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Harsco Track Technologies

Harsco

HR4500 SERIES A

REAR UNIVERSAL HY-RAIL®
GUIDE WHEEL UNIT
HYDRAULICALLY OPERATED

OPERATOR'S SERVICE AND PARTS MANUAL

ISSUED 10 - 2006 BULLETIN 1521

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

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

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SECTION 1 - GENERAL INFORMATION
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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 - Immediate hazards which WILL result in sever bodily injury or death.

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

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.**
- **DO NOT EXCEED 25 MPH (40 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.**

1

1.1 Safety Information

- **AT MAXIMUM LOADED GROSS VEHICLE WEIGHT ON TRACK (including driver, passengers, equipment, tools, payload, etc.) DO NOT EXCEED ANY OF THE FOLLOWING:**
  - **VEHICLE'S G.V.W.R. (Gross Vehicle Weight Rating).**
  - **VEHICLE'S FRONT G.A.W.R. (Gross Axle Weight Rating) OR THE 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 THE REAR GUIDE WHEEL UNIT 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:**
      25,000 lbs (11,340 kg)
      12,500 lbs (5,670 kg) maximum per guide wheel

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

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

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

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

1.2 Description

The HR4500 Series A Rear HY-RAIL® guide wheel equipment can be applied to the rear of various cab chassis trucks with single or tandem rear axles and dual wheels. 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 guide wheel unit is raised and lowered hydraulically. Hydraulic power may be supplied from the vehicle system or from an optional power pack. The guide wheel unit is mounted onto the vehicle frame. When the guide wheels are in the "highway" position, the weight of the guide wheel unit is carried on the vehicle frame, above the springs. When the guide wheels are in the "rail" position, load bearing guide wheels assemblies guide the vehicle. The guide wheel unit uses a combination of the guide wheel unit spring suspension and the vehicle suspension to support the load on the rear of the vehicle while on rail.

The vehicle's rear inner dual wheels are used for propulsion on the track. On track braking is provided by the vehicle's rear brakes, rear guide wheel unit's brakes and the front guide wheel unit's brakes, if so equipped. Since the guide wheel unit 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 brakes.

1.3 Vehicle Orientation

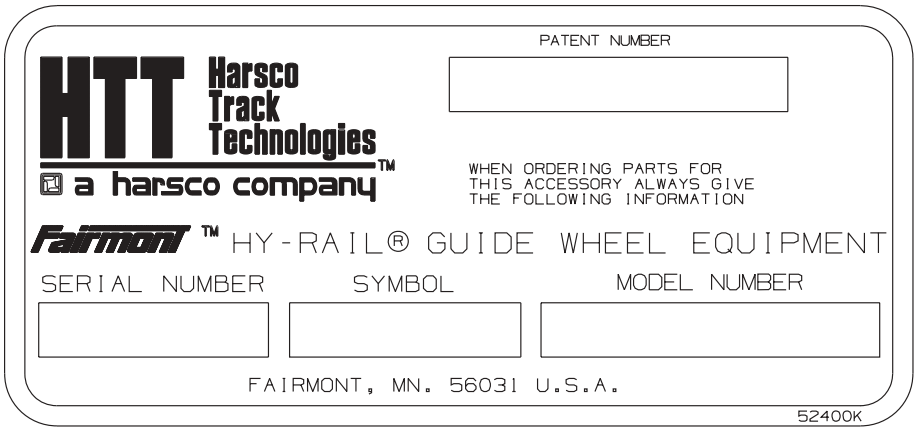
Front - rear and left - right are determined from the vehicle operator's seat.

1

1.4 Serial Numbers

When this bulletin is received, complete the following record from the serial number tag 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
GUIDE WHEEL UNIT SERIAL NUMBER TAG



1.5 Specifications

1.5.1 Vehicle

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

1.5.2 HR4500 Series A Rear Guide Wheel Unit

Track Gauge	56-1/2 in	(1435 mm)
Guide Wheels - Flange Diameter	18 in	(457 mm)
- Tread Diameter	16 in	(406 mm)
Weight	1,650 lbs	(748 kg)
* Maximum Load Capacity	25,000 lbs	(11,340 kg)
* Maximum Load Per Guide Wheel	12,500 lbs	(5,670 kg)

* *The vehicle's rear inner dual 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 inner dual wheels when on track.*

SECTION 2 - OPERATION
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2.1 Preparing Vehicle for Operation

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

a. Engine oil level.
b. Radiator fluid level.
c. Fuel tank level.
d. Hydraulic reservoir oil level.
e. Brakes work properly.
f. Parking brake works properly.
g. Head, brake and signal lights work properly.
h. Tires properly inflated to the manufacturer's recommended maximum pressure printed on the sidewall of the tires, or the 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.

2.2 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 mileage intervals.
e. Brakes work properly.
f. Hydraulic pressure properly adjusted.

2.3 Misalignment Indicators

■ **BEFORE OPERATING A VEHICLE WITH NEWLY INSTALLED GUIDE WHEEL EQUIPMENT ON TRACK, VERIFY THAT THE 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 - Guide Wheel Equipment Alignment Procedure.

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

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

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

2.4 Placing Vehicle On Track

- **PLACE VEHICLE AUTOMATIC TRANSMISSION IN "PARK" OR MANUAL TRANSMISSION IN "NEUTRAL". APPLY THE PARKING BRAKE.**
- **UNDERSTAND EQUIPMENT OPERATION AND BE AWARE OF ALL PINCH POINTS BEFORE OPERATING OR MAKING ADJUSTMENTS TO GUIDE WHEEL EQUIPMENT.**
- **BEFORE PROPELLING VEHICLE ON THE TRACK, MAKE SURE:**
  - **FRONT AND REAR GUIDE WHEELS ARE LOWERED AND LOCKED IN RAIL POSITION, AND SECURED WITH LOCK PIN.**
  - **ALL RAIL GUIDE WHEEL FLANGES ARE ENGAGED ON INSIDE RAIL.**
  - **VEHICLE FRONT TIRES MUST BE RAISED A MINIMUM OF 1-1/2" (38 mm) ABOVE THE RAIL.**
  - **FRONT WHEELS ARE POINTED STRAIGHT AHEAD AND 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.

2.4 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 vehicle automatic transmission in "PARK" or 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.

5. Lower and lock 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 wheel unit with the rails.

2.4.1 Lower Rear Guide Wheels - See Figure 2-1

1. Remove lock pin (1). Button in "T" end of the pin must be pressed in to remove the pin.

2. Raise the guide wheel unit slightly by pulling control valve handle (2) out to release pressure on the mechanical lock mechanism.

3. Rotate and hold lock handle (3) counter-clockwise to release the locking mechanism. While holding lock handle (3) in the released position, push control valve handle (2) in to lower the guide wheels.

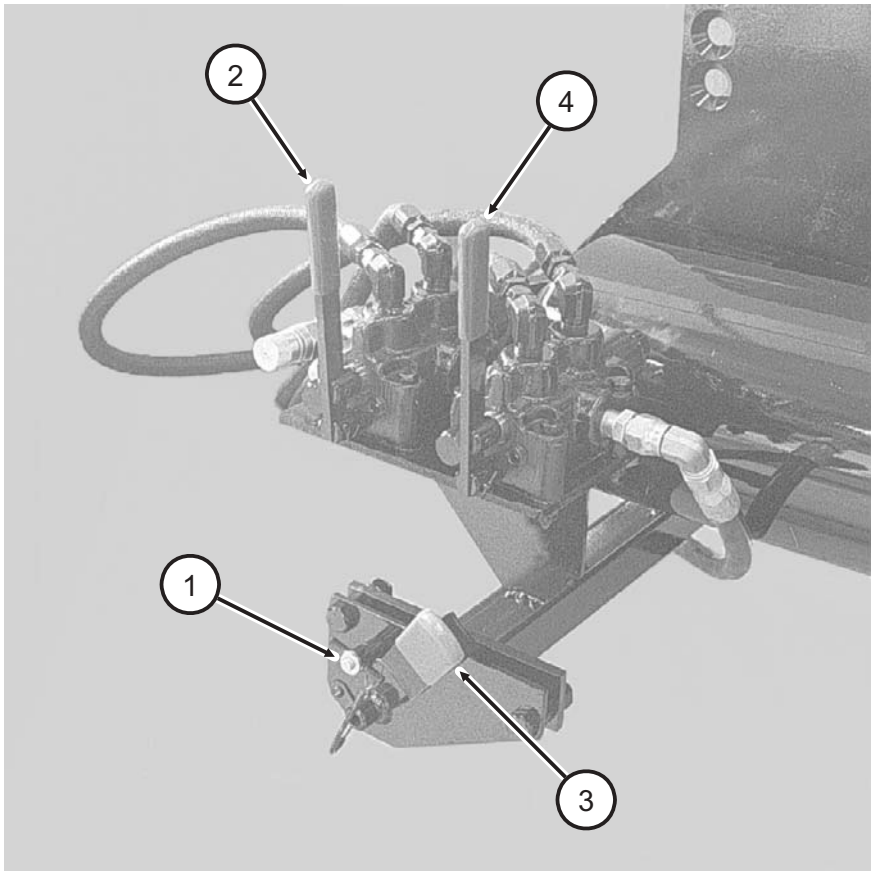
4. The guide wheel unit is equipped with side shift. The guide wheel axle can be shifted to align the guide wheels with the rail. Push control valve handle (4) in to shift the guide wheels to the right. Pull control valve handle (4) out to shift the guide wheels to the left. After shifting the guide wheels to align with the rail, continue to lower the guide wheels. The side shift self-centering mechanism will bring the vehicle into alignment with the rails.

5. As the guide wheels lower, release lock handle (3). Continue to lower the guide wheels until the wheel flanges are engaged on the inside of the rail and the lock is engaged. Release control valve handle (2).

6. Install lock pin (1) through the hole in the guide wheel unit frame to secure the mechanical lock.

2.4 Placing Vehicle On Track

FIGURE 2-1
REAR GUIDE WHEEL UNIT CONTROLS



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7. Lower the front guide wheels. See the Operator's Service and Parts manual provided with the front guide wheel unit.

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.

2.4 Placing Vehicle On Track

2.4.2 Steering Locks - See Figures 2-2, 2-3, 2-4, 2-5, 2-6 and 2-7

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 DISENGAGED

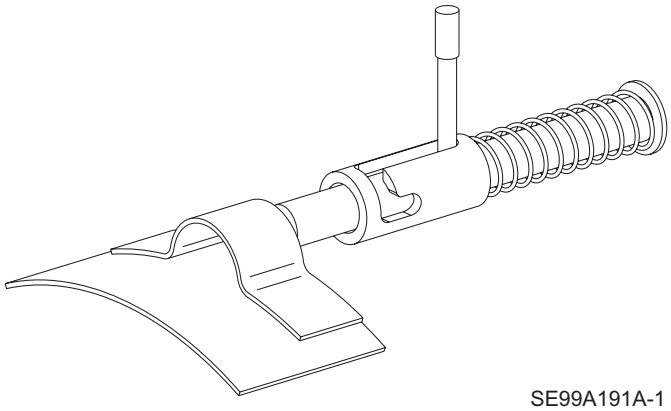

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FIGURE 2-3
STEERING LOCK ENGAGED

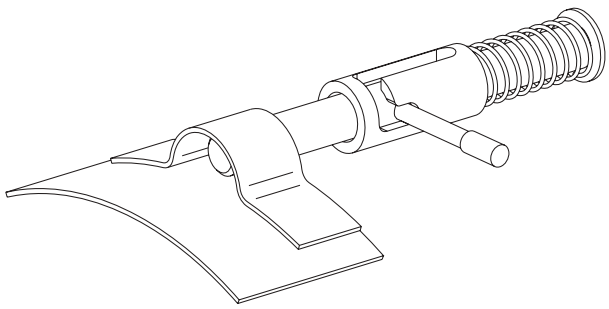

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FIGURE 2-4
STEERING LOCK DISENGAGED

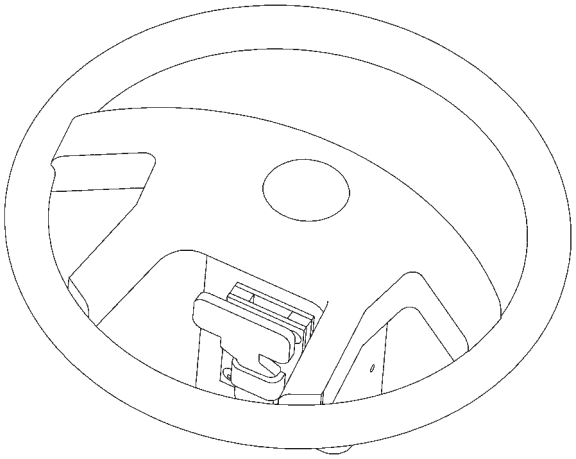
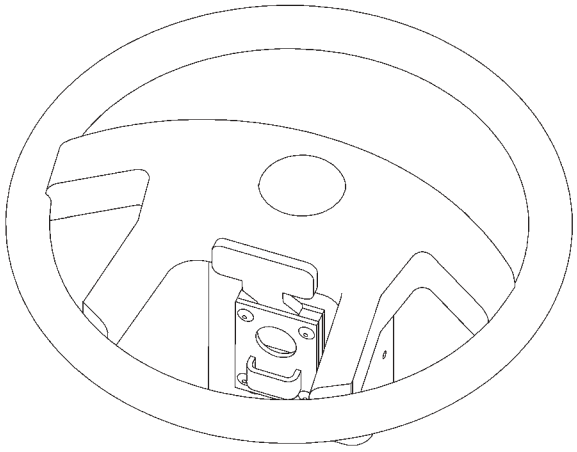


FIGURE 2-5
STEERING LOCK ENGAGED



2.4 Placing Vehicle On Track

2.4.2 Steering Locks

FIGURE 2-6
VELCRO STEERING LOCK OFF

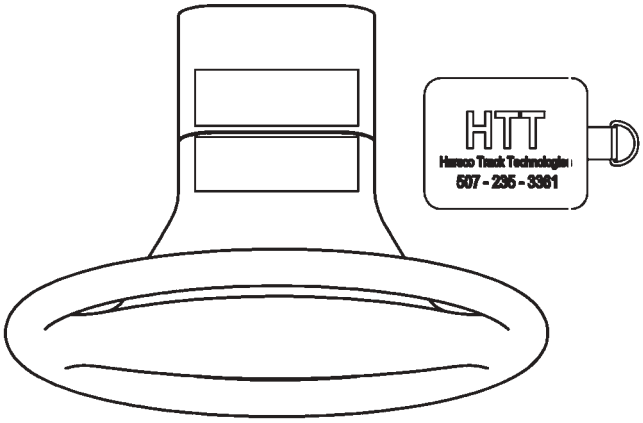
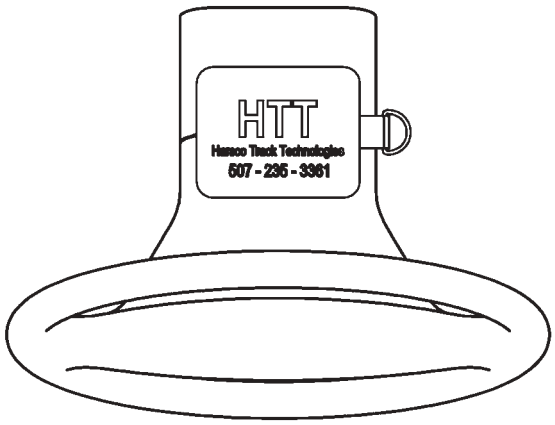


FIGURE 2-7
VELCRO STEERING LOCK ON



2.4.3 Rail Brakes

If 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.

NOTES

2.5 Guide Wheel Load On Track

- **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. THE MAXIMUM RATED LOAD ON THE REAR GUIDE WHEEL UNIT IS 25,000 LBS (11,340 kg) OR 12,500 LBS (5,670 kg) MAXIMUM PER GUIDE WHEEL.**
- **THE REAR GUIDE WHEEL UNIT MUST BE SET TO CARRY APPROXIMATELY 33% OF THE VEHICLE REAR AXLE CURB WEIGHT OR A MINIMUM OF 4,594 LBS (2,084 kg).**
- **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.

Whenever the vehicle is loaded or additional load is added to the existing vehicle load on track, check the load on the rear guide wheels. The maximum load on the rear guide wheel unit is 25,000 lbs (11,340 kg) or 12,500 lbs (5,670 kg) maximum per guide wheel. Also, check the load on the front guide wheel unit. 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 wheel unit.

2.5 Guide Wheel Load On Track

2.5.1 Checking Rear Guide Wheel Load - See Figure 2-8 and Chart 2-9

To check the load on the rear guide wheels it is necessary to measure the deflection of the coil springs in the guide wheel unit's suspension system. Use the following procedure to check the load on the rear guide wheels. Make sure the front guide wheels are in the rail position. See Placing Vehicle On Track.

1. Apply the parking brake. Stop the vehicle's engine.

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

3. The minimum rated load capacity of the rear guide wheel unit is 33% of the vehicle's rear axle curb weight, or at least 4,594 lbs (2,084 kg) total or 2,297 lbs (1,042 kg) per guide wheel.

   If the calculated rear guide wheel load does not meet the minimum rated load capacity of the rear guide wheel unit, total or per guide wheel, the rear guide wheel unit load must be re-adjusted. See the Adjustment Section - Guide Wheel Alignment Procedure. Never operate the vehicle on track if the calculated load on the rear guide wheel unit does not meet the minimum rated load capacity of 4,594 lbs (2.084 kg) total or 2,297 lbs (1,042 kg) per guide wheel.

4. The maximum rated load capacity of the rear guide wheel unit is 25,000 lbs (11,340 kg) or 12,500 lbs (5,670 kg) maximum per guide wheel.

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

   If the calculated rear guide wheel load does exceed the maximum rated load capacity of the rear 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 calculated load on the rear guide wheel unit exceeds the maximum rated load capacity of 25,000 lbs (11,340 kg) or 12,500 lbs (5,670 kg) maximum per guide wheel.

2.5 Guide Wheel Load On Track

2.5.1 Checking Rear Guide Wheel Load

FIGURE 2-8
REAR SPRING CELL

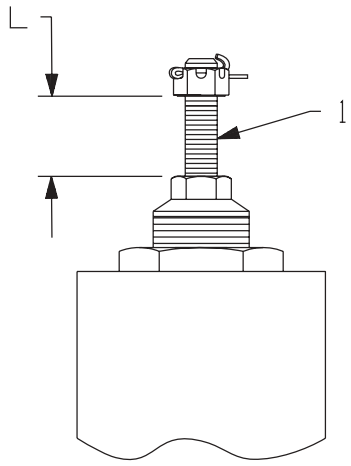


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CHART 2-9
REAR GUIDE WHEEL LOAD

DIMENSION L		APPROXIMATE LOAD PER SIDE	
1/2"	(12.7 mm)	2,300 lbs	(1,040 kg)
3/4"	(19.1 mm)	3,200 lbs	(1,450 kg)
1"	(25.4 mm)	4,100 lbs	(1,850 kg)
1-1/4"	(31.8 mm)	4,950 lbs	(2,250 kg)
1-1/2"	(38.1 mm)	5,850 lbs	(2,660 kg)
1-3/4"	(44.5 mm)	6,750 lbs	(3,060 kg)
2"	(50.8 mm)	7,650 lbs	(3,460 kg)
2-1/4"	(57.2 mm)	8,550 lbs	(3,870 kg)
2-1/2"	(63.5 mm)	9,400 lbs	(4,270 kg)
2-3/4"	(69.9 mm)	10,300 lbs	(4,680 kg)
3"	(76.2 mm)	11,200 lbs	(5,080 kg)
3-1/4"	(82.6 mm)	12,100 lbs	(5,480 kg)
*** 3-1/2"**	**(88.9 mm)**	**13,000 lbs**	**(5,890 kg)**

* **REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 25,000 LBS (11,340 kg) OR 12,500 LBS (5,670 kg) MAXIMUM PER GUIDE WHEEL.**

2.6 Vehicle Front Tire Clearance Above Rail

1. If the vehicle's front tire clearance above the rail is less than 1-1/2" (38 mm) see the Adjustment Section in the Operator's Service and Parts Manual provided with the front guide wheel unit. Never operate the vehicle on track when the front tire clearance above the rail is less than 1-1/2" (38 mm).

2.7 Propelling On Track

- **IMPROPER LOADING OF THE HY-RAIL® EQUIPPED VEHICLE CAN CAUSE DERAILMENT OF VEHICLE.**
- **ALWAYS CHECK GUIDE WHEEL LOAD BEFORE OPERATING THE VEHICLE ON TRACK.**
- **NEVER OPERATE VEHICLE ON TRACK IF LOAD EXCEEDS MAXIMUM RATED LOAD OF FRONT AND/OR REAR GUIDE WHEEL UNITS.**
- **NEVER OPERATE VEHICLE ON TRACK IF CLEARANCE BETWEEN VEHICLE FRONT TIRE 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.

- **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 25 MPH 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 THE VEHICLE.**
  - **STEERING LOCK MUST BE ENGAGED AT ALL TIMES WHEN OPERATING 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 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.

Vehicles equipped with the HR4500 Series A Rear 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 EQUIPPED, RAIL WHEEL BRAKE CONTROL VALVE MUST BE IN THE ON POSITION WHENEVER THE VEHICLE IS ON TRACK.**

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

Vehicles equipped with the HR4500 Series A Rear HY-RAIL® Guide Wheel Equipment use a combination of the vehicle's rear brakes and optional front or rear guide wheel unit brakes for braking on track. The guide wheel unit brakes will apply simultaneously when the vehicle brakes are applied. 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.

2.8.1 Vehicles with Anti-Lock Brake Systems (ABS)

While operating on track, the ABS becomes ineffective in brake application at lower speeds. If the ABS is active and the truck is moving on rail with front wheels elevated, an indicator on the dash may come on. Since the front wheels are not rotating, the motion sensors may transmit a fault indication to the ABS Electronic Control Unit (ECU), which signals the dash indicator to illuminate. This will not affect rear truck braking or rail wheel braking.

When the vehicle is returned to highway operation, the ABS fault must be cleared or the ABS will not function correctly and the indicator will remain illuminated. The fault can be cleared by stopping and restarting the vehicle's engine. When the engine is restarted, the ABS ECU will run a diagnostic check and the fault should be cleared. If the ABS fault does not clear, contact the brake system manufacture for assistance.

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 CAUSE DERAILMENT OF THE VEHICLE RESULTING IN SEVERE BODILY INJURY AND/OR DEATH.

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 VEHICLE AUTOMATIC TRANSMISSION IN "PARK" OR MANUAL TRANSMISSION IN "NEUTRAL". APPLY THE PARKING BRAKE.**
- **UNDERSTAND EQUIPMENT OPERATION AND BE AWARE OF ALL PINCH POINTS BEFORE OPERATING OR MAKING ADJUSTMENTS TO GUIDE WHEEL EQUIPMENT.**
- **BEFORE PROPELLING VEHICLE OFF TRACK, MAKE SURE:**
  - **FRONT AND REAR GUIDE WHEEL UNITS ARE RAISED, LOCKED IN HIGHWAY POSITION, AND SECURED WITH LOCK PIN.**
  - **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 THE VEHICLE ON TRACK AND WHEN REMOVING THE VEHICLE FROM THE 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 the track. Flag the crossing per railroad rules and regulations to ensure safety.

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

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

4. If 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 the front guide wheels first. See the Operator's Service and Parts Manual provided with the front guide wheel unit.

2.10.1 Raising Rear Guide Wheels - See Figure 2-10

1. Remove lock pin (1). Button in "T" end of the pin must be pressed in to remove the pin.

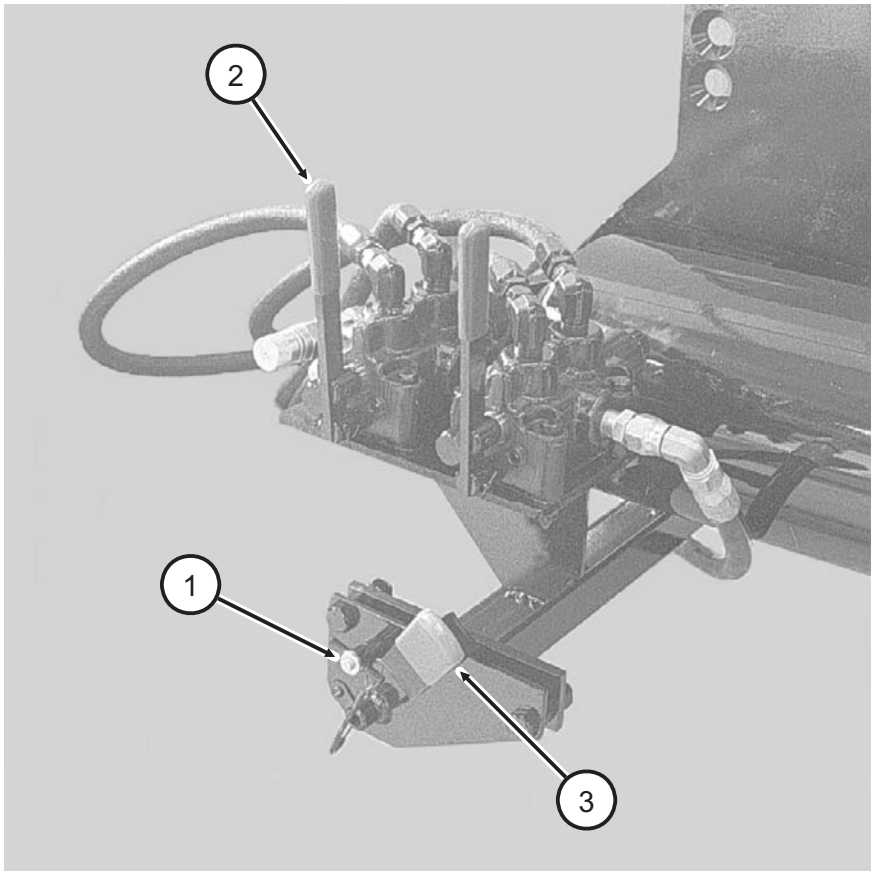
2. Push control valve handle (2) in to release pressure on the mechanical lock mechanism.

3. Rotate and hold lock handle (3) counter-clockwise to release the locking mechanism. While holding lock handle (3), pull control valve handle (2) out to raise the guide wheels.

4. As the guide wheels raise, release lock handle (3). Continue to raise the guide wheels until they are in the "highway" position and the lock is engaged. Release control valve handle (2).

5. Install lock pin (1) through the hole in the guide wheel unit frame to secure the mechanical lock.

FIGURE 2-10
REAR GUIDE WHEEL UNIT CONTROLS



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2.10 Removing Vehicle From Track

6. 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.

7. See Figures 2-11, 2-12, 2-13, 2-14, 2-15 and 2-16. Disengage the vehicle steering lock located on the steering column. Steering locks may vary from vehicle to vehicle but will operate similarly.

FIGURE 2-11
STEERING LOCK DISENGAGED

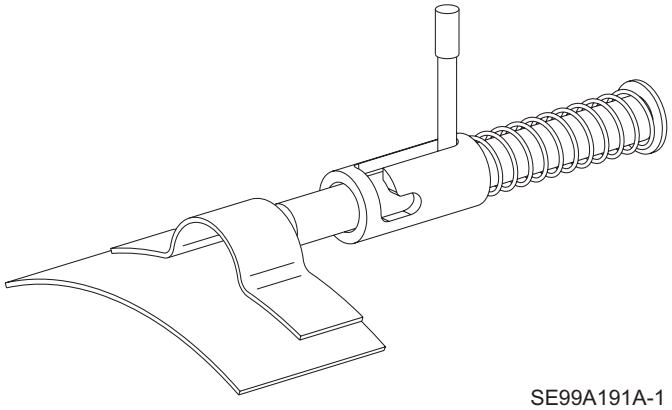

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FIGURE 2-12
STEERING LOCK ENGAGED

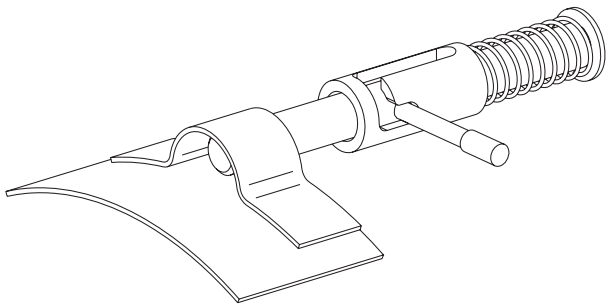

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FIGURE 2-13
STEERING LOCK DISENGAGED

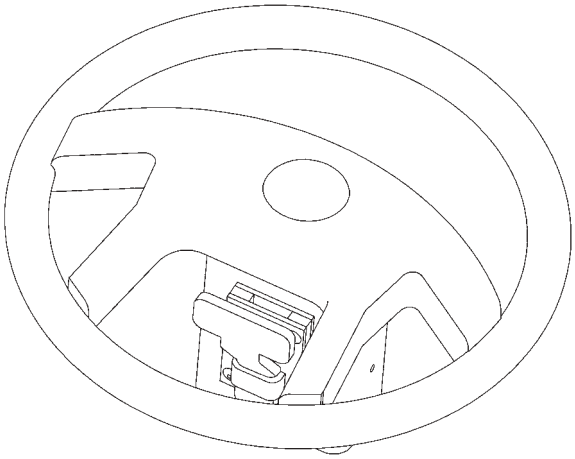
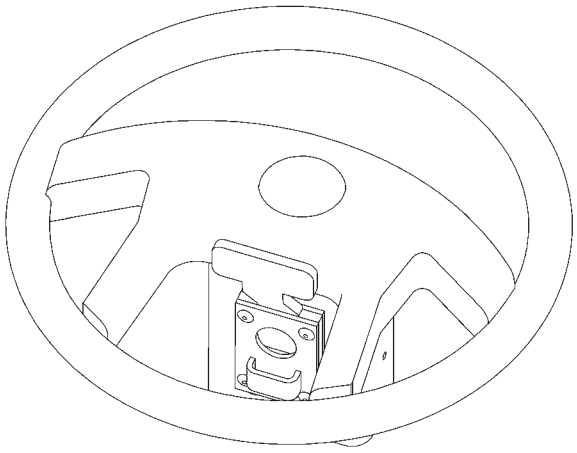


FIGURE 2-14
STEERING LOCK ENGAGED



2.10 Removing Vehicle From Track

FIGURE 2-15
VELCRO STEERING LOCK OFF

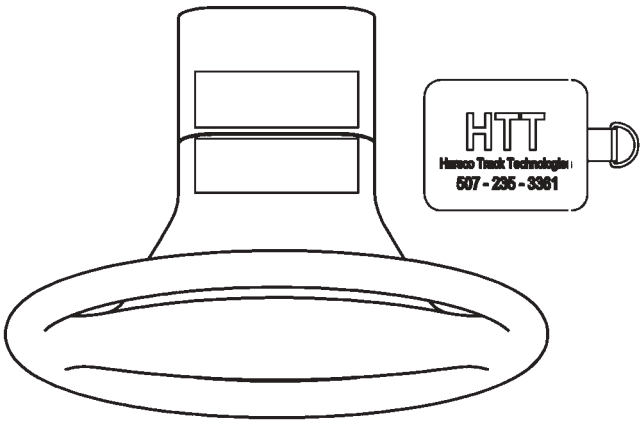
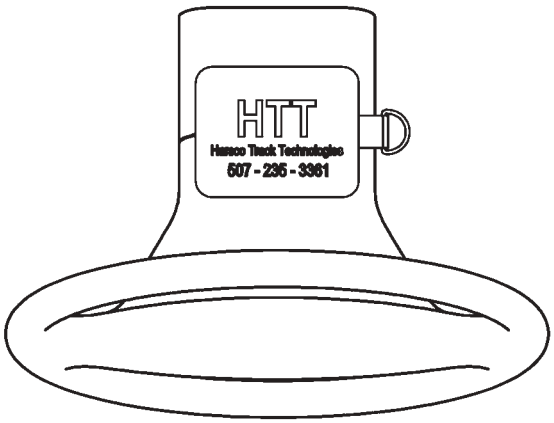


FIGURE 2-16
VELCRO STEERING LOCK ON



2.11 Highway Operation

■ **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 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 THE RAIL POSITION.**
  - **ALL GUIDE WHEEL FLANGES ARE ENGAGED ON INSIDE OF RAILS.**
  - **VEHICLE FRONT TIRES MUST BE RAISED A MINIMUM OF 1-1/2" (38 mm) ABOVE 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 guide wheel flanges are engaged on the inside of the rails.
   c. 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.**
  - **IF EQUIPPED, AXLE HOOKS MUST BE FULLY DISENGAGED FROM UNDER VEHICLE FRONT AXLE.**
  - **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. If equipped, axle hooks must be fully disengaged from under the vehicle front axle.
   c. 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 RAIL POSITION.**
  - **ALL GUIDE WHEEL FLANGES ARE ENGAGED ON INSIDE OF RAILS.**
  - **VEHICLE FRONT TIRES MUST BE RAISED A MINIMUM OF 1-1/2" (38 mm) ABOVE 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 guide wheel flanges are engaged on the inside of the rails.
   c. 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 HIGHWAY POSITION.**
  - **IF EQUIPPED, AXLE HOOKS MUST BE FULLY DISENGAGED FROM UNDER VEHICLE FRONT AXLE.**
  - **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. If equipped, axle hooks must be fully disengaged from under the vehicle front axle.
   c. 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.

NOTES

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

See The Operator's Service and Parts Manual provided with the front guide wheel unit for the proper alignment procedure for the front 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. These weights will be used when calculating the guide wheel load.

3. 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).

4. 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).

5. 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.

6. 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

7. Verify that the vehicle the guide wheel equipment is being mounted on is equipped correctly (springs, tires, wheels, etc.). See the Harsco Track Technologies HY-RAIL® Vehicle Specifications Manual.

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

    a. Frame must be square. Diagonal measurements of 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.

9. 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.

10. After mounting the guide wheel equipment, have a four point alignment completed 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.

11. Have the headlight aim checked and adjusted, if necessary.

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 56-1/2 inches (1.435 m) between the inside edges.

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

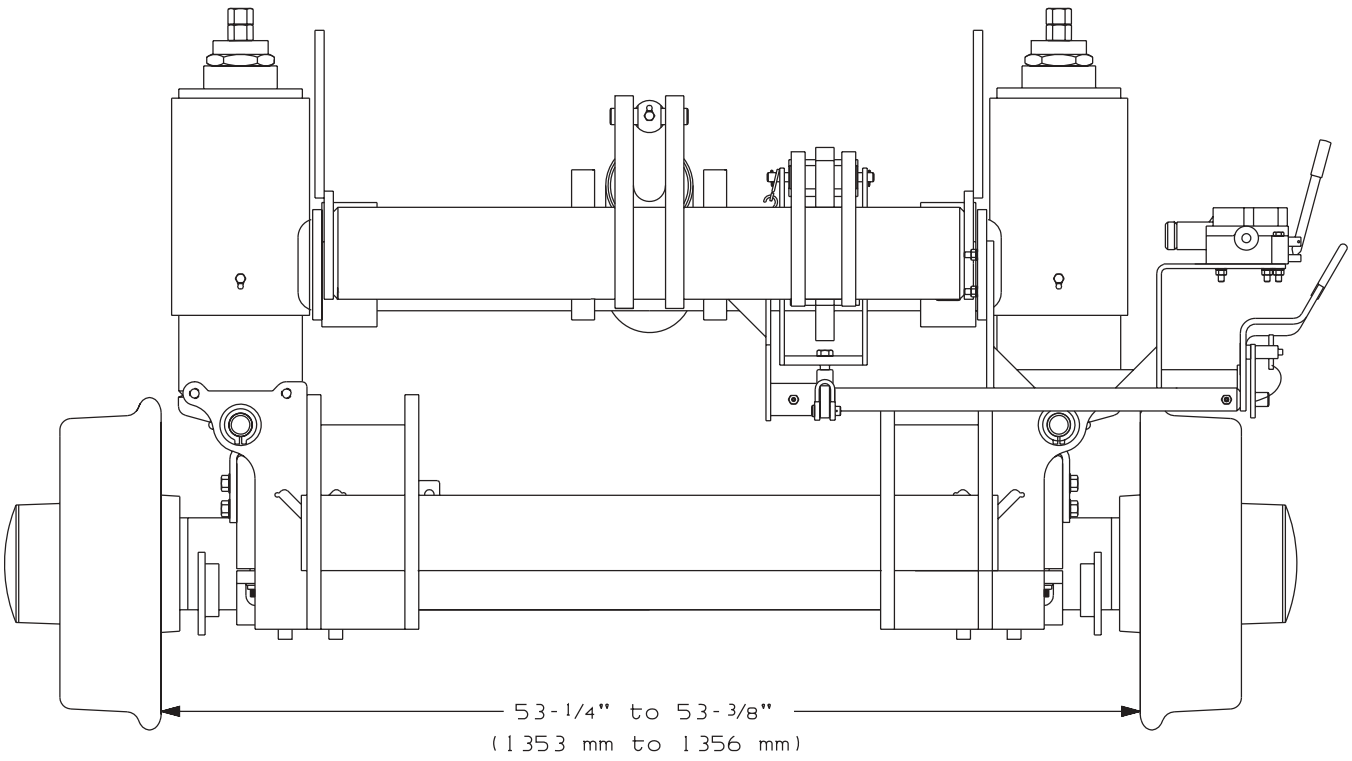
3. Set the vehicle's front wheels straight ahead. Secure the steering wheel using the steering lock. Stop the engine.

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 53-1/4 to 53-3/8 inches (1353 mm to 1356 mm). The back flange gauge is preset at the factory and is non-adjustable.

FIGURE 3-1
GUIDE WHEEL 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. THE MAXIMUM LOAD ON THE REAR GUIDE WHEEL UNIT IS 25,000 LBS (11,340 kg) OR 12,500 LBS (5,670 kg) MAXIMUM PER GUIDE WHEEL.**
- **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.

Whenever the vehicle is loaded or additional load is added to the existing vehicle load on track, check the load on the rear guide wheels. The maximum load on the rear guide wheel unit is 25,000 lbs (11,340 kg) or 12,500 lbs (5,670 kg) maximum per guide wheel.

Also, check the load on the front guide wheel unit. 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 wheel unit.

3.1.4.1 Checking Rear Guide Wheel Load

To check the load on the rear guide wheels it is necessary to measure the deflection of the coil springs in the guide wheel unit's suspension system. Use the following procedure to check the load on the rear guide wheels. Make sure the front guide wheels are in the rail position. See Placing Vehicle On Track.

1. The rear guide wheel unit is equipped with two adjustable spring cells. The rear guide wheel unit should be initially adjusted to carry approximately 33% of the vehicle’s rear axle curb weight or a minimum of 4,594 lbs (2,084 kg) with the remainder of the weight being carried by the rear, inner dual tires when the vehicle is on "rail".

2. 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 guide wheels. The maximum rated load on the rear guide wheel unit is 25,000 lbs (11,340 kg) or 12,500 lbs (5,670 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 - See Figure 3-2 and Chart 3-3

3. The protrusion of the spring cell rods (dimension L) can be used to determine the load on the rear guide wheels. Measure dimension L on both spring cells. See Chart 3-3 to convert dimension (L) to the load on the guide wheel.

FIGURE 3-2
REAR SPRING CELL

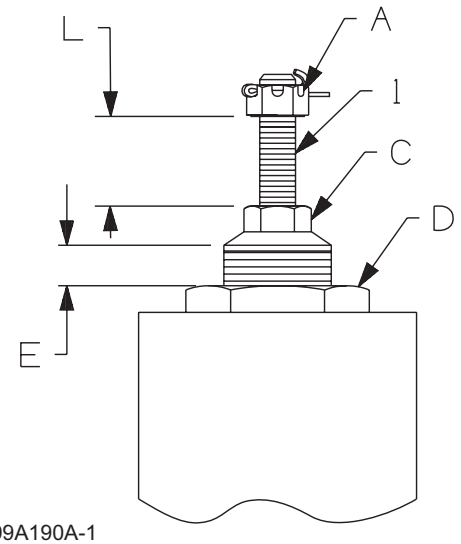

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CHART 3-3
REAR GUIDE WHEEL LOAD

	DIMENSION L	APPROXIMATE LOAD PER SIDE
1/2"	(12.7 mm).	2,300 lbs (1,040 kg)
3/4"	(19.1 mm).	3,200 lbs (1,450 kg)
1"	(25.4 mm).	4,100 lbs (1,850 kg)
1-1/4"	(31.8 mm).	4,950 lbs (2,250 kg)
1-1/2"	(38.1 mm).	5,850 lbs (2,660 kg)
1-3/4"	(44.5 mm).	6,750 lbs (3,060 kg)
2"	(50.8 mm).	7,650 lbs (3,460 kg)
2-1/4"	(57.2 mm).	8,550 lbs (3,870 kg)
2-1/2"	(63.5 mm).	9,400 lbs (4,270 kg)
2-3/4"	(69.9 mm).	10,300 lbs (4,680 kg)
3"	(76.2 mm).	11,200 lbs (5,080 kg)
3-1/4"	(82.6 mm).	12,100 lbs (5,480 kg)
*** 3-1/2"**	**(88.9 mm) . . . .**	**13,000 lbs (5,890 kg)**

*** REAR GUIDE WHEEL IS OVERLOADED. REDISTRIBUTE OR REMOVE SOME OF THE LOAD. MAXIMUM LOAD ON REAR GUIDE WHEEL UNIT MUST NOT EXCEED 25,000 LBS (11,340 kg) OR 12,500 LBS (5,670 kg) MAXIMUM PER GUIDE WHEEL.**

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. Add leaf springs, coil springs, torsion bars, etc. Do not adjust the rear guide wheel unit spring cells to compensate for permanent attachments.

3.1 Guide Wheel Equipment Alignment Procedure

3.1.4 Guide Wheel Load

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

1. The recommended load on the rear guide wheel unit is approximately 33% of the vehicle rear axle weight or a minimum of 4,594 lbs (2,084 kg).

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

   Vehicle Rear Axle Weight x 17% (0.17) = Spring Cell Load

3. Convert the calculated spring cell load into dimension (L). See Rear Guide Wheel Load Chart 3-3. If the calculated spring cell load dimension (L) is less than 1/2 inch (12.7 mm), the spring cell must be set to a minimum of 1/2 inch (12.7 mm).

4. Unlock and raise the guide wheels. Let the guide wheels rest on the rails.

5. Dimension (E), the length of the large threaded stud extending from the top of the lock nut (D) to the bottom of adjusting nut (C), is preset at the factory to 3/4 inch (19 mm). This allows approximately equal adjustment up or down. If dimension (E) is not initially set to 3/4 inch (19 mm) on both spring cells, loosen lock nut (D). Turn adjusting nut (C) until dimension (E) is set to 3/4 inch (19 mm) on both spring cells. Re-tighten lock nut (D).

6. Lower and lock the guide wheels in the "rail" position.

7. Measure dimension (L), the distance from the top of adjusting nut (C) to the bottom of nut (A). See Rear Guide Wheel Load Chart 3-3 to convert dimension (L) to the load. The spring cell must be set to the calculated load dimension (L) or the minimum load dimension (L), see Step c.

8. To adjust the spring cell load, unlock and raise the guide wheels. Let the guide wheels rest on the rails. Loosen lock nut (D). Turn adjusting nut (C) clockwise to increase the load on the guide wheel or counter-clockwise to decrease the load on the guide wheel.

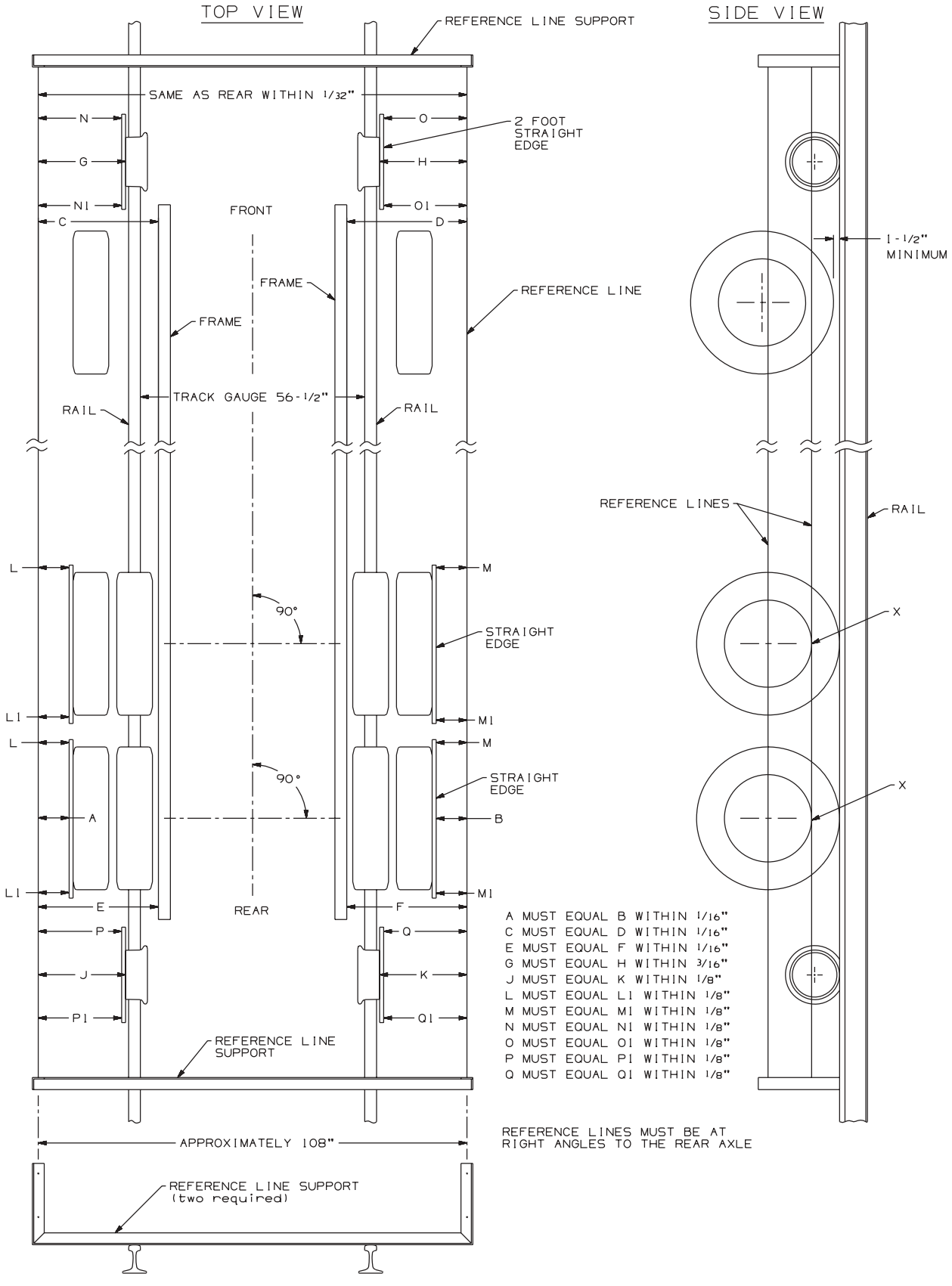
9. Lower and lock the guide wheels in the "rail" position. Re-measure dimension (L). See Rear Guide Wheel Load Chart 3-3 to convert dimension (L) to the load on the guide wheel.

10. Repeat Steps 8 and 9 until dimension (L) corresponds to the calculated load or the minimum load on the spring cell, see Step 3. Tighten lock nut (D). Both spring cells must be set to the same dimension (E) within 1/8 inch (3.2 mm).

11. If the spring cell cannot be adjusted to the calculated load or the minimum load, the guide wheel unit must be repositioned in a different set of mounting holes.

3.1 Guide Wheel Equipment Alignment Procedure

FIGURE 3-4
GUIDE WHEEL EQUIPMENT ALIGNMENT



3.1 Guide Wheel Equipment Alignment Procedure

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

1. The string lining procedure is only a guide to check and make alignment adjustments to the guide wheel equipment. String lining the vehicle and guide wheel equipment will not guarantee that the guide wheel equipped vehicle will track properly. Harsco 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 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 3-4. 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 and a few inches longer than the width of the vehicle. Wires or cords stretched between the front and rear supports will be the reference lines. The wires or cords should be spaced approximately 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 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 upper 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

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

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 ensure correct alignment.

3.1.6 Rear Guide Wheel Alignment - See Figure 3-4

1. Lower and lock the rear guide wheel units in the "rail" position. 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 (=) dimension K or is within 1/8 inch (3.2 mm). If not, see Adjustment.

3.1.7 Rear Guide Wheel Adjustment - See Figures 3-4 and 3-5

1. Unlock and raise the guide wheel unit from the "rail" position. Let the guide wheels rest on the rails. The unit is equipped with side shift, the self centering v-blocks must remain fully seated in the v-block housing.

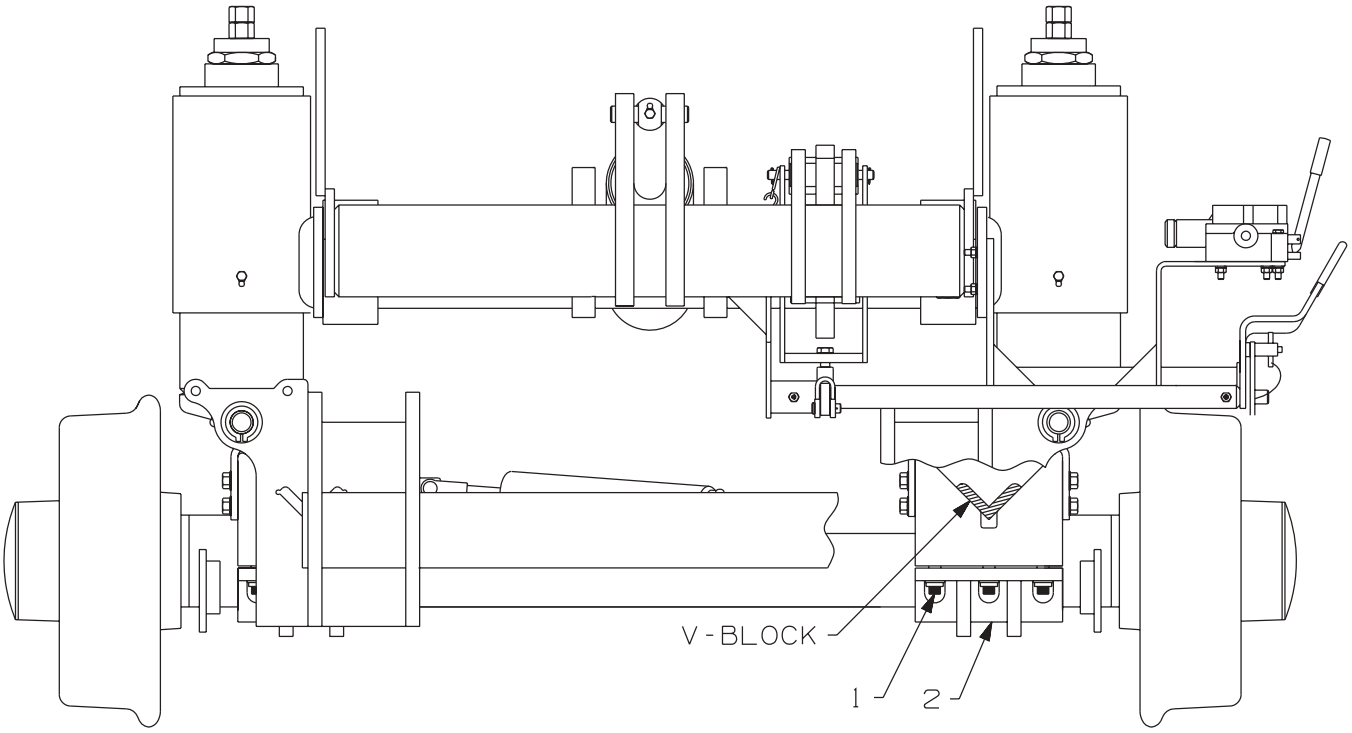
2. Loosen fasteners (1) on the axle clamps (2). Shift the axle and guide wheels until dimension J equals (=) dimension K or is within 1/8 inch (3.2 mm). Make sure the self centering v-blocks are fully seated in the v-block housing. Torque the fasteners to 247 lb.-ft. (335 N-m).

3. Lower and lock the guide wheel in the "rail" position.

4. Repeat Steps 1 through 3 until dimension J equals (=) dimension K or is within 1/8 inch (3.2 mm).

3.1 Guide Wheel Equipment Alignment Procedure

FIGURE 3-5
REAR GUIDE WHEEL ALIGNMENT



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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 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 front guide wheel flange and not off the left front guide wheel flange, the guide wheel unit is "flanging right".

   a. Unlock and raise the guide wheel unit. Let the guide wheels rest on the rail. Slightly move the right end of the front axle forward or the left end rearward. See the Operator's Service and Parts Manual for the front guide wheel unit.

   b. Repaint the flanges and treads on all guide wheels. Lower and lock the guide wheel unit in the "rail" Position. Operate the vehicle a minimum of 1/4 mile 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 guide wheel flange and not off the left 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

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

    a. Unlock and raise the guide wheel unit. Let the guide wheels rest on the rail. Slightly move the left end of the front axle forward or the right end rearward. See the Operator's Service and Parts Manual for the front guide wheel unit.

    b. Repaint the flanges and treads on all guide wheels. Lower and lock the guide wheel unit in the "rail" Position. Operate the vehicle a minimum of 1/4 mile 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 guide wheel flange and not off the right 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 Rear Unit Lock Mechanism

The rear locking mechanism should move freely so it engages when the guide wheels are raised or lowered. Periodically inspect this area for wear. When the vehicle is operated in mud or slush, foreign material may get into the locking mechanism, preventing the lock from operating properly. Remove any foreign material, being careful not to damage the lock mechanism.

1. When the rear guide wheel unit is in the "rail" position, the spring cells should be perpendicular (90 degrees) to the rail for the spring suspension to work properly.

2. Place the vehicle on straight, level track. Place the vehicle's 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.

3. Place a bubble level on the front or rear side of either spring cell. The spring cells should be vertical perpendicular (90 degrees) to the rail. If not, adjustment is necessary.

3.2.1.1 Adjustment - Rail Position - See Figure 3-6

1. Unlock and raise the rear guide wheel unit, let the guide wheels rest on the rail.

2. Turn set screws (A) counter-clockwise to move the bottom of the spring cell reward or clockwise to move the bottom of the spring cell forward. Adjust both set screws equally.

3. Lower the guide wheel unit to the "rail" position. Re-check the pilot unit spring cells to see if they are perpendicular (90 degrees) to the rail. If not, repeat Steps 4 and 5 until the spring cells are perpendicular to the rail.

4. After adjusting the spring cells to the perpendicular position, check the operation of lock pawl (B). Check the clearance between locking pawl (B) and lock arm (C). There should be approximately 1/16 - 1/8 inch (1.6 - 3.2 mm) clearance.

   If the clearance is greater than 1/8 inch (3.2 mm), a shim will have to be welded onto locking pawl (B) at point (D).

   If the clearance is less than 1/16 inch (1.6 mm) or if locking pawl (B) will not fully engage into lock arm (C), material will have to be removed from the locking pawl at point (D). Be sure to maintain the locking pawl profile when grinding material from the locking pawl.

3.2.1.2 Adjustment - Highway Position - See Figure 3-6

1. When the rear guide wheel unit is raised, locking pawl (B) must securely hold the guide wheel unit in the "highway" position. Set screws (E) must be adjusted to help keep the pilot unit from bouncing when traveling on the highway.

3.2 Adjustments

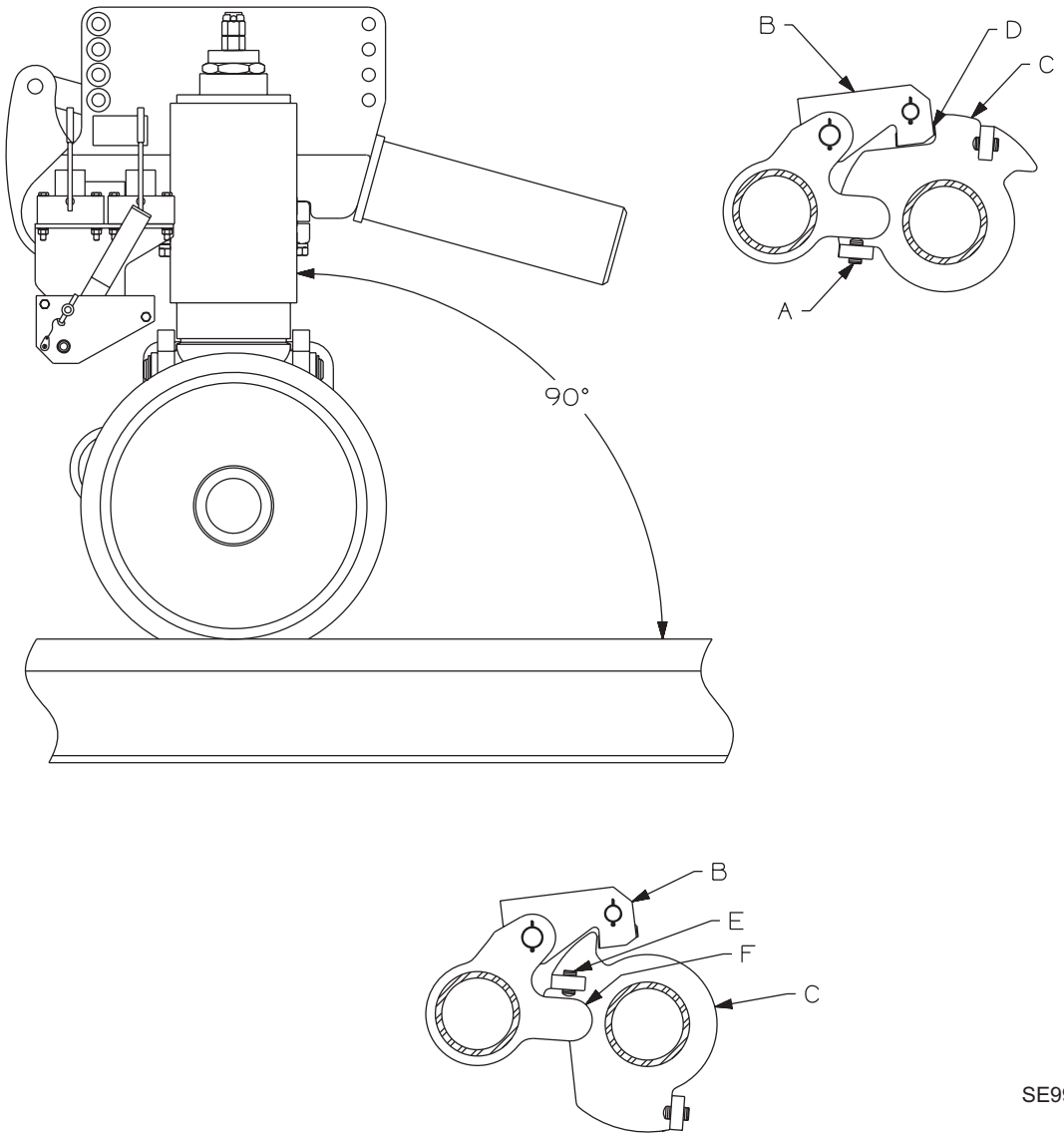
3.2.1 Rear Unit Lock Mechanism

3.2.1.2 Adjustment - Highway Position - continued

2. With the guide wheel unit in the "highway" position, check the clearance between set screws (E) and arm (F). If there is excessive clearance, turn set screws (E) clockwise. Adjust both set screws equally.

3. After adjustment, check the operation of the lock. Locking pawl (B) must fully engage locking arm (C). If not, re-adjust set screws (E).

FIGURE 3-6
REAR UNIT LOCK



3.2 Adjustments

3.2.2 Brake Shoe Clearance - See Figure 3-7

The rear guide wheel unit may be equipped with guide wheel brakes.

1. Apply the parking brakes.

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.

3.2.2.1 Brake Shoe Adjustment - See Figures 3-7

1. Loosen jam nut (1) on yoke (2). Remove the cotter pin from pin (3). Remove pin (3) from yoke (2). 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.

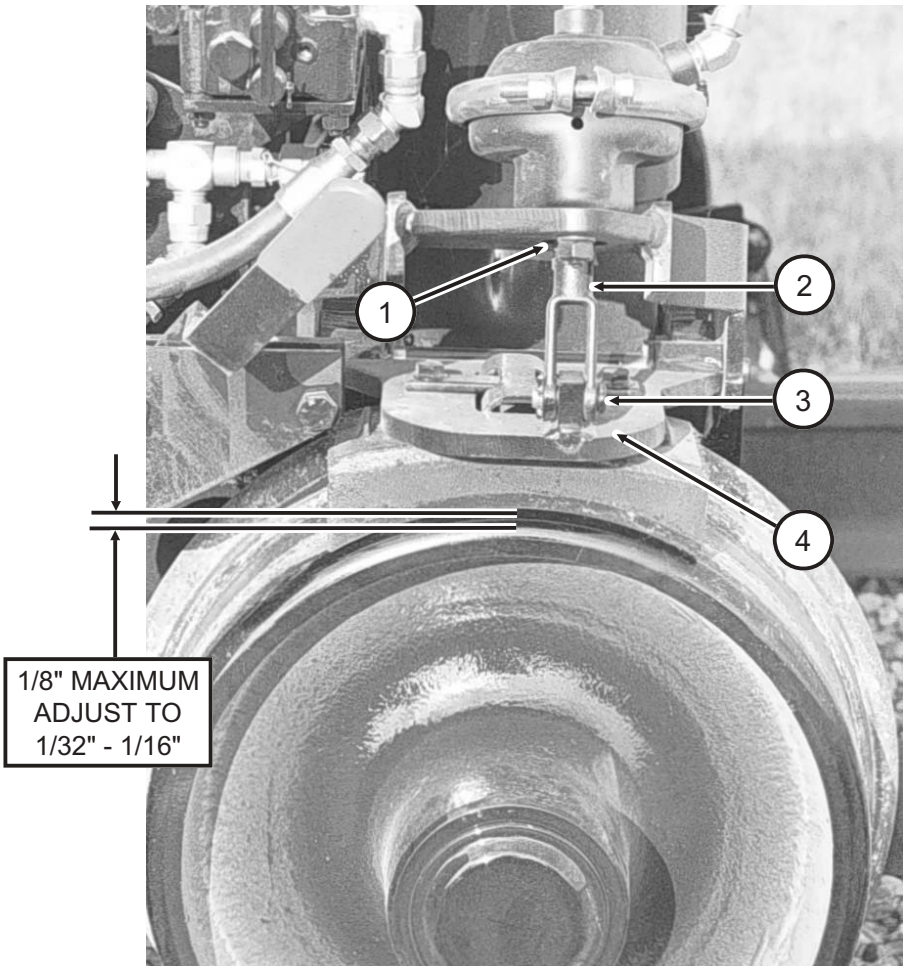
2. Adjust so the brake shoe is 1/32 - 1/16 inch (.8 - 1.6 mm) away from the guide wheel tread. Install pin (3) through yoke (2) and brake arm (4) and secure using the cotter pin. Tighten jam nut (1) securely. Recheck the brake shoe clearance and adjust if necessary.

3. Repeat Steps 1 and 2 to adjust the brake shoe clearance on the other rear guide wheel.

3.2 Adjustments

3.2.2 Brake Shoe Adjustment

FIGURE 3-7
REAR UNIT BRAKE



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3.2 Adjustments

3.2.3 Rail Sweep Clearance - See Figure 3-8

The rear guide wheel units may be equipped with the rail sweeps.

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. Lower the rail sweeps to the "rail" position by rotating them down. The rubber rail sweep (1) should clear the top of the rail by 3/16 inch (4.8 mm). If not, see Adjustment.

3.2.3.1 Rail Sweep Adjustment - See Figure 3-8

1. Loosen the two cap screws (2). Slide the rubber sweep (1) down until it clears the top of the rail by 3/16 inch (4.8 mm). Re-tighten the two cap screws (2).

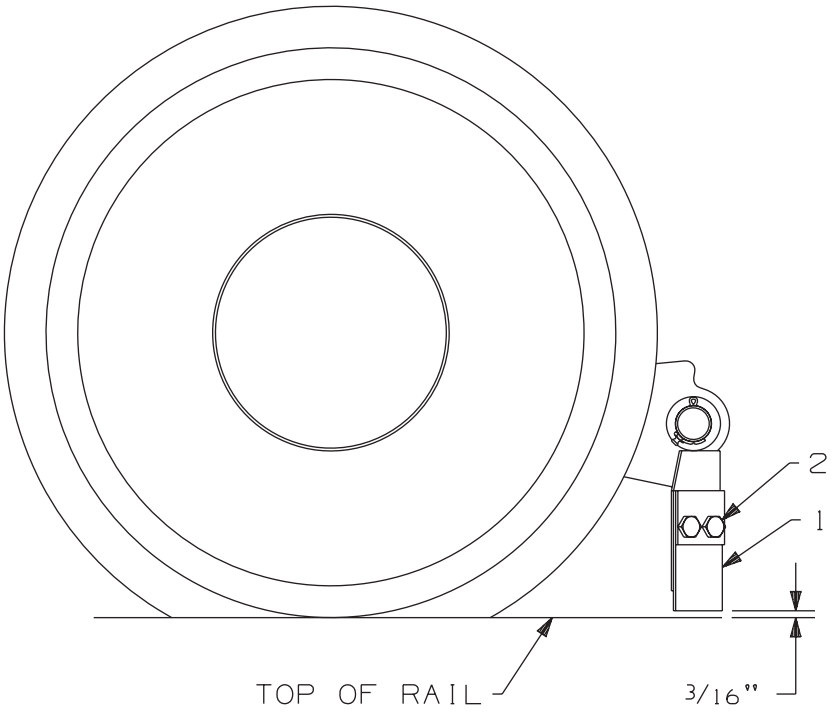
2. Repeat Step 1 to adjust the rail sweep clearance on the other guide wheel.

3. When the rubber sweep (1) is worn so it cannot be adjusted, replace the rubber sweep.

3.2 Adjustments

3.2.3 Rail Sweep Clearance

FIGURE 3-8
RAIL SWEEP



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3.2 Adjustment

3.2.4 Guide Wheel Unit Hydraulic Pressure

3.2.4.1 Checking Guide Wheel Unit Raise / Lower Pressure - See Figure 3-9

1. Attach the pressure gauge, HTT #099137K, to test port (1) on the guide wheel unit raise / lower control valve.

2. Start the vehicle engine. Place the vehicle automatic transmission in "Park" or manual transmission in "Neutral". Apply the parking brake. 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.

3. Do not release the guide wheel unit locking mechanism. Push control valve handle (2) towards the control valve to bottom out the hydraulic cylinder against the locking mechanism. Hold the control valve handle in this position while reading the hydraulic pressure on the gauge. Release the control valve handle.

   If the hydraulic pressure indicated is 1800 PSI (124 bar), the guide wheel unit hydraulic pressure is set correctly. Disengage the mechanical PTO hydraulic pump or stop the auxiliary hydraulic power source. Remove the pressure gauge from test port (1).

   If the pressure indicated is not 1800 PSI (124 bar), go to Adjustment.

3.2.4.2 Adjustment - See Figure 3-9

1. Remove the relief valve cap (3) from the control valve to expose the adjusting screw.

2. Do not release the rear guide wheel unit locking mechanism. Push the control valve handle (2) towards the control valve to bottom out the hydraulic cylinder against the locking mechanism. Hold the control valve handle in this position while adjusting and reading the hydraulic pressure on the gauge.

3. Turn the adjusting screw clockwise to increase the pressure or counter-clockwise to decrease the pressure. Stop when the pressure gauge remains steady at a constant pressure of 1800 PSI (124 bar). Release the control valve handle.

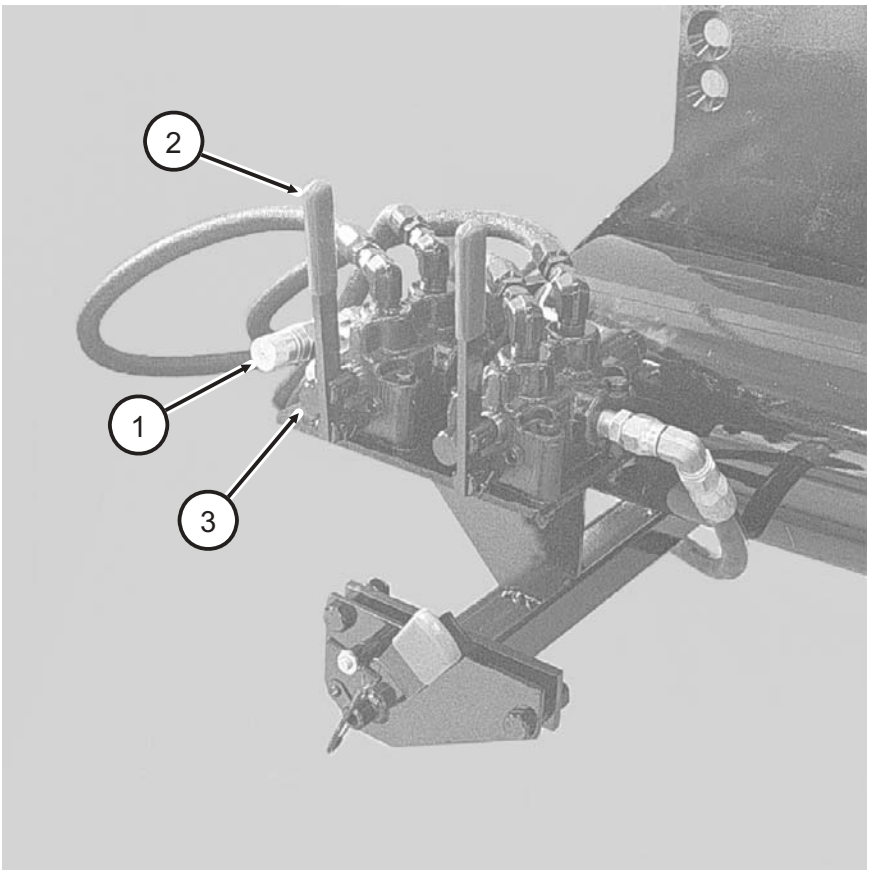
4. Disengage the mechanical PTO hydraulic pump or stop the auxiliary hydraulic power source. Remove the pressure gauge from test port (1). Install the relief valve cap (3).

5. If a constant pressure of 1800 PSI (124 bar) can not be obtained at the control valve, the flow divider valve may have to be adjusted. See Flow Divider Valve Hydraulic Pressure.

3.2 Adjustment

3.2.4 Guide Wheel Unit Hydraulic Pressure

FIGURE 3-9
GUIDE WHEEL UNIT RAISE / LOWER
HYDRAULIC PRESSURE



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3.2 Adjustment

3.2.4 Guide Wheel Unit Hydraulic Pressure

3.2.4.3 Checking Guide Wheel Unit Side Shift Pressure - See Figure 3-10

1. Attach the pressure gauge, HTT #099137K, to test port (4) on the guide wheel unit side shift control valve. If a test port is not present, one will need to be installed at the pressure out port on the valve.

2. Start the vehicle engine. Place the vehicle automatic transmission in "Park" or manual transmission in "Neutral". Apply the parking brake. 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.

3. Push or pull control valve handle (5) to bottom out the side shift hydraulic cylinder. Hold the control valve handle in this position while reading the hydraulic pressure on the gauge. Release the control valve handle.

   If the hydraulic pressure indicated is 500 PSI (34.5 bar), the side shift hydraulic pressure is set correctly. Disengage the mechanical PTO hydraulic pump or stop the auxiliary hydraulic power source. Remove the pressure gauge from test port (1).

   If the pressure indicated is not 500 PSI (34.5 bar), go to Adjustment.

3.2.4.4 Adjustment - See Figure 3-10

1. Remove the relief valve cap (6) from the control valve to expose the adjusting screw.

2. Push or pull control valve handle (5) to bottom out the side shift hydraulic cylinder. Hold the control valve handle in this position while adjusting and reading the hydraulic pressure on the gauge.

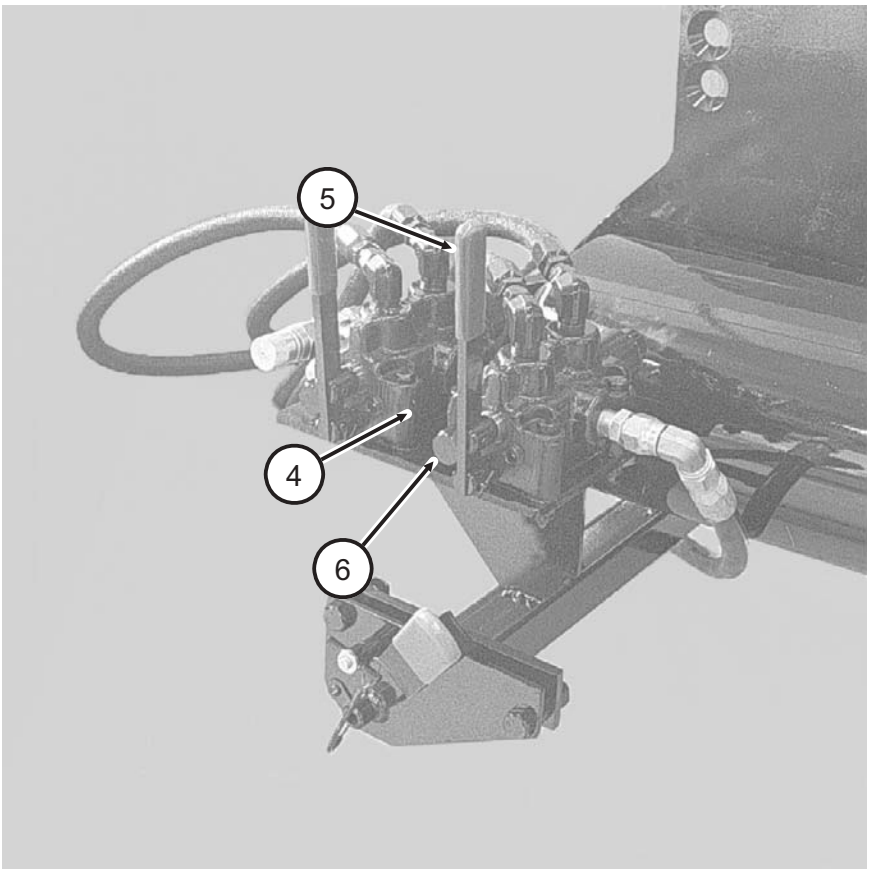
3. Turn the adjusting screw clockwise to increase the pressure or counter-clockwise to decrease the pressure. Stop when the pressure gauge remains steady at a constant pressure of 500 PSI (34.5 bar). Release the control valve handle.

4. Disengage the mechanical PTO hydraulic pump or stop the auxiliary hydraulic power source. Remove the pressure gauge from test port (4). Install the relief valve cap (6).

3.2 Adjustment

3.2.4 Guide Wheel Unit Hydraulic Pressure

FIGURE 3-10
GUIDE WHEEL UNIT SIDE SHIFT
HYDRAULIC PRESSURE



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3.2 Adjustment

3.2.5 Flow Divider Valve Hydraulic Pressure

The Harsco Track Technologies' Power Pack Groups include a flow divider valve. The following procedure is to be used with this flow divider valve.

Note: The flow divider valve is preset from the factory to 2500 PSI (172 bar).

1. Attach a properly rated and correctly calibrated pressure gauge (HTT #099137K) to the test port on the front guide wheel unit control valve.

2. Remove the relief valve cap from the control valve, to expose the adjusting screw.

3. Start the vehicle engine. Place the vehicle automatic transmission in "Park" or manual transmission in "Neutral". Apply the parking brake. 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.

4. Do not release the front guide wheel unit locking mechanism. Move the control valve handle in the direction that will bottom out the hydraulic cylinder against the locking mechanism. Hold the control valve handle in this position while reading the hydraulic pressure on the gauge.

5. While holding the control valve handle, turn the adjusting screw clockwise to increase the pressure. Stop when the pressure gauge remains steady at a constant pressure. This steady pressure is the relief setting of the flow divider valve.

   If the hydraulic pressure indicated is 2500 PSI (172 bar) and remains steady, the flow divider valve hydraulic relief pressure is set correctly. Re-adjust the pressure relief valve on the front guide wheel unit to the recommended pressure setting for the front unit.

   Disengage the mechanical PTO hydraulic pump or stop the auxiliary hydraulic power source. Remove the pressure gauge from the test port. Install the relief valve cap.

6. If the hydraulic pressure indicated is not 2500 PSI (172 bar), the flow divider valve hydraulic relief pressure will have to be adjusted. See Adjustment.

3.2.5.1 Adjustment

■ **DEPRESSURIZE HYDRAULIC SYSTEM BEFORE ATTEMPTING TO ADJUST THE FLOW DIVIDER VALVE. LOOSE COMPONENTS AND HYDRAULIC OIL UNDER PRESSURE COULD CAUSE SEVERE BODILY INJURY.**

3.2 Adjustment

3.2.5 Flow Divider Valve Hydraulic Pressure

3.2.5.1 Adjustment - See Chart 3-11 and Figure 3-12

1. Disengage the mechanical PTO hydraulic pump or stop the auxiliary hydraulic power source. Stop the vehicle engine. Depressurize the vehicle hydraulic system.

2. Disassemble the flow divider valve by removing the relief cap (1), o-ring (2), relief spring (3), shims (4) and spring guide (5). The relief ball (6), relief seat (7), back-up washer (8) and o-ring (9) in the flow divider valve do not have to be removed.

3. Add or remove different thicknesses of shims (4) between the relief spring (3) and relief guide (5) to obtain the correct pressure setting of 2500 PSI (172 bar). See Chart 3-16 for approximate pressure change in relationship to shim thickness. Re-assemble the flow divider valve in reverse order.

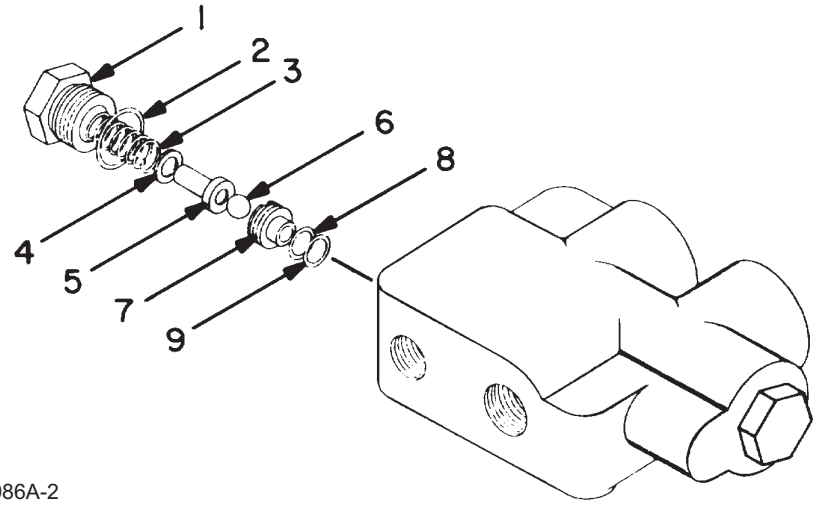
CHART 3-11
SHIM / PRESSURE CHART

SHIM THICKNESS	APPROXIMATE PRESSURE CHANGE
.010 in	75 PSI
.021 in	175 PSI
.042 in	425 PSI

4. Repeat the checking and adjustment procedure until the correct flow divider valve hydraulic pressure setting is obtained.

5. If the flow divider valve hydraulic pressure can not be adjusted to 2500 PSI (172.4 bar), the problem may be with the hydraulic pump output.

FIGURE 3-12
FLOW DIVIDER VALVE



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NOTES

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

4. When the vehicle is operated on the track, listen for unusual noises. Unusual noises may indicate incorrectly lowered guide wheels, 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, Guide Wheel Equipment Alignment Procedure - 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, Bolt Torque Requirement Charts.

4.1 Maintenance Schedule

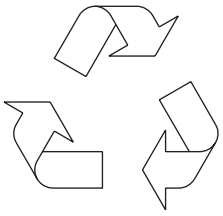
4.1.3 Every 2,000 Track Miles (3200 km):

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 Re-packing Guide Wheel Bearings.

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 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

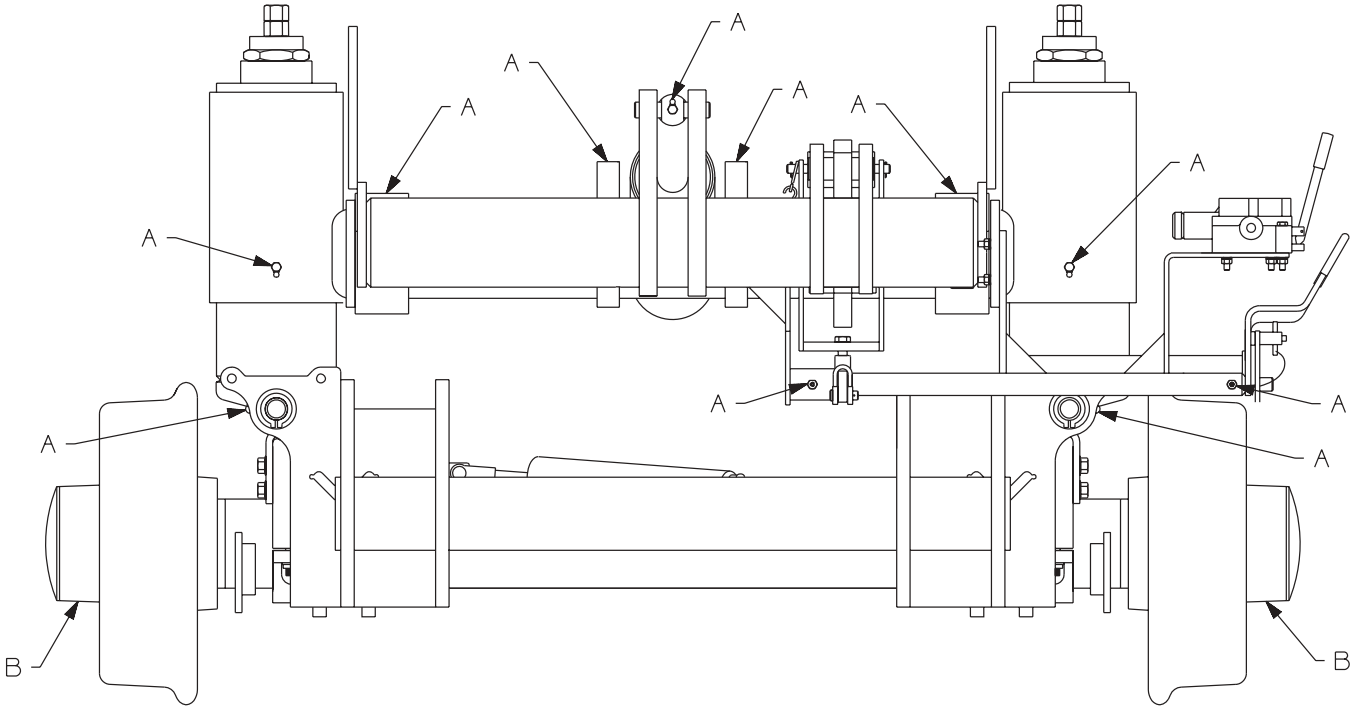
Lubricate the guide wheel equipment every 2000 track miles (maximum) or each time the vehicle is serviced.

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

1. Apply the parking brake. Stop the vehicle engine. Shut off the vehicle's ignition switch.
2. Lubricate all grease fittings (A) using Mobil Special Moly, or equivalent.
3. Re-pack the guide wheel bearings (B) every 10,000 track miles (maximum) or at least once yearly (minimum), whichever occurs first. See Re-packing Guide Wheel Bearings.

4.3 Guide Wheel Equipment Lubrication

FIGURE 4-1
REAR GUIDE WHEEL UNIT LUBRICATION DIAGRAM



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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 parking 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). Bend tab on washer (2) away from outside nut (3). Remove outside nut (3), washer with holes in it (4) and inside nut with pin (5).

3. Pull the guide wheel (6) from axle spindle (7). Remove the outer bearing cone (8) from guide the wheel (6). Remove grease seal (12) and inner bearing cone (10) from the guide wheel (6).

4. Clean all components of old grease and dirt.

5. Inspect the spindle, bearing cones and cups (8 & 9, 10 & 11) for nicks, gouges and wear. If any of these are evident, replace the component.

6. Inspect the insulation sleeves (13) for any cracks, damage or wear. If any of these are evident, the wheel must be removed from service. The wheel can be returned to Harsco Track Technologies, Fairmont, Minnesota, to have new insulation installed.

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

8. 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.

9. Install inner bearing cone (10) into the guide wheel (6). Install a new grease seal (12) into the wheel.

10. Slide the guide wheel (6) with the inner bearing (10) and grease seal (12) onto the axle spindle (7). Install the outer bearing cone (8).

11. Thread the inside nut with pin (5) onto the spindle. While rotating the guide wheel, tighten the nut until the wheel has a slight resistance when rotated or to approximately 20 lb-ft.

12. Back the nut off 1/2 to 1 flat of the nut (approximately 0.001 - 0.005 inch end play). The wheel must turn freely.

13. Install the washer with holes in it (4). The internal tab on washer (4) fits into the slot in the spindle. The pin on the inside nut (5) must line up with a hole in washer (4). If not, loosen nut (5) until the pin lines up with the nearest hole in the washer.

14. Install notched washer (2). The internal tab on washer (2) fits into the slot in the spindle.

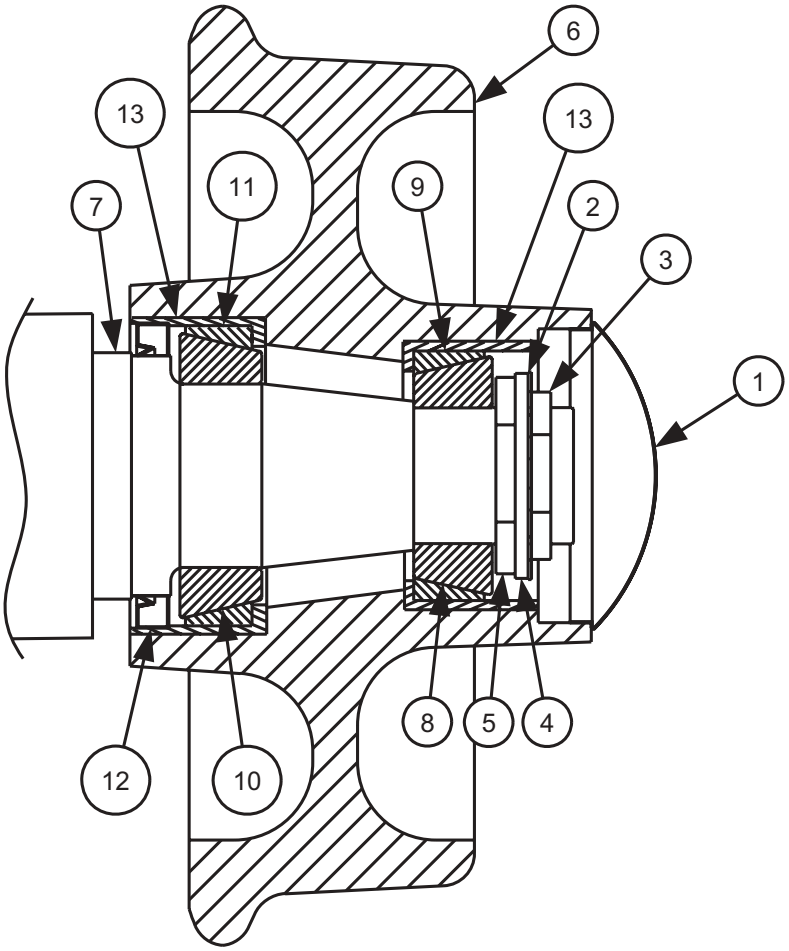
4.3 Guide Wheel Equipment Lubrication

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

15. Thread the outside nut (3) on the spindle. Tighten the nut securely. Bend one external tab on washer (2) down against one of the flats on outside nut (3).

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

FIGURE 4-2
RE-PACKING GUIDE WHEEL BEARINGS



4.4 Guide Wheels

4.4.1 Allowable Wear - See Figure 4-3

WARNING

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

The guide wheels must be checked for allowable wear a minimum of once yearly (every twelve months). Use the following procedure to check the guide wheel wear.

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 7/8 inch (22.2 mm).

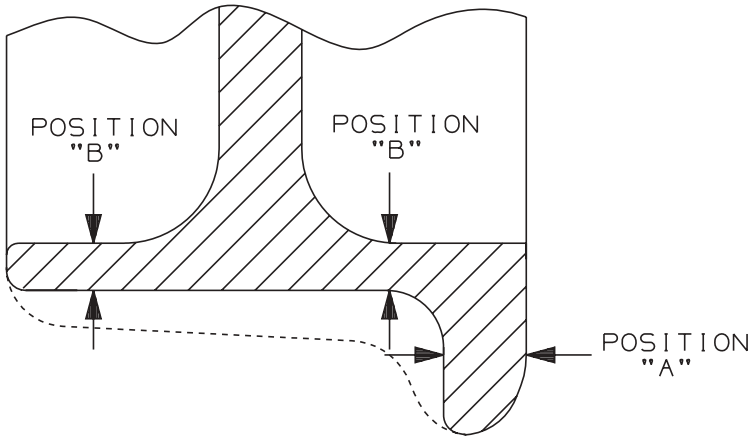
   If the guide wheel flange dimension is less than the allowable limit, replace the guide wheel immediately.

3. Measure the guide wheel tread at Position "B" with the wheel caliper. The minimum allowable tread dimension at Position "B" is 1/2 inch (12.7 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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4.5 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 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 Locking Mechanism

The locking mechanism should move freely so it can be engaged and disengaged easily when the guide wheel unit is raised or lowered. Periodically inspect this area for lubrication and wear. When the vehicle is operated in mud or slush, foreign material may get into the locking mechanism, preventing the lock from operating correctly. Remove this foreign material, being careful not to damage the locking mechanism.

The lock mechanism lever is secured in the "rail" or "highway" position by a lock pin. The lock pin must insert easily. If not, re-adjust the locking mechanism. See Adjustments - Locking Mechanism. 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.

4.8 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.

4.8.1 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.

4.8.1 Hose Band - See Figure 4-4

All Harsco Track Technologies original and replacement hose assemblies manufactured for this equipment at the Harsco Track Technologies, Harsco Corporation Fairmont, Minnesota plant facility are supplied with 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 May 2006 and is Harsco Track Technologies part number 188662.

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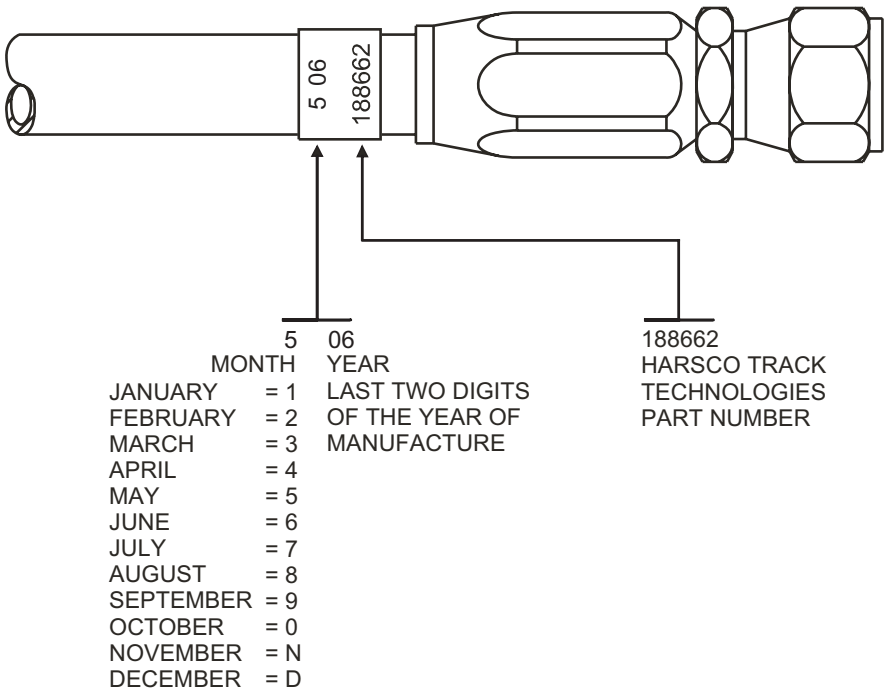
FIGURE 4-4
HOSE BAND



SECTION 5 - TROUBLESHOOTING
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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 or raise.	Mechanical lock engaged.	Disengage lock. See Operation - Placing Vehicle On Track or Removing Vehicle From 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.

5.1 Troubleshooting Guide Wheel Equipment

PROBLEM	PROBABLE CAUSE	POSSIBLE REMEDY
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.
	Control valve hydraulic relief pressure set incorrectly.	Check and adjust if necessary. See Adjustments - Hydraulic Pressure Adjustments.
	Flow divider valve hydraulic relief pressure set incorrectly.	Check and adjust if necessary. See Adjustments - Hydraulic Pressure Adjustments.
Lock pin cannot be inserted when guide wheels are in "rail" or "highway" position.	Foreign material (mud, slush, dirt, etc.) in locking mechanism.	Clean. See Maintenance - Locking Mechanism.
	Locking mechanism adjusted incorrectly.	Re-adjust. See Adjustments - Locking Mechanism.
	Lack of lubrication.	Lubricate rear locking mechanism. See Maintenance - Guide Wheel Equipment Lubrication.
	Components bent, broken, worn, etc.	Replace components.

5.1 Troubleshooting Guide Wheel Equipment

PROBLEM	PROBABLE CAUSE	POSSIBLE REMEDY
Vehicle pulls noticeably to the left or right when on track.	Vehicle loaded heavy on one side.	Move load to center of vehicle.
	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.
Vehicle derails.	Guide wheel units, vehicle rear axle(s), etc. not aligned with vehicle frame.	Check alignment. See Adjustments - Guide Wheel Equipment Alignment Procedure.
Vibration felt in the vehicle when traveling on track.	Guide wheel unit 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. See Parts - Vehicle Applications.
	Vehicle rear tires out of balance.	Balance tires.

5.1 Troubleshooting Guide Wheel Equipment

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

NOTES

SECTION 6 - PARTS
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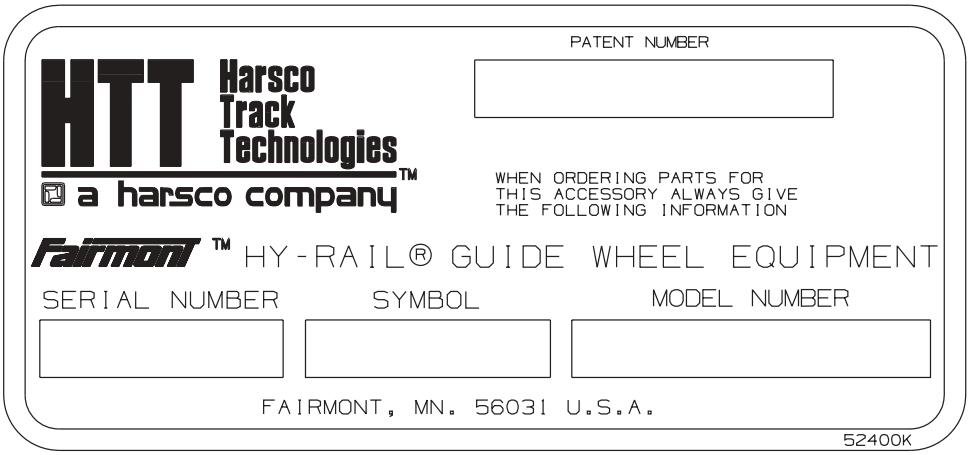
Serial Numbers

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



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Instructions For Ordering Parts

1. See Section 7 for the Vehicle Application charts.

2. Find the chart for the make, model and year of the vehicle that the unit is mounted on.

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

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

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

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

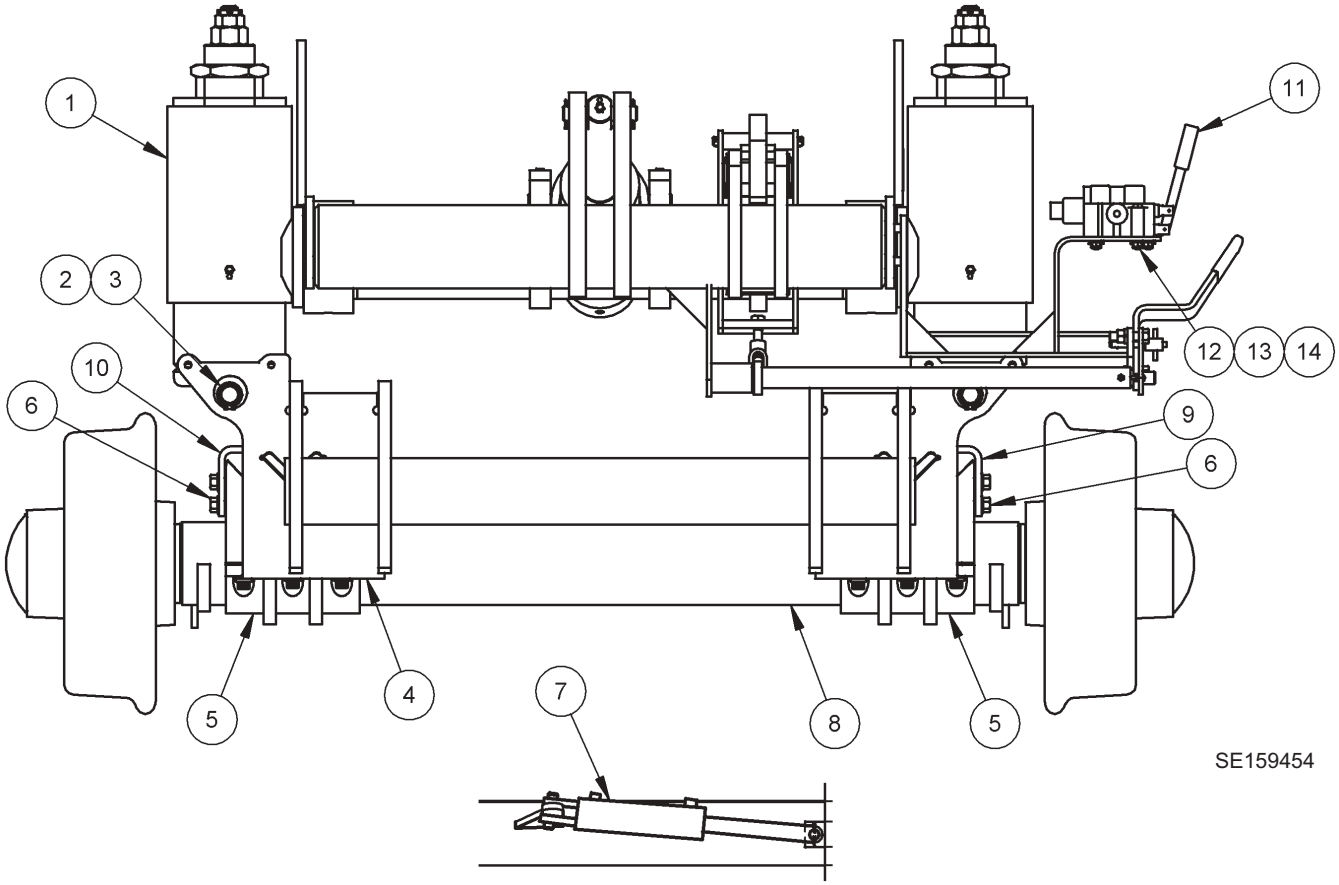
7. For convenience in ordering, parts are listed by item number, part number, description, and quantity in each assembly or group. If in doubt as to any part wanted, send full description, sketch, or send the old part with the order.

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

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

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

159454 REAR GUIDE WHEEL UNIT

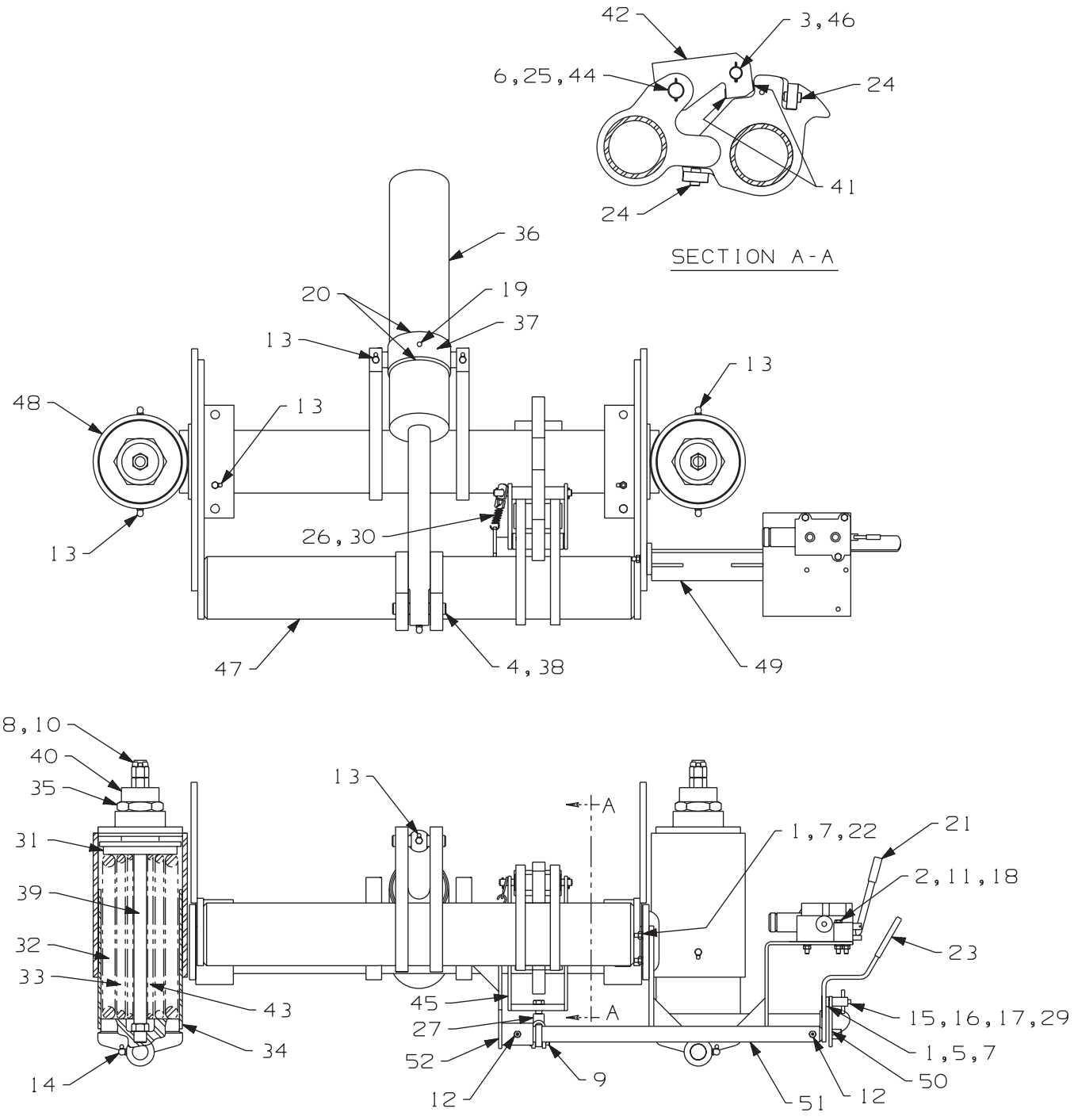


SIDE SHIFT CYLINDER MOUNTING
VIEW FROM REAR OF UNIT

159454 REAR GUIDE WHEEL UNIT

ITEM	PART NO	DESCRIPTION	QTY
1	179118	Upper Frame Assembly (see separate breakdown)	1
2	157241	Pin	2
3	700843015	Retaining Ring	4
4	157692	Lower Frame	1
5	159017	Axle Clamp	2
6	F022036	Cap Screw, 1/2-13 x 1-1/4" GR 5 Hex Flg Hd	8
7	189129	Hydraulic Cylinder (with mounting pins and cotter pins)	1
8	202302	Axle	1
9	157681	Strap	1
10	157689	Strap	1
11	F019081	Control Valve	1
12	F013428	Cap Screw 5/16-18 x 2-1/2" GR 5 Hex Hd	3
13	F001100	SAE Lock Washer, 5/16"	3
14	F007021	Hex Nut, 5/16"-18 GR 5	3

179118 UPPER FRAME ASSEMBLY



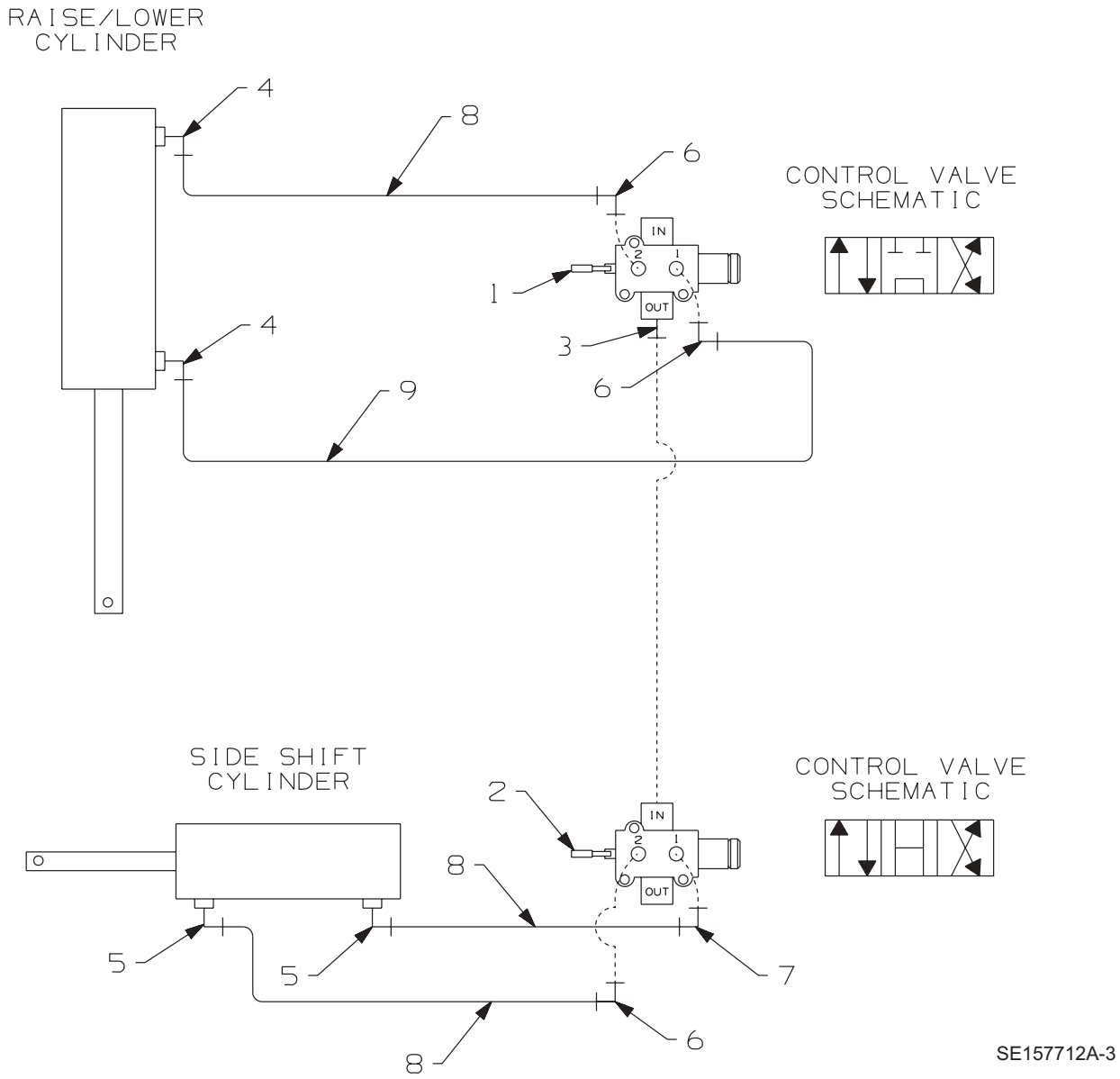
179118 UPPER FRAME ASSEMBLY

ITEM	PART NO	DESCRIPTION	QTY
	179118	UPPER FRAME ASSEMBLY	1
1	F001075	SAE Lock Washer, 1/2"	4
2	F001100	SAE Lock Washer, 5/16"	3
3	F001104	Cotter Pin, 1/8 x 1"	2
4	F001182	Cotter Pin, 1/8 x 1-1/4"	2
5	F001442	Cap Screw, 1/2-13 x 2" GR 5 Hex Hd	2
6	F002547	Cotter Pin, 1/8 x 2"	2
7	F003598	Hex Nut, 1/2"-13 GR 5	4
8	F004344	Cotter Pin, 3/16 x 2"	2
9	F005460	Yoke Pin	1
10	F006657	Hex Castle Nut, 1"-14	4
11	F007021	Hex Nut, 5/16"-18 GR 5	3
12	F008014	Grease Fitting	2
13	F009217	Grease Fitting	14
14	F009420	Grease Fitting	4
15	F009541	Lock Washer, #10	1
16	F009542	Hex Nut, #10-24	1
17	F009591	Machine Screw, #10-24 x 3/4" Rd Hd	1
18	F013428	Cap Screw, 5/16-18 x 2-1/2" GR 5 Hex Hd	3
19	F014224	Set Screw, 3/8-16 x 3/8" Locking Cup Point	1
20	F016485	Retaining Ring	2
21	F018510	Control Valve	1
22	F019634	Cap Screw, 1/2-13 x 1-3/4" Flt Soc Hd	2
23	F022846	Handle Grip	1
24	F023736	Set Screw, 3/4-10 x 1-1/2" Oval Point	4
25	M004458	Washer	8
26	M010612	Spring	1
27	M033360K1	Rod End	1
28	069859	Tube	2
29	081645K	Lock Pin And Lanyard	1
30	089216	Link	1
31	099369	Washer	2
32	176659	Spring	2
33	099371	Spring	2
34	099373	Housing	2
35	099378	Nut	2
36	099394K	HYDRAULIC CYLINDER	1
	188632	Seal Kit	1
37	099402K	Cylinder Mounting	1
38	105030	Pin	1
39	111065	Rod	2
40	111067	Adjusting Stud	2
41	113535	Bar (weld on)	4

179118 UPPER FRAME ASSEMBLY

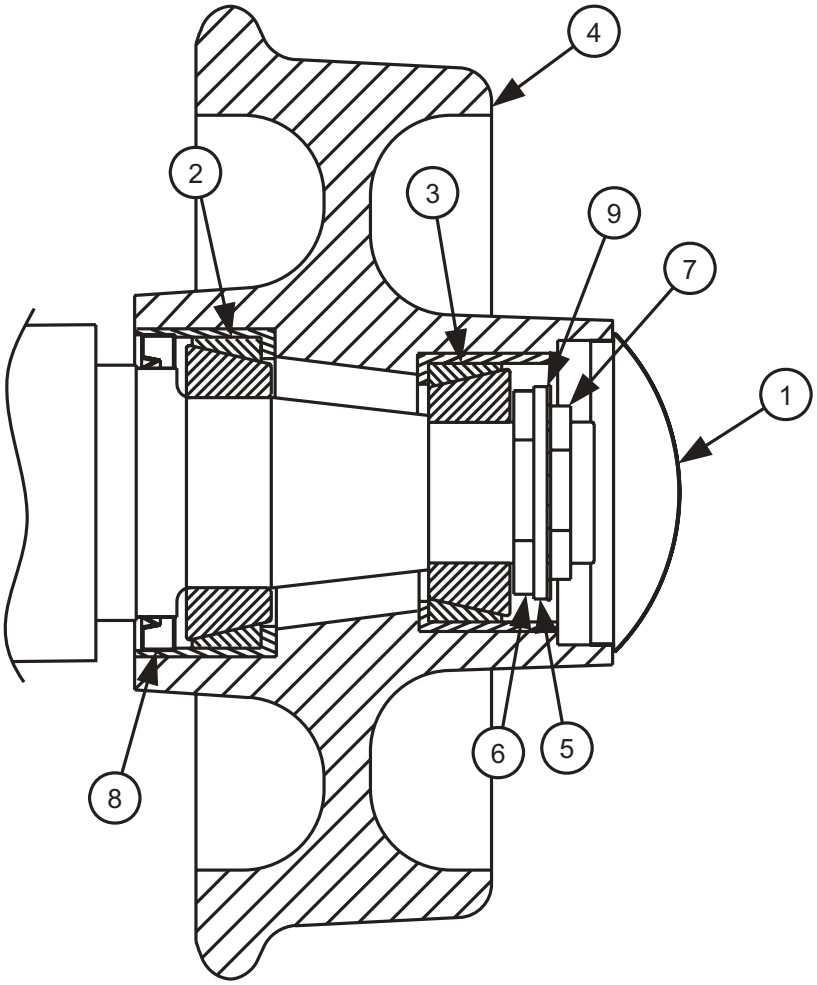
ITEM	PART NO	DESCRIPTION	QTY
42	136276	Lock	1
43	140109	Spring	2
44	140157	Lock Pin	1
45	140175	Yoke	1
46	140176	Pin	1
47	157293	FRAME MOUNTING UNIT	1
47a	F001354	SAE Lock Washer, 3/4"	2
47b	F006382	Cap Screw, 3/4-10 x 2-1/2" GR 5 Hex Hd	2
48	157295	CROSS TUBE	1
48a	F003095	Cap Screw, 1/2-13 x 2-3/4" GR 5 Hex Hd	2
48b	F001075	SAE Lock Washer, 1/2"	2
49	157707K	Bracket	1
50	158676	Bracket	1
51	158679	Handle	1
52	159016	Bracket	1

HYDRAULIC PIPING - 159454 GUIDE WHEEL UNIT



ITEM	PART NO	DESCRIPTION	QTY
1	F018510	Control Valve	1
2	F019081	Control Valve	1
3	F011604	Adapter, 3/8 M NPT x 3/8 M NPT	1
4	F010987	90° Elbow, 9/16 M JIC x 1/4 M NPT	2
5	F010988	90° Elbow, 9/16 M JIC x 1/4 M NPT	2
6	F012055	90° Elbow, 9/16 M JIC x 3/8 M NPT	3
7	108888	90° Elbow, 9/16 M JIC x 3/8 M NPT Restricted .062"	1
8	188659	Hose, 5/16 x 78" Swivel 9/16 F JIC Both Ends	3
9	188660	Hose, 5/16 x 52" Swivel 9/16 F JIC Both Ends	1

GUIDE WHEEL ASSEMBLY - 159454 GUIDE WHEEL UNIT



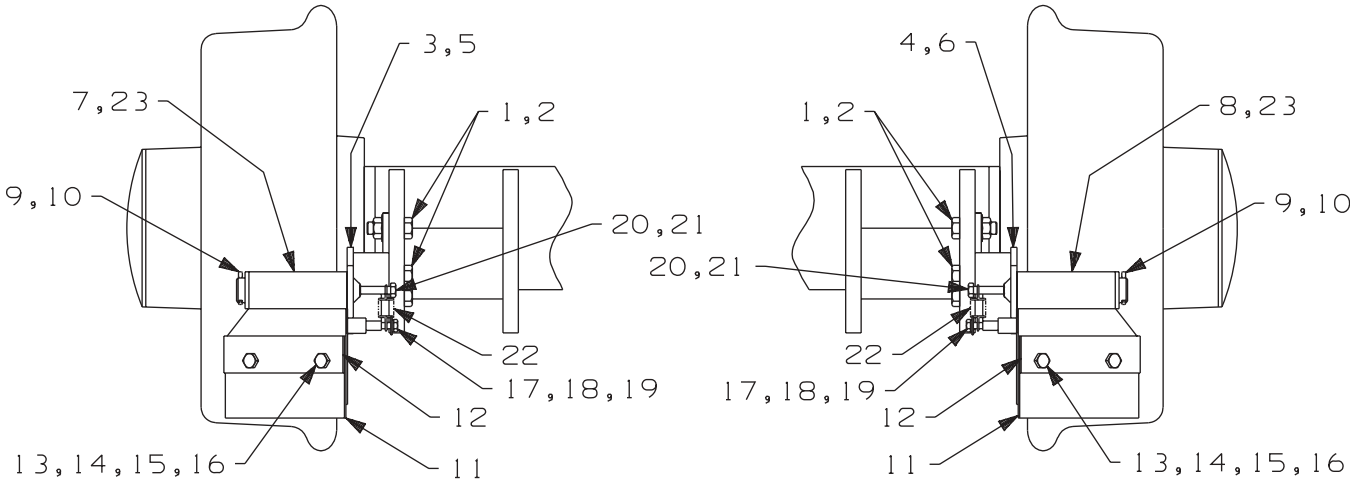
Note: Quantities listed are for one wheel only.

ITEM	PART NO	DESCRIPTION	QTY
1	171080	Hub Cap	1
2	168761	Bearing Cup And Cone, Inside	1
3	168762	Bearing Cup And Cone, Outside	1
4	159070	Wheel	1
5	F025198	Lock Washer, Inside With Holes	1
6	F025199	Nut, Inside With Pin	1
7	F025200	Nut, Outside	1
8	F025201	Grease Seal	1
9	F025226	Lock Washer, Outside With Tabs	1

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.

159453 RAIL SWEEP GROUP



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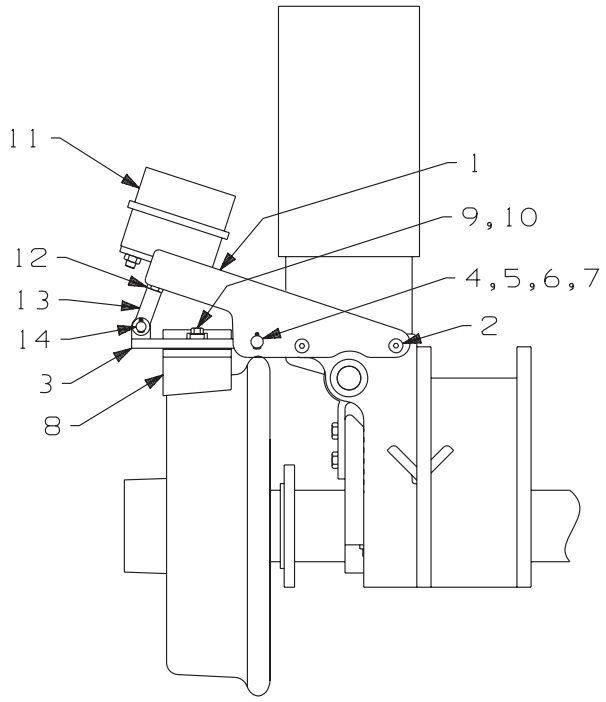
ITEM	PART NO	DESCRIPTION	QTY
	159453	RAIL SWEEP GROUP	
1	F001095	Cap Screw, 1/2-13 x 1-3/4" GR 5 Hex Hd	6
2	F022037	Hex Flg Nut, 1/2"-13 GR 5	6
3	159026	RAIL SWEEP ASSEMBLY, LEFT REAR	1
4	159063	RAIL SWEEP ASSEMBLY, RIGHT REAR	1
5	159314	Mounting Bracket - Left Rear	1
6	159062	Mounting Bracket - Right Rear	1
7	108513	Rail Sweep Plate - Left Rear	1
8	108505	Rail Sweep Plate - Right Rear	1
9	179117	Washer	2
10	F003141	Cotter Pin, 1/8 x 1-1/2"	2
11	108509K1	Rail Sweep	2
12	108510	Bracket	2
13	F001125	Cap Screw, 3/8-16 x 1-1/4" GR 5 Hex Hd	4
14	F001115	Wrought Washer, 3/8"	4
15	F001025	SAE Lock Washer, 3/8"	4
16	F007020	Hex Nut, 3/8"-16 GR 5	4
17	F002355	Cap Screw, 1/4-20 x 3/4" GR 5 Hex Hd	2
18	F001106	Wrought Washer, 1/4"	2
19	F009535	Lock Washer, 1/4"	2
20	F007021	Hex Nut, 5/16"-18 GR 5	2
21	F001113	Cap Screw, 5/16-18 x 1-1/4" GR 5 Hex Hd	2
22	072909	Spring	2
23	F008014	Grease Fitting	2

158185 REAR UNIT BRAKE GROUP



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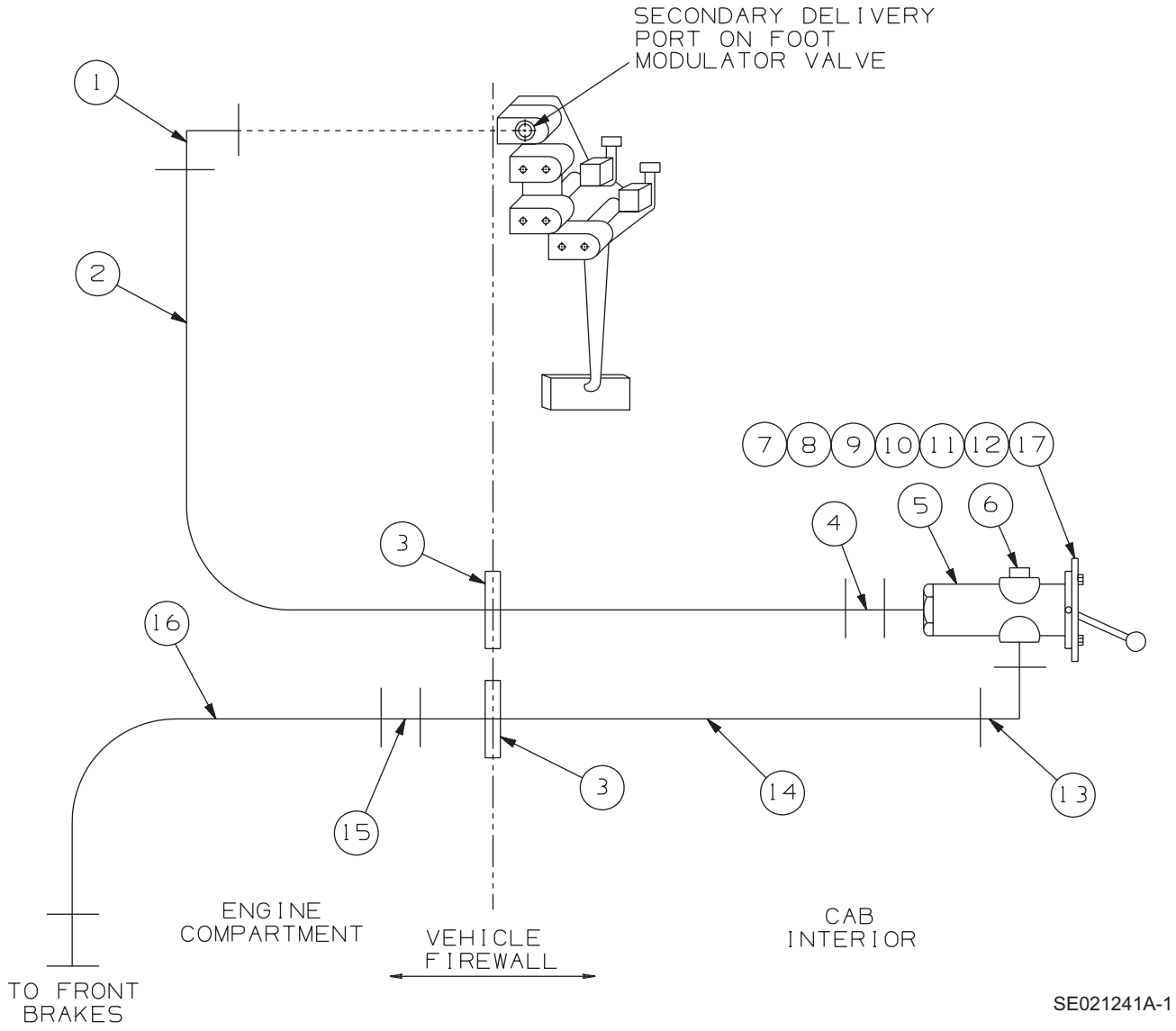
ITEM	PART NO	DESCRIPTION	QTY
	158185	REAR UNIT BRAKE GROUP	1
1	157702	Bracket	2
2	F019634	Cap Screw, 1/2-13 x 1-3/4" Flt Soc Hd	8
3	157701	Plate	2
4	157698	Pin	2
5	M033847	Washer	4
6	F001182	Cotter Pin, 1/8 x 1-1/4"	4
7	F008014	Grease Fitting	4
8	F022274	Brake Shoe	2
9	157694	Link	2
10	F023416	Cap Screw, 3/8-16 x 3/4" Hex Flg Hd	4
11	F025058	Actuator	2
12	F011013	Hex Jam Nut, 1/2"-20	2
13	F005459	Yoke End	2
14	F005460	Yoke Pin With Cotter Pin	2
*	F010693	5/16" ID Medium Pressure Hose	360"
*	F018064	Swivel Hose Fitting	6
*	F018562	45° Elbow, 6 x 6 NPT	2
*	F011260	Tee, 6 x 6 x 6	1
*	F011072	Tee, 6 x 6 x 4 NPT	1
*	F012587	Grommet	1
*	F016656	Ty-Rap	12

* Not Illustrated. Used to connect brakes to truck brake system.

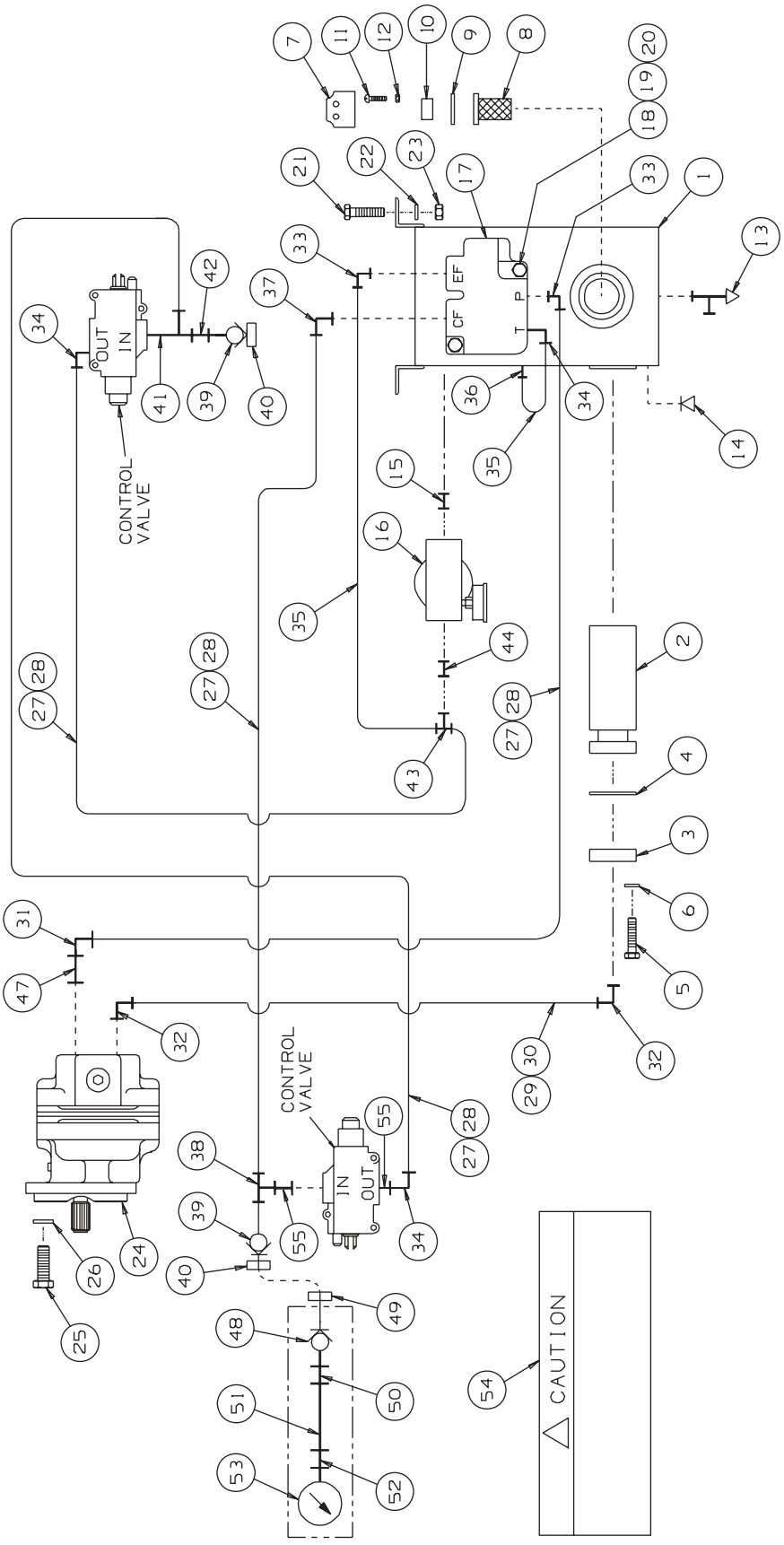
162114 TRUCK BRAKE CONNECTION



162114 TRUCK BRAKE CONNECTION

ITEM	PART NO	DESCRIPTION	QTY
	162114	TRUCK BRAKE CONNECTION	1
1	F012055	90° Elbow, 9/16 M JIC x 3/8 M NPT	1
2	F018904	Hose, 5/16 x 48" Swivel 9/16 F JIC Both Ends	1
3	F012587	Grommet	2
4	F010994	Adapter, 9/16 M JIC x 1/4 M NPT	1
5	F019332	Air Control Valve	1
6	F010989	Pipe Plug, 1/4 M NPT	1
7	120453	Bracket	1
8	F001113	Cap Screw, 5/16-18 x 1-1/4" Hex Hd	2
9	F001100	SAE Lock Washer, 5/16"	2
10	F007021	Hex Nut, 5/16"-18	2
11	122583	Instruction Plate, Rail Wheel...	1
12	F009591	Machine Screw, #10-24 x 3/4" Rd Hd	2
13	F010988	90° Elbow, 9/16 M JIC x 1/4 M NPT	1
14	079235	Hose, 5/16 x 51" Swivel 9/16 F JIC Both Ends	1
15	F011152	Adapter, 9/16 M JIC x 9/16 M JIC	1
16	075540	Hose, 5/16 x 76" Swivel 9/16 F JIC Both Ends	1
17	120457	Decal, Rail Brake Operation...	1

137926 HYDRAULIC POWER PACK - FULL



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137926 HYDRAULIC POWER PACK - FULL

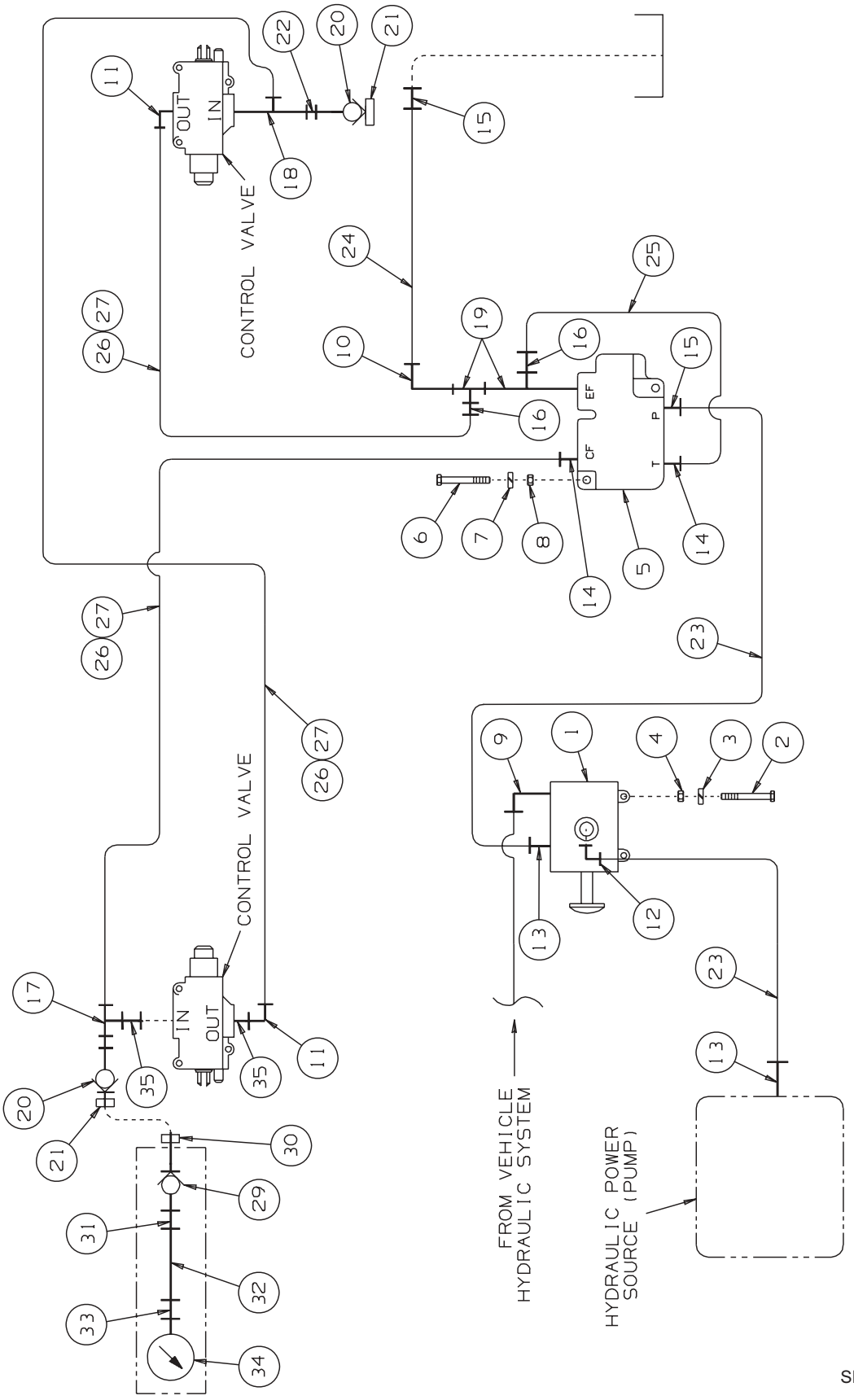
ITEM	PART NO	DESCRIPTION	QTY
	137926	HYDRAULIC POWER PACK -FULL	1
	129136	HYDRAULIC RESERVOIR ASSEMBLY	1
1	099444	Reservoir Only	1
2	F014155	Filter	1
3	082205	Filter Flange	1
4	077997	Flange Gasket	1
5	F001125	Cap Screw, 3/8-16 x 1-1/4" Hex Hd	4
6	F001025	SAE Lock Washer, 3/8"	4
7	F022655	FILLER CAP	1
8	F010465	Filler Screen	1
9	056780	Filler Flange Gasket	2
10	F010466	Filler Flange	1
11	F009723	Machine Screw, 10-24 x 3/8" Rd Hd	6
12	F009541	SAE Lock Washer, #10	6
13	F010181	Drain Valve, 1/8 M NPT	2
14	F012702	Pipe Plug, 3/8 M NPT Magnetic	1
15	F001328	Pipe Nipple, 3/4 M NPT x 1-3/8"	1
16	F015452	FILTER - RETURN	1
16a	F015453	Replacement Filter Element	1
17	120993	VALVE, FLOW DIVIDER	1
17a	F019415	Pressure Relief Washers (set of four)	1
18	F009663	Cap Screw, 5/16-18 x 2" Hex Hd	2
19	F007021	Hex Nut, 5/16"-18	2
20	F001100	SAE Lock Washer, 5/16"	2
21	F001125	Cap Screw, 3/8-16 x 1-1/4" Hex Hd	4
22	F001025	SAE Lock Washer, 3/8"	4
23	F007020	Hex Nut, 3/8"-16	4
24	F023330	Hydraulic Pump	1
25	F003136	Cap Screw, 1/2-13 x 1" Hex Hd	2
26	F001075	SAE Lock Washer, 1/2"	2
	140344	HOSE GROUP	1
27	F009947	Hose, 13/32 x 960" (cut to length)	1
28	F020713	Hose Fitting, Swivel 3/4 F JIC (install on hose F009947)	8
29	F010298	Hose, 1-1/8 x 75" (cut to length)	1
30	F014307	Hose Fitting, Swivel 1-5/8 F JIC (install on hose F010298)	2
31	F013243	90° Elbow, 3/4 M NPT x 3/4 M JIC	1
32	F021260	90° Elbow, 1 M NPT x 1-5/8 M JIC	2
33	F012054	90° Elbow, 1/2 M NPT x 3/4 M JIC	2
34	F011114	90° Elbow, 3/8 M NPT x 3/4 M JIC	3
35	067736	Hose, 13/32 x 17" Swivel 3/4 F JIC Both Ends	2
36	F011170	Adapter, 3/8 M NPT x 3/4 M JIC	1
37	F012704	90° Elbow, 3/4 M JIC x 3/8 M NPT	1

137926 HYDRAULIC POWER PACK - FULL

ITEM	PART NO	DESCRIPTION	QTY
38	F013605	Tee, 3/4 M JIC x 3/8 M NPT x 3/8 M NPT	1
39	F015303K	Nose Piece, 3/8 F NPT	2
40	F015077	Dust Cap	2
41	F014722	Tee, 3/8 F NPT x 3/4 M JIC x 3/8 M NPT	1
42	F011604	Adapter, 3/8 M NPT x 3/8 M NPT	1
43	F013629	Tee, 3/4 M JIC x 3/4 M JIC x 3/8 M NPT	1
44	F012024	Reducer Bushing, 3/4 M NPT x 3/8 F NPT	1
45	Not Used		
46	Not Used		
47	F011617	Reducer Bushing, 1 M NPT x 3/4 F NPT	1
	099137K	PRESSURE GAUGE ASSEMBLY	1
48	F015110K	Body, 3/8 F NPT	1
49	F015111	Dust Cap	1
50	F012056	Adapter, 3/8 M NPT x 9/16 M JIC	1
51	171878	Hose, 3/8 x 14" Swivel 9/16 F JIC Both Ends	1
52	F011109	Adapter, 9/16 M JIC x 1/4 F NPT	1
53	F011432K	Pressure Gauge, 1/4 M NPT	1
54	137941	Decal, Caution -Recommended...	1
55	F015103	Adapter, 3/8 F NPT x 3/4 M STR	2

NOTES

137927 HYDRAULIC POWER PACK - ABBREVIATED



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137927 HYDRAULIC POWER PACK - ABBREVIATED

ITEM	PART NO	DESCRIPTION	QTY
	137927	HYDRAULIC POWER PACK -ABBREVIATED	1
1	F016490	Selector Valve	1
2	F002760	Cap Screw, 3/8-16 x 2-1/4" Hex Hd	2
3	F001025	SAE Lock Washer, 3/8"	2
4	F009670	Hex Grip Nut, 3/8"-16	2
5	120993	VALVE, FLOW DIVIDER	1
	F019415	Pressure Relief Washers (set of four)	1
6	F009663	Cap Screw, 5/16-18 x 2" Hex Hd	2
7	F001100	SAE Lock Washer, 5/16"	2
8	F007021	Hex Nut, 5/16"-18	2
9	F012010	90° Elbow Street, 3/4 F NPT x 3/4 M NPT	1
10	F010584	90° Elbow, 1-1/16 M JIC x 1/2 M NPT	1
11	F011114	90° Elbow, 3/4 M JIC x 3/8 M NPT	2
12	F010586	90° Elbow, 1-1/16 M JIC x 3/4 M NPT	1
13	F010581	Adapter, 1-1/16 M JIC x 3/4 M NPT	2
14	F011170	Adapter, 3/4 M JIC x 3/8 M NPT	2
15	F013210	Adapter, 1-1/16 M JIC x 1/2 M NPT	2
16	F012027	Adapter, 3/4 M JIC x 1/2 M NPT	2
17	F013605	Tee, 3/4 M JIC x 3/8 M NPT x 3/8 M NPT	1
18	F014722	Tee, 3/8 F NPT x 3/4 M JIC x 3/8 M NPT	1
19	F010692	Tee, 1/2 F NPT x 1/2 M NPT x 1/2 F NPT	2
20	F015303K	Nose Piece, 3/8 F NPT	2
21	F015077	Dust Cap	2
22	F011604	Adapter, 3/8 M NPT x 3/8 M NPT	1
23	071692	Hose, 5/16 x 48" Swivel 1-1/16 F JIC Both Ends	2
24	111100	Hose, 3/4 x 28" Swivel 1-1/16 F JIC Both Ends	1
25	071867	Hose, 1/2 x 19-3/4" Swivel 3/4 F JIC Both Ends	1
	140345	HOSE GROUP	1
26	F009947	Hose, 13/32 x 960" (cut to length)	1
27	F020713	Hose Fitting, Swivel 3/4 F JIC (install on hose F009947)	6
	099137K	PRESSURE GAUGE ASSEMBLY	1
29	F015110K	Body, 3/8 F NPT	1
30	F015111	Dust Cap	1
31	F012056	Adapter, 3/8 M NPT x 9/16 M JIC	1
32	171878	Hose, 3/8 x 14" Swivel 9/16 F JIC Both Ends	1
33	F011109	Adapter, 9/16 M JIC x 1/4 F NPT	1
34	F011432K	Pressure Gauge, 1/4 M NPT	1
35	F015103	Adapter, 3/8 F NPT x 3/4 M STR	2

164574 SIGHT ROD EXTENSION GROUP

PART NO	DESCRIPTION	QTY
164574	SIGHT ROD EXTENSION GROUP	1
130195	Sight Rod Kit (includes two sight rods)	1
135809	Sight Rod Extension	2
161855	Mounting Bar	2
F022036	Cap Screw, 1/2-13 x 1-1/4" Hex Flg Hd	2
F022037	Hex Flg Nut, 1/2"-13	2

161456 DECAL SERVICE GROUP

PART NO	DESCRIPTION	QTY
161456	DECAL SERVICE GROUP	1
F018082	Decal, Safety Instructions - Lock Front Wheels....	1
F018084	Decal, HY-RAIL® Operation	2
140220	Decal, Warning - Do Not Operate...	2
155007	Decal, HY-RAIL® Vehicle Completed By...	1
3410749	Decal, HY-RAIL® Operating Instructions	1

179139 MOUNTING BRACKET GROUP

Rear Unit Mounting Parts

PART NO	DESCRIPTION	QTY
179139	MOUNTING BRACKET GROUP	1
202069	Hardened Washer, 3/4"	8
F021243	Cap Screw, 3/4-10 x 3" Hex Hd	2
154391	Shim, .025" (use as required)	4
154392	Shim, .060" (use as required)	4
700666075	Hex Locknut, 3/4"-10	6
F024283	Cap Screw, 3/4-10 x 3" Flat Hd	4
024692	Rear Unit Application Drawing	

203648 MOUNTING BRACKET GROUP

Rear Unit Mounting Parts

PART NO	DESCRIPTION	QTY
203648	MOUNTING BRACKET GROUP	1
202069	Hardened Washer, 3/4"	8
F021243	Cap Screw, 3/4-10 x 3" Hex Hd	2
154391	Shim, .025" (use as required)	4
154392	Shim, .060" (use as required)	4
700666075	Hex Locknut, 3/4"-10	6
F024283	Cap Screw, 3/4-10 x 3" Flat Hd	4
024692	Rear Unit Application Drawing	

NOTES

SECTION 7 - VEHICLE APPLICATIONS
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	2005 FREIGHTLINER M-2 106V 14,000 GAWR - FRONT 40,000 GAWR - REAR HR4000V1 FRONT HR4500A1 REAR	2006 FREIGHTLINER M-2 106V 14,000 GAWR - FRONT 40,000 GAWR - REAR HR4000V1 FRONT HR4500A1 REAR
REQUIRED GROUPS		
Guide Wheel Unit Application	201252	201252
Rear Guide Wheel Unit	159454	159454
Mounting Brackets	203648	203648
Steering Lock	203657	203657
Application Drawing - Rear	024692	024692
ACCESSORY GROUP OPTIONS		
* Rail Sweeps - Rear	159453	159453
Rear Unit Brakes	158185	158185
Truck Brake Connection	162114	162114
Hydraulic Power Pack - Full	137926	137926
Hydraulic Power Pack - Abbreviated	137927	137927
Sight Rod Kit And Extension	164574	164574

* Recommended Safety Option

2005 STERLING
LT-8511
20,000 GAWR - FRONT
40,000 GAWR - REAR
HR4500V1 FRONT
HR4500A1 REAR

REQUIRED GROUPS

Guide Wheel Unit Application 187264
Rear Guide Wheel Unit 159454
Mounting Brackets 179139
Steering Lock 201234
Application Drawing - Rear 024692

ACCESSORY GROUP OPTIONS

* Rail Sweeps - Rear 159453
Rear Unit Brakes 158185
Truck Brake Connection 162114
Hydraulic Power Pack - Full 137926
Hydraulic Power Pack - Abbreviated 137927
Sight Rod Kit And Extension 164574

* Recommended Safety Option

NOTES

APPENDIX A - CONVERSION TABLES
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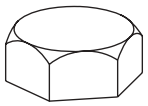
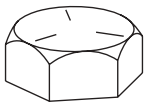
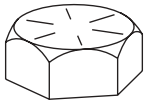
Appendix A

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

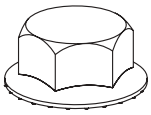
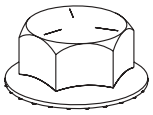
SAE Grade	1 or 2				5				8			
Fastener Standard SAE Grade Markings												
Fastener Body Size Inch-Thread	**Torque**				**Torque**				**Torque**			
	Wet		**Dry**		**Wet**		**Dry**		**Wet**		**Dry**	
	lb-in	N-m	lb-in	N-m	lb-in	N-m	lb-in	N-m	lb-in	N-m	lb-in	N-m
1/4 - 20	49	5.5	65	7.3	75	8.5	100	11.3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

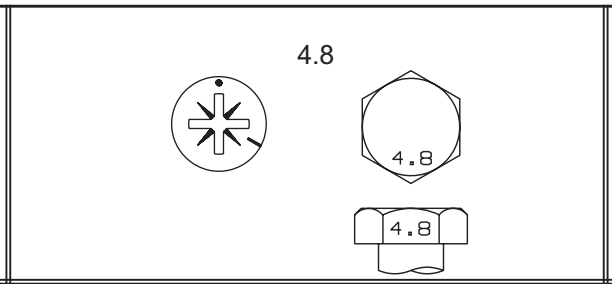
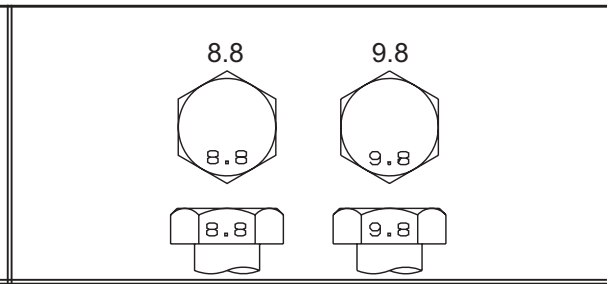
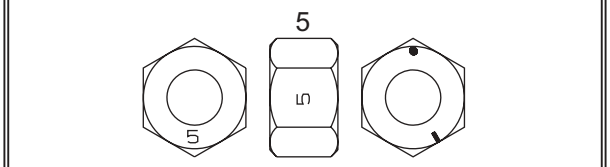
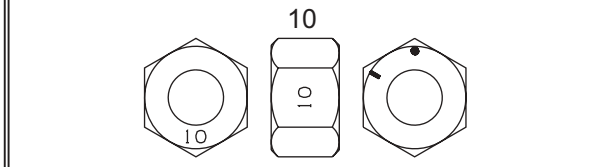
SAE Grade	**1 or 2**				5			
Fastener Standard SAE Grade Markings								
Fastener Body Size Inch-Thread	**Torque**				**Torque**			
	Wet		**Dry**		**Wet**		**Dry**	
	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m	lb-ft	N-m
1/4 - 20	8	10.8	11	14.9	11	14.9	15	20.3
1/4 - 28	9	12.2	12	16.3	12	16.3	16	21.7
5/16 - 18	13	17.6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

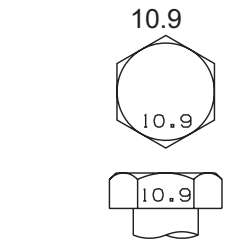
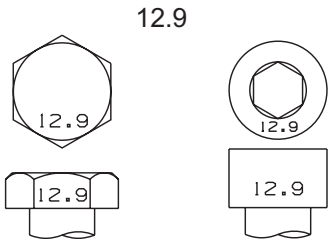
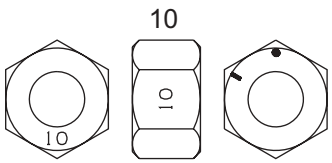
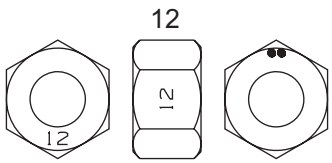
Property Class and Head Markings								
Property Class and Head Markings								
Size	Class 4.8				Class 8.8 or 9.8			
	* Lubricated		* Dry		* Lubricated		* Dry	
	N - m	lb - ft	N - m	lb - ft	N - m	lb - ft	N - m	lb - ft
M 6	4.8	3.5	6	4.5	9	6.5	11	8.5
M 8	12	8.5	15	11	22	16	28	20
M10	23	17	29	21	43	32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

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  Recommended Practices for Hydraulic Hose Assemblies

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SAE International™

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1273

REV. AUG2004

Issued 1979-09
Revised 2004-08

Superseding J1273 DEC2002

Recommended Practices for Hydraulic Hose Assemblies

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

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

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

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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.

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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.

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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.

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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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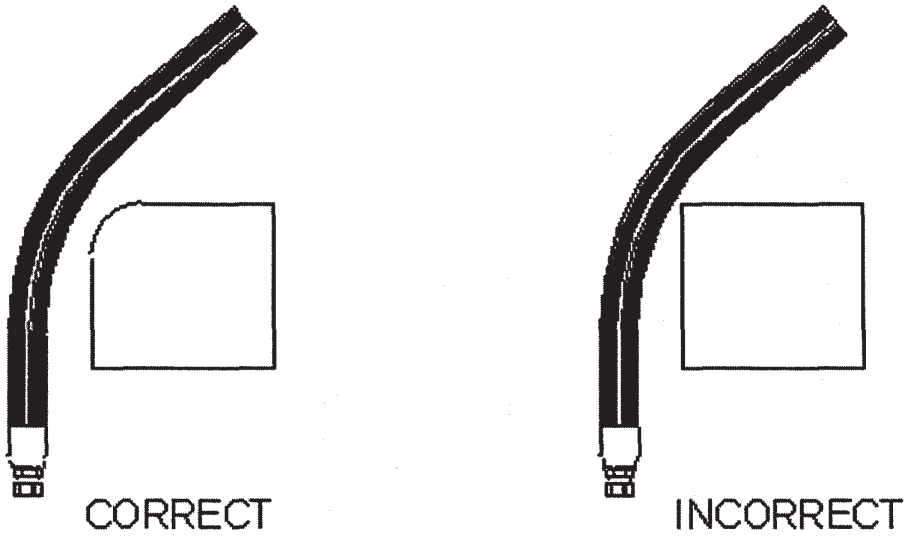

FIGURE 1—PREVENTION OF EXTERNAL DAMAGE

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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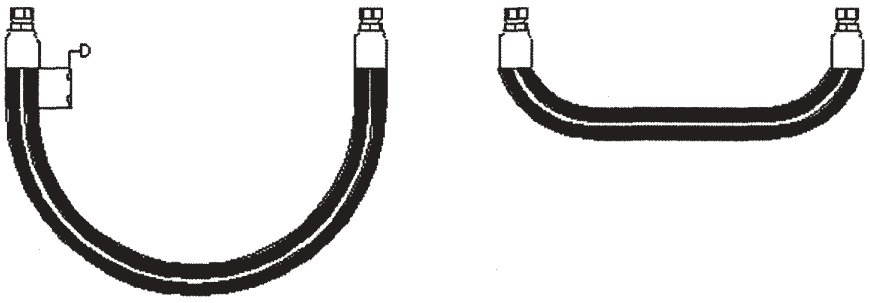

FIGURE 2A—MINIMUM BEND RADIUS

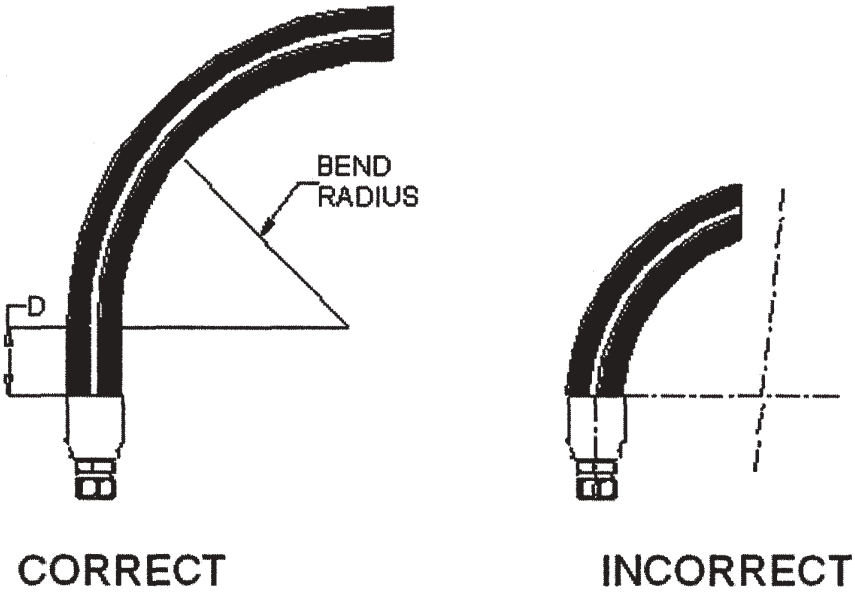

FIGURE 2B—MINIMUM BEND RADIUS

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

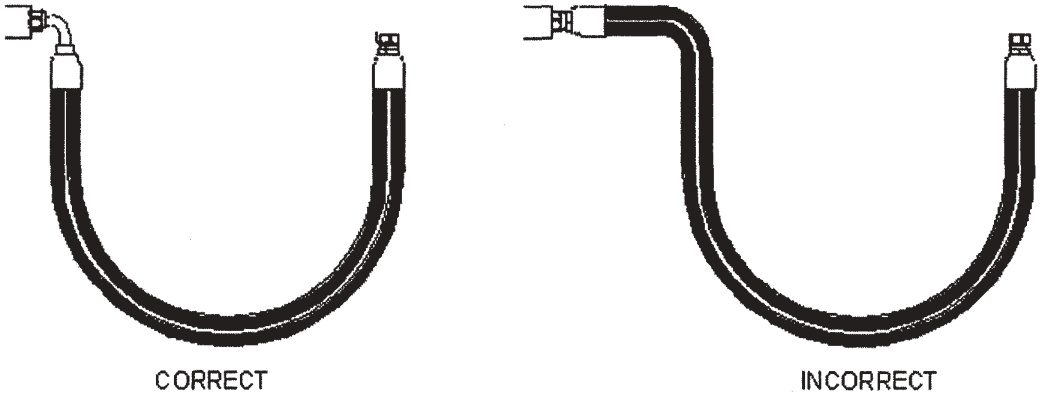

FIGURE 3—ELBOWS AND ADAPTERS

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.

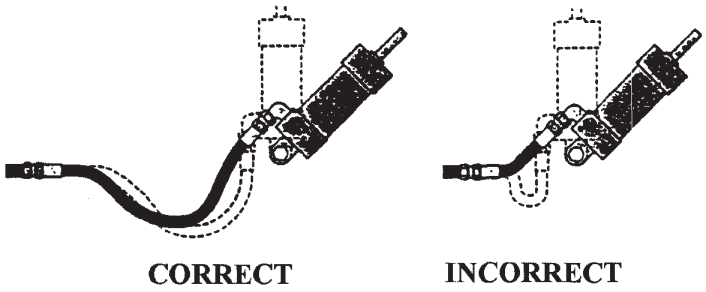

FIGURE 4—MOTION ABSORPTION

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

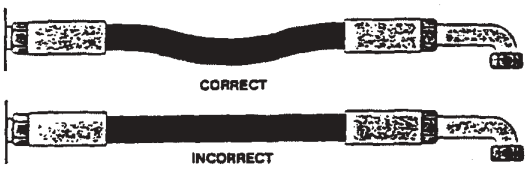

FIGURE 5—HOSE AND MACHINE TOLERANCES

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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.

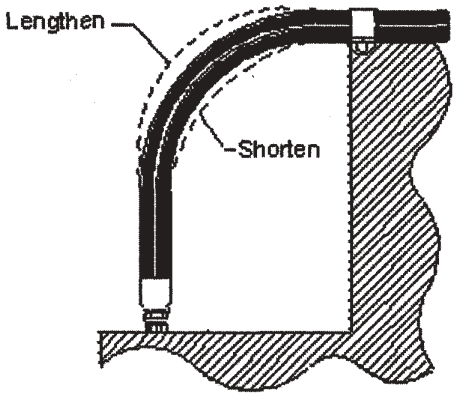

FIGURE 6—HOSE LENGTH CHANGE DUE TO PRESSURE

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

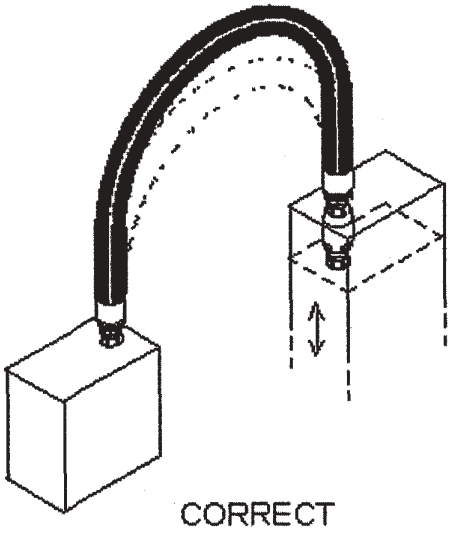

FIGURE 7A—BEND IN ONLY ONE PLANE TO AVOID TWISTING

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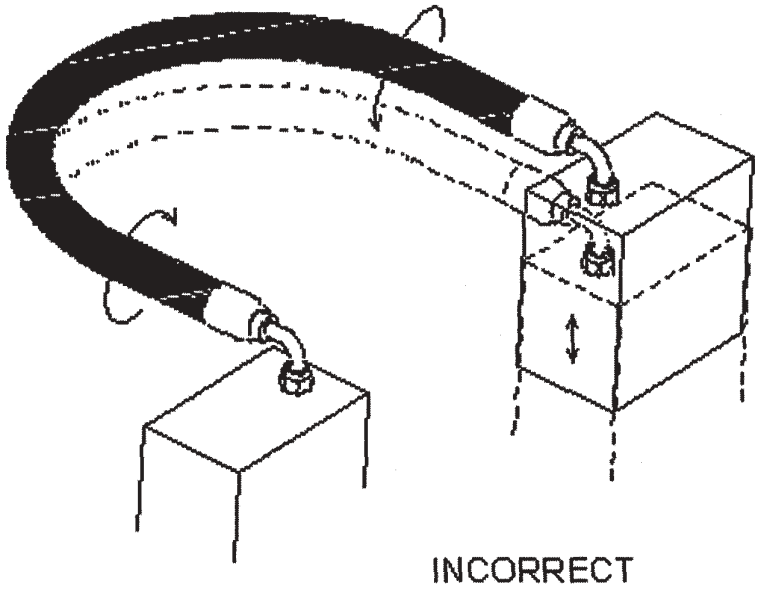

FIGURE 7B—BEND IN ONLY ONE PLANE TO AVOID TWISTING

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.

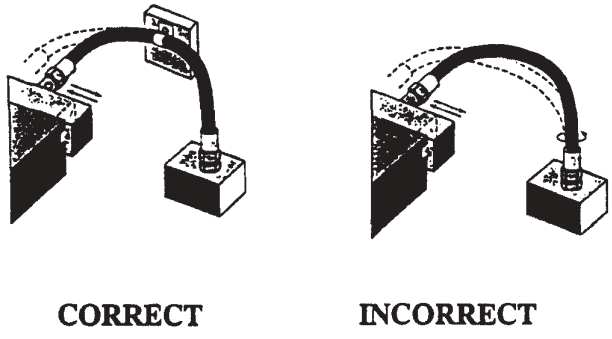

FIGURE 8—PREVENT HOSE BENDING IN MORE THAN ONE PLANE

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.

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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.

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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).

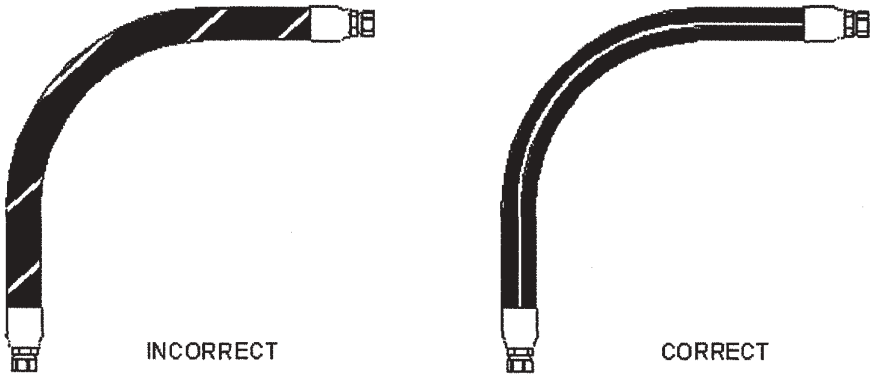

FIGURE 9—TWIST ANGLE AND ORIENTATION

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.

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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.

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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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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

HARSCO TRACK TECHNOLOGIES

TERMS AND CONDITIONS OF SALE

1. ACCEPTANCE OF TERMS AND CONDITIONS. The acceptance of the terms and conditions contained herein is an essential prerequisite to any contract of sale made by HTT, a Division of Harsco Corporation (hereinafter "HTT"). Any offer or acceptance by HTT is made subject to the terms and conditions contained herein and no additional or different terms offered by Buyer shall become a part of the agreement of sale between HTT and Buyer unless such terms have been expressly approved in writing by an authorized agent of HTT. If this document is an offer, acceptance of this offer is expressly limited to the terms hereof, and HTT reserves the right to withdraw this offer at any time before its acceptance by Buyer. If this document has been issued by HTT in response to a written offer made by Buyer, HTT's acceptance of Buyer's offer is expressly conditioned on Buyer's assent to the additional or different terms contained herein. If these terms and conditions are not acceptable, Buyer shall notify HTT in writing at once. Buyer's action in (a) accepting any goods manufactured and delivered hereunder, or (b) receiving this document without disaffirmance within three (3) business days of receipt shall constitute an unqualified acceptance by Buyer of the terms and conditions contained herein.

2. INVOICES AND PAYMENT TERMS. Product shipments shall be invoiced based on the shipment date. Payment terms are as indicated in the quotation letter and payment is due at HTT's designated lockbox.

3. TAXES. Buyer shall pay to HTT the amount of any and all taxes, excises, or other charges (except income or gross receipt taxes) which HTT may be required to pay to or to collect for any government, whether national, state or local, based upon or measured by the sale or use of the Product sold hereunder provided the amount of the tax or other charge is set forth separately on HTT's invoice.

4. DELIVERY. All delivery terms and dates are subject to the availability of the necessary shop space, transportation, and production hours.

5. FORCE MAJEURE. Neither HTT nor Buyer shall be liable for delay or failure to perform in whole or in part by reason of contingencies beyond its control, whether herein specifically enumerated or not, including among others, acts of God, force majeure, war, acts of war, revolution, civil commotion, riot, acts of public enemies, blockage or embargo, fire, explosion, breakdown of plant, strike, lockout, labor dispute, casualty or accident, earthquake, epidemic, flood, cyclone, tornado, hurricane or other windstorm, lack or failure of sources of labor, power, supplies; lack, or failure or excessive cost of raw materials which are used in the manufacture of Product by HTT, or by reason of any law, order, proclamation, regulation, ordinance, demand, requisition or requirement or any other act of governmental authority, whether national, state or local, including court orders, judgments, or decrees, or any other cause whatsoever, whether similar or dissimilar to those above enumerated, or actions of any nature beyond the reasonable control of HTT or Buyer.

6. LIMITED WARRANTY. HTT 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 HTT 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 HTT 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. HTT will not be liable for other loss, damage, or expense directly or indirectly arising from the use of its product, nor will HTT 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. HTT 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 HTT, but which are furnished in connection with HTT products, are covered directly by the warranty of the manufacturer supplying them. However, HTT 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 HTT. THE REMEDY SET FORTH ABOVE IS BUYER'S EXCLUSIVE REMEDY FOR A BREACH OF THE WARRANTY. UNDER NO CIRCUMSTANCES WILL HTT BE RESPONSIBLE FOR INCIDENTAL, CONSEQUENTIAL, SPECIAL OR OTHER INDIRECT DAMAGES.**

7. PRODUCT IMPROVEMENT LIABILITY DISCLAIMER. HTT reserves the right to make any changes in or improvements on its products without incurring any liability or obligation whatsoever and without being required to make any corresponding changes or improvements in products previously manufactured or sold.

8. INDEMNITY. Buyer agrees to indemnify and hold HTT 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 HTT's product.

9. 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 you employee safety training education and environmental health training.

10. TITLE AND RISK OF LOSS. Title to, ownership of, and risk of loss, destruction or damage to the Product shall pass to Buyer upon loading at HTT's plant.

11. CANCELLATION. No accepted purchase order may be modified except with HTT's prior written consent, nor may it be canceled except with HTT's prior written consent and by prior payment to HTT of a sum equal to the total of out-of-pocket expenses incurred in connection with the purchase order, including but not limited to any charges made to HTT by suppliers for cancellation, plus a reasonable sum for overhead expenses and lost profits, as determined by HTT.

12. SECURITY. HTT reserves the right to require payment in advance or satisfactory security or guaranty that an invoice will be promptly paid when due if at any time Buyer's financial responsibility becomes impaired or unsatisfactory to HTT.

13. COSTS AND ATTORNEY'S FEES. Buyer shall pay all costs and reasonable attorneys' fees of HTT incurred in connection with the enforcement of these terms of sale between the parties hereto.

14. EFFECT OF INVALIDITY. The invalidity in whole or in part of any provision hereof shall not affect the validity of any other provision.

15. WAIVER. No waiver by HTT of any breach of contract shall be deemed to be a waiver of any other or subsequent breach. All rights and remedies available to HTT shall be cumulative and in addition to any other rights and remedies provided herein or by law.

16. Governing Law, Jurisdiction and Venue. These terms of sale between the parties hereto shall be governed by and construed in accordance with the laws of the State of Pennsylvania. The parties agree that any controversy arising under the contract herein shall be determined by the Courts of the State of Pennsylvania, and both parties hereby submit and consent to the jurisdiction of said Courts and agree that venue for any action arising hereunder shall lie in Cumberland County, State of Pennsylvania.

VERSION DATE: June 2004

HTT

Harsco Track Technologies

Harsco

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BULLETIN 1521 Printed In U.S.A. ISSUED 10 - 2006