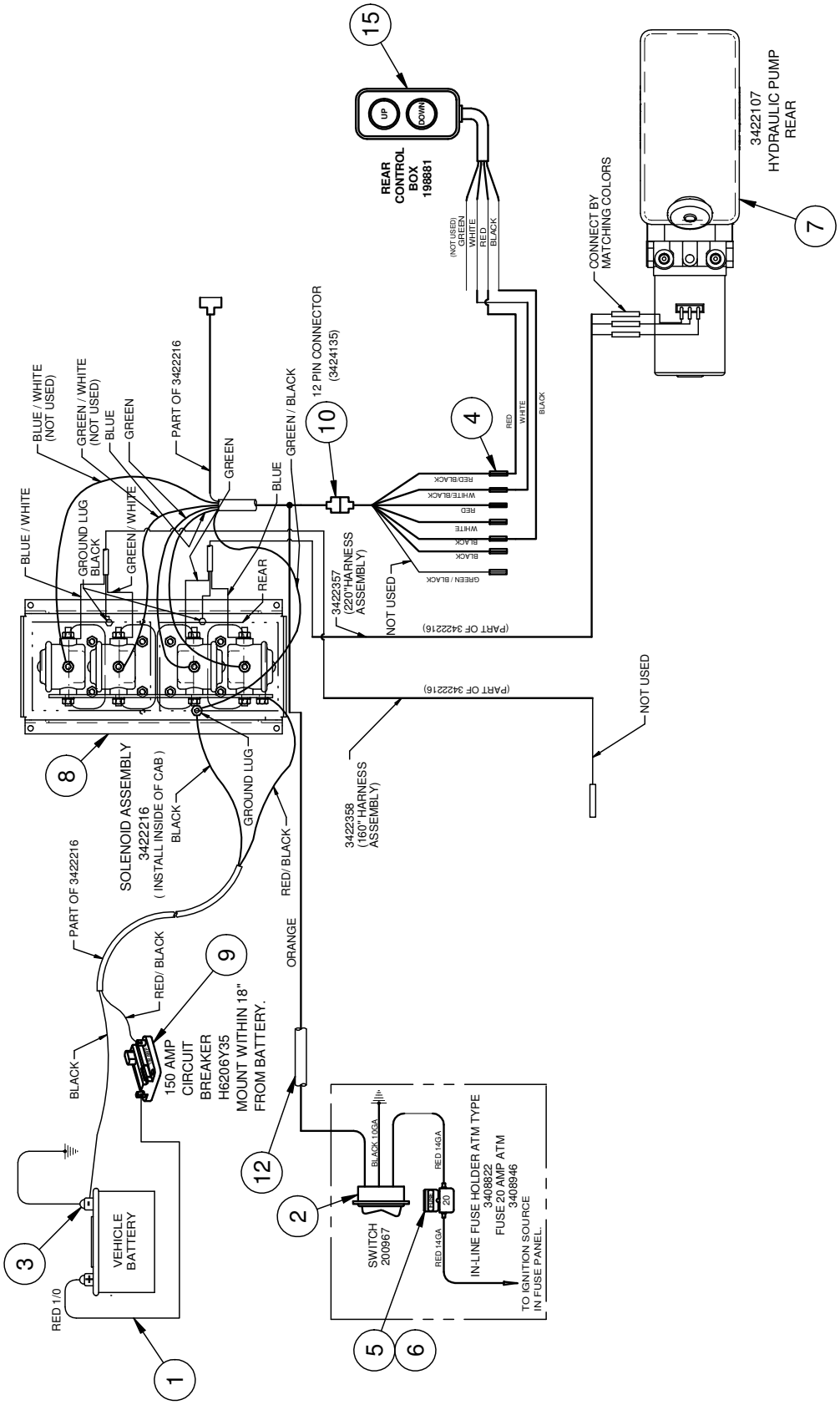
3427543 Hydraulic Power Pack



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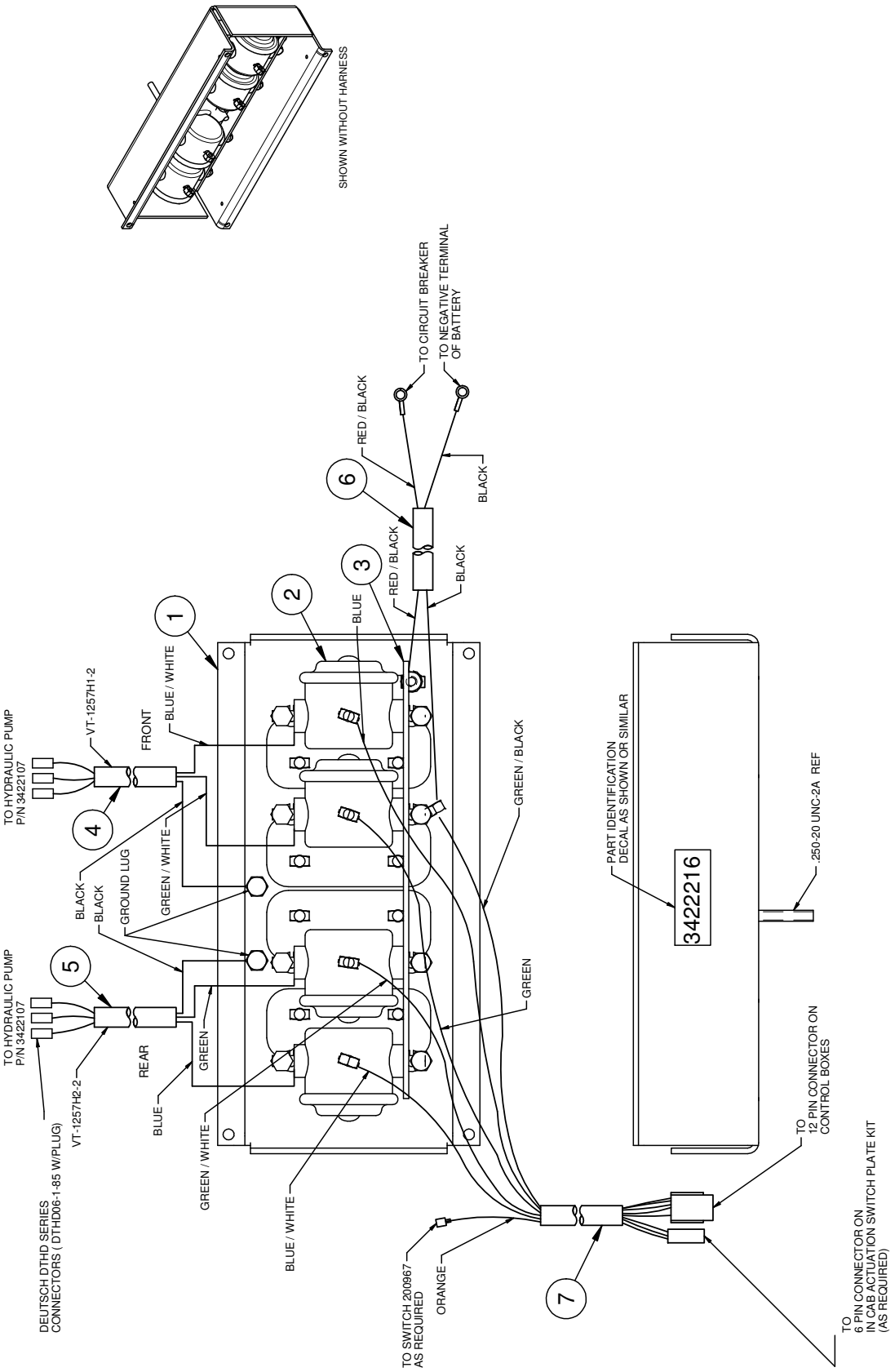
3427543 Hydraulic Power Pack

ITEM	PART NO	DESCRIPTION	QTY
1	200965	1/0 CABLE	3 ft
2	200967	SWITCH	1
3	201258	CABLE END	4
4	201260	BUTT CONNECTOR	14
5	3408822	FUSE HOLDER, IN-LINE MINI TYPE	1
6	3408946	FUSE 20 AMP - ATM BLADE TYPE	1
7	3422107	HYDRAULIC PUMP, BI-DIRECTIONAL	1
8	3422216	MOTOR CONTROL ASSEMBLY	1
9	H6206Y35	CIRCUIT BREAKER 150 AMP	1
10	3424135	12 PIN CONNECTOR	1
11	201270	PUSH ON CONNECTOR	6
12	701099063	AUTO-LOOM 5/8"	10 ft
13	F014734	ELB90 4X4SAE	2
14	F022262	ELB90 4X6SAE	2
15	198881	SWITCH BOX	1

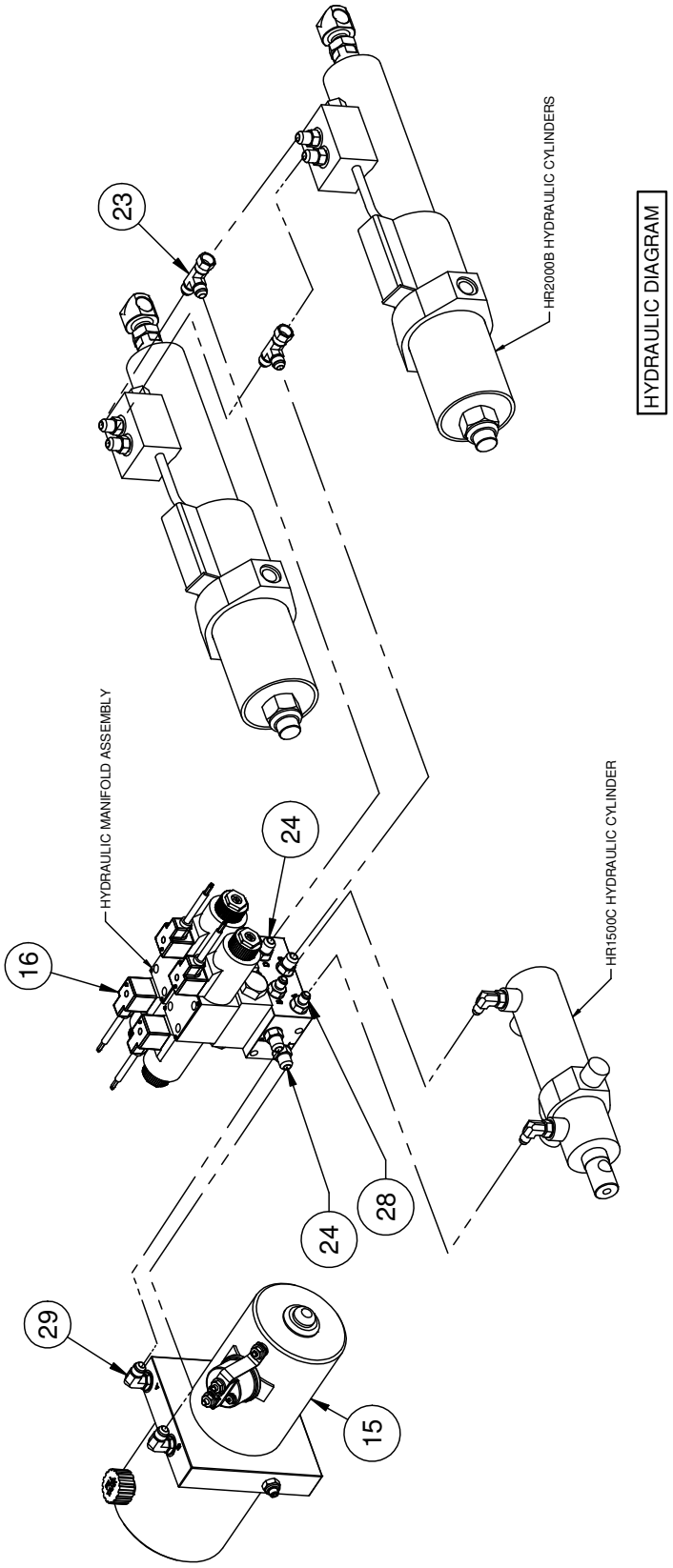
3422216 Motor Control Assembly



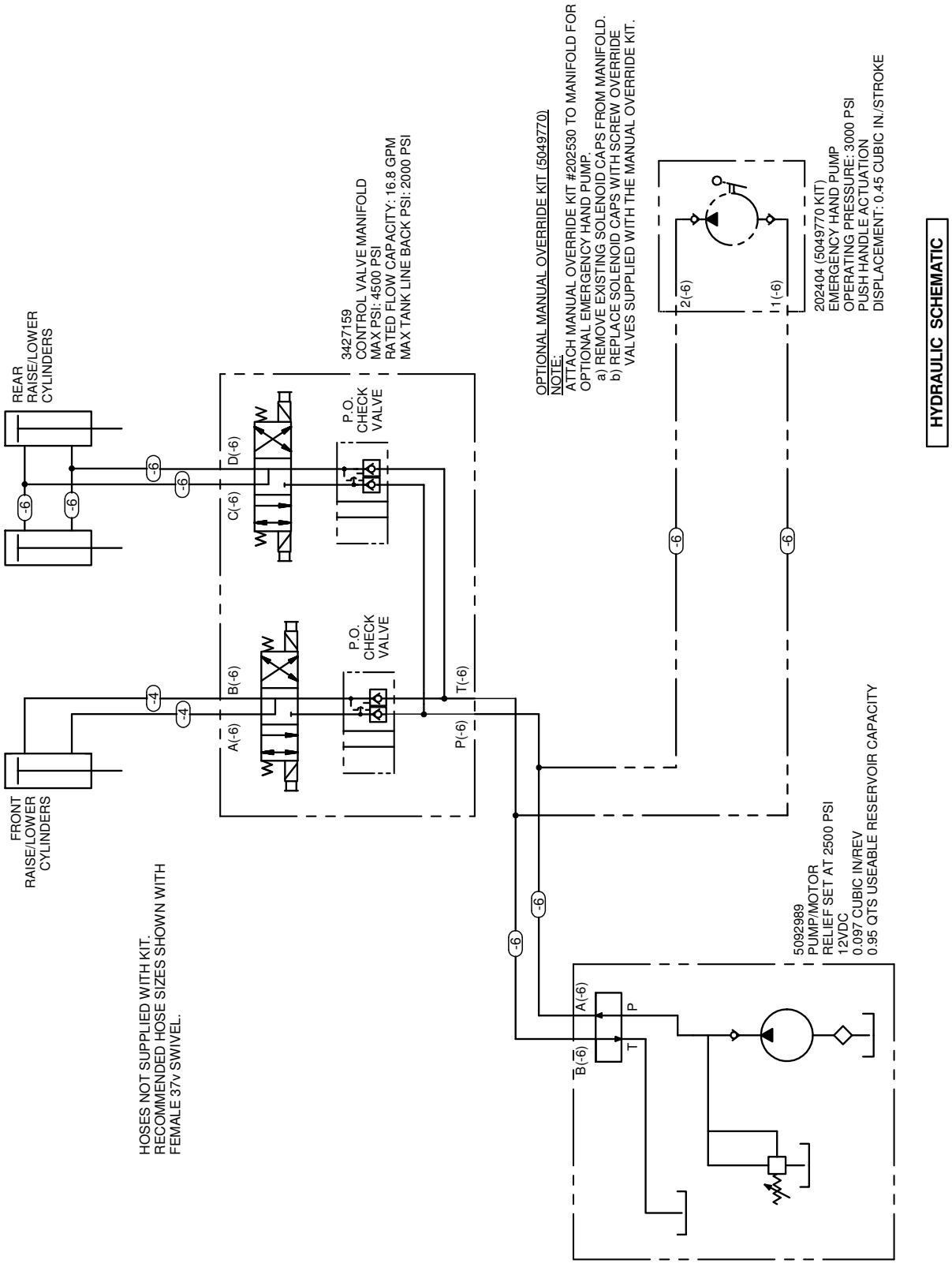
3422216 Motor Control Assembly

ITEM	PART NO	DESCRIPTION	QTY
1	3422211	MOTOR CONTROL ASSEMBLY	1
2	3422215	SOLENOID	4
3	5017900	STRIP	1
4	3422357	220" WIRE HARNESS ASSEMBLY	1
5	3422358	160" WIRE HARNESS ASSEMBLY	1
6	3422359	180" PARALLEL BATTERY CABLE	1
7	5028914	CONTROL HARNESS	1

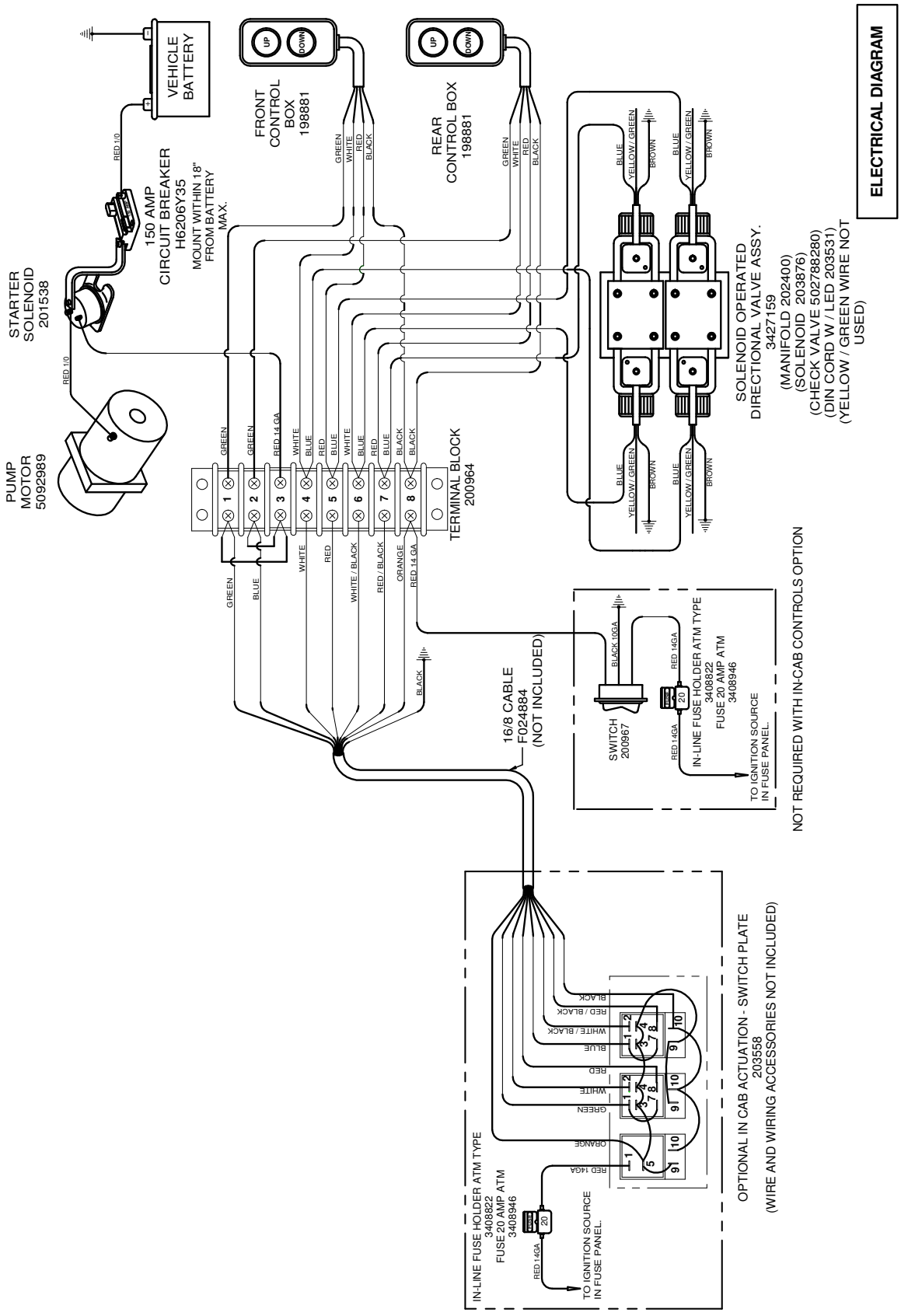
3427161 Hydraulic Power Pack Group



3427161 Hydraulic Power Pack Group



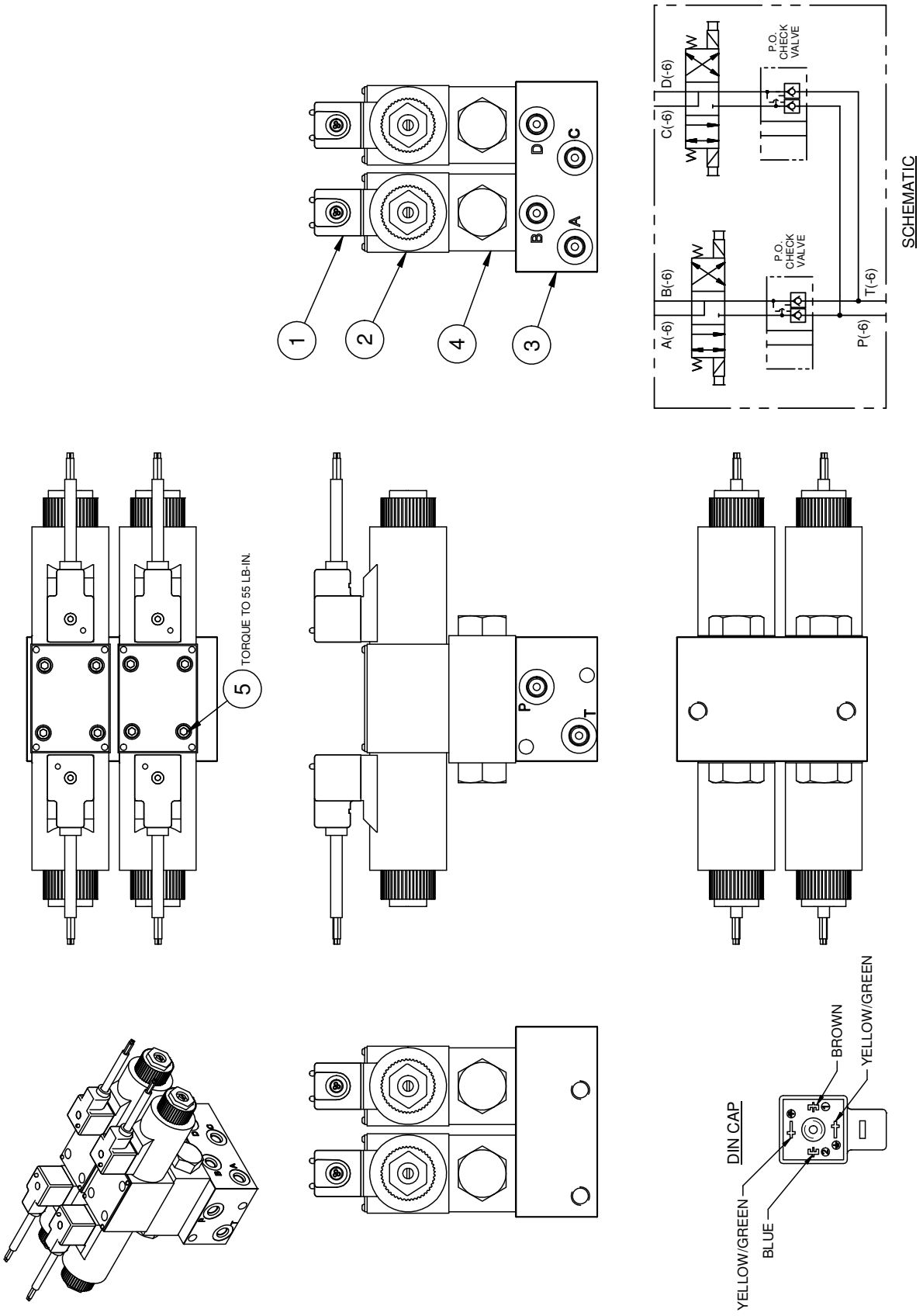
3427161 Hydraulic Power Pack Group



3427161 Hydraulic Power Pack Group

ITEM	PART NO	DESCRIPTION	QTY
1	168108	DECAL	1
2	198881	SWITCH BOX	2
3	200901	HHCS M4 X .7 X 30	4
4	200964	TERMINAL BLOCK	1
5	200965	1/0 CABLE	10 ft
6	200967	SWITCH	1
7	201258	CABLE END	4
8	201260	BUTT CONNECTOR	2
9	201265	TERMINAL, RING #10 HEAT SHRINK	6
10	201268	SPADE CONNECTOR	20
11	201269	SPADE CONNECTOR	9
12	201270	PUSH ON CONNECTOR	4
13	3408822	FUSE HOLDER, IN-LINE MINI TYPE	1
14	3408946	FUSE 20 AMP - ATM BLADE TYPE	1
15	5092989	HYDRAULIC UNIT	1
16	3427159	HR15C20B HYD MANIFOLD ASM	1
17	701099063	AUTO-LOOM 5/8"	10 ft
18	F001025	WASHER, LOCK, 3/8", MEDIUM, ZP	4
19	F001125	HEX HD CS 3/8-16X1 1/4 GR4	2
20	F004683	HEX HD CAP SCR 3/8-16X5/8 GR4	2
21	F009542	NUT, HEX, #10-24, GD2, ZP	2
22	F009681	FLAT WASHER. DIA 3/8. SAE. ZP	4
23	F013627	TEE 6X6FSX6	2
24	F013326	STR 6X6SAE	4
25	F016230	RND HD SKT CS 10-24X1-1/4	2
26	F016656	TY RAP	10
27	F020891	#14 GA WIRE-RED	5 ft
28	F022230	STR 4X6SAE	2
29	F013327	ELB90 6X6SAE	2
30	H6206Y35	CIRCUIT BREAKER 150 AMP	1

3427159 Hydraulic Manifold Assembly



3427159 Hydraulic Manifold Assembly

ITEM	PART NO	DESCRIPTION	QTY
1	203531	DIN CORD W / LED	4
2	203876	MOTOR SPOOL VALVE	2
3	3427160	HYDRAULIC MANIFOLD	1
4	502788280	VALVE	2
5	F023899	SKT HD CS #10(.190)-24 X 3.50	8

Notes:

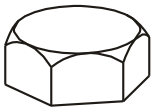
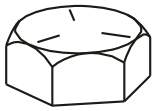
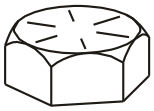
APPENDIX A - TORQUE SPECIFICATIONS AND CONVERSION TABLES
TABLE OF CONTENTS

Appendix A

STANDARD BOLT TORQUE REQUIREMENTS TABLE
STANDARD TYPE FASTENERS

The torque values listed below are for standard-type fasteners only. The torque values listed are based on wet and (lubricated) dry conditions. The torque values for 1/4 and 5/16 inch size fasteners are listed in lb-in and N-m torque equivalents. The torque values for all other size fasteners are listed lb-ft and N-m torque equivalents. Use lower grade torque values if bolt and nut have different SAE grades. Manufacturer's SAE grade markings may vary.

STANDARD MARKINGS AND TORQUE SPECIFICATIONS

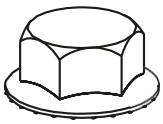
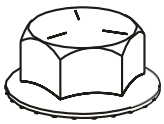
SAE Grade	1 or 2				5				8			
Fastener Standard SAE Grade Markings												
Fastener Body Size Inch-Thread	Torque				Torque				Torque			
	Wet		Dry		Wet		Dry		Wet		Dry	
	lb-in	N-m	lb-in	N-m	lb-in	N-m	lb-in	N-m	lb-in	N-m	lb-in	N-m
1/4 - 20	49	5.5	65	7.3	75	8.5	100	11.3	107	12.0	142	16.0
1/4 - 28	56	6.5	74	8.3	86	9.7	114	12.8	122	13.8	162	18.3
5/16 - 18	103	11.6	137	15.5	157	17.7	208	23.5	220	24.8	293	33.1
5/16 - 24	113	12.7	150	16.9	173	19.5	230	25.9	244	27.5	325	36.7
Fastener Body Size Inch-Thread	Torque				Torque				Torque			
	Wet		Dry		Wet		Dry		Wet		Dry	
	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m
3/8 - 16	15	20	20	27	23	31	31	42	32	43	43	58
3/8 - 24	17	23	23	31	26	35	35	47	37	50	49	66
7/16 - 14	24	32	32	43	37	50	49	66	52	70	69	93
7/16 - 20	27	36	36	49	42	57	56	76	58	78	77	104
1/2 - 13	39	53	52	70	57	77	76	103	80	108	106	144
1/2 - 20	41	55	55	74	64	87	85	115	90	122	120	163
9/16 - 12	53	72	71	96	82	111	109	148	115	156	153	207
9/16 - 18	59	80	78	106	91	123	121	164	129	175	172	233
5/8 - 11	73	99	97	131	113	155	150	203	160	217	213	289
5/8 - 18	83	112	110	149	128	173	170	230	180	244	239	324
3/4 - 10	129	175	172	233	200	271	266	361	282	382	375	508
3/4 - 16	144	195	192	260	223	302	297	403	315	427	419	568
7/8 - 9	124	168	165	224	323	438	430	583	454	615	604	819
7/8 - 14	138	187	184	249	355	481	472	640	501	679	666	903
1 - 8	188	255	250	339	483	655	642	870	681	923	906	1228
1 - 14	210	285	279	378	541	733	720	976	764	1036	1016	1377
1-1/8 - 7	266	361	354	480	596	808	793	1075	966	1310	1285	1742
1-1/8 - 12	297	403	395	535	668	906	888	1204	1083	1468	1440	1952
1-1/4 - 7	375	508	499	676	841	1140	1119	1517	1363	1848	1813	2458
1-1/4 - 12	415	563	552	748	930	1261	1237	1677	1509	2046	2007	2721
1-3/8 - 6	492	667	654	887	1102	1494	1466	1988	1787	2423	2377	3223
1-3/8 - 12	560	759	745	1010	1255	1701	1670	2264	2034	2758	2705	3667
1-1/2 - 6	653	885	868	1177	1463	1983	1946	2638	2371	3215	3153	4275
1-1/2 - 12	734	995	976	1323	1645	2230	2188	2966	2668	3617	3548	4810

Appendix A

STANDARD BOLT TORQUE REQUIREMENTS TABLE
SERRATED TYPE FLANGE FASTENERS

The torque values listed below are for serrated-type flange fasteners only. The torque values listed are based on wet (lubricated) and dry conditions. The torque values for all other size fasteners are listed in lb-ft and N-m torque equivalents. Use lower grade torque values if bolt and nut have different SAE grades. Manufacturer's SAE grade markings may vary.

STANDARD MARKINGS AND TORQUE SPECIFICATIONS

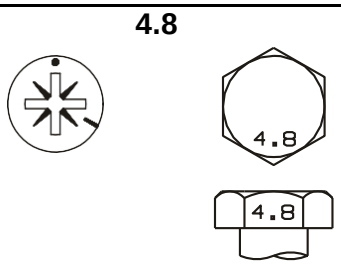
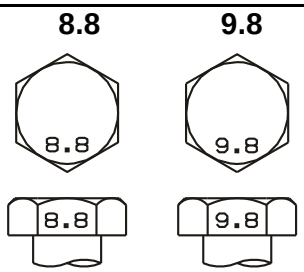
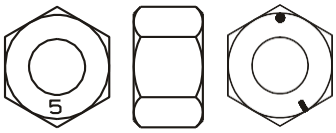
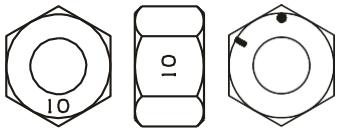
SAE Grade	1 or 2				5			
Fastener Standard SAE Grade Markings								
Fastener Body Size Inch-Thread	Torque				Torque			
	Wet		Dry		Wet		Dry	
	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m
1/4 - 20	8	10.8	11	14.9	11	14.9	15	20.3
1/4 - 28	9	12.2	12	16.3	12	16.3	16	21.7
5/16 - 18	13	17.6	17	23.0	20	27.1	27	36.6
5/16 - 24	13	17.6	17	23.0	32	43.3	43	58.3
3/8 - 16	23	31	31	42	40	54	53	72
3/8 - 24	25	34	33	45	43	58	57	77
7/16 - 14	38	51	51	69	55	74	73	99
7/16 - 20	40	54	53	72	60	81	80	108
1/2 - 13	60	81	80	108	95	129	127	172
1/2 - 20	65	88	87	118	100	135	133	180
9/16 - 12	78	106	104	141	140	190	187	253
9/16 - 18	85	115	113	153	150	203	200	271
5/8 - 11	125	169	167	226	190	258	253	343
5/8 - 18	135	183	180	244	220	298	293	397
3/4 - 10	225	305	300	407	350	474	467	633
3/4 - 16	250	339	333	451	400	542	533	723
7/8 - 9	350	474	467	633	550	746	733	994
7/8 - 14	375	508	500	678	600	813	800	1085
1 - 8	480	651	640	868	750	1017	1000	1356
1 - 14	500	678	666	903	800	1085	1066	1445

Appendix A

BOLT TORQUE REQUIREMENTS TABLE
METRIC TYPE FASTENERS

Do not use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically. Fasteners should be replaced with the same or higher property class. If higher property class fasteners are used, these should only be tightened to the strength of the original. Make sure fastener's threads are clean and that thread engagement is properly started. This will help prevent them from failing when tightening.

* Lubricated means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. Dry means plain or zinc plated without any lubrication.

Property Class and Head Markings	**4.8** 	**8.8** **9.8** 
Property Class and Head Markings	**5** 	**10** 

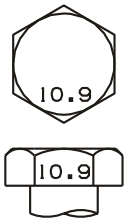
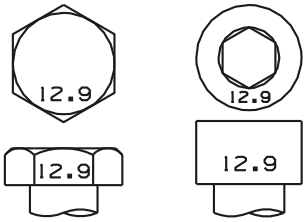
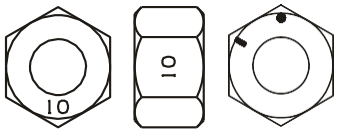
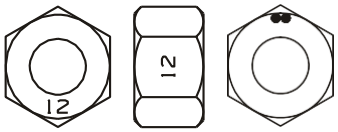
Size	**Class 4.8**				**Class 8.8 or 9.8**			
	*** Lubricated**		*** Dry**		*** Lubricated**		*** Dry**	
	N - m	lb - ft	N - m	lb - ft	N - m	lb - ft	N - m	lb - ft
M 6	4.8	3.5	6	4.5	9	6.5	11	8.5
M 8	12	8.5	15	11	22	16	28	20
M10	23	17	29	21	43	32	55	40
M12	40	29	50	37	75	55	95	70
M14	63	47	80	60	120	88	150	110
M16	100	73	125	92	190	140	240	175
M18	135	100	175	125	260	195	330	250
M20	190	140	240	180	375	275	475	350
M22	260	190	330	250	510	375	650	475
M24	330	250	425	310	650	475	825	600
M27	490	360	625	450	950	700	1200	875
M30	675	490	850	625	1300	950	1650	1200
M33	900	675	1150	850	1750	1300	2200	1650
M36	1150	850	1450	1075	2250	1650	2850	2100

Appendix A

BOLT TORQUE REQUIREMENTS TABLE
METRIC TYPE FASTENERS

Do not use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically. Fasteners should be replaced with the same or higher property class. If higher property class fasteners are used, these should only be tightened to the strength of the original. Make sure fastener's threads are clean and that thread engagement is properly started. This will help prevent them from failing when tightening.

* Lubricated means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. Dry means plain or zinc plated without any lubrication.

Property Class and Head Markings	10.9				12.9			
								
Property Class and Head Markings	**10**				**12**			
								
Size	**Class 10.9**				**Class 12.9**			
	*** Lubricated**		*** Dry**		*** Lubricated**		*** Dry**	
	N - m	lb - ft	N - m	lb - ft	N - m	lb - ft	N - m	lb - ft
M 6	13	9.5	17	12	15	11.5	19	14.5
M 8	32	24	40	30	37	28	47	35
M10	63	47	80	60	75	55	95	70
M12	110	80	140	105	130	95	165	120
M14	175	130	225	165	205	150	260	190
M16	275	200	350	255	320	240	400	300
M18	375	275	475	350	440	325	560	410
M20	530	400	675	500	625	460	800	580
M22	725	540	925	675	850	625	1075	800
M24	925	675	1150	850	1075	800	1350	1000
M27	1350	1000	1700	1250	1600	1150	2000	1500
M30	1850	1350	2300	1700	2150	1600	2700	2000
M33	2500	1850	3150	2350	2900	2150	3700	2750
M36	3200	2350	4050	3000	3750	2750	4750	3500

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Appendix A

RECOMMENDED HYDRAULIC FITTING ASSEMBLY TORQUE

Straight Thread O-Ring Boss Low Pressure with 37° (SAEJ514)			
Dash Size	Thread Size (inches)	Jam Nut or Straight Fitting Torque	
		lb-ft	N-m
-03	3/8-24	8-9	12-13
-04	7/16-20	13-15	18-20
-05	1/2-20	14-15	19-21
-06	9/16-18	23-24	32-33
-08	3/4-16	40-43	55-57
-10	7/8-14	43-48	59-64
-12	1-1/16-12	68-75	93-101
-14	1-3/16-12	83-90	113-122
-16	1-5/16-12	112-123	152-166
-20	1-5/8-12	146-161	198-218
-24	1-7/8-12	154-170	209-230
-32	2-1/2-12	218-240	296-325

Straight Thread O-Ring Boss High Pressure with O-Ring Seal (ORS) (J1453)			
Dash Size	Thread Size (inches)	Jam Nut or Straight Fitting Torque	
		lb-ft	N-m
-03	3/8-24	8-10	11-13
-04	7/16-20	14-16	20-22
-05	1/2-20	18-20	24-27
-06	9/16-18	24-26	33-35
-08	3/4-16	50-60	68-78
-10	7/8-14	72-80	98-110
-12	1-1/16-12	125-135	170-183
-14	1-3/16-12	160-180	215-245
-16	1-5/16-12	200-220	270-300
-20	1-5/8-12	210-280	285-380
-24	1-7/8-12	270-360	370-490

O-Ring Seal (ORS)			
Dash Size	Thread Size (inches)	Swivel Nut	
		lb-ft	N-m
-04	9/16-18	10-12	14-16
-06	11/16-16	18-20	24-27
-08	13/16-16	32-35	43-47
-10	1-14	46-50	62-68
-12	1-3/16-12	65-70	88-95
-16	1-7/16-12	92-100	125-136
-20	1-11/16-12	125-140	170-190
-24	2-12	150-165	204-224

SAE 37° (JIC)			
Dash Size	Thread Size (inches)	Swivel Nut	
		lb-ft	N-m
-04	7/16-20	11-12	15-16
-05	1/2-20	15-16	20-22
-06	9/16-18	18-20	24-28
-08	3/4-16	38-42	52-58
-10	7/8-14	57-62	77-85
-12	1-1/16-12	79-87	108-119
-16	1-5/16-12	108-113	148-154
-20	1-5/8-12	127-133	173-182
-24	1-7/8-12	158-167	216-227
-32	2-1/2-12	245-258	334-352

Metric		
Thread Size	Straight Adapter or Locknut Torque	
mm	lb-ft	N-m
M10 x 1	13-15	18-20
M12 x 1.5	15-19	20-25
M14 x 1.5	19-23	25-30
M16 x 1.5	33-40	45-55
M18 x 1.5	37-44	50-60
M20 x 1.5	52-66	70-90
M22 x 1.5	55-70	75-95
M26 x 1.5	81-96	110-130
M27 x 2	96-111	130-150
M33 x 2	162-184	220-250
M42 x 2	170-192	230-260
M48 x 2	258-347	350-470

British Standard Pipe Parallel (BSPP)		
Thread Size	Straight Adapter or Locknut Torque	
Inches **	lb-ft	N-m
G 1/8-28	13-15	18-20
G 1/4-19	19-23	25-30
G 3/8-19	33-40	45-55
G 1/2-14	55-70	75-95
G 3/4-14	103-118	140-160
G 1-11	162-184	220-250
G 1-1/4-11	170-192	230-260
G 1-1/2-11	258-347	350-470

** "G" denotes parallel threads, other than ISO 6149 (Port connection only)

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Appendix A

INCH TO MILLIMETER CONVERSION TABLE
1 INCH = 25.4 MILLIMETERS

FRACTIONS	DECIMALS	MILLIMETERS	FRACTIONS	DECIMALS	MILLIMETERS
1/64	.016	0.397	33/64	.516	13.097
1/32	.031	0.794	17/32	.531	13.494
3/64	.047	1.191	35/64	.547	13.891
1/16	.063	1.588	9/16	.563	14.288
5/64	.078	1.984	37/64	.578	14.684
3/32	.094	2.381	19/32	.594	15.081
7/64	.109	2.778	39/64	.609	15.478
1/8	.125	3.175	5/8	.625	15.875
9/64	.141	3.572	41/64	.641	16.272
5/32	.156	3.969	21/32	.656	16.669
11/64	.172	4.366	43/64	.672	17.066
3/16	.188	4.763	11/16	.688	17.463
13/64	.203	5.159	45/64	.703	17.859
7/32	.219	5.556	23/32	.719	18.256
15/64	.234	5.953	47/64	.734	18.653
1/4	.250	6.350	3/4	.750	19.050
17/64	.266	6.747	49/64	.766	19.447
9/32	.281	7.144	25/32	.781	19.844
19/64	.297	7.541	51/64	.797	20.241
5/16	.313	7.938	13/16	.813	20.638
21/64	.328	8.334	53/64	.828	21.034
11/32	.344	8.731	27/32	.844	21.431
23/64	.359	9.128	55/64	.859	21.828
3/8	.375	9.525	7/8	.875	22.225
25/64	.391	9.922	57/64	.891	22.622
13/32	.406	10.319	29/32	.906	23.019
27/64	.422	10.716	59/64	.922	23.416
7/16	.438	11.113	15/16	.938	23.813
29/64	.453	11.509	61/64	.953	24.209
15/32	.469	11.906	31/32	.969	24.606
31/64	.484	12.303	63/64	.984	25.003
1/2	.500	12.700	1	1.000	25.400

FEET TO METERS CONVERSION TABLE
1 FOOT = 0.3048 METER

FEET	METERS	FEET	METERS	FEET	METERS	FEET	METERS	FEET	METERS
100	30.480	10	3.048	1	0.305	0.1	0.030	0.01	0.003
200	60.960	20	6.096	2	0.610	0.2	0.061	0.02	0.006
300	91.440	30	9.144	3	0.914	0.3	0.091	0.03	0.009
400	121.920	40	12.192	4	1.219	0.4	0.122	0.04	0.012
500	152.400	50	15.240	5	1.524	0.5	0.152	0.05	0.015
600	182.880	60	18.288	6	1.829	0.6	0.183	0.06	0.018
700	213.360	70	21.336	7	2.134	0.7	0.213	0.07	0.021
800	243.840	80	24.384	8	2.438	0.8	0.244	0.08	0.024
900	274.320	90	27.432	9	2.743	0.9	0.274	0.09	0.027
1,000	304.800	100	30.480	10	3.048	1.0	0.305	0.10	0.030

Appendix A

POUNDS TO KILOGRAMS CONVERSION TABLE
1 POUND = 0.4536 KILOGRAM

LB	KG	LB	KG	LB	KG	LB	KG	LB	KG
1,000	453.59	100	45.36	10	4.54	1	0.45	0.1	0.05
2,000	907.18	200	90.72	20	9.07	2	0.91	0.2	0.09
3,000	1,360.78	300	136.08	30	13.61	3	1.36	0.3	0.14
4,000	1,814.37	400	181.44	40	18.14	4	1.81	0.4	0.18
5,000	2,267.96	500	226.80	50	22.68	5	2.27	0.5	0.23
6,000	2,721.55	600	272.16	60	27.22	6	2.72	0.6	0.27
7,000	3,175.15	700	317.51	70	31.75	7	3.18	0.7	0.32
8,000	3,628.74	800	362.87	80	36.29	8	3.63	0.8	0.36
9,000	4,082.33	900	408.23	90	40.82	9	4.08	0.9	0.41
10,000	4,535.92	1,000	453.59	100	45.36	10	4.54	1.0	0.45

POUNDS PER SQUARE INCH TO BAR CONVERSION TABLE
1 PSI = 0.06895 BAR

PSI	BAR	PSI	BAR	PSI	BAR	PSI	BAR
1,000	68.95	100	6.90	10	0.69	1	0.07
2,000	137.90	200	13.79	20	1.38	2	0.14
3,000	206.84	300	20.68	30	2.07	3	0.21
4,000	275.80	400	27.58	40	2.76	4	0.28
5,000	344.70	500	34.47	50	3.45	5	0.35
6,000	413.64	600	41.36	60	4.14	6	0.41
7,000	482.58	700	48.26	70	4.83	7	0.48
8,000	551.52	800	55.15	80	5.52	8	0.55
9,000	620.46	900	62.05	90	6.21	9	0.62
10,000	689.48	1,000	68.95	100	6.90	10	0.69

POUNDS PER SQUARE INCH TO KILOPASCALS CONVERSION TABLE
1 PSI = 6.895 kPa

PSI	kPa	PSI	kPa
10	68.95	1	6.90
20	137.90	2	13.79
30	206.84	3	20.68
40	275.80	4	27.58
50	344.70	5	34.47
60	413.64	6	41.36
70	482.58	7	48.26
80	551.52	8	55.15
90	620.46	9	62.05
100	689.48	10	68.95

Appendix A

FAHRENHEIT TO CELSIUS (Centigrade) CONVERSION TABLE
(DEGREES F - 32°) ÷ 1.8 = DEGREES C

deg F	deg C	deg F	deg C	deg F	deg C	deg F	deg C
1	-17.2	51	10.6	101	38.3	151	66.1
2	-16.7	52	11.1	102	38.9	152	66.7
3	-16.1	53	11.7	103	39.4	153	67.2
4	-15.6	54	12.2	104	40.0	154	67.8
5	-15.0	55	12.8	105	40.6	155	68.3
6	-14.4	56	13.3	106	41.1	156	68.9
7	-13.9	57	13.9	107	41.7	157	69.4
8	-13.3	58	14.4	108	42.2	158	70.0
9	-12.8	59	15.0	109	42.8	159	70.6
10	-12.2	60	15.6	110	43.3	160	71.1
11	-11.7	61	16.1	111	43.9	161	71.7
12	-11.1	62	16.7	112	44.4	162	72.2
13	-10.6	63	17.2	113	45.0	163	72.8
14	-10.0	64	17.8	114	45.6	164	73.3
15	-9.4	65	18.3	115	46.1	165	73.9
16	-8.9	66	18.9	116	46.7	166	74.4
17	-8.3	67	19.4	117	47.2	167	75.0
18	-7.8	68	20.0	118	47.8	168	75.6
19	-7.2	69	20.6	119	48.3	169	76.1
20	-6.7	70	21.1	120	48.9	170	76.7
21	-6.1	71	21.7	121	49.4	171	77.2
22	-5.6	72	22.2	122	50.0	172	77.8
23	-5.0	73	22.8	123	50.6	173	78.3
24	-4.4	74	23.3	124	51.1	174	78.9
25	-3.9	75	23.9	125	51.7	175	79.4
26	-3.3	76	24.4	126	52.2	176	80.0
27	-2.8	77	25.0	127	52.8	177	80.6
28	-2.2	78	25.6	128	53.3	178	81.1
29	-1.7	79	26.1	129	53.9	179	81.7
30	-1.1	80	26.7	130	54.4	180	82.2
31	-0.6	81	27.2	131	55.0	181	82.8
32	0.0	82	27.8	132	55.6	182	83.3
33	0.6	83	28.3	133	56.1	183	83.9
34	1.1	84	28.9	134	56.7	184	84.4
35	1.7	85	29.4	135	57.2	185	85.0
36	2.2	86	30.0	136	57.8	186	85.6
37	2.7	87	30.6	137	58.3	187	86.1
38	3.3	88	31.1	138	58.9	188	86.7
39	3.9	89	31.7	139	59.4	189	87.2
40	4.4	90	32.2	140	60.0	190	87.8
41	5.0	91	32.8	141	60.6	191	88.3
42	5.6	92	33.3	142	61.1	192	88.9
43	6.1	93	33.9	143	61.7	193	89.4
44	6.7	94	34.4	144	62.2	194	90.0
45	7.2	95	35.0	145	62.8	195	90.6
46	7.8	96	35.6	146	63.3	196	91.1
47	8.3	97	36.1	147	63.9	197	91.7
48	8.9	98	36.7	148	64.4	198	92.2
49	9.4	99	37.2	149	65.0	199	92.8
50	10.0	100	37.8	150	65.5	200	93.3

Appendix A

MILES PER HOUR TO KILOMETERS
PER HOUR CONVERSION TABLE
1 MPH = 1.609 KM/H

MPH	KM/H	MPH	KM/H	MPH	KM/H
10	16.09	1	1.61	0.1	0.16
20	32.19	2	3.22	0.2	0.32
30	48.28	3	4.83	.03	0.48
40	64.37	4	6.44	0.4	0.64
50	80.47	5	8.05	0.5	0.80
60	96.56	6	9.66	0.6	0.97
70	112.65	7	11.27	0.7	1.13
80	128.75	8	12.87	0.8	1.29
90	144.84	9	14.48	0.9	1.45
100	160.93	10	16.09	1.0	1.61

U.S. GALLONS TO LITERS CONVERSION TABLE
1 U.S. GALLON = 3.785 LITERS

GAL	LITER	GAL	LITER	GAL	LITER	GAL	LITER
100	378.54	10	37.85	1	3.79	0.1	0.38
200	757.08	20	75.71	2	7.57	0.2	0.76
300	1,135.62	30	113.56	3	11.36	0.3	1.14
400	1,514.16	40	151.42	4	15.14	0.4	1.51
500	1,892.71	50	189.27	5	18.93	0.5	1.89
600	2,271.25	60	227.12	6	22.71	0.6	2.27
700	2,649.79	70	264.98	7	26.50	0.7	2.65
800	3,028.33	80	302.83	8	30.28	0.8	3.03
900	3,406.87	90	340.69	9	34.07	0.9	3.41
1,000	3,785.41	100	378.54	10	37.85	1.0	3.79

APPENDIX B - SAE J1273

* SAE J1273 - AUG 2004
  Recommended Practices for Hydraulic Hose Assemblies

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DISCLAIMER

HARSCO RAIL RECOMMENDS THAT ALL HOSE, HOSE ASSEMBLIES AND/OR FITTINGS REPLACED BY THE CUSTOMER SHOULD BE EQUAL TO OR EXCEED THE CURRENT SPECIFICATIONS OF THE ORIGINAL EQUIPMENT SUPPLIED BY HARSCO RAIL. HARSCO RAIL WILL NOT BE LIABLE FOR ANY CLAIMS OF PERSONAL INJURY RESULTING FROM THE USE OF HOSE, HOSE ASSEMBLIES AND/OR FITTINGS THAT DO NOT MEET CURRENT ORIGINAL EQUIPMENT SPECIFICATIONS. THE CUSTOMER IS ADVISED TO COMPLY WITH SAE J1273 AUGUST 2004, RECOMMENDED PRACTICES FOR HYDRAULIC HOSE ASSEMBLIES.

NOTES

SAE International™

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1273

REV. AUG2004

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Recommended Practices for Hydraulic Hose Assemblies

Foreword - This SAE Recommended Practice is intended as a guide to consider when selecting, routing, fabricating, installing, replacing, maintaining, and storing hose for fluid-power systems. It is subject to change to keep pace with experience and technical advances. For those new to hose use in fluid-power systems, this guide outlines practices to note during each phase of system design and use. Experienced designers and users skilled in achieving proper results, as well as the less experienced, can use this outline as a list of considerations to keep in mind.

Fluid power systems are complex and require extensive knowledge of both the system requirements and the various types of hose. Therefore, all-inclusive, detailed, step-by-step instructions are not practical and are beyond the scope of this document. Less experienced designers and users who need more information can consult specialists such as hose suppliers and manufacturers. This guide can improve the communication process.

Safety Considerations - These recommended practices involve safety considerations; note these carefully during all phases of design and use of hose systems. Improper selection, fabrication, installation, or maintenance of hose and hose assemblies for fluid-power systems may result in serious personal injury or property damage. These recommended practices can reduce the likelihood of component or system failure, thereby reducing the risk of injury or damage.

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TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
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1. ***Scope*** - SAE J1273 provides guidelines for selection, routing, fabrication, installation, replacement, maintenance, and storage of hose and hose assemblies for fluid-power systems. Many of these SAE Recommended Practices also may be suitable for other hoses and systems.

2. ***References***

2.1 ***Applicable Publications*** - The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications - Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J343 - Test and Procedures for SAE 100 R Series Hydraulic Hose and Hose Assemblies
SAE J514 - Hydraulic Tube Fittings
SAE J517 - Hydraulic Hose
SAE J1927 - Cumulative Damage Analysis for Hydraulic Hose Assemblies

2.1.2 ISO Publications - Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ISO 3457 - Earth moving machinery - Guards and shields - Definitions and specifications

3. ***Definitions*** - These explanations serve only to clarify this document and are not intended to stand alone. They are presented sequentially, with the former helping to explain the latter.

3.1 **Fluid Power** - Energy transmitted and controlled using pressurized hydraulic fluids or compressed air.

3.2 **Hose** - Flexible conductor. In this document, the term hose also may refer to a hose assembly with related accessories used in fluid power applications.

3.3 **Hose Fitting or Fitting** - Connector which can be attached to the end of a hose.

3.4 **Hose Assembly** - Hose with hose fittings attached.

3.5 **Hose Failure** - Occurrence in which a hose stops meeting system requirements.

3.6 **Hose Service Life** - Length of time a hose meets system requirements without needing replacement.

4. ***Safety Considerations*** - Listed in 4.1 to 4.7 are some potential conditions and situations that may lead to personal injury and/or property damage. This list is not necessarily all inclusive. Consider reasonable and feasible means, including those described in this section, to reduce the risk of injuries or property damage.

Training, including the information in this document, for operators, maintenance personnel, and other individuals working with hoses under pressure is encouraged.

4.1 **Fluid Injections** - Fine streams of escaping pressurized fluid can penetrate skin and enter a human body. These fluid injections may cause severe tissue damage and loss of limb.

Consider various means to reduce the risk of fluid injections, particularly in areas normally occupied by operators. Consider careful routing, adjacent components, warnings, guards, shields, and training programs.

Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

Avoid contact with escaping fluids. Treat all leaks as though pressurized and hot enough to burn skin. Never use any part of your body to check a hose for leaks.

If a fluid-injection accident occurs, see a doctor immediately. **DO NOT DELAY OR TREAT AS A SIMPLE CUT!** Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should consult a knowledgeable medical source.

4.2 Whipping Hose - If a pressurized hose assembly blows apart, the fittings can be thrown off at high speed, and the loose hose can flail or whip with great force. This is particularly true in compressible-fluid systems.

When this risk exists, consider guards and restraints to protect against injury.

4.3 Burns from Conveyed Fluids - Fluid-power media may reach temperatures that can burn human skin. If there is risk of burns from escaping fluid, consider guards and shields to prevent injury, particularly in areas normally occupied by operators.

4.4 Fire and Explosions from Conveyed Fluids - Most fluid-power media, including fire-resistant hydraulic fluids, will burn under certain conditions. Fluids which escape from pressurized systems may form a mist or fine spray which can flash or explode upon contact with an ignition source.

Consider selecting, guarding, and routing hose to minimize the risk of combustion (see Section 5 and ISO 3457).

4.5 Fire and Explosions from Static-Electric Discharge - Fluid passing through hose can generate static electricity, resulting in static-electric discharge. This may create sparks that can ignite system fluids or gases in the surrounding atmosphere.

When this potential exists, select hose specifically designed to carry the static-electric charge to ground.

4.6 Electrical Shock - Electrocution could occur if hose conducts electricity through a person. Most hoses are conductive. Many contain metal or have metal fittings. Even nonconductive hoses can be conduits for electricity if they carry conductive fluids.

Be aware of routing or using hose near electrical sources. When this cannot be avoided, select appropriate hose. Nonconductive hoses should be considered. SAE J517 - 100R7 and 100R8 hoses, with orange covers marked “Nonconductive” are available for applications requiring nonconductive hose.

4.7 Mechanisms Controlled by Fluid Power - Mechanisms controlled by fluids in hoses can become hazardous when a hose fails. For example, when a hose bursts, objects supported by fluid pressure may fall, or vehicles or machines may lose their brakes or steering.

If mechanisms are controlled by fluid power, consider safe modes of failure that minimize risks of injury or damage.

5. Hose Selection and Routing - A wide variety of interacting factors influence hose service life and the ability of each fluid-power system to operate satisfactorily, and the combined effects of these factors on service life are often unpredictable. Therefore, these documents should not be construed as design standards. For applications outside the specifications in SAE J517, SAE J514, or other relevant design standards, performance of hose assemblies should be determined by appropriate testing.

Carefully analyze each system. Then design routings and select hose and related components to meet the system-performance and hose-service-life requirements, and to minimize the risks of personal injury and/or property damage. Consider the following factors:

5.1 System Pressures - Excessive pressure can accelerate hose assembly failure. Analyze the steady-state pressures, and the frequency and amplitude of pressure surges, such as pulses and spikes. These are rapid and transient rises in pressure which may not be indicated on many common pressure gages and can be identified best on high-frequency-response electronic measuring instruments.

For maximum hose service life, hose selection should be based on a system pressure, including surges, that is less than the hose maximum working pressure. Hose may be used above its maximum working pressure where reduced life expectancy is acceptable. SAE J1927 provides one method to help predict wire-reinforced hose service life for a given hydraulic application, where the surge pressure peaks vary, and/or the highest pressure peaks occur infrequently.

5.2 Suction - For suction applications, such as inlet flow to pumps, select hose to withstand both the negative and positive pressures the system imposes on the hose.

5.3 External Pressure - In certain applications, such as in autoclaves or under water, the external environmental pressures may exceed the fluid pressure inside the hose. In these applications, consider the external pressures, and if necessary, consult the manufacturers.

5.4 Temperature - Exceeding hose temperature ratings may significantly reduce hose life. Select hose so the fluid and ambient temperatures, both static and transient, fall within the hose ratings. The effects of external heat sources should not raise the temperature of the hose above its maximum operating temperature. Select hose, heat shields, sleeving, and other methods for these requirements, and route or shield hose to avoid hose damage from external heat sources.

5.5 Permeation - Permeation, or effusion, is seepage of fluid through the hose. Certain materials in hose construction are more permeable than others. Consider the effects of permeation when selecting hose, especially with gaseous fluids. Consult the hose and fluid manufacturers for permeability information.

5.6 Hose-Material Compatibility - Variables that can affect compatibility of system fluids with hose materials include, but are not limited to:

a. Fluid pressure
b. Temperature
c. Concentration
d. Duration of exposure

Because of permeation (see 5.5), consider compatibility of system fluids with the hose, tube, cover, reinforcement, and fittings. Consult the fluid and hose manufacturers for compatibility information.

NOTE - Many fluid / elastomer compatibility tables in manufacturers' catalogs show ratings based on fluids at 21 °C, room temperature. These ratings may change at other temperatures. Carefully read the notes on the compatibility tables, and if in doubt, consult the manufacturer.

5.7 Environment - Environmental conditions can cause hose and fitting degradation. Conditions to evaluate include, but are not limited to:

a. Ultraviolet light
b. Salt water
c. Air pollutants
d. Temperature (see 5.4)
e. Ozone
f. Chemicals
g. Electricity
h. Abrasion

If necessary, consult the manufacturers for more information.

5.8 Static-Electric Discharge - Fluid passing through hose can generate static electricity resulting in static- electric discharge. This may create sparks that can puncture hose. If this potential exists, select hose with sufficient conductivity to carry the static-electric charge to ground.

5.9 Sizing - The power transmitted by pressurized fluid varies with pressure and rate of flow. Select hose with adequate size to minimize pressure loss, and to avoid hose damage from heat generation or excessive velocity. Conduct calculations, or consult the manufacturers for sizing at flow velocities.

5.10 Unintended Uses - Hose assemblies are designed for the internal forces of conducted fluids. Do not pull hose or use it for purposes that may apply external forces for which the hose or fittings were not designed.

5.11 Specifications and Standards - When selecting hose and fittings for specific applications, refer to applicable government, industry, and manufacturer's specifications and standards.

5.12 Unusual Applications - Applications not addressed by the manufacturer or by industry standards may require special testing prior to selecting hose.

5.13 Hose Cleanliness - The cleanliness requirements of system components, other than hose, will determine the cleanliness requirements of the application. Consult the component manufacturers' cleanliness information for all components in the system. Hose assemblies vary in cleanliness levels; therefore, specify hose assemblies with adequate cleanliness for the system.

5.14 Hose Fittings - Selection of the proper hose fittings for the hose and application is essential for proper operation and safe use of hose and related assembly equipment. Hose fittings are qualified with the hose. Therefore, select only hose fittings compatible with the hose for the applications.

Improper selection of hose fittings or related assembly equipment for the application can result in injury or damage from leaks, or from hose assemblies blowing apart (see 4.2, 6.2, 6.3, and 6.4).

5.15 Vibration - Vibration can reduce hose service life. If required, conduct tests to evaluate the frequency and amplitude of system vibration. Clamps or other means may be used to reduce the effects of vibration. Consider the vibration requirements when selecting hose and predicting service life.

5.16 Hose Cover Protection - Protect the hose cover from abrasion, erosion, snagging, and cutting. Special abrasion-resistant hoses and hose guards are available for additional protection. Route hose to reduce abrasion from hose rubbing other hose or objects that may abrade it. (See Figure 1)

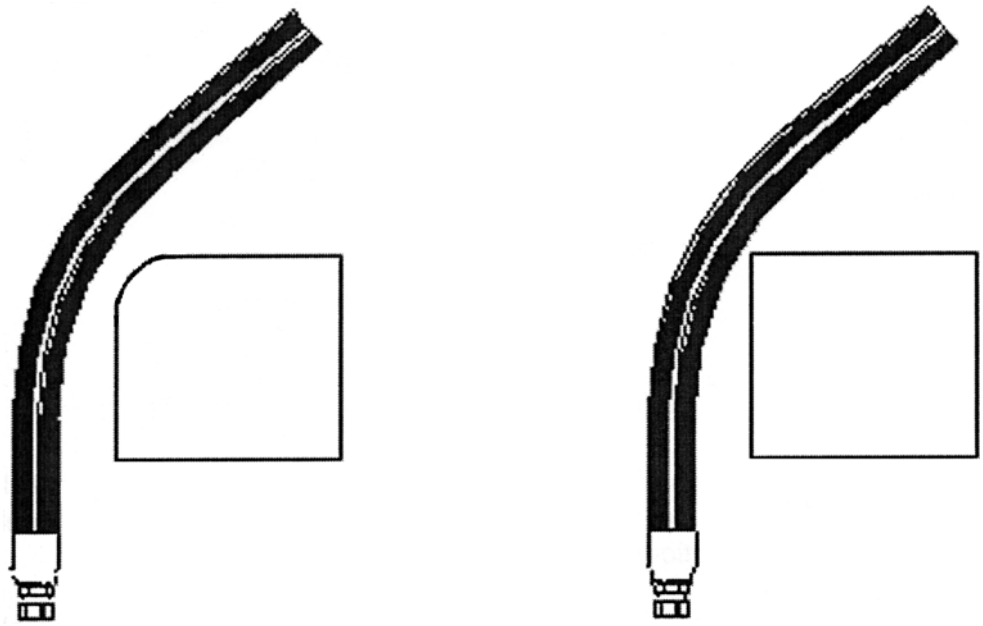

FIGURE 1 - PREVENTION OF EXTERNAL DAMAGE

5.17 External Physical Abuse - Route hose to avoid:

a. Tensile loads
b. Side loads
c. Flattening
d. Thread damage
e. Kinking
f. Damage to sealing surfaces
g. Abrasion
h. Twisting

5.18 Swivel-Type Adapters - Swivel-type fittings or adapters do not transfer torque to hose while being tightened. Use these as needed to prevent twisting during installation.

5.19 Live Swivels - If two components in the system are rotating in relation to each other, live swivels may be necessary. These connectors reduce the torque transmitted to the hose.

5.20 Slings and Clamps - Use slings and clamps to support heavy or long hose and to keep it away from moving parts. Use clamps that prevent hose movement that will cause abrasion.

5.21 Minimum Bend Radius - The minimum bend radius is defined in SAE J343 and is specified in other SAE standards and hose manufacturer's product literature. Routing at less than minimum bend radius may reduce hose life. Sharp bending at the hose/fitting juncture may result in leaking, hose rupturing, or the hose assembly blowing apart (see 4.2 and Figures 2A and 2B).

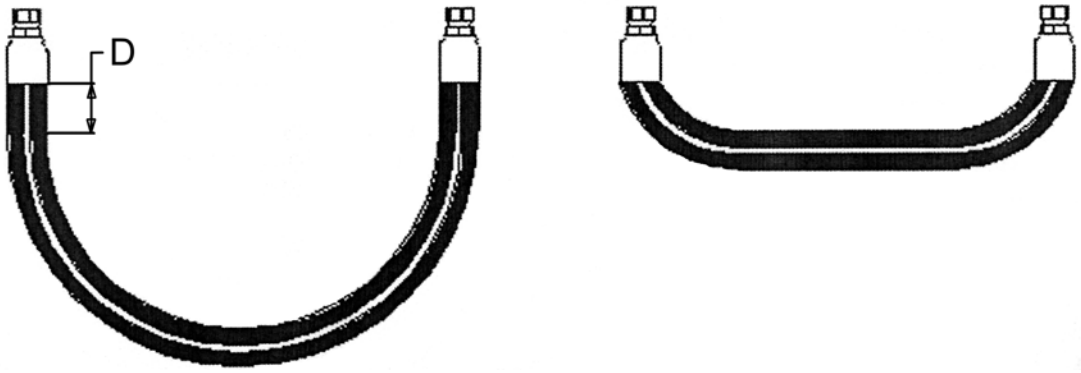

FIGURE 2A - MINIMUM BEND RADIUS

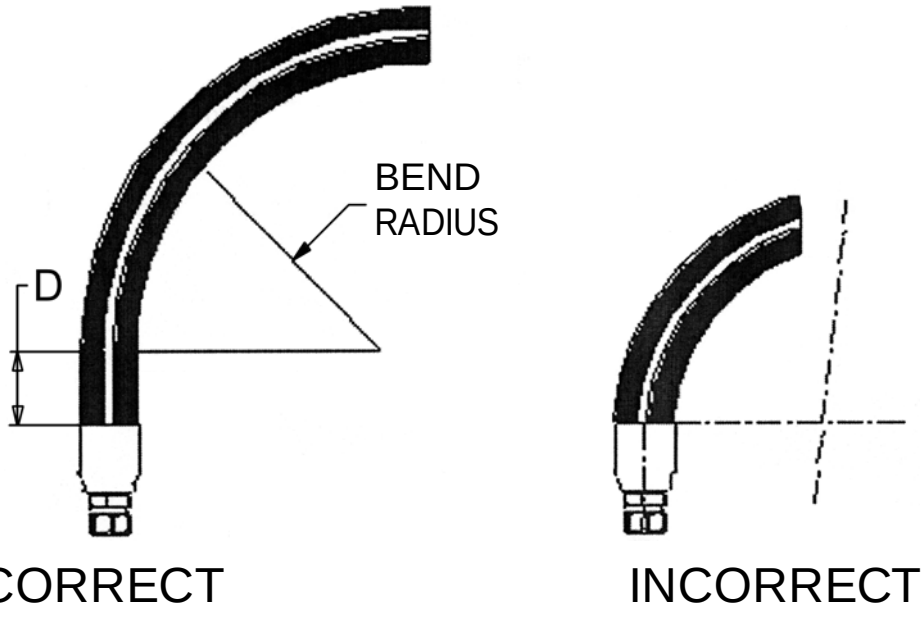

FIGURE 2B - MINIMUM BEND RADIUS

5.22 Elbows and Adapters - In special cases, use elbows or adapters to relieve hose strain (see Figure 3).

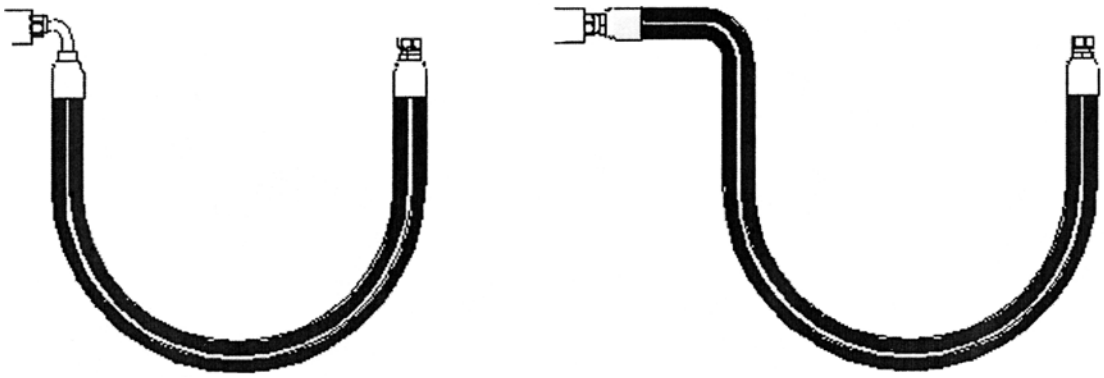

FIGURE 3 - ELBOWS AND ADAPTERS

5.23 Lengths - Unnecessarily long hose can increase pressure drop and affect system performance. When pressurized, hose that is too short may pull loose from its fittings, or stress the fitting connections, causing premature metallic or seal failures. When establishing hose length, refer to Figures 4, 5, and 6; and use the following practices:

5.23.1 MOTION ABSORPTION - Provide adequate hose length to distribute movement and prevent bends smaller than the minimum bend radius.

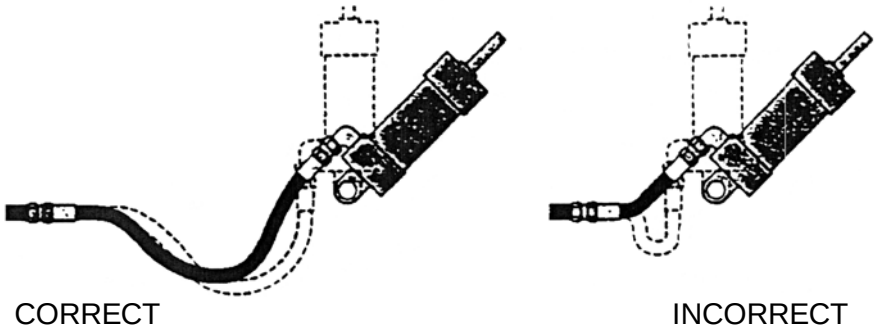

FIGURE 4 - MOTION ABSORPTION

5.23.2 HOSE AND MACHINE TOLERANCES - Design hose to allow for changes in length due to machine motion and tolerances.

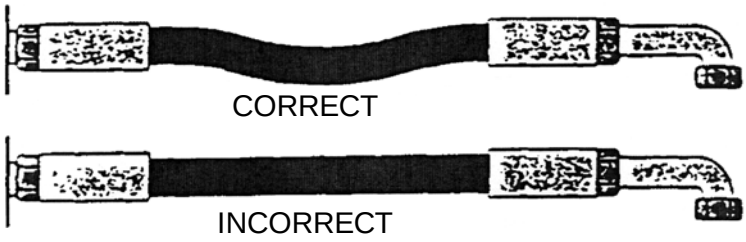

FIGURE 5 - HOSE AND MACHINE TOLERANCES

5.23.3 HOSE LENGTH CHANGE DUE TO PRESSURE - Design hose to accommodate length changes from changing pressures. Do not cross or clamp together high- and low-pressure hoses. The difference in length changes could wear the hose covers.

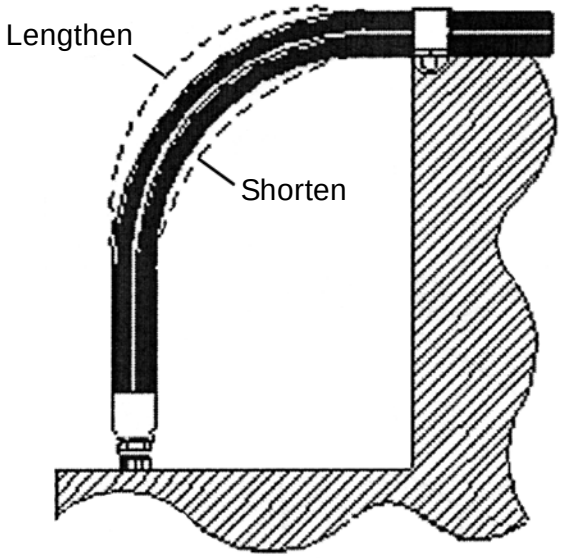

FIGURE 6 - HOSE LENGTH CHANGE DUE TO PRESSURE

5.24 Hose Movement and Bending - Hose allows relative motion between system components. Analyze this motion when designing hose systems. The number of cycles per day may significantly affect hose life. Also avoid multiple planes of motion and twisting motion. Consider the motion of the hose when selecting hose and predicting service life. In applications that require hose to move or bend, refer to Figures 7A, 7B, and 8; and use these practices:

5.24.1 BEND IN ONLY ONE PLANE TO AVOID TWISTING

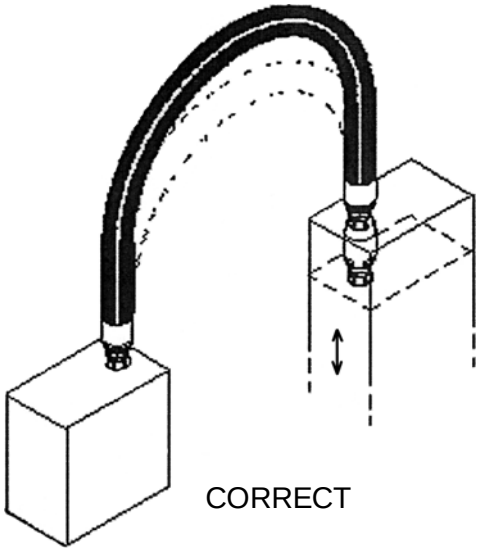

FIGURE 7A - BEND IN ONLY ONE PLANE TO AVOID TWISTING

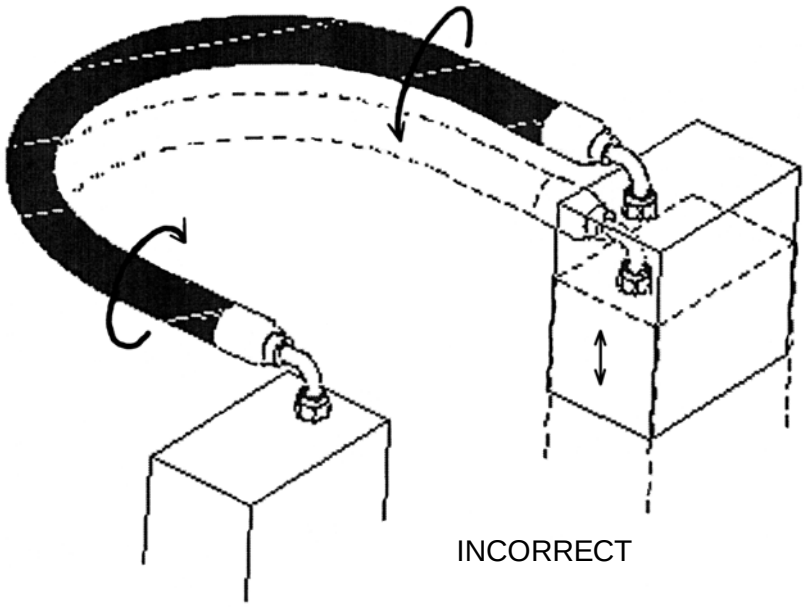

FIGURE 7B - BEND IN ONLY ONE PLANE TO AVOID TWISTING

5.24.2 PREVENT HOSE BENDING IN MORE THAN ONE PLANE - If hose follows a compound bend, couple it into separate segments, or clamp it into segments that flex in only one plane.

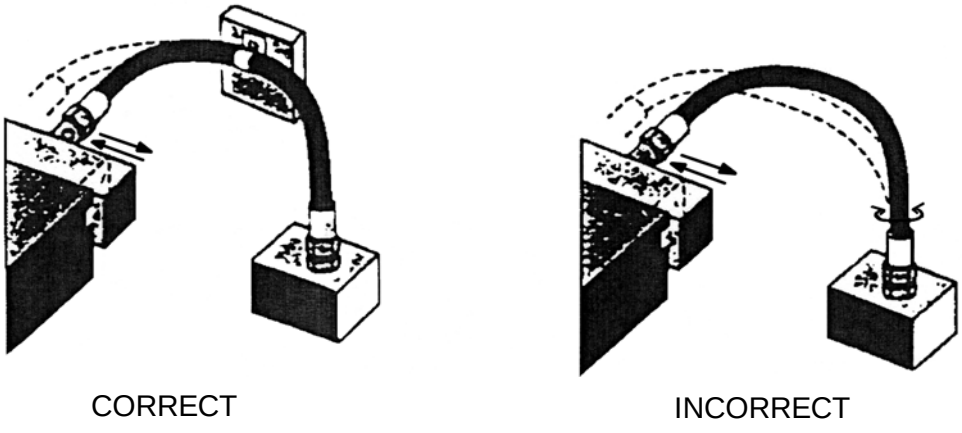

FIGURE 8 - PREVENT HOSE BENDING IN MORE THAN ONE PLANE

6. Hose-Assembly Fabrication - Persons fabricating hose assemblies should be trained in the proper use of equipment and materials. The manufacturers' instructions and the practices listed as follows must be followed. Properly assembled fittings are vital to the integrity of a hose assembly. Improperly assembled fittings can separate from the hose and may cause serious injury or property damage from whipping hose, or from fire or explosion of vapor expelled from the hose.

6.1 Component Inspection - Prior to assembly, examine components for:

a. Style or type
b. Cleanliness
c. Loose covers
d. Nicks
e. Size
f. Inside obstructions
g. Visible defects
h. Damage
i. Length
j. Blisters
k. Burrs

6.2 Hose Fittings - Hose fitting components from one manufacturer are not usually compatible with fitting components supplied by another manufacturer. For example, do not use a hose fitting nipple from one manufacturer with a hose socket from another manufacturer.

It is the responsibility of the fabricator to consult the manufacturer's written instructions or the manufacturer directly for information on proper fitting components.

6.3 Hose and Fitting Compatibility - Care must be taken to determine proper compatibility between the hose and fitting. Base selection on the manufacturers' recommendations substantiated by testing to industry standards such as SAE J517. Hose from one manufacturer is not usually compatible with fittings from another. Do not intermix hose and fittings from two manufacturers without approval from both manufacturers.

6.4 Hose Assembly Equipment - Assembly equipment from one manufacturer is usually not interchangeable with that from another manufacturer. Hoses and fittings from one manufacturer should not generally be assembled with the equipment of another manufacturer.

6.5 Safety Equipment - During fabrication, use proper safety equipment, including eye protection, breathing apparatus, and adequate ventilation.

6.6 Reuse of Hose and Fittings - When fabricating hose assemblies, do not reuse:

a. Field-attachable fittings that have blown or pulled off hose
b. Any part of hose fittings that were permanently crimped or swaged to hose
c. Hose that has been in service after system checkout (see 7.7)

6.7 Cleanliness of Hose Assemblies - Hose assemblies may be contaminated during fabrication. Clean hoses to specified cleanliness levels (see 5.13).

7. Hose installation and Replacement - Use the following practices when installing hose assemblies in new systems or replacing hose assemblies in existing systems:

7.1 Pre-Installation Inspection - Before installing hose assemblies, examine:

a. Hose length and routing for compliance with original design
b. Assemblies for correct style, size, length, and visible non-conformities
c. Fitting sealing surfaces for burrs, nicks, or other damage

NOTE - When replacing hose assemblies in existing systems, verify that the replacement is of equal quality to the original assembly.

7.2 Handling During Installation - Handle hose with care during installation. Kinking hose, or bending at less than minimum bend radius may reduce hose life. Avoid sharp bending at the hose/fitting juncture (see 5.21).

7.3 Twist Angle and Orientation - Pressure applied to a twisted hose may shorten the life of the hose or loosen the connections. To avoid twisting, use the hose lay line or marking as a reference (see Figure 9).

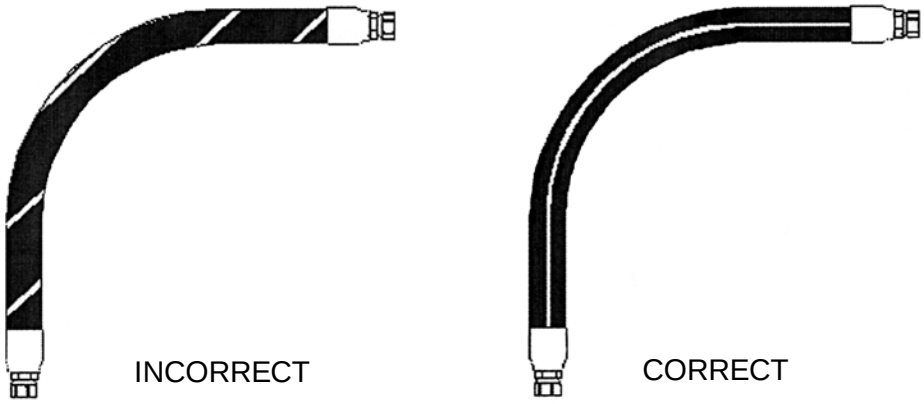

FIGURE 9 - TWIST ANGLE AND ORIENTATION

7.4 Securement and Protection - Install necessary restraints and protective devices. Determine that such devices do not create additional stress or wear points.

7.5 Routing - Review proper routing practices provided in Section 5 and make appropriate corrections to obtain optimum performance.

7.6 Assembly Torque - The connection end of a hose fitting is normally threaded to obtain a tight pressure seal when attached to a port, an adapter, or another fitting. Sometimes bolts or screws provide the threaded connection. Each size and type of connection requires different torque values, and these may vary due to type of material or exterior coating.

Follow appropriate torquing instructions to obtain a proper pressure seal without over-torquing. A properly calibrated torque wrench should be used to tighten each connection, except when the manufacturer specifies tightening a specified number of hex flat turns beyond finger tight to obtain a seal.

7.7 System Checkouts - In hydraulic or other liquid systems, eliminate all air entrapment after completing the installation. Follow manufacturers' instructions to test the system for possible malfunctions and leaks.

7.7.1 To avoid injury during system checkouts:

a. Do not touch any part of the system when checking for leaks (see 4.1).
b. Stay out of potentially hazardous areas while testing hose systems (see Section 4).
c. Relieve system pressure before tightening connections.

8. ***Maintenance inspection*** - A hose and fitting maintenance program may reduce equipment downtime, maintain peak operating performance, and reduce the risk of personal injury and/or property damage. The user should design and implement a maintenance program that suits the specific application and each specific hose in that application.

8.1 **Inspection Frequency** - Evaluate factors such as the nature and severity of the application, past history, and manufacturers' information to establish the frequency of visual inspections and functional tests.

8.2 **Visual Inspection (Hose and Fittings)** - Visually inspect hose and fittings for:

a. Leaks at hose fitting or in hose
b. Damaged, cut, or abraded cover
c. Exposed reinforcement
d. Kinked, crushed, flattened, or twisted hose
e. Hard, stiff, heat cracked, or charred hose
f. Blistered, soft, degraded, or loose cover
g. Cracked, damaged, or badly corroded fittings
h. Fitting slippage on hose
i. Other signs of significant deterioration

If any of these conditions exist, evaluate the hose assemblies for correction or replacement.

8.3 **Visual Inspection (All Other Components)** - When visually inspecting hose and fittings, inspect for related items including:

a. Leaking ports
b. Damaged or missing hose clamps, guards, or shields
c. Excessive dirt and debris around hose
d. System fluid: level, type, contamination, condition, and air entrainment

If any of these are found, address them appropriately.

8.4 **Functional Test** - Functional tests determine if systems with hose are leak free and operating properly. Carry out functional tests per information from equipment manufacturers.

9. ***Hose Storage*** - Age control and the manner of storage can affect hose life. Use the following practices when storing hose.

9.1 **Age Control** - Maintain a system of age control to determine that hose is used before its shelf life has expired. Shelf life is the period of time when it is reasonable to expect the hose to retain full capabilities for rendering the intended service.

Store hose in a manner that facilitates age control and first-in, first-out usage based on manufacturing date on hose or hose assembly. Per SAE J517:

a. Shelf life of rubber hose in bulk form, or in hose assemblies passing visual inspection and proof test, is forty quarters (ten years) from the date of manufacture.
b. Shelf life of thermoplastic and polytetrafluoroethylene hose is considered to be unlimited.

9.2 **Storage** - Store hose and hose assemblies in a cool, dark, dry area with the ends capped. When storing hose, take care to avoid damage that could reduce hose life, and follow the manufacturers' information for storage and shelf life. Examples of factors that can adversely affect hose products in storage are:

a. Temperature
b. Ozone
c. Oils
d. Corrosive liquids and fumes
e. Rodents
f. Humidity
g. Ultraviolet light
h. Solvents
i. Insects
j. Radioactive materials

If there are questions regarding the quality or usability of hose or hose assemblies, evaluate appropriately:

a. Flex the hose to the minimum bend radius and compare it with new hose. After flexing, examine the cover and tube for cracks. If any appear, no matter how small, reject the hose.
b. If the hose is wire reinforced, and the hose is unusually stiff, or a cracking sound is heard during flexing, check for rust by cutting away a section of the cover from a sample. Rust would be another reason for rejection.
c. If doubt still persists, contact hose assembler to conduct proof-pressure tests or any other tests needed to verify hose quality.

10. Notes

10.1 **Marginal Indicia** - The (R) is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

PREPARED BY THE SAE FLUID CONDUCTORS AND CONNECTORS TECHNICAL COMMITTEE SC3 - TRAINING AND EDUCATION SUBCOMMITTEE

SAE J1273 Revised AUG2004

Rationale - To correct verbiage in Section 9.1.

Relationship of SAE Standard to ISO Standard - Not applicable.

Application - SAE J 1273 provides guidelines for selection, routing, fabrication, installation, replacement, maintenance, and storage of hose and hose assemblies for fluid-power systems. Many of these SAE Recommended Practices also may be suitable for other hoses and systems.

Reference Section

SAE J343 - Test and Procedures for SAE 100 R Series Hydraulic Hose and Hose Assemblies

SAE J514 - Hydraulic Tube Fittings

SAE J517 - Hydraulic Hose

SAE J1927 - Cumulative Damage Analysis for Hydraulic Hose Assemblies

ISO 3457 - Earth moving machinery - Guards and shields - Definitions and specifications

Developed by the SAE Fluid Conductors and Connectors Technical Committee SC3 - Training and Education Subcommittee

Sponsored by the SAE Fluid Conductor and Connectors Technical Committee

NOTES

APPENDIX RR - REVISION RECORD

CHANGE	REV	REVISION DESCRIPTION	BY	DATE
EC616458	A	NEW RELEASE	GHK	05 - 2024

APPENDIX RR - NOTES

LIMITED WARRANTY

HARSCO RAIL warrants products of its manufacture to be free of defects in material and workmanship, under normal use and service for a period of six (6) months from date of delivery to the original user. The obligation of Harsco Rail under this warranty is limited to repairing or replacing at its factories, or other location designated by it, any part or parts thereof which are returned within 30 days of the date when failure occurs or defect is noted, with transportation charges prepaid, and which upon examination appears to the satisfaction of Harsco Rail to have been defective. Such free repair or replacement does not include transportation charges, or the cost of installing the new part or any other expense incident thereto. Harsco Rail will not be liable for other loss, damage, or expense directly or indirectly arising from the use of its product, nor will Harsco Rail be liable for special, incidental, or consequential damages.

Ordinary wear and tear, and damage from abuse, misuse, neglect or alteration are not covered by this warranty. Harsco Rail assumes no liability for expense incurred or repairs made outside its factories except by written consent. This warranty is null and void if instructions and operating procedures are not followed.

Equipment and parts not manufactured by Harsco Rail, but which are furnished in connection with Harsco Rail products, are covered directly by the warranty of the manufacturer supplying them. However, Harsco Rail will assist in obtaining adjustment on such equipment or parts when necessary.

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INDEMNITY

Buyer agrees to indemnify and hold Harsco Rail harmless for all loss, cost including but not limited to legal and other cost of proceedings, and damages suffered by Buyer or claimed by third parties by or related to Buyer's use of Harsco Rail's products.

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Harsco Rail reserves the right to make any changes in or improvements to its products without incurring any liability or obligation whatsoever and without being required to make any corresponding changes or improvements to products previously manufactured or sold.

HAZARDOUS MATERIAL DISCLAIMER

The parts/assemblies that are used in this Product are classified as "articles" according to 29 CFR 1910.1200 (C). They are formed to a specific shape or design during manufacture, have end use function dependent upon their shape or design, and do not release any hazardous chemical under normal conditions of use. Accordingly, we are not required to supply Safety Data Sheets (SDS) or to label shipping containers for "articles". However, lubricants, liquids, gaseous chemicals and solids used in operation or maintenance of the product may require that user's take occupational protective measures. SDS sheets for such materials will be supplied, upon request, to your Purchasing Manager/Safety Director to be used in your employee safety training education and environmental health training.

HARSCO RAIL, LLC
2401 Edmund Road, Box 20
Cayce-West Columbia, SC 29171-0020 U.S.A.

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