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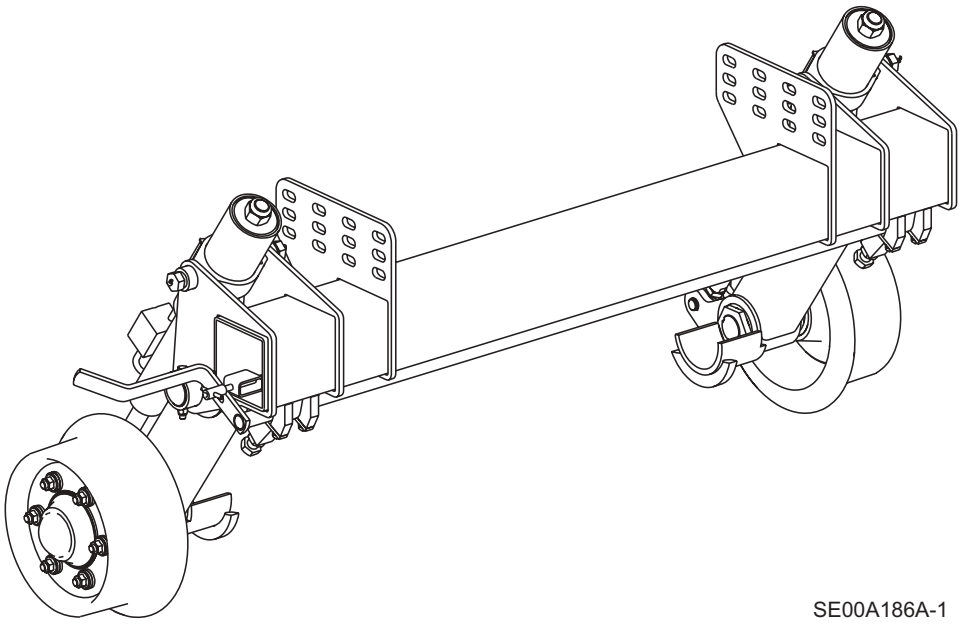
Harsco Track Technologies

Harsco

HR2000 SERIES B

REAR UNIVERSAL HY-RAIL®
GUIDE WHEEL EQUIPMENT
HYDRAULICALLY OPERATED



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OPERATOR'S SERVICE AND PARTS MANUAL

ISSUED 5 - 2007

BULLETIN 1255C

■ **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 rail pilot 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 Track Technologies, Harsco Corporation.

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

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TABLE OF CONTENTS

NOTES

1

SECTION 1 - GENERAL INFORMATION
TABLE OF CONTENTS

1

1.1 Safety Information

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

SAFETY IS A CRITICAL FACTOR IN THE DESIGN OF HARSCO TRACK TECHNOLOGIES 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 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 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 GUIDE WHEEL EQUIPMENT.**

- **IF A DERAILMENT SHOULD OCCUR WHILE VEHICLE IS OPERATING IN ELECTRIFIED 3RD-RAIL TERRITORY, VEHICLE OR GUIDE WHEEL EQUIPMENT MIGHT BE IN ELECTRICAL CONTACT WITH ELECTRIFIED RAIL. DO NOT ATTEMPT TO EXIT FROM VEHICLE UNTIL ELECTRICAL POWER TO 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 35 MPH (56 km/h) WHEN OPERATING VEHICLE ON TRACK. RAILROAD RULES GOVERNING SPEEDS SHOULD BE OBSERVED AT ALL TIMES. REDUCE SPEED WHEN PROPELLING VEHICLE THROUGH SWITCHES, CROSSINGS, BRANCH LINES AND ANY SPECIAL TRACK WORKS. OPERATING VEHICLE AT UNSAFE SPEEDS COULD RESULT IN DERAILMENT OF VEHICLE.**

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

- **ON VEHICLES EQUIPPED WITH 19.5" WHEELS AND TIRES, THE MINIMUM LOAD ON THE REAR GUIDE WHEEL UNIT SHOULD BE ADJUSTED TO CARRY APPROXIMATELY 50% OF THE VEHICLE'S REAR AXLE CURB WEIGHT, OR AT LEAST 1,550 lbs (703 kg) or 775 lbs (352 kg) PER GUIDE WHEEL.**

- **ON VEHICLES EQUIPPED WITH 22.5" WHEELS AND TIRES, THE MINIMUM LOAD ON THE REAR GUIDE WHEEL UNIT SHOULD BE ADJUSTED TO CARRY APPROXIMATELY 40% OF THE VEHICLE'S REAR AXLE CURB WEIGHT, OR AT LEAST 1,550 lbs (703 kg) or 775 lbs (352 kg) PER GUIDE WHEEL.**

1

1.1 Safety Information

■ AT MAXIMUM LOADED GROSS VEHICLE WEIGHT ON RAIL (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 FRONT GUIDE WHEEL UNIT RATED LOAD CAPACITY, WHICHEVER IS LOWER.**
- **VEHICLE'S REAR G.A.W.R. (Gross Axle Weight Rating) OR THE SUM OF 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. REAR GUIDE WHEEL UNIT RATED LOAD CAPACITY:**

HR2000B1
5,500 lbs (2,495 kg).
2,750 lbs (1,247 kg) maximum per guide wheel.

HR2000B2
6,750 lbs (3,062 kg).
3,375 lbs (1,531 kg) maximum per guide wheel.

HR2000B2-1
4,200 lbs (1,905 kg).
2,100 lbs (953 kg) maximum per guide wheel.

HR2000B3
6,750 lbs (3,062 kg).
3,375 lbs (1,531 kg) maximum per guide wheel.

HR2000B3-1
4,200 lbs (1,905 kg).
2,100 lbs (953 kg) maximum per guide wheel.

HR2000B3-3
6,750 lbs (3,062 kg).
3,375 lbs (1,531 kg) maximum per guide wheel.

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

1.1 Safety Information

CAUTION

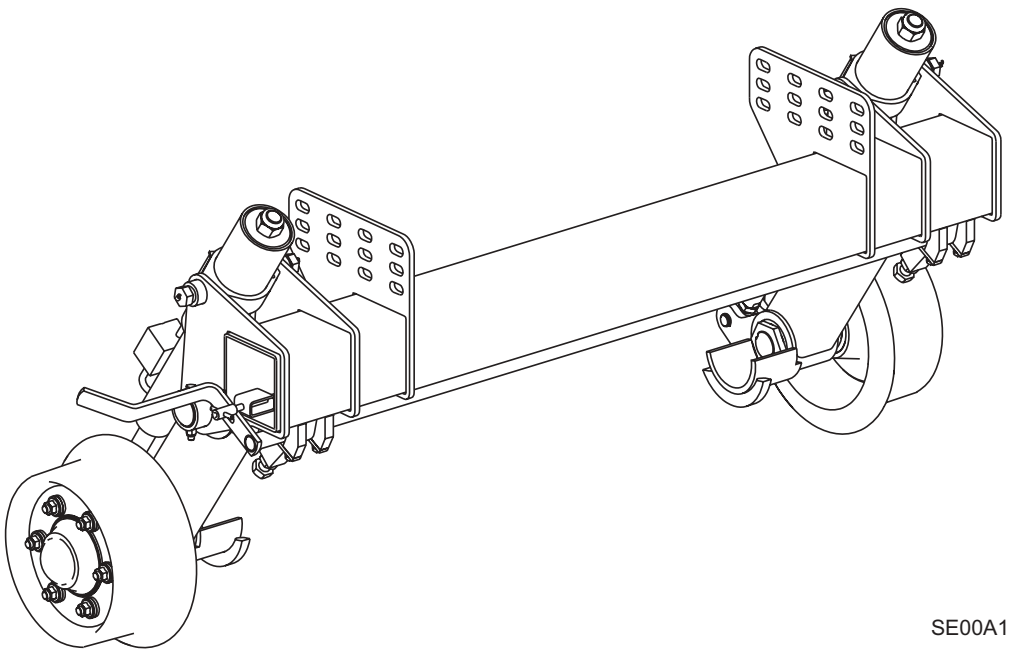
- **OBSERVE AND FOLLOW ALL RAILROAD SAFETY RULES AND REGULATIONS.**
- **KNOW THE POSITIONS AND FUNCTIONS OF ALL CONTROLS BEFORE ATTEMPTING TO OPERATE VEHICLE.**
- **THIS GUIDE WHEEL EQUIPMENT IS DESIGNED WITH YOUR SAFETY IN MIND. NEVER DISCONNECT AND/OR ATTEMPT TO OVERRIDE SAFETY FEATURES.**

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 Identification View

FIGURE 1-1
HR2000 SERIES B HY-RAIL® GUIDE WHEEL UNIT



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1.3 Description

The HR2000 Series B HY-RAIL® guide wheel equipment can be applied to the rear of 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 Track Technologies. For information regarding special applications, contact Harsco Track Technologies, Harsco Corporation, Fairmont, Minnesota.

The HR2000 Series B rear guide wheel unit mounts to the vehicle's frame. When the vehicle is placed in the "rail" position, load bearing guide wheel assemblies guide the vehicle on the track. The individual wheel arms and guide wheel assemblies are raised and lowered hydraulically. Hydraulic power may be supplied from the vehicle system or from an optional power pack. When the vehicle is on track, the load on the rear of the vehicle is supported by a combination of the guide wheel unit's disc type spring suspension and the vehicle's suspension. The guide wheel arms are locked in the "rail" position hydraulically. The guide wheel arms are secured in the "highway" position with a lever actuated mechanical lock.

The vehicle's rear wheels are used for propulsion on the track. On track braking is provided by the vehicle's rear brakes. Both the front and rear guide wheel units may also be equipped with optional air-actuated tread-type composition brake shoes to assist with on track braking. Since the guide wheel unit's brakes are air actuated, the vehicle on which the guide wheel equipment is mounted should be equipped with air brakes. If not, an electric / air system is available to provide air for the guide wheel unit's brakes.

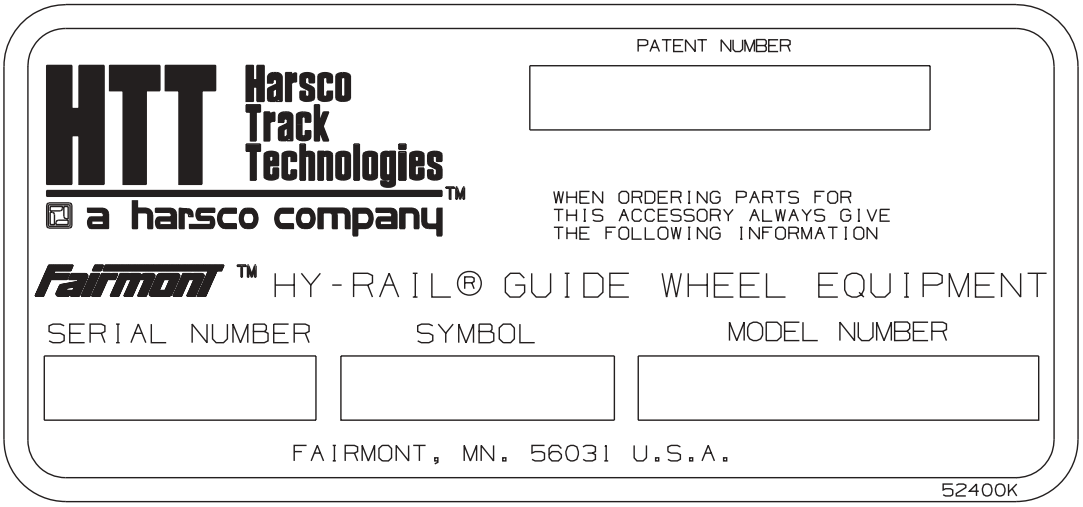
1.4 Orientation

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

1.5 Serial Number

When this bulletin is received, complete the following record from the serial number tag located on the guide wheel unit. Always provide these factory serial numbers when calling or writing about the unit. The serial number tag is located on the frame assembly of the unit.

FIGURE 1-2
REAR GUIDE WHEEL UNIT SERIAL NUMBER TAG



1.6 Specifications

1.6.1 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 Track Technologies. For information regarding special applications, contact Harsco Track Technologies, Harsco Corporation, Fairmont, Minnesota.

1

1.6 Specifications

1.6.2 Guide Wheel Units

Track Gauge	56-1/2 in	(1,435 mm)
Guide Wheels - Flange Diameter	13-1/4 in	(337 mm)
- Tread Diameter	11 in	(280 mm)
Guide Wheel Unit Weight	425 lbs	(193 kg)

HR2000B1

Maximum Load Capacity	5,500 lbs	(2,495 kg)
Maximum Load Per Guide Wheel	2,750 lbs	(1,134 kg)

HR2000B2

Maximum Load Capacity	6,750 lbs	(3,062 kg)
Maximum Load Per Guide Wheel	3,375 lbs	(1,531 kg)

HR2000B2-1

Maximum Load Capacity	4,200 lbs	(1,905 kg)
Maximum Load Per Guide Wheel	2,100 lbs	(953 kg)

HR2000B3

Maximum Load Capacity	6,750 lbs	(3,062 kg)
Maximum Load Per Guide Wheel	3,375 lbs	(1,531 kg)

HR2000B3-1

Maximum Load Capacity	4,200 lbs	(1,905 kg)
Maximum Load Per Guide Wheel	2,100 lbs	(953 kg)

HR2000B3-3

Maximum Load Capacity	6,750 lbs	(3,062 kg)
Maximum Load Per Guide Wheel	3,375 lbs	(1,531 kg)

Note: The vehicle's rear wheels carry the remaining load capacity. Do not exceed the tire manufacturer's and / or the wheel manufacturer's load rating capacity for the rear wheels when on track.

SECTION 2 - OPERATION
TABLE OF CONTENTS

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, tires and 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 to tire manufacturer's recommended maximum pressure, printed on the sidewalls of the tires or wheel manufacturer's recommended maximum pressure, stamped on the wheel, whichever is lower.
j. 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 USER'S GUIDE TO WHEELS AND RIMS produced by THE MAINTENANCE COUNCIL. To obtain this guide, contact:

THE MAINTENANCE COUNCIL
AMERICAN TRUCKING ASSOCIATION
2200 MILL ROAD
ALEXANDRIA, VA. 22314
Phone: (703) 838-1763

k. 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. Air and hydraulic hoses and fittings for damage, wear or leaks.
b. Overall for damaged or worn parts.
c. Proper alignment and guide wheel loads.
d. Proper lubrication at recommended operating hourly intervals.
e. Hydraulic pressure properly adjusted.

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 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 GUIDE WHEEL EQUIPMENT.**

- **BEFORE PROPELLING VEHICLE ON THE TRACK, MAKE SURE:**
  - **FRONT AND REAR GUIDE WHEELS ARE LOWERED AND LOCKED IN THE RAIL POSITION.**
  - **ALL RAIL GUIDE WHEEL FLANGES ARE ENGAGED ON INSIDE OF RAIL.**
  - **IF APPLICABLE, VEHICLE FRONT TIRES MUST BE RAISED A MINIMUM OF 1-1/2" (38 MM) ABOVE THE RAIL.**
  - **THE FRONT WHEELS ARE POINTED STRAIGHT AHEAD AND THE STEERING WHEEL LOCK IS ENGAGED.**
  - **IF EQUIPPED, BRAKE CONTROL VALVE IS IN THE ON POSITION AND GUIDE WHEEL BRAKE EQUIPMENT IS FUNCTIONAL.**

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

- **WHEN USING VEHICLE MECHANICAL PTO HYDRAULIC PUMP TO LOWER/RAISE GUIDE WHEEL EQUIPMENT, DO NOT EXCEED HYDRAULIC SYSTEM FLOW OF 8 GPM (30 LPM) OR HYDRAULIC PRESSURE OF 2500 PSI (172 bar). EXCESSIVE FLOW AND / OR PRESSURE COULD DAMAGE HYDRAULIC SYSTEM COMPONENTS.**

- **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 rails so that the rear vehicle wheels are centered on the rails. On vehicles with dual rear wheels, the inner dual wheels must be centered on the 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 the automatic transmission in "PARK" or the manual transmission in "NEUTRAL". Apply the parking brake.

4. Engage the mechanical PTO hydraulic pump or start the auxiliary hydraulic power source. If the vehicle is equipped with an auxiliary control valve, place the valve in the proper position to direct hydraulic oil flow to the guide wheel equipment.

2.5.1 Lowering Rear Guide Wheels - See Figure 2-1

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

2. Remove lock pin (1). Button in "T" end of lock pin must be pushed in to remove pin. Rotate lock handle (2) counter-clockwise and hold.

3. While holding lock handle (2) in the released position, move the hydraulic control valve handle to lower the guide wheels.

4. Continue to lower the guide wheels until they are fully lowered. *Make sure that the hydraulic cylinders are fully extended.* The hydraulic cylinders must be fully extended to ensure that the guide wheels are in the rail position. Ensure that the flanges on both guide wheels are engaged on the inside of the rails.

5. Insert lock pin (1) in the hole in the frame. Release lock handle (2).

6. If the unit is equipped with the mechanical lock pin group, push the T-handle lock pin (3) in to engage the mechanical lock. Rotate the T-handle lock pin to secure it in the lock position. Repeat the procedure on the opposite side guide wheel arm.

7. Lower the front guide wheels. See the Operator's Service And Parts Manual provided with the front guide wheel unit for information on lowering the front guide wheels.

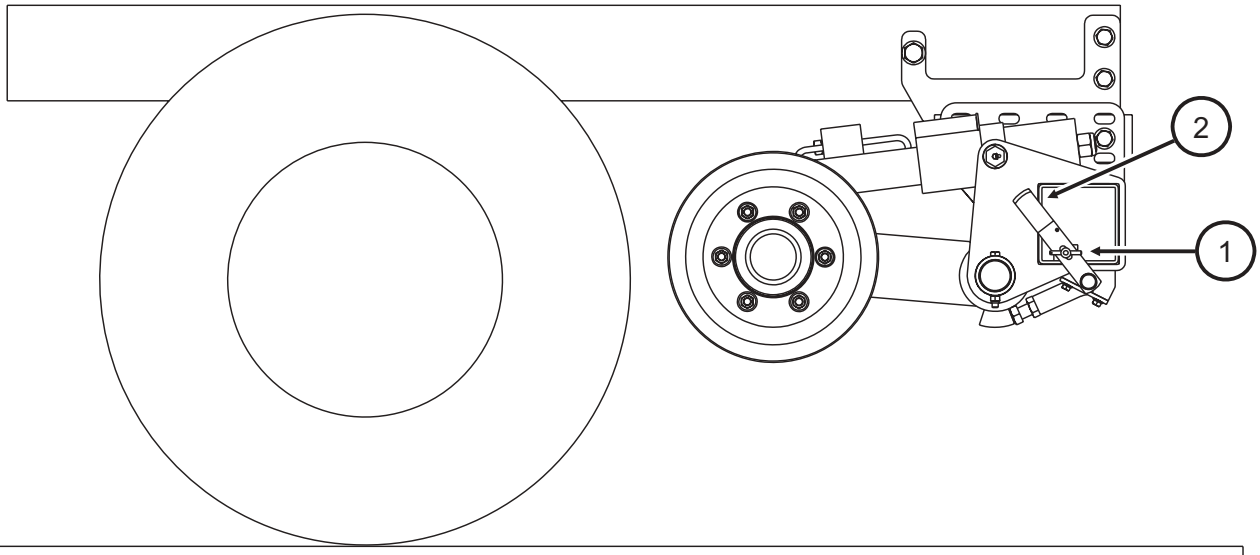
8. Disengage the mechanical PTO hydraulic pump or stop the auxiliary hydraulic power source. If the vehicle is equipped with an auxiliary control valve, place the valve in the proper position to shut off hydraulic oil flow to the guide wheel equipment.

9. If so equipped, move the rail wheel brake control valve to the ON position to activate the guide wheel equipment brakes whenever the vehicle is on track. The vehicle brake pedal will actuate the vehicle brakes and the guide wheel equipment brakes simultaneously.

2.5 Placing Vehicle On Track

2.5.1 Lowering Rear Guide Wheels

FIGURE 2-1
LOWERING REAR GUIDE WHEELS



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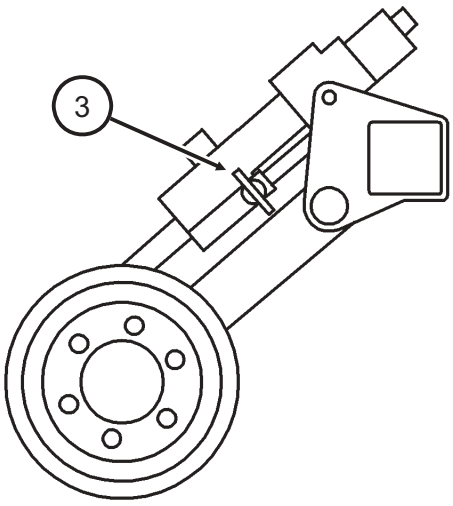

2.5 Placing Vehicle On Track

10. See Figures 2-2, 2-3, 2-4 and 2-5. 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 2-2
STEERING LOCK IN UN-LOCK POSITION

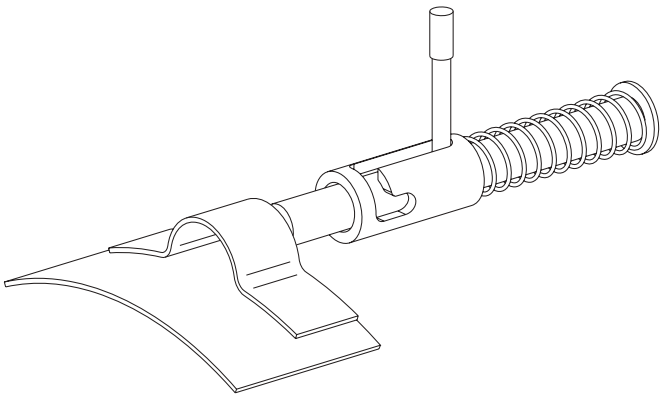

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FIGURE2-3
STEERING LOCK IN
LOCKED POSITION

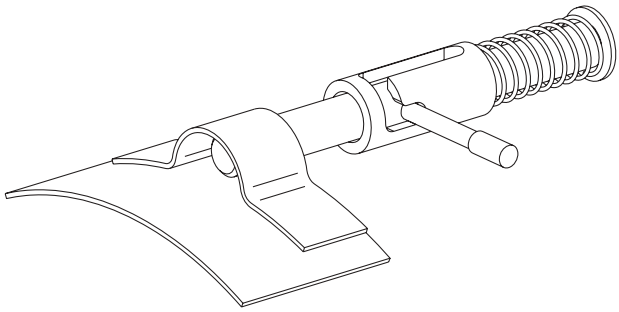

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FIGURE 2-4
VELCRO STEERING LOCK OFF

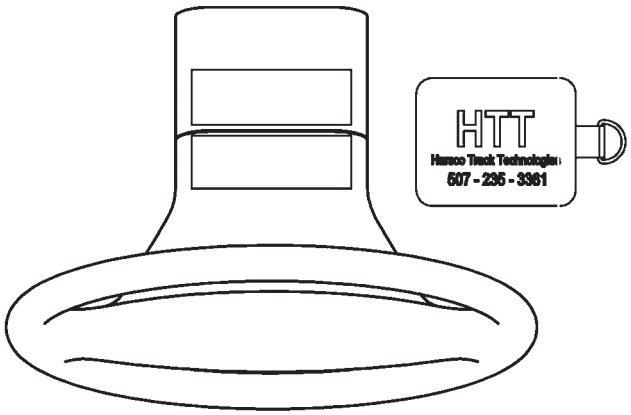
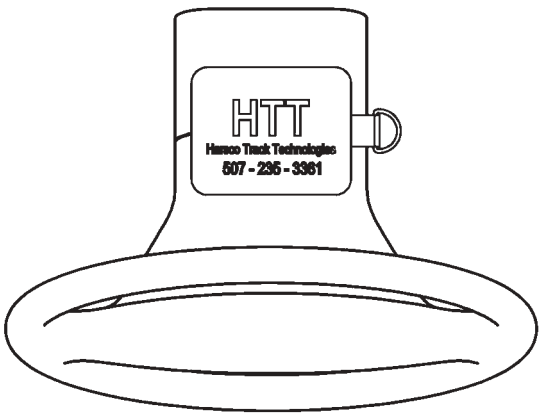


FIGURE 2-5
VELCRO STEERING LOCK ON



2.6 Guide Wheel Load On Track

- **IMPROPER LOADING OF GUIDE WHEEL EQUIPMENT CAN CAUSE DERAILMENT OF VEHICLE.**
- **ALWAYS CHECK GUIDE WHEEL LOAD BEFORE OPERATING A LOADED VEHICLE ON TRACK.**
- **ON VEHICLES EQUIPPED WITH 19.5 INCH WHEELS AND TIRES, THE REAR GUIDE WHEEL UNIT MUST BE SET TO CARRY APPROXIMATELY 50% OF VEHICLE REAR AXLE CURB WEIGHT OR A MINIMUM OF 1,550 LBS (703 kg) or 775 lbs (352 kg) PER GUIDE WHEEL.**
- **ON VEHICLES EQUIPPED WITH 22.5 INCH WHEELS AND TIRES, THE REAR GUIDE WHEEL UNIT MUST BE SET TO CARRY APPROXIMATELY 40% OF VEHICLE REAR AXLE CURB WEIGHT OR A MINIMUM OF 1,550 LBS (703 kg) or 775 lbs (352 kg) PER GUIDE WHEEL.**
- **NEVER OPERATE THE VEHICLE ON TRACK IF LOAD EXCEEDS MAXIMUM RATED LOAD OF THE FRONT AND/OR REAR GUIDE WHEEL UNITS. WITH THE VEHICLE AT CURB WEIGHT, THE MAXIMUM LOAD ON THE REAR GUIDE WHEEL UNIT IS:**

HR2000B1	**5,500 lbs (2,495 kg) or 2,750 lbs (1,247 kg) maximum per guide wheel.**
HR2000B2	**6,750 lbs (3,062 kg) or 3,375 lbs (1,531 kg) maximum per guide wheel.**
HR2000B2-1	**4,200 lbs (1,905 kg) or 2,100 lbs (953 kg) maximum per guide wheel.**
HR2000B3	**6,750 lbs (3,062 kg) or 3,375 lbs (1,531 kg) maximum per guide wheel.**
HR2000B3-1	**4,200 lbs (1,905 kg) or 2,100 lbs (953 kg) maximum per guide wheel.**
HR2000B3-3	**6,750 lbs (3,062 kg) or 3,375 lbs (1,531 kg) maximum per guide wheel.**

- **IF APPLICABLE, NEVER OPERATE VEHICLE ON TRACK IF CLEARANCE BETWEEN VEHICLE FRONT TIRES AND THE RAIL IS LESS THAN 1-1/2" (38 mm).**

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

2.6 Guide Wheel Load On Track

Whenever the vehicle is loaded or additional load is added to the existing vehicle load on track, check the load on the rear guide wheel unit.

On vehicles equipped with 19.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 50% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires.

On vehicles equipped with 22.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 40% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires.

With the vehicle at curb weight, the maximum load on the rear guide wheel unit is:

HR2000B1	5,500 lbs (2,495 kg) or 2,750 lbs (1,247 kg) maximum per guide wheel.
HR2000B2	6,750 lbs (3,062 kg) or 3,375 lbs (1,531 kg) maximum per guide wheel.
HR2000B2-1	4,200 lbs (1,905 kg) or 2,100 lbs (953 kg) maximum per guide wheel.
HR2000B3	6,750 lbs (3,062 kg) or 3,375 lbs (1,531 kg) maximum per guide wheel.
HR2000B3-1	4,200 lbs (1,905 kg) or 2,100 lbs (953 kg) maximum per guide wheel.
HR2000B3-3	6,750 lbs (3,062 kg) or 3,375 lbs (1,531 kg) maximum per guide wheel.

Also, check the load on the front guide wheels. See the Operator's Service And Parts Manual provided with the front guide wheel unit for information on checking the load on the front guide wheels.

2.6 Guide Wheel Load On Track

NOTES

2.6 Guide Wheel Load On Track

2.6.1 Checking Guide Wheel Load - HR2000B1

To check the load on the rear guide wheels it is necessary to measure the deflection of the disc springs in the guide wheel unit's suspension system. Use the following procedure to check the load on the rear guide wheels.

1. All guide wheels must be locked in the "rail" position. Apply the parking brake. Stop the vehicle's engine.

2. See Figure 2-6. The protrusion of rod (1) on the spring cell is used to determine the load on the guide wheels. Measure dimension (L) on both spring cells. This measurement (dimension L) will be used to determine the load on the rear guide wheels. See Chart 2-7 to convert dimension L to the load on the guide wheel.

3. On vehicles equipped with 19.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 50% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires. The load on the guide wheel unit should be at least 1,550 lbs (703 kg) or 775 lbs (352 kg) per guide wheel.

   If the load on the rear guide wheel unit does not meet the minimum load, total or per guide wheel, the rear guide wheel unit load must be re-adjusted. See Adjustments - Guide Wheel Alignment Procedure. Never operate the vehicle on track if the load on the rear guide wheel unit does not meet the minimum load of 1,550 lbs (703 kg) or 775 lbs (352 kg) per guide wheel.

4. The maximum load capacity of the rear guide wheel unit is 5,500 lbs (2,495 kg) or 2,750 lbs (1,247 kg) maximum per guide wheel.

   If the load on the rear guide wheel unit does not exceed the maximum load capacity of the guide wheel unit, total or per guide wheel, the load on the guide wheel unit is acceptable.

   If the load on the rear guide wheel unit exceeds the maximum load capacity of the guide wheel unit, total or per guide wheel, the vehicle load must be redistributed or some of the load removed. Never operate the vehicle on track if the load on the rear guide wheel unit exceeds the maximum load capacity of 5,500 lbs (2,495 kg) or 2,750 lbs (1,247 kg) maximum per guide wheel.

2.6 Guide Wheel Load On Track

2.6.1 Checking Guide Wheel Load - HR2000B1

FIGURE 2-6
HR2000B1 SPRING CELL

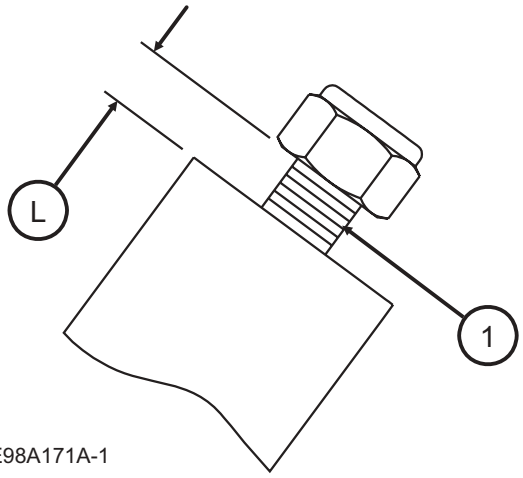


CHART 2-7
HR2000B1 GUIDE WHEEL LOAD

DIMENSION L		APPROXIMATE LOAD PER SIDE	
1/2"	(12.7 mm)	540 lbs	(245 kg)
5/8"	(15.8 mm)	750 lbs	(340 kg)
3/4"	(19.1 mm)	960 lbs	(435 kg)
7/8"	(22.2 mm)	1,160 lbs	(526 kg)
1"	(25.4 mm)	1,370 lbs	(621 kg)
1-1/8"	(28.6 mm)	1,580 lbs	(717 kg)
1-1/4"	(31.8 mm)	1,790 lbs	(812 kg)
1-3/8"	(34.9 mm)	2,000 lbs	(907 kg)
1-1/2"	(38.1 mm)	2,210 lbs	(1,002 kg)
1-5/8"	(41.3 mm)	2,420 lbs	(1,098 kg)
1-3/4"	(44.5 mm)	2,630 lbs	(1,193 kg)
*** 1-7/8"**	**(47.6 mm) . . . . . .**	**2,850 lbs**	**(1,293 kg)**

*** REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 5,500 LBS (2,495 kg) OR 2,750 LBS (1,247 kg) PER GUIDE WHEEL.**

2.6 Guide Wheel Load On Track

2.6.2 Checking Guide Wheel Load - HR2000B2

To check the load on the rear guide wheels it is necessary to measure the deflection of the disc springs in the guide wheel unit's suspension system. Use the following procedure to check the load on the rear guide wheels.

1. All guide wheels must be locked in the "rail" position. Apply the parking brake. Stop the vehicle's engine.

2. See Figure 2-8. The protrusion of rod (1) on the spring cell is used to determine the load on the guide wheels. Measure dimension (L) on both spring cells. This measurement (dimension L) will be used to determine the load on the rear guide wheels. See Chart 2-9 to convert dimension L to the load on the guide wheel.

3. On vehicles equipped with 19.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 50% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires.

   On vehicles equipped with 22.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 40% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires.

   If the load on the rear guide wheel unit does not meet the recommended load, total or per guide wheel, the rear guide wheel unit load must be re-adjusted. See Adjustments - Guide Wheel Alignment Procedure. Never operate the vehicle on track if the load on the rear guide wheel unit does not meet the recommended load.

4. The maximum load capacity of the rear guide wheel unit is 6,750 lbs (3,063 kg) or 3,375 lbs (1,531 kg) maximum per guide wheel.

   If the load on the rear guide wheel unit does not exceed the maximum load capacity of the guide wheel unit, total or per guide wheel, the load on the guide wheel unit is acceptable.

   If the load on the rear guide wheel unit exceeds the maximum load capacity of the guide wheel unit, total or per guide wheel, the vehicle load must be redistributed or some of the load removed. Never operate the vehicle on track if the load on the rear guide wheel unit exceeds the maximum load capacity of 6,750 lbs (3,063 kg) or 3,375 lbs (1,531 kg) maximum per guide wheel.

2.6 Guide Wheel Load On Track

2.6.2 Checking Guide Wheel Load - HR2000B2

FIGURE 2-8
HR2000B2 SPRING CELL

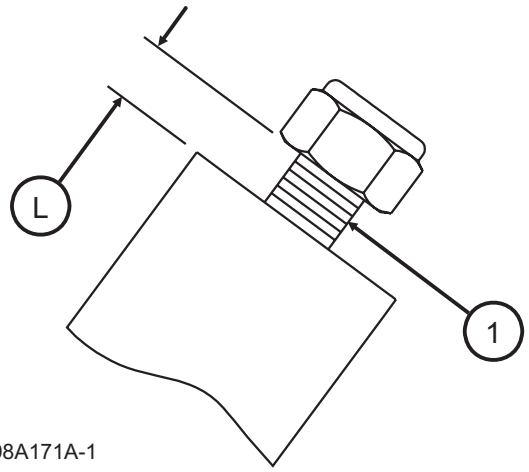


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CHART 2-9
HR2000B2 GUIDE WHEEL LOAD

	DIMENSION L		APPROXIMATE LOAD PER SIDE	
	3/8"	(9.5 mm)	870 lbs	(395 kg)
	1/2"	(12.7 mm)	1,160 lbs	(526 kg)
	5/8"	(15.8 mm)	1,450 lbs	(658 kg)
	3/4"	(19.1 mm)	1,740 lbs	(790 kg)
	7/8"	(22.2 mm)	2,030 lbs	(921 kg)
	1"	(25.4 mm)	2,320 lbs	(1,053 kg)
	1-1/8"	(28.6 mm)	2,610 lbs	(1,184 kg)
	1-1/4"	(31.8 mm)	2,900 lbs	(1,315 kg)
	1-3/8"	(34.9 mm)	3,190 lbs	(1,447 kg)
*	**1-1/2"**	**(38.1 mm) . . . . . .**	**3,480 lbs**	**(1,580 kg)**

*** REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 6,750 LBS (3,063 kg) OR 3,375 LBS (1,531 kg) PER GUIDE WHEEL.**

2.6 Guide Wheel Load On Track

2.6.3 Checking Guide Wheel Load - HR2000B2-1

To check the load on the rear guide wheels it is necessary to measure the deflection of the disc springs in the guide wheel unit's suspension system. Use the following procedure to check the load on the rear guide wheels.

1. All guide wheels must be locked in the "rail" position. Apply the parking brake. Stop the vehicle's engine.

2. See Figure 2-10. The protrusion of rod (1) on the spring cell is used to determine the load on the guide wheels. Measure dimension (L) on both spring cells. This measurement (dimension L) will be used to determine the load on the rear guide wheels. See Chart 2-11 to convert dimension L to the load on the guide wheel.

3. On vehicles equipped with 19.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 50% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires. The load on the guide wheel unit should be at least 1,550 lbs (703 kg) or 775 lbs (352 kg) per guide wheel.

   On vehicles equipped with 22.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 40% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires. The load on the guide wheel unit should be at least 1,550 lbs (703 kg) or 775 lbs (352 kg) per guide wheel.

   If the load on the rear guide wheel unit does not meet the minimum load, total or per guide wheel, the rear guide wheel unit load must be re-adjusted. See Adjustments - Guide Wheel Alignment Procedure. Never operate the vehicle on track if the load on the rear guide wheel unit does not meet the minimum load of 1,550 lbs (703 kg) or 775 lbs (352 kg) per guide wheel.

4. The maximum load capacity of the rear guide wheel unit is 4,200 lbs (1,905 kg) or 2,100 lbs (953 kg) maximum per guide wheel.

   If the load on the rear guide wheel unit does not exceed the maximum load capacity of the guide wheel unit, total or per guide wheel, the load on the guide wheel unit is acceptable.

   If the load on the rear guide wheel unit exceeds the maximum load capacity of the guide wheel unit, total or per guide wheel, the vehicle load must be redistributed or some of the load removed. Never operate the vehicle on track if the load on the rear guide wheel unit exceeds the maximum load capacity of 4,200 lbs (1,905 kg) or 2,100 lbs (953 kg) maximum per guide wheel.

2.6 Guide Wheel Load On Track

2.6.3 Checking Guide Wheel Load - HR2000B2-1

FIGURE 2-10
HR2000B2-1 SPRING CELL

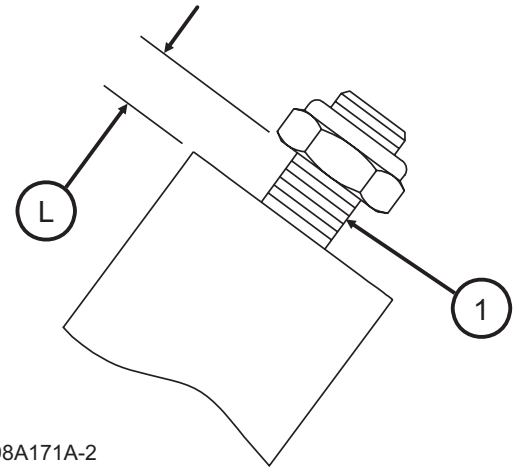

CHART 2-11
HR2000B2-1 GUIDE WHEEL LOAD

	DIMENSION L		APPROXIMATE LOAD PER SIDE	
	1/2"	(12.7 mm)	610 lbs	(277 kg)
	5/8"	(15.8 mm)	760 lbs	(345 kg)
	3/4"	(19.1 mm)	900 lbs	(408 kg)
	7/8"	(22.2 mm)	1,050 lbs	(476 kg)
	1"	(25.4 mm)	1,190 lbs	(542 kg)
	1-1/8"	(28.6 mm)	1,340 lbs	(608 kg)
	1-1/4"	(31.8 mm)	1,490 lbs	(676 kg)
	1-3/8"	(34.9 mm)	1,630 lbs	(740 kg)
	1-1/2"	(38.1 mm)	1,780 lbs	(807 kg)
	1-5/8"	(41.3 mm)	1,920 lbs	(871 kg)
	1-3/4"	(44.5 mm)	2,070 lbs	(1,193 kg)
*	**1-7/8"**	**(47.6 mm) . . . . . .**	**2,220 lbs**	**(1,293 kg)**

*** REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 4,200 LBS (1,905 kg) OR 2,100 LBS (953 kg) PER GUIDE WHEEL.**

2.6 Guide Wheel Load On Track

2.6.4 Checking Guide Wheel Load - HR2000B3

To check the load on the rear guide wheels it is necessary to measure the deflection of the disc springs in the guide wheel unit's suspension system. Use the following procedure to check the load on the rear guide wheels.

1. All guide wheels must be locked in the "rail" position. Apply the parking brake. Stop the vehicle's engine.

2. See Figure 2-12. The protrusion of rod (1) on the spring cell is used to determine the load on the guide wheels. Measure dimension (L) on both spring cells. This measurement (dimension L) will be used to determine the load on the rear guide wheels. See Chart 2-13 to convert dimension L to the load on the guide wheel.

3. On vehicles equipped with 19.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 50% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires.

   On vehicles equipped with 22.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 40% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires.

   If the load on the rear guide wheel unit does not meet the recommended load, total or per guide wheel, the rear guide wheel unit load must be re-adjusted. See Adjustments - Guide Wheel Alignment Procedure. Never operate the vehicle on track if the load on the rear guide wheel unit does not meet the recommended load.

4. The maximum load capacity of the rear guide wheel unit is 6,750 lbs (3,063 kg) or 3,375 lbs (1,531 kg) maximum per guide wheel.

   If the load on the rear guide wheel unit does not exceed the maximum load capacity of the guide wheel unit, total or per guide wheel, the load on the guide wheel unit is acceptable.

   If the load on the rear guide wheel unit exceeds the maximum load capacity of the guide wheel unit, total or per guide wheel, the vehicle load must be redistributed or some of the load removed. Never operate the vehicle on track if the load on the rear guide wheel unit exceeds the maximum load capacity of 6,750 lbs (3,063 kg) or 3,375 lbs (1,531 kg) maximum per guide wheel.

2.6 Guide Wheel Load On Track

2.6.4 Checking Guide Wheel Load - HR2000B3

FIGURE 2-12
HR2000B3 SPRING CELL

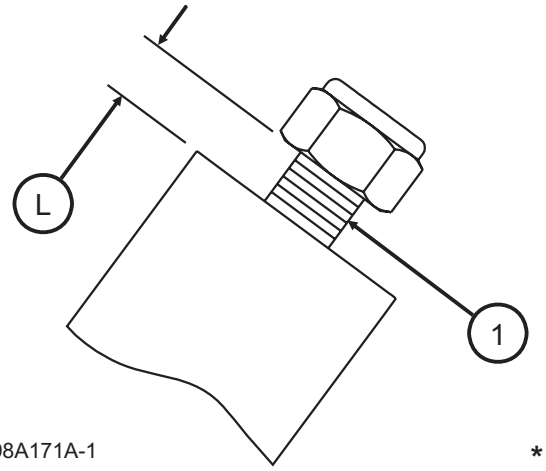

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CHART 2-13
HR2000B3 GUIDE WHEEL LOAD

	DIMENSION L		APPROXIMATE LOAD PER SIDE	
	3/8"	(9.5 mm)	870 lbs	(395 kg)
	1/2"	(12.7 mm)	1,160 lbs	(526 kg)
	5/8"	(15.8 mm)	1,450 lbs	(658 kg)
	3/4"	(19.1 mm)	1,740 lbs	(789 kg)
	7/8"	(22.2 mm)	2,030 lbs	(921 kg)
	1"	(25.4 mm)	2,320 lbs	(1,052 kg)
	1-1/8"	(28.6 mm)	2,610 lbs	(1,184 kg)
	1-1/4"	(31.8 mm)	2,900 lbs	(1,315 kg)
	1-3/8"	(34.9 mm)	3,190 lbs	(1,447 kg)
*	**1-1/2"**	**(38.1 mm) . . . . . .**	**3,480 lbs**	**(1,579 kg)**

*** REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 6,750 LBS (3,063 kg) OR 3,375 LBS (1,531 kg) PER GUIDE WHEEL.**

2.6 Guide Wheel Load On Track

2.6.5 Checking Guide Wheel Load - HR2000B3-1

To check the load on the rear guide wheels it is necessary to measure the deflection of the disc springs in the guide wheel unit's suspension system. Use the following procedure to check the load on the rear guide wheels.

1. All guide wheels must be locked in the "rail" position. Apply the parking brake. Stop the vehicle's engine.

2. See Figure 2-14. The protrusion of rod (1) on the spring cell is used to determine the load on the guide wheels. Measure dimension (L) on both spring cells. This measurement (dimension L) will be used to determine the load on the rear guide wheels. See Chart 2-15 to convert dimension L to the load on the guide wheel.

3. On vehicles equipped with 19.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 50% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires. The load on the guide wheel unit should be at least 1,550 lbs (703 kg) or 775 lbs (352 kg) per guide wheel.

   On vehicles equipped with 22.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 40% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires. The load on the guide wheel unit should be at least 1,550 lbs (703 kg) or 775 lbs (352 kg) per guide wheel.

   If the load on the rear guide wheel unit does not meet the minimum load, total or per guide wheel, the rear guide wheel unit load must be re-adjusted. See Adjustments - Guide Wheel Alignment Procedure. Never operate the vehicle on track if the load on the rear guide wheel unit does not meet the minimum load of 1,550 lbs (703 kg) or 775 lbs (352 kg) per guide wheel.

4. The maximum load capacity of the rear guide wheel unit is 4,200 lbs (1,905 kg) or 2,100 lbs (953 kg) maximum per guide wheel.

   If the load on the rear guide wheel unit does not exceed the maximum load capacity of the guide wheel unit, total or per guide wheel, the load on the guide wheel unit is acceptable.

   If the load on the rear guide wheel unit exceeds the maximum load capacity of the guide wheel unit, total or per guide wheel, the vehicle load must be redistributed or some of the load removed. Never operate the vehicle on track if the load on the rear guide wheel unit exceeds the maximum load capacity of 4,200 lbs (1,905 kg) or 2,100 lbs (953 kg) maximum per guide wheel.

2.6 Guide Wheel Load On Track

2.6.5 Checking Guide Wheel Load - HR2000B3-1

FIGURE 2-14
HR2000B3-1 SPRING CELL

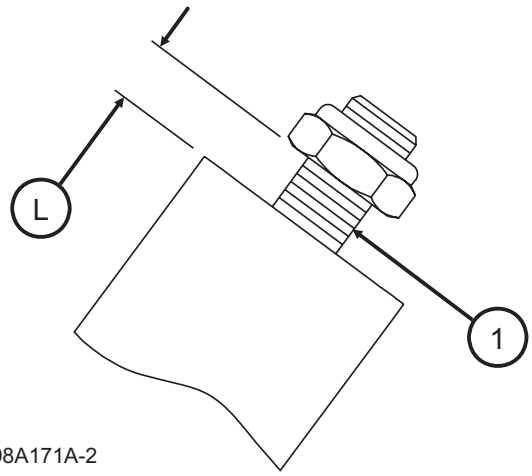

CHART 2-15
HR2000B3-1 GUIDE WHEEL LOAD

	DIMENSION L		APPROXIMATE LOAD PER SIDE	
	1/2"	(12.7 mm)	610 lbs	(277 kg)
	5/8"	(15.8 mm)	760 lbs	(345 kg)
	3/4"	(19.1 mm)	900 lbs	(408 kg)
	7/8"	(22.2 mm)	1,050 lbs	(476 kg)
	1"	(25.4 mm)	1,190 lbs	(542 kg)
	1-1/8"	(28.6 mm)	1,340 lbs	(608 kg)
	1-1/4"	(31.8 mm)	1,490 lbs	(676 kg)
	1-3/8"	(34.9 mm)	1,630 lbs	(740 kg)
	1-1/2"	(38.1 mm)	1,780 lbs	(807 kg)
	1-5/8"	(41.3 mm)	1,920 lbs	(871 kg)
	1-3/4"	(44.5 mm)	2,070 lbs	(1,193 kg)
*	**1-7/8"**	**(47.6 mm) . . . . . .**	**2,220 lbs**	**(1,293 kg)**

*** REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 4,200 LBS (1,905 kg) OR 2,100 LBS (953 kg) PER GUIDE WHEEL.**

2.6 Guide Wheel Load On Track

2.6.6 Checking Guide Wheel Load - HR2000B3-3

To check the load on the rear guide wheels it is necessary to measure the deflection of the disc springs in the guide wheel unit's suspension system. Use the following procedure to check the load on the rear guide wheels.

1. All guide wheels must be locked in the "rail" position. Apply the parking brake. Stop the vehicle's engine.

2. See Figure 2-16. The protrusion of rod (1) on the spring cell is used to determine the load on the guide wheels. Measure dimension (L) on both spring cells. This measurement (dimension L) will be used to determine the load on the rear guide wheels. See Chart 2-17 to convert dimension L to the load on the guide wheel.

3. On vehicles equipped with 19.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 50% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires.

   On vehicles equipped with 22.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 40% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires.

   If the load on the rear guide wheel unit does not meet the recommended load, total or per guide wheel, the rear guide wheel unit load must be re-adjusted. See Adjustments - Guide Wheel Alignment Procedure. Never operate the vehicle on track if the load on the rear guide wheel unit does not meet the recommended load.

4. The maximum load capacity of the rear guide wheel unit is 6,750 lbs (3,063 kg) or 3,375 lbs (1,531 kg) maximum per guide wheel.

   If the load on the rear guide wheel unit does not exceed the maximum load capacity of the guide wheel unit, total or per guide wheel, the load on the guide wheel unit is acceptable.

   If the load on the rear guide wheel unit exceeds the maximum load capacity of the guide wheel unit, total or per guide wheel, the vehicle load must be redistributed or some of the load removed. Never operate the vehicle on track if the load on the rear guide wheel unit exceeds the maximum load capacity of 6,750 lbs (3,063 kg) or 3,375 lbs (1,531 kg) maximum per guide wheel.

2.6 Guide Wheel Load On Track

2.6.6 Checking Guide Wheel Load - HR2000B3-3

FIGURE 2-16
HR2000B3-3 SPRING CELL

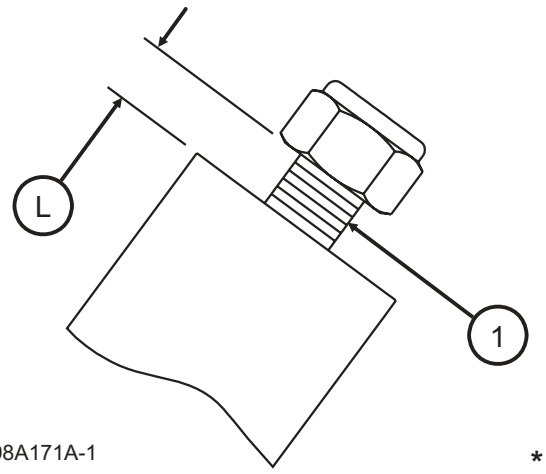

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CHART 2-17
HR2000B3-3 GUIDE WHEEL LOAD

	DIMENSION L		APPROXIMATE LOAD PER SIDE	
	3/8"	(9.5 mm)	870 lbs	(395 kg)
	1/2"	(12.7 mm)	1,160 lbs	(526 kg)
	5/8"	(15.8 mm)	1,450 lbs	(658 kg)
	3/4"	(19.1 mm)	1,740 lbs	(789 kg)
	7/8"	(22.2 mm)	2,030 lbs	(921 kg)
	1"	(25.4 mm)	2,320 lbs	(1,052 kg)
	1-1/8"	(28.6 mm)	2,610 lbs	(1,184 kg)
	1-1/4"	(31.8 mm)	2,900 lbs	(1,315 kg)
	1-3/8"	(34.9 mm)	3,190 lbs	(1,447 kg)
*	**1-1/2"**	**(38.1 mm) . . . . . **	**3,480 lbs**	**(1,579 kg)**

*** REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 6,750 LBS (3,063 kg) OR 3,375 LBS (1,531 kg) PER GUIDE WHEEL.**

2.7 Propelling On Track

- **IMPROPER LOADING OF THE HY-RAIL® EQUIPPED VEHICLE CAN CAUSE DERAILMENT OF THE VEHICLE.**
- **ALWAYS CHECK GUIDE WHEEL LOAD BEFORE OPERATING THE VEHICLE ON TRACK.**
- **NEVER OPERATE THE VEHICLE ON TRACK IF LOAD EXCEEDS MAXIMUM RATED LOAD OF FRONT AND/OR REAR GUIDE WHEEL UNITS.**
- **IF APPLICABLE, NEVER OPERATE VEHICLE ON TRACK IF CLEARANCE BETWEEN VEHICLE FRONT TIRES AND THE RAIL IS LESS THAN 1-1/2" (38 mm).**

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

- **BEFORE OR WHEN PROPELLING ON TRACK:**
  - **OBSERVE AND FOLLOW ALL RAILROAD SAFETY RULES AND REGULATIONS.**
  - **OPERATOR MUST LOOK IN 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 35 MPH (56 km/h) WHEN OPERATING VEHICLE ON TRACK. RAILROAD RULES GOVERNING SPEEDS SHOULD BE OBSERVED AT ALL TIMES. REDUCE SPEED WHEN PROPELLING VEHICLE THROUGH SWITCHES, ROAD 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 THE VEHICLE ON 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 the HR2000 Series B HY-RAIL® Guide Wheel Equipment use the vehicle propulsion system to propel on track. Do not accelerate suddenly. Traction is reduced on track 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 MAY NOT OPERATE TRACK SIGNAL CIRCUITS, AND ONCOMING VEHICLES OR PEDESTRIANS MAY NOT YIELD THE RIGHT OF WAY.**

- **IF SO EQUIPPED, RAIL WHEEL BRAKE CONTROL VALVE MUST BE IN THE "ON" POSITION WHENEVER VEHICLE IS ON TRACK.**

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

The HR2000 Series B HY-RAIL® Guide Wheel Equipment may be equipped with brakes. If the guide wheel unit is equipped with brakes, the vehicle uses a combination of the rear guide wheel unit brakes and the vehicle's rear brake system for braking on track. The guide wheel unit brakes will apply simultaneously when the vehicle brakes are applied. The front guide wheel unit may also be equipped with brakes. Stopping distance is greater on track than on typical road surfaces. Apply the brakes gradually to avoid sliding the vehicle tires and rail guide wheels.

2.9 Vehicles Equipped With Crane Or Aerial Lift Device

- **WHEN OPERATING CRANE, AERIAL LIFT DEVICE, ETC., WHILE THE VEHICLE'S GUIDE WHEELS ARE ON THE RAILS, DO NOT OVERLOAD THE GUIDE WHEEL EQUIPMENT OR EXCEED THE CAPACITY OF ANY OF THE EQUIPMENT BEING USED.**
- **THE UNIT SHOULD BE EQUIPPED WITH OUTRIGGERS TO HELP PREVENT ACCIDENTS AND THE POSSIBILITY OF DAMAGE TO THE GUIDE WHEEL EQUIPMENT. WHEN USING THE EQUIPMENT TO TRANSFER ANY LOAD, SET THE OUTRIGGERS ON A STABLE BASE TO PREVENT SETTLING OF THE OUTRIGGERS AND SHIFTING OF THE VEHICLE.**
- **IF OPERATING CONDITIONS REQUIRE LIFTING A LOAD WITH THE CRANE WHILE ON RAIL, BUT WITHOUT THE OUTRIGGERS BEING USED, THE LOAD APPLIED BY LIFTING WITH THE CRANE MUST NOT OVERLOAD ANY COMPONENT OF THE GUIDE WHEEL EQUIPMENT.**
- **CAREFULLY READ THE CRANE OR AERIAL LIFT DEVICE OPERATOR'S MANUAL FOR THE SAFE USE AND EFFICIENT OPERATION OF THE EQUIPMENT.**

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

1. When operating a crane, aerial lift device, etc., while the vehicle's guide wheels are on the rails, do not overload the guide wheel equipment or exceed the capacity of any of the equipment being used.

2. The crane, aerial lift device, etc. should be equipped with outriggers to help prevent accidents and the possibility of damage to the guide wheel equipment. When using the crane, aerial lift device, etc. to transfer any load, set the outriggers on a stable base to prevent settling of the outriggers and shifting of the vehicle. Carefully read the crane or aerial lift equipment operator's manual for the safe use and efficient operation of the equipment.

3. If operating conditions require lifting a load with the crane while on rail, but without the outriggers being used, the load applied by lifting with the crane must not overload any component of the guide wheel equipment.

2.10 Removing Vehicle From Track

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

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

- **WHEN USING VEHICLE MECHANICAL PTO HYDRAULIC PUMP TO LOWER/RAISE GUIDE WHEEL EQUIPMENT, DO NOT EXCEED HYDRAULIC SYSTEM FLOW OF 8 GPM (30 LPM) OR HYDRAULIC PRESSURE OF 2500 PSI (172 bar). EXCESSIVE FLOW AND / OR PRESSURE COULD DAMAGE HYDRAULIC SYSTEM COMPONENTS.**
- **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 AND REMOVING THE VEHICLE FROM TRACK.**

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

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

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

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

4. If so equipped, move the rail wheel brake control valve to the OFF position, whenever the vehicle is removed from the track for highway use.

5. Engage the mechanical PTO hydraulic pump or start the auxiliary hydraulic power source. If the vehicle is equipped with an auxiliary control valve, place the valve in the proper position to direct hydraulic oil flow to the guide wheel equipment.

2.10 Removing Vehicle From Track

6. Raise and lock the front guide wheels in the "highway" position. See the Operator's Service And Parts Manual provided with the front guide wheel unit for information on raising the front guide wheels.

2.10.1 Raising Rear Guide Wheels - See Figure 2-18

1. If the unit is equipped with the mechanical lock pin group, rotate the T-handle lock pin (3) to release it from the lock position. Pull the T-handle lock pin out to the unlocked position. Repeat the procedure on the opposite side guide wheel arm.

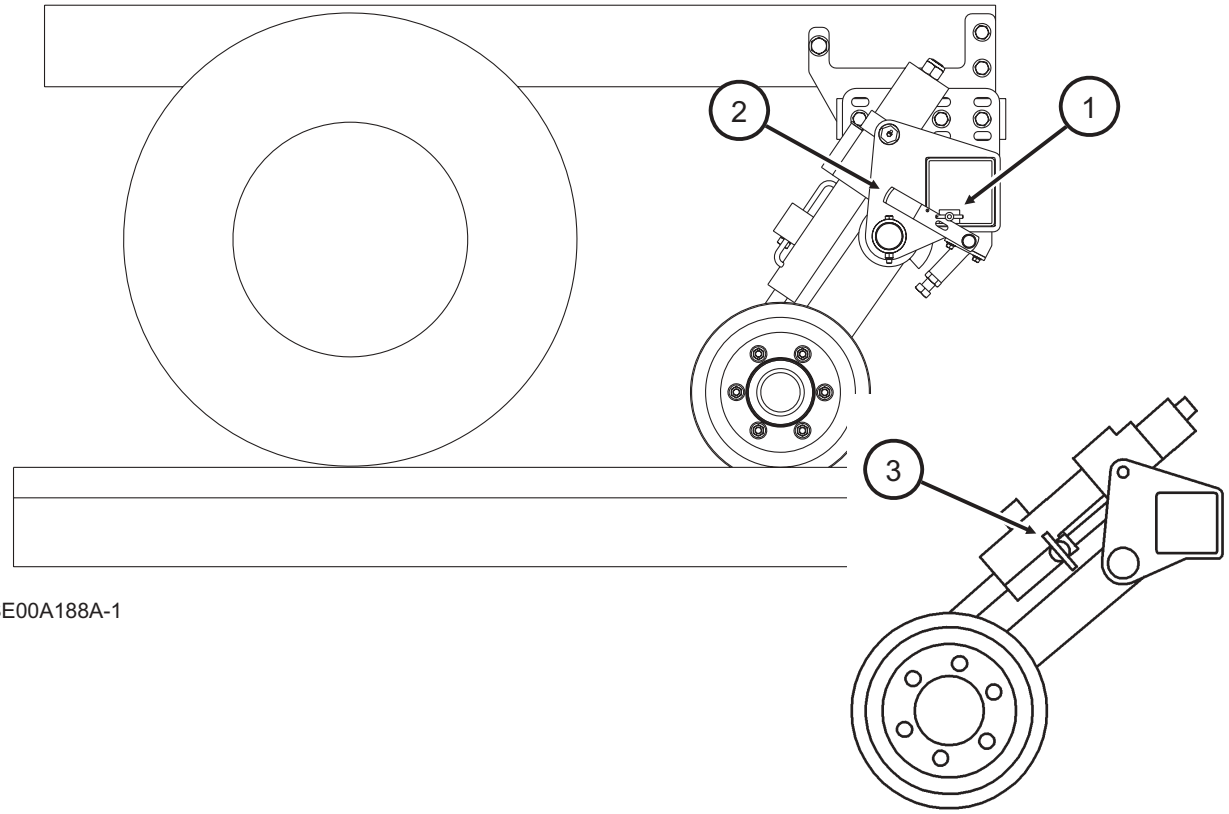
1. Move the hydraulic valve control handle to raise the guide wheels. Hold the control valve handle until the guide wheels are fully raised.

2. Remove lock pin (1) from the hole in the frame. Rotate lock handle (2) clockwise. Install the lock pin (1) through the hole in the lock handle and the hole in the frame.

3. Disengage the mechanical PTO hydraulic pump or stop the auxiliary hydraulic power source. If the vehicle is equipped with an auxiliary control valve, place the valve in the proper position to shut off hydraulic oil flow to the guide wheel equipment.

4. See Figures 2-19, 2-20, 2-21 and 2-22. Disengage the vehicle steering lock located on the steering column. Steering locks may vary from vehicle to vehicle but will operate similarly.

FIGURE 2-18
RAISING REAR GUIDE WHEELS



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2.10 Removing Vehicle From Track

FIGURE 2-19
STEERING LOCK IN UN-LOCK POSITION

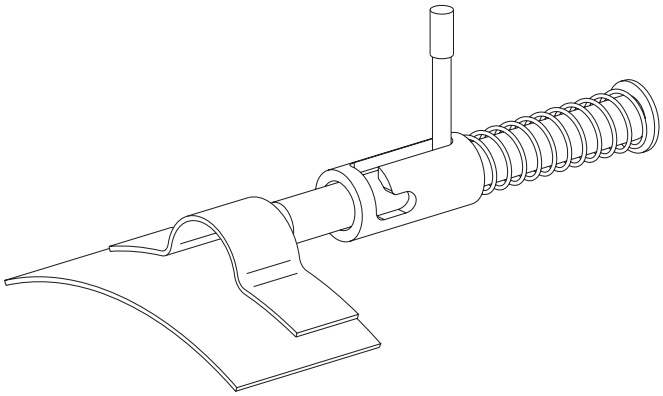

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FIGURE2-20
STEERING LOCK IN
LOCKED POSITION

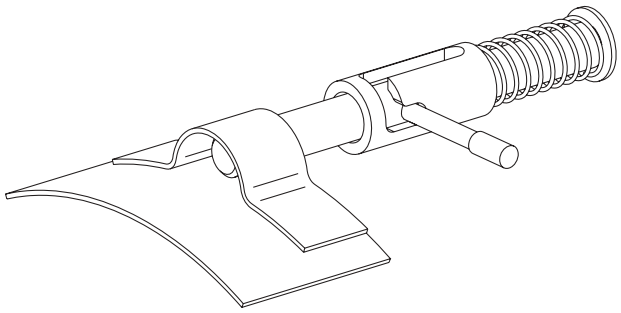

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FIGURE 2-21
VELCRO STEERING LOCK OFF

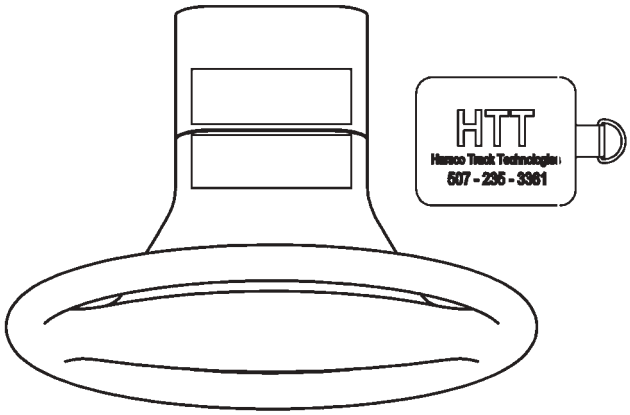
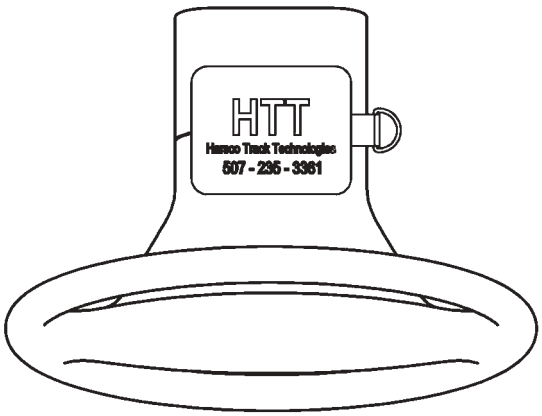


FIGURE 2-22
VELCRO STEERING LOCK ON



2.11 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.**

2.12 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 RAIL GUIDE WHEELS.**

- **TOW TRAILER / EQUIPMENT AT A REASONABLE SPEED (20 MPH 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'S:**
  - **FRONT AND REAR GUIDE WHEELS ARE LOWERED AND LOCKED IN RAIL POSITION.**
  - **ALL RAIL GUIDE WHEEL FLANGES ARE ENGAGED ON INSIDE OF RAILS.**
  - **IF APPLICABLE, VEHICLE FRONT TIRES MUST BE RAISED A MINIMUM OF 1-1/2" (38 mm) ABOVE THE RAIL.**
  - **VEHICLE STEERING WHEEL LOCK ENGAGED WITH FRONT WHEELS STRAIGHT AHEAD.**

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

2.12 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'S GUIDE WHEEL EQUIPMENT.**
- **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.**
- **ALWAYS CHOCK TRAILER WHEELS BEFORE UNHOOKING TRAILER FROM TOWING VEHICLE.**

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

2.12 Towing Trailer / Equipment With Vehicle On Track

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

2. Use the vehicle manufacturer's recommendations to determine the maximum weight the towing vehicle can tow. Do not exceed 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's:
   a. Front and rear guide wheels are lowered and locked in the rail position.
   b. All front and rear guide wheel flanges are engaged on the inside of the rails.
   c. If applicable, vehicle front tires must be raised a minimum of 1-1/2" (38 mm) above the rail.
   d. Vehicle 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 vehicle's guide wheel equipment.

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

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

10. Stopping distance is greater on rail 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 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.

2.13 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'S:**
  - **FRONT AND REAR GUIDE WHEELS ARE RAISED AND LOCKED IN HIGHWAY POSITION.**
  - **VEHICLE STEERING WHEEL LOCK DISENGAGED.**

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

2.13 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 VEHICLE'S GUIDE WHEEL EQUIPMENT.**

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

- **ALWAYS CHOCK TRAILER WHEELS BEFORE UNHOOKING TRAILER FROM TOWING VEHICLE.**

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

2.13 Towing Trailer / Equipment With Vehicle On Road

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

2. Use the vehicle manufacturer's recommendations to determine the maximum weight the towing vehicle can tow. Do not exceed 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's:
   a. Front and rear guide wheels are raised and locked in the highway position.
   b. Vehicle 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 vehicle's guide wheel equipment.

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.

2.14 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 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'S:**
  - **FRONT AND REAR GUIDE WHEELS ARE LOWERED AND LOCKED IN THE RAIL POSITION.**
  - **ALL RAIL GUIDE WHEEL FLANGES ARE ENGAGED ON INSIDE OF RAILS.**
  - **IF APPLICABLE, VEHICLE FRONT TIRES MUST BE RAISED A MINIMUM OF 1-1/2" (38 mm) ABOVE THE RAIL.**
  - **VEHICLE STEERING WHEEL LOCK ENGAGED WITH FRONT WHEELS STRAIGHT AHEAD.**

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

2.14 Towing Disabled Vehicle On Track

- **TOW BAR MUST BE ATTACHED TO DISABLED VEHICLE'S FRAME. DO NOT MOUNT OR ATTACH TOW BAR TO DISABLED VEHICLE'S GUIDE WHEEL EQUIPMENT.**
- **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 RAIL. 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.

2.14 Towing Disabled Vehicle On Track

1. See your vehicle's operators 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's:
   a. Front and rear guide wheels are lowered and locked in the rail position.
   b. All rail guide wheel flanges are engaged on the inside of the rails.
   c. If applicable, vehicle front tires must be raised a minimum of 1-1/2" (38 mm) above the rail.
   d. Vehicle 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's guide wheel equipment. 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 rail. Spinning the towing vehicle tires / machine wheels could damage them.

9. Stopping distance is greater on rail 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 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.

2.15 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'S:**
  - **FRONT AND REAR GUIDE WHEELS ARE RAISED AND LOCKED IN THE HIGHWAY POSITION.**
  - **VEHICLE 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'S FRAME. DO NOT MOUNT OR ATTACH TOWING EQUIPMENT TO DISABLED VEHICLE'S GUIDE WHEEL EQUIPMENT.**
- **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.

2.15 Towing Disabled Vehicle On Road

1. See your vehicle's operators 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 wheels 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's frame. Do not mount or attach the towing equipment to the disabled vehicle's guide wheel equipment.

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

- **ENGINE MUST BE RUNNING TO OPERATE MECHANICAL PTO HYDRAULIC PUMP TO RAISE / LOWER THE GUIDE WHEELS. BEFORE PERFORMING ANY ADJUSTMENTS TO GUIDE WHEEL EQUIPMENT OR VEHICLE, ALWAYS PLACE 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 THE GUIDE WHEEL EQUIPMENT.**

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

The Guide Wheel Alignment Check must be completed when any of the misalignment indicators occur. See Operation - Misalignment Indicators.

See The Operator's Service and Parts Manual provided with the rear guide wheel unit for the proper alignment procedure for the rear guide wheel unit.

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 (adding leaf springs, coil springs, etc).

4. Tires must be inflated to the tire manufacturer's recommended maximum pressure printed on the sidewalls of the tires or wheel manufacturer's recommended maximum pressure, stamped on the wheel, whichever is lower.

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.

3.1 Guide Wheel Equipment Alignment Procedure

3.1.1 Vehicle Check

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

7. Check the following measurements on the vehicle.

   a. Frame must be square. Diagonal measurements of the 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 304 mm). Harsco Track Technologies, Harsco Corporation recommends that this be checked by a reputable alignment shop.

8. Follow the mounting instructions on the application drawings which are 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 Track Technologies, Fairmont Minnesota Facility to obtain these drawings.

9. Make sure that the applicator of the guide wheel equipment performed a four point alignment on the vehicle including checking the caster, camber, toe-in on the front wheels and 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. Make sure the headlight aim is checked and adjusted.

3.1 Guide Wheel Equipment Alignment Procedure

3.1.2 Placing Vehicle On Track

1. Place the vehicle on straight, level, tangent track or an alignment rack constructed for guide wheel equipment alignment. If track or an alignment rack is not available, use 4 x 4 inch lumber on a level floor to simulate track. Space the lumber so it measures 57-1/2 inches (1.46 m) between the inside edges.

2. Place the vehicle automatic transmission in "Park" or manual transmission in "Neutral". Apply the parking brake. Lower the guide wheels to the rail position. See Operation - Placing Vehicle On Track.

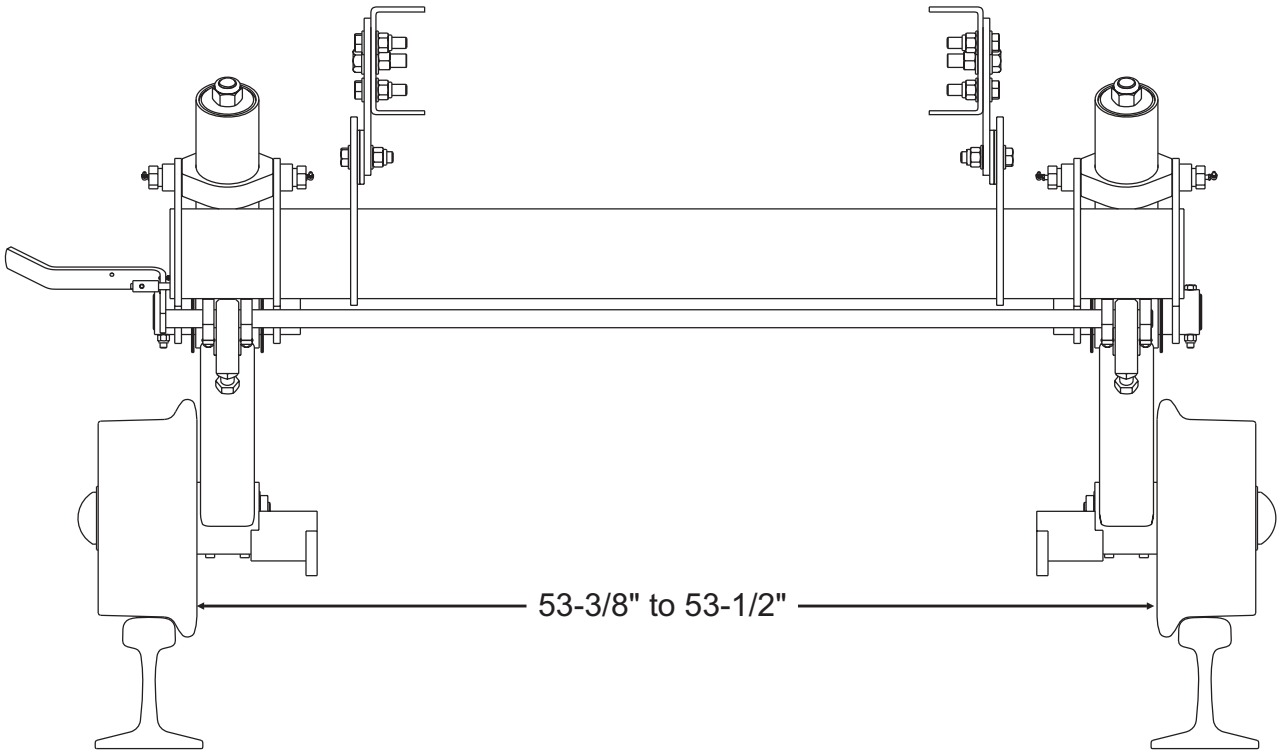
3. Set the vehicle's front wheels straight ahead. Secure the steering wheel using the steering lock. Stop the engine.

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 rear guide wheel unit. 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 53-3/8 to 53-1/2 inches (1356 mm to 1359 mm). The rear guide wheel unit track gauge is preset at the factory and should not require adjustment. Incorrect track gauge may indicate damaged guide wheel equipment.

FIGURE 3-1
GUIDE WHEEL UNIT BACK FLANGE GAUGE



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3.1 Guide Wheel Equipment Alignment Procedure

3.1.4 Guide Wheel Load

- **IMPROPER LOADING OF GUIDE WHEEL EQUIPMENT 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 OF THE FRONT AND/OR REAR GUIDE WHEEL UNITS.**
- **NEVER OPERATE THE VEHICLE ON TRACK IF CLEARANCE BETWEEN VEHICLE FRONT TIRES AND RAIL IS LESS THAN 1-1/2" (38 mm).**

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

3.1.4.1 Checking Rear Guide Wheel Load

HR2000B1 See Figure 3-2 and Chart 3-3
HR2000B2 See Figure 3-4 and Chart 3-5
HR2000B2-1 See Figure 3-6 and Chart 3-7
HR2000B3 See Figure 3-8 and Chart 3-9
HR2000B3-1 See Figure 3-10 and Chart 3-11
HR2000B3-3 See Figure 3-12 and Chart 3-13

1. When the guide wheel unit is mounted on the vehicle, the initial guide wheel load is determined by the mounting location of the guide wheel unit on the vehicle frame. Final adjustment is made by adjusting the cylinder rod component of the spring cell.

2. On vehicles equipped with 19.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 50% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires.

3. On vehicles equipped with 22.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 40% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires.

4. Lower and lock the front and rear guide wheels in the "rail" position. The protrusion of rod (1) on the spring cell (dimension L) can be used to determine the rear guide wheel load when the vehicle is on track. See Guide Wheel Load Adjustment.

Note: Adjustment of the cylinder rod to obtain the correct load on the guide wheel may require re-adjustment of the lock stop bolts when the guide wheels are raised to the highway position.

3.1 Guide Wheel Equipment Alignment Procedure

3.1.4 Guide Wheel Load

3.1.4.1 Checking Rear Guide Wheel Load

FIGURE 3-2
HR2000B1 SPRING CELL

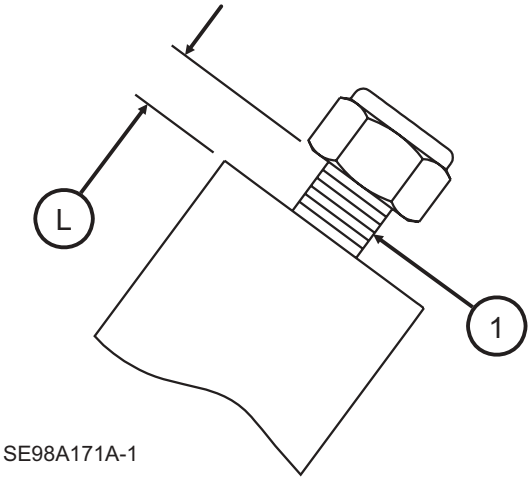

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CHART 3-3
HR2000B1 GUIDE WHEEL LOAD

DIMENSION L		APPROXIMATE LOAD PER SIDE	
1/2"	(12.7 mm)	536 lbs	(243 kg)
5/8"	(15.8 mm)	745 lbs	(338 kg)
3/4"	(19.1 mm)	955 lbs	(433 kg)
7/8"	(22.2 mm)	1,164 lbs	(528 kg)
1"	(25.4 mm)	1,374 lbs	(623 kg)
1-1/8"	(28.6 mm)	1,583 lbs	(718 kg)
1-1/4"	(31.8 mm)	1,789 lbs	(811 kg)
1-3/8"	(34.9 mm)	2,002 lbs	(908 kg)
1-1/2"	(38.1 mm)	2,212 lbs	(1,003 kg)
1-5/8"	(41.3 mm)	2,422 lbs	(1,099 kg)
1-3/4"	(44.5 mm)	2,631 lbs	(1,193 kg)
*** 1-7/8"**	**(47.6 mm) . . . . . .**	**2,850 lbs**	**(1,293 kg)**

*** REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 5,500 LBS (2,495 kg) OR 2,750 LBS (1,247 kg) PER GUIDE WHEEL.**

FIGURE 3-4
HR2000B2 SPRING CELL

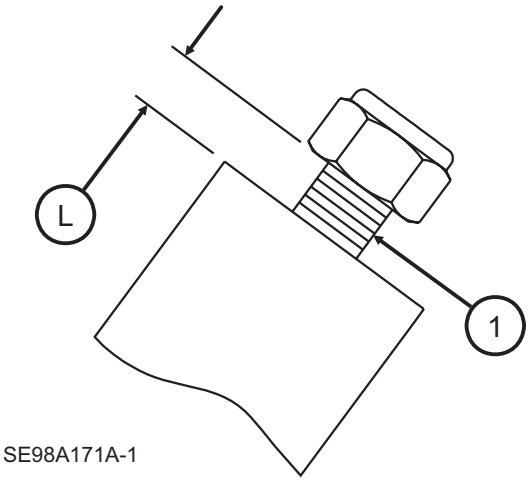

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CHART 3-5
HR2000B2 GUIDE WHEEL LOAD

DIMENSION L		APPROXIMATE LOAD PER SIDE	
3/8"	(9.5 mm)	871 lbs	(400 kg)
1/2"	(12.7 mm)	1,161 lbs	(527 kg)
5/8"	(15.8 mm)	1,451 lbs	(658 kg)
3/4"	(19.1 mm)	1,742 lbs	(790 kg)
7/8"	(22.2 mm)	2,032 lbs	(922 kg)
1"	(25.4 mm)	2,322 lbs	(1,053 kg)
1-1/8"	(28.6 mm)	2,613 lbs	(1,185 kg)
1-1/4"	(31.8 mm)	2,903 lbs	(1,317 kg)
1-3/8"	(34.9 mm)	3,193 lbs	(1,448 kg)
*** 1-1/2"**	**(38.1 mm) . . . . . .**	**3,483 lbs**	**(1,580 kg)**

*** REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 6,750 LBS (3,063 kg) OR 3,375 LBS (1,531 kg) PER GUIDE WHEEL.**

3.1 Guide Wheel Equipment Alignment Procedure

3.1.4 Guide Wheel Load

3.1.4.1 Checking Rear Guide Wheel Load

FIGURE 3-6
HR2000B2-1 SPRING CELL

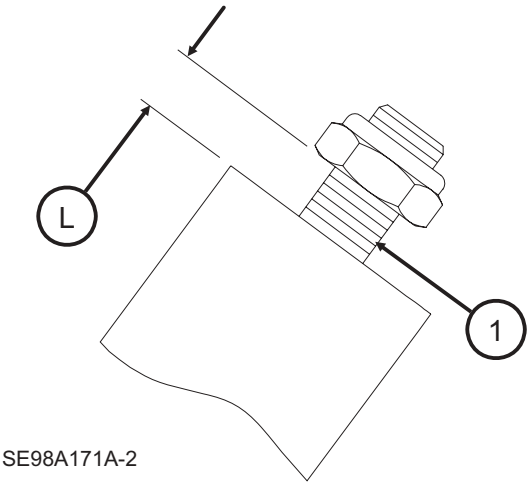

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CHART 3-7
HR2000B2-1 GUIDE WHEEL LOAD

	DIMENSION L		APPROXIMATE LOAD PER SIDE	
	1/2"	(12.7 mm)	610 lbs	(277 kg)
	5/8"	(15.8 mm)	756 lbs	(343 kg)
	3/4"	(19.1 mm)	902 lbs	(409 kg)
	7/8"	(22.2 mm)	1,048 lbs	(475 kg)
	1"	(25.4 mm)	1,194 lbs	(542 kg)
	1-1/8"	(28.6 mm)	1,340 lbs	(608 kg)
	1-1/4"	(31.8 mm)	1,486 lbs	(674 kg)
	1-3/8"	(34.9 mm)	1,632 lbs	(740 kg)
	1-1/2"	(38.1 mm)	1,778 lbs	(807 kg)
	1-5/8"	(41.3 mm)	1,924 lbs	(873 kg)
	1-3/4"	(44.5 mm)	2,070 lbs	(1,193 kg)
*	**1-7/8"**	**(47.6 mm) . . . . . .**	**2,216 lbs**	**(1,293 kg)**

*** REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 4,200 LBS (1,905 kg) OR 2,100 LBS (953 kg) PER GUIDE WHEEL.**

FIGURE 3-8
HR2000B3 SPRING CELL

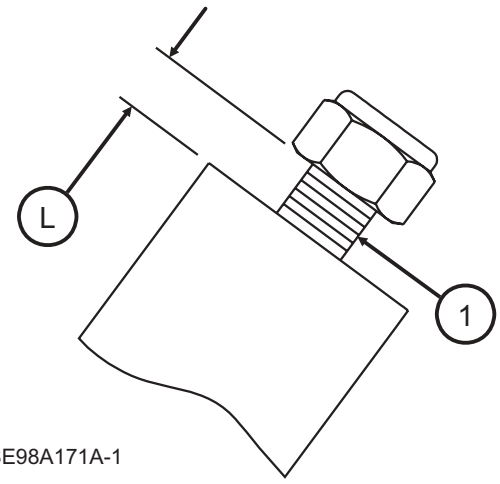

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CHART 3-9
HR2000B3 GUIDE WHEEL LOAD

	DIMENSION L		APPROXIMATE LOAD PER SIDE	
	3/8"	(9.5 mm)	871 lbs	(400 kg)
	1/2"	(12.7 mm)	1,161 lbs	(527 kg)
	5/8"	(15.8 mm)	1,451 lbs	(658 kg)
	3/4"	(19.1 mm)	1,742 lbs	(790 kg)
	7/8"	(22.2 mm)	2,032 lbs	(922 kg)
	1"	(25.4 mm)	2,322 lbs	(1,053 kg)
	1-1/8"	(28.6 mm)	2,613 lbs	(1,185 kg)
	1-1/4"	(31.8 mm)	2,903 lbs	(1,317 kg)
	1-3/8"	(34.9 mm)	3,193 lbs	(1,448 kg)
*	**1-1/2"**	**(38.1 mm) . . . . . .**	**3,483 lbs**	**(1,580 kg)**

*** REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 6,750 LBS (3,063 kg) OR 3,375 LBS (1,531 kg) PER GUIDE WHEEL.**

3.1 Guide Wheel Equipment Alignment Procedure

3.1.4 Guide Wheel Load

3.1.4.1 Checking Rear Guide Wheel Load

FIGURE 3-10
HR2000B3-1 SPRING CELL

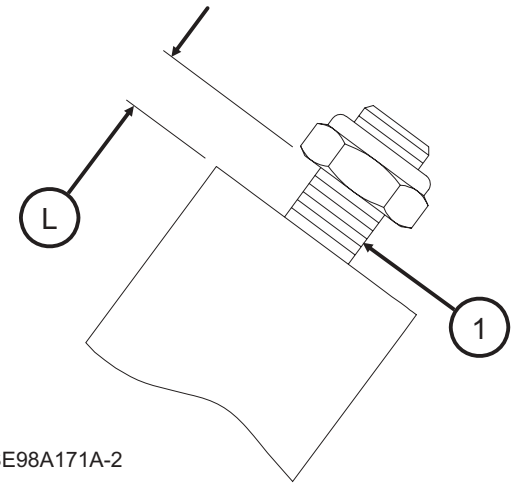

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CHART 3-11
HR2000B3-1 GUIDE WHEEL LOAD

	DIMENSION L		APPROXIMATE LOAD PER SIDE	
	1/2"	(12.7 mm)	610 lbs	(277 kg)
	5/8"	(15.8 mm)	756 lbs	(343 kg)
	3/4"	(19.1 mm)	902 lbs	(409 kg)
	7/8"	(22.2 mm)	1,048 lbs	(475 kg)
	1"	(25.4 mm)	1,194 lbs	(542 kg)
	1-1/8"	(28.6 mm)	1,340 lbs	(608 kg)
	1-1/4"	(31.8 mm)	1,486 lbs	(674 kg)
	1-3/8"	(34.9 mm)	1,632 lbs	(740 kg)
	1-1/2"	(38.1 mm)	1,778 lbs	(807 kg)
	1-5/8"	(41.3 mm)	1,924 lbs	(873 kg)
	1-3/4"	(44.5 mm)	2,070 lbs	(1,193 kg)
*	**1-7/8"**	**(47.6 mm) . . . . . .**	**2,216 lbs**	**(1,293 kg)**

*** REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 4,200 LBS (1,905 kg) OR 2,100 LBS (953 kg) PER GUIDE WHEEL.**

FIGURE 3-12
HR2000B3-3 SPRING CELL

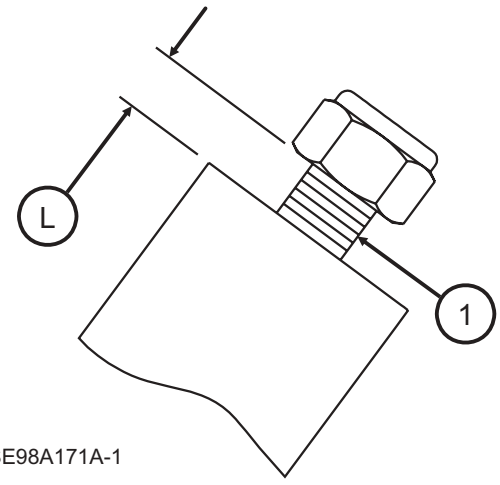

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CHART 3-13
HR2000B3-3 GUIDE WHEEL LOAD

	DIMENSION L		APPROXIMATE LOAD PER SIDE	
	3/8"	(9.5 mm)	871 lbs	(400 kg)
	1/2"	(12.7 mm)	1,161 lbs	(527 kg)
	5/8"	(15.8 mm)	1,451 lbs	(658 kg)
	3/4"	(19.1 mm)	1,742 lbs	(790 kg)
	7/8"	(22.2 mm)	2,032 lbs	(922 kg)
	1"	(25.4 mm)	2,322 lbs	(1,053 kg)
	1-1/8"	(28.6 mm)	2,613 lbs	(1,185 kg)
	1-1/4"	(31.8 mm)	2,903 lbs	(1,317 kg)
	1-3/8"	(34.9 mm)	3,193 lbs	(1,448 kg)
*	**1-1/2"**	**(38.1 mm) . . . . . .**	**3,483 lbs**	**(1,580 kg)**

*** REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 6,750 LBS (3,063 kg) OR 3,375 LBS (1,531 kg) PER GUIDE WHEEL.**

3.1 Guide Wheel Equipment Alignment Procedure

3.1.5 Guide Wheel Load Adjustment - See Figures 3-14 and 3-15

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

1. On vehicles equipped with 19.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 50% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires. The load on the guide wheel unit should be at least 1,550 lbs (703 kg) or 775 lbs (352 kg) per guide wheel.

   To calculate the load setting for each rear spring cell, use the following formula:

   Vehicle Rear Axle Weight x 25% (0.25) = Spring Cell Load.

2. On vehicles equipped with 22.5 inch wheels and tires, the recommended load on the rear guide wheel unit is 40% of the vehicle's rear axle curb weight with the remainder of the weight being carried by the vehicle rear tires. The load on the guide wheel unit should be at least 1,550 lbs (703 kg) or 775 lbs (352 kg) per guide wheel.

   To calculate the load setting for each rear spring cell, use the following formula:

   Vehicle Rear Axle Weight x 20% (0.20) = Spring Cell Load.

3. Convert the calculated spring cell load into dimension L. See Spring Cell Load Chart for the applicable guide wheel unit. If the spring cell is not set to the calculated spring cell load (dimension L) or is less than the minimum of 1,550 lbs (703 kg) or 775 lbs (352 kg) per guide wheel, the guide wheel unit must be adjusted.

4. Using dimension L, determine the amount of adjustment to the cylinder rod that will be required to obtain the desired load.

5. Raise the rear guide wheels from the "rail" position. Let the guide wheels rest on the rails.

6. To increase the load on the guide wheel (increase dimension L), loosen jam nut (1). Using a wrench on the flats of the cylinder rod (2), rotate the cylinder rod clockwise, extending the adjusting stud, to the desired dimension. Tighten jam nut (1).

7. To decrease the load on the guide wheel (decrease dimension L), loosen jam nut (1). Using a wrench on the flats of the cylinder rod (2), rotate the cylinder rod counter-clockwise, retracting the adjusting stud, to the desired dimension. Tighten jam nut (1).

8. When adjusting the guide wheel load, care must be taken not to adjust trunnion (3) too far out of cylinder rod (2). To check this: loosen jam nut (1) down against trunnion (3). The maximum allowable exposed threads (4) must not exceed 3/4" (19 mm).

3.1 Guide Wheel Equipment Alignment Procedure

3.1.5 Guide Wheel Load Adjustment - See Figures 3-14 and 3-15

9. Lower the rear guide wheels to the "rail" position. Re-measure dimension L to determine the guide wheel load on both spring cells. See Spring Cell Load Chart for the applicable guide wheel unit to convert dimension L to the load.

10. Repeat the adjustment procedure until dimension L corresponds to the calculated load or the minimum load setting. Both Spring cells must be set to the same dimension L within 1/16 inch (1.6 mm).

FIGURE 3-14
GUIDE WHEEL LOAD ADJUSTMENT

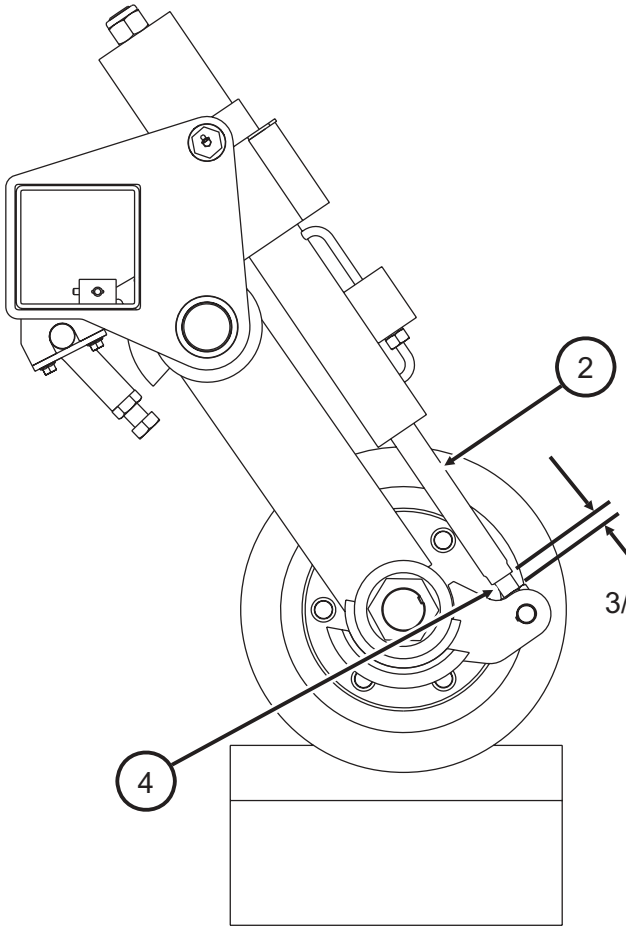

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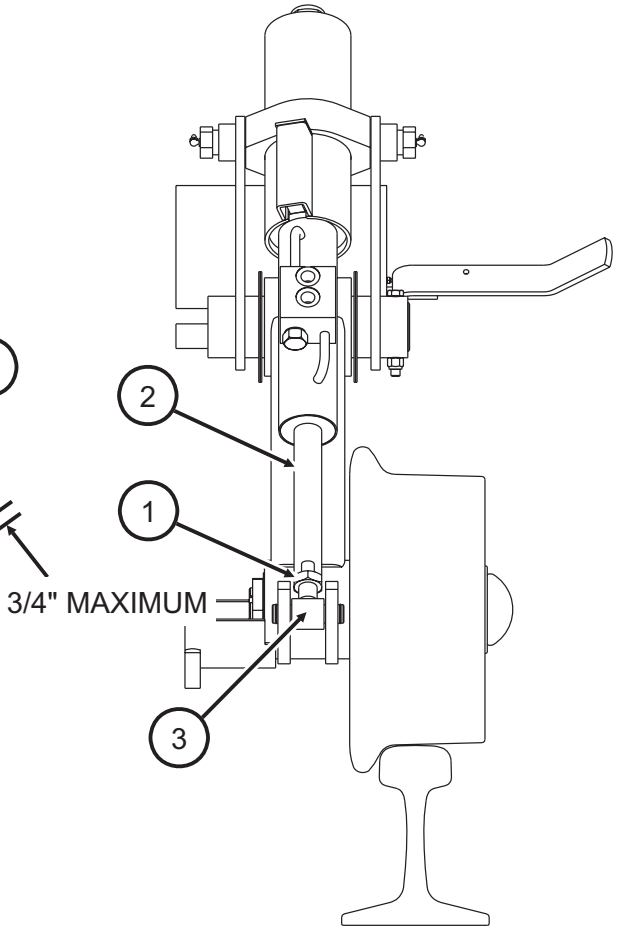
FIGURE 3-15
GUIDE WHEEL LOAD ADJUSTMENT



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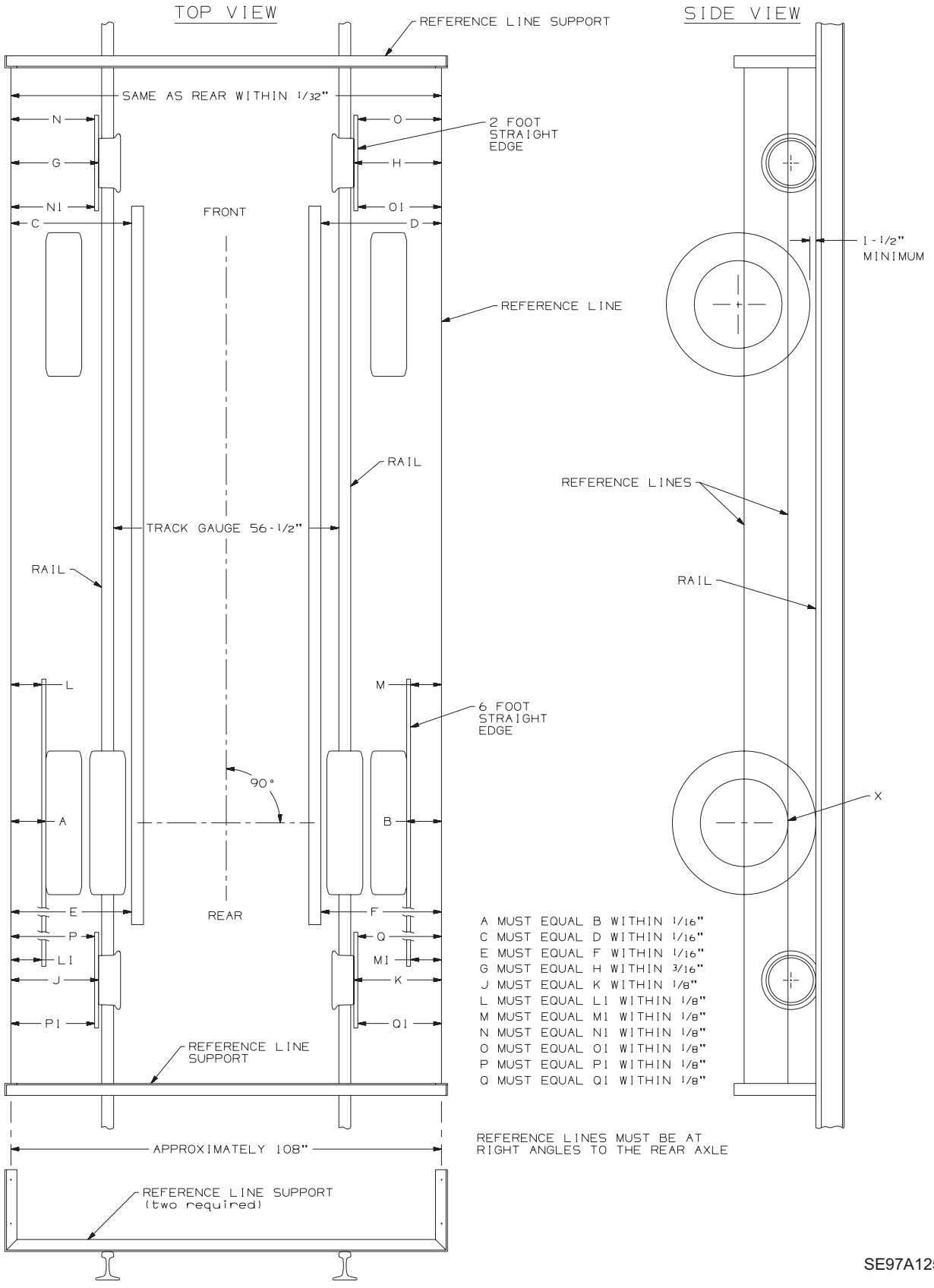
3.1 Guide Wheel Equipment Alignment Procedure

FIGURE 3-16
GUIDE WHEEL EQUIPMENT ALIGNMENT



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3.1 Guide Wheel Equipment Alignment Procedure

3.1.6 String Lining Set-Up - See Figure 3-16

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 Track Technologies 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. Lower and lock both the front and rear guide wheel units in the "rail" position. See Operation Section - Placing Vehicle On Track. Set the vehicle wheels straight ahead. Secure the vehicle steering wheel using the steering lock.

3. Establish parallel reference lines on each side of the vehicle as shown in Figure 3-2. 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 must be high enough so the top reference line is through the center of the rear axle. The supports need to be 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 108 inches (2743 mm) apart. The distance between the wires or cords must be equal or within 1/32 inch (.8 mm) 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, so the lower reference line is level with the bottom edge of the rear vehicle wheel rim(s) (point X) and the upper reference line is through the center of the rear axle(s). The reference lines must be level.

5. Shift the supports on the rail until dimension A equals (=) B and dimension C equals (=) D or within 1/16 inch (1.6 mm). Measurements A and B should be taken from the edge of the rear vehicle rim(s) directly below the axle (point X) to the reference lines. Measurements C and D are taken from the front of the vehicle frame. When shifting the supports, keep them at right angles to the rail so the reference lines stay level and parallel to each other.

6. Hold a six (6) foot straight edge against the outer edge of the rear, outside tires with the straight edge centered on the tires. Record dimensions L, L1, M and M1 to the reference line. Rotate the rear tires 180 degrees and record a second set of dimensions at L, L1, M and M1. Average the two dimensions taken at L, L1, M and M1.

   Example: [L (first dimension) + L (second dimension)] ÷ 2 = L (average dimension)

3.1 Guide Wheel Equipment Alignment Procedure

3.1.6 String Lining Set-Up - See Figure 3-16

7. Shift the supports on the rail until dimension L (average) equals (=) M (average) and dimension L1 (average) equals (=) M1 (average) or within 1/8 inch (3.2 mm). When shifting the supports, keep them at right angles to the rail so the reference lines stay level and parallel to each other. The reference lines will be parallel only when the rear axle is straight.

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

3.1.7 Rear Guide Wheel Alignment - See Figures 3-16 and 3-17

1. Take measurements J and K. Measure from the outer edge of the guide wheel, directly below the center line of the wheel spindle, to the reference lines. Check that dimension J equals (=) K or within 1/8 inch (3.2 mm). If not, see Adjustment.

3.1.7.1 Adjustment

a. Unlock and raise the rear guide wheels from the "rail" position. Let the guide wheels rest on the rails.

b. Block or support the rear guide wheel unit.

c. Loosen and remove the eight cap screws (1) that secure the rear guide wheel unit to the mounting brackets. Remove the desired number of 1/16, 1/8 or 1/4 inch thick shims (2) located between the guide wheel unit and the mounting bracket. Install the removed shims on the other side of the vehicle between the guide wheel unit and the mounting bracket. Install and tighten the mounting cap screws (1). Torque the cap screws. See Appendix A - Bolt Torque Charts.

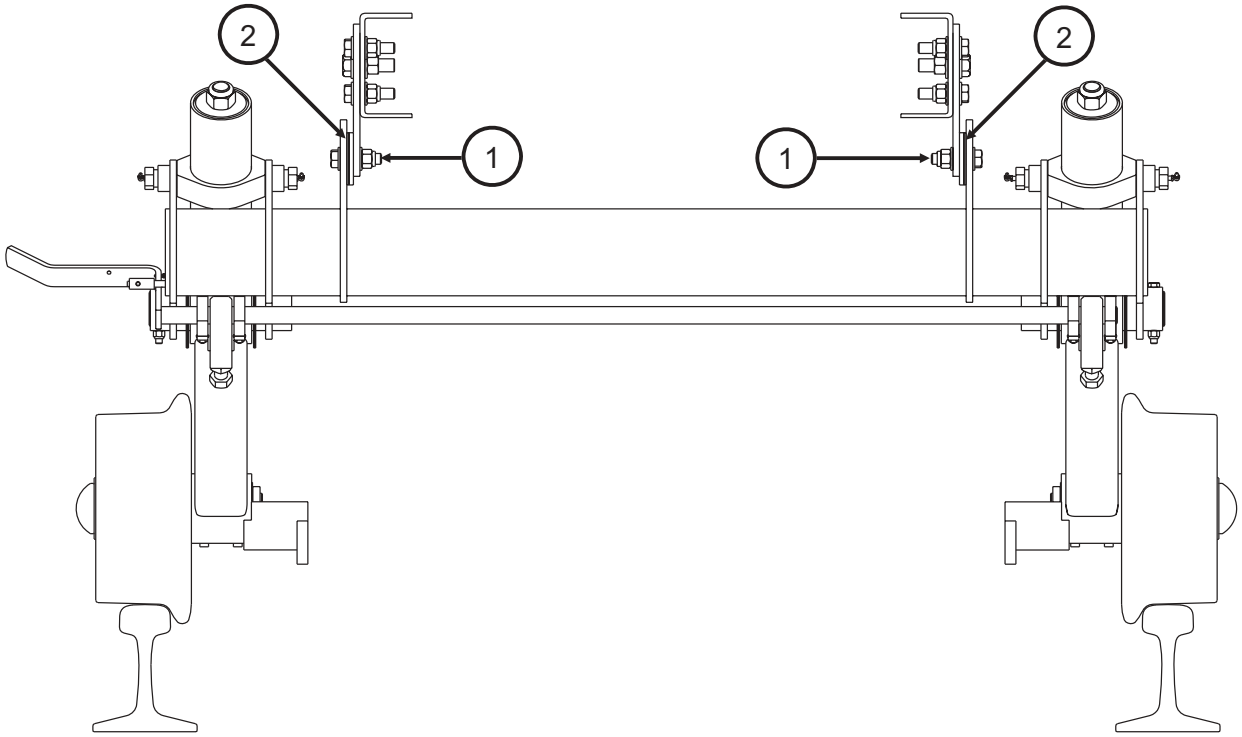
d. Lower and lock the rear guide wheels in the "rail" position.

e. Repeat the adjustment procedure until dimension J equals (=) K or is within 1/8 inch (3.2 mm).

3.1 Guide Wheel Equipment Alignment Procedure

3.1.7 Rear Guide Wheel Alignment

FIGURE 3-17
REAR GUIDE WHEEL ALIGNMENT



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3.1 Guide Wheel Equipment Alignment Procedure

3.1.7 Rear Guide Wheel Alignment - See Figure 3-16 & 3-18

2. Lower and lock both guide wheel units in the "rail" position.

3. Hold a two foot long straight edge against the outer edge of the guide wheel. Check dimensions P and P1, Q and Q1 as shown in Figure 3-10. These dimensions must be equal or within 1/8 inch (3.2 mm). If not see Adjustment.

3.1.7.2 Adjustment

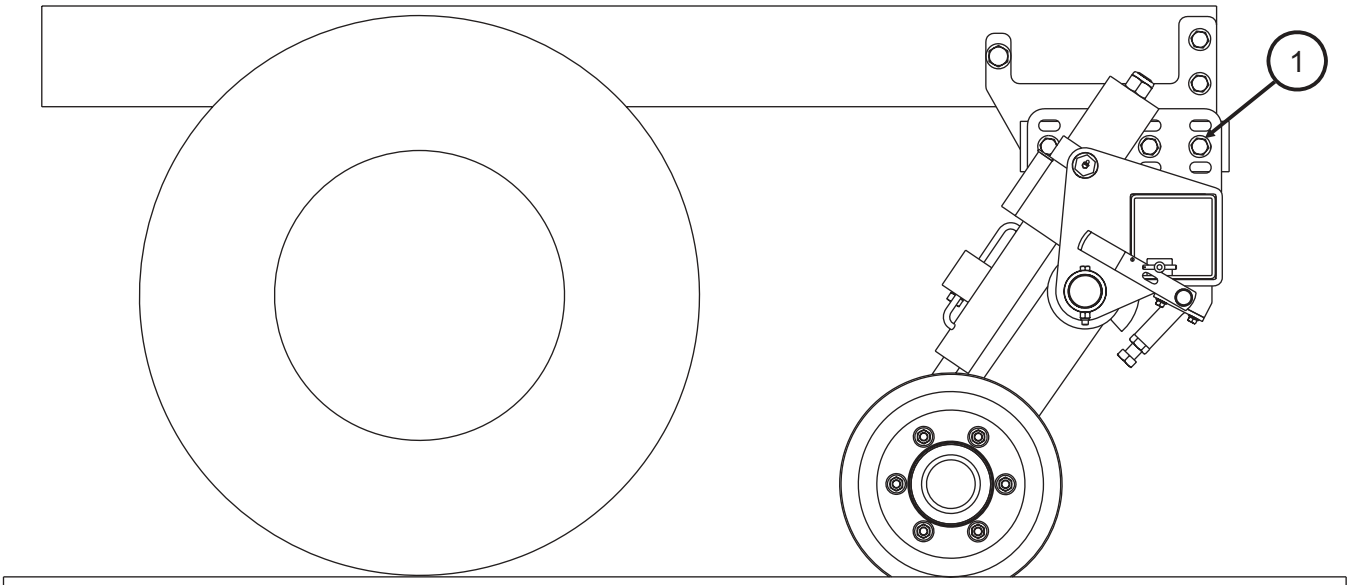
a. Unlock and raise the rear guide wheels from the "rail" position. Let the guide wheels rest on the rails.

b. Block or support the rear guide wheel unit.

c. Loosen the eight cap screws (1) that secure the rear guide wheel unit to the mounting brackets. Shift the guide wheel unit until the dimensions are equal or within 1/8 inch (3.2 mm). Re-tighten and torque the cap screws and nuts (1) to the torque specifications shown in Appendix A - Bolt Torque Charts.

d. Lower and lock the rear guide wheels in the "rail" position. Recheck dimensions P and P1, Q and Q1. Repeat the adjustment procedure until the measurements are equal or within 1/8 inch (3.2 mm).

FIGURE 3-18
REAR GUIDE WHEEL ALIGNMENT



3.1 Guide Wheel Equipment Alignment Procedure

3.1.8 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 Track technologies Tamper 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 both guide wheel units in the "rail" position.

5. Operate the vehicle a minimum of 1/4 mile 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 wore off the right rear guide wheel flange and not off the left rear guide wheel flange, the guide wheel unit is "flanging right".

   a. Unlock and raise the rear guide wheels. Let the guide wheels rest on the rail. Support the guide wheel unit. Loosen the mounting bolts and slightly move the right side of the guide wheel unit forward or the left side of the guide wheel unit slightly rearward. Torque the mounting bolts to the torque specifications shown in Appendix A - Bolt Torque Charts.

   b. Repaint the flanges and treads on all guide wheels. Lower and lock the guide wheel unit in the "rail" Position. Operate the vehicle for a short distance at a normal operating speed. If the paint is worn evenly on all guide wheels, the vehicle and guide wheel equipment is properly aligned.

   c. If the paint continues to wear off the right rear guide wheel flange and not off the left rear guide wheel flange, repeat Steps a. & b. If the vehicle unit continues to track improperly, go to Step 9.

3.1 Guide Wheel Equipment Alignment Procedure

3.1.8 Vehicle Track Test - Continued

8. If the paint wore off the left rear guide wheel flange and not off the right rear guide wheel flange, the guide wheel unit is "flanging left".

    a. Unlock and raise the rear guide wheels. Let the guide wheels rest on the rail. Support the guide wheel unit. Loosen the mounting bolts and slightly move the left side of the guide wheel unit forward or the right side of the guide wheel unit slightly rearward. Torque the mounting bolts to the torque specifications shown in Appendix A - Bolt Torque Charts.

    b. Repaint the flanges and treads on all guide wheels. Lower and lock the guide wheel unit in the "rail" Position. Operate the vehicle for a short distance at a normal operating speed. If the paint is worn evenly on all guide wheels, the vehicle and guide wheel equipment is properly aligned.

    c. If the paint continues to wear off the left rear guide wheel flange and not off the right rear guide wheel flange, repeat Steps a. & b. If the vehicle continues to track improperly, go to Step 9.

9. 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 the right front flange when traveling forward and then off the left rear flange when traveling in reverse or off the left front flange when traveling forward and then off the right rear flange when traveling in reverse, the vehicle is probably not aligned properly. Have the frame checked for proper alignment. See Vehicle Check.

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

3.2 Adjustments

3.2.1 Lock Adjustment - Highway Position - See Figure 3-19

1. Place the vehicle automatic transmission in "Park" or manual transmission in "Neutral". Apply the parking brake.

2. Before adjusting the locking mechanism, make sure the guide wheel unit is fully raised.

3. The locking mechanism must be fully engaged so the "T" lock pin (1) can be inserted to secure the lock lever (2) in the "locked" position. Also, with the lock lever fully engaged, lock bars (3) must be tight against the head of stop bolts (4) on both ends of the guide wheel unit. If not, see Adjustment.

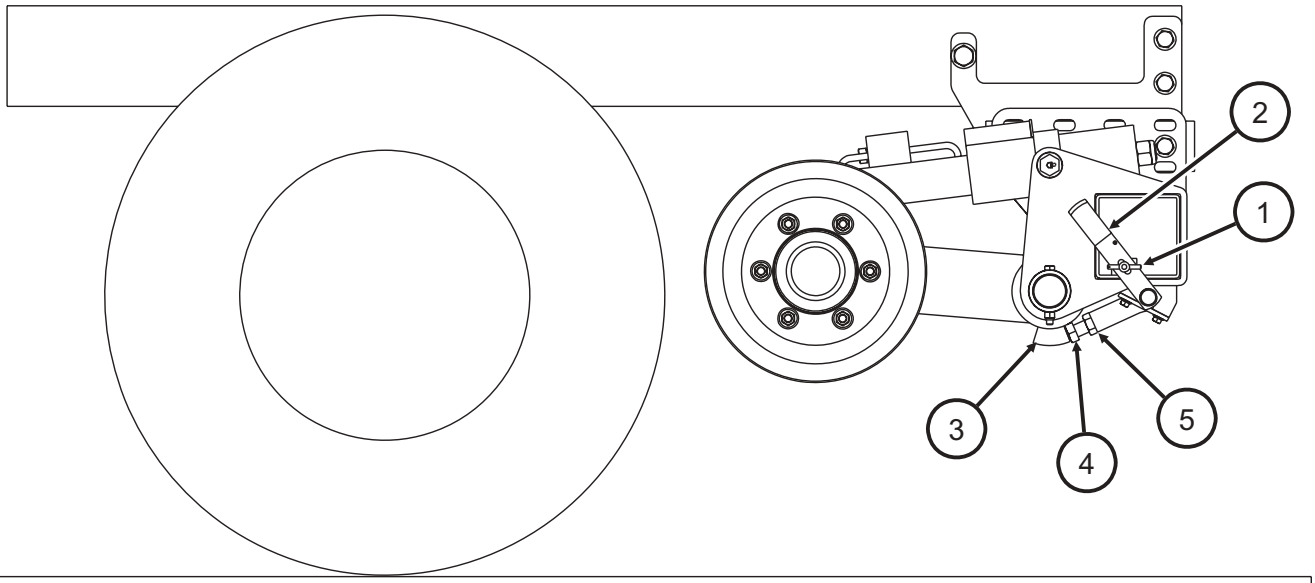
3.2.1.1 Adjustment

1. Determine the approximate amount of adjustment required. Unlock and lower the guide wheel unit from the "highway" position. Let the guide wheels rest on the rails.

2. Loosen lock nuts (5). Adjust both stop bolts (4) so they will be tight against lock bars (3) and the "T" lock pin (1) can also be inserted to secure the lock lever (2) in the "locked" position. Raise and lock the guide wheel unit in the "highway" position.

3. Re-check the lock engagement. If necessary, repeat the adjustment procedure until the lock mechanism is adjusted correctly.

FIGURE 3-19
LOCK ADJUSTMENT - HIGHWAY POSITION



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3.2 Adjustments

3.2.2 Rail Sweep Clearance - See Figure 3-20

1. Place the vehicle on straight, level track. Place the vehicle automatic transmission in "Park" or manual transmission in "Neutral". Apply the parking brake. Lower and lock the front and rear guide wheel units in the "rail" position.

2. The rubber rail sweeps (1) should be adjusted as they become worn. The recommended clearance is approximately 1/4 inch (6.4 mm).

3.2.2.1 Rail Sweep Adjustment

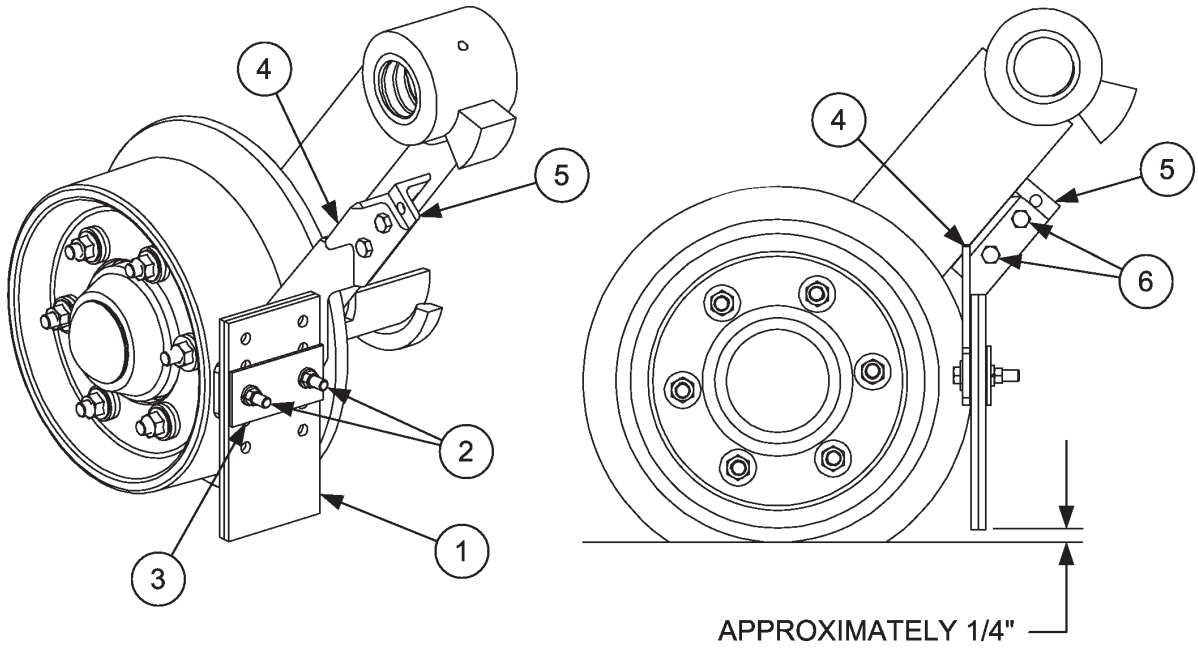
1. Loosen and remove fasteners (2) and plate (3). Move the rail sweeps up or down to a different set of holes in the sweeps. Re-install plate (3) and fasteners (2). Tighten the fasteners securely.

2. Additional adjustment may be achieved by moving rail sweep bracket (4) to a different pair of mounting holes in bracket (5) on the wheel arm. Loosen and remove fasteners (6). Move rail sweep bracket (4) to a different pair of mounting holes in bracket (5). Re-install fasteners (6) and tighten securely.

2. Repeat Steps 1 and 2 to adjust the rail sweep on the other guide wheel.

3. Replace the rubber sweeps when they are worn so they cannot be adjusted.

FIGURE 3-20
RAIL SWEEP ADJUSTMENT



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3.2 Adjustments

3.2.3 Brake Shoe Clearance - See Figure 3-21

The rear guide wheel unit may be equipped with the 186185 Brake Group.

1. Apply the parking brake. Be sure the vehicle air brake system or the optional Electrical / Air Brake Group is at operating pressure to fully release the guide wheel brakes. Move the rail wheel brake control valve to the On position.

2. Measure the clearance between the brake shoe and the guide wheel tread. The clearance must not exceed 1/8 inch (3.2 mm), or adjustment is required. See Adjustment.

3. Repeat Step 2 to check the brake shoe clearance on the other guide wheel brake.

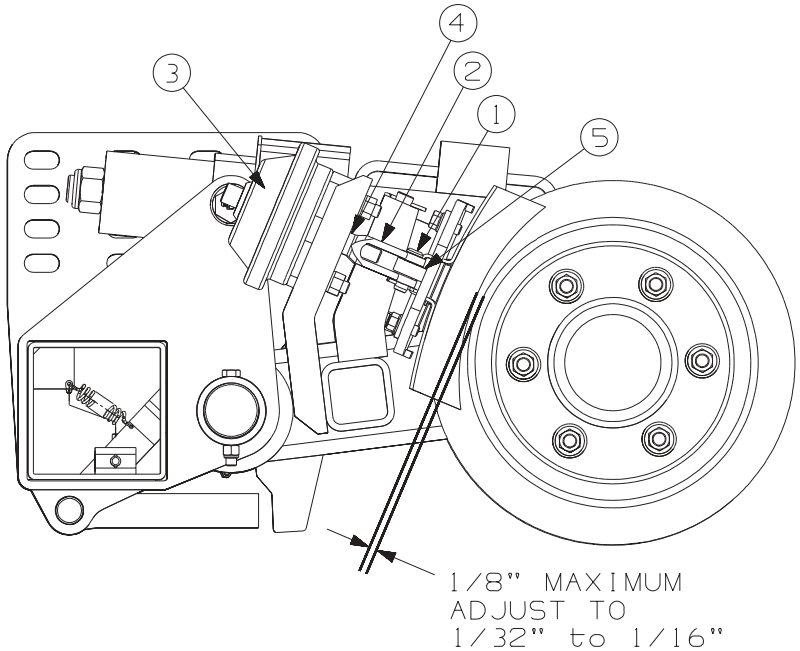
3.2.3.1 Adjustment

1. Remove the cotter pin from the pin (1). Remove the pin (1) from the yoke (2) on the brake actuator (3). Loosen jam nut (4) and turn yoke (2) counter-clockwise to adjust the brake shoe closer to the guide wheel tread or clockwise to adjust the brake shoe away from the guide wheel tread. Adjust so the brake shoe is 1/32 - 1/16 inch (.8 - 1.6 mm) away from the guide wheel tread.

2. Install the pin (1) through the yoke (2) and brake arm (5) and secure using the cotter pin. Tighten jam nut (4) securely. Recheck the brake shoe clearance.

3. Repeat the adjustment procedure to adjust the brake shoe clearance on the other guide wheel brake.

FIGURE 3-21
BRAKE SHOE ADJUSTMENT



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3.2 Adjustments

3.2.4 Brake Air Pressure Regulator Valve - See Figure 3-22

Vehicles that are not equipped with an air brake system from the vehicle manufacturer must be equipped with an auxiliary air system such as Harsco Track Technologies Electric Air Brake System. Any air supply system that is used must have an air regulator valve installed in the air system to regulate the air pressure to the rail guide wheel brakes. Figure 3-8 shows a typical installation of the Brake Air Pressure Regulator Valve in a HTT Electric Air Brake System.

1. Place the vehicle on track. See Section 2 - Placing Vehicle On Track.

2. Apply the vehicle's parking brake. Place the vehicle's automatic transmission in PARK or manual transmission in NEUTRAL. Leave the vehicle's engine operating. Activate the rail guide wheel air brake system by moving the toggle switch to the ON position. Be sure the air brake system is at operating pressure.

3. The vehicle must be at normal operating weight when the brake system air pressure is set. A heavier loaded vehicle will require a higher air pressure setting while a lighter loaded vehicle will require a lower air pressure setting. If the system air pressure is set too high for the load on the vehicle, the guide wheels will lock up and slide on the rail causing flat spots to develop on the guide wheels. Likewise, If the system air pressure is set too low for the load on the vehicle, braking force will be reduced resulting in longer stopping distances.

4. Initially adjust the air regulator valve (1) until 25 PSI (172 kPa) is indicated on the air pressure gauge (2). To adjust the regulator valve, loosen jam nut (3). Turn the adjusting handle (4) clockwise to increase pressure or counter-clockwise to decrease pressure. After this initial adjustment, tighten the jam nut securely.

5. Be sure the test track is clear of all rail traffic before testing the brakes. Follow all railroad rules and regulations. Release the vehicle's parking brakes. Propel the vehicle forward and then apply the vehicle's brakes. The vehicle must stop in the shortest possible stopping distance without the rail guide wheels locking up and sliding on the rail.

   a. If the rail guide wheels lock up and slide on the rail when the vehicle's brakes are applied, adjust the regulator valve to a lower air pressure setting. Repeat Step 4.

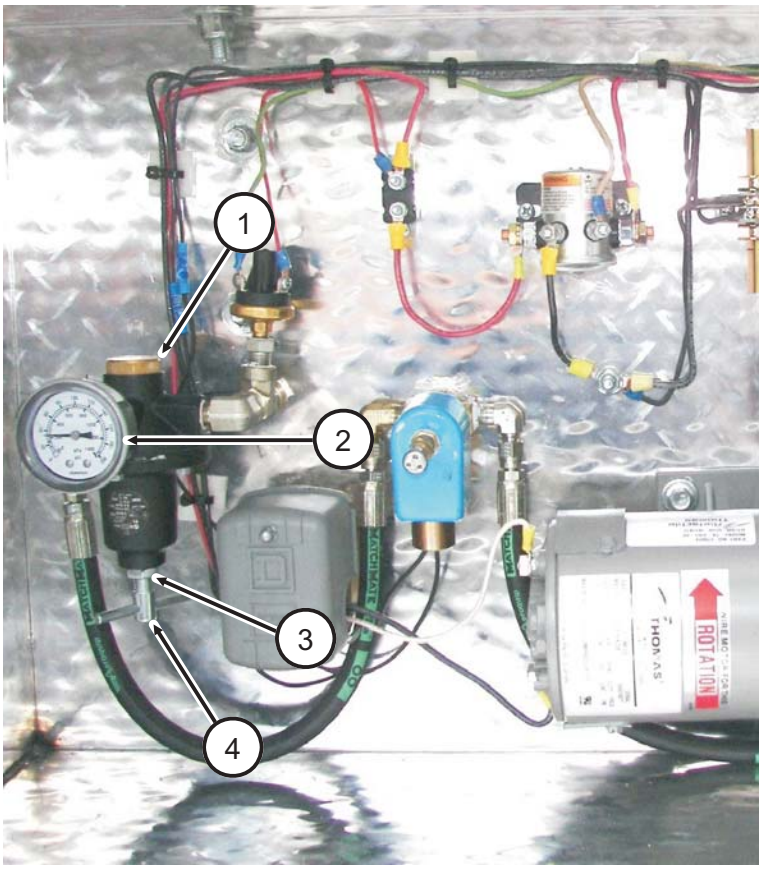
   b. If the rail guide wheels do not stop the vehicle in the shortest possible stopping distance, adjust the regulator valve to a higher air pressure setting. Repeat Step 4.

Note: Many factors will determine the shortest possible stopping distance for a vehicle on track; such as vehicle weight, rear tire tread wear, vehicle speed, single or tandem rear axles, whether the front and/or rear guide wheel units are equipped with guide wheel brakes, rail conditions, etc.

3.2 Adjustments

3.2.4 Brake Air Pressure Regulator Valve

FIGURE 3-22
BRAKE SYSTEM AIR PRESSURE REGULATOR AND GAUGE



3.2 Adjustments

3.2.5 Hydraulic Pressure Adjustment - See Figure 3-23

3.2.5.1 Checking Guide Wheel Unit Control Valve Relief Pressure

Note: Hydraulic pressure settings are preset at the factory and should not be changed unless an operation malfunction indicates an incorrect pressure setting. It is very important that any pressure gauge being used is accurate and sized properly. Hydraulic pressure checks and adjustments must be with the pump at no flow. An incorrectly adjusted pressure setting could cause system damage.

1. Place the vehicle automatic transmission in "Park" or manual transmission in "Neutral". Apply the parking brake.

2. The relief pressure at the rear guide wheel unit control valve must be set at 2200 PSI ± 100 PSI (151.7 bar ± 6.9 bar). The relief pressure is checked at the test port connected to the "IN" port of the control valve.

3. Remove the dust cap from the test port. Attach a pressure gauge to test port (1).

4. Engage the mechanical PTO hydraulic pump or start the auxiliary hydraulic power source. If the vehicle is equipped with an auxiliary control valve, place the valve in the proper position to direct hydraulic oil flow to the guide wheel equipment.

5. Do not release the locking mechanism. Shift the control valve to "bottom" the hydraulic cylinder out against the lock mechanism. Hold the control valve handle in this position to obtain a pressure reading on the pressure gauge.

   a. If the pressure indicated on the pressure gauge is 2200 PSI ± 100 PSI (151.7 bar ± 6.9 bar), the relief pressure is set correctly. Disengage the mechanical PTO hydraulic pump or stop the auxiliary hydraulic power source. If the vehicle is equipped with an auxiliary control valve, place the valve in the proper position to stop hydraulic oil flow to the guide wheel equipment.

   b. If the pressure indicated on the pressure gauge is not 2200 PSI ± 100 PSI (151.7 bar ± 6.9 bar), See Adjustment.

3.2.5.2 Adjustment

1. Remove cap (2) from the control valve to expose the adjusting screw.

2. Do not release the locking mechanism. Shift the control valve to "bottom" the hydraulic cylinder out against the lock mechanism. Hold the control valve handle in this position while adjusting the pressure.

3.2 Adjustments

3.2.5 Hydraulic Pressure Adjustment - See Figure 3-23

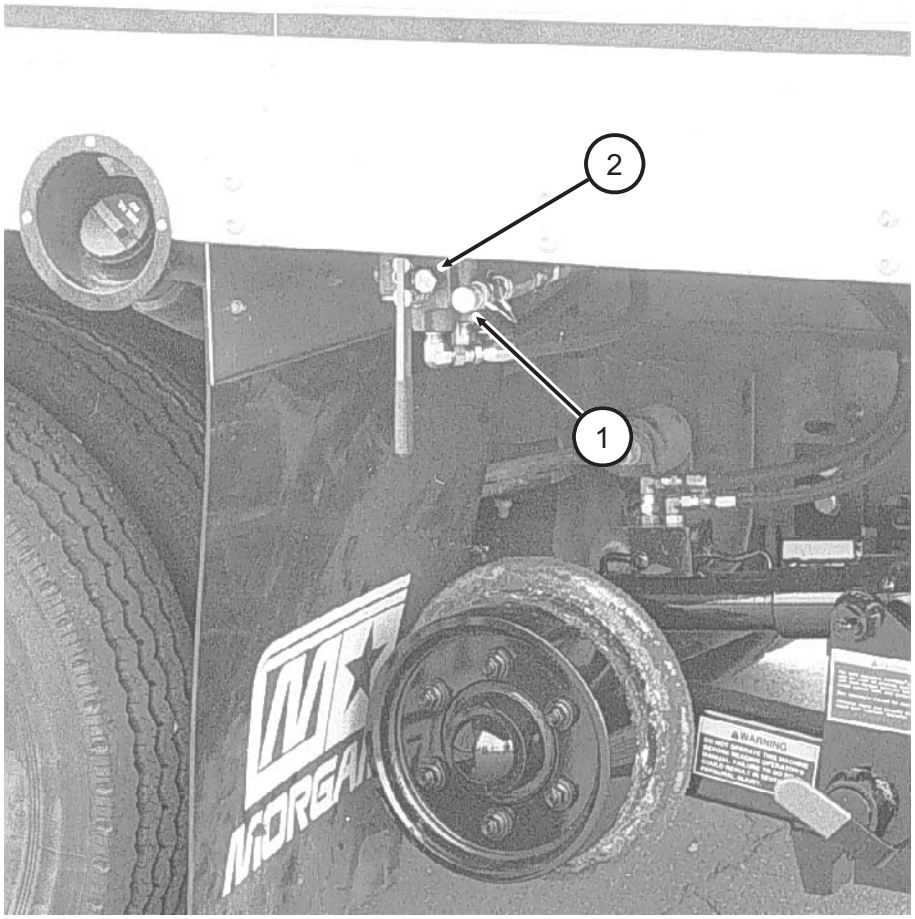
3.2.5.2 Adjustment

3. Turn the adjusting screw clockwise to increase the pressure setting or counter-clockwise to decrease the pressure setting. Stop when the pressure gauge remains steady at 2200 PSI ± 100 PSI (151.7 bar ± 6.9 bar).

4. Disengage the mechanical PTO hydraulic pump or stop the auxiliary hydraulic power source. If the vehicle is equipped with an auxiliary control valve, place the valve in the proper position to stop hydraulic oil flow to the guide wheel equipment.

5. Install cap (2) on the control valve. Remove the pressure gauge from the test port. Install the dust cap on the test port.

FIGURE 3-23
HYDRAULIC PRESSURE ADJUSTMENT



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NOTES

SECTION 4 - MAINTENANCE
TABLE OF CONTENTS

4.1 Maintenance Schedule

■ **RE-TORQUE VEHICLE WHEEL LUG NUTS AND GUIDE WHEEL LUG NUTS AFTER THE FIRST 50 MILES OF OPERATION. THEREAFTER TORQUE WHEEL LUG NUTS ACCORDING TO VEHICLE MANUFACTURER'S WHEEL TORQUE SPECIFICATIONS. FAILURE TO COMPLY COULD RESULT IN SEVERE BODILY INJURY.**

4.1.1 Daily:

1. Inspect the front and rear guide wheel units for damaged, worn or missing parts.

2. Check the mechanical locks and lock pins for ease of operation.

3. The lock pins should never be able to be pulled out unless the button on the "T" end of the pin is pushed in. The button in the lock pin must push in easily and also pop out when released. The locking balls in the end of the pin must work freely so the pin cannot be removed until the button in the lock pin is depressed. If the lock pin does not operate properly, replace the lock pin.

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

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

4.1.2 Weekly:

1. Check the guide wheel equipment alignment. See Adjustment Section - Vehicle Track Test.

2. Inspect the 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. If the guide wheel does not rotate easily, the guide wheel bearings may be lacking lubrication or may be damaged. Inspect, re-pack or replace the bearings if necessary.

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

5. Check the vehicle tires for correct inflation pressure. Operate at the tire manufacturer's recommended maximum pressure printed on the sidewalls of the tires, or the wheel manufacturer's recommended maximum pressure stamped on the wheel, whichever is lower.

6. Check all bolts for tightness. See Appendix A - Fastener Torque Charts.

4.1 Maintenance Schedule

4.1.3 At 2000 Track Miles (3200 km):

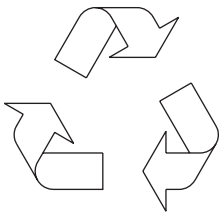
Lubricate the guide wheel unit locations provided with grease fittings. See Guide Wheel Equipment Lubrication.

4.1.4 At 10,000 Track Miles (16000 km):

Re-pack and adjust the guide wheel bearings. See Guide Wheel Equipment Lubrication - Re-packing Guide Wheel Bearings.

Note: The HR2000B3-2 Guide Wheel Unit is equipped with an integral spindle. The bearings in the integral spindle can not be re-packed.

4.2 Waste Disposal



Dispose of waste properly. Improper disposal of waste can threaten the environment. The operation and maintenance of Harsco Track Technologies equipment may involve the use and disposal 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.

4.3 Guide Wheel Equipment Lubrication

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

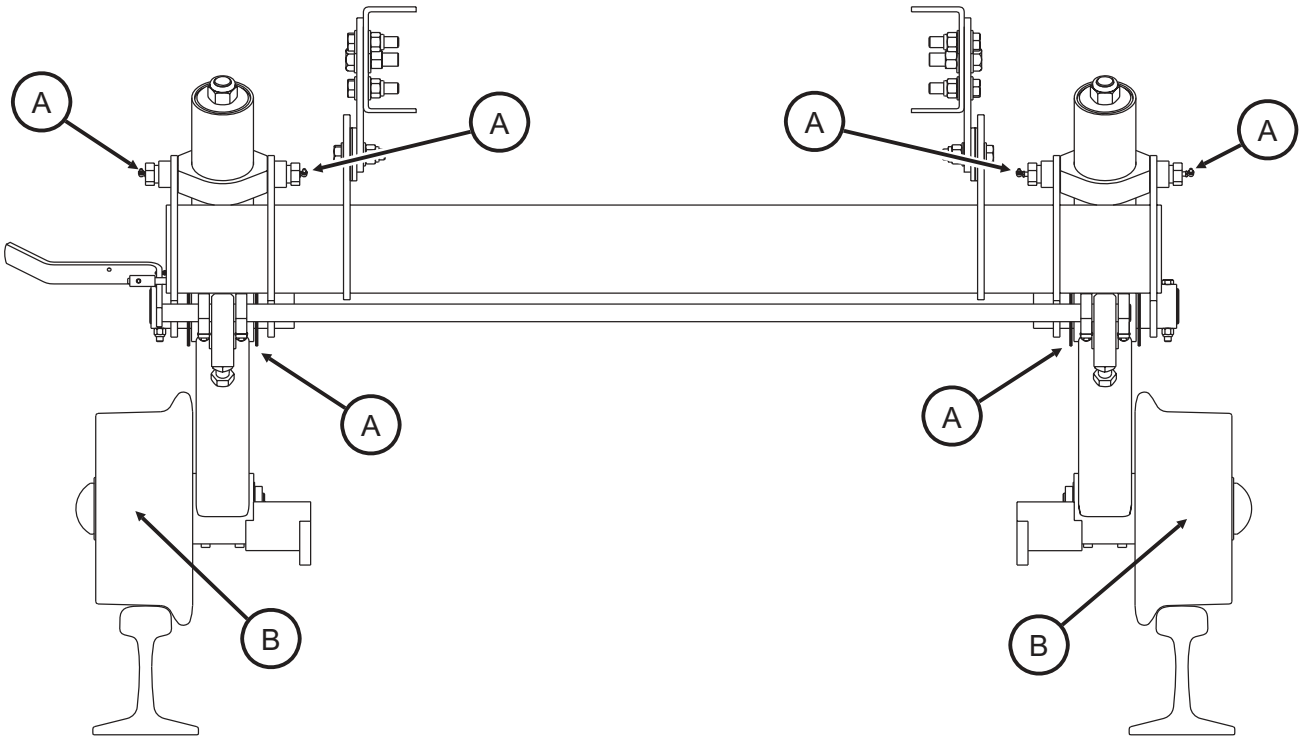
4.3.1 Rear Guide Wheel Unit Lubrication - See Figure 4-1

1. Apply the vehicle parking brake. Stop the vehicle engine. Shut off the vehicle ignition switch.

2. Lubricate grease fittings (A), four cylinder pivots and two wheel arm pivots, using Mobil Special Moly, or equivalent. The guide wheel unit may also be equipped with guide wheel brakes. Lubricate grease fittings on the brake pivot arms.

3. Re-pack the guide wheel bearings (B) every 10,000 track miles (maximum) or at least once every two years (minimum), whichever occurs first. See Maintenance - Lubrication, Re-Packing Guide Wheel Bearings.

FIGURE 4-1
REAR GUIDE WHEEL UNIT LUBRICATION



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4.3 Guide Wheel Equipment Lubrication

4.3.2 Re-Packing Guide Wheel Bearings - See Figure 4-2

Re-pack the guide wheel bearings every 10,000 track miles (maximum) or at least once yearly (minimum), whichever occurs first.

1. Apply the vehicle parking / emergency brake. Raise and lock the front and rear guide wheel units in the "highway" position. Stop the vehicle engine. Shut off the vehicle ignition switch.

2. Remove the hub cap (1). Remove the 1/8 x 1-1/4 inch cotter pin (2), 1 inch castle nut (3) and spindle washer (4).

3. Pull the guide wheel (5) from the spindle (6). Remove the outer bearing cone (7) from the guide wheel (5). Remove the grease seal (11) and inner bearing cone (9) from the guide wheel (5).

4. Clean all components of old grease and dirt.

5. Inspect the spindle, bearing cones and cups (7 & 8, 9 & 10) for nicks, gouges and wear. If any of these are evident, replace the component.

6. Measure the guide wheel wear. See Maintenance - Guide Wheels, Allowable Wear.

7. Coat the spindle surface, grease seal surface, both bearing cup surfaces, pack both bearing cones and fill the guide wheel cavity 1/2 full (50 %) using Mobil HP grease, or equivalent.

8. Install the inner bearing cone (9) into the guide wheel (5). Install a new grease seal (11) into the wheel.

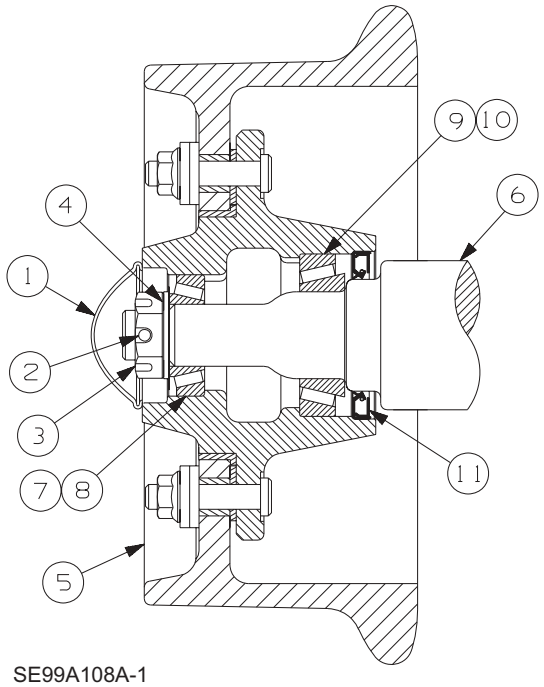
9. Slide the guide wheel (5) with the inner bearing (9) and grease seal (11) onto the spindle (6). Install the outer bearing cone (7), spindle washer (4) and 1 inch castle nut (3) onto the spindle (6).

10. Torque the castle nut (3) to approximately 20 ft lbs. Then loosen the castle nut. This is especially important if new bearing cups have been installed.

11. Re-torque the castle nut (3) to 7 ft lbs (zero clearance). Then back the castle nut off 1/2 to 1 flat of the nut (0.001 - 0.010 inch clearance). Secure the castle nut using a new cotter pin (2).

12. Install the hub cap (1) onto the guide wheel.

FIGURE 4-2
RE-PACKING GUIDE WHEEL BEARINGS



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4.4 Guide Wheels

Revised 10-2007

4.4.1 Allowable Wear - HR2000B Standard Wheel - See Figure 4-3

■ **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 Track Technologies 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 1/2 inch (12.7 mm).

   If the guide wheel flange dimension is less than the allowable limit, replace the guide wheel immediately.

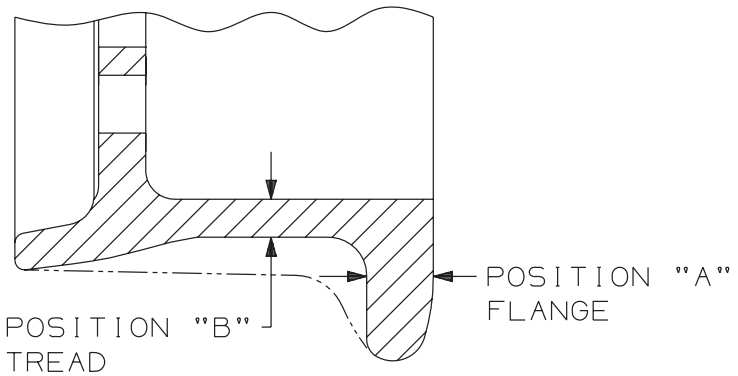
4

3. Measure the guide wheel tread at Position "B" with the wheel caliper. The minimum allowable tread dimension at Position "B" is 5/16 inch (8 mm).

   If the guide wheel tread dimension is less than the allowable limit, replace the guide wheel immediately.

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

FIGURE 4-3
ALLOWABLE GUIDE WHEEL WEAR



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4.4 Guide Wheels

4.4.2 Allowable Wear - HR2000B3-2 Wheels Only

4.4.2.1 198690 Steel Guide Wheel - See Figure 4-4

■ **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.**

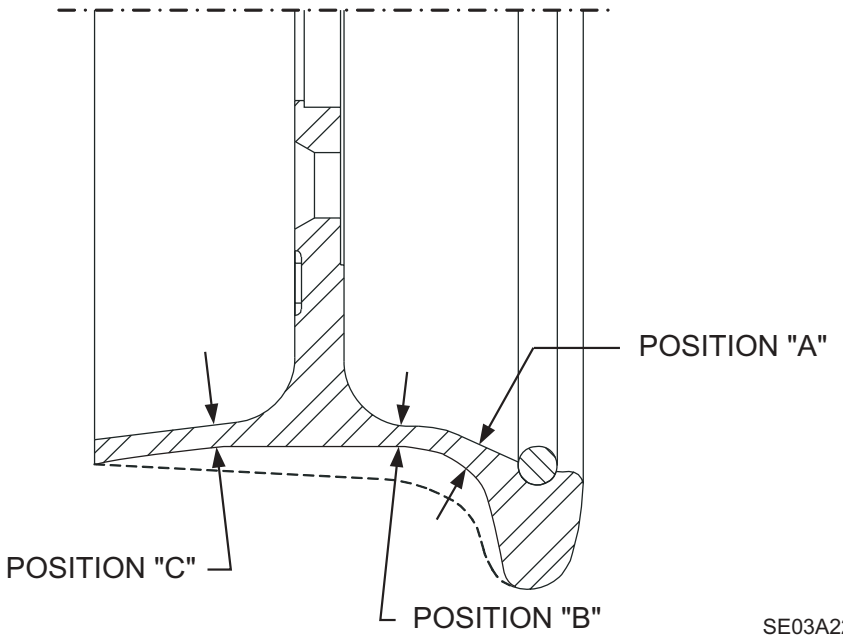
1. Tools needed: Harsco Track Technologies wheel caliper (M019889), or equivalent.

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 4-4
ALLOWABLE WEAR - 198690 STEEL GUIDE WHEEL



4.4 Guide Wheels

4.4.2 Allowable Wear - HR2000B3-2 Wheels Only

4.4.2.2 198510 Rubber Tread Guide Wheel - See Figure 4-5

■ **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 Track Technologies wheel caliper (M019889), or equivalent.

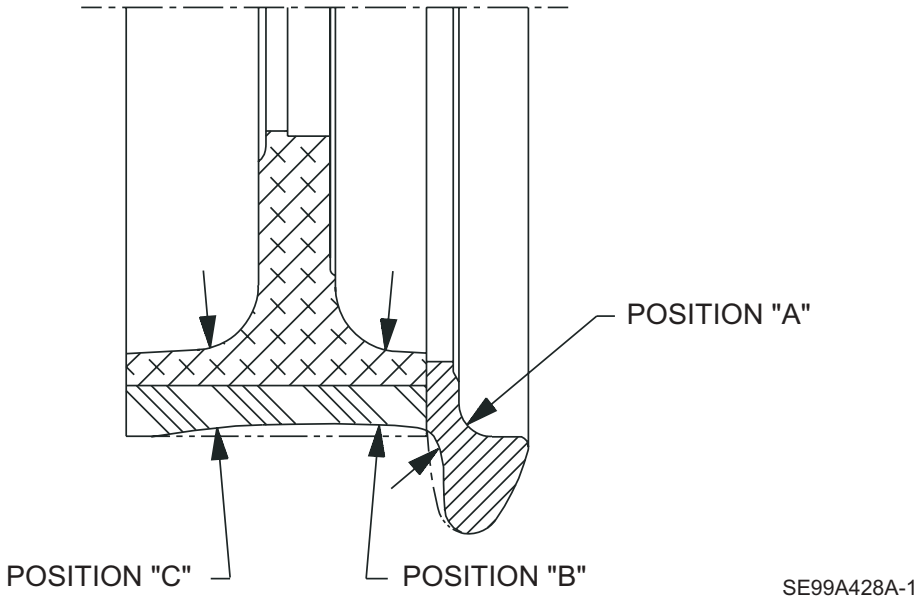
2. Measure the guide wheel flange at position "A" with the wheel caliper. The minimum allowable flange dimension at Position "A" is 1/4 inch (6.4 mm). If the guide wheel flange dimension is less than the allowable limit, replace the wheel immediately.

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 4-5
ALLOWABLE WEAR - 198510 ALUMINUM GUIDE WHEEL WITH RUBBER TREAD



4.5 Vehicle Wheels

4.5.1 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 the vehicle manufacturer. Using tires of equal diameter will help keep the speedometer reading and the guide wheel load accurate. Tires must have a minimum 6-1/2 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 the tire manufacturer's recommended maximum pressure printed on the sidewalls of the tires or the wheel manufacturer's recommended maximum pressure stamped on the wheel, whichever is lower. 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 manufacturer's recommended 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

■ 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 4-6

All Harsco Track Technologies original and replacement hose assemblies supplied for this equipment from Harsco Track Technologies, Fairmont Minnesota plant facility, have a hose band displaying the date of manufacture and the Harsco Track Technologies part number. The hose assembly illustrated in the example was manufactured in March 2007 and is Harsco Track Technologies part number 188662.

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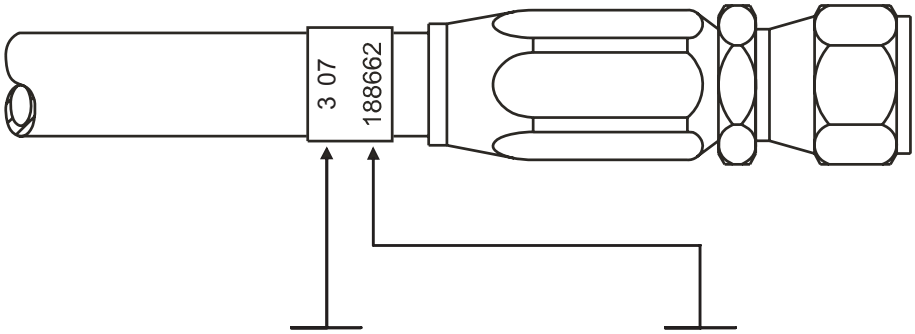
FIGURE 4-6
HOSE BAND



3 MONTH
JANUARY = 1
FEBRUARY = 2
MARCH = 3
APRIL = 4
MAY = 5
JUNE = 6
JULY = 7
AUGUST = 8
SEPTEMBER = 9
OCTOBER = 0
NOVEMBER = N
DECEMBER = D

07 YEAR LAST TWO DIGITS OF THE YEAR OF MANUFACTURE

188662 HARSCO TRACK TECHNOLOGIES PART NUMBER

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SECTION 5 - TROUBLESHOOTING
TABLE OF CONTENTS

5.1 Troubleshooting Guide Wheel Equipment

PROBLEM	PROBABLE CAUSE	POSSIBLE REMEDY
Hydraulic pump not delivering oil.	Mechanical PTO not engaged or control valve not shifted to direct oil flow to guide wheel equipment.	Engage mechanical PTO. Shift control valve to direct oil flow to guide wheel equipment.
	Hydraulic reservoir oil level low.	Fill reservoir to full level with recommended hydraulic oil.
	Oil restricted to pump intake.	Check all strainers and filters for dirt and sludge. Clean and replace if necessary.
	Components bent, broken, worn, etc.	Replace components.
Guide wheel unit does not lower.	Lock not disengaged.	Disengage lock. See Operation - Placing Vehicle On Track.
	Hydraulic pump not operating.	Start 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 guide wheel unit. See Maintenance - Guide Wheel Equipment 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 Adjustments - Guide Wheel Equipment Alignment Procedure.
	Components bent, broken, worn, etc.	Replace components.
	Lack of lubrication.	Lubricate guide wheel unit. See Maintenance - Guide Wheel Equipment Lubrication.

5.1 Troubleshooting Guide Wheel Equipment

PROBLEM	PROBABLE CAUSE	POSSIBLE REMEDY
Guide wheels do not stay locked in the "rail" position.	Check valve on hydraulic cylinder inoperative.	Repair or replace hydraulic cylinder.
	Control valve inoperative.	Repair or replace control valve.
Vehicle pulls noticeably to the left or right when on track.	Vehicle loaded heavy on one side.	Move load to center of vehicle.
	Guide wheel units, vehicle rear axle(s), etc. not aligned with vehicle frame.	Check alignment. See Adjustments - Guide Wheel Equipment Alignment Procedure.
	Incorrect or worn vehicle rear tire.	Check for correct rear tire. Replace if necessary. Replace worn rear tire.
	Vehicle rear tires under inflated.	Check pressure. Inflate if low. Do not exceed tire manufacturer's recommended maximum pressure printed on the sidewalls, or wheel manufacturer's recommended maximum pressure stamped on the wheel, whichever is lower.
	Guide wheel brake shoes dragging.	Re-adjust brake shoes. See Adjustments - Brakes Shoe Clearance.
Vehicle derails.	Guide wheel units, vehicle rear axle(s), etc. not aligned with vehicle frame.	Check alignment. See Adjustments - Guide Wheel Equipment Alignment Procedure.

5.1 Troubleshooting Guide Wheel Equipment

PROBLEM	PROBABLE CAUSE	POSSIBLE REMEDY
Vehicle load on rear spring cells exceed rear guide wheel unit maximum rated load.	Vehicle overloaded.	Redistribute or remove some of the load.
	Vehicle rear tires under inflated.	Check pressure. Inflate if low. Do not exceed tire manufacturer's recommended maximum pressure printed on the sidewalls, or wheel manufacturer's recommended maximum pressure stamped on the wheel, whichever is lower.
	Vehicle rear spring broken.	Repair or replace spring.
	On vehicles equipped with 19.5 inch wheels and tires, rear guide wheel unit not initially set to carry approximately 50% of vehicle rear axle curb weight.	Re-adjust. See Adjustments - Guide Wheel Equipment Alignment Procedure.
	On vehicles equipped with 22.5 inch wheels and tires, rear guide wheel unit not initially set to carry approximately 40% of vehicle rear axle curb weight.	Re-adjust. See Adjustments - Guide Wheel Equipment Alignment Procedure.
Vibration felt in the vehicle when traveling on track.	Guide wheel units mounting fasteners loose.	Tighten all bolts to recommended torque.
	Guide wheel bearings worn.	Replace bearings, wheel or axle.
	Guide wheels worn.	Check guide wheel wear. See Maintenance - Guide Wheels, Allowable Wear.
	Vehicle rear rim bent.	Replace rim.
	Vehicle rear tires out of balance.	Balance tires.

5.1 Troubleshooting Guide Wheel Equipment

PROBLEM	PROBABLE CAUSE	POSSIBLE REMEDY
Vibration felt in the vehicle when traveling on highway.	Guide wheel units mounting fasteners loose.	Tighten all bolts to recommended torque.
	Guide wheel units not locked in "highway" position.	STOP IMMEDIATELY. Make sure both guide wheel units are locked in "highway" position.
	Vehicle rim bent.	Replace rim.
	Vehicle tires out of balance.	Balance tires.

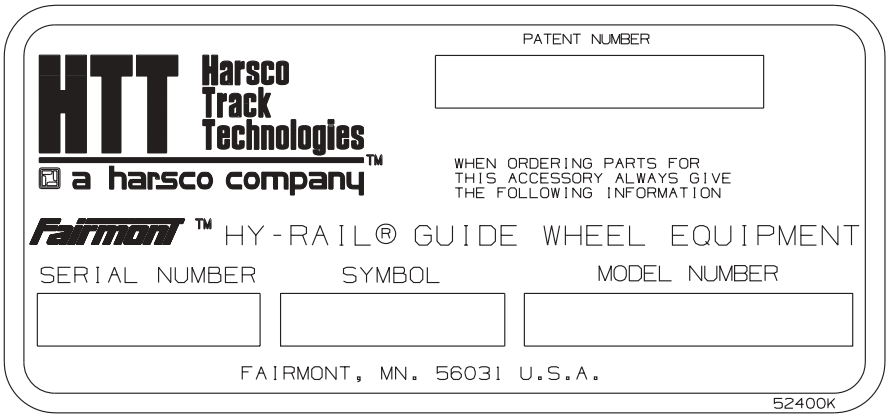
NOTES

SECTION 6 - PARTS
TABLE OF CONTENTS

Serial Numbers

When this bulletin is received, fill in the spaces provided below using the information from the serial number tag on the front rail pilot unit. Always provide these factory serial numbers when calling or writing about the unit. The serial number tag is located on the mounting frame on the unit.

REAR GUIDE WHEEL UNIT SERIAL NUMBER



Instructions For Ordering Parts

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

6

Assemblies: When assemblies can be used, always order them to save work of fitting separate parts.

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

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

1. Quantity of each part wanted.
2. Part number of each part as shown in this book. Include any prefix and suffix letters.
3. Description of each part as shown in this book.
4. Factory serial numbers from the serial number tag on the guide wheel unit.
5. Purchase order number (if required).
6. Preferred method of shipment.

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

Limited Warranty

HARSCO TRACK TECHNOLOGIES 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 Track Technologies 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 Track Technologies 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 Track Technologies will not be liable for other loss, damage, or expense directly or indirectly arising from the use of its product, nor will Harsco Track Technologies 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 Track Technologies 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 Track Technologies, but which are furnished in connection with Harsco Track Technologies products, are covered directly by the warranty of the manufacturer supplying them. However, Harsco Track Technologies will assist in obtaining adjustment on such equipment or parts when necessary.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE HEREBY DISCLAIMED AND OF ANY OTHER OBLIGATION OR LIABILITY OF HARSCO TRACK TECHNOLOGIES. THE REMEDY SET FORTH ABOVE IS BUYER'S EXCLUSIVE REMEDY FOR A BREACH OF THE WARRANTY. UNDER NO CIRCUMSTANCES WILL HARSCO TRACK TECHNOLOGIES BE RESPONSIBLE FOR INCIDENTAL, CONSEQUENTIAL, SPECIAL OR OTHER INDIRECT DAMAGES.

Indemnity

Buyer agrees to indemnify and hold Harsco Track Technologies 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 Track Technologies' products.

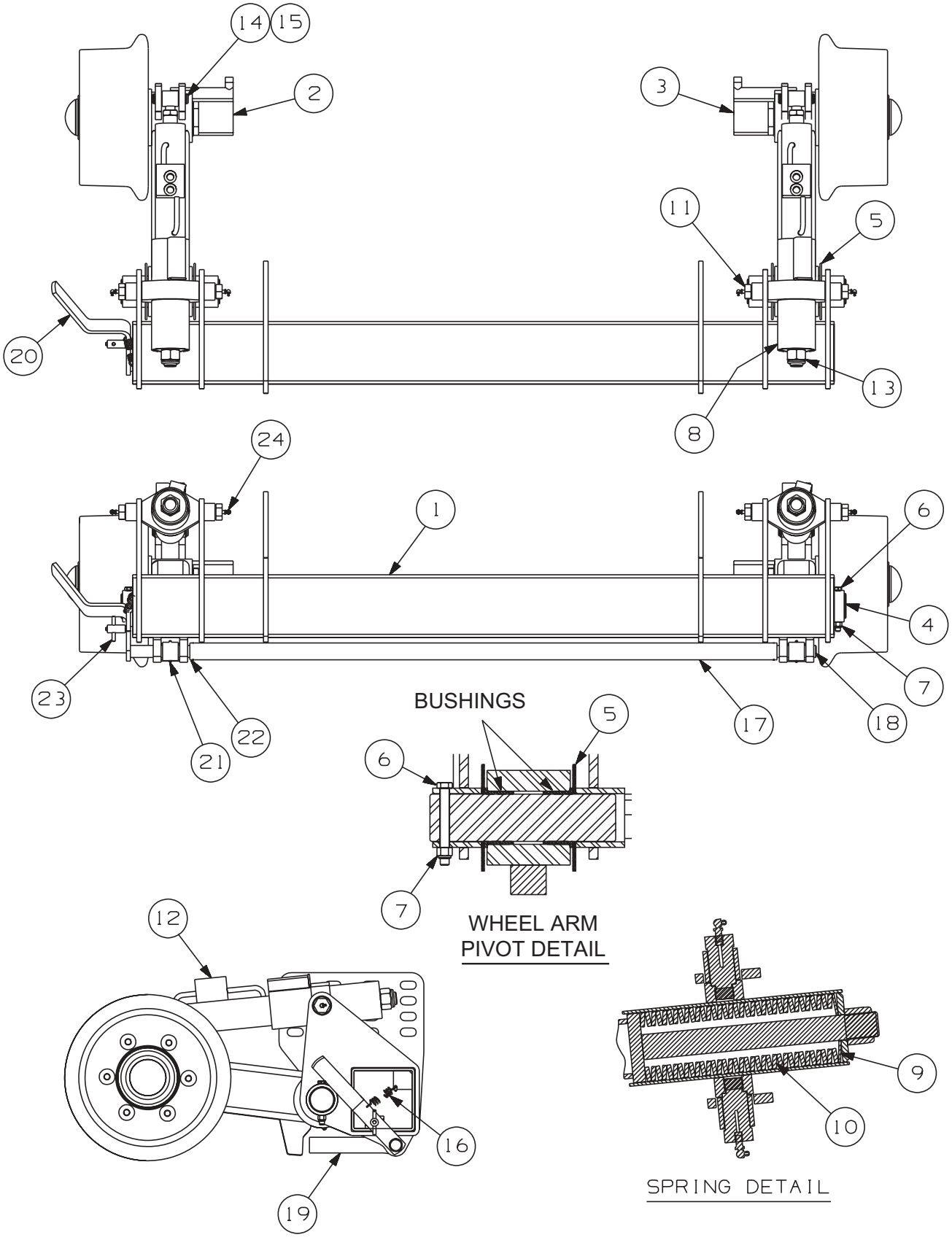
Product Improvement Liability Disclaimer

Harsco Track Technologies 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 Material Safety Data Sheets (MSDS) 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. MSDS sheets for such materials will be supplied to your Purchasing Manager/Safety Director to be used in your employee safety training education and environmental health training.

HR2000B1 GUIDE WHEEL UNIT - 179114

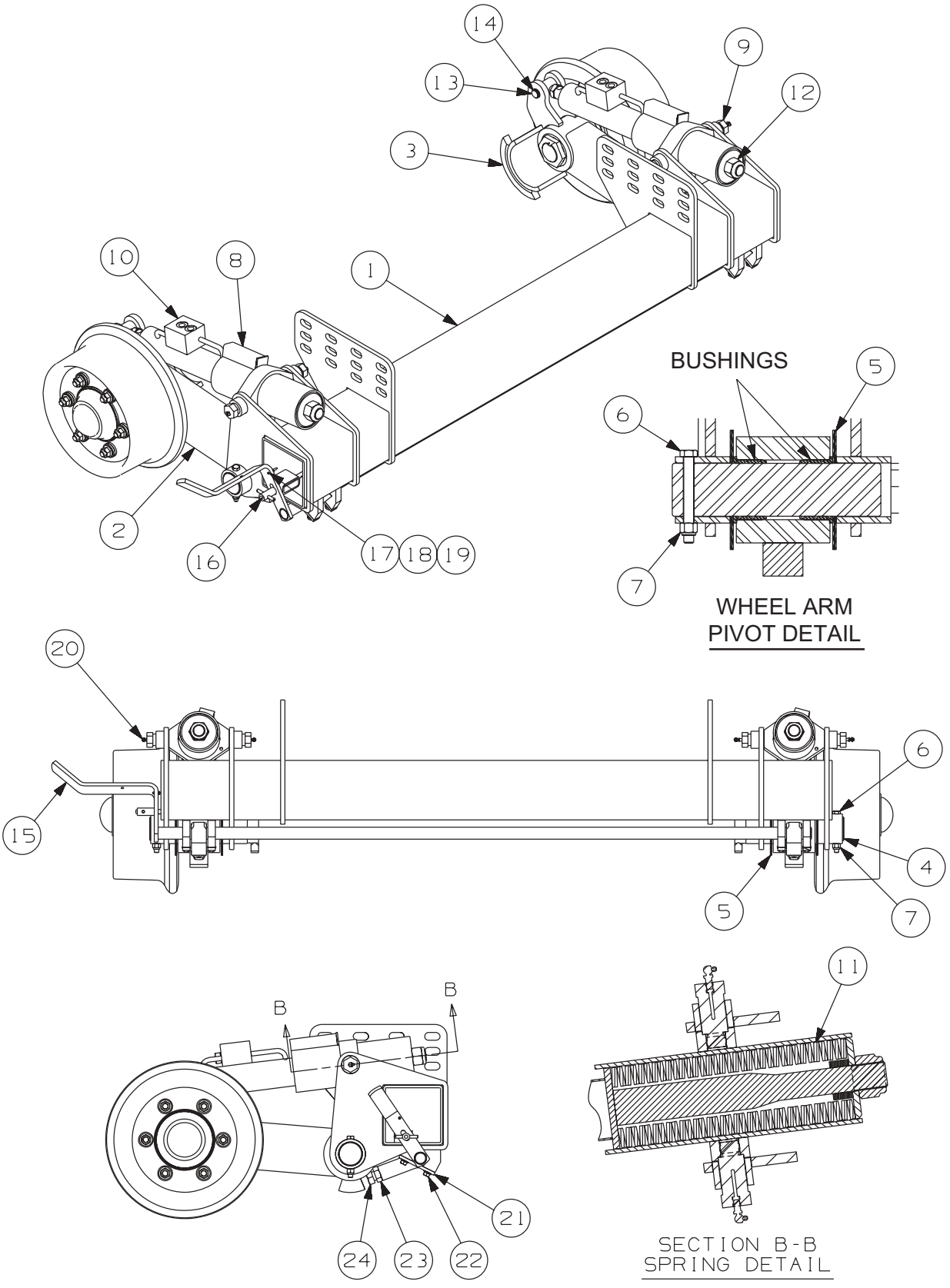


SE179114A-1

HR2000B1 GUIDE WHEEL UNIT - 179114

ITEM	PART NO	DESCRIPTION	QTY
1	176718	Frame	1
2	181546	WHEEL ARM ASSEMBLY, LEFT	1
	176697	Wheel Arm	1
	176680	Axle	1
	180029	Bushing	2
	077735	Nut	1
	F007820K	Lock Washer	1
	F023270	Hex Slotted Nut, 1"	1
	F001182	Cotter Pin, 1/8 x 1-1/4"	1
3	181547	WHEEL ARM ASSEMBLY, RIGHT	1
	176701	Wheel Arm	1
	176680	Axle	1
	180029	Bushing	2
	077735	Nut	1
	F007820K	Lock Washer	1
	F023270	Hex Slotted Nut, 1"	1
	F001182	Cotter Pin, 1/8 x 1-1/4"	1
4	176715	Pin	2
5	187213	Washer (2 on each side of wheel arm)	8
6	F002915	Cap Screw, 3/8-16 x 3-1/4" GR 5 Hex Hd	2
7	F015922	Elastic Stop Nut, 3/8"-16	2
8	178217	Spring Cell	2
9	180032	Disc Spring, 1 Per Cell	2
10	180033	Disc Spring, 35 Per Cell	70
11	180030	Trunnion	4
12	186135	HYDRAULIC CYLINDER	2
	188641	Seal Kit	1
13	F012232K	Hex Lock Nut, 1"-14	2
14	180050	Pin	2
15	F011054	Snap Ring	4
16	072909	Spring	1
17	179112	Tube	1
18	179111	Pin	1
19	179105	Bar	2
20	177958	Handle	1
21	F012413	Spring Pin, 3/16 x 1-3/4"	2
22	F022008	Roll Pin, 3/16 x 1-3/8"	2
23	F022104	Lock Pin & Lanyard	1
24	F010722	Grease Fitting, 90°	6

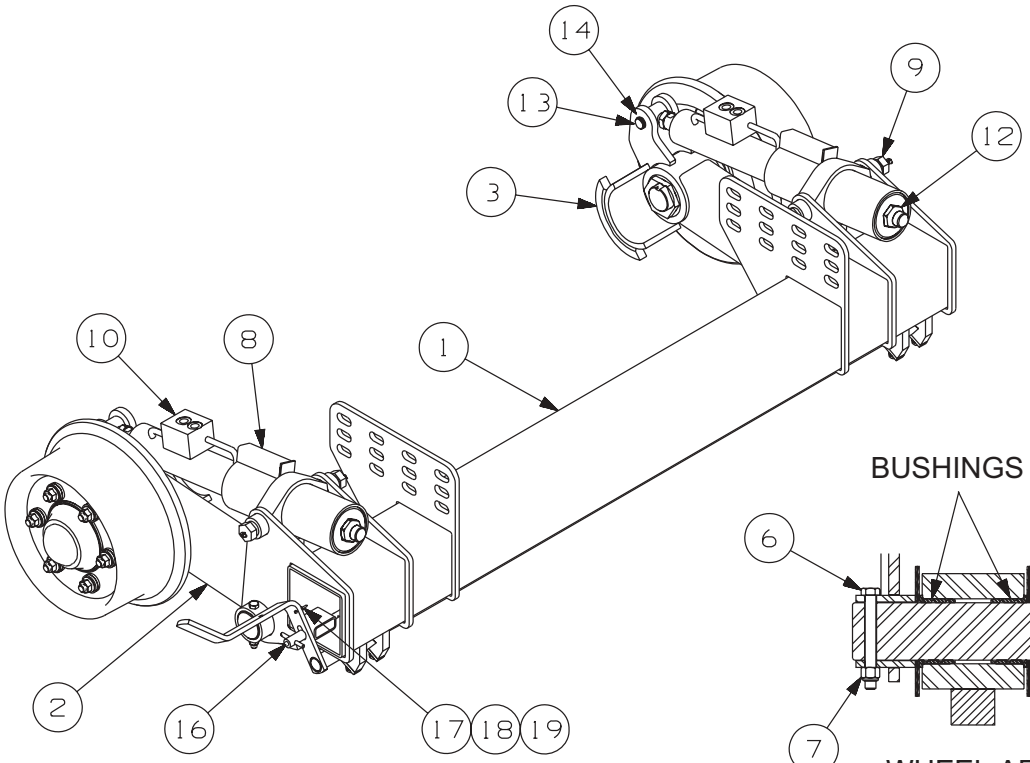
HR2000B2 GUIDE WHEEL UNIT - 186133

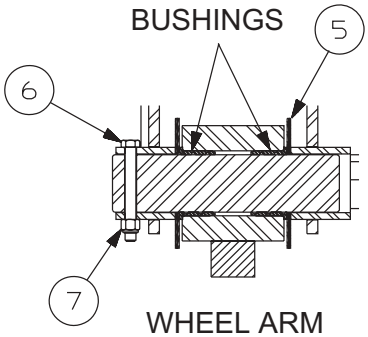


HR2000B2 GUIDE WHEEL UNIT - 186133

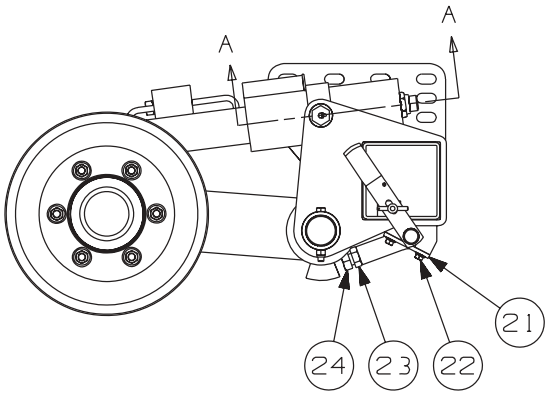
ITEM	PART NO	DESCRIPTION	QTY
1	186127	Frame	1
2	186218	WHEEL ARM ASSEMBLY, LEFT	1
	186217	Wheel Arm	1
	180029	Bushing	2
	176680	Axle	1
	077735	Nut	1
	F007820K	Lock Washer	1
	F023270	Hex Slotted Nut, 1"	1
	F001182	Cotter Pin, 1/8 x 1-1/4"	1
3	186219	WHEEL ARM ASSEMBLY, RIGHT	1
	186220	Wheel Arm	1
	180029	Bushing	2
	176680	Axle	1
	077735	Nut	1
	F007820K	Lock Washer	1
	F023270	Hex Slotted Nut, 1"	1
	F001182	Cotter Pin, 1/8 x 1-1/4"	1
4	176715	Pin	2
5	187213	Washer (2 on each side of wheel arm)	8
6	F002915	Cap Screw, 3/8-16 x 3-1/4" Hex Hd	2
7	F015922	Elastic Stop Nut, 3/8"-16	2
8	186272	Spring Cell	2
9	180030	Trunnion	4
10	186135	HYDRAULIC CYLINDER	2
	188360	Check Valve	1
	188641	Seal Kit	1
	198729	Clevis	1
11	196431	Disc Spring (35 per spring cell)	70
12	F012232K	Hex Lock Nut, 1"-14	2
13	180050	Pin	2
14	F011054	Retaining Ring	4
15	186224	Handle	1
16	F022104	Lock Pin And Lanyard	1
17	F017061	Machine Screw, #4-40 x 1" Rd Hd	1
18	F010193	Hex Nut, #4-40	1
19	F022981	Lock Washer, #4	1
20	F010722	Grease Fitting	6
21	186222	Plate	4
22	F022070	Cap Screw, 5/16-18 x 1" Hex Flg Hd	8
23	F010972	Hex Jam Nut, 3/4"-16	2
24	F040059	Cap Screw, 3/4-16 x 2" Hex Hd	2

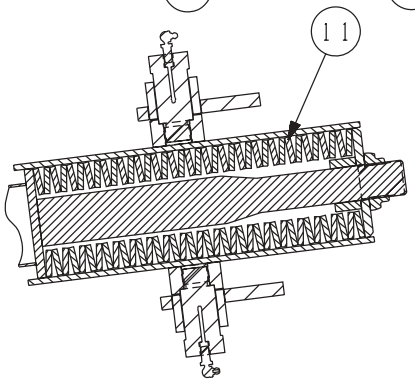
HR2000B2-1 GUIDE WHEEL UNIT - 187271





WHEEL ARM
PIVOT DETAIL



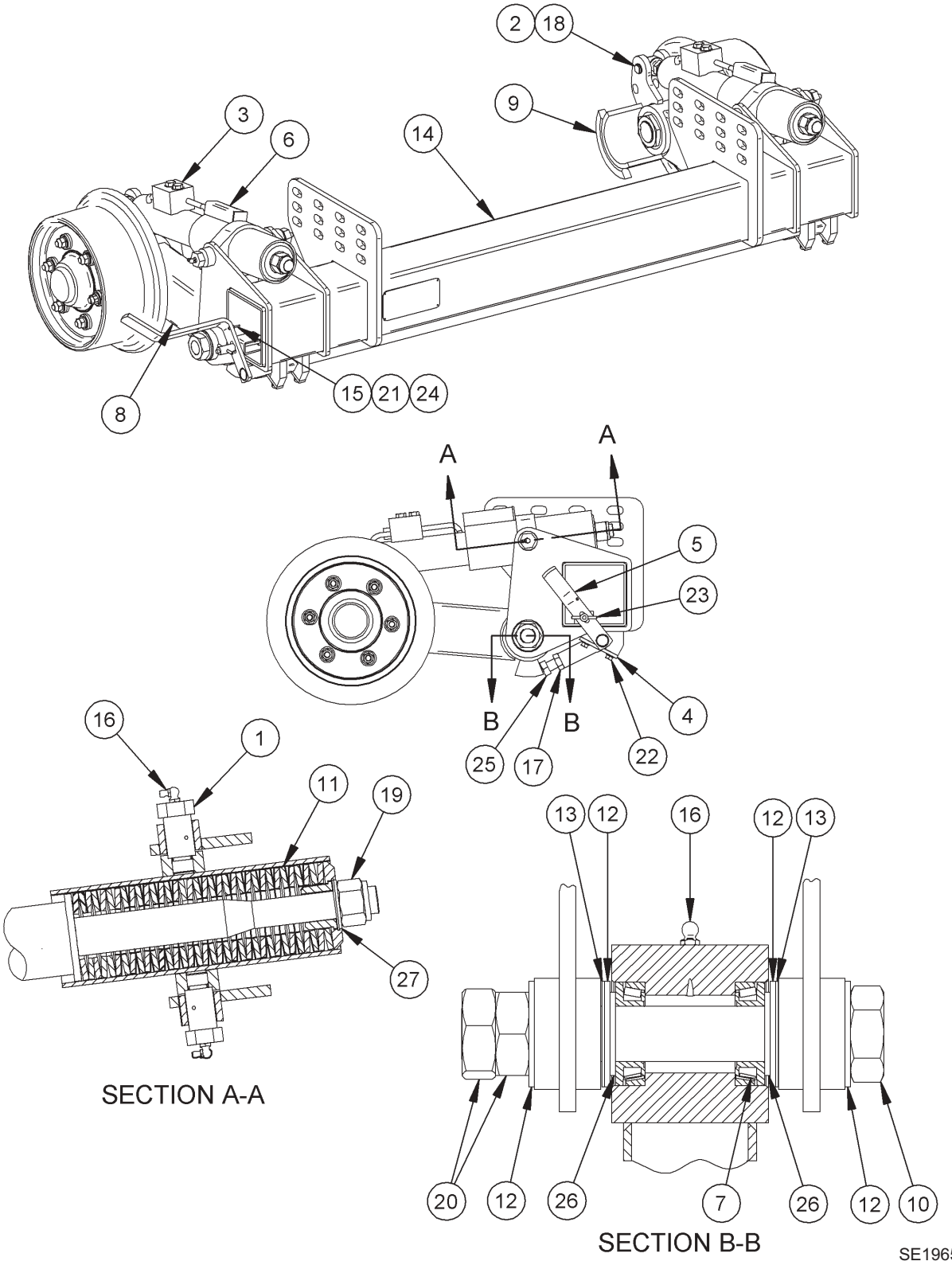


SECTION A-A
SPRING DETAIL

HR2000B2-1 GUIDE WHEEL UNIT - 187271

ITEM	PART NO	DESCRIPTION	QTY
1	186127	Frame	1
2	186218	WHEEL ARM ASSEMBLY, LEFT	1
	186217	Wheel Arm	1
	180029	Bushing	2
	176680	Axle	1
	077735	Nut	1
	F007820K	Lock Washer	1
	F023270	Hex Slotted Nut, 1"	1
	F001182	Cotter Pin, 1/8 x 1-1/4"	1
3	186219	WHEEL ARM ASSEMBLY, RIGHT	1
	186220	Wheel Arm	1
	180029	Bushing	2
	176680	Axle	1
	077735	Nut	1
	F007820K	Lock Washer	1
	F023270	Hex Slotted Nut, 1"	1
	F001182	Cotter Pin, 1/8 x 1-1/4"	1
4	176715	Pin	2
5	187213	Washer (2 on each side of wheel arm)	8
6	F002915	Cap Screw, 3/8-16 x 3-1/4" Hex Hd	2
7	F015922	Elastic Stop Nut, 3/8"-16	2
8	186272	Spring Cell	2
9	180030	Trunnion	4
10	186135	HYDRAULIC CYLINDER	2
	188360	Check Valve	1
	188641	Seal Kit	1
	198729	Clevis	1
11	187267	Disc Spring (38 per spring cell)	76
12	F017591	Hex Lock Nut, 1"-14	2
13	180050	Pin	2
14	F011054	Retaining Ring	4
15	186224	Handle	1
16	F022104	Lock Pin And Lanyard	1
17	F017061	Machine Screw, #4-40 x 1" Rd Hd	1
18	F010193	Hex Nut, #4-40	1
19	F022981	Lock Washer, #4	1
20	F010722	Grease Fitting	6
21	186222	Plate	4
22	F022070	Cap Screw, 5/16-18 x 1" Hex Flg Hd	8
23	F010972	Hex Jam Nut, 3/4"-16	2
24	F040059	Cap Screw, 3/4-16 x 2" Hex Hd	2

HR2000B3 GUIDE WHEEL UNIT - 196564

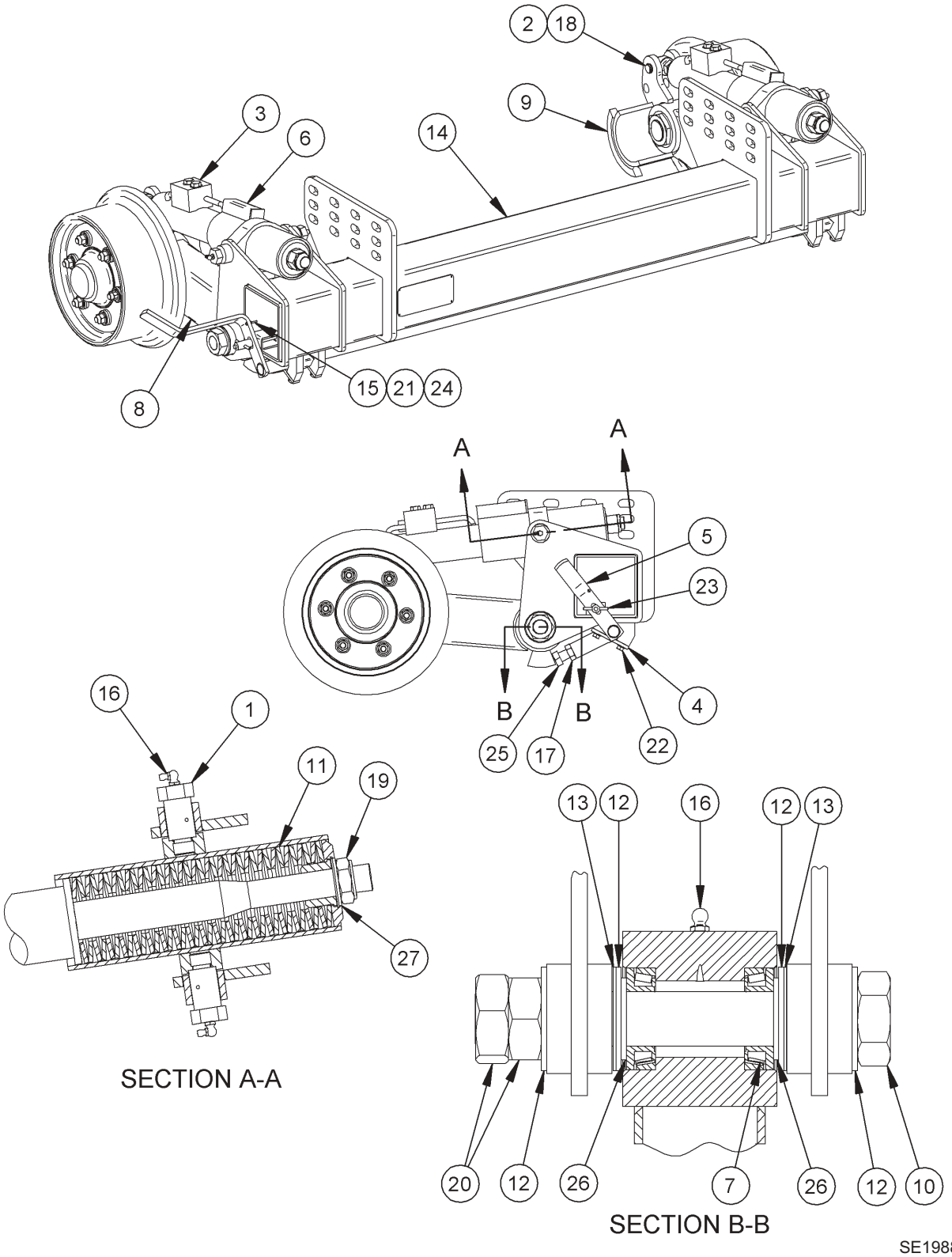


ITEM	PART NO	DESCRIPTION	QTY
1	180030	Trunnion	4
2	180050	Pin	2

HR2000B3 GUIDE WHEEL UNIT - 196564

ITEM	PART NO	DESCRIPTION	QTY
3	186135	HYDRAULIC CYLINDER	2
	188360	Check Valve	1
	188641	Seal Kit	1
	198729	Clevis	1
4	186222	Plate	4
5	186224	Lock Handle	1
6	196404	SPRING CELL	2
	196407	Nylatron Bushing.	1
	F013991	Retaining Ring	1
7	196420	Pivot Bearing Cone	4
8	196424	WHEEL ARM ASSEMBLY, LEFT	1
	077735	Nut	1
	176680	Axle.	1
	196405	Wheel Arm	1
	196419	Bearing Cup	2
	F001182	Cotter Pin, 1/8 x 1-1/4"	1
	F007820K	Lock Washer.	1
	F023270	Hex Slotted Nut, 1"	1
9	196425	WHEEL ARM ASSEMBLY, RIGHT	1
	077735	Nut	1
	176680	Axle.	1
	196419	Bearing Cup	2
	196426	Wheel Arm	1
	F001182	Cotter Pin, 1/8 x 1-1/4"	1
	F007820K	Lock Washer.	1
	F023270	Hex Slotted Nut, 1"	1
10	201704	Bolt	2
11	196431	Disc Spring (35 per spring cell)	70
12	196432	Washer.	8
13	196433	Washer.	4
14	196562	Frame	1
15	F010193	Hex Nut, #4-40 GR 2	1
16	F010722	Grease Fitting.	6
17	F010972	Hex Jam Nut, 3/4"-16" GR 2	2
18	F011054	Retaining Ring	4
19	F012232K	Hex Lock Nut, 1"-14	2
20	F014796	Hex Jam Nut, 1-1/4"-12 GR 2	4
21	F017061	Machine Screw, #4-40 x 1" Slotted Rd Hd	1
22	F040090	Cap Screw, 5/16-18 x 3/4" GR 5 Hex Flg Hd	8
23	F022104	Lock Pin And Lanyard	1
24	F022981	Lock Washer, #4	1
25	F040059	Cap Screw, 3/4-16 x 2" GR 5 Hex Hd	2
26	200400	Washer.	4
27	F203271	Washer.	2

HR2000B3-1 GUIDE WHEEL UNIT - 198815

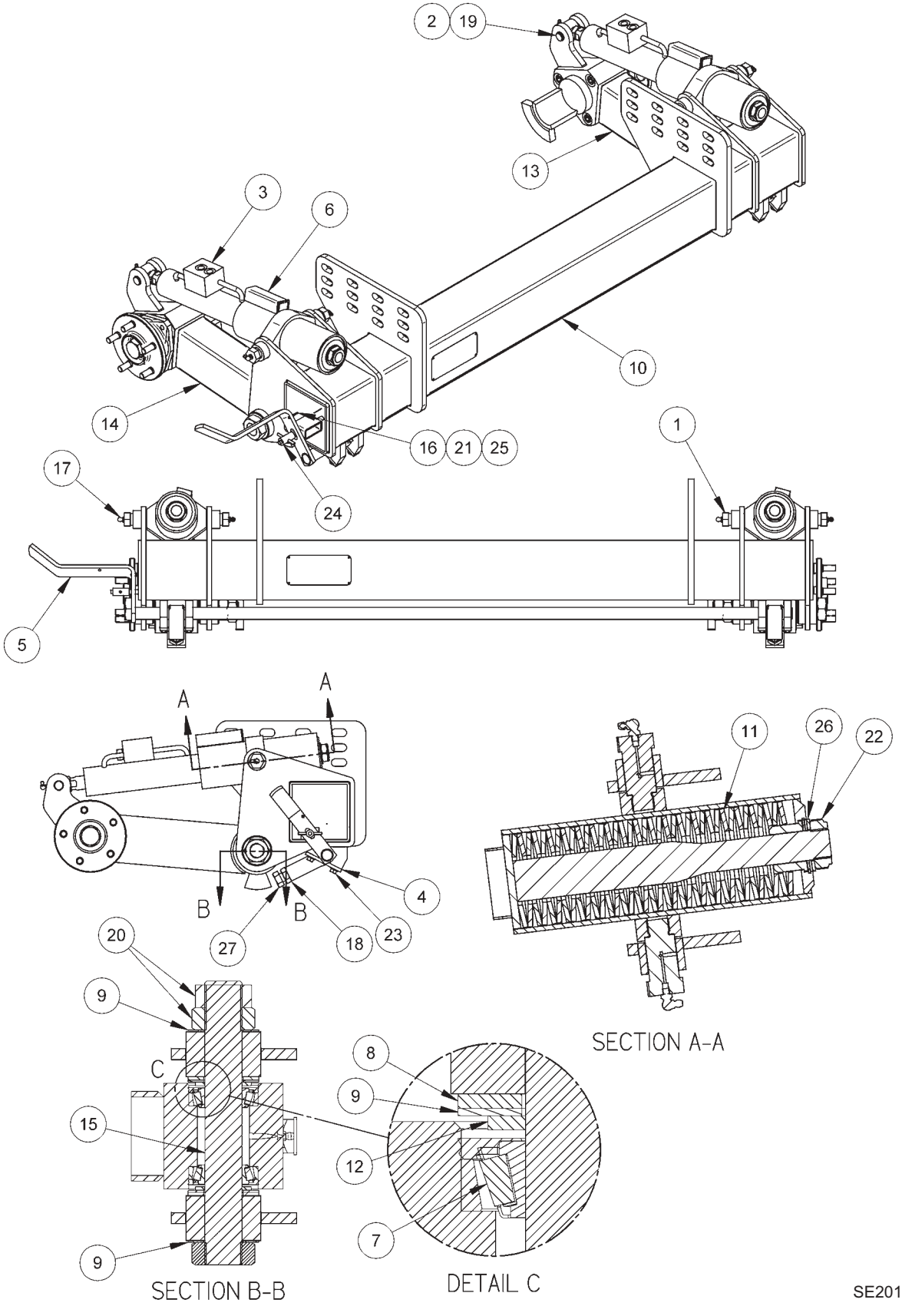


ITEM	PART NO	DESCRIPTION	QTY
1	180030	Trunnion	4
2	180050	Pin	2

HR2000B3-1 GUIDE WHEEL UNIT - 198815

ITEM	PART NO	DESCRIPTION	QTY
3	186135	HYDRAULIC CYLINDER	2
	188360	Check Valve	1
	188641	Seal Kit	1
	198729	Clevis	1
4	186222	Plate	4
5	186224	Lock Handle	1
6	196404	SPRING CELL	2
	196407	Nylatron Bushing.	1
	F013991	Retaining Ring	1
7	196420	Pivot Bearing Cone	4
8	196424	WHEEL ARM ASSEMBLY, LEFT	1
	077735	Nut	1
	176680	Axle.	1
	196405	Wheel Arm	1
	196419	Bearing Cup	2
	F001182	Cotter Pin, 1/8 x 1-1/4"	1
	F007820K	Lock Washer.	1
	F023270	Hex Slotted Nut, 1"	1
9	196425	WHEEL ARM ASSEMBLY, RIGHT	1
	077735	Nut	1
	176680	Axle.	1
	196419	Bearing Cup	2
	196426	Wheel Arm	1
	F001182	Cotter Pin, 1/8 x 1-1/4"	1
	F007820K	Lock Washer.	1
	F023270	Hex Slotted Nut, 1"	1
10	201704	Bolt	2
11	198856	Disc Spring (38 per spring cell)	76
12	196432	Washer.	8
13	196433	Washer.	4
14	196562	Frame	1
15	F010193	Hex Nut, #4-40 GR 2	1
16	F010722	Grease Fitting.	6
17	F010972	Hex Jam Nut, 3/4"-16" GR 2	2
18	F011054	Retaining Ring	4
19	F017591	Hex Elastic Stop Nut, 1"-14	2
20	F014796	Hex Jam Nut, 1-1/4"-12 GR 2	4
21	F017061	Machine Screw, #4-40 x 1" Slotted Rd Hd	1
22	F040090	Cap Screw, 5/16-18 x 3/4" GR 5 Hex Flg Hd	8
23	F022104	Lock Pin And Lanyard	1
24	F022981	Lock Washer, #4	1
25	F040059	Cap Screw, 3/4-16 x 2" GR 5 Hex Hd	2
26	200400	Washer.	4
27	F203271	Washer.	2

HR2000B3-2 GUIDE WHEEL UNIT - 201334



SE201334-F

HR2000B3-2 GUIDE WHEEL UNIT - 201334

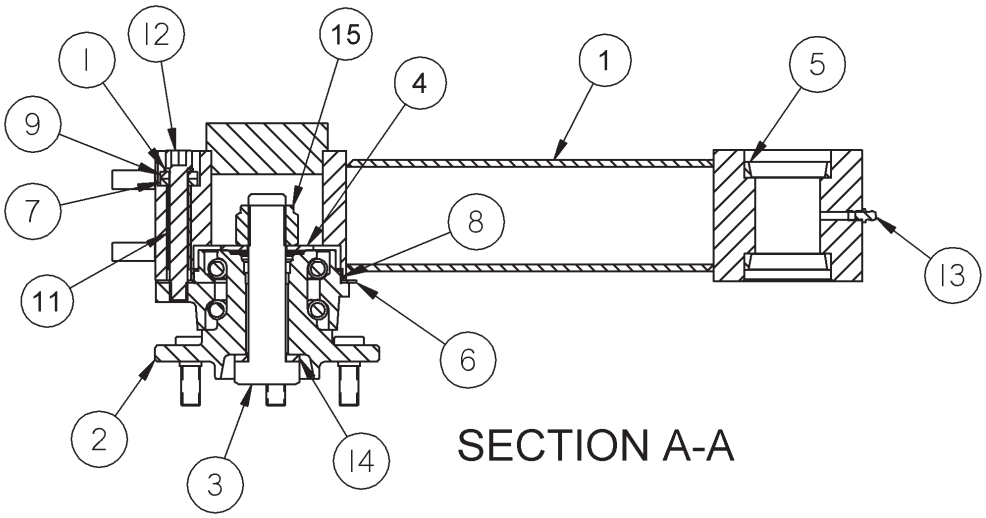
ITEM	PART NO	DESCRIPTION	QTY
1	180030	Trunnion	4
2	180050	Pin	2
3	186135	HYDRAULIC CYLINDER	2
	188360	Check Valve	1
	188641	Seal Kit	1
	198729	Clevis	1
4	186222	Plate	4
5	186224	Lock Handle	1
6	196404	SPRING CELL	2
	196407	Nylatron Bushing	1
	F013991	Retaining Ring	1
7	196420	Pivot Bearing Cone	4
8	196432	Washer	4
9	196433	Washer	8
10	196562	Frame	1
11	198856	Disc Spring (38 per spring cell)	76
12	200400	Washer	4
13	201332	Wheel Arm Assembly, Right (see separate breakdown)	1
14	201333	Wheel Arm Assembly, Left (see separate breakdown)	1
15	201704	Bolt	2
16	F010193	Hex Nut, #4-40 GR 2	1
17	F010722	Grease Fitting, 1/4"-28 x 90°	6
18	F010972	Hex Jam Nut, 3/4"-16 GR 2	2
19	F011054	Retaining Ring	4
20	F014796	Hex Jam Nut, 1-1/4"-12 GR 2	4
21	F017061	Machine Screw, #4-40 x 1" Slotted Rd Hd	1
22	F017591	Hex Lock Nut, 1"-14	2
23	F040090	Cap Screw, 5/16-18 x 3/4" GR 5 Hex Flg Hd	8
24	F022104	Lock Pin And Lanyard	1
25	F022981	Lock Washer, #4	1
26	F023271	Washer	2
27	F040059	Cap Screw, 3/4-16 x 2" GR 5 Hex Hd	2

HR2000B3-2 GUIDE WHEEL OPTIONS

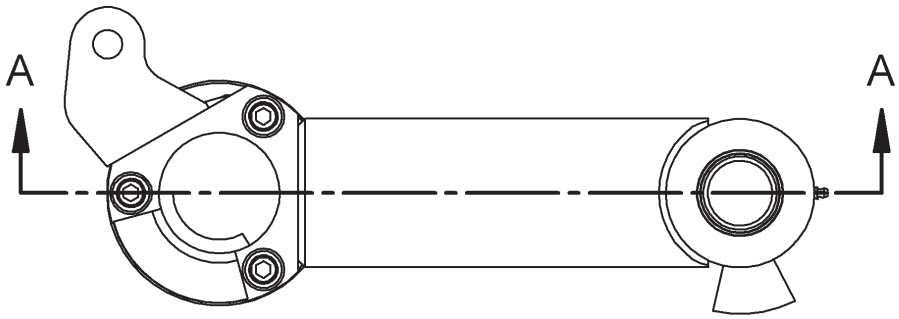
PART NO	DESCRIPTION	QTY
198510	Guide Wheel, Rubber Tread (see separate breakdown)	2
198690	Guide Wheel, Steel Tread (see separate breakdown)	2

WHEEL ARM ASSEMBLY, RIGHT - 201332

ITEM	PART NO	DESCRIPTION	QTY
	201332	WHEEL ARM ASSEMBLY, RIGHT	1
1	150791	Lock Washer, 12 mm	3
2	186139	Integral Spindle	1
3	187193	Hex Head Cap Screw	1
4	187244	Washer	1
5	196419	Bearing Cup	2
6	200415	Plate	1
7	200416	Washer	3
8	200417	Bushing	1
9	200419	Washer	3
10	201330	Wheel Arm, Right	1
11	201502	Bushing	3
12	201582	Cap Screw, M12 x 1.75 x 90 mm Hex Soc Hd	3
13	F008014	Grease Fitting	1
14	F008727	Washer	1
15	F012232K	Hex Lock Nut, 1"-14	1



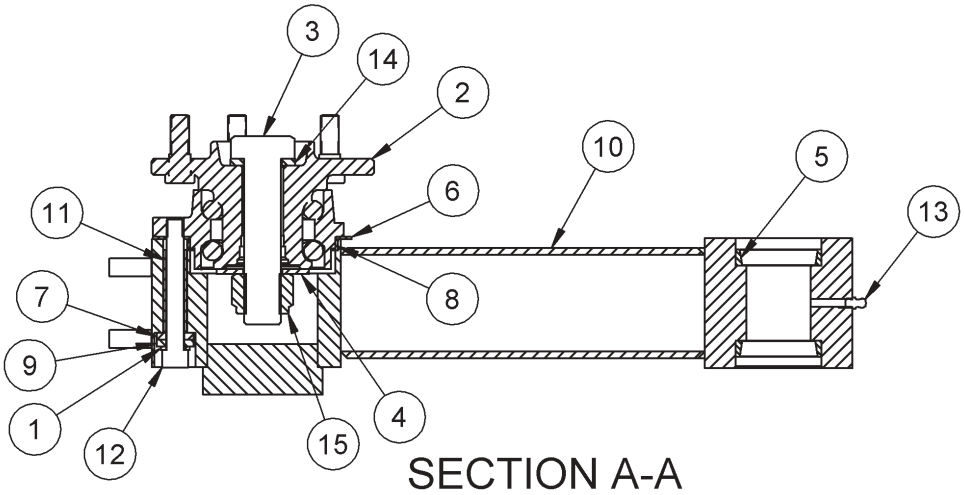
SECTION A-A



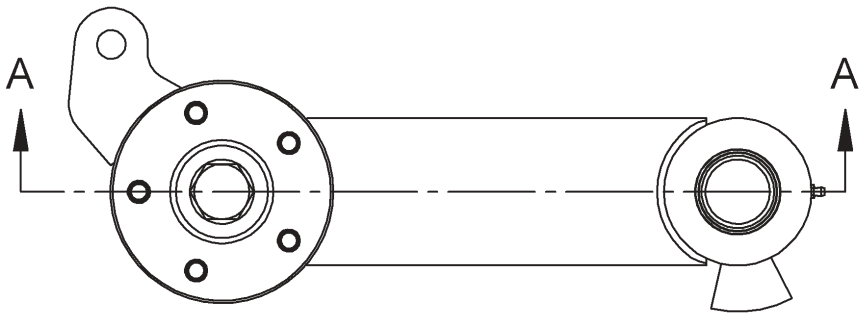
SE201332-F

WHEEL ARM ASSEMBLY, LEFT - 201333

ITEM	PART NO	DESCRIPTION	QTY
	201333	WHEEL ARM ASSEMBLY, LEFT	1
1	150791	Lock Washer, 12 mm	3
2	186139	Integral Spindle	1
3	187193	Hex Head Cap Screw	1
4	187244	Washer	1
5	196419	Bearing Cup	2
6	200415	Plate	1
7	200416	Washer	3
8	200417	Bushing	1
9	200419	Washer	3
10	201331	Wheel Arm, Left	1
11	201502	Bushing	3
12	201582	Cap Screw, M12 x 1.75 x 90 mm Hex Soc Hd	3
13	F008014	Grease Fitting	1
14	F008727	Washer	1
15	F012232K	Hex Lock Nut, 1"-14	1

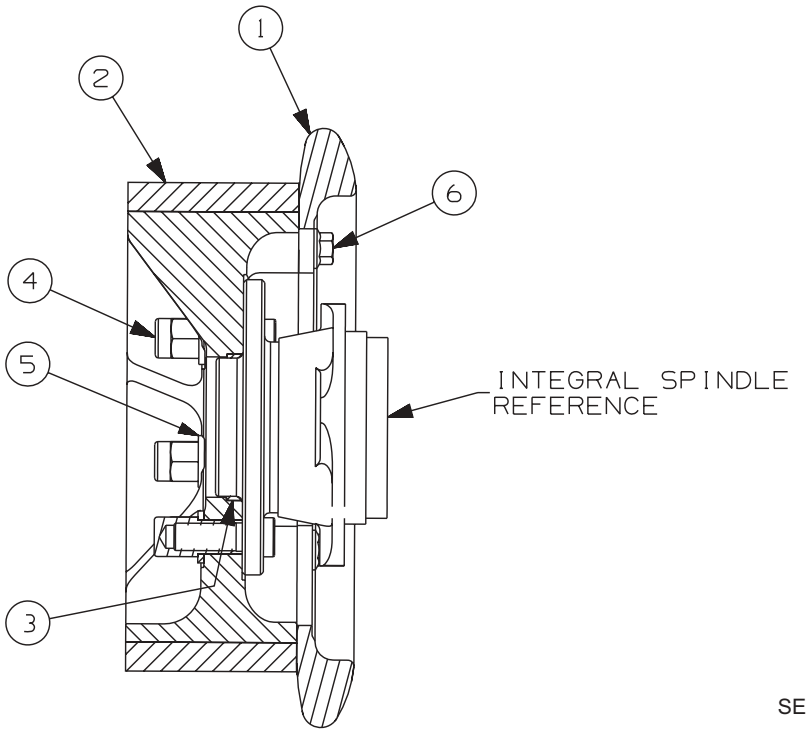


SECTION A-A



SE201333-F

RUBBER TREAD GUIDE WHEEL - 198510

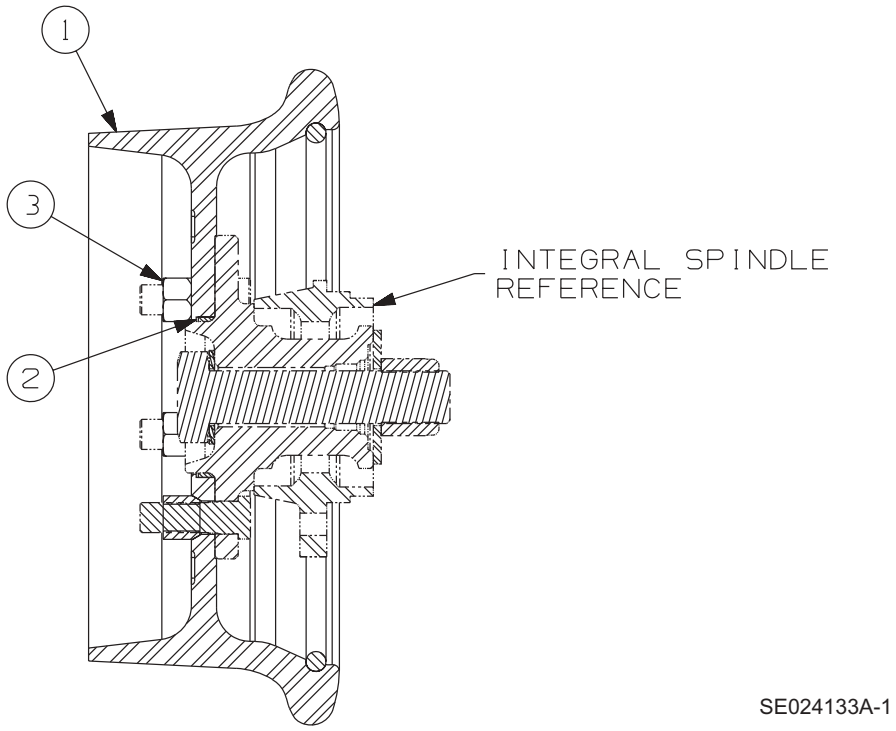


Note: Quantities Listed Are For One Wheel Only.

6

ITEM	PART NO	DESCRIPTION	QTY
	198510	GUIDE WHEEL, RUBBER TREAD	1
1	136133	Flange	1
2	196489	Rubber Tread	1
3	194007	Bushing	1
4	196492	Lug Nut (torque to 90 ft / lbs)	5
5	F023457	Washer	5
6	F023255	Cap Screw, 3/8-16 x 1" GR 5 Hex Flg Hd (torque to 40 ft / lbs)	6

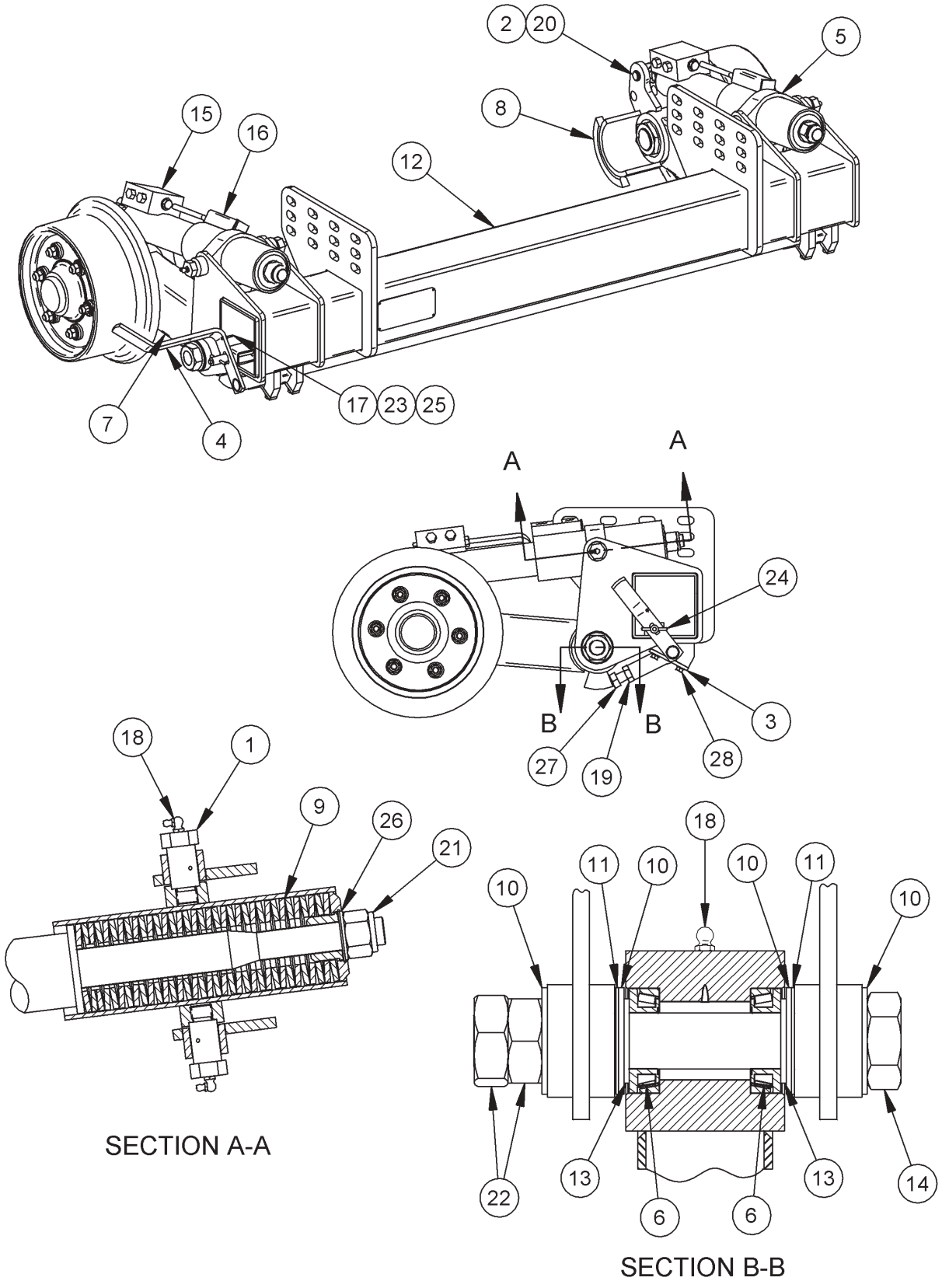
STEEL TREAD GUIDE WHEEL - 198690



Note: Quantities Listed Are For One Wheel Only.

ITEM	PART NO	DESCRIPTION	QTY
	198690	GUIDE WHEEL, STEEL TREAD	1
1	200854	Steel Tread	1
2	194007	Bushing	1
3	F010448	Wheel Nut (torque to 90 ft / lbs)	5

HR2000B3-3 GUIDE WHEEL UNIT - 202417



SE202417-F

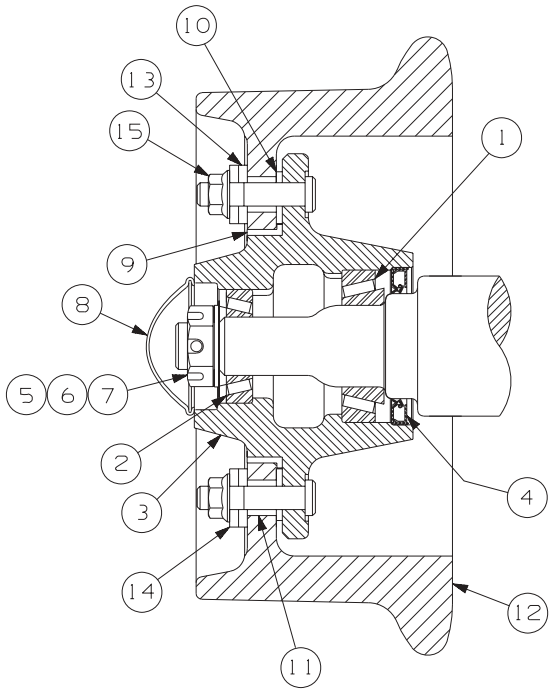
HR2000B3-3 GUIDE WHEEL UNIT - 202417

ITEM	PART NO	DESCRIPTION	QTY
1	180030	Trunnion	4
2	180050	Pin	2
3	186222	Plate	4
4	186224	Lock Handle	1
5	196404	SPRING CELL, RIGHT	2
	196407	Nylatron Bushing	1
	F013991	Retaining Ring	1
6	196420	Bearing Cone	4
7	196424	WHEEL ARM ASSEMBLY, LEFT	1
	077735	Nut	1
	176680	Axle	1
	196405	Wheel Arm	1
	196419	Bearing Cup	2
	F001182	Cotter Pin, 1/8 x 1-1/4"	1
	F007820K	Lock Washer	1
	F023270	Hex Slotted Nut, 1"	1
8	196425	WHEEL ARM ASSEMBLY, RIGHT	1
	077735	Nut	1
	176680	Axle	1
	196419	Bearing Cup	2
	196426	Wheel Arm	1
	F001182	Cotter Pin, 1/8 x 1-1/4"	1
	F007820K	Lock Washer	1
	F023270	Hex Slotted Nut, 1"	1
9	196431	Disc Spring (35 per spring cell)	70
10	196432	Washer	4
11	196433	Washer	8
12	196562	Frame	1
13	200400	Washer	8
14	201704	Bolt	2
15	202452	HYDRAULIC CYLINDER	2
	188360	Check Valve	2
	188641	Seal Kit	1
	198729	Clevis	1
16	202543	SPRING CELL, LEFT	1
	196407	Nylatron Bushing	1
	F013991	Retaining Ring	1
17	F010193	Hex Nut, #4-40 GR 2	1
18	F010722	Grease Fitting, 1/4"-28 x 90°	6
19	F010972	Hex Jam Nut, 3/4"-16 GR 2	2
20	F011054	Retaining Ring	4
21	F012232K	Hex Lock Nut, 1"-14	2
22	F014796	Hex Jam Nut, 1-1/4" -12	4
23	F017061	Machine Screw, #4-40 x 1" Slotted Rd Hd	1

HR2000B3-3 GUIDE WHEEL UNIT - 202417

ITEM	PART NO	DESCRIPTION	QTY
24	F022104	Lock Pin & Lanyard	1
25	F022981	Lock Washer, #4	1
26	F023271	Washer	2
27	F040059	Cap Screw, 3/4-16 x 2" GR 5 Hex Hd	2
28	F040090	Cap Screw, 5/16-18 x 3/4" GR 5 Hex Flg Hd	8

GUIDE WHEEL ASSEMBLY

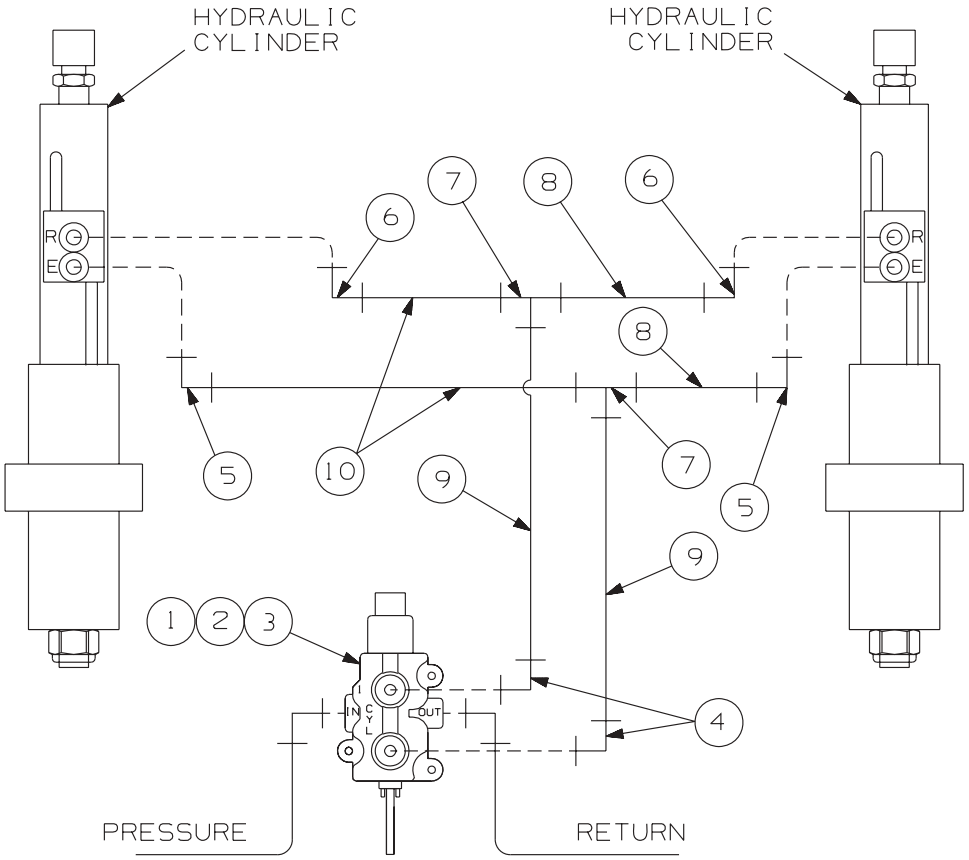


SE92A128A-1

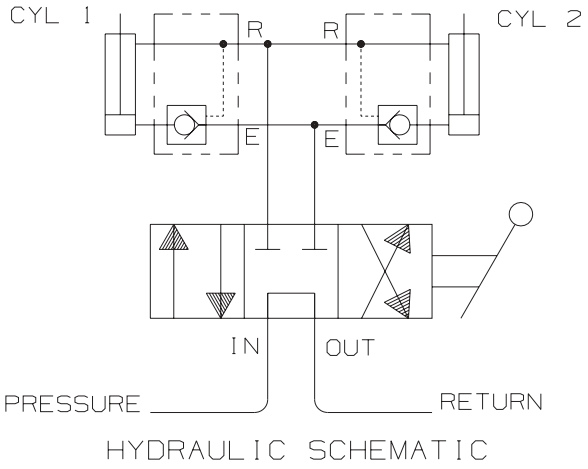
Note: Quantities Listed Are For One Wheel Only.

ITEM	PART NO	DESCRIPTION	QTY
1	154745	Bearing Cup & Cone, Inside	1
2	157622	Bearing Cup & Cone, Outside	1
3	153739	HUB ASSEMBLY	1
3a	120884	Stud Bolt, 1/2-20 x 2-5/16"	6
4	F024339	Grease Seal	1
5	F008727	Axle Washer	1
6	F023270	Hex Slotted Nut, 1"	1
7	F001182	Cotter Pin, 1/8 x 1-1/4"	1
8	F023272	Dust Cap	1
9	108585	Insulating Flange	1
10	108586	Insulating Washer	1
11	100765	Insulating Bushing	6
12	140104	Guide Wheel	1
13	090177	Insulating Washer	6
14	072897	Washer, 33/64"	6
15	F021281	Hex Flg Nut, 1/2"-20	6

HYDRAULIC PIPING - 181526



SE022742A-1



HYDRAULIC SCHEMATIC

SE022742A-2

HYDRAULIC PIPING - 181526

ITEM	PART NO	DESCRIPTION	QTY
1	F018510	Control Valve	1
2	F013428	Cap Screw, 5/16-18 x 2-1/2" Hex Hd	3
3	F040088	Hex Flg Nut, 5/16"-18	3
4	F012055	90° Elbow, 9/16 M JIC x 3/8 M NPT	2
5	F024244	90° Elbow, 9/16 M JIC x 9/16 M STR	2
6	F013327	90° Elbow, 9/16 M JIC x 9/16 M STR	2
7	F011260	Tee, 9/16 M JIC x 9/16 M JIC x 9/16 M JIC	2
8	174925	Hose, -06 x 26-1/2"	2
9	179245	Hose, -06 x 19"	2
10	183982	Hose, -06 x 69"	2

GUIDE WHEEL UNIT LUBRICANTS AND LOCTITE

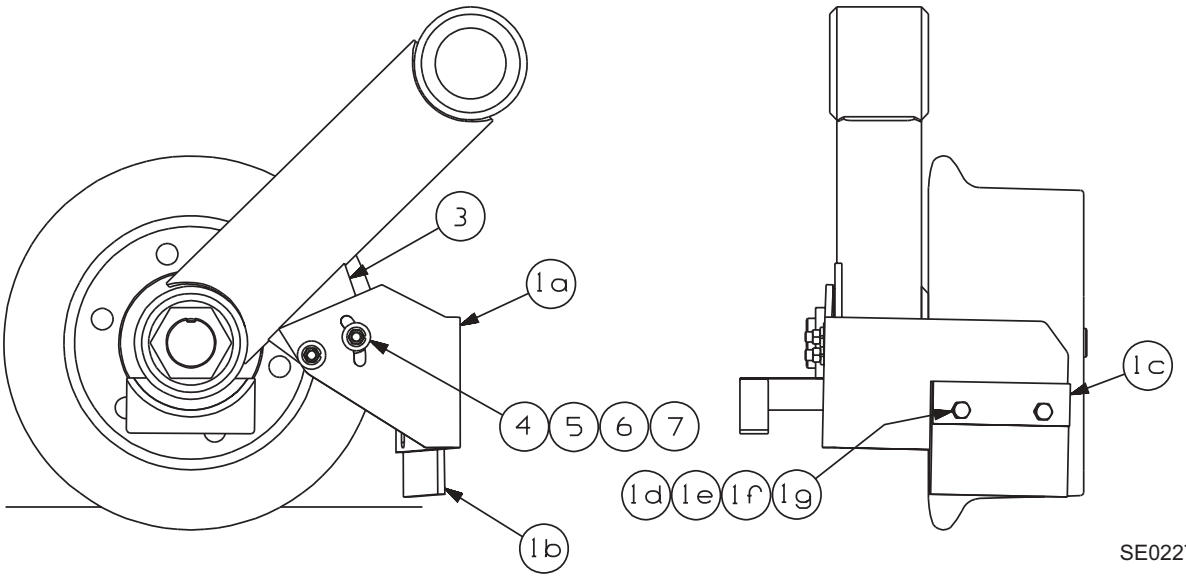
PART NO	DESCRIPTION	QTY
200898	Rust Inhibitor, NO-OX-ID "E-HB" (one gallon)	1
F013571	Grease (wheel bearings and grease fittings)	as needed
F016443	Anti-Seize Lubricant	as needed
F015774	Loctite 242 Blue	as needed

STEERING LOCK GROUPS

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

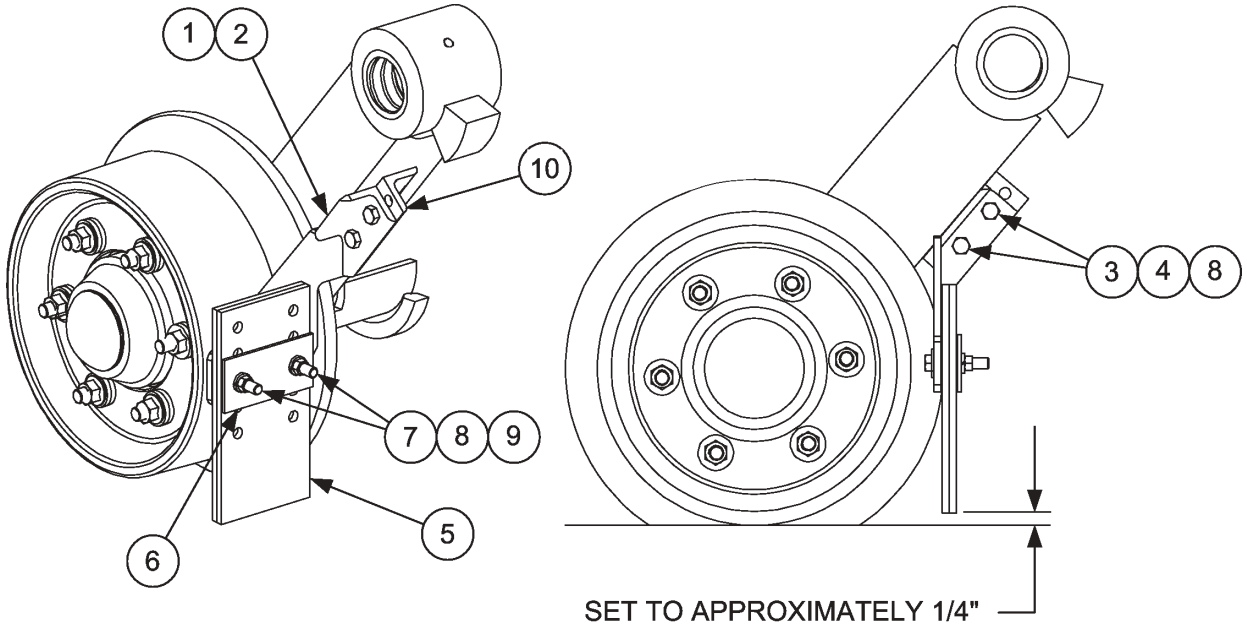
RAIL SWEEP GROUP - 181500

RIGHT RAIL SWEEP SHOWN



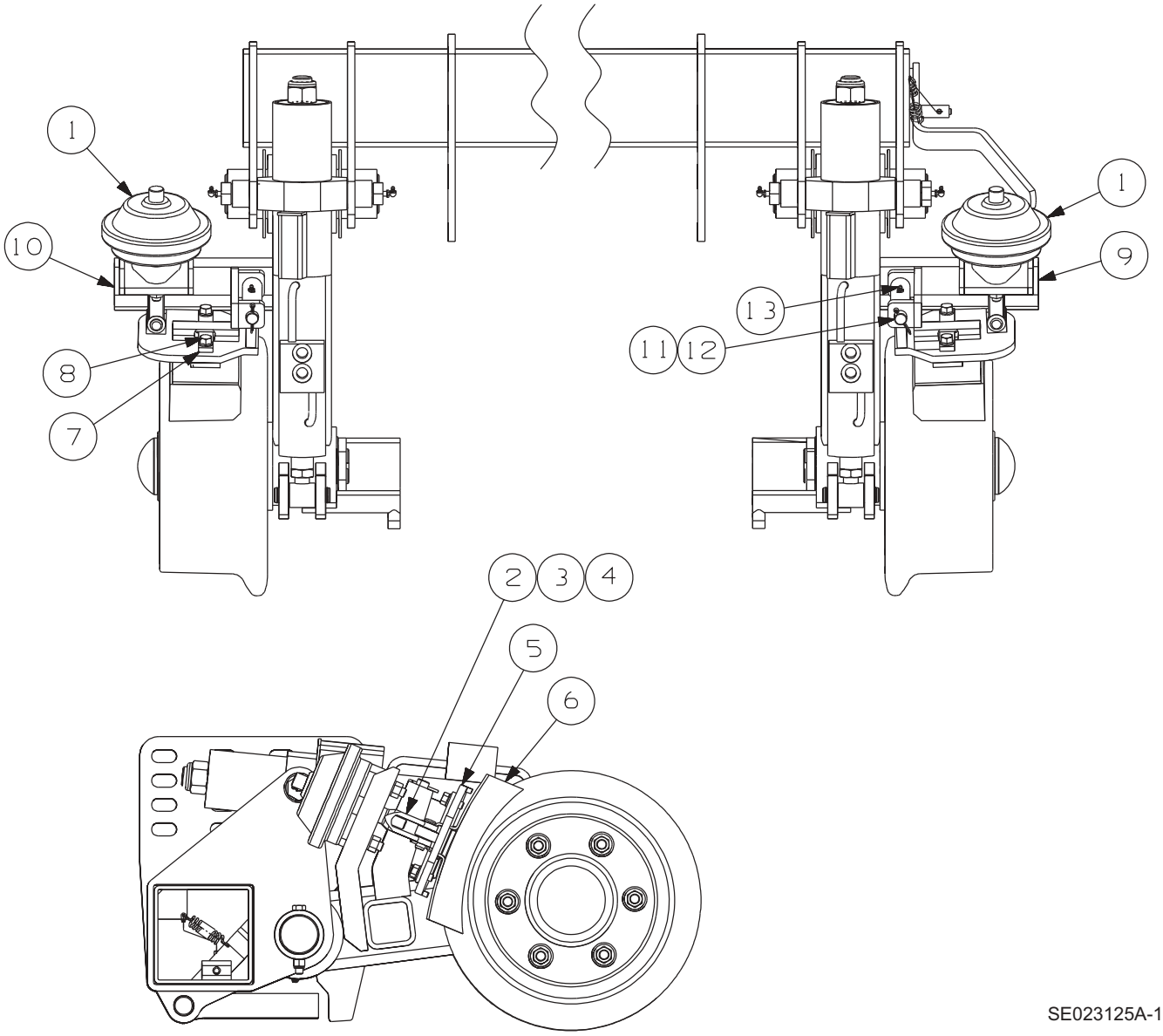
ITEM	PART NO	DESCRIPTION	QTY
1	181496	RAIL SWEEP ASSEMBLY, RIGHT	1
1a	181493	Bracket	1
1b	108509K1	Rubber Sweep	1
1c	108510	Bar	1
1d	F001125	Cap Screw, 3/8-16 x 1-1/4" Hex Hd	2
1e	F001115	Wrought Washer, 3/8"	2
1f	F001025	SAE Lock Washer, 3/8"	2
1g	F007020	Hex Nut, 3/8"-16	2
2	181497	RAIL SWEEP ASSEMBLY, LEFT	1
2a	181494	Bracket	1
2b	108509K1	Rubber Sweep	1
2c	108510	Bar	1
2d	F001125	Cap Screw, 3/8-16 x 1-1/4" Hex Hd	2
2e	F001115	Wrought Washer, 3/8"	2
2f	F001025	SAE Lock Washer, 3/8"	2
2g	F007020	Hex Nut, 3/8"-16	2
3	181495	Bar (weld on)	2
4	F007020	Hex Nut, 3/8"-16	4
5	F001115	Wrought Washer, 3/8"	4
6	F001025	SAE Lock Washer, 3/8"	4
7	F001125	Cap Screw, 3/8-16 x 1-1/4" Hex Hd	4

RAIL SWEEP GROUP - 188391
LEFT RAIL SWEEP SHOWN



ITEM	PART NO	DESCRIPTION	QTY
	188391	RAIL SWEEP GROUP	1
1	188381	Bracket, Left	1
2	188382	Bracket, Right	1
3	F001125	Cap Screw, 3/8-16 x 1-1/4" GR 5 Hex Hd	4
4	F001115	Wrought Washer, 3/8"	4
5	200919	Rail Sweep	4
6	088525	Outer Plate	2
7	F001640	Cap Screw, 3/8-16 x 2" GR 5 Hex Hd	4
8	F001025	SAE Lock Washer, 3/8"	8
9	F007020	Hex Nut, 3/8"-16 GR 5	8
10	188383	Angle (weld on)	2
	023321	Rail Sweep Application Drawing	1

BRAKE GROUP - 186185

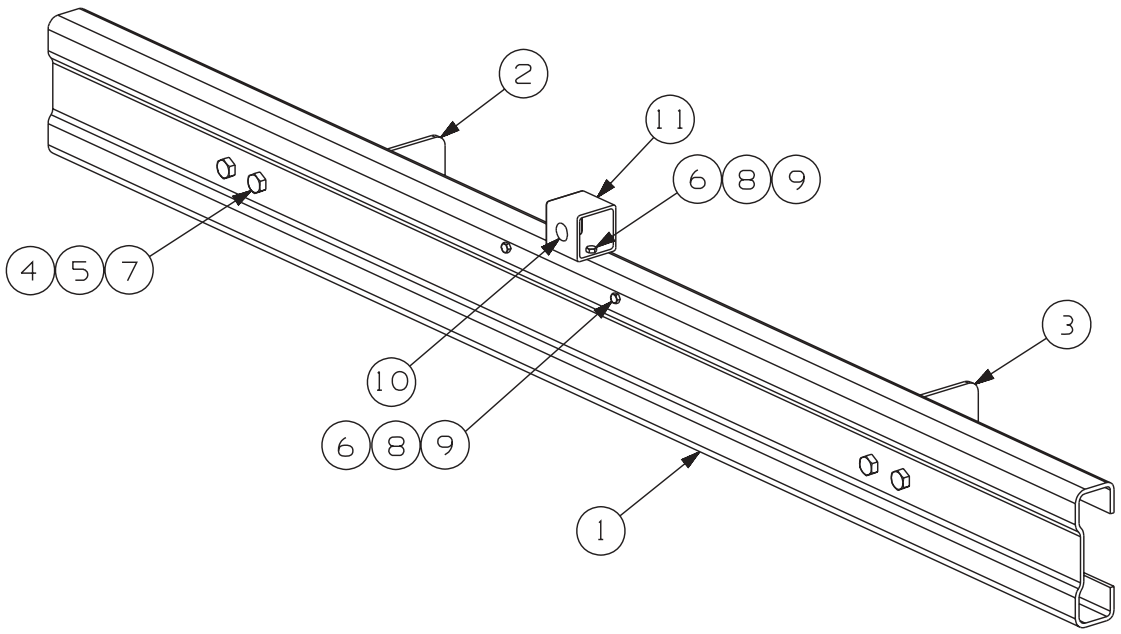


SE023125A-1

BRAKE GROUP - 186185

ITEM	PART NO	DESCRIPTION	QTY
1	F025058	Brake Actuator	2
2	F011013	Hex Jam Nut, 1/2"-20	2
3	184125	Yoke	2
4	F005460	Yoke Pin With Cotter Pin	2
5	184130	Plate	2
6	F022274	Brake Shoe	2
7	157694	Link	2
8	F023416	Cap Screw, 3/8-16 x 3/4" Hex Flg Hd	4
9	184134	Mounting Bracket, Left	1
10	184135	Mounting Bracket, Right	1
11	3410306	Pin	2
12	F001182	Cotter Pin, 1/8 x 1-1/4"	4
13	F008014	Grease Fitting	2
	138206	Hose Assembly (not shown)	1

BUMPER GROUP - 184500



SE023059A-1

ITEM	PART NO	DESCRIPTION	QTY
1	164510	Bumper	1
2	184498	Bumper Bracket	1
3	184499	Bumper Bracket	1
4	F001075	SAE Lock Washer, 1/2"	4
5	F001090	Cap Screw, 1/2-13 x 1-1/2" Hex Hd	4
6	F002355	Cap Screw, 1/4-20 x 3/4" hex Hd	4
7	F003598	Hex Nut, 1/2"-13	4
8	F007022	Hex Nut, 1/4"-20	4
9	F009535	Lock Washer, 1/4"	4
10	F015664	Lamp	1
11	107874	Light Bracket	1

SECTION 7 - VEHICLE APPLICATIONS
TABLE OF CONTENTS

	2000 - 2004 CHEV/GMC C31003 HD 4 X 2 CHASSIS CAB 15,000 GVWR HR18A1 FRONT HR2000B1 REAR	2000 - 2004 CHEV/GMC C31003 HD 4 X 2 CHASSIS CAB 15,000 GVWR HR18A1 FRONT HR2000B2 REAR
REQUIRED GROUPS		
HY-RAIL® Application	181522	192443
Rear Guide Wheel Unit	179114	186133
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	181523	192442
Steering Lock - Dead Bolt	169632	169632
Steering Lock - Velcro	201711	201711
Wheel Modification	175595	175595
Application Drawing - Rear	022741	023543
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Front and Rear	168104	168104
Hydraulic Power Pack - Front and Rear	186157	186157
Hydraulic Power Pack - Rear Only	168105	168105
Hydraulic Power Pack - Rear Only	186159	186159
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

* Recommended Safety Option

	2000 - 2004 CHEV/GMC C30943 4 X 2 CHASSIS CAB 10,000 GVWR HR18A1 FRONT HR2000B2-1 REAR	2000 - 2004 CHEV/GMC C30943 4 X 2 CHASSIS CAB 10,000 GVWR HR18A1 FRONT HR2000B3-1 REAR
REQUIRED GROUPS		
HY-RAIL® Application	188411	198852
Rear Guide Wheel Unit	187271	198815
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	188410	188410
Steering Lock - Dead Bolt	169632	169632
Steering Lock - Velcro	201711	201711
Wheel Modification	181586	181586
Application Drawing - Rear	023346	023346
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Front and Rear	168104	168104
Hydraulic Power Pack - Front and Rear	186157	186157
Hydraulic Power Pack - Rear Only	168105	168105
Hydraulic Power Pack - Rear Only	186159	186159
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

* Recommended Safety Option

	2005 CHEV/GMC CK36053 4 X 4 EXTENDED CHASSIS CAB 12,000 GVWR HR18A1 FRONT HR2000B3 REAR	2006 CHEV/GMC CC25743 4 X 2 CREW CAB PICKUP 9,200 GVWR HR1500B2 FRONT HR2000B3-1 REAR
REQUIRED GROUPS		
HY-RAIL® Application	203235	203685
Rear Guide Wheel Unit	196564	198815
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	203552	———
Mounting Brackets (rear only)	———	3409307
Steering Lock - Dead Bolt	169632	169632
Steering Lock - Velcro	201711	201711
Wheel Modification	203828	193871
Application Drawing - Rear	024647	———
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Front and Rear	168104	168104
Hydraulic Power Pack - Front and Rear	186157	186157
Hydraulic Power Pack - Rear Only	168105	168105
Hydraulic Power Pack - Rear Only	186159	186159
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

7

* Recommended Safety Option

	2000 - 2004 FORD F350 4 X 2 REGULAR, SUPER & CREW CAB PICKUP WITH SRW 9,900 GVWR HR0307A1 FRONT HR2000B1 REAR	2000 - 2004 FORD F350 4 X 4 REGULAR, SUPER & CREW CAB PICKUP WITH SRW 9,900 GVWR HR0307A1 FRONT HR2000B1 REAR
REQUIRED GROUPS		
HY-RAIL® Application	186144	184524
Rear Guide Wheel Unit	179114	179114
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	186145	184493
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Wheel Modification	184448	188439
Application Drawing - Rear	023053	023053
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Rear Only	168105	168105
Hydraulic Power Pack - Rear Only	186159	186159
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

* Recommended Safety Option

	2000 - 2004 FORD F350 4 X 2 REGULAR, SUPER & CREW CHASSIS CAB WITH SRW 9,900 GVWR HR0307A1 FRONT HR2000B1 REAR	2000 - 2004 FORD F350 4 X 4 REGULAR, SUPER & CREW CHASSIS CAB WITH SRW 9,900 GVWR HR0307A1 FRONT HR2000B1 REAR
REQUIRED GROUPS		
HY-RAIL® Application	186153	184089
Rear Guide Wheel Unit	179114	179114
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	186150	184085
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Wheel Modification	184448	188439
Application Drawing - Rear	023077	023077
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Rear Only	168105	168105
Hydraulic Power Pack - Rear Only	186159	186159
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

* Recommended Safety Option

2000 - 2004 FORD
F350 4 X 2
REGULAR, SUPER &
CREW CHASSIS CAB
WITH SRW
9,900 GVWR
HR0307A1 FRONT
HR2000B3-1 REAR

REQUIRED GROUPS

HY-RAIL® Application 198854
Rear Guide Wheel Unit 198815
Rear Unit Hydraulic Valve Piping. 181526
Mounting Brackets. 186145
Steering Lock - Dead Bolt 181548
Steering Lock - Velcro 201711
Wheel Modification 200371
Application Drawing - Rear 023053

ACCESSORY GROUP OPTIONS

* Rail Sweeps - Rear 188391
Hydraulic Power Pack - Rear Only 168105
Hydraulic Power Pack - Rear Only 186159
Brakes
Rear Unit Brake Group 186185
Electric / Air Brake Group - Full. 163987
Electric / Air Brake Group - Abbr. 163988

* Recommended Safety Option

	2000 - 2004 FORD F350 4 X 2 REGULAR, SUPER & CREW CHASSIS CAB WITH DRW 11,200 GVWR HR18A1 FRONT HR2000B1 REAR	2000 - 2004 FORD F350 4 X 4 REGULAR, SUPER & CREW CHASSIS CAB WITH DRW 11,200 GVWR HR18A1 FRONT HR2000B1 REAR
REQUIRED GROUPS		
HY-RAIL® Application	184091	187167
Rear Guide Wheel Unit	179114	179114
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	184090	184090
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Application Drawing - Rear	023077	023077
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Front and Rear	168104	168104
Hydraulic Power Pack - Front and Rear	186157	186157
Hydraulic Power Pack - Rear Only	168105	168105
Hydraulic Power Pack - Rear Only	186159	186159
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

* Recommended Safety Option

	2000 - 2004 FORD F350 4 X 2 REGULAR, SUPER & CREW CHASSIS CAB WITH DRW 11,200 GVWR HR18A1 FRONT HR2000B2-1 REAR	2000 - 2004 FORD F350 4 X 4 REGULAR, SUPER & CREW CHASSIS CAB WITH SRW 11,200 GVWR HR18A1 FRONT HR2000B2-1 REAR
REQUIRED GROUPS		
HY-RAIL® Application	198534	198534
Rear Guide Wheel Unit	187271	187271
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	187154	187154
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Application Drawing - Rear	023235	023235
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Front and Rear	168104	168104
Hydraulic Power Pack - Front and Rear	186157	186157
Hydraulic Power Pack - Rear Only	168105	168105
Hydraulic Power Pack - Rear Only	186159	186159
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

* Recommended Safety Option

2000 - 2004 FORD
F350 4 X 4
REGULAR, SUPER &
CREW CHASSIS CAB
WITH DRW
9,900 GVWR
HR18A1 FRONT
HR2000B3-1 REAR

REQUIRED GROUPS

HY-RAIL® Application 198850
Rear Guide Wheel Unit 198815
Rear Unit Hydraulic Valve Piping. 181526
Mounting Brackets. 194036
Steering Lock - Dead Bolt 181548
Steering Lock - Velcro 201711
Wheel Modification 194037
Application Drawing - Rear 023077

ACCESSORY GROUP OPTIONS

* Rail Sweeps - Rear 188391
Hydraulic Power Pack - Front and Rear 168104
Hydraulic Power Pack - Front and Rear 186157
Hydraulic Power Pack - Rear Only 168105
Hydraulic Power Pack - Rear Only 186159
Brakes
Rear Unit Brake Group 186185
Electric / Air Brake Group - Full. 163987
Electric / Air Brake Group - Abbr. 163988

* Recommended Safety Option

	2000 - 2004 FORD F350 4 X 2 REGULAR, SUPER & CREW CHASSIS CAB WITH DRW 11,200 GVWR HR18A1 FRONT HR2000B3-1 REAR	2000 - 2004 FORD F350 4 X 4 REGULAR, SUPER & CREW CHASSIS CAB WITH DRW 11,200 GVWR HR18A1 FRONT HR2000B3-1 REAR
REQUIRED GROUPS		
HY-RAIL® Application	198853	198853
Rear Guide Wheel Unit	198815	198815
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	187154	187154
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Application Drawing - Rear	023235	023235
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Front and Rear	168104	168104
Hydraulic Power Pack - Front and Rear	186157	186157
Hydraulic Power Pack - Rear Only	168105	168105
Hydraulic Power Pack - Rear Only	186159	186159
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

* Recommended Safety Option

	2000 - 2004 FORD F450 4 X 2 REGULAR & CREW CHASSIS CAB WITH DRW 15,000 GVWR HR18A1 FRONT HR2000B1 REAR	2000 - 2004 FORD F450 4 X 2 REGULAR & CREW CHASSIS CAB WITH DRW 15,000 GVWR HR18A1 FRONT HR2000B2 REAR

REQUIRED GROUPS

HY-RAIL® Application	187145	187187
Rear Guide Wheel Unit	179114	186133
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	184090	187154
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Wheel Modification	187149	187149
Application Drawing - Rear	023077	023235

ACCESSORY GROUP OPTIONS

*	Rail Sweeps - Rear	188391	188391
	Hydraulic Power Pack - Front and Rear	168104	168104
	Hydraulic Power Pack - Front and Rear	186157	186157
	Hydraulic Power Pack - Rear Only	168105	168105
	Hydraulic Power Pack - Rear Only	186159	186159
	Brakes		
	Rear Unit Brake Group	186185	186185
	Electric / Air Brake Group - Full	163987	163987
	Electric / Air Brake Group - Abbr.	163988	163988

7

* Recommended Safety Option

	2000 - 2004 FORD F450 4 X 4 REGULAR & CREW CHASSIS CAB WITH DRW 15,000 GVWR HR18A1 FRONT HR2000B1 REAR	2000 - 2004 FORD F450 4 X 4 REGULAR & CREW CHASSIS CAB WITH DRW 15,000 GVWR HR18A1 FRONT HR2000B2 REAR
REQUIRED GROUPS		
HY-RAIL® Application	187145	187187
Rear Guide Wheel Unit	179114	186133
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	184090	187154
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Wheel Modification	187149	187149
Application Drawing - Rear	023077	023235
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Front and Rear	168104	168104
Hydraulic Power Pack - Front and Rear	186157	186157
Hydraulic Power Pack - Rear Only	168105	168105
Hydraulic Power Pack - Rear Only	186159	186159
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

* Recommended Safety Option

	2000 - 2004 FORD F450 4 X 2 REGULAR, SUPER & CREW CHASSIS CAB WITH DRW 15,000 GVWR HR18A1 FRONT HR2000B3 REAR	2000 - 2004 FORD F450 4 X 4 REGULAR, SUPER & CREW CHASSIS CAB WITH DRW 15,000 GVWR HR18A1 FRONT HR2000B3 REAR
REQUIRED GROUPS		
HY-RAIL® Application	198647	198647
Rear Guide Wheel Unit	196564	196546
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	198646	198646
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Wheel Modification	187149	187149
Application Drawing - Rear	024126	024126
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Front and Rear	168104	168104
Hydraulic Power Pack - Front and Rear	186157	186157
Hydraulic Power Pack - Rear Only	168105	168105
Hydraulic Power Pack - Rear Only	186159	186159
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

7

* Recommended Safety Option

	2000 - 2004 FORD F550 4 X 2 REGULAR & CREW CHASSIS CAB WITH DRW 17,500 GVWR HR18A1 FRONT HR2000B2 REAR	2000 - 2004 FORD F550 4 X 4 REGULAR & CREW CHASSIS CAB WITH DRW 17,500 GVWR HR18A1 FRONT HR2000B2 REAR
REQUIRED GROUPS		
HY-RAIL® Application	187187	187187
Rear Guide Wheel Unit	186133	186133
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	187154	187154
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Wheel Modification	187149	187149
Application Drawing - Rear	023235	023235
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Front and Rear	168104	168104
Hydraulic Power Pack - Front and Rear	186157	186157
Hydraulic Power Pack - Rear Only	168105	168105
Hydraulic Power Pack - Rear Only	186159	186159
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

* Recommended Safety Option

	2000 - 2004 FORD F550 4 X 2 REGULAR & CREW CHASSIS CAB WITH DRW 17,500 GVWR HR18A1 FRONT HR2000B3 REAR	2000 - 2004 FORD F550 4 X 4 REGULAR & CREW CHASSIS CAB WITH DRW 17,500 GVWR HR18A1 FRONT HR2000B3 REAR
REQUIRED GROUPS		
HY-RAIL® Application	198647	198647
Rear Guide Wheel Unit	196564	196564
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	198646	198646
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Wheel Modification	187149	187149
Application Drawing - Rear	024126	024126
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Front and Rear	168104	168104
Hydraulic Power Pack - Front and Rear	186157	186157
Hydraulic Power Pack - Rear Only	168105	168105
Hydraulic Power Pack - Rear Only	186159	186159
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

7

* Recommended Safety Option

2003 FORD
E550
19,000 GVWR
HR18A1 FRONT
HR2000B3 REAR

REQUIRED GROUPS

HY-RAIL® Application 201335
Rear Guide Wheel Unit 196564
Rear Unit Hydraulic Valve Piping. 181526
Mounting Brackets. 201336
Steering Lock - Dead Bolt 181548
Steering Lock - Velcro 201711
Application Drawing - Rear 024380

ACCESSORY GROUP OPTIONS

* Rail Sweeps - Rear 188391
Hydraulic Power Pack - Front and Rear 168104
Hydraulic Power Pack - Front and Rear 186157
Hydraulic Power Pack - Rear Only 168105
Hydraulic Power Pack - Rear Only 186159
Brakes
Rear Unit Brake Group 186185
Electric / Air Brake Group - Full. 163987
Electric / Air Brake Group - Abbr. 163988

* Recommended Safety Option

	2005 FORD F350 4 X 4 CHASSIS CAB WITH SRW 10,400 GVWR HR1500B2 FRONT HR2000B3-1 REAR	2005 FORD F350 4 X 4 CHASSIS CAB WITH SRW 10,400 GVWR HR1500B2 FRONT HR2000B3-1 REAR
REQUIRED GROUPS		
HY-RAIL® Application	203685	203685
Rear Guide Wheel Unit	198815	198815
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets (rear only)	203897	203897
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Wheel Modification	203476	203738
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack Group	202460	202460

* Recommended Safety Option

2005 FORD
F350 4 X 4
CHASSIS CAB
WITH SRW
11,200 GVWR
HR1500B2 FRONT
HR2000B3-2 REAR

REQUIRED GROUPS

HY-RAIL® Application 201506
Rear Guide Wheel Unit 201334
Rear Unit Hydraulic Valve Piping. 181526
Mounting Brackets 201507
Steering Lock - Dead Bolt 181548
Steering Lock - Velcro 201711
Wheel Modification 203237
Application Drawing - Rear 024422

ACCESSORY GROUP OPTIONS

* Rail Sweeps - Rear 188391
Hydraulic Power Pack Group. 201568

* Recommended Safety Option

	2005 FORD F350 4 X 4 CREW CAB PICKUP 11,200 GVWR HR0307A1 FRONT HR2000B3-1 REAR	2005 FORD F350 4 X 4 CREW CAB PICKUP 11,200 GVWR HR0307A1 FRONT HR2000B3-1 REAR
REQUIRED GROUPS		
HY-RAIL® Application	198854	198854
Rear Guide Wheel Unit	198815	198815
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	203646	203646
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Wheel Modification	203237	203738
Application Drawing - Rear	024694	024694
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Rear Only	168105	168105
Hydraulic Power Pack - Rear Only	186159	186159

* Recommended Safety Option

	2005 FORD F550 4 X 4 CHASSIS CAB WITH DRW 17,950 GVWR HR18A1-1 FRONT HR2000B3 REAR	2005 FORD F550 4 X 4 CHASSIS CAB WITH DRW 17,950 GVWR HR18A1-1 FRONT HR2000B3 REAR
REQUIRED GROUPS		
HY-RAIL® Application	203235	203235
Rear Guide Wheel Unit	196564	196564
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	198646	198646
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Wheel Modification	203233	203233
Application Drawing - Rear	024126	024126
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Front and Rear	186157	186157
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

* Recommended Safety Option

2005 FORD
F550 4 X 4
CHASSIS CAB
WITH DRW
17,950 GVWR
HR18A1-2 FRONT
HR2000B3 REAR

REQUIRED GROUPS

HY-RAIL® Application 203944
Rear Guide Wheel Unit 196564
Rear Unit Hydraulic Valve Piping. 181526
Mounting Brackets 198646
Steering Lock - Dead Bolt 181548
Steering Lock - Velcro 201711
Application Drawing - Rear 024126

ACCESSORY GROUP OPTIONS

* Rail Sweeps - Rear 188391
Hydraulic Power Pack - Front and Rear 186157
Brakes
Rear Unit Brake Group 186185
Electric / Air Brake Group - Full 163987
Electric / Air Brake Group - Abbr. 163988

* Recommended Safety Option

	2006 FORD F250 4 X 4 CREW CAB PICKUP 9,200 GVWR HR1500B-2 FRONT HR2000B3-2 REAR	2006 FORD F350 4 X 4 CREW CAP PICKUP 11,200 GVWR HR1500B-2 HR2000B3-1
REQUIRED GROUPS		
HY-RAIL® Application	201506	203685
Rear Guide Wheel Unit	201334	198815
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets	203687	———
Mounting Brackets - Rear Only	———	3410058
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
Wheel Modification		
Steel (GKN)	203688	203688
Steel (Accuride)	203738	203738
Aluminum (Accuride)	203712	203712
Application Drawing - Rear	024694	———
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
Hydraulic Power Pack - Front and Rear	202460	202460
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

* Recommended Safety Option

	2006 FORD F550 4 X 4 EXTENDED CAB CHASSIS WITH DRW 17,950 GVWR HR1900A1 FRONT HR2000B3 REAR	2006 FORD F550 4 X 4 EXTENDED CAP CHASSIS WITH DRW 17,950 GVWR HR1900A1 FRONT HR2000B3-3 REAR ①
REQUIRED GROUPS		
HY-RAIL® Application	3408706	3410751
Rear Guide Wheel Unit	196564	196564
Rear Unit Hydraulic Valve Piping	181526	181526
Mounting Brackets - Rear Only	3408681	3408681
Steering Lock - Dead Bolt	181548	181548
Steering Lock - Velcro	201711	201711
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	188391	188391
PTO / Hydraulic Groups		
Push Button Control	3408507	———
Push Button Control W/Hydraulic Locks	———	3410647
Manual Control Valves	3408509	———
Push Button W/Emergency Pump	3408510	———
Push Button W/Emergency Pump W/Hydraulic Locks	———	3410644
Electric / Hydraulic Groups		
Push Button Control	3408646	———
Push Button Control W/Hydraulic Locks	———	3410646
Push Button W/Emergency Pump	3408511	———
Push Button W/Emergency Pump W/Hydraulic Locks	———	3410645
Brakes		
Rear Unit Brake Group	186185	186185
Electric / Air Brake Group - Full	163987	163987
Electric / Air Brake Group - Abbr.	163988	163988

* Recommended Safety Option

① Rear Unit With Double P.O. Check Valves

7

2008 FORD
F350 4 X 4
REGULAR CAB
PICKUP
10,000 GVWR
HR0307A1 FRONT
HR2000B3-1 REAR

REQUIRED GROUPS

HY-RAIL® Application 3411013
Rear Guide Wheel Unit 198815
Rear Unit Hydraulic Valve Piping. 181526
Mounting Brackets - Rear Only 3411231
Steering Lock - Dead Bolt 181548
Steering Lock - Velcro 201711
Wheel Modification 203738

ACCESSORY GROUP OPTIONS

* Rail Sweeps - Rear 188391
Hydraulic Power Pack - Manual Lock 186159

* Recommended Safety Option

NOTES

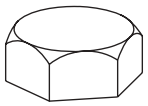
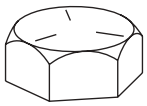
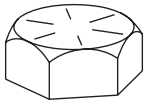
APPENDIX A - CONVERSION TABLES
TABLE OF CONTENTS

Appendix A

FIGURE A-1
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

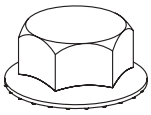
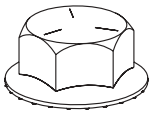
SAE Grade	1 or 2				5				8			
Fastener Standard SAE Grade Markings												
Fastener Body Size Inch-Thread	**Torque**				**Torque**				**Torque**			
	Wet		**Dry**		**Wet**		**Dry**		**Wet**		**Dry**	
	lb-in	N-m	lb-in	N-m	lb-in	N-m	lb-in	N-m	lb-in	N-m	lb-in	N-m
1/4 - 20	49	5.5	65	7.3	75	8.5	100	11.3	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

FIGURE A-2
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

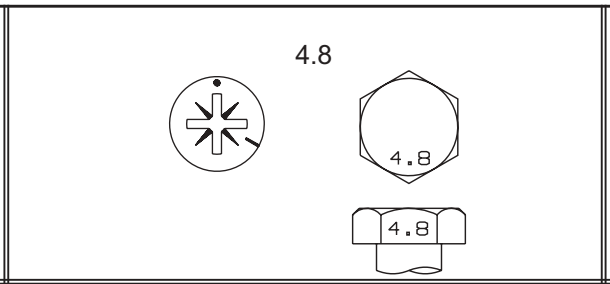
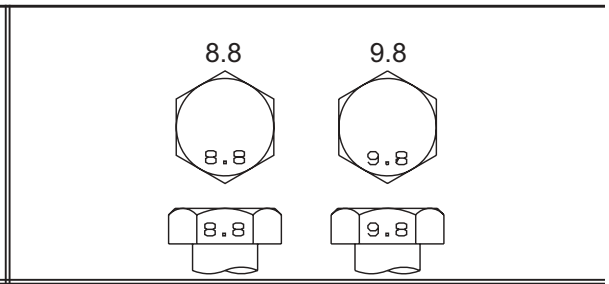
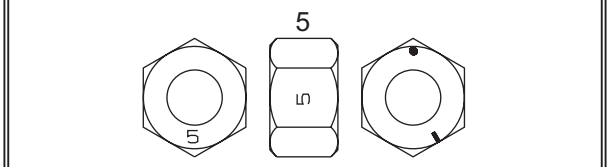
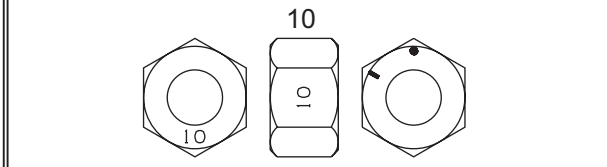
SAE Grade	**1 or 2**				5			
Fastener Standard SAE Grade Markings								
Fastener Body Size Inch-Thread	**Torque**				**Torque**			
	Wet		**Dry**		**Wet**		**Dry**	
	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m
1/4 - 20	8	10.8	11	14.9	11	14.9	15	20.3
1/4 - 28	9	12.2	12	16.3	12	16.3	16	21.7
5/16 - 18	13	17.6	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

FIGURE A-3
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.

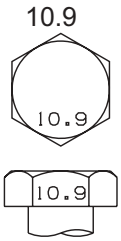
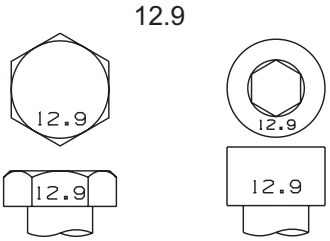
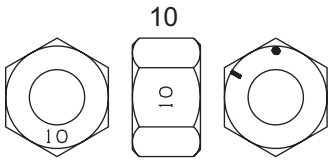
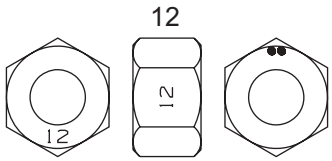
Property Class and Head Markings								
Property Class and Head Markings								
Size	Class 4.8				Class 8.8 or 9.8			
	* Lubricated		* Dry		* Lubricated		* Dry	
	N - m	lb - ft	N - m	lb - ft	N - m	lb - ft	N - m	lb - ft
M 6	4.8	3.5	6	4.5	9	6.5	11	8.5
M 8	12	8.5	15	11	22	16	28	20
M10	23	17	29	21	43	32	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

FIGURE A-4
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								
Property Class and Head Markings								
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

Appendix A

FIGURE A-5
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

A

FIGURE A-6
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

FIGURE A-7
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

FIGURE A-8
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

FIGURE A-9
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

FIGURE A-10
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

FIGURE A-11
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

FIGURE A-12
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

NOTES

APPENDIX B - SAE J1273

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

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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.

TABLE OF CONTENTS

B

SAE J1273 Revised AUG2004

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 PUBLICATION—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.

B

SAE J1273 Revised AUG2004

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.

B

SAE J1273 Revised AUG2004

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.

B

SAE J1273 Revised AUG2004

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)

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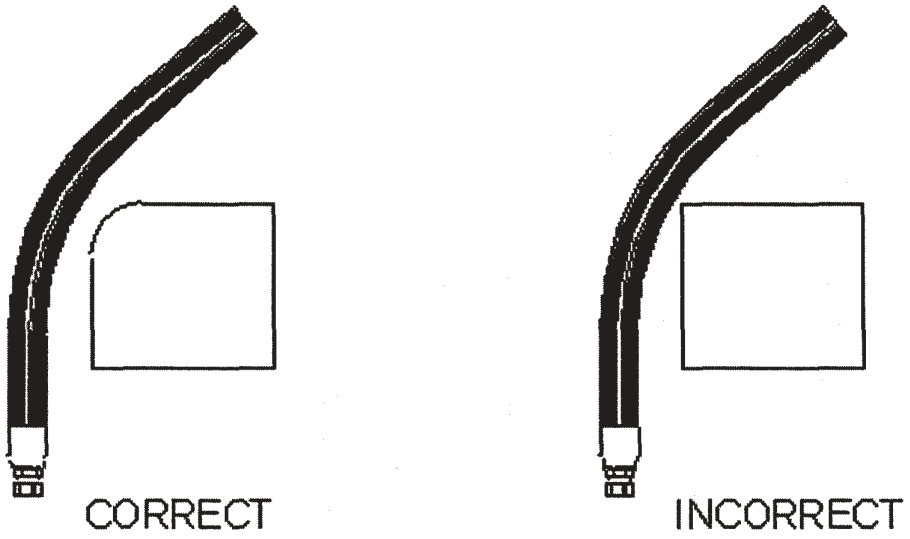

FIGURE 1—PREVENTION OF EXTERNAL DAMAGE

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).

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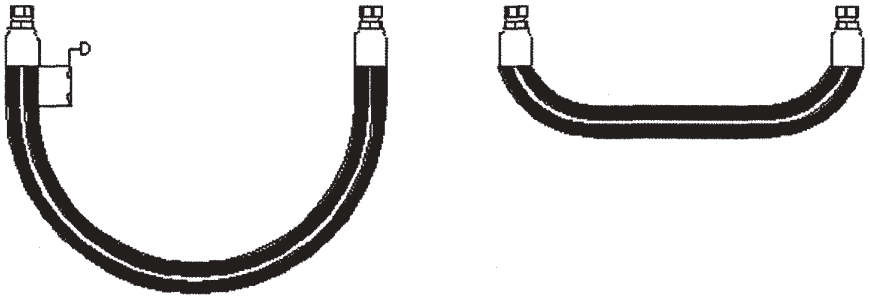

FIGURE 2A—MINIMUM BEND RADIUS

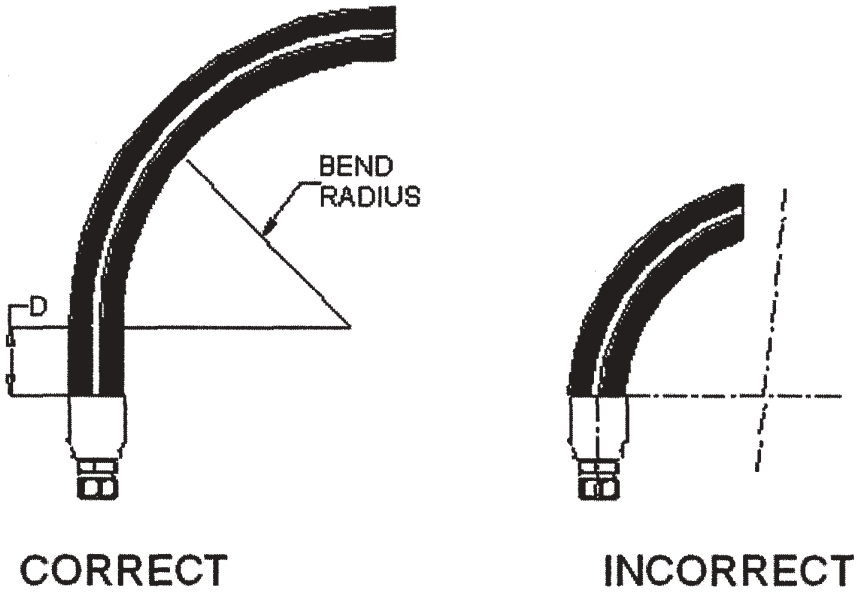

FIGURE 2B—MINIMUM BEND RADIUS

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

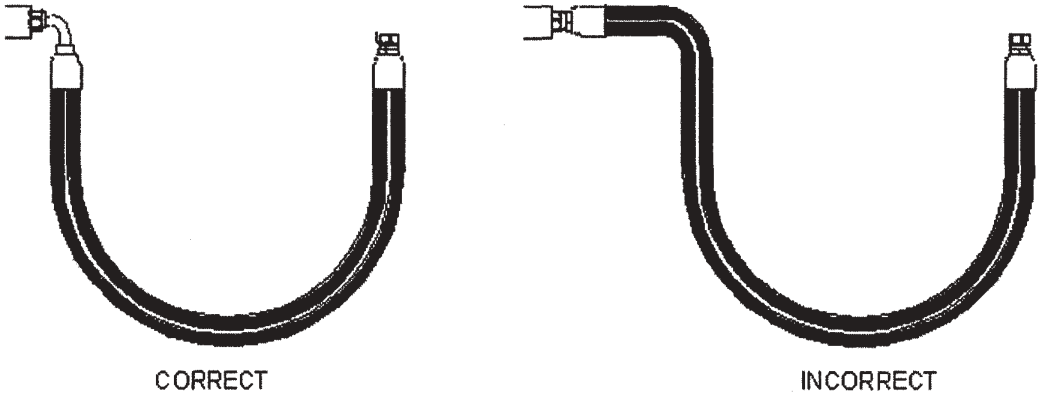

FIGURE 3—ELBOWS AND ADAPTERS

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.

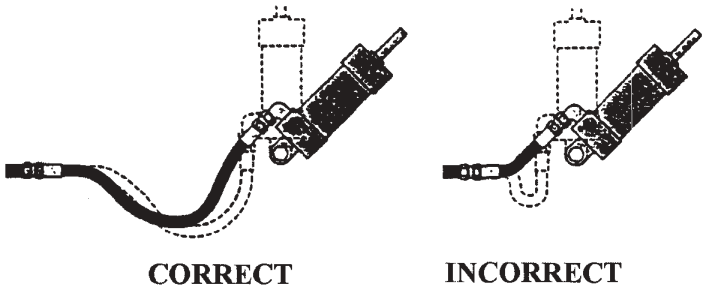

FIGURE 4—MOTION ABSORPTION

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

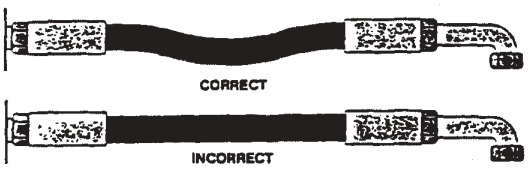

FIGURE 5—HOSE AND MACHINE TOLERANCES

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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.

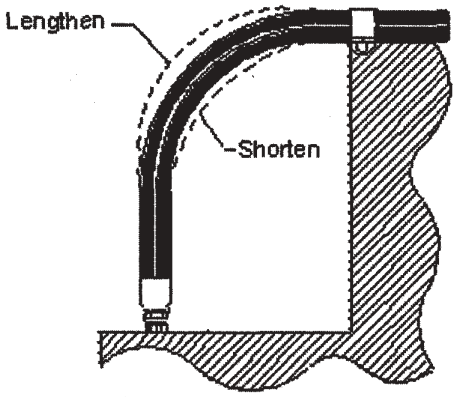

FIGURE 6—HOSE LENGTH CHANGE DUE TO PRESSURE

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

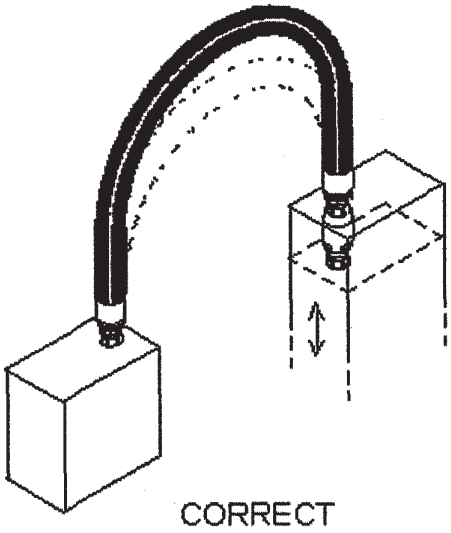

FIGURE 7A—BEND IN ONLY ONE PLANE TO AVOID TWISTING

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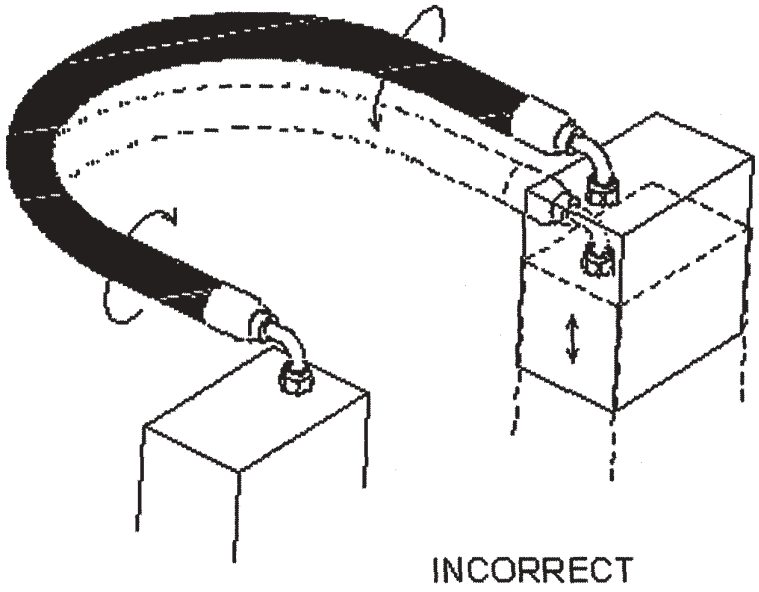

FIGURE 7B—BEND IN ONLY ONE PLANE TO AVOID TWISTING

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.

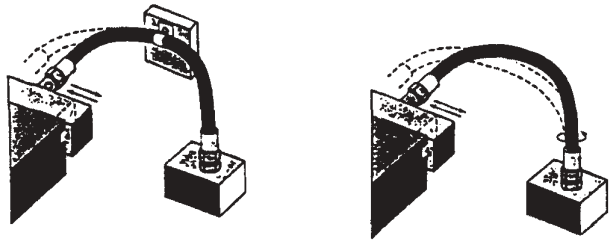

FIGURE 8—PREVENT HOSE BENDING IN MORE THAN ONE PLANE

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.

B

SAE J1273 Revised AUG2004

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 nonconformities
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.

B

SAE J1273 Revised AUG2004

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).

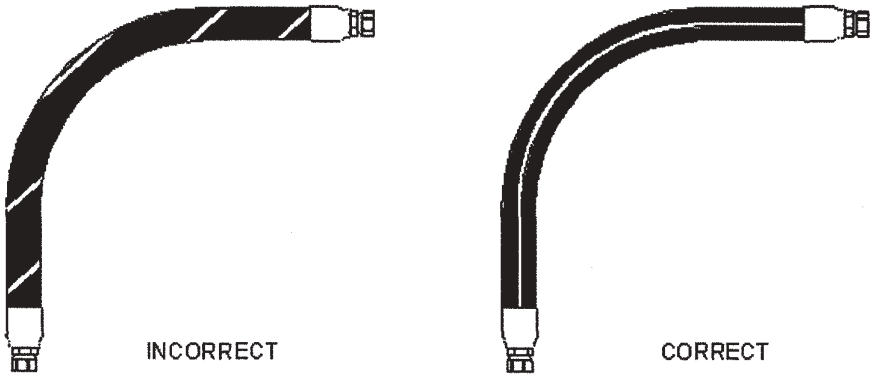

FIGURE 9—TWIST ANGLE AND ORIENTATION

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.

B

SAE J1273 Revised AUG2004

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.

B

SAE J1273 Revised AUG2004

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

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SAE J1273 Revised AUG2004

Rationale—To correct verbiage in Section 9.1.

Relationship of SAE Standard to ISO Standard—Not applicable.

Application—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.

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

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