



SUTPHEN FIRE TRUCK OPERATOR AND MAINTENANCE MANUAL



SUTPHEN

IMPORTANT

READ AND UNDERSTAND THIS MANUAL BEFORE OPERATING

FAILURE TO USE, UNDERSTAND, AND FOLLOW PROPER USAGE INSTRUCTIONS AS MADE AVAILABLE BY SUTPHEN CORPORATION/OPERATOR'S MANUAL, VARIOUS VENDOR SUPPLIED LITERATURE, GUIDELINES OF N.F.P.A., I.S.F.S.I., O.S.H.A., ETC., COULD CAUSE SERIOUS INJURY AND/OR DEATH.

**SUTPHEN
Since 1890**

Rev. 20 - January 2025



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Appendix A

ALLISON TRANSMISSION - EMERGENCY VEHICLE SERIES 3000/4000 -
ALLISON 5th GENERATION CONTROLS - OPERATOR'S MANUAL

Appendix B

MERITOR WABCO - ANTI-LOCK BRAKING SYSTEM (ABS) FOR TRUCKS,
TRACTORS AND BUSES
MAINTENANCE MANUAL MM-0112

Appendix C

MERITOR WABCO - SYSTEM SAVER SERIES SINGLE CARTRIDGE AIR DRYERS

Appendix D

ALLISON TRANSMISSION - SHIFT SELECTOR - OPERATION AND CODE
MANUAL

Appendix E

RIDEWELL SUSPENSIONS - THE ENGINEERED SUSPENSION COMPANY
RAD-241 OWNER'S MANUAL

Appendix F

FREQUENTLY ASKED QUESTIONS - FIRE AND EMERGENCY VEHICLE -
EMISSIONS DERATE EXEMPTION - CUSTOMER FAQ

Appendix G

HENDRICKSON PRIMAAAX EX/ FIREMAAX EX/ PRIMAAAX/ FIREMAAX
SERIES

Appendix H

HENDRICKSON STEERTEK NXT HIGH CAPACITY



Chapter 1

Introduction and General Description

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1.2 Truck Identification.....	1-7
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CONTACTS FOR SERVICE AND/OR PARTS

If you have a need for SERVICE, TECHNICAL SUPPORT, WARRANTY CLAIM, OR NEW PARTS, please contact the appropriate personnel below:

SP, SPH, SPI and Aerial Towers

Program 1& Program 2 Pumpers, and Custom-Built Chassis

Service Support, Tech Support, Training, Warranty, & Parts

1-866-287-5549 or 937-969-8851

SUTPHEN CORPORATION - Service & Technical Division

49 N. Ludlow Road

Urbana, OH. 43078

Fax: 937-969-8869

Introduction and General Description

CONTACTS FOR SERVICE AND/OR PARTS

If you have a need for **SERVICE, TECHNICAL SUPPORT, WARRANTY CLAIM OR NEW PARTS**, please contact the appropriate facility below:

65', 70', 75' Aerial Towers - 104' Aerials

Pumpers with Stainless Body and Custom-Built Chassis

Service, Warranty, Parts

1 -800-343-2712 or 614-876-1262

Service or Warranty Contacts:

SUTPHEN TOWERS

4500 Sutphen Court

Hilliard, OH. 43026

Fax: 614-876-3073

Commercial (Aluminum and Stainless Body) and
Special Eastern Custom Pumpers (Aluminum and Stainless Body)

Service, Warranty, Parts

1-800-244-6202 or 845-583-4720

SUTPHEN EAST

55 Innovation Drive

Lake Ariel, PA. 18436

Fax: 570-666-9130



NOTICE

UPON TRANSFER OF OWNERSHIP

• IT SHALL BE THE RESPONSIBILITY OF THE SELLER TO PROVIDE THE MANUFACTURER'S MANUAL(S) FOR THE APPARATUS TO THE PURCHASER.

• IT IS THE RESPONSIBILITY OF THE PURCHASER TO NOTIFY THE MANUFACTURER OF THE UNIT MODEL AND SERIAL NUMBER AND THE NAME AND ADDRESS OF THE NEW OWNER WITHIN 60 DAYS.

UPON TRANSFER OF OWNERSHIP, COMPLETE THE FOLLOWING
(Please Print) AND MAIL TO:

SUTPHEN CORPORATION
7000 Columbus-Marysville Road
PO Box 158
Amlin, OH 43002-0158
Attn: Sales Department

Sutphen Apparatus: Model _____ (i.e. aerial, pumper, etc.)

VIN _____ HS No. _____

NAME OF NEW OWNER: _____

MAILING ADDRESS: _____

FIRE CHIEF: _____ PHONE () _____

MECHANIC: _____ PHONE () _____

ADDRESS OF MAINTENANCE FACILITY (If different from above mailing address):

DATE OF TRANSFER OF OWNERSHIP: _____

Introduction and General Description

1.1 Introduction

This manual provides important information to familiarize you with safe operating and maintenance procedures for your Sutphen fire truck. You may be acquainted with similar equipment, but you must read and understand this operator's manual before operating the truck.

Safe operation depends on reliable equipment and the use of proper operating procedures. Performing the checks and services described in this manual will help to keep your truck in good condition. These recommended operational procedures will help you avoid unsafe practices.

This manual is divided into eight sections:

SECTION 1 - INTRODUCTION

SECTION 2 - SAFETY

SECTION 3 - COMPONENTS

SECTION 4 - 2010 CUMMINS ENGINES AND AFTERTREATMENT INFORMATION

SECTION 5 - OPERATION

SECTION 6 - MAINTENANCE

SECTION 7 - TROUBLESHOOTING

SECTION 8 - WARRANTY

We strongly recommend that any system on your fire truck be serviced by experienced mechanics or at a component manufacturer's service facility.



Sutphen Corporation recommends, where possible, using Mistras and Underwriters Laboratories Inc. for aerial inspections. They are recognized nationally and have been thoroughly trained and are familiar with the Sutphen unit, as they do the aerial inspection inside the factory while the truck is in various stages.

Jim Kelker

Pat Ginnaty-Moore

Mistras

Underwriters Laboratories Inc.

1480 James Parkway

333 Pfingsten Road

Heath, OH 43056

Northbrook, IL 60062-2096

Phone: 800-333-8629

Phone: 847-664-2366

There are several independent testing companies having limited knowledge or experience with our unit; however, they tend to have more problems understanding a Sutphen apparatus.

Sutphen trucks are built to conform to all Federal Standards and Regulations applicable at the time of manufacture. Sutphen Corporation cannot be held liable for any unapproved alterations to systems or components, certified or otherwise.



CAUTION

Do not weld to or make any alterations or add any devices to the aerial device without first consulting Sutphen Corporation for approval.

Introduction and General Description

1.2 Truck Identification

When making any correspondence relative to your vehicle, such as ordering parts, be sure to specify the Vehicle Identification Number (VIN) or the HS number (HS and 4 digits) of your truck and date manufactured. These can be found in your manual or mounted on the left side of the driver's seat on the truck certification tag.

1.3 Vehicle Certification Label

A Vehicle Certification Label is located near the doorpost on the left side of the truck. This label certifies that the vehicle conforms to all applicable Federal Motor Vehicle Safety Standards in effect at the date of the manufacture. This label also certifies the Gross Vehicle Weight Rating (GVWR) of the vehicle. The GVWR is the maximum total vehicle weight, including the chassis, water, hose, personnel, and miscellaneous equipment. **DO NOT EXCEED MAXIMUM RATING.** The Gross Axle Weight Rating (GAWR) is the load carrying capacity of a single axle system and is also on the label. The GAWR is developed on the basis of the minimum component rating, be it axle, suspension, tires or wheels.

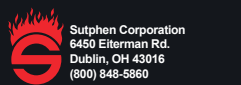
DO NOT REMOVE THIS LABEL



Truck Record

3002347 Sutphen Master Data Label

Submit by Email Print Form



Parts & Service
1-866-287-5549

MONTH-YEAR BUILT
DATE SHIPPED
CUSTOMER
VEHICLE IDENTIFICATION NO.
HS

CHASSIS PART AND SERIAL NUMBERS

TRANSMISSION	MAKE	MODEL	S/N
CAB	MAKE	MODEL	S/N
FRONT AXLE	MAKE	MODEL	S/N
REAR AXLE SINGLE	MAKE	MODEL	S/N
REAR AXLE TANDEM	MAKE	MODEL	S/N
STEERING GEAR	MAKE	MODEL	
ALTERNATOR	MAKE	MODEL	
BELTS - A/C	MAKE	MODEL	
BELTS - FDW	MAKE	MODEL	
BELTS - ALTERNATOR	MAKE	MODEL	
FIRE PUMP	MAKE	MODEL	S/N
GENERATOR	MAKE	MODEL	S/N
CAB HYD. TILT CYLINDER	MAKE	MODEL	
PTO AERIAL	MAKE	MODEL	
PTO (GENERATOR)	MAKE	MODEL	
HYD. PUMP-GENERATOR	MAKE	MODEL	S/N
AC COMPRESSOR	MAKE	MODEL	
AC ROOF UNIT	MAKE	MODEL	
AC HOOD UNIT	MAKE	MODEL	
AC CONDENSOR	MAKE	MODEL	

FLUID DATA

QTY.	TYPE
	CHASSIS ENGINE OIL
	CHASSIS ENGINE COOLANT
	CHASSIS TRANSMISSION FLUID
	PUMP TRANSMISSION FLUID
	DRIVE AXLE LUBRICATION FLUID
	TANDEM DRIVE AXLE LUBRICATION FLUID
	AIR-CONDITIONING REFRIGERANT FLUID
	AIR-COND. LUBRICAT. OIL SYS. LUBRICANT
	POWER STEERING FLUID
	CAB TILT MECH. FLUID
	TRANSFER CASE FLUID / AUTO LUBE
	EQUIPMENT RACK FLUID
	GENERATOR SYSTEM LUBRICANT
	CAFS COMPRESSOR FLUID
	CAFS CLUTCH FLUID
	AERIAL-TOWER HYDRAULIC FLUID
	LEVELING SYSTEM FLUID
	FUEL TANK DIESEL NO. 2
	FRONT / REAR TIRE COLD PSI

BODY PART AND SERIAL NUMBERS

EQUIP. / LADDER RACK	MAKE	MODEL	P/N
DECK GUN / MONITOR	MAKE	MODEL	P/N
DECK GUN NOZZLE	MAKE	MODEL	P/N
WATER TANK	MAKE	SIZE	S/N
FOAM SYSTEM	MAKE	MODEL	P/N

CHASSIS FILTERS

CHASSIS ENGINE OIL FILTER PART NO.	
TRANSMISSION OIL FILTER PART NO.	
CHASSIS AIR CLEANER FILTER PART NO.	
CHASSIS FUEL FILTER PRIMARY PART NO.	
CHASSIS FUEL FILTER SECONDARY PART NO.	
CHASSIS ENGINE WATER FILTER PART NO.	
AIR DRYER ASSEMBLY FILTER PART NO.	
AERIAL HYDRAULIC FILTER CARTRIDGE PART NO.	

CHASSIS SPECIFICATIONS

MODEL	
FRONT TIRES	REAR TIRES
ENGINE	
SERIAL NO.	NO. CYLINDERS
BORE	STROKE
H.P. SAFE	DISPLACEMENT
PAINT COLOR	



Chapter 2 Safety

This chapter contains safety guidelines for operating Sutphen vehicles. It describes safety instructions included throughout this manual, lists safety precautions to follow when operating or working on the vehicle, and describes safety practices.

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2.1 Recommended Training by Fire Department Personnel	2-2
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2.1 Recommended Training by Fire Department Personnel

After each trainee is familiar and reasonably proficient with operation, the unit should be moved to several different sites that simulate actual fire situations typical of your area.

Each operator should be given the chance to observe and operate the boom in these conditions. The Sutphen platform is equipped with proportional controls for all movements. With practice, each operator should be able to move the boom smoothly and accurately to the desired position. The process should soon be second nature, which will then permit the operator to give his/her attention to the unusual aspects of any particular situation.

The following recommendations are invaluable aids to ensuring the safe, efficient operation of the platform and to minimize hazards to people and property.

- 1.** Assign operators for the operation of the unit.
- 2.** Be certain that all operators assigned to the unit have undergone a training course which included:
 - a.** Study of this manual
 - b.** Supervised practice in an open area, until they control the boom smoothly and naturally.
 - c.** A training stint which includes placing the unit, erecting the boom, and discharging water at several sites which simulate actual fire conditions for your area.
- 3.** Each assigned operator must be familiar with the capacities and operating procedures for the unit.
- 4.** A periodic review of the precautions that must be observed for safe operations.
- 5.** Have repairs and adjustments performed only by qualified mechanics who have a working familiarity with pertinent contents of this manual.

Training rev. 03/22

 **Safety**

2.2 Fire Chief or Training Officer

1. Sutphen requires the manual be thoroughly read and studied before trying to operate this piece of apparatus.
2. Sutphen recommends that this manual be readily available to persons operating and/or servicing this equipment.
3. Sutphen further recommends that no operator drive or work on Sutphen apparatus without being trained by the Training Officer or person(s) attending the Demonstration of Operation.
4. We also recommend that the driver be certified and be CDL licensed before driving the apparatus.
5. When replacing parts on your Sutphen Fire Truck, use only Sutphen-approved parts. When parts are purchased from Sutphen, or an approved Sutphen service center, they are to be installed by a qualified person, or warranty will be void, and Sutphen will not assume any liability.

We recommend the above to eliminate any potential injury resulting from the misuse or negligence on the part of the operator. It is so important to have properly informed personnel to operate the Sutphen apparatus.

2.3 Operator's Responsibilities

The safe and reliable operation of this vehicle includes a thorough working knowledge of all its mechanical components. When checking the vehicle over or driving it, you should be able to recognize problems when they exist and determine if your truck can be driven without affecting its safe operation or causing more serious mechanical problems. When work is required, you should be able to report accurately on the problem.



2.4 Safety Instructions

Safety instructions are noted throughout this manual. Each safety instruction is given as a WARNING or a CAUTION and is accompanied by a safety symbol in the left-hand margin as shown below:

WARNING



Failure to observe a safety instruction noted by WARNING could result in severe injury or death.

CAUTION



Failure to observe a safety instruction noted by CAUTION could result in injury or damage to the equipment.

NOTE: Used throughout this manual, NOTES provide useful additional data, but are never used to communicate safety hazards.

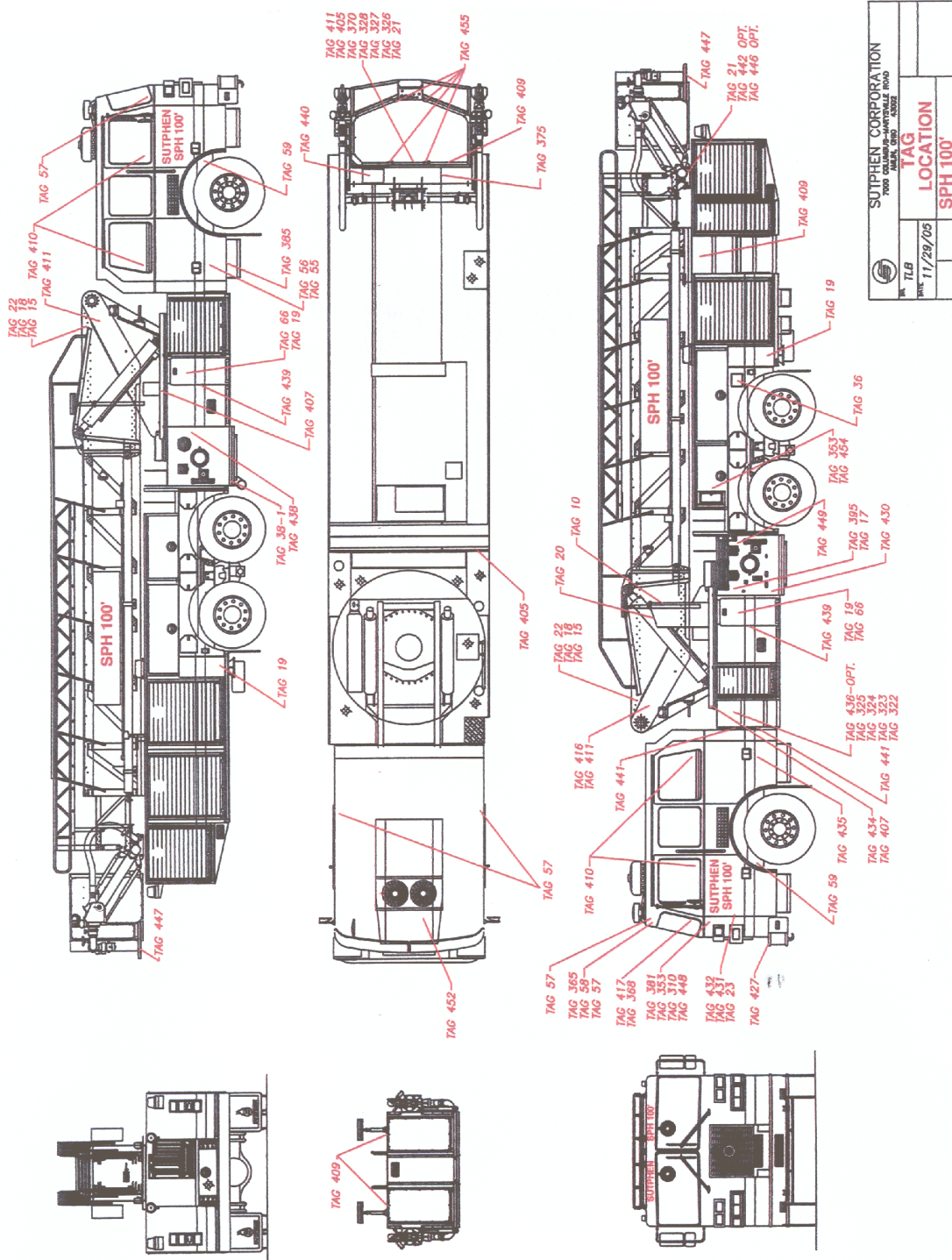
 **Safety**

2.5 Warning Labels

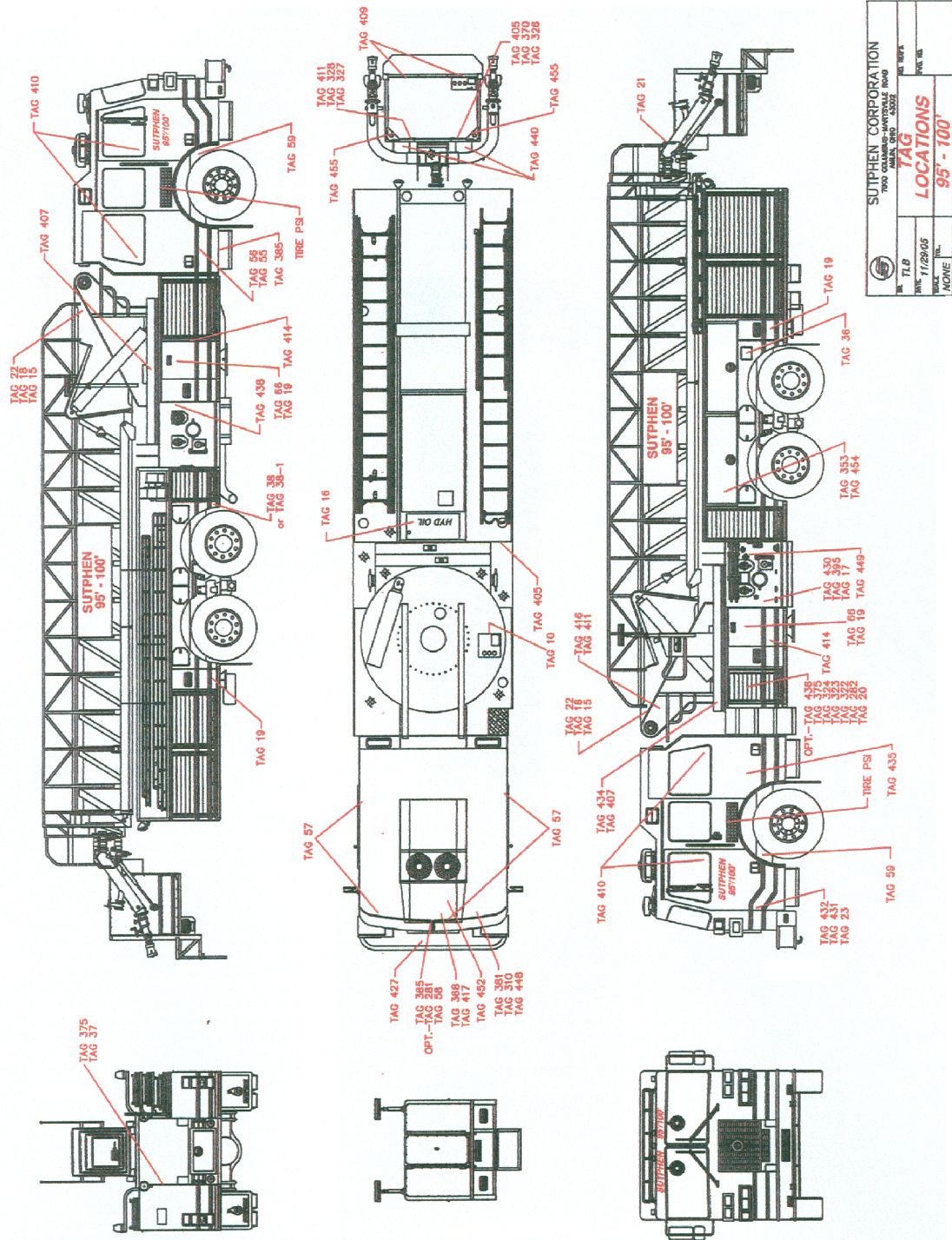
Warning labels indicate special hazards in and around the vehicle. Read all warning labels and follow instructions on them. Following are some examples of warning labels you may observe while working on the vehicle. All labels may not pertain to your specific apparatus. Learn and watch for labels.



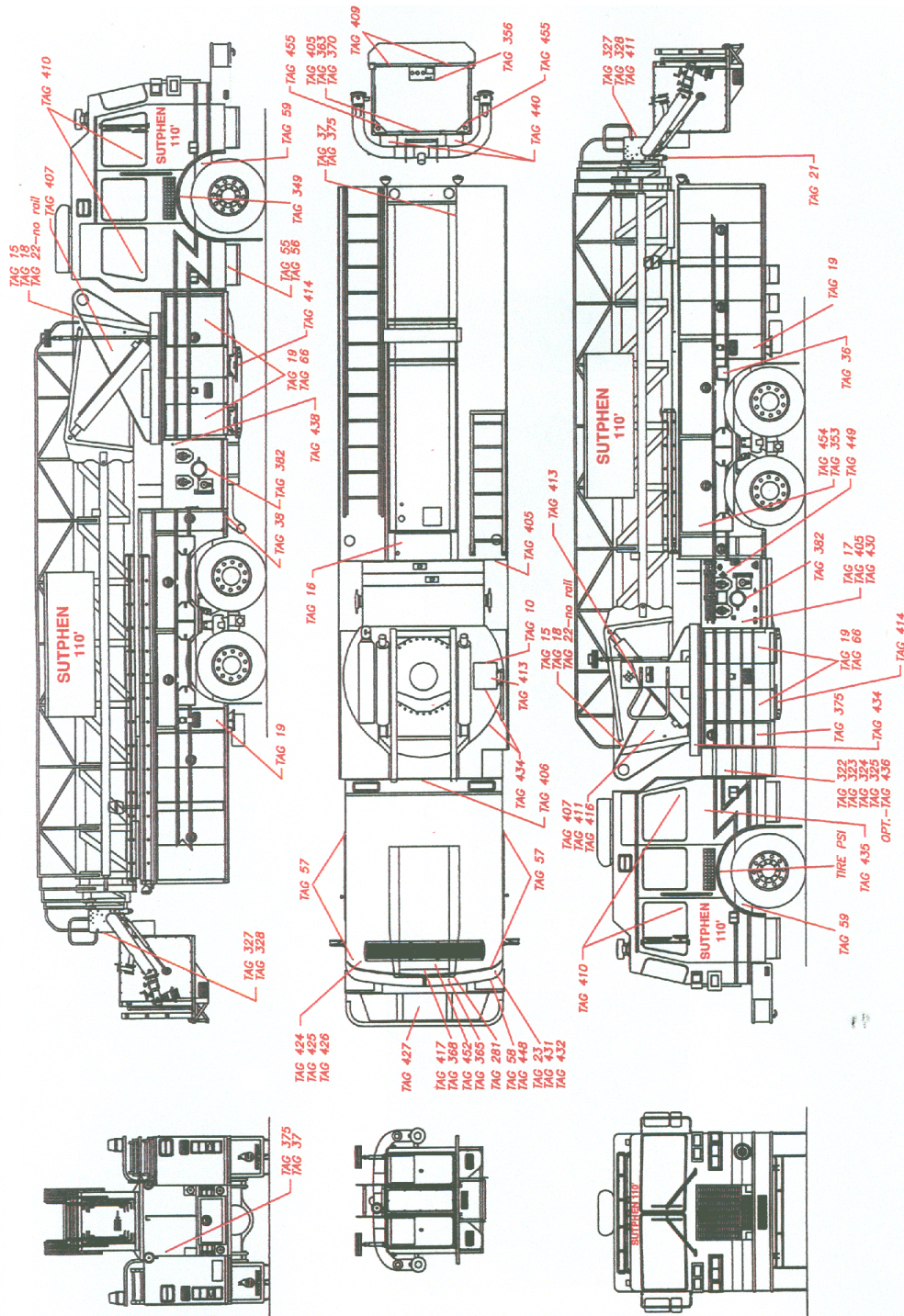
Aerial Warning Labels



Safety



Sutphen-2



SUTPHEN CORPORATION 7000 COLLIER-HAYDALE ROAD MUN. CD. 3026	
W. 7LB	TAG LOCATIONS
DATE: 10/10/03	110' MAGNUM

Sutphen-3



Safety



TAG 16



TAG 18



TAG 15



TAG 17



TAG 10



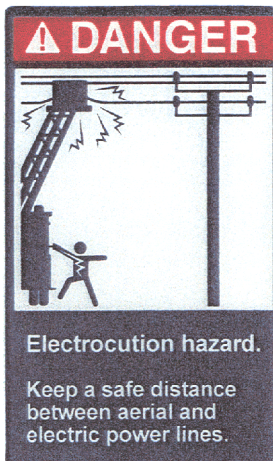
Sutphen-5

Safety

TAG 22



TAG 20



TAG 19



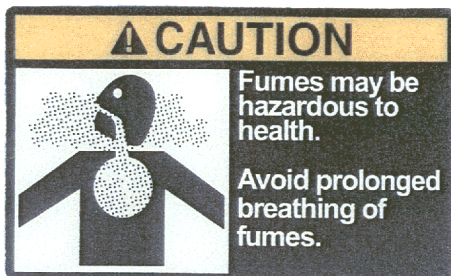
TAG 21



Sutphen-6



TAG 38-1



TAG 56



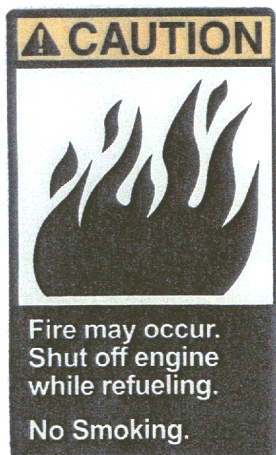
TAG 37



TAG 57



TAG 36



TAG 38



Sutphen-7

TAG 55

SAFETY INSTRUCTIONS

Jump Starting Precautions:

1. Jump starting with voltages greater than 16 volts DC or reversing the polarity will damage the engine computer.
2. Before attempting to jump-start the engine, make sure jumper cables are connected properly (positive to positive, negative to negative) and in the proper sequence (connect positive to positive first). Failure to do so can result in alternator and/or equipment damage.
3. Reversing battery polarity can also result in personal injury caused by a sudden discharge of electrolyte from the battery vents or by the sudden rupture of the battery case caused by an explosion of internal hydrogen gas.

Battery Charging Precautions

1. When using battery charger to charge batteries, set on 12 VOLT LOW CHARGE. Do not exceed a maximum of 16 volts DC.
2. Electrical damage or explosion can occur when charging batteries or boosting batteries.

Welding Precautions:

1. Serious damage to the ECM(s) and DDEC components may result from welding if all ECM connectors are not disconnected.
2. Serious damage to the multiplexed platform controls may occur if the power supply to them is not disconnected.

Sutphen-



TAG 66

WARNING

Crushing injury may occur.
Stand clear of outrigger.

TAG 60

WARNING

Truck may be damaged.
Close crosslay cover before tilting cab.

TAG 58

WARNING

Truck may lose traction.
Do not use auxiliary braking systems on wet slippery roads.

TAG 282

Yes	Yes	Yes	Yes
Left	Left	Right	Right
Outrigger	Outrigger	Outrigger	Outrigger
Extended	Pinned	Extended	Pinned

Stabilizer Interlock System

SAFETY INSTRUCTIONS

1. Do not operate aerial unless interlock system is completely in "Yes" mode.
2. Do not operate aerial unless you are fully trained and aware of possible dangers.
3. Only set up on firm, stable pavement.

TAG 281

SAFETY INSTRUCTIONS

Tire Chains Operation

1. Check that tire chains are working properly before each trip.
2. Engage and disengage chains while vehicle is moving. Chains may only be engaged at or below 25 MPH. Chains should be disengaged at or below 35 MPH.
3. Engage chains before encountering slippery conditions. Tire chains will assist traction in forward, reverse, and while braking.
4. Avoid locking the wheels.
5. If tire chains are not engaged before stopping on a slippery road:
 1. Spin the tires up to 5 MPH.
 2. Engage the chains
 3. When chains engage, adjust acceleration and drive on slowly.

TAG 59

WARNING

Stay clear of fan when engine is running.

Sutphen-9

Safety

SAFETY INSTRUCTIONS

Before raising cab:

1. Read operator manual.
2. Provide sufficient cab clearance.
3. Secure or remove any loose items.
4. Make sure nothing is on the front bumper.
5. Make sure cab doors are shut and latched.
6. Make sure cab tilts fully and the safety bar engages.

Before lowering cab:

1. Make sure all service items are removed from engine area.
2. Raise cab to maximum height to release safety latch.
3. Make sure all personnel are clear of cab area.
4. Pull safety latch handle and hold out to lower cab.

TAG 323

TAG 328

⚠ DANGER



Fall Hazard

Do not open valves completely. Use only in an emergency.

TAG 322

⚠ WARNING



Crushing injuries may occur.

Stand clear when lowering cab.

TAG 327

SAFETY INSTRUCTIONS

Leveling System Override:

1. For emergency use only
2. Open only if automatic leveling system fails.
3. Open both valves one turn.
4. Read operator's manual before operating this equipment.

TAG 310

Computer Code Switch

TAG 324

Cab Tilt

Up



Down

TAG 325

Cab Tilt Safety Latch

Pull to Release



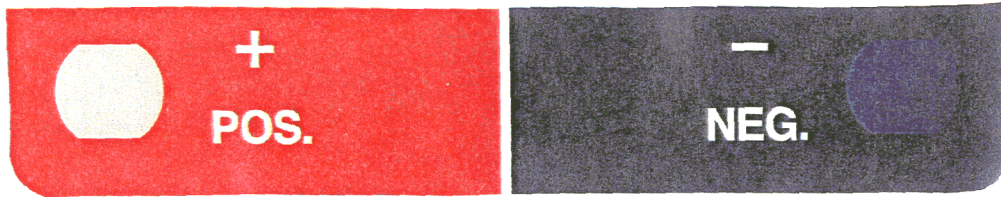
TAG 326



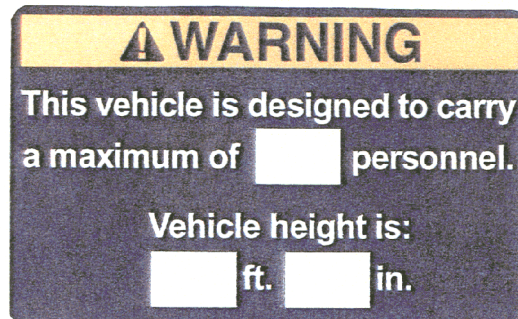
Sutphen-11

▼ Safety

TAG 385



TAG 365



TAG 355



Sutphen-12



⚠ WARNING TAG 382

Serious injury or death may occur if inlets are supplied by a pressurized source when valve is closed.

TAG 381

ABS
Code Switch

TAG 370

All equipment in the platform must be mounted in a holder. The total weight of equipment should not exceed 80 lbs.

TAG 371

⚠ CAUTION

Yoke must be drained through water curtain and yoke drain valve after each use.

The waterway drain must be opened after each use.

For proper draining procedures, refer to operator's manual.

TAG 375

⚠ CAUTION

Properly set rear jacks before raising the boom to load hose, fill water tank, etc.

Failure to do so may result in body or chassis damage.

TAG 368

To Engage PTO:

1. Bring engine to idle.
2. Move PTO switch to ON position.
3. Confirm that PTO dash light is on.
4. Resume operations.

Sutphen-13

Safety

TAG 407



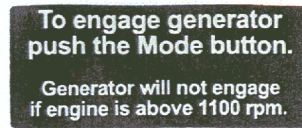
TAG 396



TAG 395



TAG 417



TAG 416



TAG 410



TAG 409



Sutphen-14



TAG 405

! DANGER

Electrocution Hazard

Death or serious injury may result from contact with this vehicle if it should be electrically charged.

Maintain 17 foot minimum clearance from all power sources during aerial operations.

Pump operator must use pull-out safety platform during aerial operations.

Always designate a spotter at pedestal to help avoid power lines during aerial operations.

Avoid simultaneous contact with truck and ground during aerial operations.

Stuphen-15

Safety

WARNING

LOWER CAB RAISE CAB

PUMP VALVE HANDLE POSITIONS

TAG 428

Read operators manual before raising cab. Failure to do so may result in serious injury or death, or property damage. Provide sufficient cab clearance before raising cab.

Cab will free fall to fully tilted position when raised past balance point. To stop cab free fall, move pump valve handle to "Lower" position.

Leave pump handle in "Lower" position to operate vehicle.

Always raise cab to full 60° before working under cab.

WARNING

Do not walk on this surface.

TAG 427

Mechanical Siren TAG 426

Electronic Siren TAG 425

Air Horn TAG 424

TAG 440

The total weight of equipment should not exceed 5 lbs.

TAG 438

Waterway Valve Override

Open

Ladder Rack

Up

Down

TAG 437

TAG 436

WARNING

Front suction elbow must be facing forward before raising cab.

TAG 435

Auto-Pump Air Compressor has a moisture trap that must be drained periodically.

Check trap weekly.



TAG 406

UP	Front Axle Lock	DOWN
RET	Left Front Stabilizer	EXT
RET	Left Rear Stabilizer	EXT
RET	Right Front Stabilizer	EXT
RET	Right Rear Stabilizer	EXT
UP	Right Stabilizer	DOWN
UP	Left Stabilizer	DOWN
UP	Rear Stabilizer	DOWN

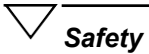
TAG 414

INSTALL SAFETY PINS


TAG 439

INSTALL SAFETY PIN

Sutphen-17



TAG 431



CHASSIS DATA

Sutphen Corporation
7000 Columbus-Marysville Road
Amlin, OH 43022
(800) 848-5860


CHASSIS FILTERS

CHASSIS ENGINE OIL FILTER PART NO.	
TRANSMISSION OIL FILTER PART NO.	
CHASSIS AIR CLEANER FILTER PART NO.	
CHASSIS FUEL FILTER PRIMARY PART NO.	
CHASSIS FUEL FILTER SECONDARY PART NO.	
CHASSIS ENGINE WATER FILTER PART NO.	
AIR DRYER ASSEMBLY FILTER PART NO.	
AERIAL HYDRAULIC FILTER CARTRIDGE PART NO.	

CHASSIS SPECIFICATIONS

MODEL		TRUCK NO.	
FRONT TIRES		REAR TIRES	
ENGINE			
SERIAL NO.		NO. CYLINDERS	
BORE		STROKE	
H.P. SAFE		DISPLACEMENT	
PAINT COLOR			

TAG 430



Sutphen Corporation
7000 Columbus-Marysville Road
Amlin, OH 43022
(800) 848-5860

PUMP DATA

	PUMP MAKE	HALE	
	GPM	PRESSURE	ENGINE RPM
	XXXXXX	150 PSI	XXXXXX
CAPACITY	1500 GPM	200 PSI	XXXXXX
MODEL NO.	QMAX 150-23S	250 PSI	XXXXXX
SERIAL NO.	QMAX 150-23S	GOVERNOR SPEED	2100 RPM
PRODUCTION NO.	QMAX 150-23S	GEAR RATIO	2.28 TO 1

Sutphen-18



TAG 434

WARNING

Keep legs and feet inside kick gaurd during aerial operations. Failure to do so may result in serious injury or death.

POWER SOURCE SPECIFICATIONS	
OPERATIONAL CATEGORY	CONTINUOUS DUTY RATING
RATED VOLTAGE(S) AND TYPE (AC OR DC)	XXXXXX
PHASE	XXXXXX
RATED FREQUENCY	XXXXXX
RATED AMPERAGE	XXXXXX
CONTINUOUS RATED WATTS	XXXXXX
POWER SOURCE ENGINE SPEED	XXXXXX

TAG 433

TAG 432

FLUID DATA

Sutphen Corporation
7000 Columbus-Marysville Road
Amlin, OH 43022
(800) 848-5860

	QTY.	TYPE		QTY.	TYPE
CHASSIS ENGINE OIL			CAB TILT MECH. FLUID		
CHASSIS ENGINE COOLANT			TRANSFER CASE FLUID / AUTO LUBE		
CHASSIS TRANSMISSION FLUID			EQUIPMENT RACK FLUID		
PUMP TRANSMISSION FLUID			GENERATOR SYSTEM LUBRICANT		
PUMP PRIMER FLUID			AERIAL-TOWER HYDRAULIC FLUID		
DRIVE AXLE LUBRICATION FLUID			LEVELING SYSTEM FLUID		
AIR-CONDITIONING REFRIGERANT FLUID			FUEL TANK DIESEL NO. 2		
AIR-COND. LUBRICAT. OIL SYS. LUBRICANT			FRONT TIRE COLD PSI		
POWER STEERING FLUID			REAR TIRE COLD PSI		
MONTH-YEAR BUILT			DATE SHIPPED		
VEHICLE IDENTIFICATION NO.				HS-	

Sutphen-19



TAG 441

UP Front Axle Lock DOWN	RET Right Front Stabilizer EXT	RET Left Front Stabilizer EXT	UP Right Stabilizer DOWN	UP Left Stabilizer DOWN	UP Rear Stabilizer DOWN
----------------------------------	---	--	-----------------------------------	----------------------------------	----------------------------------

TAG 442

▲ WARNING Maximum lifting eye capacity of 800 lbs.

▲ WARNING Static load only. No rappelling from platform.

▲ WARNING Any weight suspended from lifting eye must be subtracted from available platform payload.

TAG 446

SAFETY INSTRUCTIONS

1. Lifting eye capacity - 800 lbs.
2. Any weight suspended from eye must be subtracted from platform capacity.



TAG 447

SAFETY INSTRUCTIONS

1. Stokes arm capacity - 250 lbs.
2. Max. of 500 lbs. in platform when using Stokes Arms.

TAG 450

CAUTION

Operate Pressure Governor in RPM Mode Only when Using Cafs

TAG 448

WHEN DIFFERENTIAL LOCK IS ENGAGED, THE MAXIMUM SPEED IS 25 MPH

TAG 449

CAUTION

When filling water tank, do not exceed 100 psi. Failure to do so could cause the tank to rupture.

TAG 454

WARNING

Do Not Exceed Wattage Rating of Generator. Generator may be Permanently Damaged and Void Warranty.

TAG 452

GEN. PTO

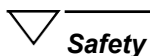
TAG 455

Ladder Belt Tie-Off Point

WARNING

Not For Rescue or Rappelling
250lb. Max.

Sutphen-21



Warning/Danger/Caution Labels List

TAG 10	ALIGNMENT LIGHT
TAG 15	DO NOT MODIFY
TAG 16	DO NOT GET OIL IN EYES
TAG 17	STAND ON STEP - ELECTROCUTION
TAG 18	PINCH POINT
TAG 19	CRUSHING INJURY
TAG 20	ELECTROCUTION HAZARD
TAG 21	LIFTING EYE
TAG 22	DO NOT CLIMB BOOM
TAG 23	AERIAL DATA PLACARD
TAG 36	FIRE MAY OCCUR
TAG 37	SEAT BELTS FASTENED
TAG 38	BREATHING OF FUMES
TAG 38-1 HORZ.	BREATHING OF FUMES
TAG 55	JUMP STARTING PRECAUTIONS
TAG 56	EXPLOSION MAY OCCUR - BATTERIES
TAG 57	OCCUPANTS MUST BE SEATED
TAG 58	DO NOT USE AUXILIARY BRAKING
TAG 59	STAY CLEAR OF FAN
TAG 60	CLOSE CROSSLAY COVER
TAG 66	STAND CLEAR OF OUTRIGGER
TAG 281	TIRE CHAIN OPERATION
TAG 282	STABILIZER SYSTEM
TAG 310	COMPUTER CODE SWITCH
TAG 322	STAND CLEAR - LOWERING CAB
TAG 323	BEFORE RAISING CAB
TAG 324	CAB TILT UP & DOWN
TAG 325	CAB TILT SAFETY LATCH
TAG 326	DO NOT RAPPEL FROM AERIAL
TAG 327	LEVELING SYSTEM OVERRIDE
TAG 328	FALL HAZARD
TAG 355	SUTPHEN - TEAMSTER LOGO
TAG 365	CARRY MAX. PERSONNEL
TAG 368	TO ENGAGE PTO
TAG 370	EQUIPMENT MOUNTED
TAG 371	PROPER DRAINING - WATERWAY
TAG 375	SET REAR JACKS
TAG 381	ABS CODE SWITCH
TAG 382	PRESSURIZED INLETS
TAG 385	POSITIVE/NEGATIVE
TAG 395	FLOW OR RECIRCULATE
TAG 396	DO NOT WALK ON SURFACE



Warning/Danger/Caution Labels List - Continued

TAG 405	ELECTROCUTION HAZARD
TAG 406	MANUAL LEVERS OVERRIDE
TAG 407	PEDESTAL AREA
TAG 408	LOCK - DOWN
TAG 409	EXITING BUCKET
TAG 410	EXITING CAB
TAG 414	INSTALL SAFETY PINS
TAG 416	SAFETY CHAIN FASTENED
TAG 417	ENGAGE GENERATOR
TAG 424	AIR HORN
TAG 425	ELECTRIC SIREN
TAG 426	MECHANICAL SIREN
TAG 427	DO NOT WALK ON SURFACE
TAG 428	PUMP HANDLE WARNING
TAG 430	PUMP DATA PLACARD
TAG 431	CHASSIS DATA PLACARD
TAG 432	FLUID DATA PLACARD
TAG 433	POWER SOURCE SPECS.
TAG 434	KEEP FEET INSIDE KICK GUARD
TAG 435	KUSSMAL AUTO-PUMP DRAIN
TAG 436	FRONT SUCTION - RAISING CAB
TAG 437	LADDER RACK UP-DOWN
TAG 438	WATERWAY VALVE OVERRIDE
TAG 439	INSTALL SAFETY PIN (VERTICAL)
TAG 440	EQUIPMENT LIMITS - 5 LB. (BUCKET)
TAG 441	MANUAL OVERRIDE OUTRIGGER CONTROLS (SPH)
TAG 442	BUCKET STATIC LOAD
TAG 443	PUMP DATA PLACARD (METRIC)
TAG 444	TIRE PRESSURE FR. 120 R. 95
TAG 445	TIRE PRESSURE FR. 120 R. 110
TAG 446	LIFTING EYE CAPACITY 800 LB.
TAG 447	STOKES ARM CAPACITY 250 LB.
TAG 448	DIFFERENTIAL LOCK ENGAGEMENT
TAG 449	WATER TANK REFILL
TAG 450	PRESS. GOV. RPM MODE
TAG 451	HYDR. COMPT. JACK CONTROL 95/100
TAG 452	GENERATOR PTO
TAG 453	TIRE PRESSURE (AERIAL)
TAG 454	GENERATOR
TAG 455	LADDER BELT TIE-OFF POINT



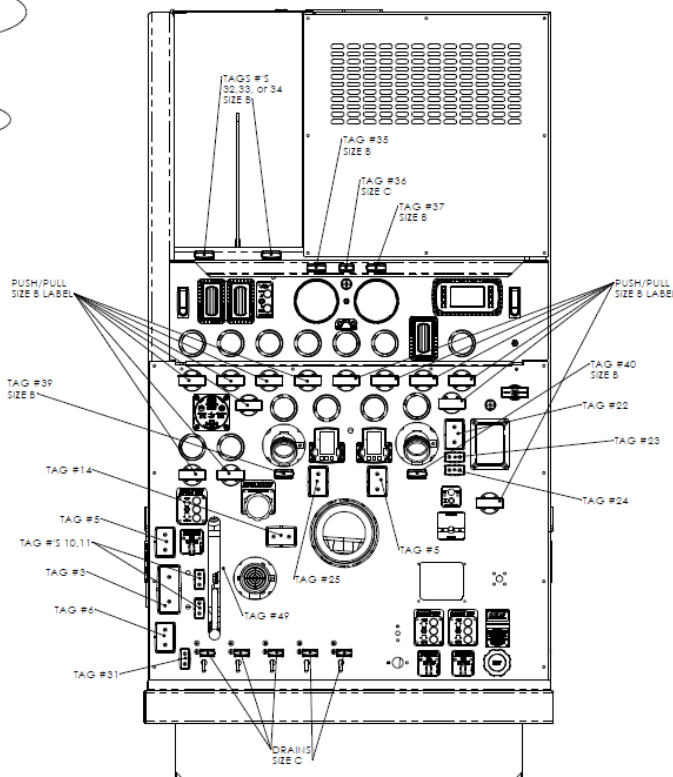
NFPA STANDARD COLORS		
VERBAGE	COLORS	CONTROLS
FRONT DISCHARGE	TURQUOISE	PUSH-PULL
FRONT CROSSLAY	ORANGE	PUSH-PULL
REAR CROSSLAY	RED	PUSH-PULL
FRONT SPEEDLAY	BROWN	PUSH-PULL
REAR SPEEDLAY	MAGENTA	PUSH-PULL
NO.1 DISCHARGE	YELLOW	HORIZONTAL SWING
NO.2 DISCHARGE	WHITE	HORIZONTAL SWING
NO.3 DISCHARGE	BLUE	HORIZONTAL SWING
NO.4 DISCHARGE	BLACK	HORIZONTAL SWING
NO.5 DISCHARGE	GREEN	HORIZONTAL SWING
LEFT REAR PRECONNECT	TAN	PUSH-PULL
RIGHT REAR PRECONNECT	LAVENDER	PUSH-PULL
LEFT REAR DISCHARGE	OLIVE	PUSH-PULL
RIGHT REAR DISCHARGE	LT. BLUE	PUSH-PULL
DECK GUN	SILVER/PLATINUM	PUSH-PULL
LEFT REEL	GRAY/GRAPHITE	PUSH-PULL
RIGHT REEL	GRAY/GRAPHITE	PUSH-PULL
PUMP INTAKE	BURGUNDY	VERTICAL SWING
TANK FILL/PUMP RECIRCULATE	LIME GREEN	PUSH-PULL
TANK TO PUMP	BURGUNDY	PUSH-PULL
WATERWAY	PURPLE	PUSH-PULL
FOAM CAPABLE	RED TEXT	SWING OR PULL
CAFS CAPABLE	BLUE TEXT	SWING OR PULL


EX. FOAM LABEL
 LEFT SIDE
 2-1/2" PRECONNECT
 WATER-FOAM

EX. CAFS LABEL
 2 1/2" CROSSLAY
 CAFS

COLORS LISTED ARE NFPA STANDARD BUT CAN BE CUSTOMISED TO CUSTOMER'S PREFERENCE

PUMP MODULE					
TAG #	LABEL	SIZE	STANDARD	FOAM	CAFS
32	FRONT CROSSLAY	C	3000030-01-0666	3000030-02-0666	3000030-03-0667
33	MIDDLE CROSSLAY	C	3000030-01-1011	3000030-02-0960	3000030-03-0945
34	REAR CROSSLAY	C	3000030-01-1011	3000030-02-7960	3000030-03-0945
35	PUMP INTAKE	B	3000030-01-1490	3000030-02-1330	3000030-03-1317
36	STATUS CENTER ALARM	C	3000030-01-1803		
37	PUMP DISCHARGE	B	3000031-01-1481		
38	FRONT DISCHARGE	C	3000030-01-0670	3000030-02-0670	3000030-03-0671
39	NO.1 DISCHARGE	B	3000031-01-1040	3000031-02-1040	3000031-03-1041
40	NO.2 DISCHARGE	C	3000030-01-1089	3000030-02-1089	3000030-03-1090
41	NO.3 DISCHARGE	B	3000031-01-1123	3000031-02-1123	3000031-03-1124
42	NO.4 DISCHARGE	C	3000030-01-1152	3000030-02-1152	3000030-03-1153
43	DECK GUN	C	3000030-01-0896	3000030-02-0896	3000031-03-0897
44	LEFT SIDE 2-1/2" REAR DISCHARGE	B	3000031-01-0962	3000030-02-0962	3000030-03-0963
45	RIGHT SIDE 2-1/2" REAR DISCHARGE	C	3000030-01-1671	3000030-02-1671	3000031-03-1672
46	TANK FILL / PUMP RECIRCULATE	C	3000030-01-1836		
47	TANK TO PUMP	B	3000031-01-1836		
48	AIR HORN	C	3000030-01-0239		
49	PUMP INLET w/g BEZEL (BURGUNDY)	N/A	100R7571		

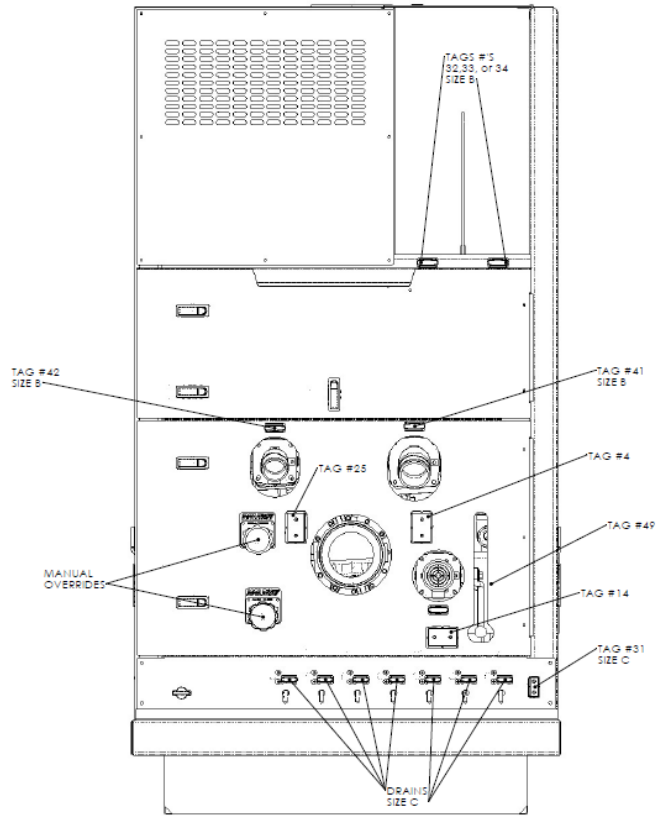



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AX Item Number: _____
 DOCUMENT NUMBER: P-C-30260
 REV: _____
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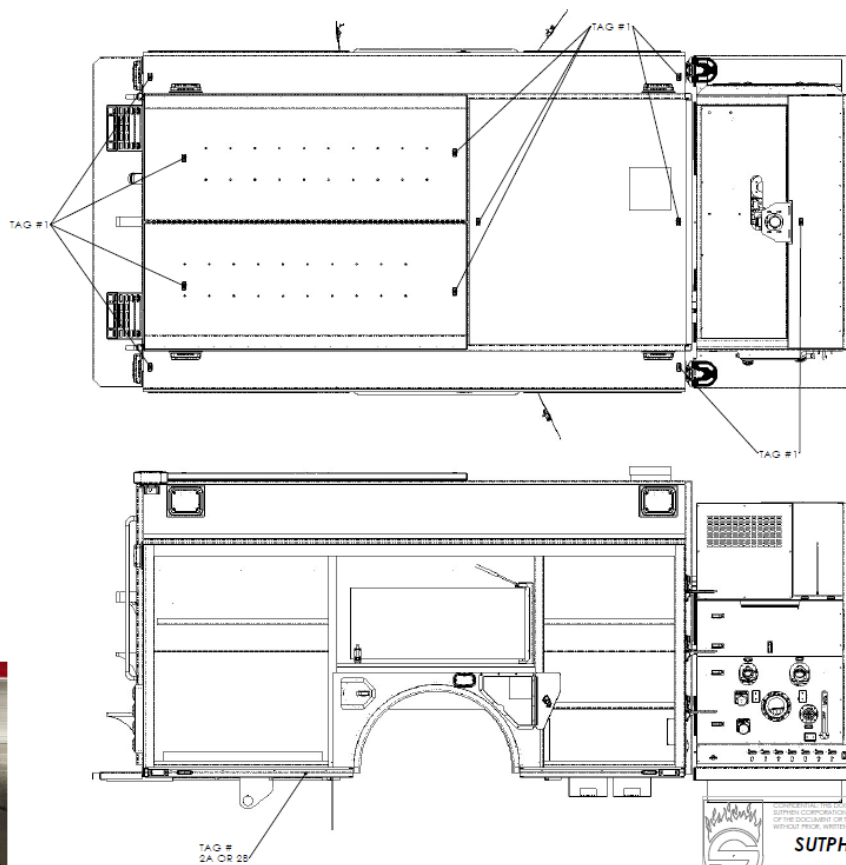
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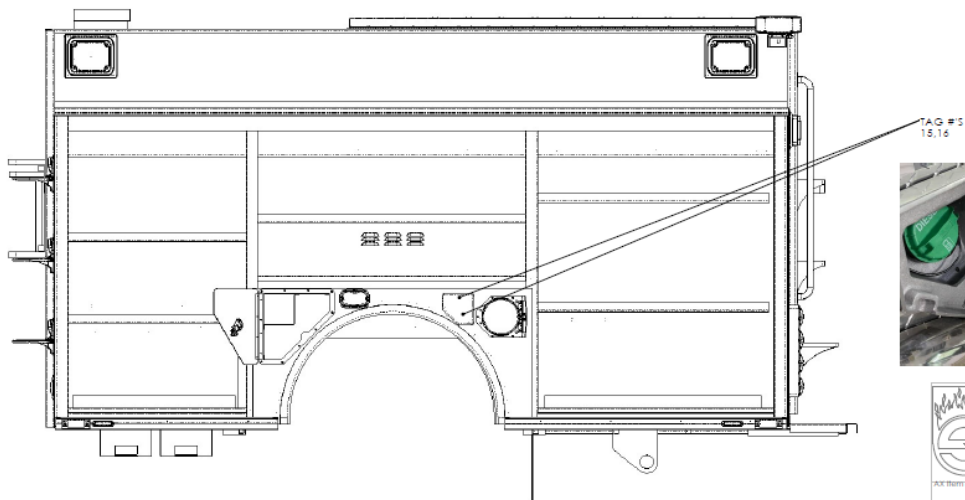
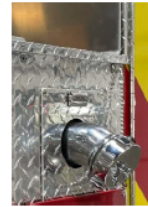
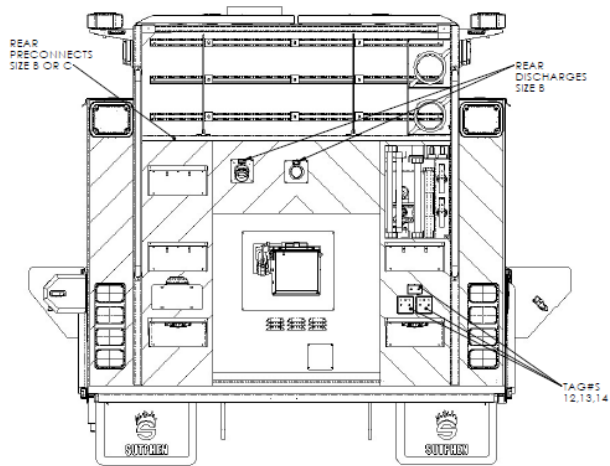
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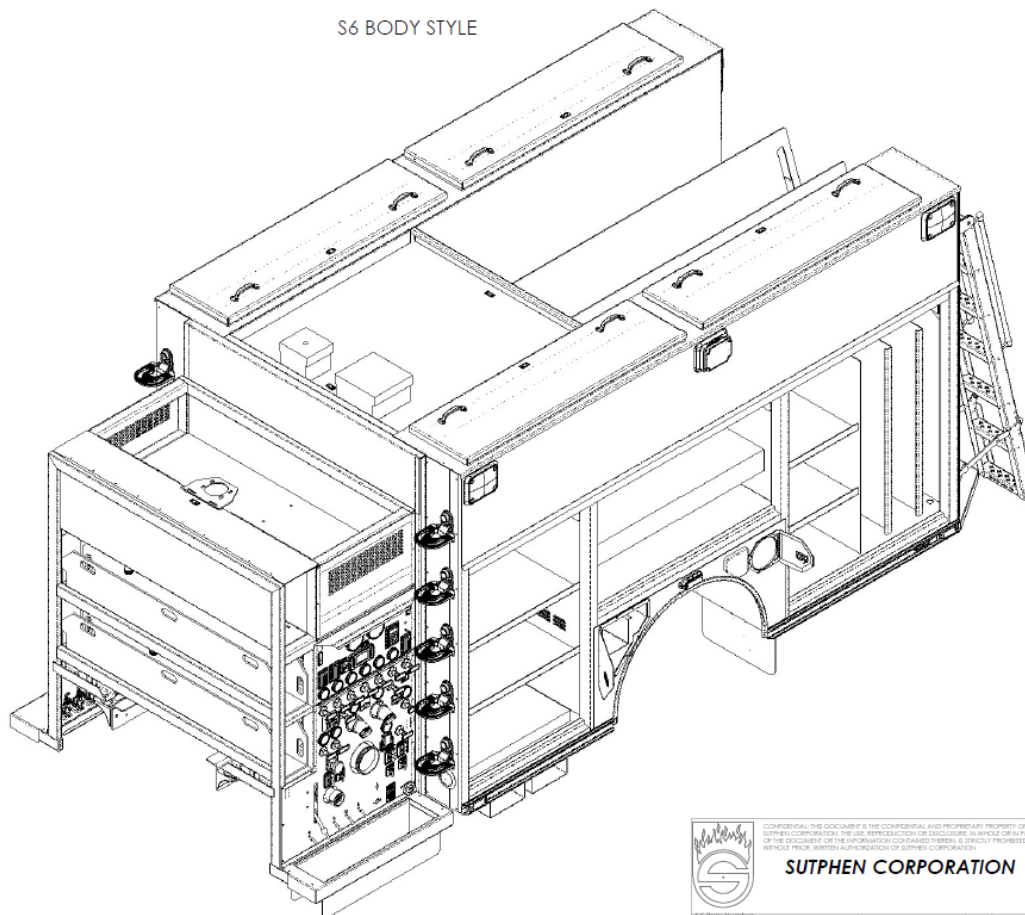

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S6 BODY STYLE



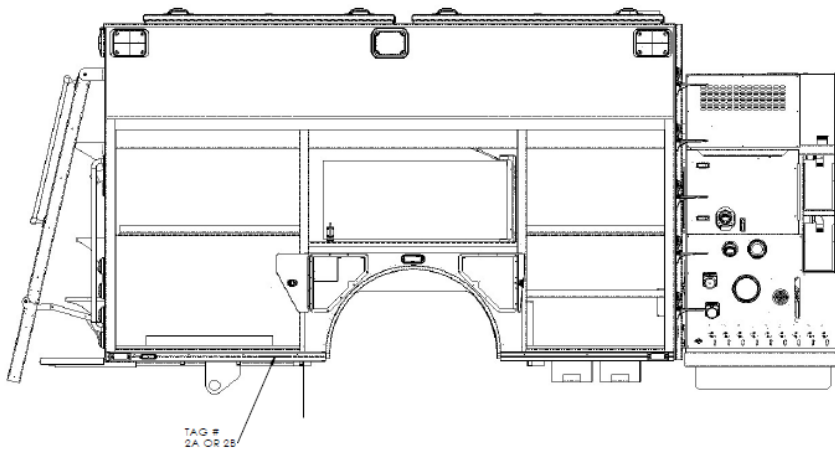
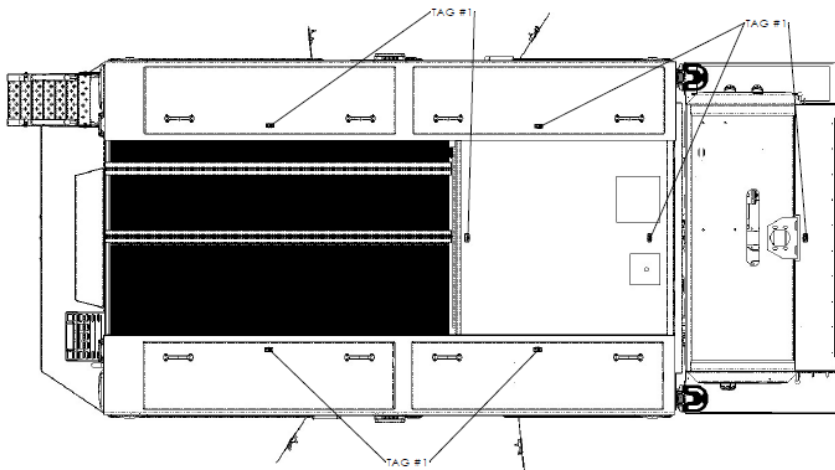
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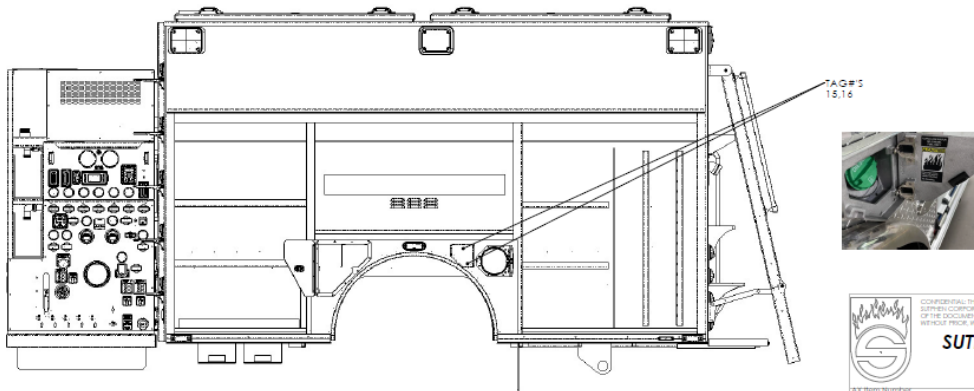
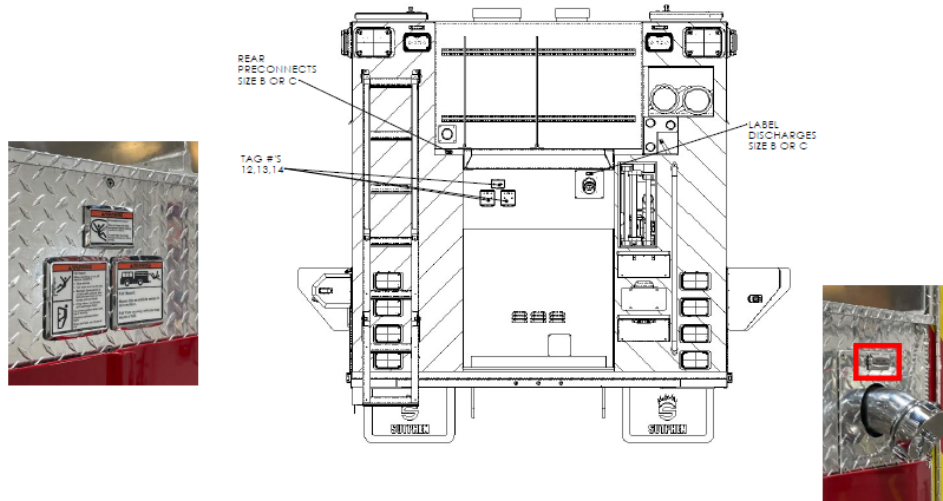
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Safety

TAG #1



TAG # 2a



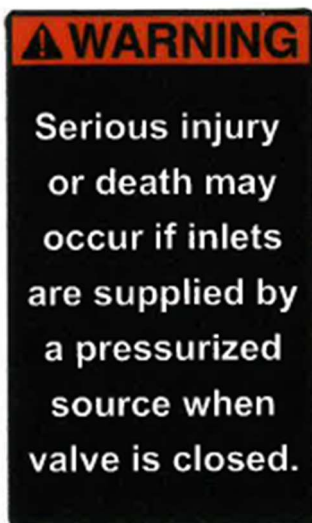
TAG #2b



TAG #3



TAG #4





TAG #5



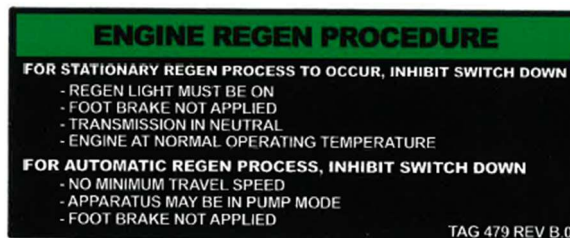
TAG #6



TAG #7



TAG # 8



TAG #10



TAG # 9



Safety

TAG #11a



TAG #11b



TAG #12



TAG #13



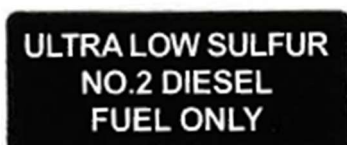
TAG #14



TAG #15



TAG #16





TAG #17



TAG # 18



TAG #19



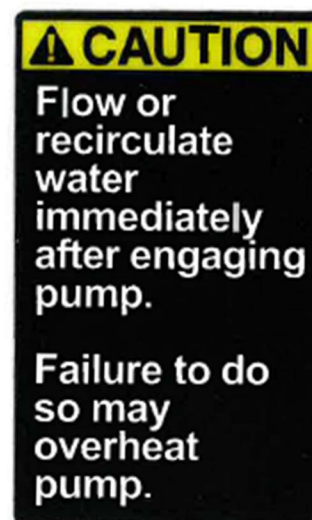
TAG #20



TAG #21



TAG #22

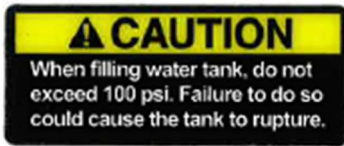


TAG #23



Safety

TAG #24



TAG #26



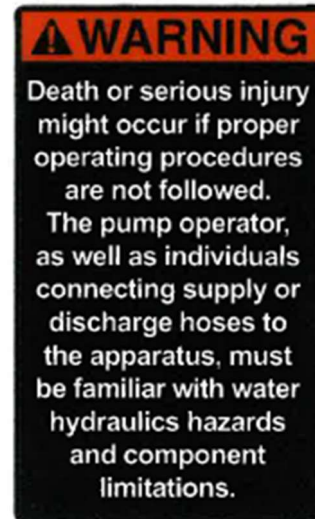
TAG #28



TAG #30



TAG #25



TAG # 27



TAG # 29

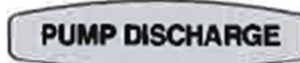




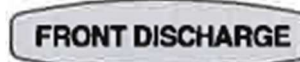
TAG #31



TAG #37



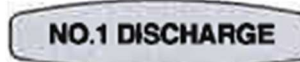
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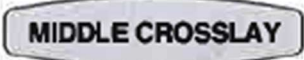
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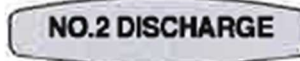
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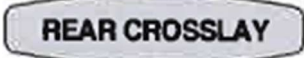
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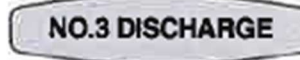
TAG #40



TAG #34



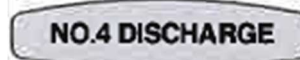
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TAG #35



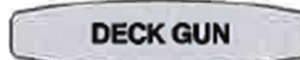
TAG #42



TAG #36



TAG #43



TAG #44



▼ **Safety**

TAG #45

**RIGHT SIDE 2 1/2"
REAR DISCHARGE**

TAG #46

**TANK FILL/ PUMP
RECIRCULATE**

TAG # 47

TANK TO PUMP

TAG #48

AIR HORN

TAG #49

OPEN ▲
PUMP
INLET ▼
CLOSE



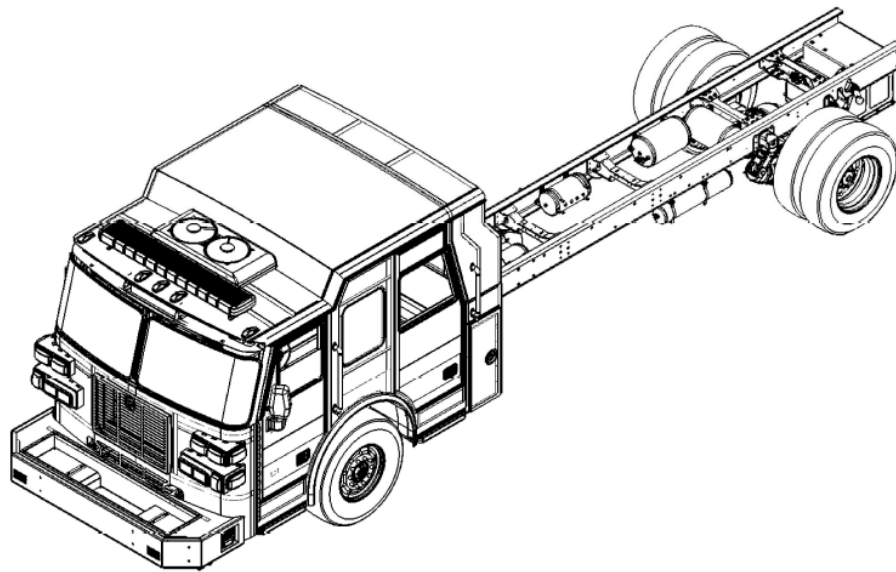
STAGE 2 MASTER LIST		
TAG #	LABEL	BEZEL SIZE
1	NOT A STEP	C
2a	FUMES MAY BE HAZARDOUS (VERTICAL)	D
2b	FUMES MAY BE HAZARDOUS (HORIZONTAL)	D
3	CAB TILT SAFETY INSTRUCTIONS	B
4	SERIOUS INJURY OR DEATH MAY OCCUR CLOSED VALVE	D
5	CLOSE CROSSLAY COVER WARNING	D
6	STAND CLEAR CRUSH INJURY WARNING	D
?	LOWERING CAB WARNING	D
7	FRONT SUCTION CAB TILT WARNING	D
8	ENGINE REGEN PROCEDURE	B
9	SAFETY LATCH PULL TO RELEASE	C
10	CAB TILT (UP DOWN)	C
11a	CAB TILT SAFETY LATCH (HORIZONTAL)	C
11b	CAB TILT SAFETY LATCH (VERTICLE)	C
12	FALL HAZARD FAMA23	E
13	FALL HAZARD FAMA24	E
14	ENTANGLEMENT HAZARD	D
15	FIRE MAY OCCUR NO SMOKING DURING FUELING	D
16	ULTRA LOW SULFUR NO.2 DIESEL FUEL ONLY	C
17	GEN PTO	N/A
18	REEL REWIND	N/A
19	DUMP TANK UP/DOWN	C
20	OPEN/COLSE	C
21	SUCTION RACK UP/DOWN	C
22	PUMP OVERHEAT PROCEDURE	D
23	DO NOT OVERFILL	C
24	100 PSI WATER TANK LIMIT	C
25	SERIOUS INJURY OR DEATH MAY OCCUR HYDRAULICS HAZARDS	D
26	ROPE ANCHOR CAPACITY 1000 LBS	C
27	RECIEVER CAPACITY 5000 LBS	C
28	LADDER RACK UP/DOWN	C
29	KEEP CLEAR WHEN RAISING/LOWERING LADDER	D
30	LADDER EXCESSIVE VIBRATION WARNING	D
31	DRAIN VALVE	C



Chassis Warning Tags

CPE-294 CHASSIS/CAB WARNING TAGS

See sheet 2 for cab exterior warning tags/locations
 See sheets 3-5 for cab interior warning tags/locations
 See sheets 6-8 for chassis warning tags/locations
 See sheet 9 for tag/location list



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.XX = ±.06		ANGLE = ±1°		DESCRIPTION: CPE-294 CAB/CHASSIS WARNING TAGS		
.XXX = ±.031		FRACT = ±1/16		MATERIAL: SEE BILL OF MATERIALS		
A.O INITIAL RELEASE 20186 2/9/2022 JM					AX Item Number: _____ DOCUMENT NUMBER: CPE-294 SHEET: 1 OF 8	
Released	DESCRIPTION	ECN#	DATE	BY	WEIGHT	LBS



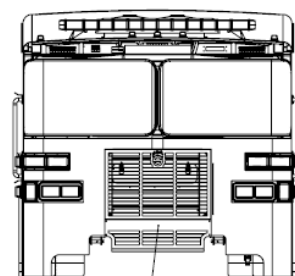
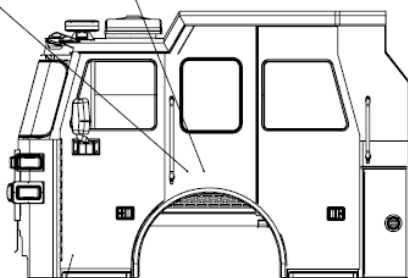
CAB EXTERIOR WARNING TAGS

Cab Exterior, Air outlet (if applicable):

- 10012126 - NLA 10121366 TAG Air Outlet Size B. 10012478 bezel

Cab Exterior, Shore Power inlets (if applicable):

- 10085126 - TAG Shoreline Inlet 15A. 10063490 bezel
- 10085127 - TAG Shoreline Inlet 20A 3000584-0268. 10063491 bezel
- 10085128 - TAG Shoreline Inlet 30A. 10063490 bezel



Cab Exterior, Lower Grille:

- 10003087 - NAMEPLATE Sutphen Logo 5m 7.875" x 3.5" w/psa




Cab Exterior, Driver's & Officer's doors:

- 10118510 - LABEL, MONARCH STAINLESS STEEL LOGO



Cab Exterior, Cab tilt (bumper, pump, etc.):

- 10063692 - LOWERING CAB WARNING 3000588-0004 BEZEL D. 10063489 bezel
- 10063696 - CAB TILT 3000584-0001 BEZEL C
- 10063874 - TAG sfty instrc raise cab 07

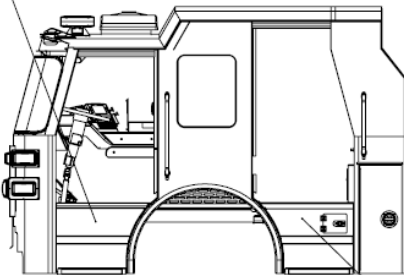
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Safety

CAB INTERIOR WARNING TAGS

Cab Interior, Driver's front step well:

- 10114863 - TAG Fall Hazard Climbing Methods (FAMA 23), 10063492 bezel
- 10114860 - TAG Crash Hazard Tire Safety (FAMA 12), 10063491 bezel
- Cab ID tag (comes with raw cab), 10063491 bezel
- Lower step well, 10121365 - LABEL Air Inlet Sz B Blk/Slvr, 10012457 bezel
- 10071213 - TAG Battery Disconnect (if applicable), 10063489 bezel



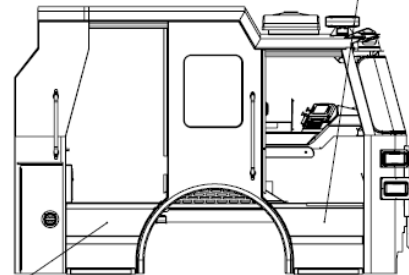
Cab Interior, Driver's crew step well:

- 10114863 - TAG Fall Hazard Climbing Methods (FAMA 23), 10063492 Bezel
- 10043913 - TAG DEF Document Sticker 2010
- 10063811 - TAG410-B EXITING CAB 3000588-0013 BEZEL D (if DEF door)
- 10100465 - LABEL DEF "Cab Must Be Raised Completely To Fill DEF Tank" (if DEF panel)



Cab Interior, Officer's front step well:


- 10114863 - TAG Fall Hazard Climbing Methods (FAMA 23), 10063492 bezel.



Cab Interior, Officer's crew step well:

- 10114863 - TAG Fall Hazard Climbing Methods (FAMA 23), 10063492 bezel.




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CAB INTERIOR WARNING TAGS, CONT'D

Cab interior, EMS-Compt light (if applicable, multiple possible locations):

- 10084578 - LABEL "Comp Light" Size C. 10012498 bezel



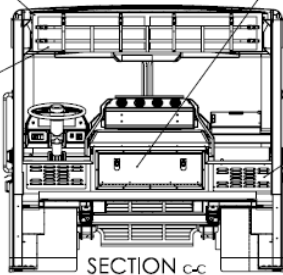
Cab Interior, Engine access door:

- 10012218 - NLA See 10121245 TAG Oil/Trans Dipsticks Size B BLACK. 10012478 Bezel



Cab interior, 125V outlet (if applicable, multiple possible locations):

- 10011834 - NLA See 10120838 TAG 125V 20A 1PH sz C BLACK ON SILVER. 10012498 bezel



Cab Interior, Accessory fuse panel/data recorder:

- 10085849 - TAG Accessory Fuse Panel
- 10068774 - TAG Vehicle Data Recorder Size C



Cab Interior, Mirror switch:

- 10121361 - LABEL Remote Mirrors Sz C Blk/Slvr. 10012498 bezel.



Cab Interior, PTO Switch (if applicable):

- 10063749 - TAG Engage PTO Used With Bezel C. 10063490 bezel.



Cab Interior, Shift Pad:

- 10150254 - TAG Engine Operating Guidelines.

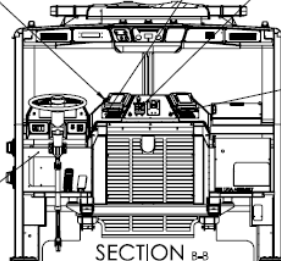


Cab Interior, Driver's kick panel area:

- 10085382 - STICKER "OBD"
- 10071530 - TAG Regen Inhibit Toe Panel
- 10102520 - TAG Adhesive EPA 2014 Exempt White With Black Letters
- 10063888 - TAG Engine Regen Procedure B Size Bezel. 10063489 bezel

Cab Interior, Driver's dash:

- 10063770 - TAG ABS Code Switch 3000584-0002 BEZEL A. 10063490 bezel
- 10063679 - TAG Computer Code Switch 3000584-0003 BEZEL C. 10063490 bezel



Cab Interior, Power points (if applicable, multiple possible locations)

- 10120846 - LABEL Power Point Battery Sz C Blk/Slvr. 10012498 bezel.



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Safety

CAB INTERIOR WARNING TAGS, CONT'D

Cab Interior, Defroster:

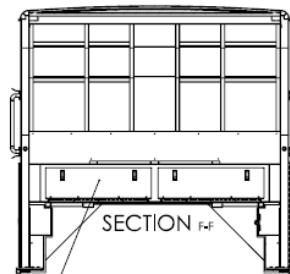
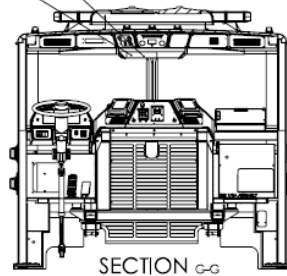
- 10063919 - TAG Traction Warning 3000598-0012 BEZEL D. 10063491 bezel
- 10114858 - TAG Crash Hazard Seat Belt Use (FAMA 07). 10063491 bezel.
- 10114861 - TAG Crash Hazard Helmet Use In Cab (FAMA 15). 10063491 bezel
- 10114859 - TAG Crash Hazard Secure Loose Items (FAMA 10). 10063491 bezel
- 10139212 - TAG, FAMA SAFETY SIGN, FAMA42 SIREN NOISE. 10063491 bezel



Defroster side:

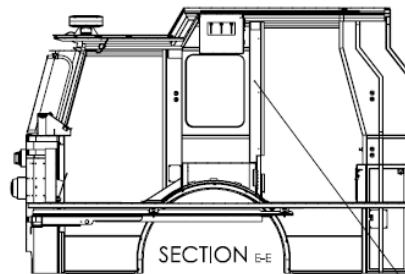
Cab Interior, Upper command console "Do Not Move" light (if applicable):

- 10065986 - TAG Do Not Move Apparatus. 10063490 bezel



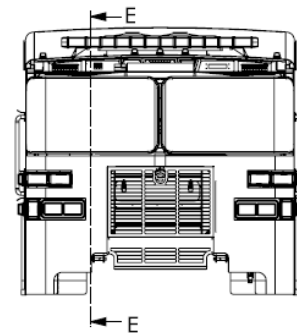
Cab Interior, Helmet storage (if applicable, multiple possible locations):


- 10063889 - TAG helmet storage compt. 10063490 bezel.



Cab Interior, Driver's and Officer's C-Pillars:

- 10114858 - TAG Crash Hazard Seat Belt Use (FAMA 07). 10063491 bezel.
- 10114861 - TAG Crash Hazard Helmet Use In Cab (FAMA 15). 10063491 bezel.
- 10114859 - TAG Crash Hazard Secure Loose Items (FAMA 10). 10063491 bezel.
- 10139212 - TAG, FAMA SAFETY SIGN, FAMA42 SIREN NOISE. 10063491 bezel.




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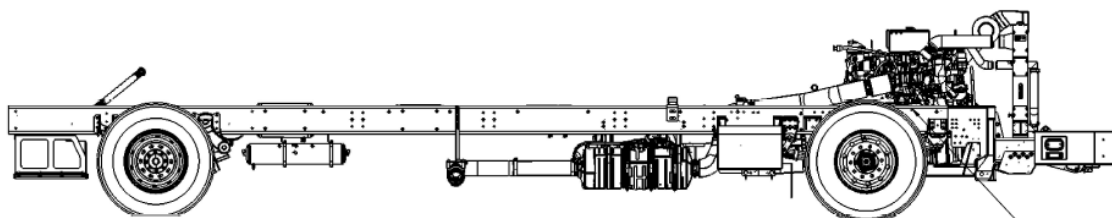
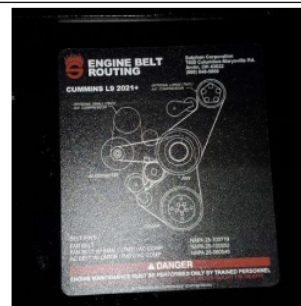
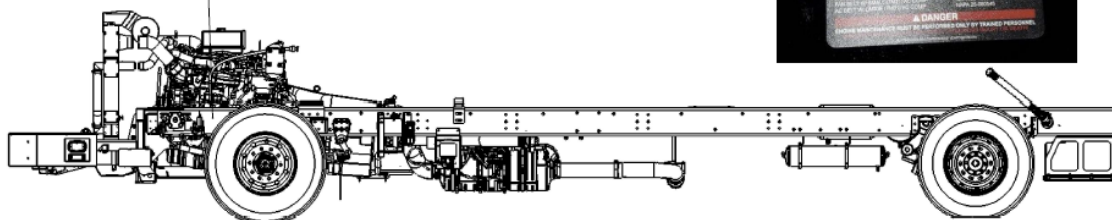
Alt Item Number	DOCUMENT NUMBER	REV.	SHEET
	CPE-294	A.0	5 OF 8



CHASSIS WARNING TAGS

Chassis, Under cab, Driver's side frame, Engine belt routing:


- L9, 10141477 - DECAL, ENGINE BELTS, CUMMINS L9, 2021
- X12, 10127617 - DECAL, SERPENTINE BELT ROUTING, CUMMINS X12
- X15, 10112387 - DECAL, BELT ROUTING, CUMMINS ISX 15L



Chassis, Under cab, Officer's side frame, water manifold:

- 10063876 - TAG Cab Heater Shut Off Mnlfd



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	SUTPHEN CORPORATION		
AX Form Number	DOCUMENT NUMBER	REV.	SHEET
	CPE-294	A.0	6 OF 8

Safety

CHASSIS WARNING TAGS, CONT'D



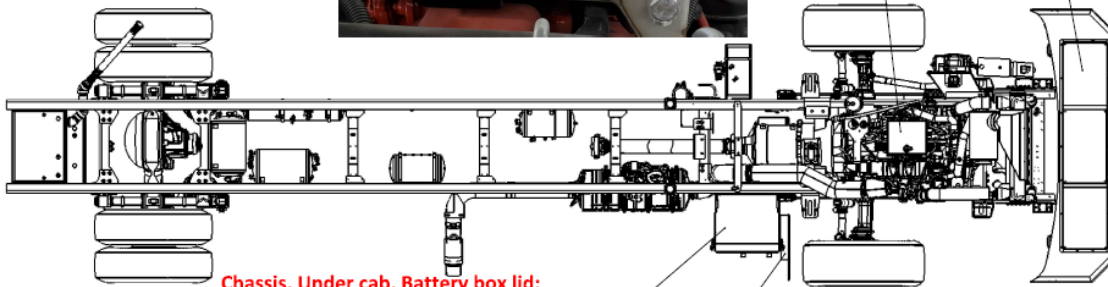
Chassis, Under cab, Surge tank:

- Surge tank top - 10119367 - TAG, CUMMINS COOLANT WARNING
- Surge tank back - 10084756 TAG Coolant Fill Procedure
- Surge tank back - 10119368 TAG, SIGHT GLASS STICKER FOR SURGE TANK, L9 CUMMINS ONLY



Bumper Lid (if applicable):

- 10063900 - TAG warning do not walk/stand "D" BEZEL FRT BUMPER/SURFACE. 10063491 bezel.
- 10114862 - TAG Crash Hazard Secure Loose Hose (FAMA 22). 10063491 bezel.



Chassis, Under cab, Battery box lid:

- 10137538 - TAG, BATTERY REMOVAL & INSTALLATION INSTRUCTIONS
- 10063913 - TAG Battery Safety Precaution
- 10063915 - TAG Explosion Warning 3000588-0008 BEZEL D



Chassis, Under cab, Officer's mud flap:

- 10063900 - TAG, Not A Step



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SUTPHEN CORPORATION

AX Item Number	DOCUMENT NUMBER	REV	SHEET
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CHASSIS WARNING TAGS, CONT'D

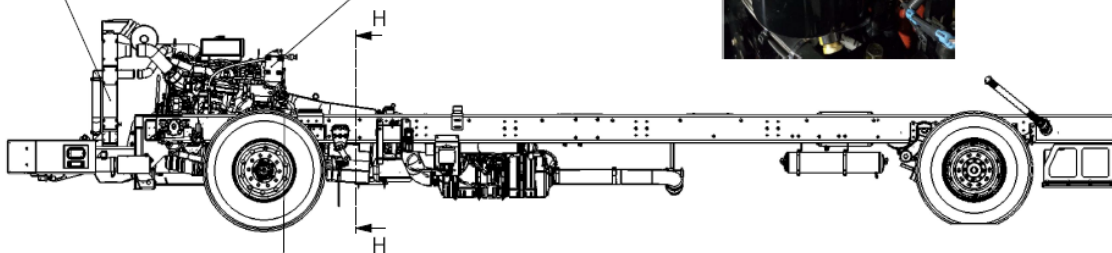
Chassis, Under cab, Fan shroud (both sides):

- (2) 10063921 - TAG Fan Warning 3000588-0006 BEZEL D



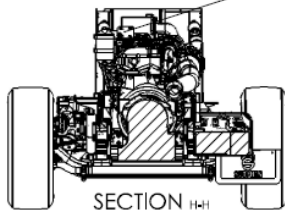
Chassis, Under cab, Power steering reservoir:


- 10043856 - TAG Power Steering Fluid



Chassis, Under cab, Engine compt light

- 10043855 - TAG Under Hood Light




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SUTPHEN CORPORATION

AX Form Number	DOCUMENT NUMBER	REV.	SHEET
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Safety

CAB/CHASSIS WARNING TAGS

Location	TAG AX NUMBER DESCRIPTION CAB EXTERIOR	BEZEL
Cab Exterior, Driver's door	10118510 - LABEL, MONARCH STAINLESS STEEL LOG	N/A
Cab Exterior, Officer's door	10118510 - LABEL, MONARCH STAINLESS STEEL LOGO	N/A
Cab Exterior, shore power inlet 15A	10085126 - TAG Shoreline Inlet 15A	10063490
Cab Exterior, shore power inlet 20A	10085127 - TAG Shoreline Inlet 20A 3000584-0268	10063490
Cab Exterior, shore power inlet 30A	10085128 - TAG Shoreline Inlet 30A	10063490
Cab Exterior, air outlet	10012126 - NLA 10121366 TAG Air Outlet Size B	10012478
Cab Exterior, cab tilt (multiple possible locations - bumper, pump, etc.)	10063692 - LOWERING CAB WARNING 3000588-0004 BEZEL D	10063489
	10063696 - CAB TILT 3000584-0001 BEZEL C	N/A
	10063874 - TAG safety instruction raise cab 07	N/A
Cab Exterior, Grille, Sutphen plaque	10003087 - NAMEPLATE Sutphen Logo Sm 7.875" x 3.5" w/psa	N/A
CAB INTERIOR TAGS		
Cab Interior, Driver's kick panel area	10085382 - STICKER "OBD"	N/A
	10071530 - TAG Regen Inhibit Toe Panel	N/A
	10102520 - TAG Adhesive EPA 2014 Exempt White With Black Letters	N/A
	0063888 - TAG Engine Regain Procedure B Size Bezel	10063489
Cab Interior, Driver's dash	10063770 - TAG ABS Code Switch 3000584-0002 BEZEL A	10063490
	10063770 - TAG ABS Code Switch 3000584-0002 BEZEL A	10063490
Cab Interior, Officer's front step well	10114863 - TAG Fall Hazard Climbing Methods (FAMA 23)	10063492
	10114860 - TAG Crash Hazard Tire Safety (FAMA 12)	10063491
	Cab ID tag (comes with raw cab)	10063491
	Lower step well, 10121365 - LABEL Air Inlet SIZE B Blk/SLVR	10012457
If Master Battery Disconnect (if applicable, multiple possible locations)	10071213 - TAG Battery Disconnect (if applicable, multiple possible locations)	10063489
Cab Interior, Driver's crew step well	10114863 - TAG Fall Hazard Climbing Methods (FAMA 23)	10063492
	10043913 - TAG DEF Document Sticker 2010	N/A
	10100465 - LABEL DEF "Cab Must Be Raised Completely To Fill DEF Tank" (if DEF panel)	N/A
	10100465 - LABEL DEF "Cab Must Be Raised Completely To Fill DEF Tank" (if DEF panel)	N/A
Cab Interior, Officer's front step well	10114863 - TAG Fall Hazard Climbing Methods (FAMA 23)	10063492
Cab Interior, Officer's crew step well	10114863 - TAG Fall Hazard Climbing Methods (FAMA 23)	10063492
Cab Interior, Defroster	10063919 - TAG Traction Warning 3000588-0012 BEZEL D	10063491
	10114858 - TAG Crash Hazard Seat Belt Use (FAMA 07)	10063491
	10114861 - TAG Crash Hazard Helmet Use In Cab (FAMA 15)	10063491
	10114859 - TAG Crash Hazard Secure Loose Items (FAMA 10)	10063491
	10139212 - TAG, FAMA SAFETY SIGN, FAMA42 SIREN NOISE	10063491
Cab Interior, Upper command console "Do Not Move" light (if applicable)	10065986 - TAG Do Not Move Apparatus	10063490
Cab Interior, Mirror switch	10121361 - LABEL Remote Mirrors SIUZE C Blk/Silver	10012498
Cab Interior, Shift Pad	10150264 - TAG Engine Operating Guidelines.	N/A
Cab Interior, PTO Switch (if applicable)	10063749 - TAG Engage PTO Used With Bezel C	10063490
Cab Interior, Power points (if applicable, multiple possible locations)	10120846 - LABEL Power Point Battery Sze C Blk/Silver	10012498



CAB/CHASSIS WARNING TAGS

Location	TAG AX NUMBER DESCRIPTION	BEZEL
Cab Interior, Driver's C-Pillar	10114858 - TAG Crash Hazard Seat Belt Use (FAMA 07)	10063491
	10114861 - TAG Crash Hazard Helmet Use In Cab (FAMA 15)	10063491
	10114859 - TAG Crash Hazard Secure Loose Items (FAMA 10)	10063491
	10085127 - TAG SHORELINE INLET20A 3000584-0268	10063491
Cab Interior, Officer's C-Pillar	10114858 - TAG Crash Hazard Seat Belt Use (FAMA 07)	10063491
	10114861 - TAG Crash Hazard Helmet Use in Cab (FAMA 15)	10063491
	10114859 - TAG Crash Hazard Secure Loose Items (FAMA 10)	10063491
	10139212 - TAG, FAMA SAFETY SIGN, FAMA42 SIREN NOISE	10063491
Cab Interior, Engine access door	10012218 - NLA See 10121245 TAG Oil/Trans Dipsticks Size B BLACK	10012478
Cab Interior, Rear facing Officer's seat riser panel	10085849 - TAG Accessory Fuse Panel	N/A
	10068774 - TAG Vehicle Data Recorder Size C	N/A
Cab Interior, Helmet storage (if applicable, multiple possible locations)	10063889 - TAG helmet storage compt. (if applicable, multiple possible locations)	10063490
Cab interior, EMS-Compt. light (if applicable, multiple possible locations).	10084578 - LABEL "Comp Light" Size C	10012498
Cab interior, 125V outlet (if applicable, multiple possible locations)	10011834 - NLA See 10120838 TAG 125V 20A 1PH size C BLACK ON SILVER	10012498
	CAB INTERIOR TAGS	
Chassis, Under cab, Driver's side frame, Engine belt routing	L9, 10141477 - DECAL, ENGINE BELTS, CUMMINS L9, 2021	N/A
	X12, 10127617 - DECAL, SERPENTINE BELT ROUTING, CUMMINS X12	N/A
	X15, 10112387 - DECAL, BELT ROUTING, CUMMINS ISX 15L	N/A
Chassis, Under cab, Officer's side frame, water manifold	10063876 - TAG Cab Heater Shut Off Manifold	N/A
Chassis, Under cab, Surge tank	Surge tank top - 10119367 - TAG, CUMMINS COOLANT WARNING	N/A
	Surge tank back - 10084756 TAG Coolant Fill Procedure	N/A
	Surge tank back - 10119368 TAG, SIGHT GLASS STICKER FOR SURGE TANK, L9 CUMMINS ONLY	N/A
Chassis, Under cab, Battery box lid	10137538 - TAG, BATTERY REMOVAL & INSTALLATION INSTRUCTIONS	N/A
	10063913 - TAG Battery Safety Precaution	N/A
	10063915 - TAG Explosion Warning 3000588-0008 BEZEL D	N/A
Chassis, Under cab, Officer's mud flap	10063900 - TAG, Not A Step	N/A
Bumper Lid	10063831 - TAG warning do not walk/stand "D" BEZEL FRT BUMPER/SURFACE	10063491
	10114862 -TAG Crash Hazard Secure Loose Hose (FAMA 22)	10063491
Chassis, Under cab, Fan shroud (both sides)	(2) 10063921 - TAG Fan Warning 3000588-0006 BEZEL D	N/A
Chassis, Under cab, Engine compt. light	10043855 - TAG Under Hood Light	N/A
Chassis, Under cab, Power steering reservoir	10043856 - TAG Power Steering Fluid	N/A

Chapter 3 Components

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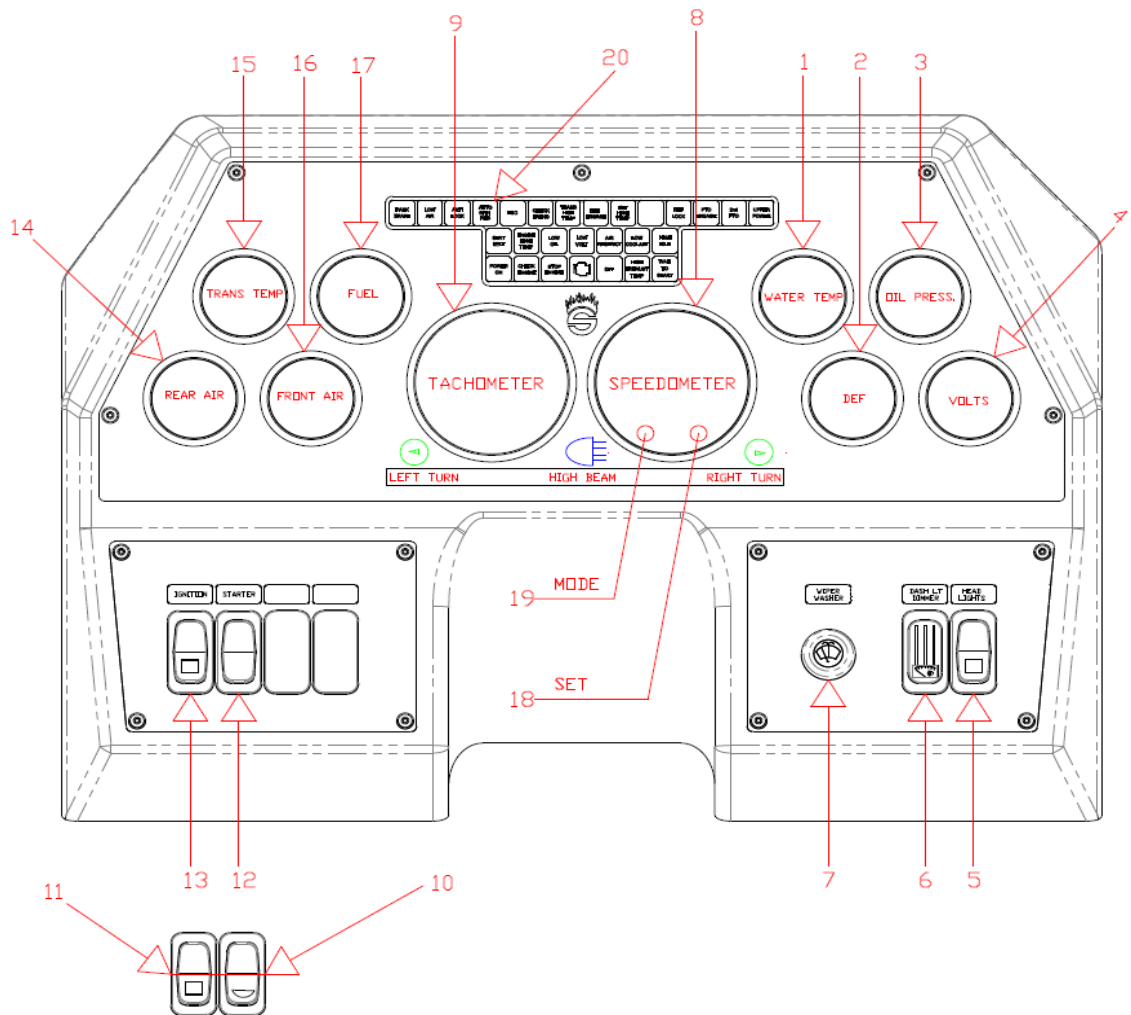
Components

3.1 Instrument Panels

Analog Instrument Panel

FOR SAFE DRIVING, LEARN TO READ AND UNDERSTAND THE INSTRUMENT PANEL

Since equipment specifications vary, not all units will have identical gauges and controls on the instrument panel. Occasionally, the location of the instrument will also vary. Some of the options are not on the standard panel.





-
- 1. ENGINE COOLANT TEMPERATURE GAUGE (100-240°)**
- Part No. ENGLISH 00078664-B11540 , METRIC 00078664-B11500
If engine temperature exceeds the high temp limit (approximately 225°F), decrease engine speed to idle and let cool before running at load condition again, check for problems.

- 2. DEF FLUID GAUGE (E-F) - Part No. 0078664-B13D**

Indicates amount of DEF in DEF tank.

NOTE: Low level warning light included in gauge.

- 3. ENGINE OIL PRESSURE GAUGE (0-80 PSI) - Part No. ENGLISH 00078664-B11E40, METRIC 00078664-B11E0**

Indicates the pressure of the lubricating oil in the engine.

- 4. VOLTMETER (10-16V) - Part No. 00078664-B10D40**

Indicates battery condition by showing state of charge (13 to 14.5 VDC is normal). Electronically controlled engines will lose power (or die) if voltage is under 10 VDC for any period of time.

- 5. REGEN**

This switch is used to start a stationary regeneration of the Diesel Particulate Filter (DPF). During normal operation, the DPF collects soot from the engine. When the DPF is full, the engine will burn the soot out of it. Under normal operation, this is done automatically while the truck is moving at high speeds. This regen button is only used to manually initiate a stationary regeneration when needed.

- 6. REGEN INHIBIT**

This switch will not allow a stationary regeneration when in the inhibit position (pressing the top half of the switch). Removing it from the inhibit position (pressing the bottom half of the switch), will allow the use of the REGEN button noted above. Removing it from the inhibit position will also allow the system to regenerate automatically as needed.

- 7. WINDSHIELD WIPER AND WASHER CONTROL**

To operate washers, press in control, which is located on left side of dash. This starts an electric pump which pumps window washing fluid onto the windshield. Press enough to spread solution as needed on windshield and then turn on wipers to clean the windshield. Keep fluid reservoirs full at all times.

 **Components**

**8. SPEEDOMETER (0-85 MPH) - Part No. ENGLISH 00078664-2E6641
METRIC 00078664-2E6601**

Indicates speed of vehicle in miles per hour (mph) and registers the amount of miles the truck has traveled. In most cases, speedometer will record pumping, as it is driven by transmission.

**9. TACHOMETER WITH HOUR METER RECORDER (0-4000 RPM)
- Part No. 00078664-B41940**

The tachometer indicates the engine speed in hundreds of revolutions per minute (rpm).

10. ENGINE STARTER SWITCH

This spring-loaded switch activates the starter.

11. MASTER IGNITION SWITCH

An OFF-ON-ON switch in 2nd position turns on breaker panel; in 3rd position, turns on ignition. Pushing switch in 1st position at the top until flush with dash will put the truck in OFF position. This turns electrical power off.

12. HEADLIGHT SWITCH

Operates the headlights, taillights, and running lights. Also operates instrument lights or backlighting. First position is off; second position is running lights, taillights, and back lighting; third position adds headlights.

13. DASH DIM CONTROL

This switch is used to control the brightness of all lights on the dash.

**14. REAR AIR PRESSURE (0-150 PSI) - Part No. ENGLISH 00078664-B11D43
METRIC 00078664-B11D03**

Air pressure gauge that works in conjunction with low air pressure warning light and beeper (in 28-light bar) will be on until the gauge reaches a safe operating level. Normal operating level is 110 to 125 psi.

**15. TRANSMISSION OIL TEMPERATURE GAUGE (100-240°) -
AUTOMATIC TRANSMISSION ONLY -
ENGLISH 00078664-B10540, METRIC 00078664-B10500**

Indicates operating temperature of transmission oil. Normal operating temperature is between 100 and 220°F. Maximum allowable temperature is 250°F. If temperature exceeds this limit, slow engine to idle until cooled off. See Transmission Manual for troubleshooting.



16. FRONT BRAKE PRESSURE (0-150 PSI) -

Indicates amount of air pressure in the brake system. Normal operating pressure is 110 to 125 psi. This also works with low air light and beeper (in 21- light bar). Truck should have full air pressure before moving.

17. FUEL GAUGE (E-F) - Part No. 947697

Indicates amount of fuel in fuel tank.

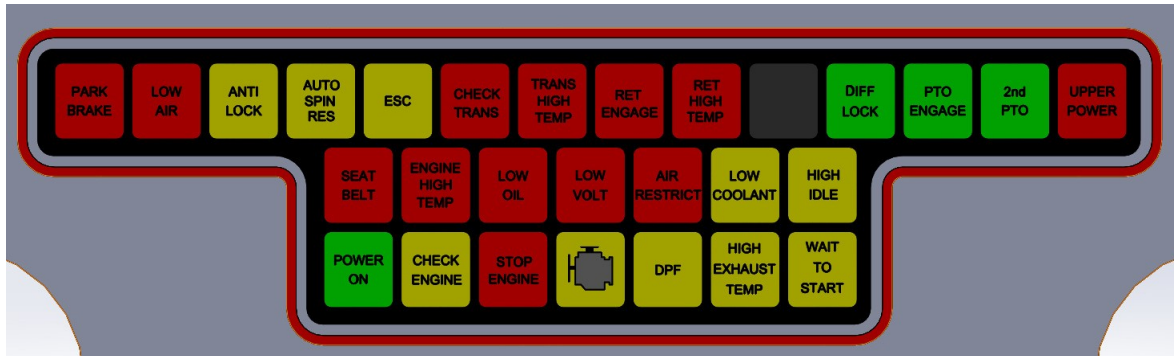
18. SET BUTTON

Scrolling through speedometer for data information.

19. MODE BUTTON

Entering for data information in speedometer..

Components



20. INDICATOR LIGHT BAR

Contains indicator lights as follows:

- LP1 - PARKING BRAKE - Lights when parking brake is activated.
- LP2 - LOW AIR
- LP3 - ANTILOCK BRAKES
- LP4 - AUTO SPIN RESPONSE - Improved traction on slippery surfaces by reducing drive wheel overspin. Managed by applying brake to slipping wheel so torque is transferred to wheel with better traction. Or, if all wheels are spinning, engine torque is reduced and throttle control may be taken out of driver's hands.
- LP5 - ELECTRONIC STABILITY CONTROL
- LP6 - CHECK TRANSMISSION - This light has two functions:
 - a. Used as a warning lamp to tell the driver that a problem has occurred and that the vehicle should be for serviced as soon as possible.
 - b. Used by the technician to read trouble codes to help diagnose system problems.



- LP7 - TRANSMISSION TEMPERATURE HIGH (light and beeper) - This will light and sound when transmission temperature exceeds the prescribed temperature. See transmission manual and take corrective measures.
- LP8 - RETARDER ENGAGED - If truck is equipped with optional retarder, this light will come on to tell driver it has been activated.
- LP9 - RETARDER HIGH TEMPERATURE - If truck is equipped with optional retarder, light and beeper will come on in case the temperature exceeds the prescribed temperature. If light and beeper come on, discontinue use of retarder until they turn off.
- LP10 -
- LP11 - DIFFERENTIAL LOCK - Lights when interaxle differential lock is activated.
- LP12 - PTO ENGAGED - Lights when primary PTO is activated.
- LP13 - SECOND PTO - Lights when secondary PTO is activated.
- LP14 - UPPER POWER - Indicates upper power switch in ON position and should be shut off.
- LP15 - FASTEN SEAT BELTS - Lights at startup as a reminder to wear safety belts. This light will stay on as long as parking brake is engaged.
- LP16 - ENGINE HIGH TEMPERATURE - This light is set to come on at 205°F. If warning light and beeper come on, reduce engine speed to idle and let cool before running at load temperature again. Correct the problem causing engine to run hot. (DO NOT RUN AT TEMPERATURES EXCEEDING 205°F.)

▽ **Components**

- LP17 - LOW OIL - Light and buzzer will come on at start-up until oil pressure rises to correct pressure. The light and beeper will also come on if oil pressure drops below the prescribed level. In the event that light and buzzer come on, stop engine and correct problem before continuing operation.
- LP18 - LOW VOLTAGE
- LP19 - AIR RESTRICTION - When this light comes on, change air filter.
- LP20 - LOW COOLANT
- LP21 - HIGH IDLE - Increases idle to 1,000 rpm in low voltage conditions.
- LP22 - POWER ON
- LP23 - CHECK ENGINE - This light has two functions:
 - a. Used as a warning lamp to tell the driver that a problem has occurred and that vehicle should be for serviced as soon as possible.
 - b. Used by the technician to determine trouble codes to help diagnose system problems.

The CHECK ENGINE light will come on for about 5 seconds when the ignition is turned on. If the light remains on, it means the self-diagnostic system has detected a problem. If the problem goes away, the light will go out, but a trouble code will be stored in the ECM.

- LP24 - STOP ENGINE - Its main function is to turn on and notify the driver when a potential damaging condition has been detected, such as low oil pressure, low coolant, or engine over-temperature. As a light bulb and system check, the STOP ENGINE light will come on for about 5 seconds when ignition turns on.



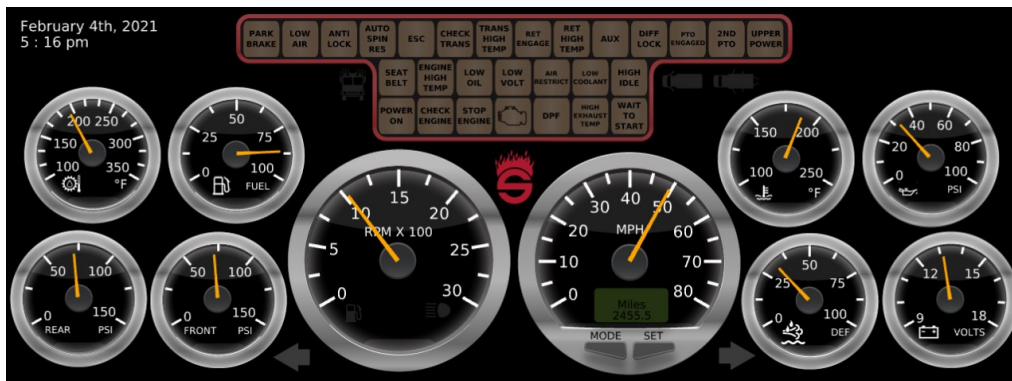
- LP25 - MIL LAMP - Problem with regeneration.
- LP26 - DPF - Regeneration is required (run vehicle on highway or perform Stationary Regeneration).
- LP27 - HIGH EXHAUST TEMPERATURE - Exhaust temperature has exceeded recommended levels. This light may come on during the regeneration cycle. **This is normal and is a cautionary note only.** Do not turn off regen switch if light is on.
- LP28 - WAIT FOR START

Digital Instrument Panel

Display Views

2 screens can be accessed in the beta release to verify functionality by pressing the middle top of either screen.

Traditional look



Modern look

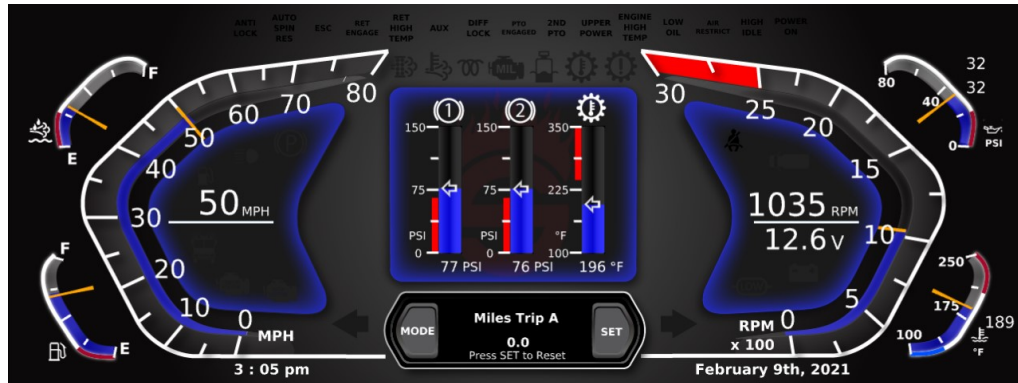


Components

Mode Selection

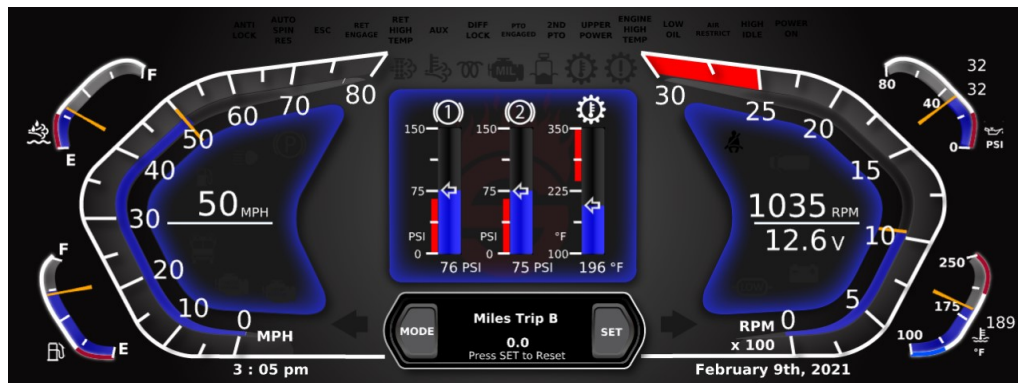
Trip “A”

View or reset Trip “A” values.



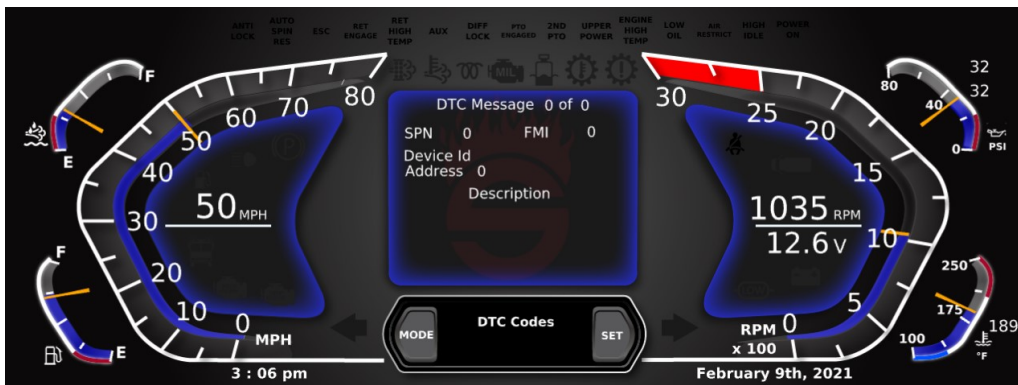
Trip “B”

View or reset Trip “A” values.



DTC Message

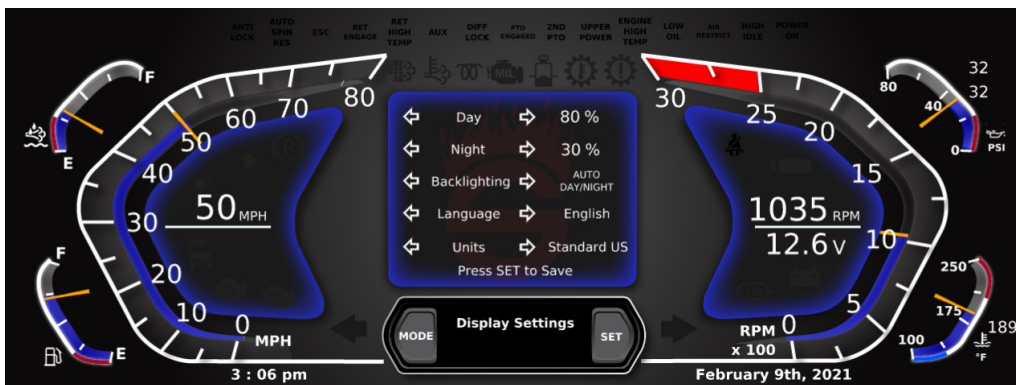
View or acknowledge current DTC messages, if codes are active. If more than 1 code is active, the left/right arrows to move to the previous or next code will be available on the screen.





Display Settings

Touch the left arrow to decrease the value or touch the right arrow to increase the value.

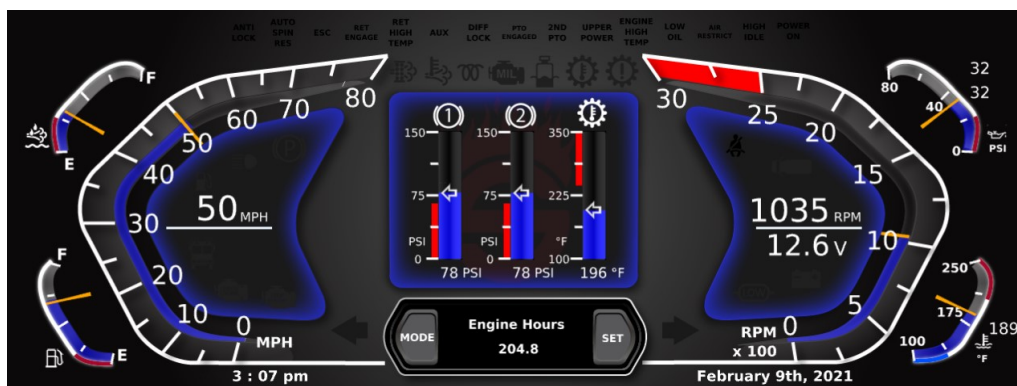


Date and Time Settings

Touch the left arrow to decrease the value or touch the right arrow to increase the value.



Engine Hours



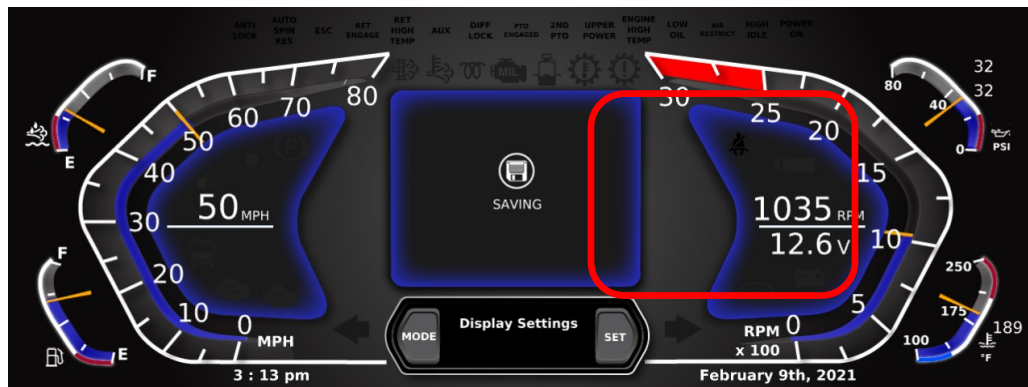
Components

Set - CAM Button

The “Set Button” will save, reset and acknowledge the appropriate change within each mode. The “Set Button” will change to the CAM when on the default main screen. Once the mode button has been selected, the CAM button is not available and the camera will default to off.

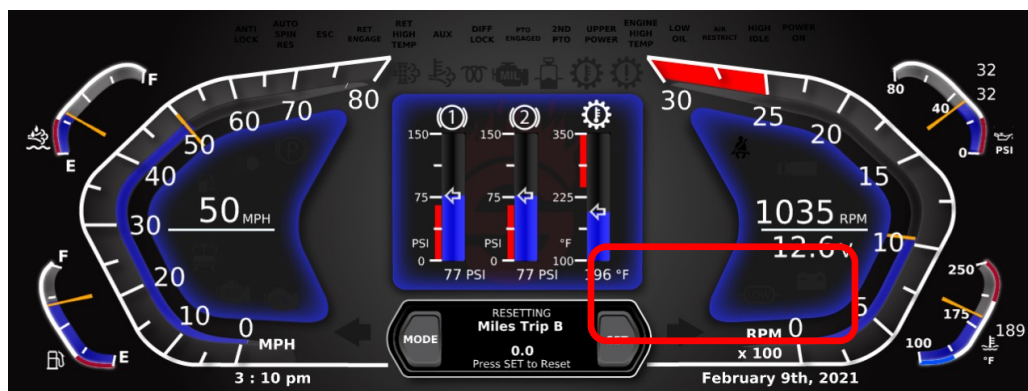
Saving

Will be displayed when saving modified items on the Date/Time and Display Settings.



Resetting

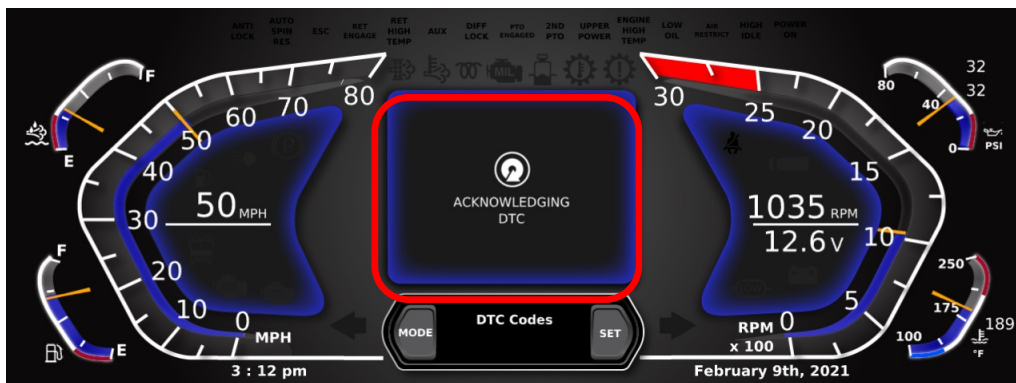
Will be displayed on the Trip “A” and ”B” when resetting the distance traveled.





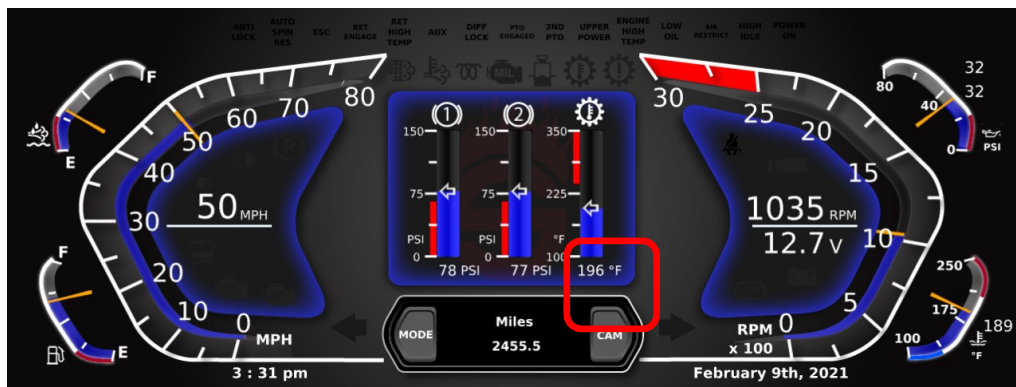
Acknowledge

Will be displayed when a DTC code is acknowledged.






















CAM – Camera Button

The camera button is only visible when no modes are accessed.



Components

Indicator Icons - Descriptions

	Compartment or Door Ajar		Low Fuel
	Seat Belt Violation		Diesel Particulate Filter
	All Seated Properly		Exhaust System Temperature High
	High Beams		Low Air Tank
	Check Engine		Park Brake
	Stop Engine		Primary Air Tank
	Malfunction Indicator Lamp		Secondary Air Tank
	Battery Voltage Low		Catalyst Low Level
	Check Transmission		
	Transmission High Temperature		
	Coolant Low		



Additional Switches

NOTE: See custom switch layout for locations of optional switches.

MASTER EMERGENCY SWITCH

When activated, this switch supplies ground to all other emergency switches located on the top row of the switch panel.

CAB BEACON SWITCH

When master emergency switch is on, this switch is grounded and can be used to turn on the light bar located on the top front of the cab.

REAR BEACON SWITCH

When master emergency switch is on, this switch is grounded and can be used to turn on beacons located at the top rear of the apparatus.

SIREN/HORN TOGGLE SWITCH

When this switch is in the ON position, the horn button on the steering wheel sounds the siren instead of the horn.

Components

WARNING



Do not use in wet or slippery conditions.

JAKE BRAKE SWITCH OFF/ON

This is a vehicle slowing device, not a vehicle stopping device. It is not a substitute for the service braking system. The vehicle's service brakes must be used to bring the vehicle to a complete stop.

NOTE: When switch is on and Jake brake is applied, the brake lights will also come on.

WARNING



Do not use in wet or slippery conditions.

JAKE BRAKE LOW/MEDIUM/HIGH

This is a three-position switch – Top position is JB LOW, middle is JB MED, and bottom is JB HIGH.

REMOTE MIRROR CONTROL

The remote mirror control is used to adjust both left- and right-side mirrors.

PARKING BRAKE CONTROL

When the vehicle is stopped, pull out knob to set the parking brake. When ready to start moving with engine running and primary air supply at 90 psi, and beeper and low air pressure lights off, push in knob to release the brake. Location for all models but Shields is on the engine hood.

ALTERNATE FLASHER SWITCH

When master emergency switch is on, this switch is grounded and can be used to turn on sequential lights on front of cab.

SPOTLIGHTS SWITCH

This switch is used to turn on the power to the spotlights.



PTO SWITCH

This is only an aerial or used with high pressure pumps. This switch is used to activate the power take-off (PTO). For detailed instructions, read Engaging PTO, under Transmission.

SEVEN LIGHT BAR



Upon release of the Park Brake:

- There is a 3-second lamp test of Blue Lights,
- a 3-second lamp test of Red Lights,
- and all lights off for normal operation.

In the event there is a WARNING, the corresponding Red Light will flash.



WARNING

The apparatus must not be moved if a warning is active upon the release of the park brake.

 **Components**

The seven lightbar can be configured with any of the following indicator lights:

- a. CAB DOOR OPEN
- b. COMPARTMENT DOOR OPEN
- c. OUTRIGGER OUT
- d. OUTRIGGER DOWN
- e. MAST UP
- f. LADDER RACK
- g. DECK GUN
- h. SRS
- i. LIGHT TOWER
- j. HOSE BED DOOR
- k. CAB LOCK
- l. TELE LIGHTS
- m. HOSE RACK
- n. TOWER UP
- o. CHUTE EXTEND
- p. LADDER DOOR
- q. PORTATANK RACK
- r. CAB TILT LIMIT
- s. NEUTRAL



AIR BRAKE PEDAL

Used for stopping truck. Apply foot pressure to the pedal until braking action can be felt, then slowly decrease or increase foot pressure, as required, until the truck has slowed to desired speed or comes to a stop. (DO NOT RIDE WITH FOOT RESTING ON BRAKE.)

NOTE: Do not pump (fan) the brake pedal. A long series of rapid brake applications can reduce system pressure to a point where effective service braking is lost until the air compressor can restore pressure. If the air pressure in the service brake system drops below a safe operating level, the low air warning light and beeper on instrument panel will come on. When this occurs, stop the chassis. Do not resume operations until the proper air pressure can be maintained. If the air pressure in the air brake system falls below a safe operating level, the parking brakes will automatically apply.

ACCELERATOR FOOT PEDAL

Controls forward and backward travel speed of the truck. Depress to go faster and release to slow. If revving above 2200 rpm, truck will go to idle - remove foot from pedal momentarily, reapply foot and resume.

SEAT ADJUSTMENT

The standard seat has adjustment on front to control forward and backward movement. Do this by pulling lever on front. For more information, see SEAT.

HAZARD WARNING FLASHER SWITCH

Located under steering wheel on steering column. Pull switch in to activate flasher, which will flash all turn signal indicator lights and front and rear turn signal lights.

TRANSMISSION

A shifter stand and control is on right side of driver with five (or six) forward speeds, one reverse, and neutral. For more information, see AUTOMATIC TRANSMISSION.

Components

3.2 Heating and Air Conditioning Control Panel



For units shipped by ProAir® prior to April 2014



For units shipped by ProAir® after April 2014



For units shipped by ProAir® after October 2019



NOTE: Better AC cooling can be achieved by turning off the heating valves located on the right front frame rail. Be sure to turn off only the rear valves.

Rear Fan

This switch controls the main unit blower fan speeds. Rotating the switch clockwise increases blower fan speed. Rotating the switch counterclockwise decreases blower fan speed until off.

Rocker Switch with Snowflake Symbol

This switch turns the air conditioner on or off. With the snowflake symbol illuminated, the air conditioner is on. (This switch is not present on heat only units.)

Rear Temp

This switch controls the opening and closing of the main unit water control valve. Rotating the switch clockwise opens the valve. Rotating the switch counterclockwise closes the valve. (A/C will not operate properly if not turned to the full cool position.)

Front Fan

This switch controls the overhead windshield blower fan speeds. Rotating the switch clockwise increases blower fan speed. Rotating the switch counterclockwise decreases blower fan speed until off.

Front Temp

This switch controls the opening and closing of the overhead windshield water control valve. Rotating the switch counterclockwise opens the valve. Rotating the switch clockwise closes the valve. (A/C will not operate properly if not turned to the full cool position.)

Components

3.3 Heating and Air Conditioning



Commercial Products Service Manual

Frigiking, Premium roof mount condenser

Part Number: 31 000 030

For units shipped out of ProAir prior to Feb. 2009



#	PART NUMBER	DESCRIPTION
1	01 000 365	(2) fan "Weather Pack" Wire Harness
2	03 000 157	18" x 32" condenser coil
3	05 000 682	Drier w/sight glass - w/(2) 1/2" MIO fitting's
4	60 001 396	16" puller fan Sub assy ((1)01 000 372 needed with each 60 001 396)
5	01 000 372	(2) cavity "Weather Pack" female connector (not shown inside the assembly (1) needed per 60 001 396)
6	62 000 549	#8 AOC x 1.00' hose assembly

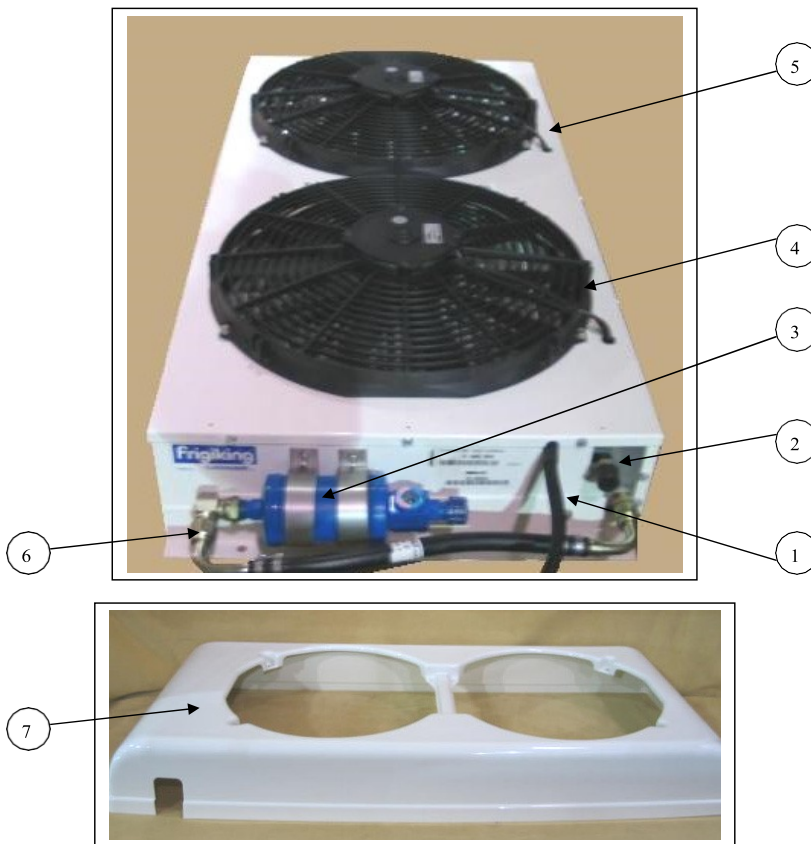


Commercial Products Service Manual

Frigiking, Premium roofmount condenser

Part Number: 31 000 030

For units shipped out of ProAir after Feb. 2009



#	PART NUMBER	DESCRIPTION
1	01 000 365	(2) fan "Weather Pack" Wire Harness
2	03 000 157	18" x 32" condenser coil
3	05 000 682	Drier w/sight glass - w/(2) 1/2" MIO fitting's
4	60 001 396	16" puller fan Sub assy ((1)01 000 372 needed with each 60 001 396)
5	01 000 372	(2) cavity "Weather Pack" female connector (not shown inside the assembly (1) needed per 60 001 396)
6	62 000 549	#8 AOC x 1.00' hose assembly
7	07 000 533	Cover,2 Fan Condenser SN

Components

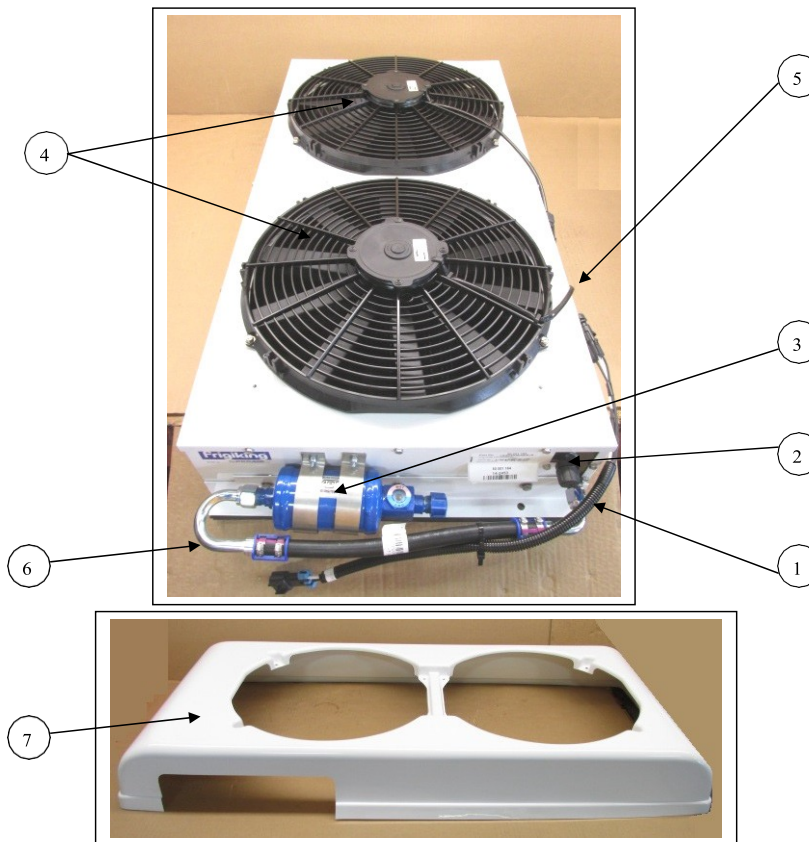


Commercial Products Service Manual

Frigiking, Premium roofmount condenser

Part Number: 31 000 030

For units shipped out of Proair after Dec. 2013



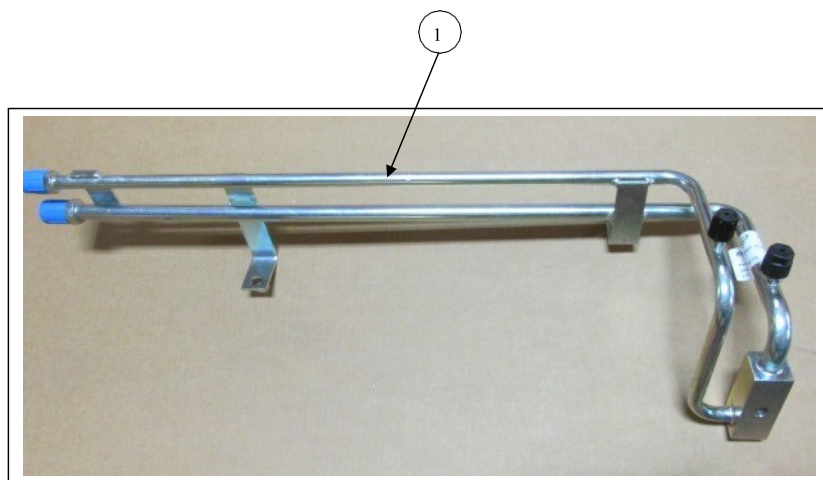
#	PART NUMBER	DESCRIPTION
1	01 000 365	(2) fan "Weather Pack" Wire Harness
2	03 000 157	18" x 32" condenser coil
3	05 000 682	Drier w/sight glass - w/(2) 1/2" MIO fitting's
4	60 001 396	16" puller fan Sub assy ((1)01 000 372 needed with each 60 001 396)
5	01 000 372	(2) cavity "Weather Pack" female connector (not shown inside the assembly (1) needed per 60 001 396)
6	62 000 549	#8 AOC x 1.00' hose assembly
7	07 000 533	Cover,2 Fan Condenser SN



Commercial Products Service Manual

Tube Kit, TM21

Part Number: 50 001 567



Replaced with part # 05-001-400

#	PART NUMBER	DESCRIPTION
1	05 001 114	Tube Assembly, TM21
2	63 001 184	Part Bag (not pictured) (1) 10mm Bolt x 45 (1) 10mm Lock Washer
3		
4		
5		
6		
7		
8		
9		



Components



Commercial Products Service Manual



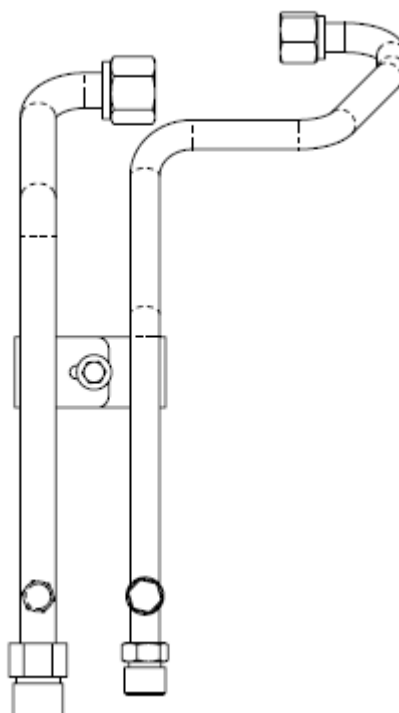
For units shipped after April 2020

#	PART NUMBER	DESCRIPTION
1	05-001-400	Tube Assembly, TM21 L9 CHF-9384
2	63 001 184	Part Bag (not pictured) (1) 10mm Bolt x 45 (1) 10mm Lock Washer
3		
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8		
9		



PROAIR LLC

Commercial Products Service Manual



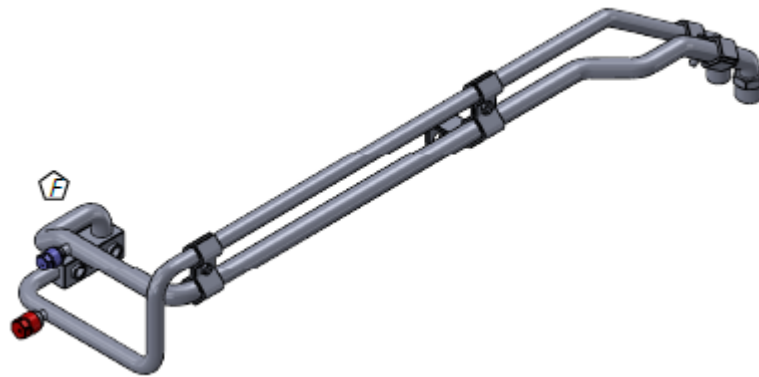
L9 TM31

#	PART NUMBER	DESCRIPTION
1	05 001 266	Tube Assembly, TM L9
2		
3		
4		
5		
6		
7		
8		
9		

Components



Commercial Products Service Manual



For 2018 TO PRESENT X12 ENGINES

#	PART NUMBER	DESCRIPTION
1	60-001-760	Tube Assembly, TM21 X12 CHF-9136
2	63 001 184	Part Bag (not pictured) (1) 10mm Bolt x 45 (1) 10mm Lock Washer
3		
4		
5		
6		
7		
8		
9		



PROAIR LLC

Commercial Products Service Manual



For 2018 TO PRESENT X12 ENGINES

#	PART NUMBER	DESCRIPTION
1	60-001-759	Tube Assembly, TM31 X12 CHF-9137
2	63 001 184	Part Bag (not pictured) (1) 10mm Bolt x 45 (1) 10mm Lock Washer
3		
4		
5		
6		
7		
8		
9		

▼ **Components**



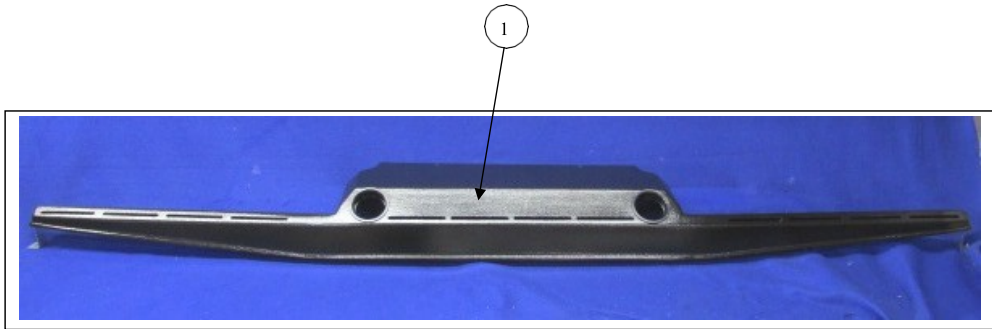
Commercial Products Service Manual

52-001-189 L9-X12 A/C HOSE KIT PRO AIR

Parent Part	P2	P3	P4	P5	P6	P7	P8	Qty Per	Uom
52-001-189: Hose Kit '19 Sutphen									
	08-000-279: Sleeve,Fire 1" I.D.-Reflective							2.00	FT
	12-000-096: Box,20 3/8x12 1/4x9 5/8 Htr							1.00	EA
	62-001-221: Hose Assy, #8 x 13.083'							1.00	EA
	62-001-222: Hose Assy, #8 x 1.979'							1.00	EA
	62-001-224: Hose Assy, #10 x 1.64'							1.00	EA
	62-001-225: Hose Assy, #12 x 15.00'							1.00	EA
	62-001-329: Hose Assy, #10 x 21.333'							1.00	EA
	BL012174: Sleeve,Fire 1.25" I.D.-Reflect							1.00	FT



Commercial Products Service Manual



#	PART NUMBER	DESCRIPTION
1	07 000 641	Duct Assembly, Defrost
2	11 000 188	(2) 2.7 Round Sonora Louvers
3		
4		
5		
6		
7		
8		
9		

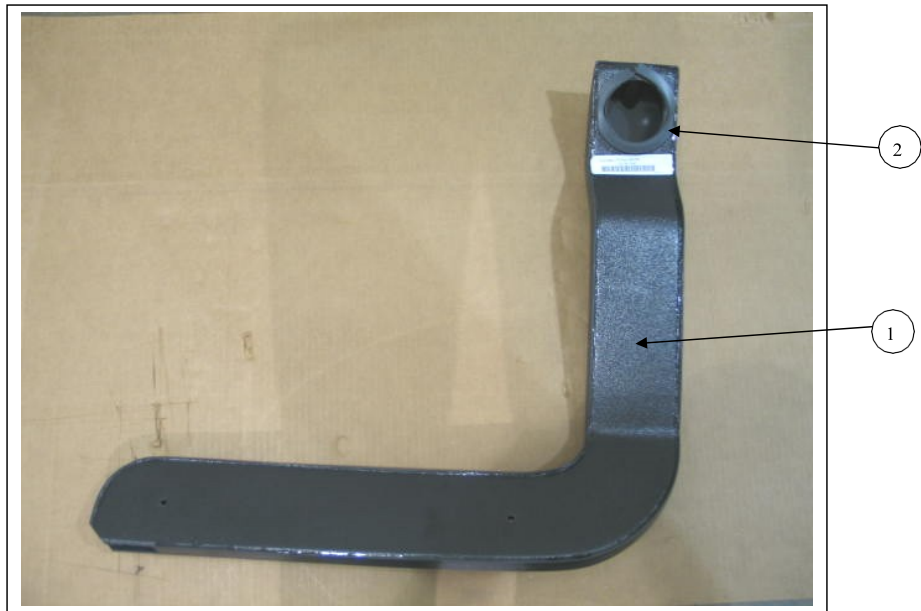
Components



Commercial Products Service Manual

Duct Assembly, PS Floor

Part Number: 60 001 549



#	PART NUMBER	DESCRIPTION
1	07 000 636	Duct Assembly, PS Floor
2	08 000 135	Foam Tape, 3/8" x 1/2"
3		
4		
5		
6		
7		
8		
9		



Commercial Products Service Manual

Duct Assembly, DS Floor

Part Number: 60 001 550



#	PART NUMBER	DESCRIPTION
1	07 000 633	Duct Assembly, DS Floor
2	08 000 135	Foam Tape, 3/8" x 1/2"
3		
4		
5		
6		
7		
8		
9		

Components



Commercial Products Service Manual

Duct Assembly, PS Floor 33.50

Part Number: 60 001 593



#	PART NUMBER	DESCRIPTION
1	07 000 679	Duct Assembly, PS Floor 33.50
2	08 000 135	Foam Tape, 3/8" x 1/2"
3		
4		
5		
6		
7		
8		
9		



Commercial Products Service Manual

Duct Assembly, DS Floor 33.50

Part Number: 60 001594



#	PART NUMBER	DESCRIPTION
1	07 000 678	Duct Assembly, DS Floor 33.50
2	08 000 135	Foam Tape, 3/8" x 1/2"
3		
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9		

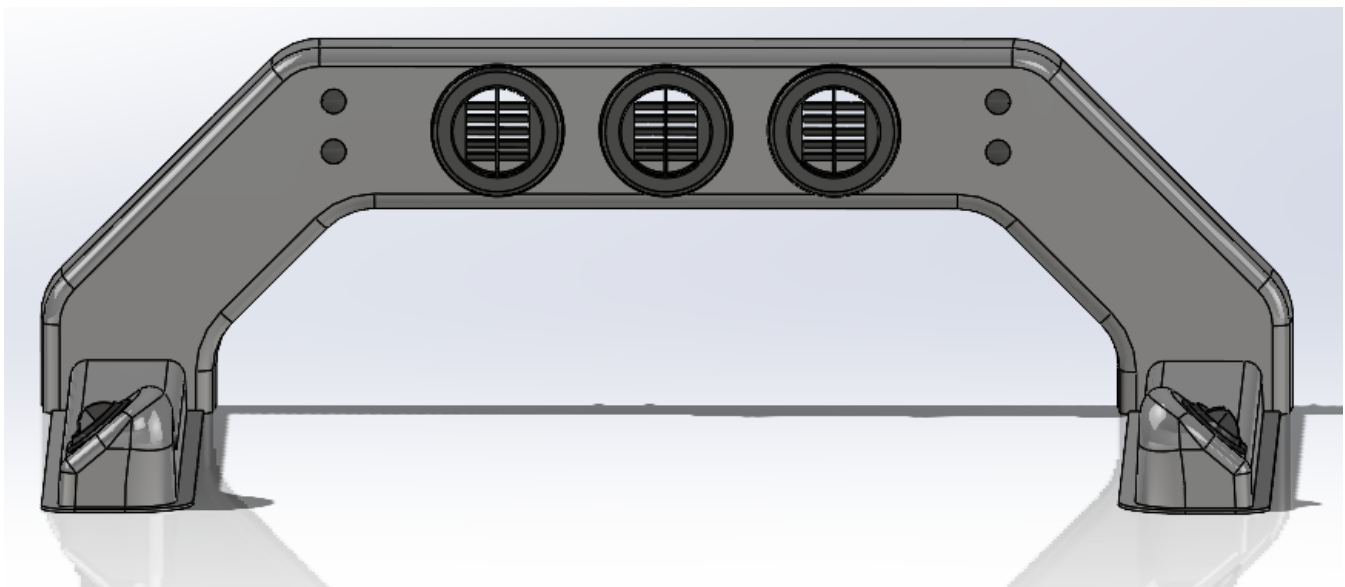
Components



Commercial Products Service Manual

A/C to Face

Part Number: PD 05817001



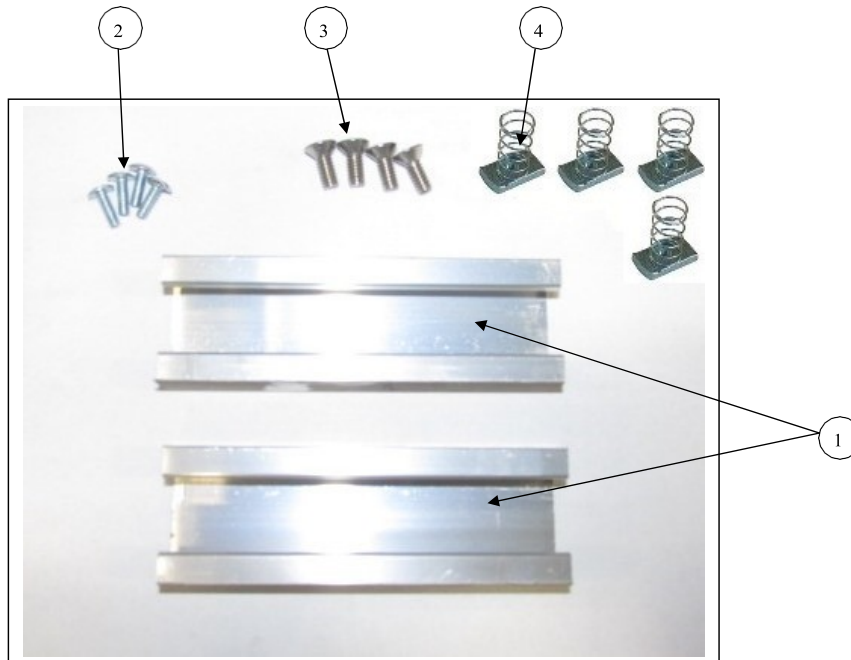
#	PART NUMBER	DESCRIPTION
1	PDO58 17 001	A/C TO FACE OPTION
2		
3		
4		
5		
6		
7		
8		
9		



Commercial Products Service Manual

Part Bag, Rear Plate

Part Number: 63 000 855



#	PART NUMBER	DESCRIPTION
1	60 001 412	Unistrut Rear w/Holes
2	02 000 076	Screw, 8/32 x 1/2"
3	02 000 451	Screw, 1/4-20 x 5/8 Stainless
4	02 000 452	Channel Nut, 1/4-20 w/ springs
5		
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8		
9		

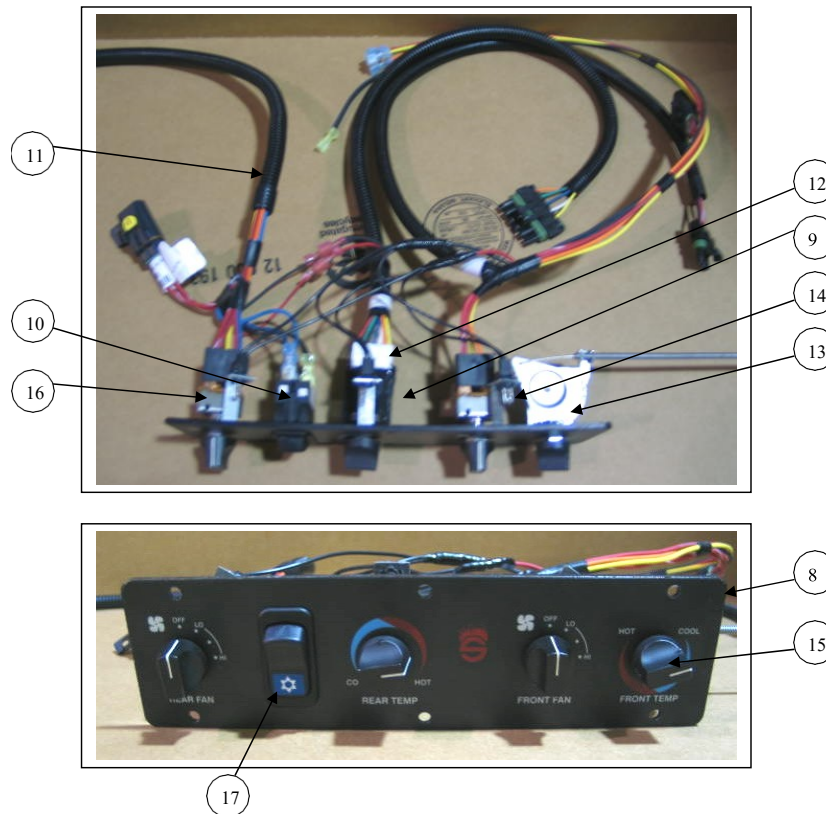


Commercial Products Service Manual

Frigiking, Power Pack overhead unit

Part Number: Standard Overhead unit heat only with A/C switch 66 000 227
Standard Overhead unit heat only with out A/C switch 66 000 234

For Units shipped by Pro Air prior to August 2013



#	PART NUMBER	DESCRIPTION
8	60 001 393	Control head assembly with A/C switch (used on the 66 000 227)
	60 001 397	Control head assembly with/out A/C switch (used on the 66 000 234)
9	01 000 190	Water valve temperature controller w/nut lock washer and spacer (used on all units)
10	68 000 059	Switch assembly w/snowflake (used on the 66 000 227)
11	01 000 359	Rear switch wiring harness (used on all units)
12	01 000 360	Temperature controller wiring harness (used on all units)
13	02 000 397	Controller with cable for water valve (used on all units)
14	01 000 084	Light bulb (used on all units)
15	01 000 086	Hard knob w/set screw (used on all units)
16	01 000 008	4 - position. extended shaft switch (used on all units)
17	02 000 399	Switch Plug (used on the 66 000 234)

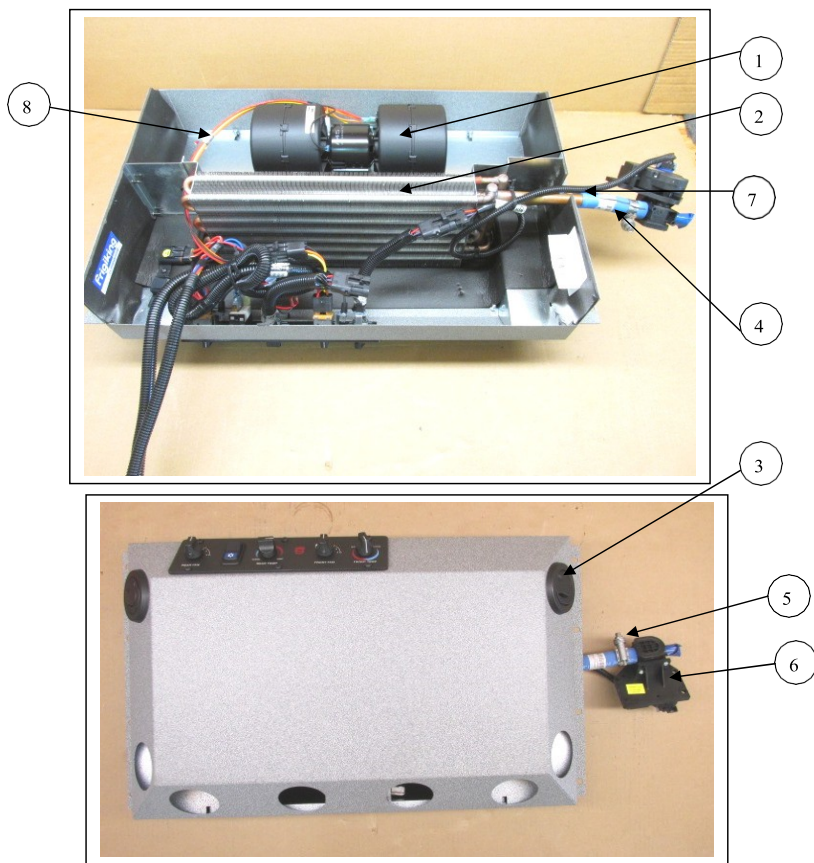
Components



Commercial Products Service Manual

Frigiking, Power Pack overhead unit Part Number: Standard Overhead unit heat only with A/C switch 66 000 227
 Standard Overhead unit heat only with out A/C switch 66 000 234

For units shipped out of ProAir after August 2013



#	PART NUMBER	DESCRIPTION
1	11 000 156	Spal 12v double small blower assembly w/resister (used on all units)
2	03 000 159	Heat only coil (used on 66 000 227 & 234)
3	11 000 188	2.7 round Sonora louver (used on all units)
4	62 000 810	5/8" x 4.5" Hose assembly (Blue, Hi-M) (used on all units)
5	02 000 437	#10 Constant Torque Clamp (used on all Silicone hose – torque to 30 to 35 in-lbs.) (used on all units)
6	05 000 852	Water valve Electric 2-port 12v (used on all units)
7	01 000 709	Water valve electrical harness (used on all units)
8	01 000 705	Blower electrical harness (used on all units)

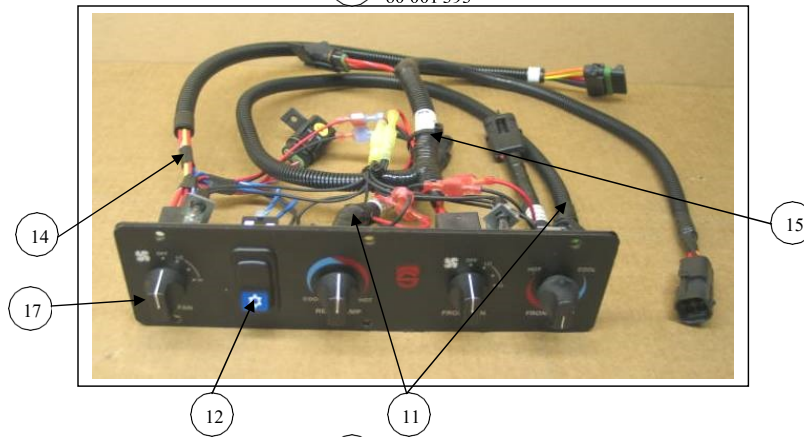


Commercial Products Service Manual

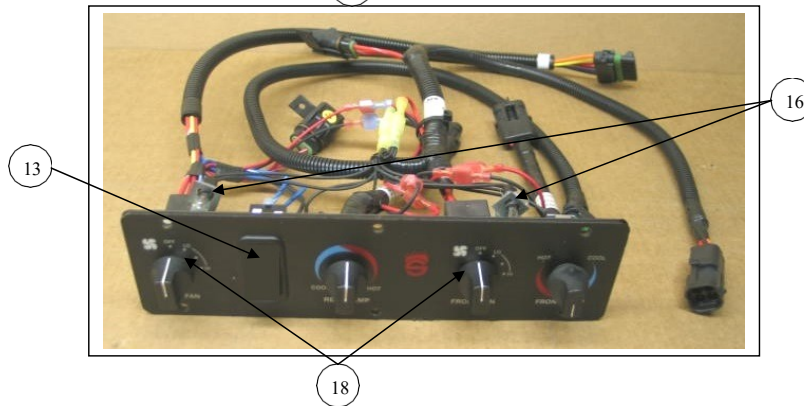
Frigiking, Power Pack overhead unit

Part Number: Standard Overhead unit heat only with A/C switch 66 000 227
Standard Overhead unit heat only with out A/C switch 66 000 234

9 60 001 393



10 60 001 397



#	PART NUMBER	DESCRIPTION
9	60 001 393	Control head assembly with A/C switch (used on 66 000 227)
10	60 001 397	Control head assembly with/out A/C switch (used on 66 000 234)
11	01 000 703	(2) Temperature control potentiometer harness (used on all units)
12	68 000 059	Switch assembly w/snowflake (used on the 66 000 227)
13	02 000 399	Plug cap (used on 66 000 234)
14	01 000 359	Rear fan switch wiring harness (used on all units)
15	01 000 706	Front fan switch wiring harness (used on all units)
16	01 000 084	Light bulb (used on all units)
17	15 000 007	(4) Hard knob w/set screw (used on all units)
18	01 000 008	4 - position. extended shaft switch (used on all units)

Components

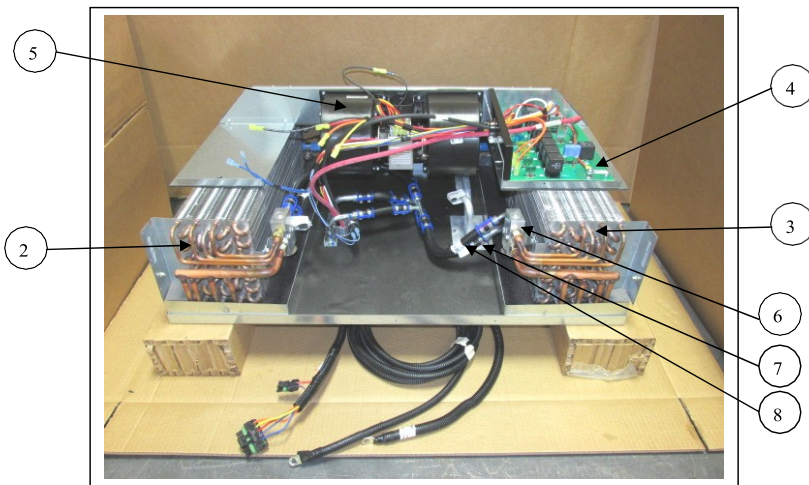
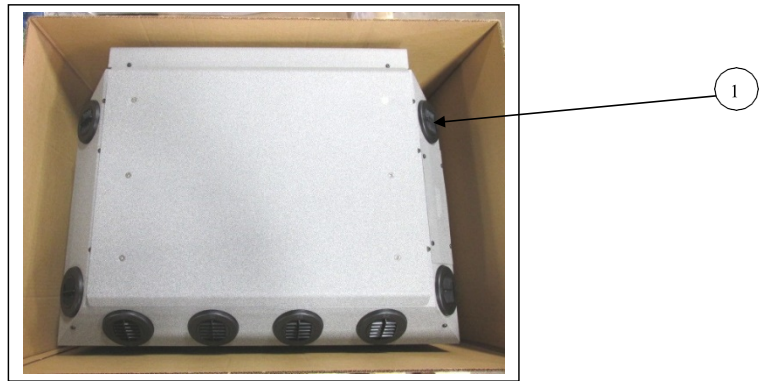


Commercial Products Service Manual

Frigiking, Power Pack, Rear Unit

Part Number: 66 000 351(H/C) & 352(H/O)

For units shipped out of Proair after April 2014



#	PART NUMBER	DESCRIPTION
1	11 000 225	Louver, 4" Sonora Grille w/ MtRet
2	03 000 201	Coil, Driver's Side H/C (used in 66 000 351)
	03 000 203	Coil, Driver's Side Heat Only (used in 66 000 352)
3	03 000 202	Coil, Passenger Side H/C (used in 66 000 351)
	03 000 204	Coil, Passenger Side Heat Only (used in 66 000 352)
4	01 000 351	Circuit Board Assembly
5	11 000 214	Blower Assembly with Resistor 12v
6	05 000 022	(2) Expansion block valve (used in 66 000 351)
7	62 000 822	Hose Assembly, #10 (used in 66 000 351)
8	62 000 821	Hose Assembly, #8 (used in 66 000 351)

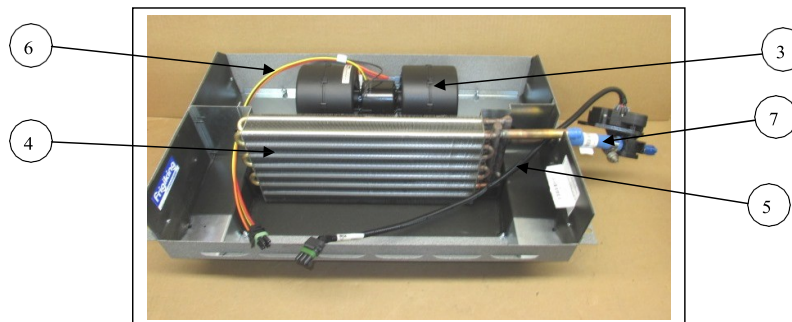
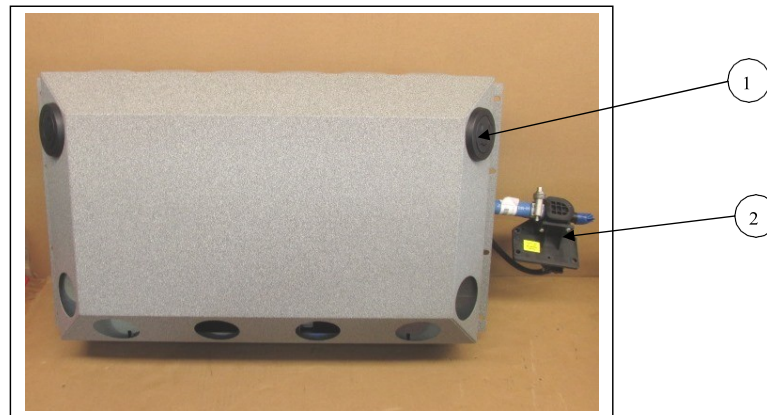


Commercial Products Service Manual

Frigiking, Power Pack, Rear Unit H/C

Part Number: 66 000 409

For units shipped out of Proair after April 2014



#	PART NUMBER	DESCRIPTION
1	11 000 188	Louver 2.7 round Sonora
2	05 000 852	Water Valve, Electric 2 port
3	11 000 156	Blower, Spal 12v Double Small w/ resistor
4	03 000 159	Coil, Heat Only
5	01 000 709	Harness, Electric water valve
6	01 000 705	Harness, Blower
7	62 000 810	Hose Assembly, Blue Hi-M

Components



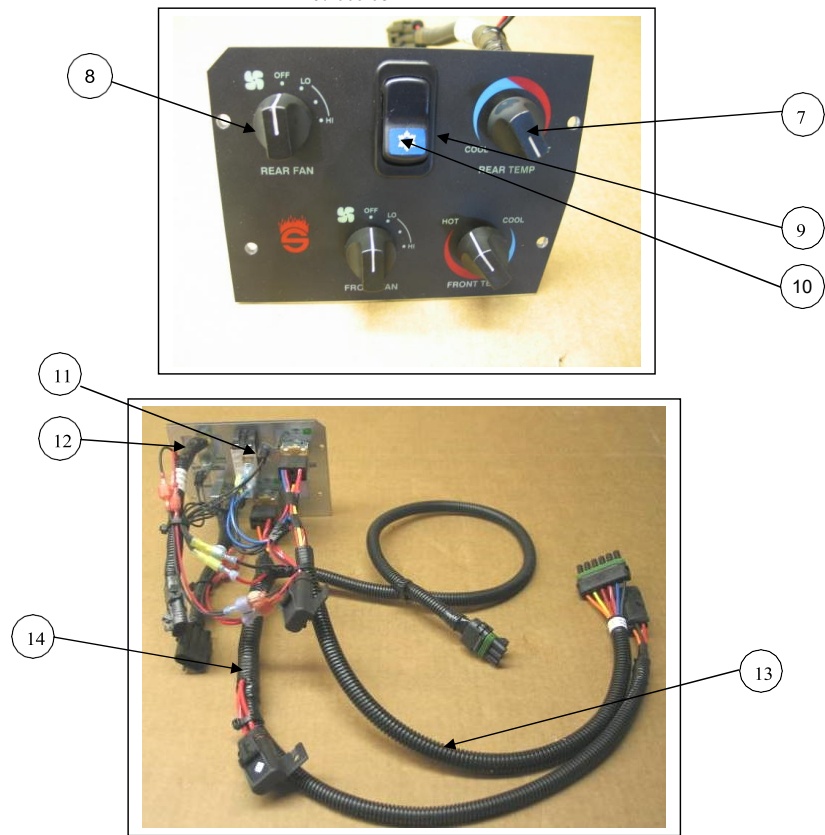
Commercial Products Service Manual

Frigiking, Power Pack, Rear Unit H/C

Part Number: 66 000 409

For units shipped out of Proair after April 2014

67 000 084 Control Head



#	PART NUMBER	DESCRIPTION
7	15 000 007	(4) Knob with set-screw
8	01 000 008	(2) Switch, 4 Position Rotary
9	01 000 357	Switch, Rocker with Light
10	01 000 366	Switch, Button with snow-flake
11	01 000 084	(4) Light Bulb #73
12	01 000 703	(2) Hot/Cold potentiometer harness
13	01 000 359	Harness, Rear switch
14	01 000 706	Harness, Control head blower



PROAIR LLC

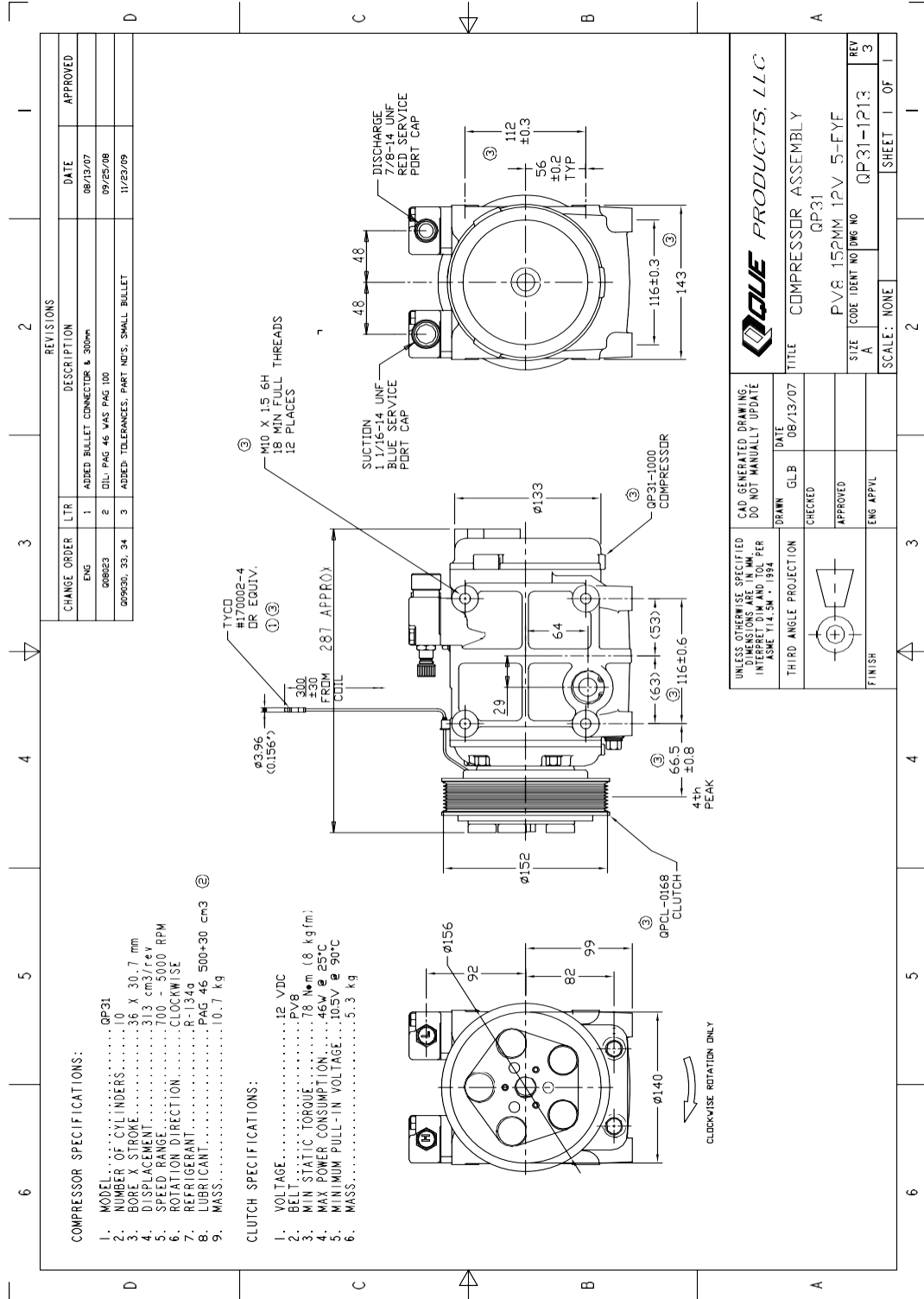
Commercial Products Service Manual

For units shipped after July 2019

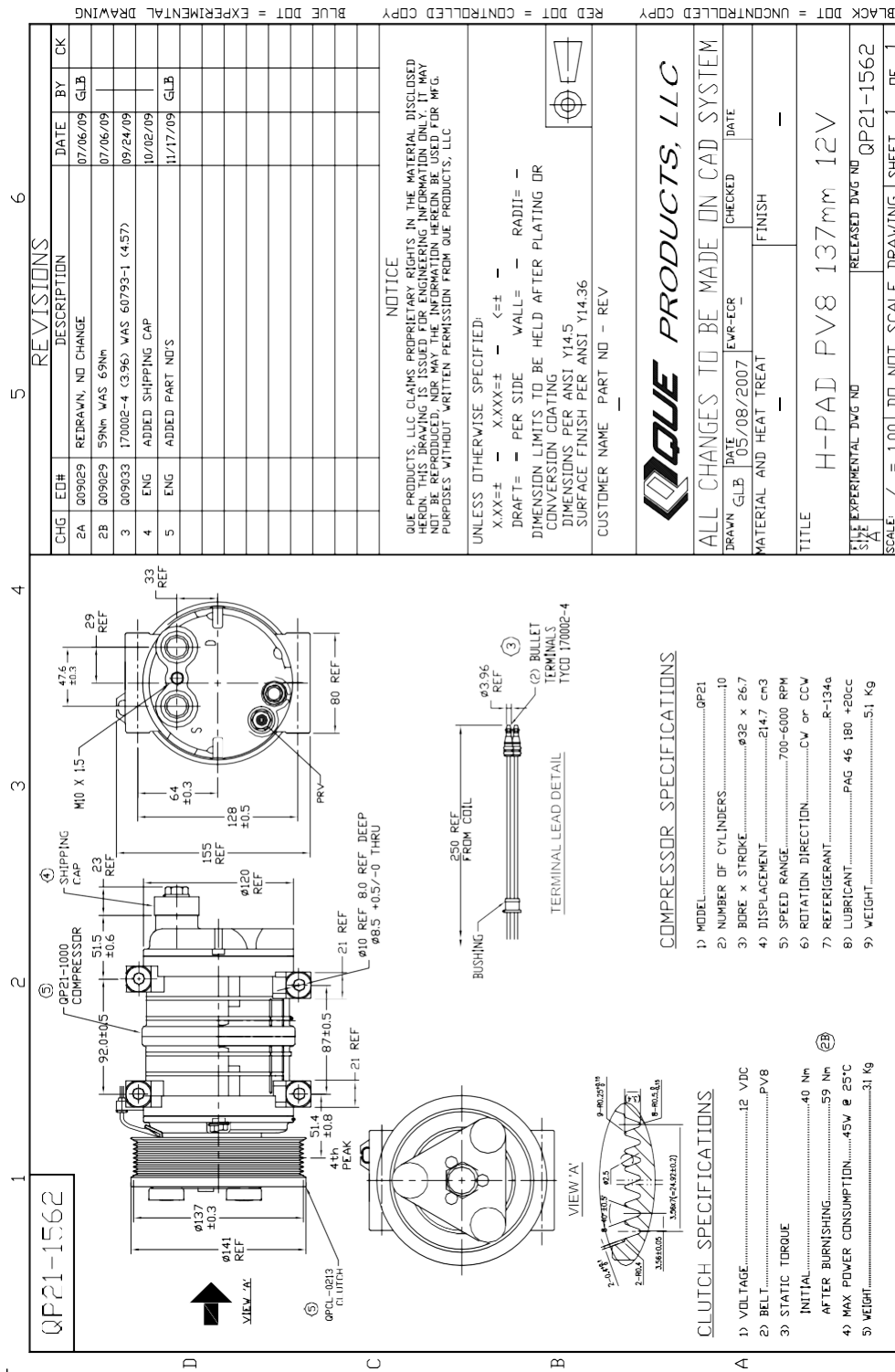


Components

PRO AIR PART # 05 000 927



PRO AIR PART # 05 000 928



BLACK DOT = UNCONTROLLED COPY RED DOT = CONTROLLED COPY BLUE DOT = EXPERIMENTAL DRAWING

CHG	ED#	DESCRIPTION	DATE	BY	CK
2A	009029	REDRAWN, NO CHANGE	07/06/09	GLB	
2B	009029	59Nm WAS 69Nm	07/06/09		
3	009033	170002-4 (3.96) WAS 60793-1 (4.57)	09/24/09		
4	ENG	ADDED SHIPPING CAP	10/02/09		
5	ENG	ADDED PART NOS	11/17/09	GLB	

REVISIONS

1 2 3 4 5 6

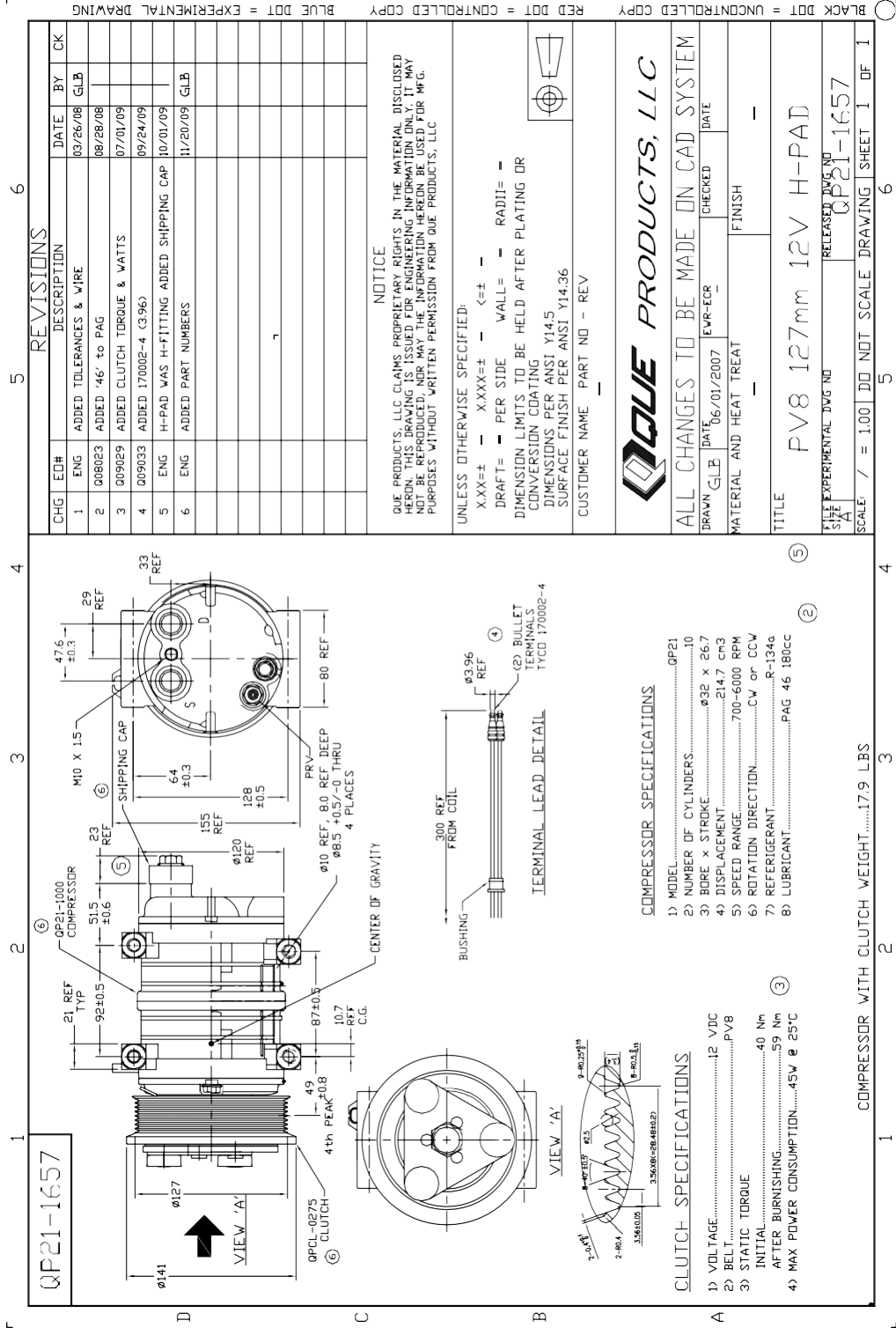
TITLE H-PAD PV8 137mm 12V
RELEASED DWG NO QP21-1562
SCALE: / = 1.00 DO NOT SCALE DRAWING SHEET 1 OF 1

1 2 3 4 5 6

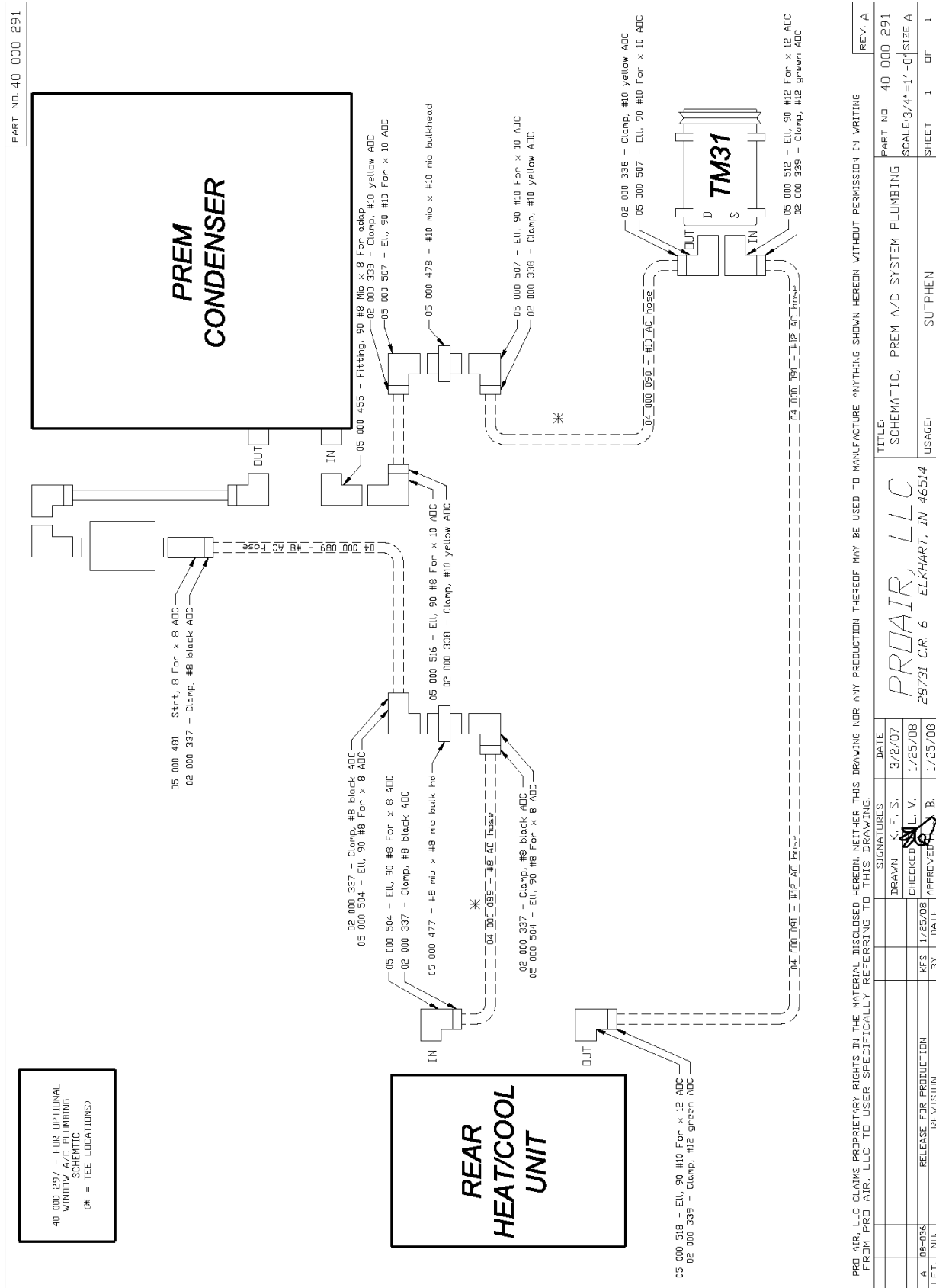


Components

PRO AIR PART # 05 001 131



Components



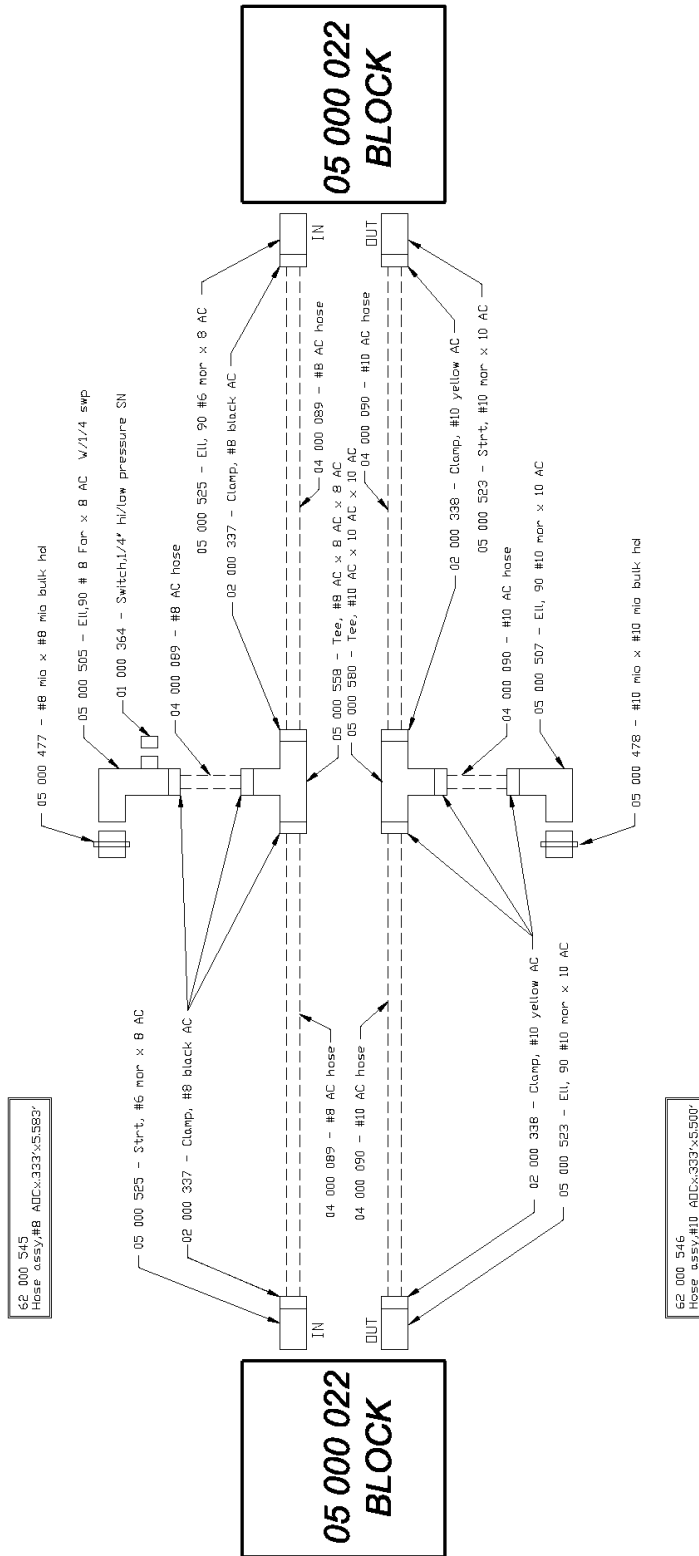
PART NO. 40 000 291

40 000 297 - FOR OPTIONAL WINDOW A/C PLUMBING SCHEMATIC (* = TEE LOCATIONS)

PER AIR, LLC CLAIMS PROPRIETARY RIGHTS IN THE MATERIAL DISCLOSED HEREIN, NEITHER THIS DRAWING NOR ANY PRODUCTION THEREOF MAY BE USED TO MANUFACTURE ANYTHING SHOWN HEREON WITHOUT PERMISSION IN WRITING FROM PRO AIR, LLC TO USER SPECIFICALLY REFERRING TO THIS DRAWING.		REV. A	
LET. NO.	BY	DATE	SIGNATURES
A	KFS	1/25/08	K. F. S.
			CHECKED L. V.
			APPROVED B.
RELEASE FOR PRODUCTION		DATE	
REVISION			
TITLE: SCHEMATIC, PREM A/C SYSTEM PLUMBING		PART NO. 40 000 291	SCALE: 3/4" = 1' - 0" SIZE A
USAGE: SUTPHEN		SHEET 1	OF 1



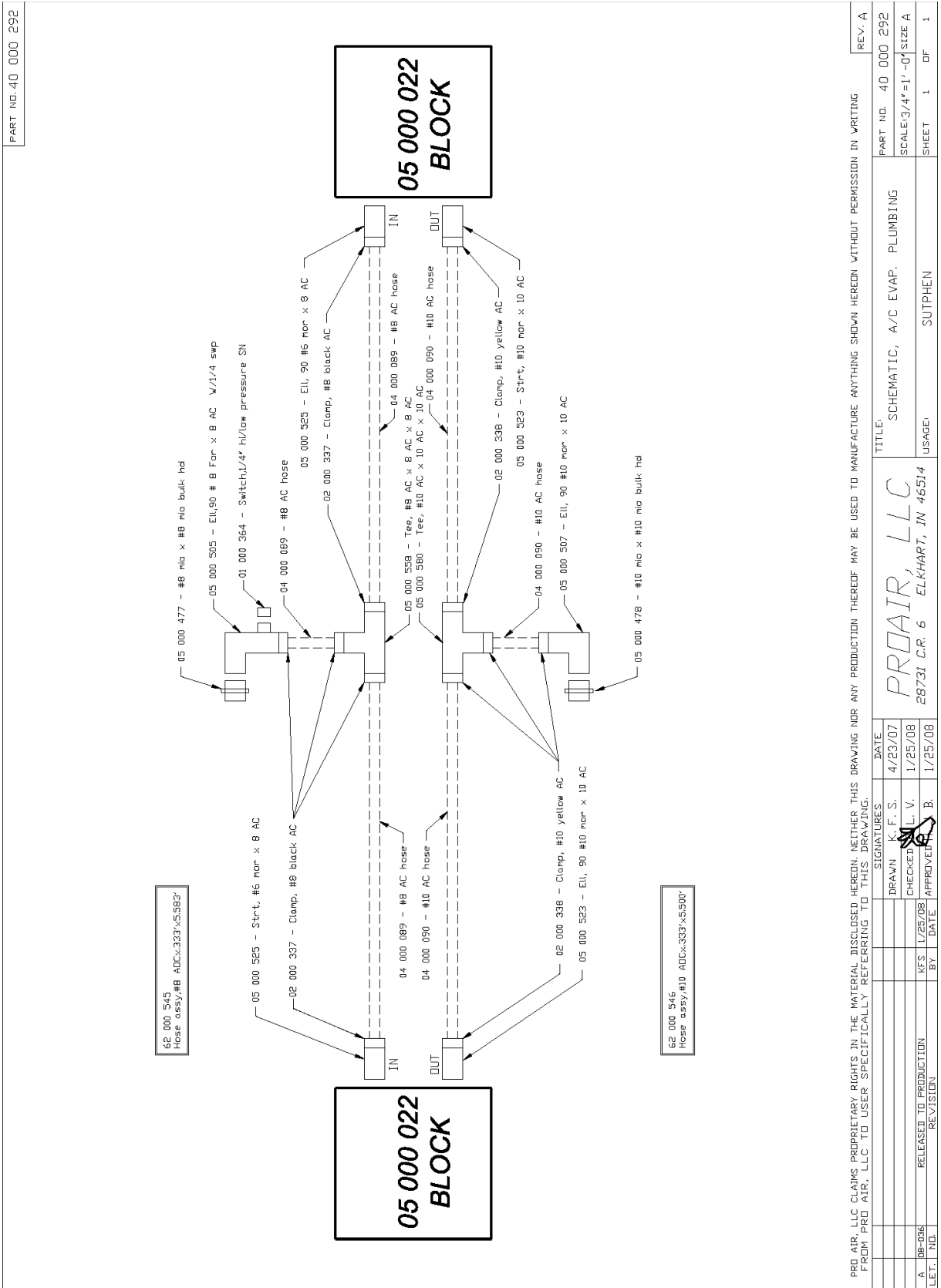
PART NO. 40 000 292



REV. A		PART NO. 40 000 292	
SCALE: 3/4" = 1' - 0"		SIZE A	
SHEET 1 OF 1		SUTPHEN	
TITLE: SCHEMATIC, A/C EVAP. PLUMBING		PRORAIR, LLC	
USAGE: SUTPHEN		28731 C.R. 6 ELKHART, IN 46514	
DATE	SIGNATURES	DATE	SIGNATURES
4/23/07	DRAWN K. F. S.	4/23/07	DRAWN K. F. S.
1/25/08	CHECKED M. L. V.	1/25/08	CHECKED M. L. V.
1/25/08	APPROVED [Signature]	1/25/08	APPROVED [Signature]
BY	DATE	BY	DATE

PRO AIR, LLC CLAIMS PROPRIETARY RIGHTS IN THE MATERIAL DISCLOSED HEREON. NEITHER THIS DRAWING NOR ANY PRODUCTION THEREOF MAY BE USED TO MANUFACTURE ANYTHING SHOWN HEREON WITHOUT PERMISSION IN WRITING FROM PRO AIR, LLC TO USER SPECIFICALLY REFERRING TO THIS DRAWING.

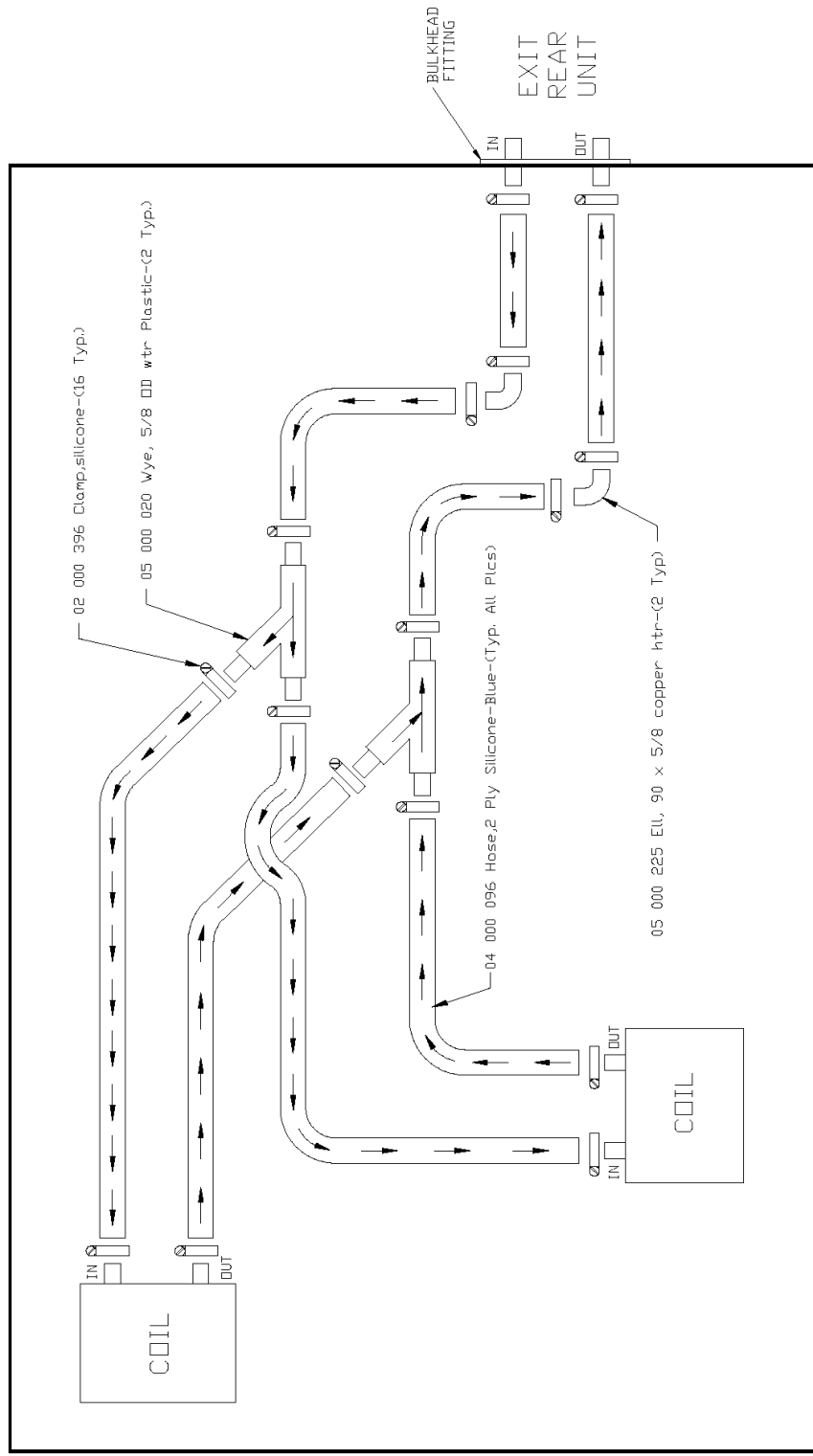
Components



PRD AIR, LLC CLAIMS PROPRIETARY RIGHTS IN THE MATERIAL DISCLOSED HEREIN. NEITHER THIS DRAWING NOR ANY PRODUCTION THEREOF MAY BE USED TO MANUFACTURE ANYTHING SHOWN HEREIN WITHOUT PERMISSION IN WRITING FROM PRD AIR, LLC TO USER SPECIFICALLY REFERRING TO THIS DRAWING.		REV. A
DATE	4/23/07	PART NO. 40 000 292
SIGNATURES		SCALE 3/4" = 1' - 0"
DRAWN	K. F. S.	SHEET 1 OF 1
CHECKED	L. V.	DF
RELEASED TO PRODUCTION	1/25/08	
BY	B.	
REVISION	1/25/08	
TITLE		
PROAIR, LLC		
28731 C.R. 6 ELKHART, IN 46514		
USAGE:		
SCHEMATIC, A/C EVAP. PLUMBING		
SUTPHEN		



PART NO. 40 000 300



REAR UNIT

INDICATES WATER FLOW DIRECTION

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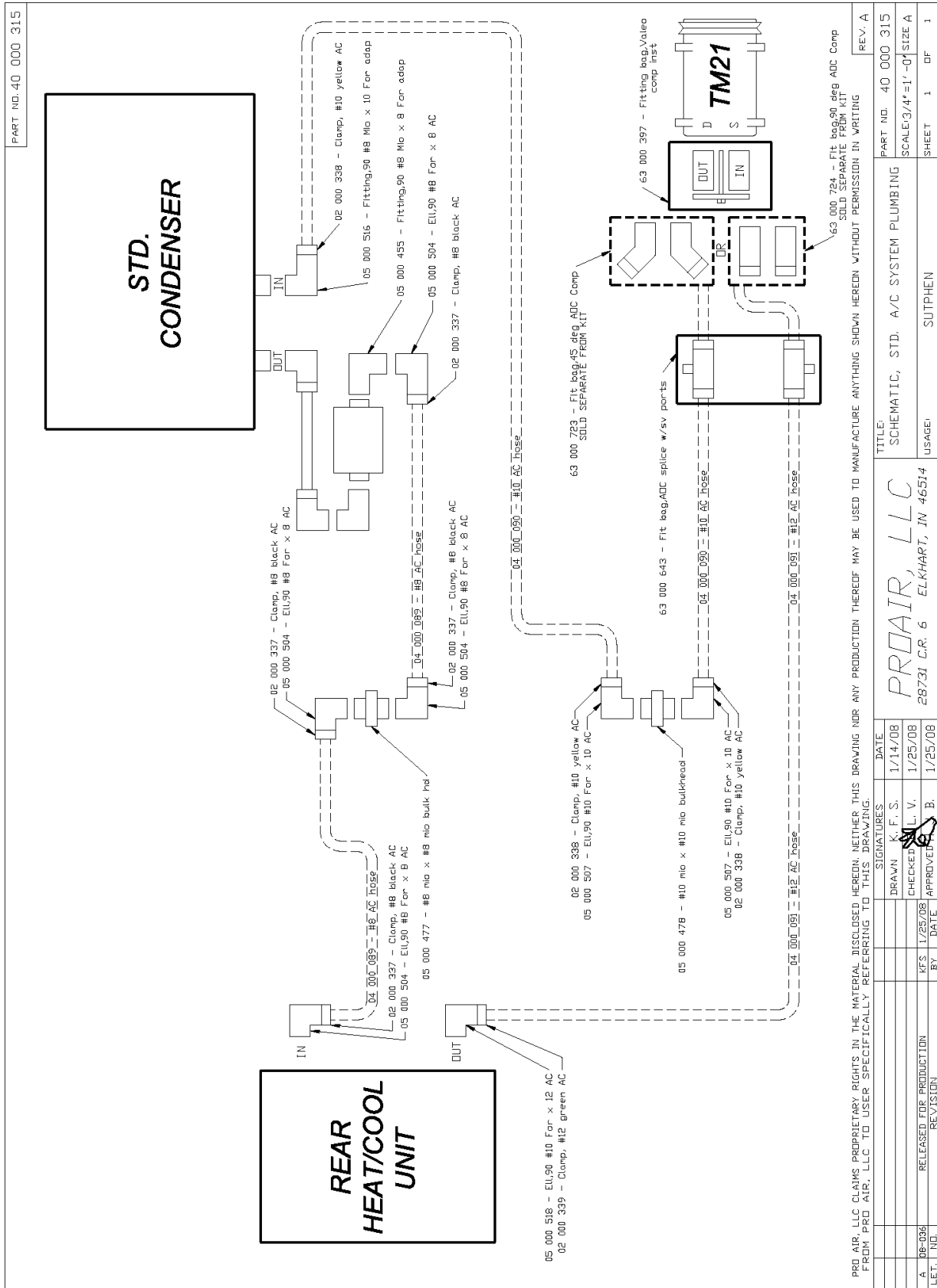
LET. NO.	REV.	DATE	BY	DESCRIPTION
A	08-036	1/25/08	GBH	RELEASED FOR PRODUCTION
		1/25/08		REVISION

SIGNATURES		DATE
DRAWN	G. J. H.	9/04/07
CHECKED	M. S.	1/25/08
APPROVED	[Signature]	1/25/08

TITLE:	SCHEMATIC, EVAP WATER PLUMBING
USAGE:	SUTPHEN

PART NO.	40 000 300	REV.	A
SCALE:	3/8" = 1" SIZE A	SHEET	1 OF 1

Components



PART NO. 40 000 315

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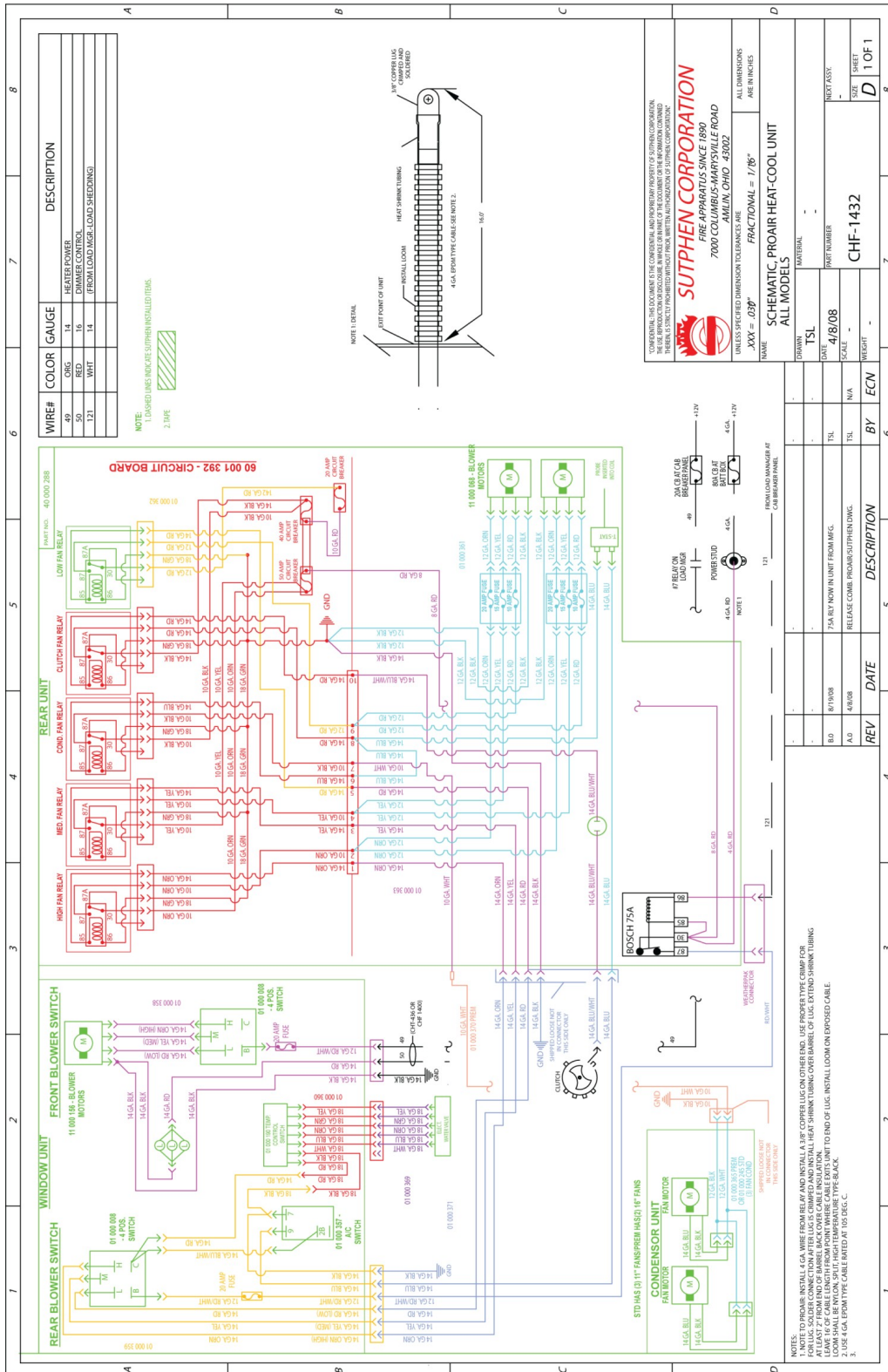
TITLE: SCHEMATIC, STD. A/C SYSTEM PLUMBING

USAGE: SUTPHEN

PROAIR, LLC
 28731 C.R. 6 ELKHART, IN 46514

PART NO. 40 000 315
 SCALE: 3/4" = 1' - 0" SIZE A
 SHEET 1 OF 1

Components



WIRE#	COLOR	GAUGE	DESCRIPTION
49	ORG	14	HEATER POWER
50	RED	16	DIMMER CONTROL
171	WHT	14	(FROM LOAD MGR. LOAD SHEDDING)

NOTE:
1. DASHED LINES INDICATE SUPPLEMENTAL ITEMS.
2. LAMP

SUTPHEN CORPORATION
FIRE APPARATUS SINCE 1890
7000 COLUMBIAN AVENUE, SUITE 100
MARIETTA, GA 30067

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NAME: SCHEMATIC, PROAIR HEAT-COOL UNIT
ALL DIMENSIONS ARE IN INCHES
FRACTIONAL = 1/16"
XXX = 03P

DATE: 4/8/08
SCALE: -
BY: TSL
ECN: D 1 OF 1

- NOTES:
- NOTE TO PROMOTE: INSTALL 14 GA. WIRE FROM RELAY AND INSTALL A 3/16" COPPER LUG ON OTHER END. USE PROPER TYPE CRIMP FOR AT LEAST 2" FROM END OF BARREL. BACK OVER BARREL OF LUG. EXTEND SHRINK TUBING TO END OF LUG. INSTALL LOOM ON EXPOSED CABLE. LOOMS SHALL BE INSTALLED ON BOTH ENDS OF CABLE. USE 1/2" DIA. THERMOPLASTIC TYPE BAR.
 - USE 14 GA. EPDM TYPE CABLE RATED AT 105 DEG. C.
 -

Components

3.4 Slip-Resistant Flooring



PRECISION TESTING LABORATORIES, INC.
 313 Hill Avenue, Nashville TN 37210
 Phone 615-254-3401 Fax 615-254-3488
 www.precisiontesting.com

Laboratory Report No. 87483
 15-Apr-10

Mr. John Gagliardi
 Technicon Acoustics
 4412 Republic Court
 Concord, NC 28027

Cc: n/a

PO # n/a

Item: 8" x 8" sample of rubber with foam backing

Identification: VBF-351-01-DT-00

Purpose: Slip Resistance to NFPA 1901-2009, Section 15.7.4

Test	Unit of Measure	Specimen Results				Average	Requirement	Pass / Fail
Slip Resistance								
NFPA 1901-09, Section 15.7.4								
ASTM F 1677, Brungraber Mark II								
Standard Neolite® Test Sensor								
		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>			
Side A	Wet	0.56	0.57	0.58	0.58	0.57	0.52	Pass
	Dry	1.10	1.05	1.06	1.05	1.07	0.47	Pass
Side B	Wet	0.63	0.67	0.62	0.58	0.63	0.52	Pass
	Dry	1.04	1.05	1.04	1.08	1.05	0.47	Pass
Side C	Wet	0.59	0.53	0.60	0.57	0.57	0.52	Pass
	Dry	1.08	1.10	1.08	1.10	1.09	0.47	Pass
Side D	Wet	0.66	0.56	0.61	0.56	0.60	0.52	Pass
	Dry	1.07	1.10	1.08	1.10	1.09	0.47	Pass

Note: The four sides of the test panel were identified with letters A through D on the back of the sample. Neolite was slipped four (4) times for each side.

Slip Resistance, Test Description
 Dry = Dry.
 Wet = 25 mls distilled water.

Requirement:
 NFPA 1901-09, Section 15.7.4.1 - All materials used for exterior surfaces designated as stepping, standing, and walking areas and all interior steps shall have a minimum slip resistance in any orientation of .52 when tested wet using the Brungraber Mark II tester in accordance with the manufacturer's recommendations.
 NFPA 1901-09, Section 15.7.4.2 - All materials used for interior floors shall have a minimum slip resistance in any orientation of .47 when tested dry using the Brungraber Mark II tested in accordance with the manufacturer's recommendations.

I certify that the above tests under my supervision were performed in accordance with the specification test requirements and that the reported results are true, valid and applicable to the samples tested. I further certify that these samples were the only samples tested from the lot of end items identified above.

Signed: Suzanne Piispanen
 Suzanne Piispanen, VP Operations

Signed: Don G. Roney
 Don G. Roney, Laboratory Manager

This report is limited to and related only to the particular instrument, material or other subject to which it refers. These test results can not be compared to results obtained using different methods or under different conditions. No representation is made that similar articles will be of like quality. Neither Precision Testing Laboratories, Inc (hereinafter "PTL") nor its employees, agents, or representatives, shall be held liable for any loss or damage resulting directly or indirectly from any failure, error or omission in testing, or in the reporting of test results. Precision Testing has no control, and assumes no responsibility for the tested product's functionality or use. Precision Testing's liability shall not exceed the fees paid for the testing reflected on this report. Precision Testing observes and maintains client confidentiality, and limits reproduction of this report, except in full, without prior approval of Precision Testing.
 gm



Chapter 4 2013 Cummins Engines and Aftertreatment Information

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Cummins Engines and Aftertreatment Information

CUMMINS ENGINES FOR 2021

FIRE AND EMERGENCY VEHICLES



ALWAYS ON



WHAT'S NEW FOR 2021?

Cummins L9, X12 and X15 engines are providing reliability and performance improvements while meeting EPA 2021 and Greenhouse Gas Standards.

By optimizing current technology, Cummins is delivering greater performance, resulting in minimized impact for OEM installations, extended maintenance intervals and improved reliability to ensure that your Cummins engine is Always On.

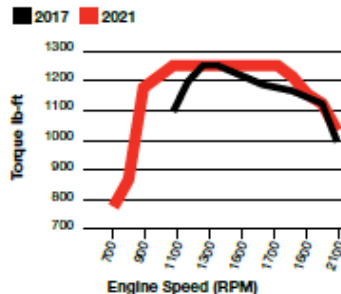


L9 – IMPROVED RELIABILITY AND PERFORMANCE

- Improved performance with peak torque over a wider RPM range
- Maintenance-free crankcase breather
- Increased oil drain intervals without increasing oil pan capacity
- Optional higher capacity oil pans for even longer oil drain intervals
- Maintained ratings of up to 450 hp and 1250 lb-ft of torque
- Improved reliability with higher temperature capability for head gasket and turbo actuator, oil pan rail sealing, air handling improvements and aftertreatment sensing technology improvements



L9 EPA 2017 AND 2021 TORQUE CURVES

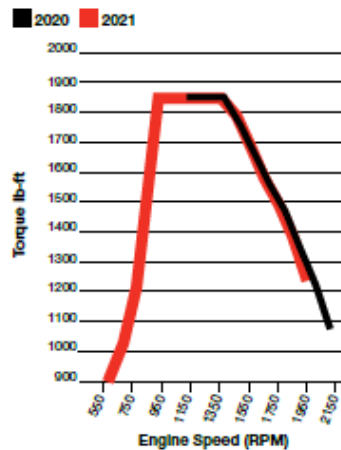


X12 – LEADING POWER-TO-WEIGHT RATIO

- Increased already class-leading filter change intervals
- Improved fuel economy
- Improvements to camshaft, crank seal and gear train to maximize uptime
- Maintained ratings of up to 500 hp and 1700 lb-ft of torque
- Optional air compressor resonator for reduced noise
- Maintained 400-600 lb weight savings from previous product



X15 EPA 2020 AND 2021 TORQUE CURVES



X15 – IMPROVED PERFORMANCE

- New 500 hp rating with 2000 RPM governed speed
- Reduced noise, especially at idle, with updated gear train
- Maintained best-in-class power with 605 hp
- Improved fault detection for greater engine protection
- Improved performance with peak torque over a wider operating range



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Cummins Engines and Aftertreatment Information

**“WE SHOULD DO
EVERYTHING IN
OUR POWER...”**

- CLESSIE CUMMINS

CUMMINS 2021 X15™ ENGINE PORTFOLIO



EFFICIENCY SERIES



PRODUCTIVITY SERIES



PERFORMANCE SERIES





THE POWER TO DELIVER. WORK GLOVES. HARD HAT. STEEL-TOED BOOTS.

X15 Productivity Series ratings are designed, built and optimized for vocational, specialty, multi-purpose and heavy-haul applications. Whether you're transporting raw materials in a quad-axle dump, moving 130,000 GVW down the interstate or need reliability in emergency applications, Cummins delivers the power you need – with torque to match.

Components have been carefully selected to match output characteristics and load demands. Ratings from 430-500 horsepower share proven hardware from the X15 Efficiency Series, while ratings from 565-605 hp utilize higher-capacity hardware from the X15 Performance Series.

Front-end PTO capability is another feature of the Productivity Series that makes these ratings the ideal choice for applications that require unique power demands.

With available ratings of up to 605 hp and 2050 lb-ft of peak torque, the X15 Productivity Series has the highest power output of any on-highway engine in North America, with a longer power curve than any engine in its class – making it the best choice for heavy-haul applications where having massive pulling power is the most mission-critical factor.



X15 PRODUCTIVITY SERIES SPECIFICATIONS

ADVERTISED HORSEPOWER	430 - 605 hp	321 - 451 kW
PEAK TORQUE	1650 - 2050 lb-ft	2237 - 2779 N • m
GOVERNED SPEED	2000 - 2100 RPM	
CLUTCH ENGAGEMENT TORQUE	1000 lb-ft	1356 N • m
NUMBER OF CYLINDERS	6	
SYSTEM WEIGHT	3152 lb	1430 Kg
ENGINE (DRY)	2961 lb	1343 Kg
AFTERTREATMENT SYSTEM	191 lb	87 Kg



Cummins Engines and Aftertreatment Information

PROVEN COMPONENTS. PROVEN TECHNOLOGY.

- **VGT Turbocharger** – Highly reliable and precise design for rapid acceleration
- **XPI Fuel System** – High pressure enables multiple injection events per cycle for industry-leading fuel economy and quieter operation
- **Single Module™ Aftertreatment System** – A compact and lightweight system that offers increased ash capacity for industry-leading Diesel Particulate Filter maintenance intervals of up to 800,000 miles and improved serviceability compared to modular systems
- **Fleetguard Fuel And Lube Filters** – Superior holding capacity provides better protection and enables longer service intervals
- **High-Capacity Electronic Control Module** – This allows full integration of data inputs from all subsystems, optimizing performance
- **Cummins Engine Brake** – With up to 600 braking horsepower, it's the most powerful in the industry. Stronger braking capacity reduces wear on service brakes and replacement costs

CUMMINS WARRANTY – CONFIDENCE IN WRITING.

The base engine warranty coverage* on Cummins X15 engines includes parts and labor on warrantable failures for both the engine and aftertreatment system – with no deductible. Cummins base warranty coverage is good for 2 years/250,000 miles (402,336 km).

Cummins wide variety of extended coverage plans allows you to make financial projections with complete confidence, with protection plans for up to 7 years or up to 600,000 miles (804,672 km) on registered parts and labor. Cummins extended coverage plans are available covering internal components and major engine systems, including the turbocharger, water pump and fuel injectors, air compressor, fuel pump and select engine sensors. New Protection Plan Plus and aftertreatment extended coverage plans allow customers to add coverage for additional components beyond what is covered by standard extended coverage plans.

*Covers defects in Cummins materials or factory workmanship.

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Truck Maintenance and Operation X15

Quick Reference Guide

For ease of identification, important characteristics of this engine are:

- Single camshaft
- XPI fuel system
- Single Module DPF and SCR aftertreatment system
- ECM 2350 (this control module incorporates DEF dosing control)
- Variable Geometry Turbocharger (VGT)
- Exhaust Gas Recirculation system (EGR)

Maintenance Intervals

Duty Cycle (mpg)	Severe (3-4.9)	Short Haul (5-5.9)	Normal (6-6.9)	Light (7+)
	Miles / Hours / Months			
Oil Drain Intervals (ODI)*:	25,000 / 500 / 12	40,000 / 500 / 12	50,000 / 500 / 12	60,000 / 500 / 12
With Oil Guard Program				Up to 80,000
Fuel Filter(s):	25,000 / 500 / 12	40,000 / 500 / 12	50,000 / 500 / 12	60,000 / 500 / 12
Check SCA levels:	30,000 / 1,000 / 6			
Diesel Particulate Filter ¹ :	250,000-400,000	400,000-600,000	600,000-800,000	
Coolant Filter (if equipped):	250,000 / 6,000 / 48			
Coolant System Flush**:	250,000 / 6,000 / 48			
DEF Filter:	300,000 / 6,750 / NA			
Engine Brake Assembly:	500,000 / 10,000 / 60			
Overhead Adjustment:	500,000 / 10,000 / 60			

*Add 5,000 miles to Severe, Short Haul and Normal ODI when using Valvoline Premium Blue
Add 10,000 miles to Light duty when using Valvoline Premium Blue
**Interval can be extended with long-life coolant. Follow supplier recommendations

Maintenance Information

Caution

- Never crack a high pressure fuel line with the engine running. With the engine stopped, relieve pressure only at the fuel pump inlet line fitting on the side of the rail.
- When changing the engine mounted fuel filter, never pre-fill by pouring fuel in the center hole (clean side).
- Recommended procedure is to install filter dry and cycle the key switch on 3-4 times and allow the priming pump to fill the filter.
- If you have to pre-fill the filter, use the smaller outside holes (dirty side) and let the fuel flow through the filter media to provide clean, filtered fuel to the clean side.
- Synthetic or Semi-Synthetic oils may be beneficial for extreme arctic or extreme heat conditions but DO NOT EXTEND Oil Drain Intervals with synthetic or semi-synthetic oils.
- 10W-30 and 15W-40 oils meeting Cummins specifications may be used in these engines.

Check the oil pressure indicators, temperature indicators, warning lights, and other gauges daily to make sure they are operational.

Check the oil pressure, coolant temperatures, DEF level, and other engine parameters daily via the OEM instrument panel or gauge cluster to make sure they are operational. Check the instrument panel regularly for any alarm messages. Take appropriate action to rectify the alarm condition or contact your nearest Cummins Distributor.

Electronic Features

For best fuel economy and performance, take advantage of the following electronic engine features. Set the parameters to meet your needs:

- ADEPT for X15 Efficiency Series paired with Automated Manual Transmissions (AMT)
- Predictive Cruise Control
- Road Speed Governor and Cruise Control
- Idle Control
- Load-Based Speed Control
- Gear Down Protection

For guidance in parameter settings:
<https://www.cummins.com/support/digital-products-and-services-support/powerspec-support>

¹DPF Cleaning or Change Intervals

X15 engines incorporate an ash load monitor that the customers can rely on to determine when the DPF cleaning is due. The driver will be notified by the Check Engine Lamp or Amber Warning Lamp, which will flash for 30 seconds after the key switch is set to ON.

If the aftertreatment DPF has been removed for cleaning and is considered reusable (according to the Aftertreatment Diesel Oxidation Catalyst and Aftertreatment Diesel Particulate Filter Reuse Guidelines, Bulletin 4021600), the aftertreatment DPF should be returned to Cummins Inc. to be exchanged.

Cummins Inc. does not endorse localized air cleaning machines for ash removal. All DPFs requiring ash cleaning should be returned to a Cummins Inc. Authorized Repair Location in exchange for a New/Recon DPF.

Cummins Engines and Aftertreatment Information**Truck Maintenance and Operation
X15****Quick Reference Guide****Lubricating Oil and Cooling Systems****Specifications****Preferred Oil Filter**

Fleetguard Part Number LF1400NN

Oil PressureAt Idle (min at operating temperature) 103 kPa [15 psi]
At No-Load Governed Speed 241 to 278 kPa [35 to 40 psi]**Oil Pan Drain Fitting Size**

M27x2 STOR 41 lb-ft Torque

Oil Change Capacity (Pan and Filter)Stamped Steel 43.4 liters [11.5 gal]
Aluminum (wedge type cast) 45.4 liters [12 gal]
Aluminum (rear center sump) 41.6 liters [11 gal]**Cooling System****Specifications****Coolant Capacity (Engine Only)**

26.5 liters [28qt]

Normal Coolant TemperatureGreater than 180°F [82.2°C]
Fan on at 210°F [99.0°C]
High Temp Alert 225°F [107.2°C]**Minimum Recommended Pressure Cap Range**

90 kPa [13 psi]

Fuel System**Specifications****Spin-On Pressure Fuel Filter**

Fleetguard Part Number FF5825NN

Spin-On Suction Fuel Filter

Consult Owner's Manual for OEM Filter Housing

Maximum Pressure Drop across Fuel Filter

69 kPa [10 psi]

Maximum Fuel Drain Line PressureHigh Idle 102 mm-Hg [4 in-Hg]
Loaded Condition 203 mm-Hg [8 in-Hg]**Cooling System Information**

Cummins Inc. recommends using either a 50/50 mixture of good quality water and fully formulated antifreeze, or fully formulated coolant when filling the cooling system. The fully formulated antifreeze or coolant must meet Cummins Engineering Standard (CES)14603 specifications.

Most coolants which meet American Society of Testing and Materials (ASTM) D6210 also meet CES14603.

However, some OAT coolants such as Shell™ Rotell ELC, Chevron™, Texaco™, and Delo ELC and their private label counterparts meet ASTM D6210, but do not meet the elastomer compatibility test of CES14603. These coolants are acceptable for use, assuming the OEM added silicate at initial fill. Refer to Bulletin 3666132, Cummins® Coolant Requirements and Maintenance, Section 3, Extended Service Interval, for more details.

Good-quality water is important for cooling system performance. Excessive levels of calcium and magnesium contribute to scaling problems, and excessive levels of chlorides and sulfates cause cooling system corrosion.

Diesel Exhaust Fluid

It is unlawful to tamper with or remove any component of the aftertreatment system. It is also unlawful to use a Diesel Exhaust Fluid (DEF) that does not meet the specifications provided or to operate the vehicle/equipment with no DEF. Cummins Inc. is not responsible for failures or damage resulting from what Cummins Inc. determines to be abuse or neglect.

In compliance with the regulatory agencies (EPA and CARB), the Cummins engine system incorporates on board diagnostics and electronic controls to monitor and ensure that tail pipe emissions requirements are met. A DEF lamp will notify the driver when the DEF tank level is running low and/or the quality of the DEF in the tank is not meeting specifications. Failure to promptly refill or replace DEF in the tank will trigger an inducement sequence, limiting engine torque and, eventually, vehicle speed to 5 mph.

For further details and discussion of DEF for Cummins engines, refer to Diesel Exhaust Fluid Specifications for Cummins Selective Catalytic Reduction Systems, Service Bulletin Number 4021566.

For engines using SCR operating in the United States and Canada, it is also strongly recommended that the DEF used be certified by the American Petroleum Institute (API). This would be indicated by a symbol on the container/dispensing system.

To ensure the correct DEF is used, Cummins Inc. recommends the use of Fleetguard® Diesel Exhaust Fluid. Fleetguard® carries different quantity options from small to bulk containers.

For complete maintenance recommendations and guidelines, refer to EPA 2017 X15 CM2350 Owner's Manual, Bulletin 5411183 and EPA 2017 X15 CM2350 Operation and Maintenance Manual, Bulletin 5411182.



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Truck maintenance and operation

L9 (EPA 2021)

QUICK REFERENCE GUIDE



For ease of identification, important characteristics of this engine are:

- Single camshaft
- XPI fuel system
- Single module DPF and SCR aftertreatment system
- ECM 2450 (incorporates DEF dosing control)
- Variable geometry turbocharger (VGT)
- Exhaust gas recirculation system (EGR)

MAINTENANCE INTERVALS

Oil drain interval*:		FUEL CONSUMPTION			
		Extreme (< 2.9 mpg) (< 1.2 km/liter)	Severe (3 - 4.9 mpg) (1.3 - 2.1 km/liter)	Normal (5 - 7.9 mpg) (2.1 - 3.3 km/liter)	Light (> 8 mpg) (> 3.4 km/liter)
Oil capacity: ≥ 29 quarts	Miles	6,000	15,000	30,000	50,000
	Kilometers	9,600	24,000	48,000	80,000
	Hours	1,500			
	Months	18			
Oil capacity: < 29 quarts	Miles	5,000	12,500	25,000	40,000
	Kilometers	8,000	20,000	40,000	64,000
	Hours	1,000			
	Months	18			
Fuel filter:		50,000 miles (80,000 km) / 1,500 hours / 18 months			
Crankcase ventilation:		Maintenance free			
Overhead adjustment:		150,000 miles (240,000 km) / 4,500 hours			
DPF clean:		200,000 miles (320,000 km) / 6,500 hours			
DEF filter:		200,000 miles (320,000 km) / 6,500 hours			

*Requires the use of LF14009 Oil Filter. Consult the relevant procedures in the Owners or Maintenance and Operation manuals.

MAINTENANCE INFORMATION

CAUTION

- **Never** loosen a high-pressure fuel line with the engine running. With the engine stopped, relieve pressure **only** at the fuel pump inlet line fitting on the side of the rail.
- Drain water from the fuel filter daily. Follow procedure [006-075](#) when the Water-In-Fuel (WIF) sensor is activated.
- When changing the engine mounted fuel filter, **never** pre-fill by pouring fuel in the center hole (clean side). Recommended procedure is to install filter dry and turn the key switch on and off 3-4 times and allow the priming pump to fill the filter.
- If you have to pre-fill the filter, use the smaller outside holes (dirty side) and let the fuel flow through the filter media to provide clean, filtered fuel to the clean side.
- Synthetic or Semi-Synthetic oils may be beneficial for extreme arctic or extreme heat conditions but **DO NOT EXTEND** Oil Drain Intervals with synthetic or semi-synthetic oils.
- Oils complying with CES 200B6 must be used, 10W30 or 15W40 is recommended. For areas with cooler ambient temperatures, please consult the owner's manual for additional information.

Check the oil pressure, coolant temperatures, WIF sensor, DEF level, and other engine parameters daily via the OEM instrument panel or gauge cluster to make sure they are operational.

Check the instrument panel regularly for any alarm messages. Take appropriate action to rectify the alarm condition or contact your nearest authorized Cummins Service and Sales location.

ELECTRONIC FEATURES

For best fuel economy and performance, take advantage of the following electronic engine features, setting the parameters to meet your needs:

- Road Speed Governor
- Cruise Control
- Idle Control
- Gear Down Protection

For guidance in parameter settings:

<https://www.cummins.com/parts-and-service/digital-products-and-services/powerspec>

Cummins Engines and Aftertreatment Information

Truck maintenance and operation L9 (EPA 2021)

QUICK REFERENCE GUIDE

DPF CLEANING OR CHANGE INTERVALS

Cummins Inc. recommends aftertreatment DPFs that require ash cleaning to be returned to a Cummins authorized repair location for replacement. Unauthorized cleaning methods are not to be used to clean the aftertreatment DPF.

The Aftertreatment Diesel Oxidation Catalyst and Aftertreatment Diesel Particulate Filter Reuse Guidelines, Bulletin [4021600](#), can be used to determine if the aftertreatment DPF is suitable for use.

LUBRICATING OIL SYSTEMS

SPECIFICATIONS

Oil pressure

Low idle (min allowed)	69 kPa (10 psi)
At rated speed (min allowed)	207 kPa (30 psi)

Oil capacity (standard pan)

Pan only	18.9 – 22.7 liters (20 – 24 qt)
Total system	21.74 – 25.54 liters (27 qt)

Oil capacity (high capacity)

Pan only	24.6 – 28.4 liters (26 – 30 qt)
Total system	27.44 – 31.24 liters (33 qt)

Oil filter capacity

2.84 liters (3 qt)

COOLING SYSTEM

SPECIFICATIONS

Coolant capacity

15.6 liters (16.5 qt)

Normal coolant temperature range

175 – 203°F (79 – 95°C)

Maximum top tank temperature

225°F (107°C)

Minimum recommended pressure cap range

90 kPa (13 psi)

FUEL SYSTEM

SPECIFICATIONS

Maximum pressure drop across fuel filter

80 kPa (11.7 psi)

Maximum fuel return line pressure

30 kPa (4.3 psi)

COOLING SYSTEM INFORMATION

Cummins recommends using either a 50/50 mixture of good quality water and fully formulated antifreeze, or fully formulated coolant when filling the cooling system. The fully formulated antifreeze or coolant must meet Cummins Engineering Standard (CES)14603 specifications.

Most coolants which meet American Society of Testing and Materials (ASTM) D6210 also meet CES14603.

However, some OAT coolants such as Shell™ Rotell ELC, Chevron™, Texaco™, and Delo ELC and their private label counterparts meet ASTM D6210, but do not meet the elastomer compatibility test of CES14603. These coolants are acceptable for use, assuming the OEM added silicate at initial fill. Refer to bulletin [3666132](#), Cummins® Coolant Requirements and Maintenance, Section 3, Extended Service Interval, for more details.

DIESEL EXHAUST FLUID

It is unlawful to tamper with or remove any component of the aftertreatment system. It is also unlawful to use a Diesel Exhaust Fluid (DEF) that does not meet the specifications provided or to operate the vehicle/equipment with no DEF. Cummins is not responsible for failures or damage resulting from what Cummins determines to be abuse or neglect.

In compliance with the regulatory agencies (EPA and CARB), the Cummins engine system incorporates on board diagnostics and electronic controls to monitor and ensure that tail pipe emissions requirements are met. A DEF lamp will notify the driver when the DEF tank level is running low and/or the quality of the DEF in the tank is not meeting specifications. Failure to promptly refill or replace DEF in the tank will trigger an inducement sequence, limiting engine torque and, eventually, vehicle speed to 5 mph.

For further details and discussion of DEF for Cummins engines, refer to Diesel Exhaust Fluid Specifications for Cummins Selective Catalytic Reduction Systems, bulletin [4021565](#).

For engines using SCR operating in the United States and Canada, it is also strongly recommended that the DEF used be certified by the American Petroleum Institute (API). This would be indicated by a symbol on the container/dispensing system.

To ensure the correct DEF is used, Cummins recommends the use of Fleetguard® Diesel Exhaust Fluid. Fleetguard® carries different quantity options from small to bulk containers.

For complete maintenance recommendations and guidelines, refer to EPA 2021 L9 CM2450 Owner's Manual, Bulletin [5613075](#) and EPA 2021 L9 CM2450 Operation and Maintenance Manual, Bulletin [5613076](#).



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4.1 Cummins Engines L9 for EPA 2017



VGT® Turbocharger from Cummins Turbo Technologies

The patented design is widely recognized as an industry performance leader. Electronic actuation improves precision and responsiveness. The VGT Turbo is a key element in providing exceptional fuel economy and braking horsepower.



Connected Diagnostics™

Wirelessly connects your engine to Cummins through a telematics device for immediate diagnosis of a fault alert. Provides a clear recommendation for continued operation, or the need for service, within seconds.

XPI Fuel System From Cummins Fuel Systems

Delivers superior performance even in lower engine rpm ranges. Enables multiple injection events per cycle, for improved fuel efficiency with quieter, smoother operation.

Single Module Aftertreatment From Cummins Emission Solutions

Combines high-efficiency SCR, a more reliable dosing unit and a DPF into a single flow-through unit. It's up to 70 percent smaller, so it's easier to install, and as much as 30 percent lighter than the aftertreatment units it replaces. Better heat management improves fuel efficiency and minimizes periodic maintenance.



Fuel And Lube Filters From Cummins Filtration

Flotguard® filters protect against corrosion and contaminants with innovative technology, including NanoNet® media, which provides 10 times better protection than conventional fuel filters.



Single High-Capacity Electronic Control Module (ECM)

A higher capacity offers faster processing of more information. Fully integrated control over the engine and aftertreatment system for optimized performance, and an improved engine lamp strategy.



The L9 continues to be fully compliant with On-Board Diagnostics requirements, and meets 2017 U.S. Environmental Protection Agency (EPA) and National Highway Traffic Safety Administration (NHTSA) greenhouse gas GHG and fuel-economy regulations.

▼ **Cummins Engines and Aftertreatment Information**

Cummins L9 Features And Benefits

- **Designed for Fire Service** – Customized design includes a fire pump governor interface, and no derates for emissions-related faults.
- **Proven Performance** – Building on a legacy of over 5 million L Series engines built, with 27 years of continual improvement, for total confidence.
- **Best Power-to-Weight Ratio in Emergency Vehicles** – Lighter weight allows for flexibility in cab features.
- **Single Module™ Aftertreatment** – Up to 30 percent less weight with up to 70 percent less space than previous designs; UL2 dosing system improves reliability and efficiency.
- **Heavy-Duty Engine Components** – Replaceable wet cylinder liners and roller followers, for added durability and longevity.
- **VGT® Turbocharger** – Delivers faster engine warm-up, enhanced engine braking horsepower and improved throttle response.
- **Cummins on Every™ Corner** – Over 3,500 authorized locations across North America to support parts and service needs.
- **Heavy-Duty Warranty** – 5-year/100,000-mile coverage, for peace of mind.
- **Integrated Solutions** – Simplified single-source service by coupling with Cummins Onan® hydraulic or PTO generators.
- **Cummins Care** – Call 1-800-DIESELS™ (1-800-343-7357) for answers to your questions and support for your service needs.
- **Connected Solutions™** – Combine with QuickServe® Online Mobile, Cummins Fault Advisor and Connected Diagnostics™, for even better support.



L9 Ratings

Engine Model	Advertised HP (kW)	Governed Speed	Peak Torque LB-FT (N•M) @ RPM
L9 450	450 (336)	2200	1250 (1695) @ 1400
L9 400	400 (298)	2200	1250 (1695) @ 1400
L9 380	380 (283)	2200	1150 (1559) @ 1400
L9 370	370 (276)	2100	1250 (1695) @ 1400
L9 350	350 (261)	2200	1000 (1356) @ 1400
L9 330	330 (246)	2200	1000 (1356) @ 1400
L9 300	300 (224)	2200	860 (1166) @ 1300
L9 270	270 (201)	2200	800 (1085) @ 1300

L9 Specifications

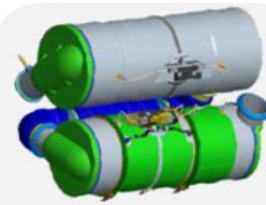
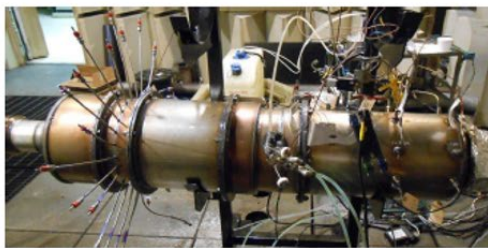
Idle Speed	700-800 rpm	
Engine Braking Horsepower	Up to 370 hp @ 2600 rpm	
No Load Governed Speed	2400 rpm	
Number of Cylinders	6	
Engine Weight (Dry)	1,695 LB	769 KG
(Wet)	1,770 LB	803 KG
Aftertreatment Weight	132-179 LB	60-81 KG
Injection Pressure	32,000 PSI	

Cummins Engines and Aftertreatment Information

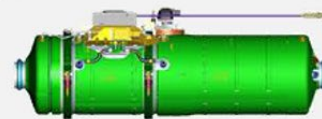
2017 Change Overview (B6.7, L9, X15 aftertreatment)

Single Module Aftertreatment

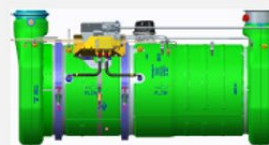
- Reduced weight
- Reduced space claim
- Reduced proliferation
- Eliminates ancillary piping (DPF to SCR)
- Scalable architecture → MR/HD, LHP/MHP/HHP
- Emissions and OBD Robustness



2013 Switchback Aftertreatment



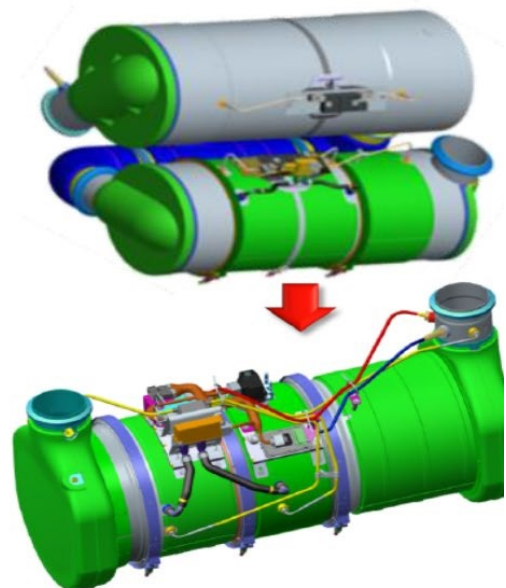
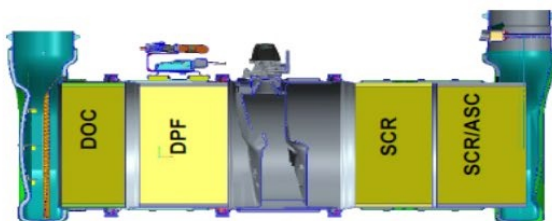
2017 Single Module Aftertreatment



2017 Single Module Aftertreatment

Single Module Aftertreatment

- Compared to 2013, SM Reduces:
 - Space Claim 60%
 - Weight up to 40%
- Improves emission and OBD robustness via reduced variation
- Reduces installation proliferation





L9 Maintenance Intervals

Maintenance Item	Miles/Kilometers	Hours	Months
Oil and Filter	15,000 MI 24,000 KM	500	6
Fuel Filter	15,000 MI 24,000 KM	500	6
Overhead Adjustment	150,000 MI 240,000 KM	5,000	48
Coalescing Filter	60,000 MI 96,000 KM	2,000	

Consult your Operation and Maintenance Manual for more information.

Cummins Engines and Aftertreatment Information

TAILOR-MADE SOLUTION.

Cummins X12 is the productivity champion thanks to its optimization for weight-sensitive applications and regional routes. Cummins recognizes that one size doesn't fit all. That's why we also offer the X15™ Productivity Series and X15 Efficiency Series for interstate transit applications. Therefore you can choose the power solution that's best tailored for your application with ratings ranging from 350-500 hp with 1700 lb-ft peak torque for the X12 and 400-605 hp with 1450 to 2050 lb-ft peak torque for the X15.

MAINTENANCE INTERVALS

ITEM	VOCATIONAL	SEVERE 3-4.9 mpg	SHORT-HAUL 5.0-5.9 mpg	NORMAL 6.0-6.9 mpg	LIGHT >7.0 mpg
Oil Drain Interval*	1500 hrs. / 18 months	40,000 MI 64,000 Km	50,000 MI 80,000 Km	60,000 MI 97,000 Km	75,000 MI 120,000 Km
Oil Drain with Valvoline PB	1500 hrs. / 18 months	45,000 MI 72,000 Km	55,000 MI 89,000 Km	65,000 MI 105,000 Km	80,000 MI 130,000 Km
Oil Drain with OilGuard™	Extensions available	Extensions available	Extensions available	Extensions available	Up to 100,000 MI Up to 160,000 Km
Fuel Filter**	1500 hrs.	30,000 MI 48,000 Km	40,000 MI 64,000 Km	50,000 MI 80,000 Km	60,000 MI 97,000 Km
Fuel Filter Extensions***	—	40,000 MI 64,000 Km	50,000 MI 80,000 Km	60,000 MI 97,000 Km	75,000 MI 120,000 Km
DPF Ash Maintenance****	12,000- 18,000 hrs.	300,000- 400,000 MI 480,000- 640,000 Km	300,000- 400,000 MI 480,000- 640,000 Km	400,000- 600,000 MI 640,000- 960,000 Km	600,000- 800,000 MI 960,000- 1,300,000 Km

* If combined percent idle time plus power takeoff (PTO) time is greater than 40% for Short-haul, Normal or Light Intervals, use the next lower drain interval.

** Less than 3 MPG ODI and Fuel Filter at 4,500 miles.

*** A remote mount filter using FF597-1NN is recommended for filter extensions.

**** Cummins recommends using Cummins Pleinmanufactured DPF at the DPF ash maintenance interval. Users can experience extended DPF ash maintenance using the DPF maintenance fault lamp (FC5383).

LESS WEIGHT. MORE FREIGHT.

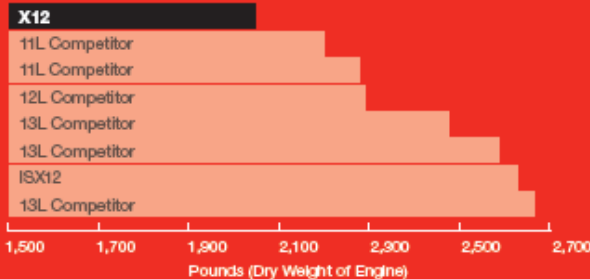
At up to 600 lbs. lighter than other 11-13L engines, the X12 offers customers increased payload.

BETTER FUEL ECONOMY IN REGIONAL HAUL CYCLES WITH INTEGRATED POWERTRAIN FEATURES.

Up to 2.5% better fuel economy over the EPA 2018 X12, and up to 8.5% fuel economy improvement over the ISX12.

NO COMPROMISE.

Cummins X12 gives you the best of all worlds with the power of a 13L engine but lighter than an 11L. It's the absolute winner for bulk haulers with best-in-class payload and 90% of peak torque available in under 1.5 seconds. Durability wasn't sacrificed by the weight savings thanks to analysis-led optimization.

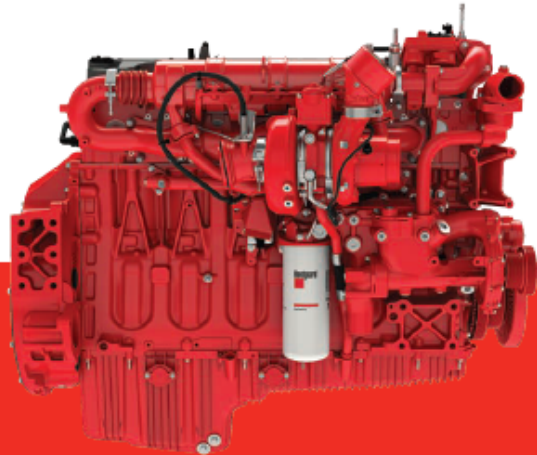


X12™

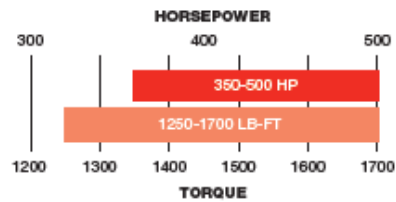




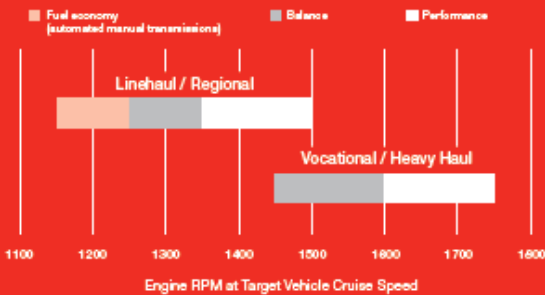
X12™



- Ideal for growth markets: regional haul, intermodal and vocational applications
- The productivity champion, with industry-leading power-to-weight ratio
- Performance and transient response that impresses 15L drivers
- Lower operating costs: fuel-efficient from idle to interstate through low-friction design
- Compatible with a broad choice of transmissions: fully automatic, AMT and manual



GEARING AND AXLE RECOMMENDATIONS

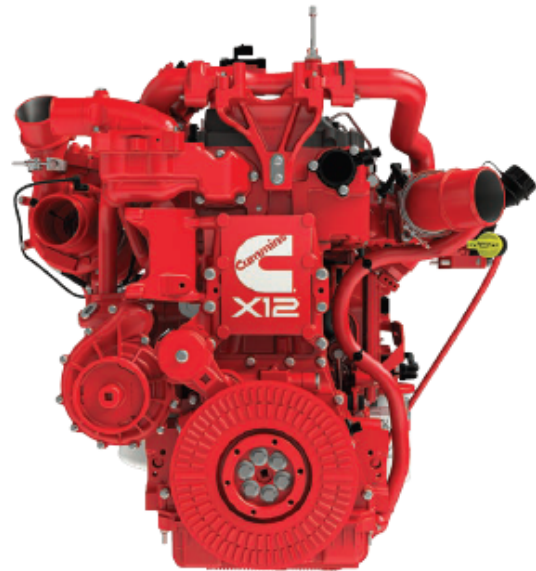


	Fuel Economy	Balanced	Performance
Efficiency series (Regional haul)	1150-1250 RPM*	1250-1350 RPM	1350-1500 RPM
Productivity series (Vocational)	Not Available	1450-1600 RPM	1600-1750 RPM

*Automated Manual Transmissions only

CUSTOMER SUPPORT IS ALWAYS ON WITH CUMMINS CARE.

We are here to make your life easier by creating a seamless support experience. We are equipped with quality tools and innovative resources to address issues with varying degrees of complexity. We deliver complete solutions while working with one of over 3,700 authorized parts and service locations. Visit care.cummins.com or call 1-800-CUMMINS™ to connect with a Cummins Care expert.



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Cummins Engines and Aftertreatment Information

Truck maintenance and operation X12

QUICK REFERENCE GUIDE



For ease of identification, important characteristics of this engine are:

- Single camshaft
- XPI fuel system
- Single module DPF and SCR aftertreatment system
- ECM 2350 (this control module incorporates DEF dosing control)
- Variable geometry turbocharger (VGT)
- Exhaust gas recirculation system (EGR)

MAINTENANCE INTERVALS

DUTY CYCLE (MPG) ²	VOCATIONAL	SEVERE (3-4.9 MPG) ¹	SHORT HAUL (5-5.9 MPG)	NORMAL (6-6.9 MPG)	LIGHT (>7 MPG)
Oil drain intervals (ODI)**	1,500 hours / 18 months	40,000 miles	50,000 miles	60,000 miles	75,000 miles
with OilGuard™ program	Extensions available				Up to 100,000
Fuel filter(s)	1,500 hours / 12 months	30,000 miles	40,000 miles	50,000 miles	60,000 miles
Check SCA levels	1,000 hours / 6 months	30,000 miles			
Diesel particulate filter ¹	12,000-16,000 hrs	300,000-400,000 miles		400,000-600,000 miles	600,000-800,000 miles
Coolant system flush	6,000 hours / 24 months	250,000 miles			
DEF filter	6,750 hours	300,000 miles			
Engine brake assembly	6,750 hours	300,000 miles			
Overhead adjustment	6,750 hours	300,000 miles			

** If idle and PTO time exceed 40%, move down one "duty cycle" bucket.

** Oil drain intervals can be extended by 5,000 miles with the use of Valvoline Premium Blue.

** If less than 3 miles per gallon, follow the extreme duty cycle recommendations of 4,500 miles / 1,000 hours / 12 months.

¹ Extreme severe is any application with less than 3 mpg. Consult your owners manual in this situation.

MAINTENANCE INFORMATION

CAUTION

- Never crack a high pressure fuel line with the engine running. With the engine stopped, relieve pressure only at the fuel pump inlet line fitting on the side of the rail.
- When changing the engine mounted fuel filter, never pre-fill by pouring fuel in the center hole (clean side).
- Recommended procedure is to install filter dry and cycle the key switch on 3-4 times and allow the priming pump to fill the filter.
- If you have to pre-fill the filter, use the smaller outside holes (dirty side) and let the fuel flow through the filter media to provide clean, filtered fuel to the clean side.
- Synthetic or semi-synthetic oils may be beneficial for extreme arctic or extreme heat conditions but DO NOT EXTEND oil drain intervals with synthetic or semi-synthetic oils.
- 10W-30 and 15W-40 oils meeting Cummins specifications may be used in these engines.
- Check the oil pressure indicators, temperature indicators, warning lights, and other gauges daily to make sure they are operational.
- Check the oil pressure, coolant temperatures, DEF level and other engine parameters daily via the OEM instrument panel or gauge cluster to make sure they are operational. Check the instrument panel regularly for any alarm messages. Take appropriate action to rectify the alarm condition or contact your nearest Cummins distributor.

ELECTRONIC FEATURES

For best fuel economy and performance, take advantage of the following electronic engine features. Set the parameters to meet your needs:

- ADEPT for X12 Efficiency Series paired with automated manual transmissions (AMT)
- Road speed governor and cruise control
- Idle control
- Load-based speed control
- Gear down protection

For guidance in parameter settings:

<https://www.cummins.com/support/digital-products-and-services-support/powerspec-support>



Truck maintenance and operation X12

QUICK REFERENCE GUIDE

DIESEL PARTICULATE FILTER (DPF) CLEANING

X12 engines incorporate an ash load monitor that the customers can rely on to determine when the DPF cleaning is due. The driver will be notified by the check engine lamp or amber warning lamp, which will flash for 30 seconds after the key switch is set to ON.

If the aftertreatment DPF has been removed for cleaning and is considered reusable (according to the Aftertreatment Diesel Oxidation Catalyst and Aftertreatment Diesel Particulate Filter Reuse Guidelines, bulletin [4021600](#)), the aftertreatment DPF should be returned to Cummins to be exchanged.

Cummins does not endorse localized air cleaning machines for ash removal. All DPFs requiring ash cleaning should be returned to a Cummins authorized repair location in exchange for a New/Recon DPF.

LUBRICATING OIL AND COOLING SYSTEMS SPECIFICATIONS

Preferred oil filter

Fleetguard part number LF14000NN

Oil pressure

At idle (min at operating temperature) 103 kPa (15 psi)
At no-load governed speed 241 to 276 kPa (35 to 40 psi)

Oil pan drain fitting size

M22x1.5 21 lb-ft torque (N*m)

Oil change capacity (pan and filter)

Composite 42.3 liters (11.17 gal)
Cast aluminum 42.3 liters (11.17 gal)

COOLING SYSTEM

SPECIFICATIONS

Coolant capacity (engine only)

21.4 liters (22.6 qt)

Minimum recommended operating temp

Greater than 158°F (70°C)

Minimum recommended pressure cap

Minimum recommended 103 kPa (15 psi)

FUEL SYSTEM

SPECIFICATIONS

Preferred spin-on pressure fuel filter

Fleetguard part number FF5825NN

Spin-on suction fuel filter

Consult owner's manual for OEM filter housing

Maximum pressure drop across fuel filter

241 kPa (35 psi)

COOLING SYSTEM INFORMATION

Cummins recommends using either a 50/50 mixture of distilled water and fully formulated antifreeze, or fully formulated coolant when filling the cooling system. The fully formulated antifreeze or coolant must meet Cummins Engineering Standard (CES)14603 specifications.

Most coolants which meet American Society of Testing and Materials (ASTM) D6210 also meet CES14603.

However, some OAT coolants such as Shell™ Rotell ELC, Chevron™, Texaco™, and Delo ELC and their private label counterparts meet ASTM D6210, but do not meet the elastomer compatibility test of CES14603. These coolants are acceptable for use, assuming the OEM added silicate at initial fill. Refer to bulletin [3666132](#), Cummins® Coolant Requirements and Maintenance, Section 3, Extended Service Interval, for more details.

Follow the OEM factory fill coolant guidelines for coolant system maintenance.

DIESEL EXHAUST FLUID

It is unlawful to tamper with or remove any component of the aftertreatment system. It is also unlawful to use a diesel exhaust fluid (DEF) that does not meet the specifications provided or to operate the vehicle/equipment with no DEF. Cummins is not responsible for failures or damage resulting from what Cummins determines to be abuse or neglect.

In compliance with the regulatory agencies (EPA and CARB), the Cummins engine system incorporates on board diagnostics and electronic controls to monitor and ensure that tail pipe emissions requirements are met. A DEF lamp will notify the driver when the DEF tank level is running low and/or the quality of the DEF in the tank is not meeting specifications. Failure to promptly refill or replace DEF in the tank will trigger an inducement sequence, limiting engine torque and, eventually, vehicle speed to 5 mph.

For further details and discussion of DEF for Cummins engines, refer to Diesel Exhaust Fluid Specifications for Cummins Selective Catalytic Reduction Systems, bulletin [4021566](#).

For engines using SCR operating in the United States and Canada, it is also strongly recommended that the DEF used be certified by the American Petroleum Institute (API). This would be indicated by a symbol on the container/dispensing system.

To ensure the correct DEF is used, Cummins recommends the use of Fleetguard® Diesel Exhaust Fluid. Fleetguard® carries different quantity options from small to bulk containers.

For complete maintenance recommendations and guidelines, refer to EPA 2017 X12 CM2350 Owner's Manual, bulletin [5467517](#), and EPA 2017 X12 CM2350 Operation and Maintenance Manual, bulletin [5467516](#).



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Cummins Engines and Aftertreatment Information

4.1 Cummins Engines ISL9 for EPA 2013



Cummins 2013 ISL9 meets 2013 U.S. Environmental Protection Agency (EPA) regulations as well as the 2014 greenhouse gas (GHG) and U.S. Department of Transportation (DOT) fuel-efficiency regulations.

Emergency vehicle ratings for the ISL9 range from 270 hp to 450 hp (201- 336 kW), with a peak torque of 1250 lb-ft (1695 N•m). Firefighters have more than enough power to respond to every call.

Cummins 2013 ISL9 uses the XPI fuel system and shares the same Electronic Control Module (ECM) with all other Cummins on-highway engines. ISL9 engines for 2013 are equipped with the required On-Board Diagnostics system that monitors and ensures optimal performance of the emissions system.



The XPI fuel system, with multiple injection events per cycle, is managed simultaneously with the Cummins Aftertreatment System through a single, robust Electronic Control Module (ECM) that optimizes everything from throttle response to combustion efficiency to emissions control.

ISL9 Specifications

Advertised Horsepower	270-450 HP	201-336 kW
Peak Torque	800-1250 LB-FT	1084-1695 .s-
Governed Speed	2100-2200 20-	
Clutch Engagement Torque	500-550 LB-FT	678-746 .s-
Number of Cylinders	6	
System Weight	1,912 LB	867 KG
Engine (Dry)	1,695 LB	769 KG
Aftertreatment System*	217 LB	98 KG

*Increase over standard muffler; does not include chassis OEM-supplied components

ISL9 Maintenance Intervals

Maintenance Item	Miles/Kilometers	Hours	Months
Oil and Filter*	15,000 MI 24,000 KM	500	6
Fuel Filter	15,000 MI 24,000 KM	500	6
Coolant Filter	15,000 MI 24,000 KM	500	6
Overhead Adjustment	150,000 MI 240,000 KM	5,000	48
Standard Coolant Change	60,000 MI 96,000 KM	2,000	24
Coalescing Filter	Every 3rd to 4th Oil Change Interval		
DEF Filter	200,000 MI 320,000 KM	6,500	
Particulate Filter Cleaning	200,000 MI 320,000 KM		

Consult your Operations and Maintenance Manual for more information.

*Assuming severe duty cycle for fire/emergency vehicle applications

Cummins Engines and Aftertreatment Information

Emergency Vehicle Maintenance And Operation ISL9 Diesel (Through EPA 2010)



Quick Reference Guide

Cooling

Routine Maintenance Recommendations

- Check coolant level before every trip.
- The ISL requires supplemental coolant additive (SCA).
- Check SCA concentration level every 20,000 miles / 6 months.
- Add liquid SCA as necessary or change coolant filter (if equipped) every 20,000 miles / 6 months.
- Drain/flush cooling system every 80,000 miles / 2 years and refill with heavy-duty coolant (as described below).
* Extended coolant drain/flush/fill intervals may be followed when certain requirements are met. For more information on these requirements, refer to the Cummins Coolant Requirements and Maintenance Service Bulletin, 3666132.

Definition of Heavy-Duty Coolant

A combination of 50/50 water and low silicate antifreeze (ethylene glycol or propylene glycol are acceptable) will protect to -34°F. Freeze protection decreases above 68% antifreeze.

Always use antifreeze. In addition to freeze protection, antifreeze is essential for overheat and corrosion protection.

Antifreeze must meet ASTM4985 (GM6038M) specs.

Cummins recommends the use of a fully formulated coolant, such as Fleetguard Compleat, that meets ASTM D6210 (EG) or ASTM D6211 (PG) specifications. Fully formulated coolant offers the vehicle owner the convenience of a pre-mixed antifreeze solution containing high quality water and the correct chemical balance of antifreeze and SCA.

How to Test the Antifreeze and Coolant Additive (SCA) Concentration

Every 6 months, test antifreeze concentration and coolant additive levels. Use Fleetguard part number CC2806 to test antifreeze concentration. Do not use a floating ball hydrometer. Use Fleetguard part number CC2602 to test coolant additive levels.

Diesel Exhaust Fluid (DEF)

- Applies to engines meeting EPA '10 emissions regulations
 - Required to use DEF that meets ISO 22241-1 and strongly recommend DEF that is API Certified.
 - DEF has a storage life of a minimum of 18 months.
 - Storage temperature between 23°F and 77°F (-5°C and 25°C).
 - Store in sealed containers to avoid contamination.
 - Avoid direct sunlight.
- DEF freezes around -12°C (11°F). The DEF system on the vehicle is designed to accommodate this and doesn't require intervention by the vehicle operator.

Contact Number

Cummins 1-800-DIESELS™ (1-800-343-7357)
Customer Assistance Center

Lubricating Oil

Routine Maintenance Recommendations

- Check oil level daily.
- | | |
|-------------------------|-------------------|
| Oil Drain Interval | Fleetguard Filter |
| 15,000 miles / 6 months | LF 9009 |
- Replace oil filter at EVERY oil drain interval.

Lubricating Oil Recommendations

The primary Cummins recommendation is to use SAE 15W40 oil for normal operation at ambient temperatures above 5°F (-15°C). Consult the Owners Manual or a Cummins distributor for recommendation concerning colder operating temperatures.

	Engines without a Diesel Particulate Filter (DPF) (pre-EPA '07)	Engines with DPF or SCR* (EPA '07 and '10)
Must meet Cummins Engineering Specification (CES)	CES 20078	CES 20081
API Specification	API CI-4/SL	API CJ-4/SL

* A non-low ash oil meeting CES 20078 (API CI-4/SL) can be used with no change to the oil change interval, but will reduce the service interval of the Cummins Particulate Filter.

Synthetic Oil

- May be used provided performance and chemical requirements are met.
- Recommended for use in ambient temperatures consistently below -13°F (-25°C) for improved engine cranking and flowability.
- Should NOT BE USED to extend oil drain intervals.

Engine Break-in Oil

Special break-in oil should not be used.

Supplemental Oil Additives

Supplemental oil additives such as friction-reducers and graphitizers should not be used unless the oil supplier can provide evidence of satisfactory performance. If there is any doubt about suitability of an oil, consult the oil manufacturer for a definitive recommendation, or data to establish that the oil has performed satisfactorily in Cummins engines.

Oil Analysis

Oil analysis, as a method to extend drain intervals, is NOT recommended. Different methods of measuring soot, lack of correlation among testing labs, and differing driving patterns and idle time are the basis of the recommendation.

Always refer to your Owners Manual for complete information.



Emergency Vehicle Maintenance And Operation ISL9 Diesel (Through EPA 2010)



Quick Reference Guide

Fuel

Routine Maintenance Recommendations

Fuel filter should be changed at EVERY oil change.

Part numbers for:

High-Pressure Common-Rail I XPI Fuel Systems:

	EPA '02	EPA '07/'10
10 micron water-separating filter	FS1003	FS1065
2 micron primary fuel filter	FF5488*	FF5636*

* Change every other oil change. The 2 micron secondary filter must be changed when the warning lamp flashes and water is drained from the 10 micron water-separating filter.

CAPS Fuel System:

Spin-on Filter FS1022**

** Transfer water sensor/drain to new filter.

LowUltraLowSulfurDiesel(ULSD)FuelandFuelLubricity

Fuel additives for lubricity are NOT required by Cummins when using commercially available #2 diesel fuel or #1 / #2 winter blend diesel fuels. ULSD fuel must be used on EPA '07 and later engines.

Biodiesel

ISL engines that are certified to EPA '02 and later regulations are approved for use with B20 biodiesel. The appropriate ASTM standards must be met.

Biocide Treatment

A biocide or fungicide can help when fuels are prone to contamination with bacteria or fungus (black slime).

Other Fuel Additives

Any fuel additive product should be accompanied with data supporting its performance and benefit. Engine failures caused by incorrect fuel are NOT covered under warranty. It is not the policy of Cummins to test, approve or endorse any product not manufactured or sold by Cummins.

Extended Shutdown Start Procedure

When starting an engine that has not been operated for more than 30 days:

- Engine oil pressure must be indicated on gauge within 15 seconds after starting. If oil pressure does NOT register within 15 seconds after starting, shut off engine immediately and contact your local Cummins distributor.

Ether I Cold Start Up

Ether MUST NOT be used for ISL engines. The ISL comes equipped from the factory with an integrated grid heater for cold starting.

In ambient conditions below 0°F, it is recommended to plug in the engine block heater for easier engine starting and to reduce the time for engine warm up. Keep in mind that this only warms the coolant. The rest of the vehicle's fluids may still be cold.

Component Maintenance

The following components require periodic maintenance / inspection. Please refer to the appropriate vehicle / engine manual for details.

Valve Adjustment Interval

Check / adjust at 150,000 miles.

Air Filter and Intake System

Follow Emergency Vehicle manufacturer's recommended filter change interval. Visually inspect intake air components at each oil change for cracks or loose connections. Inspect filter minder daily.

Charge Air Cooler (CAC)

The long-term integrity of the CAC system is the responsibility of the vehicle and component manufacturers. However, CAC diagnostics can be performed by your Cummins distributor.

Vibration Damper

Inspection required at 80,000 miles / 2 years which includes visual inspection for deformation.

Front Accessory Drive Belt

Inspection required at 40,000 miles / 1 year which includes visual inspection of all components.

Coalescing Filter

Replace every 3rd to 4th Oil Change Interval.

Particulate Filter

Clean every 200,000 miles.

DEF Filter

Replace every 200,000 miles.

Additional details can be found in the 'Maintenance Guidelines' section of the engine's Owners Manual.

Idle I Cooldown

Fast Idle

ISL engines with the common rail fuel system may automatically increase engine speed under cold ambient conditions to decrease time for engine warm up under idling conditions.

Engine Cooldown

Prior to shutdown, an engine should be idled 3-5 minutes after extended full throttle or high power operation. However, under normal driving conditions, such as exiting a highway, engine operation is generally lighter in nature and thereby, the 3-5 minute cooldown is not necessary.



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ISX12 for EPA 2013



Cummins 2013 ISX12 meets Environmental Protection Agency (EPA) regulations as well as 2014 EPA greenhouse gas (GHG) and U.S. Department of Transportation (DOT) fuel-efficiency standards while providing the power needed ranging from 370 hp to 500 hp (276-373 kW).

The engine operations are managed simultaneously with the Cummins Aftertreatment System through a single, robust Electronic Control Module (ECM) that optimizes everything from throttle response to combustion efficiency to emissions control. There are no major hardware changes in 2013.

The Cummins 2013 ISX12 uses the XPI fuel system and VGT™ Turbocharger,



ISX12 engines for 2013 are equipped with the required On-Board Diagnostics system that monitors performance of the emissions system.

ISX12 Specifications

Advertised Horsepower	370-500 HP	276-373 kW
Peak Torque	1450-1645 ,"-&4	1966-2232 .s-
Governed Speed	2100 rpm	
Clutch Engagement Torque	800 ,"-&4	1085 .s-
Number of Cylinders	6	
System Weight	2,880 LB	1,306 KG
Engine (Dry)	2,640 LB	1,197 KG
Aftertreatment System*	204 LB	109 KG

*Increase over standard muffler; does not include chassis OEM-supplied components

ISX12 Maintenance Intervals

Maintenance Item	Miles/Kilometers	Hours	Months
Oil and Filter*	15,000 -) 24,000 +-)	400	6
Fuel Filter	30,000 -) 48,000 +-)	1,000	6
Coolant Filter**	50,000 -) 80,000 +-)	1,500	12
Valve Adjustment	250,000 -) 400,000 +-)	6,000	24
Coalescing Filter	150,000 -) 240,000 +-)	4,000	24
DEF Filter	300,000 -) 480,000 +-)	6,750	24
Hydrocarbon Doser Injector Cleaning	150,000 -) 240,000 +-)	4,000	24
Particulate Filter Cleaning	200,000 -) 320,000 +-)	4,500	24

Consult your Operations and Maintenance Manual for more information.

*Assuming severe duty cycle for fire/emergency vehicle applications and using CJ-4 oils meeting CES 20081

**With appropriate filter

Emergency Vehicle Maintenance And Operation ISX12 Electronic Diesel



Quick Reference Guide

Cooling

Routine Maintenance Recommendations

- Check coolant level before every trip.
- Check SCA concentration level every 15,000 miles (24,000 km) / 6 months.
- Perform a radiator pressure cap test every 400 hours / 6 months.
- Change coolant filter as necessary to maintain correct SCA concentration levels.
- Drain and flush system every 250,000 miles (402,000 km) / 6,000 hours / 2 years and refill with heavy-duty coolant - 50/50 mix of good-quality water and fully formulated antifreeze.*
- The supplemental coolant additive (SCA) is required with ISX engines.

* Extended coolant drain/flush/fill intervals may be followed when certain requirements are met. For more information on these requirements, refer to the Cummins Coolant Requirements and Maintenance Service Bulletin, 3666132.

Definition of Heavy-Duty Coolant

- A combination of 50/50 good-quality water and fully formulated antifreeze (ethylene glycol or propylene glycol) are acceptable).
- In addition to freeze protection, antifreeze is essential for overheating and corrosion protection. Protects to -33°F.
- Freeze protection decreases above 68% antifreeze.
- Antifreeze must meet Cummins CES 14603 specifications.

How to Test the Antifreeze and Coolant Additive (SCA) Concentration

- Every 6 months, test antifreeze concentration and coolant additive levels. Do not use a floating ball hydrometer.
- Use Fleetguard Quik-Chek™ Coolant Quality Test Strips, part number CC2608, to test coolant quality.
 - Use Fleetguard Coolant Test Strips 3-Way™, part number CC2602 (A,B,M,AM), to test coolant additive levels.
 - Use Fleetguard Refractometer, part number CC2806, to test freeze point measurement.

Fully Formulated Coolant

Fully formulated coolant that meets Cummins CES 14603, such as Fleetguard coolants, may be used. Reference Owners Manual for details.

Water Quality Requirements

Calcium/Magnesium	Max. 170ppm as CaCO ₃ +MgCO ₃
Chloride	Max. 40ppm as Cl
Sulfur	Max. 100ppm as SO ₄

A conservative approach to cooling system maintenance would include an analysis of your home-base tap water supply.

- Use Fleetguard Water-Check™ H₂O 3-Way Test Strips, part number CC2609, to check water quality.
- The use of distilled water is also acceptable.

Always refer to your Owners Manual for complete information.

Lubricating Oil

Routine Maintenance Recommendations

Oil Drain Interval Fleetguard Filter
15,000 miles (24,000 km) / 400 hours / 6 months LF 9001

Replace oil filter at EVERY oil drain interval.

Lubricating Oil Recommendations

Recommend the use of high quality 15W40 oil that meets Cummins Engineering Specifications (CES) 20081 or API CJ4.

	Engines with DPF or SCR* (EPA '07 and '10)
Must meet Cummins Engineering Specification (CES)	CES 20081
API Specification	API CJ-4/SL

* A non-low ash oil meeting CES 20078 (API CI-4/SL) can be used with no change to the oil change interval, but will reduce the service interval of the Cummins Particulate Filter.

Synthetic Oil

Synthetic oils offer improved cold flow performance but not extended drain intervals. Synthetic oils may be used in ISX engines provided they meet performance and chemical requirements.

- Recommended for use in ambient temperatures consistently below -13°F (-25°C) for improved engine cranking and flowability.
- Should NOT BE USED to extend oil drain intervals.

Engine Break-in Oil

Special break-in oil should not be used. If synthetic or synthetic blend oil has been used prior to an engine rebuild, petroleum-based oil should be used for the first oil change interval, after which use of synthetic oil can be resumed.

Supplemental Oil Additives

Supplemental oil additives are not required with a Cummins ISX and should not be used.

Oil Analysis

Oil analysis, as a method to extend drain intervals, is NOT recommended.

Diesel Exhaust Fluid (DEF)

Applies to engines meeting EPA '10 emissions regulations

- Required to use DEF that meets ISO 22241-1 and strongly recommend DEF that is API Certified.

- DEF has an estimated storage life of 18 months when storage temperature is between 23°F and 77°F (-5°C and 25°C).
- Store in sealed containers to avoid contamination.
- Avoid direct sunlight.

DEF freezes around -12°C (11°F). The DEF system on the vehicle is designed to accommodate this and doesn't require intervention by the vehicle operator.



Emergency Vehicle Maintenance And Operation ISX12 Electronic Diesel



Quick Reference Guide

Fuel

Routine Maintenance Recommendations

Fuel filter should be changed at EVERY oil change.

Fleetguard fuel filter:

Spin-On Pressure Filter	Fleetguard FF5686	Cummins 3685306
Spin-On Suction Filter*	FS19764	3685711

* OEM Dependent

LowUltraLowSulfurDiesel (ULSD) Fuel and Fuel Lubricity

Fuel additives for lubricity are NOT required by Cummins when using commercially available #2 diesel fuel or #1 / #2 winter blend diesel fuels. ULSD fuel must be used on EPA '07 and later engines.

Biodiesel

ISX engines that are certified to EPA '02 and later regulations are approved for use with B20 biodiesel. The appropriate ASTM standards must be met.

Biocide Treatment

A biocide or fungicide can help when fuels are prone to contamination with bacteria or fungus (black slime).

Other Fuel Additives

Any fuel additive product should be accompanied with data supporting its performance and benefit. Engine failures caused by incorrect fuel are NOT covered under warranty. It is not the policy of Cummins to test, approve or endorse any product not manufactured or sold by Cummins.

Extended Shutdown Start Procedure

When starting an engine that has not been operated for more than 30 days:

- Engine oil pressure must be indicated on gauge within 15 seconds after starting. If oil pressure does NOT register within 15 seconds after starting, shut off engine immediately and contact your local Cummins distributor.

Starting Aids

Starting aids may be used with ISX engines. Do not use excessive amount of starting fluids when starting the engine. Damage will occur. Refer to the Owners Manual for details.

Contact Number

Cummins 1-800-DIESELS™ (1-800-343-7357)
Customer Assistance Center



Always refer to your Owners Manual for complete information.

Component Maintenance

Valve Adjustment Interval

Check at 250,000 miles (402,000 km), 6,000 hours or 2 years. Reference Owners Manual.

Air Filter and Intake System

Follow Emergency Vehicle manufacturer's recommended filter change interval. Visually inspect intake air components at each oil change for cracks or loose connections.

Air Handling System (if equipped)

Follow Emergency Vehicle manufacturer's recommendations for system maintenance.

Charge Air Cooler (CAC)

The long-term integrity of the CAC system is the responsibility of the vehicle and component manufacturers. However, CAC diagnostics can be performed by your Cummins distributor.

Vibration Damper and Belt Tension

Inspection required at 250,000 miles (402,000 km), 6,000 hours or 2 years which includes visual inspection for deformation. Reference Owners Manual for details.

Fan Idler Pulley and Hub

Inspection required at 120,000 miles (193,000 km) / 1 year which includes visual inspection of all components. Reference Owners Manual for details.

Coalescing Filter

Replace every 150,000 miles (240,000 km) / 4,000 hours*.

* If blowby <12 in. H₂O

Particulate Filter

Clean every 300,000 miles (480,000 km).

DEF Filter

Replace every 200,000 miles (320,000 km) or 4,500 hours.

Hydrocarbon Doser Injector Cleaning

Clean every 150,000 miles (240,000 km) or 4,000 hours.

Additional Routine Maintenance Recommendation for EGR Systems

Check EGR system and hoses at 120,000 miles (193,000 km) / 2 years.

Idle I Cooldown

Engine Cooldown

Prior to shutdown, an engine should be idled 3-5 minutes after extended full throttle or high power operation. However, under normal driving conditions, such as exiting a highway, engine operation is generally lighter in nature and thereby, the 3-5 minute cooldown is not necessary.



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ISX15 for EPA 2013



Cummins 2013 ISX15 meets 2013 U.S. Environmental Protection Agency (EPA) regulations as well as 2014 EPA greenhouse gas (GHG) and U.S. Department of Transportation (DOT) while providing ratings from 455 hp to 600 hp (339-447 kW).

Engine operations are managed simultaneously with the Cummins Aftertreatment System through a single, robust Electronic Control Module (ECM) that optimizes everything from throttle response to combustion efficiency to emissions control. There are no major hardware changes in 2013.

The Cummins 2013 ISX15 uses the XPI fuel system and VGT™ Turbocharger,

ISX12 engines for 2013 are equipped with the required On-Board Diagnostics system that monitors performance of the emissions system.



ISX15 Specifications

Advertised Horsepower	455-600 HP	339-447 kW
Peak Torque	1750-1850 ,"-&4	2373-2508 .s-
Governed Speed	2100 20-	
Clutch Engagement Torque	1000 ,"-&4	1356 .s-
Number of Cylinders	6	
System Weight	3,204 LB	1,453 KG
Engine (Dry)	2,964 LB	1,344 KG
Aftertreatment System*	240 LB	109 KG

*Increase over standard muffler; does not include chassis OEM-supplied components

ISX15 Maintenance Intervals

Maintenance Item	Miles/Kilometers	Hours	Months
Oil and Filter*	20,000 -) 32,000 +-	500	6
Fuel Filter	20,000 -) 32,000 +-	500	6
Coolant Filter**	50,000 -) 80,000 +-	1,500	12
Valve Adjustment	500,000 -) 800,000 +-	10,000	60
Coalescing Filter	125,000 -) 200,000 +-	3,000	
DEF Filter	300,000 -) 480,000 +-	6,750	
Hydrocarbon Doser Injector Cleaning	150,000 -) 240,000 +-	4,500	
Particulate Filter Cleaning	200,000 -) 320,000 +-	4,500	

Consult your Operations and Maintenance Manual for more information.

*Assuming severe duty cycle for fire/emergency vehicle applications and using CJ-4 oils meeting CES 20081

**With appropriate filter

Cummins Engines and Aftertreatment Information

Emergency Vehicle Maintenance And Operation ISX15 Diesel (Through EPA 2010)



Quick Reference Guide

Cooling

Routine Maintenance Recommendations

- Check coolant level before every trip.
- Check SCA concentration level every 15,000 miles / 6 months.
- Change coolant filter as necessary to maintain correct SCA concentration levels.
- Drain and flush system every 250,000 miles / 2 years and refill with heavy-duty coolant - 50/50 mix of good-quality water and fully formulated antifreeze.*
- The supplemental coolant additive (SCA) is required with ISX engines.

* Extended coolant drain/flush/fill intervals may be followed when certain requirements are met. For more information on these requirements, refer to the Cummins Coolant Requirements and Maintenance Service Bulletin, 3666132.

Definition of Heavy-Duty Coolant

- A combination of 50/50 good-quality water and fully formulated antifreeze (ethylene glycol or propylene glycol) are acceptable).
- In addition to freeze protection, antifreeze is essential for overheating and corrosion protection. Protects to -33°F.
- Freeze protection decreases above 68% antifreeze.
- Antifreeze must meet Cummins CES 14603 specifications.

How to Test the Antifreeze and Coolant Additive (SCA) Concentration

- Every 6 months, test antifreeze concentration and coolant additive levels. Do not use a floating ball hydrometer.
- Use Fleetguard Quik-Chek™ Coolant Quality Test Strips, part number CC2608, to test coolant quality.
 - Use Fleetguard Coolant Test Strips 3-Way™, part number CC2602 (A, B, M, AM) to test coolant additive levels.
 - Use Fleetguard Refractometer, part number CC2806, to test freeze point measurement.

Fully Formulated Coolant

Fully formulated coolant that meets Cummins CES 14603, such as Fleetguard coolants, may be used. Reference Owners Manual for details.

Water Quality Requirements

Calcium/Magnesium	Max. 170ppm as CaCO ₃ +MgCO ₃
Chloride	Max. 40ppm as Cl
Sulfur	Max. 100ppm as SO ₄

A conservative approach to cooling system maintenance would include an analysis of your home-base tap water supply.

- Use Fleetguard Water-Check™ H₂O 3-Way Test Strips, part number CC2609, to check water quality.
- The use of distilled water is also acceptable.

Always refer to your Owners Manual for complete information.

Lubricating Oil

Routine Maintenance Recommendations

Oil Drain Interval	Fleetguard Filter
15,000 miles / 6 months	LF 9001

Replace oil filter at EVERY oil drain interval.

Lubricating Oil Recommendations

The primary Cummins recommendation is to use SAE 15W40 oil for normal operation at ambient temperatures above 5°F (-15°C). Consult the Owners Manual or a Cummins distributor for recommendation concerning colder operating temperatures.

	Engines without a Diesel Particulate Filter (DPF) (pre-EPA '07)	Engines with DPF or SCR* (EPA '07 and '10)
Must meet Cummins Engineering Specification (CES)	CES 20078	CES 20081
API Specification	API CI-4/SL	API CJ-4/SL

* A non-low ash oil meeting CES 20078 (API CI-4/SL) can be used with no change to the oil change interval, but will reduce the service interval of the Cummins Particulate Filter.

Synthetic Oil

Synthetic oils offer improved cold flow performance but not extended drain intervals. Synthetic oils may be used in ISX engines provided they meet performance and chemical requirements.

- Recommended for use in ambient temperatures consistently below -13°F (-25°C) for improved engine cranking and flowability.
- Should NOT BE USED to extend oil drain intervals.

Engine Break-in Oil

Special break-in oil should not be used. If synthetic or synthetic blend oil has been used prior to an engine rebuild, petroleum-based oil should be used for the first oil change interval, after which use of synthetic oil can be resumed.

Supplemental Oil Additives

Supplemental oil additives are not required with a Cummins ISX and should not be used.

Oil Analysis

Oil analysis, as a method to extend drain intervals, is NOT recommended.

Diesel Exhaust Fluid (DEF)

Applies to engines meeting EPA '10 emissions regulations

- Required to use DEF that meets ISO 22241-1 and strongly recommend DEF that is API Certified.

- DEF has a storage life of a minimum of 18 months.
- Storage temperature between 23°F and 77°F (-5°C and 25°C).

- Store in sealed containers to avoid contamination.
- Avoid direct sunlight.

DEF freezes around -12°C (11°F). The DEF system on the vehicle is designed to accommodate this and doesn't require intervention by the vehicle operator.



Emergency Vehicle Maintenance And Operation ISX15 Diesel (Through EPA 2010)



Quick Reference Guide

Fuel

Routine Maintenance Recommendations

Fuel filter should be changed at EVERY oil change. Fuel filters with water drains should be routinely opened to remove captured water.

Fleetguard Part numbers for:

	Pre-EPA '10 (no SCR)	EPA '10 (SCR)
Spin-On Suction Filter*	FS2203	FS19764
Spin-On Pressure Filter	FF2200	FF5686

* OEM Dependent

LowUltraLow Sulfur Diesel (ULSD) Fuel and Fuel Lubricity

Fuel additives for lubricity are NOT required by Cummins when using commercially available #2 diesel fuel or #1 / #2 winter blend diesel fuels. ULSD fuel must be used on EPA '07 and later engines.

Biodiesel

ISX engines that are certified to EPA '02 and later regulations are approved for use with B20 biodiesel. The appropriate ASTM standards must be met.

Biocide Treatment

A biocide or fungicide can help when fuels are prone to contamination with bacteria or fungus (black slime).

Other Fuel Additives

Any fuel additive product should be accompanied with data supporting its performance and benefit. Engine failures caused by incorrect fuel are NOT covered under warranty. It is not the policy of Cummins to test, approve or endorse any product not manufactured or sold by Cummins.

Extended Shutdown Start Procedure

When starting an engine that has not been operated for more than 30 days:

- Engine oil pressure must be indicated on gauge within 15

seconds after starting. If oil pressure does NOT register within 15 seconds after starting, shut off engine immediately and contact your local Cummins distributor.

Starting Aids

Starting aids may be used with ISX engines. Do not use excessive amount of starting fluids when starting the engine. Damage will occur. Refer to the Owners Manual for details.

Contact Number

Cummins 1-800-DIESELS™ (1-800-343-7357)
Customer Assistance Center

Component Maintenance

Valve Adjustment Interval

Check at 500,000 miles or 5 years. Reference Owners Manual.

Air Filter and Intake System

Follow Emergency Vehicle manufacturer's recommended filter change interval. Visually inspect intake air components at each oil change for cracks or loose connections.

Air Handling System (if equipped)

Follow Emergency Vehicle manufacturer's recommendations for system maintenance.

Charge Air Cooler (CAC)

The long-term integrity of the CAC system is the responsibility of the vehicle and component manufacturers. However, CAC diagnostics can be performed by your Cummins distributor.

Vibration Damper and Belt Tension

Inspection required at 50,000 miles / 1 year which includes visual inspection for deformation. Reference Owners Manual for details.

Fan Idler Pulley and Hub

Inspection required at 120,000 miles / 1 year which includes visual inspection of all components. Reference Owners Manual for details.

Coalescing Filter

Replace every 125,000 miles / 1 year*.
* If blowby <12 in. H₂O

Particulate Filter

Clean every 300,000 to 400,000 miles.

DEF Filter

Replace every 200,000 miles.

Hydrocarbon Doser Injector Cleaning

Clean every 150,000 miles.

Additional Routine Maintenance Recommendation

for EGR Systems

Check EGR system and hoses at 120,000 miles / 2 years. Turbocharger air shutoff valve filter change 250,000 miles / 2 years.

Idle I Cooldown

Engine Cooldown

Prior to shutdown, an engine should be idled 3-5 minutes after extended full throttle or high power operation. However, under normal driving conditions, such as exiting a highway, engine operation is generally lighter in nature and thereby, the 3-5 minute cooldown is not necessary.

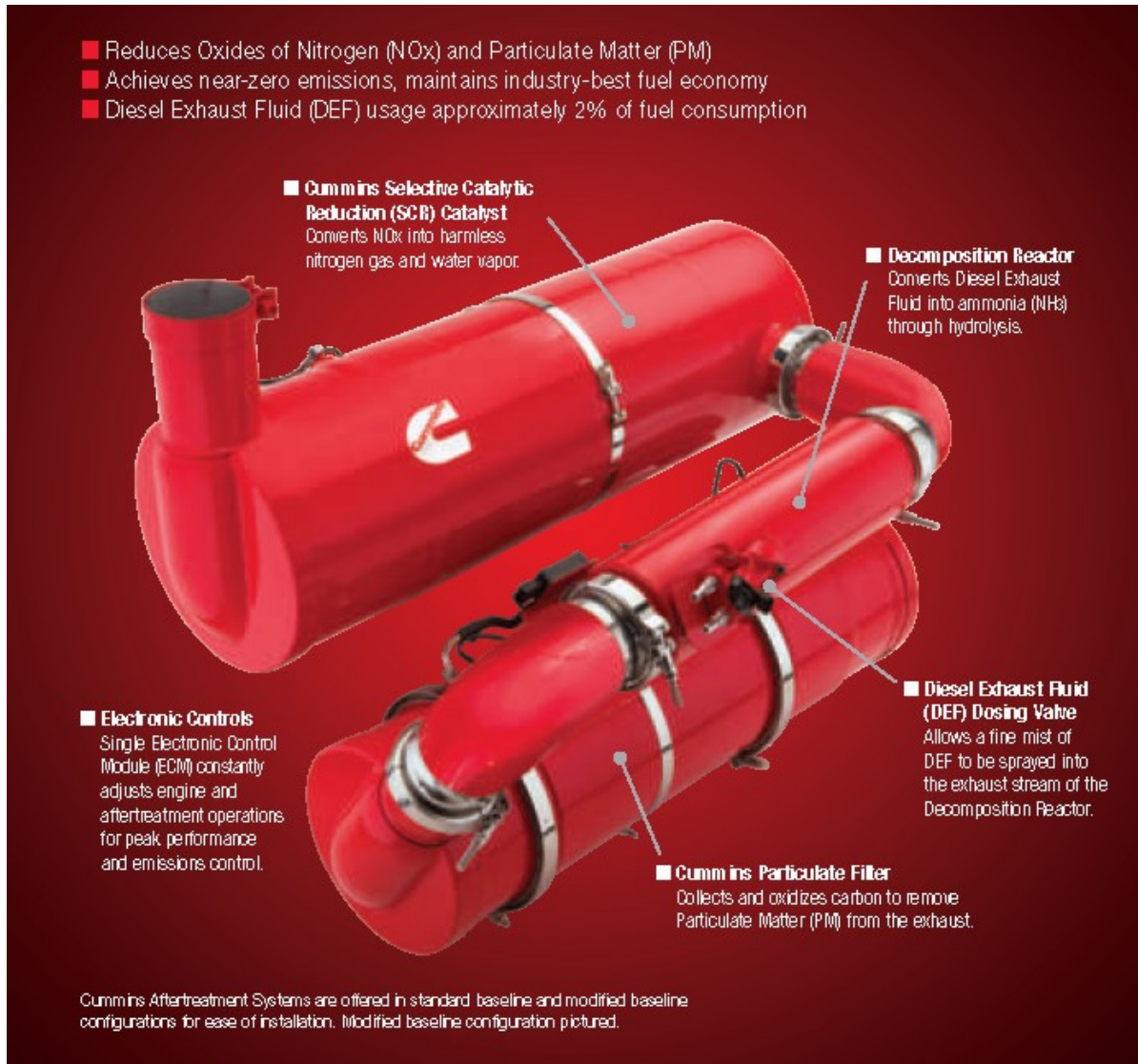


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4.2 Selective Catalytic Reduction (SCR)

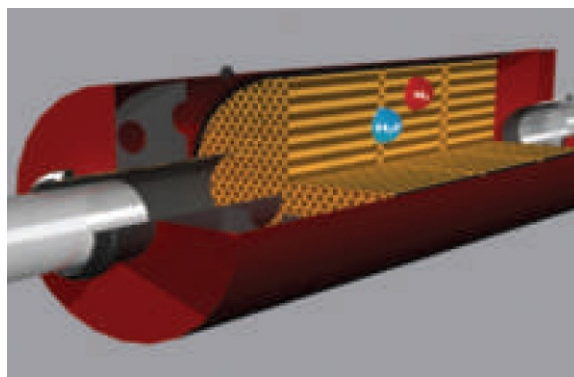


SCR is not a new technology for Cummins, having over 200,000 systems operating throughout Europe, using Selective Catalytic Reduction, with proven success in a variety of applications. Cummins has all of that knowledge and experience and improved on it, utilizing the latest technology to achieve near-zero emissions without any compromise of fuel economy, reliability or durability. In fact, many on-highway users see their mpg increase with Cummins 2013 engines.



How SCR Works

Exhaust gas containing Oxides of Nitrogen (NOx) exits the Cummins Particulate Filter and enters a tube called the Decomposition Reactor, where a fine mist of Diesel Exhaust Fluid (DEF) from the holding tank is sprayed into the hot exhaust stream. DEF is a solution of 32.5% urea and deionized water, which breaks down into ammonia (NH₃) during a chemical reaction in the Decomposition Reactor through a process known as hydrolysis.



The NOx and ammonia (NH₃) pass into the SCR element where a catalytic reaction takes place, converting the NOx into harmless nitrogen gas (N₂) and water vapor (H₂O).

They then pass over a secondary catalyst, which converts any leftover traces of ammonia before the exhaust exits the system. That is how near-zero emissions is achieved.

What Drivers Need To Know

The Cummins Aftertreatment System with adequate DEF levels will not change the driving performance of your vehicles in terms of pulling power, engine responsiveness, durability or dependability. The DEF tank will need to be replenished periodically. How often will depend on the size of the tank installed by the equipment manufacturer.

Cummins Engines and Aftertreatment Information

DEF consumption will be approximately 2% of your fuel consumption. So for every 50 gallons of fuel you consume, the Cummins Aftertreatment System will use one gallon of Diesel Exhaust Fluid. Vehicles will come equipped with a “low fluid” lamp which will indicate to the driver or maintenance staff when the DEF level is getting low.

Maintenance Intervals Unchanged

Cummins engines and aftertreatment system are designed to keep you on the road and out of the shop. Oil filter, oil, fuel filter, coolant filter, overhead adjustment and all the other normal maintenance items will have the same intervals as current Cummins engines.

The only addition will be a DEF filter that will need to be changed at 200,000-mile (320,000 km) or 5,000-hour intervals.

Service You Trust. Every Time

Cummins has the largest network of service providers with over 3,500 locations in North America. They are already developing a comprehensive training program so that you can have complete confidence in your 2013 engine and aftertreatment system.

For more details about Cummins 2013 technology, see your local Cummins dealer or distributor, call 1-800-DIESELS™ (1-800-343-7357) Customer Assistance Center or visit our the site at everytime.cummins.com.



4.3 Driver Tips for Fire and Emergency Vehicles

For EPA 2013 Cummins On-Highway Heavy-Duty And MidRange Engines
With Aftertreatment

General Engine Indicator Lamps

NOTE: Lamps shown are for illustrative purposes only. Be sure to reference your vehicle manufacturer's Owners Manual for specific lamps and details.

Check Engine Lamp of Amber Warning Lamp



The Check Engine Lamp (which may also be referred to as the Amber Warning Lamp) illuminates when the engine needs to be serviced at the first available opportunity.

Stop Engine Lamp



The red Stop Engine Lamp indicates, when illuminated, that the vehicle needs to be stopped as soon as it is safe to do so.

On-Board Diagnostics

In 2013, all on-highway engines will include On-Board Diagnostics as a part of the emissions regulation requirement. On-Board Diagnostics monitors all emissions related engine systems during operation. If the system detects any emissions related malfunctions, it will alert the operator to these detected malfunctions - through a dash lamp known as the Malfunction Indicator Lamp (MIL).

Malfunction Indicator Lamp



The MIL illuminates when the On-Board Diagnostics system detects a malfunction related to the emissions control system. The illuminated MIL indicates that the engine and aftertreatment system should be diagnosed and serviced at your next available opportunity. The MIL can be illuminated along with any of the engine indicator lamps.

Cummins Engines and Aftertreatment Information



If the MIL is illuminated with the red Stop Engine Lamp, the vehicle should be stopped as soon as it is safe to do so. It should then be taken to an authorized Cummins location for repair.

Diesel Exhaust Fluid For Selective Catalytic Reduction (SCR) Aftertreatment

Every vehicle with a U.S. Environmental Protection Agency (EPA) 2010 or later engine has an on-frame storage tank for Diesel Exhaust Fluid (DEF) and a dash lamp that indicates low DEF levels. Refilling this tank with DEF is critical in order for your vehicle to comply with EPA emissions regulations.

Diesel Exhaust Fluid (DEF) Gauge



A DEF gauge is provided to monitor the amount of DEF. DEF should be added when the fluid level is within the yellow area of the gauge.

A red warning light in the gauge will illuminate to indicate that the DEF level has fallen below a critical level. This can be corrected by refilling the DEF tank.

Engines built prior to July 8, 2011, and not upfit with the new calibration will experience a power loss rather than a speed limitation. Normal engine power and vehicle speed will be restored after the DEF tank is refilled.



Emissions Derate Exemptions

Cummins EPA 2013 diesel engines for fire and emergency vehicles should not experience any emissions-related vehicle speed or engine torque derates. Some EPA 2013 ISX12 and ISX15 engines for fire and emergency vehicles built in early 2013 may require an electronic calibration update to eliminate emissions-related derates. For information regarding the calibration update, contact Cummins Care at 1-800-DIESELS™ (1-800-343-7357) with your Engine Serial Number (ESN). Visit cumminsengines.com/fire-and-emergency for more details and information on engines built prior to 2013.

Fire and Emergency Vehicle Emissions Derate Exemption Customer Frequently Asked Questions

For information on Fire and Emergency Vehicle Emissions Derate Exemption, refer to Appendix F, Frequently Asked Questions - Fire and Emergency Vehicle Emissions Derate Exemption Customer FAQ -Cummins Inc. Rev. 3.14.13

Diesel Particulate Filter (DPF)

The DPF is an integral component of the aftertreatment system on vehicles equipped with EPA 2007 engines, excluding some EPA 2007 ISM engines. It captures Particulate Matter (PM) in a wall-flow ceramic filter. The exhaust system periodically undergoes regeneration, raising temperatures to oxidize captured PM and clean the system. Lamps alert the driver when a regeneration is needed.

High Exhaust System Temperature (HEST) Lamp



The HEST Lamp illuminates to indicate that high exhaust temperatures may exist due to aftertreatment regeneration. This is normal, and does not signify the need for any kind of vehicle service or engine service. When this lamp is illuminated, ensure that the exhaust pipe outlet is not directed at any combustible surface or material. Reference your Cummins Owners Manual for complete instructions.

Aftertreatment Diesel Particulate Filter (DPF) Lamp



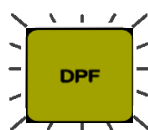
Illuminated

The Aftertreatment DPF Lamp indicates, when illuminated or flashing, that the Aftertreatment DPF requires regeneration. This is accomplished by the following:

1. If the vehicle is equipped with a Regeneration Inhibit Switch, ensure that the switch is not in the Inhibit position.
2. Perform a DPF regeneration by one of the following methods:
 - a. Change to a more challenging duty cycle; such as highway driving, for at least 20 minutes to increase exhaust temperatures.

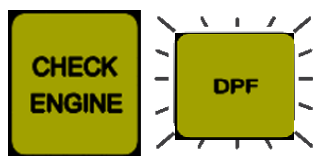
OR

- b. Perform a parked regeneration.



Flashing

If a regeneration is not performed in a timely manner after the DPF Lamp is illuminated, the DPF Lamp will begin to flash. This indicates a higher level of PM in the DPF.



Flashing With Check Engine Lamp/Amber Warning Lamp

A flashing DPF Lamp combined with an illuminated Check Engine Lamp/Amber Warning Lamp indicates that the aftertreatment DPF needs regeneration immediately. A parked regeneration is required.



Stop Engine Lamp

If a parked regeneration is not performed, the red Stop Engine Lamp will illuminate. As soon as it is safe to do so, the vehicle should be stopped. It should then be taken to an authorized Cummins location for repair.



NOTE: Cummins engines calibrated for emergency vehicle use are programmed to not reduce power or speed due to soot load. However, excessive soot load may impact engine performance.

Regeneration Inhibit Switch



The purpose of this switch is to prevent or disable active aftertreatment DPF regeneration. Reference the vehicle Owners Manual for complete operation and use of this switch. Unnecessary or excessive use of the Regeneration Inhibit Switch will result in a loss of fuel economy, or an increased need for parked regeneration.

How to Perform a Parked (Stationary) Regeneration

If the vehicle has a Stationary Regeneration Switch and the DPF Lamp is illuminated or flashing:

- Park vehicle in an appropriate location, set parking brake and place transmission in Park (if provided) or Neutral, and allow up to one hour for the regeneration.
- Set up a safe exhaust area. Confirm that nothing is on or near the exhaust system surfaces.
- Ensure that your fast-idle and power take-off (PTO) switches are off before starting regeneration.
- Push the Stationary Regeneration Switch to begin a parked regeneration.

▼ **Cummins Engines and Aftertreatment Information**

NOTE: Engine speed will increase, and there may be a noticeable change to the sound of the turbocharger during the regeneration process. Once the DPF is regenerated, the engine will automatically return to the normal idle speed.

- Monitor the vehicle and surrounding area during regeneration. If any unsafe condition occurs, shut off the engine immediately. To stop a parked regeneration, depress the brake or throttle pedal.
- Once regeneration is complete, exhaust gas and exhaust surface temperatures will remain elevated for three to five minutes.

Reference your Cummins Owners Manual and vehicle Owners Manual for complete operating instructions.

Fuel, Oil, and DEF

- Use only Ultra-Low Sulfur Diesel (ULSD) fuel.
- CJ-4 (low ash) is the recommended oil.
- Be sure to check the DEF gauge at every refueling. Cummins recommends topping off the DEF tank when refueling. DEF meeting ISO 22241-1 must be used.
- Please read your vehicle manufacturer Owners Manual to familiarize yourself with the location and capacity of the DEF tank.
- Put only DEF in the DEF tank, which has a blue cap.





Items the Driver Will Notice

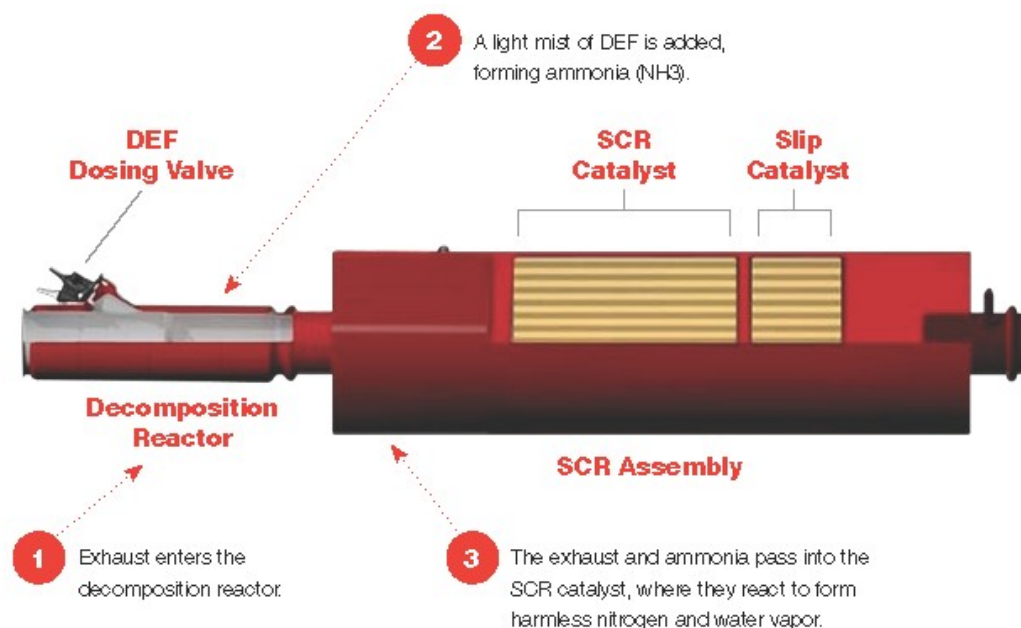
- Under certain conditions (cold or very dry), condensation in the form of water vapor can be seen coming from the vehicle tailpipe. This is normal. It will clear within a few minutes of normal vehicle operation.
- If the engine is left at idle for significant periods of time without reaching the minimum exhaust operating temperatures, the engine will automatically increase the engine idle speed for several minutes to maintain the condition of the particulate filter. This can be interrupted by pressing the service brake.
- After prolonged idle, you may notice momentary white vapor and an odor. This is normal.
- When the High Exhaust System Temperature Lamp is illuminated, you may notice an odor. This is normal. If the odor is excessive and you also notice white vapor, have the exhaust system inspected for leaks.

4.4 Air Shield™ Diesel Exhaust Fluid

In support of EPA emissions standards, oxides of nitrogen and particulate matter (PM) are reduced by 90% from 2004 standards to near-zero emissions levels. In order to meet these new standards and the needs of customers, engine manufacturers have invested in new and innovative technologies. The leading technology being used to achieve the emissions goals is SCR (Selective Catalytic Reduction). This proven aftertreatment technology enables the engine to be fully optimized for performance and fuel economy.

The SCR Aftertreatment System

The SCR aftertreatment system consists of three elements: catalyst, Diesel Exhaust Fluid (DEF) and DEF dosing system.



The Cummins/Valvoline Relationship

Cummins and Valvoline signed a technical alliance in 1995 to market heavy-duty lubricants in North America. The partnership has since expanded to include joint ventures and alliances in emerging markets around the world. This worldwide cooperation combines engine, lubricant, filtration and now DEF technology to deliver products and services that reduce total cost of ownership.



Air Shield DEF

Compatible with all on- and off-highway SCR systems, Air Shield DEF is API- and AdBlue®-certified. Air Shield enables on-highway diesel engines to meet the EPA's near-zero NOx emission levels required for 2011 and later on-highway diesel engines. The SCR systems work by injecting DEF into the engine exhaust, creating ammonia which then flows through a SCR catalyst and reacts to form harmless nitrogen and water vapor.

Dispensing Equipment

To prevent contamination, clean dispensing equipment made with DEF compatible materials must be used when dispensing Air Shield into the vehicle. Cummins Filtration offers a complete line of DEF compatible dispensing equipment.

DEF Storage

To maximize shelf life, ideal storage temperature is below 86° F (30° C) and above 12° F (-11° C) to prevent freezing; however, frozen DEF can be thawed and used without any concerns. Many bulk dispensers (1,000 gallons +) have integrated climate control system options. Intermediate Bulk Containers (IBC) do not. Therefore, in cold temperature regions, it is recommended to keep DEF-IBC's in a storage unit. In warm temperature regions it is recommended to store DEF in a shaded area and avoid prolonged exposure to temperatures above 90° F.

Vehicle Operation

Each SCR equipped vehicle carries DEF in a storage tank. Depending on the OEM application, DEF tank size will range in capacity. The storage tank is usually designed in terms of a minimum of two to three diesel fillups corresponds to 1 DEF fill-up.

Cummins Engines and Aftertreatment Information

Because all vehicles will have a DEF gauge incorporated into the dashboard, the level of DEF in the tank is always visible. Additionally, vehicles have a DEF notification system, ensuring the operator has ample notices to replenish the DEF. With approximately 10% DEF left in the tank, the DEF indicator lamp will first illuminate to alert the driver to low DEF. The lamp will then begin to flash with approximately 5% DEF left in the tank. On-highway vehicles can travel 200 to 300 miles on one gallon of DEF. At no time is the vehicle shut down - even if there is no DEF in the tank.

During vehicle operation in cold climates, the SCR system is designed to provide heating for the DEF tank and supply lines. If DEF freezes when the vehicle is shut down, start up and normal operation of the vehicle will not be inhibited. The heating system is designed to quickly return the DEF to liquid form and the operation of the vehicle will not be impacted.

Calculating Air Shield™ Usage

DEF use is directly related to fuel consumption. DEF consumption is expected to be approximately 2-3% of the diesel fuel consumed, dependent on application and vehicle operation. Another way to consider it is that DEF will be consumed approximately at a 50 to 1 ratio with diesel (for every 50 gallons of diesel fuel burned, 1 gallon of DEF). A truck averaging 6 MPG can expect to go approximately 6,000 miles on one 20 gallon tank of DEF.

To easily calculate your estimated DEF usage, go to our online Air Shield Usage Calculator at cumminsfiltration.com/def.

Packaging Options

- Convenient packaging including 1 Gal. and 2.5 Gal. containers
- Intermediate bulk containers, including 330 Gal. plastic and 275 Gal. disposable totes and 55 Gal. drums
- Bulk delivery direct from blending facility



Air Shield DEF Products Available for OEM First Fill and Aftermarket

Description	Part Number
Air Shield 4/1 Gal. DEF (3.78 L)	728770
Air Shield 2/2.5 Gal. DEF (9.45 L)	729566
Air Shield 55 Gal. DEF Drum (208 L)	749714
Air Shield 275 Gal. DEF Disposable Tote (1040 L)	729566
Air Shield 330 Gal. DEF Plastic Tote (1250 L)	728802
Bulk DEF	0036057

NOTE: Available in North America only.

For more detailed information, refer to the Fleetguard Technical Information Catalog – LT32599 or visit Fleetschool at cumminsfiltration.com. To find the nearest retailer of Fleetguard products, visit cumminsfiltration.com/wrl.

4.5 Cummins Engines Wiring Schematics and Routing

Refer to the Electrical CD supplied with the vehicle for information on 2017 wiring schematics and routing.

▼ **Cummins Engines and Aftertreatment Information**

4.6 Allison/Cummins Service Intervals



Engine Transmission Service Schedule

All vehicles are shipped with their own operators / maintenance manual.

Cummins tech support can be sourced at 1-800-343-7537
 Note: they will require engine serial number (found on top of engine)

Cummins Bridgeway
 4000 Lyman Drive
 Hilliard, OH 43026
 (248) 240-0522
 (614) 771-1000
<http://cumminsbridgeway.com/>

Allison Transmission
 Don Bixler
 Clarke Power Systems, Inc.
 3488 W1200N Decatur, In 46733
 (260) 433-1156
<http://www.allisontransmission.com/>

2022 Cummins Engines Fire Trucks

L9 X12 X15

Air Cleaner

Restriction light warning

Lube Oil, Oil Filter (10W30 OR 15W40) Fuel Filters (pressure/suction)

15,000 miles, 1500 hours or 6 months	40,000 miles, 1500 hours or 6 months	25,000 miles, 500 hours or 6 months
--	--	---

Coolant Filter

50,000 miles, 1,500 hours or 18 months	50,000 miles, 1,500 hours or 12 months	250,000 miles, 6,000 hours or 48 months
--	--	---

Crank Case Filter

Maintanance Free	N/A	N/A
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Diesel Particulate Filter

200,000 miles, 6,500 hours	300,000 miles, 12,000 hours	300,000 miles, 6,750 hours
----------------------------------	-----------------------------------	----------------------------------

Diesel Exhaust Fluid Filter

200,000 miles, 6,000 hours	300,000 miles, 6,750 hours	300,000 miles, 6,500 hours
-------------------------------	-------------------------------	-------------------------------

Valve and Injector Adjustment

150,000 miles, 4500 hours	250,000 miles, 6,000 hours	500,000 miles, 10,000 hours or 5 years
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2022 Allison Transmission - EVS 3000 & EVS 4000

Filter **75,000 miles** 3 years TES 668 /TES 295 FLUID
 Oil **300,000 miles** 4 years

If equipped with MY09-prognostics:
 a wrench symbol will appear on the shift pad when service is required



Filters and Fluids

When It's Time For A Change
Choose Allison

Fluid and Filter Change Recommendations



Fluid and Filter Change Recommendations

Use of the proper fluid and filters is the simplest thing that an owner can do to ensure the ongoing performance and reliability of Allison automatic transmissions. Allison Transmission has designed extensive specification and testing programs to verify the quality of fluids. As a result, the specific fluid and filter change interval recommendations closely match today's operating environments.

Local conditions, severity of operation or duty-cycle may require more or less frequent fluid change intervals that differ from the information contained in the following charts. Allison Transmission recommends that customers use fluid analysis as the primary method for determining fluid change intervals for those vehicles not equipped with prognostic software. In the absence of a fluid analysis program, the fluid change intervals listed in the following charts should be used.

If you have questions regarding fluid or filter change intervals, or models not listed in this brochure, a complete list of approved fluids can be found at allisontransmission.com. You can also contact the Allison Technical Assistance Center at 1-800-252-5283.



Fluids

Allison Transmission recommends that customers use an Allison Approved TES 668™ or TES 295® automatic transmission fluid to extend drain intervals and to enhance transmission performance and durability in all operating environments with on-highway products.

TES-389® fluids may be used in traditional on-highway products but do not provide the same drain intervals or filter change intervals as Allison Approved TES 295®.

TES 468® fluids can be used anywhere a TES 295® product is specified, H 40/50 EP™ products require use of a TES 468® approved fluid.

A complete list of approved fluids can be found at allisontransmission.com. C4 fluids and DEXRON®-VI are no longer recommended in any commercial on-highway transmission.

Fluid Loss With Filter Change Only

When changing the Control Main Filter (1000/2000 Series) and Main or Lube Filters (3000/4000 Series or TC10®), approximate fluid loss for each filter is as follows:

- 1000 and 2000 Product Families Transmissions
Control Main Filter = 1 pint (0.47 liters)
- 3000 and 4000 Product Families Transmissions
Main Filter = 2 quarts (1.9 liters)
Lube Filter = 8 quarts (7.6 liters)
- TC10 Product Transmission
Lube Filter = 8.1 quarts (7.75 liters)

Prognostics

Model Year 2009 and 2010 Prognostics:

Prognostics that monitor and maximize fluid and filter life were offered in model Year 2009 for 1000/2000/3000/4000 Product Families. 3000/4000 Product Families Transmissions began using Prognostics with serial numbers 6510822005, 6520099957, 6610257671, 6620007438.

1000/2000 Product Families Transmission Prognostics were first available in July of 2008 (MY2009). MY2009 Allison Prognostics must only be used with Allison Approved TES 668™, TES 295® and TES 468® fluids.

January 2010 Allison Prognostics are compatible with TES 668™, TES 295® and TES 389®-approved fluids in 3000/4000 Product Families Transmissions starting with TCM calibration CIN 4C or later (4C-xxx-yyy-z) and all January 2010 1000/2000 Product Families Transmissions.

All 3000/4000 Product Families Transmissions utilizing Prognostics require the use of Allison High Capacity filters. All 1000/2000 Product Families Transmissions utilizing Prognostics require the use of Allison control main spin-on filter, P/N 29539579. 1000/2000/3000/4000 Product Families Transmissions may or may not have this feature "enabled" or turned ON. This option requires that the OEM provide the wiring necessary and the feature enabled in the TCM. Refer to the appropriate operator's manual for the methods of identifying if Prognostics is enabled.

High Capacity Filters allow extended filter change intervals when used with an Allison Approved TES 668™, TES 295® or TES 468® automatic transmission fluid.



3000/4000 SERIES™ Fluid And Filter Change Interval Recommendations							
		Prognostics Turned Off or Not Calibrated in TCM		Prognostics Turned On			
Duty Cycle		Allison Approved TES 668™/295® Fluid	Allison Approved TES 389® Fluid	Allison Approved TES 668™/295® Fluid	Allison Approved TES 389® Fluid		
Fluid		General*	300,000 Miles (480,000 km) or 6,000 Hours or 48 Months	25,000 Miles (40,000 km) or 1,000 Hours or 12 Months	When indicated by controller or 60 months, whichever occurs first	When indicated by controller or 24 months, whichever occurs first	
		Severe**	150,000 Miles (240,000 km) or 6,000 Hours or 48 Months	12,000 Miles (20,000 km) or 500 Hours or 6 Months			
Filters		Main Filter	General*	75,000 Miles (120,000 km) or 3,000 Hours or 36 Months	25,000 Miles (40,000 km) or 1,000 Hours or 12 Months	When indicated by controller or 60 months, whichever occurs first	When indicated by controller or 24 months, whichever occurs first
			Severe**	75,000 Miles (120,000 km) or 3,000 Hours or 36 Months	12,000 Miles (20,000 km) or 500 Hours or 6 Months		
		Internal Filter	All	Overhaul	Overhaul	Overhaul	Overhaul
		Lube/ Auxiliary Filter	General*	75,000 Miles (120,000 km) or 3,000 Hours or 36 Months	25,000 Miles (40,000 km) or 1,000 Hours or 12 Months	When indicated by controller or 60 months, whichever occurs first	When indicated by controller or 24 months, whichever occurs first
Severe**	75,000 Miles (120,000 km) or 3,000 Hours or 36 Months		12,000 Miles (20,000 km) or 500 Hours or 6 Months				

*General Vocation: All vocations not classified as Severe

**Severe Vocation: On/Off Highway, Refuse, City Transit, Shuttle Transit


Cummins Engines and Aftertreatment Information
Fluid Capacity (Approximate)

1000/2000 SERIES™				
Sump	Initial Fill		Refill	
	Liters	Quarts	Liters	Quarts
Standard	14	14.8	10	10.6
Shallow	12	12.7	7	7.4
3000 SERIES™				
Sump	Initial Fill		Refill	
	Liters	Quarts	Liters	Quarts
4 Inch	27	29	18	19
2 Inch	25	26	16	17
4000 SERIES™				
Sump	Initial Fill		Refill	
	Liters	Quarts	Liters	Quarts
4 Inch*	45	48	37	39
2 Inch*	38	40	30	31
TC10® TRACTOR SERIES				
Sump	Initial Fill**		Refill**	
	Liters	Quarts	Liters	Quarts
Standard	49	52	38	40

*Add additional 2.8 liters (3 quarts) for transmissions with PTO

**Approximate quantities do not include external circuits

NOTE: Approximate quantities do not include external lines and cooler hose. Fluid fill capacity is dependent on vehicle configuration. Final fluid capacity must be determined by dipstick level (see Mechanic's Tips MT3004EN Section 1 or your Operator's Manual under "Care and Maintenance").

Chapter 5 Operation

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Operation

5.1 Vehicle Operation

After performing the daily inspection and safety checks, you are ready to operate the vehicle. Safety on the road also depends on you. Observe weather and road conditions, then drive accordingly. Be physically and mentally alert.



WARNING

Do not run engine for long periods of time in a closed or poorly ventilated building, where exhaust gases can accumulate.

If, while driving the vehicle, any of the items below are noticed, correct condition immediately.

STEERING ACTION - Binding, wander, shimmy, excessive steering wheel play, pulling to one side.

BRAKING ACTION - Increased pedal travel, slow response, chatter, grabbing, weak, pulling to one side, excessive air pressure drop for brake application.

VIBRATION - From engine, driveline, accessories, wheel imbalance. Scan the instrument panel frequently and be alert for any changes from normal gauge readings.

Refer to appropriate subject in this manual for detailed data.



5.2 Starting the Engine

1. Turn master ignition to first position.
2. Place transmission in NEUTRAL.
3. Turn ignition to ON position by depressing switch to lower position.
4. Depress spring-loaded ignition switch for starter to energize.
5. Check engine oil pressure.

As soon as engine starts, watch the oil pressure gauge. Oil pressure at engine idle speed should be at least 15 to 20 psi, depending on make and model. Consult your engine manufacturer's manual for exact pressure. If oil pressure does not come up within a few seconds, shut down the engine. Locate and correct the trouble before starting the engine again.

6. Check system air pressure gauge, making sure the pressure is increasing. The air pressure warning light and buzzer will be ON until air pressure builds up to a safe operating level. The truck should not be moved until the buzzer and light go off.

Turbocharged Engines

Do not idle or accelerate the engine over 1000 rpm until proper engine oil pressure registers on gauge.

NOTE: The free-floating bearings in the turbocharger center housing require positive lubrication. This is provided by the above procedure before the turbocharger reaches its maximum operating speed, which is produced by high engine speeds. Starting any turbocharged engine and accelerating to any speed above idle before engine oil supply and pressure has reached the free floating bearings can cause severe damage to the shaft and bearings of the turbocharger.

Start and run the engine at idle until oil supply pressure has reached all of the turbocharger moving parts. A good indicator that all the moving parts are getting lubrication is when the oil pressure gauge registers 20 psi (138 kPa) pressure at idle speed.

5.3 Engine Warm-up

After engine starts, let it idle while you check oil pressure, air pressure, and alternator output. The engine should be brought up to operating temperature gradually while oil films are reestablished between pistons and liners, shafts and bearings.

In colder climates, when temperature is often below 32°F, the warm-up period for turbocharged engines is especially important. The chilled external oil lines leading to the turbocharger will tend to slow oil flow until the oil warms up. Slow oil flow to turbocharger reduces oil available for bearings. Watch engine temperature or oil pressure gauge for a warming trend before increasing engine idle rpm.

After a couple of minutes of idling at 700 rpm, increase engine speed to 900 or 1000 rpm and continue warm-up. This procedure allows the oil to warm up and flow freely while pistons, liners, shafts, and bearings expand slowly and evenly. Idling the engine too slowly does not allow sufficient splash lubrication of cylinder walls and may result in excessive wearing of pistons and liners. Idling too fast during warm-up will cause too rapid and uneven expansion, resulting in premature engine wear.

Continue the warm-up until the coolant temperature reaches at least 130 °F. At this temperature, part throttle is permissible. Do not operate at full throttle until the coolant temperature is at least 160°F.



5.4 Transmission Warm-up

Automatic Transmission

Leave in NEUTRAL. This lets all parts turn, except the output shaft, and will warm fluid in the transmission.

5.5 Air System

Observe the system air pressure gauge, while the engine is warming up, to be sure the reservoir air pressure is increasing. The low air pressure warning light will go out. Do not release the parking brake nor attempt to move the vehicle until air pressure is at least 90 psi.

5.6 Idling

CAUTION



Avoid unnecessary or prolonged idling. Long periods of idling, with resultant low engine temperature, may cause gummed piston rings, clogged injectors, and possible engine damage due to lack of lubrication from low oil pressure.

5.7 Power Steering

While operating the vehicle, the driver should avoid deep ruts or obstructions, which cause a binding condition on front wheels.

Operation

5.8 PreDriving Tips



WARNING

Driver's Footwear

Sutphen Corporation, at no time, recommends driving apparatus while wearing fireman's structural or large boots. Due to the size of the brake pedal and the throttle pedal, there is better control when not wearing structural fire fighting or large boots.

1. Adjust seat(s).
2. Fasten seatbelt and make sure all other passengers have seatbelts on.
3. Check ALL operating temperatures and pressures are within normal range.
4. Check to see that the interaxle differential (if tandem axle) is unlocked.
5. Check service brake operation and air pressure gauges.

Per NFPA 1901 guidelines, "Fire helmets shall not be worn by persons riding in enclosed driving and crew areas. Fire helmets are not designed for crash protection and they will interfere with the protection provided by head rests. The use of seat belts is essential to protecting fire fighters during d



5.9 Class 1 Programmable Load Manager 2 (Optional)

Sequencing to reduce strain on the chassis charging system, loads controlled by the load manager may be programmed to turn on in sequence when the activating input is triggered. Each load can be assigned to one of four sequence stages. The loads will sequence off in reverse order.

Shedding

To reduce the demand on the chassis charging system, nonessential loads controlled by the load manager can be programmed to turn off under conditions of extreme electrical load. All twenty-four outputs controlled by the load manager can be assigned to shed at one of eight priority levels, including a never-shed priority. Loads will begin to shed when the system voltage drops below 12.8 VDC, and all loads programmed to shed will turn off after the system voltage drops below 11.5 VDC. In order for a load to shed, the system voltage must drop below the shed point voltage for a thirty seconds. Shed loads will remain off until the system voltage rises above the unshed point for ten seconds. Load shedding is only active with the park brake set (scene mode). Each load controlled by the load manager can be given a shed priority independent of its sequence priority. To reduce the demand on the chassis charging sequence priority.

Automatic High Idle

To increase alternator output under conditions of extreme electrical load, the load manager will boost the engine idle speed after the system voltage drops below 12.8 VDC for eight seconds. The high idle will remain active as long as the voltage remains below 12.8V and for 3 minutes after the system voltage rises above 12.8V. Automatic high idle will only be available with the park brake set, transmission in neutral, and when the vehicle is not in pump mode. The automatic high idle function can be momentarily deactivated by depressing the brake pedal. Automatic high idle mode is indicated by the HIGH IDLE light in the dash displaying the brake pedal. Automatic high idle mode is indicated by the HIGH IDLE light dash display.

Low Voltage Light and Alarm

The load manager provides a LOW VOLT light in the dash display and activates the alarm when the system voltage falls below 11.9 VDC. The load manager provides a C.


Operation

5.10 Class 1 Total System Manager Operational Data Sequencing

Electrical loads may turn on sequentially in order from one to four when their respective switch is activated. Loads will sequence off in reverse order. Electrical loads activated. Loads will sequence off in reverse order.

Shedding

Electrical loads will be turned off (shed) when the system voltage drops to the shed point for thirty seconds (this prevents load shedding due to momentary system power loading, such as high-current start-up devices). Once shed, loads will remain off until the unshed voltage is achieved for ten seconds. Electrical loads will be turned off (shed) when the system voltage drops to the shed point for thirty seconds (this prevents load shedding due to momentary system power loading, such as high-current start-up devices). Once shed, loads will remain off until the unshed voltage is achieved for ten seconds.

12 Volt System		
Priority	Shed Voltage	Unshed Voltage
7	<12.8V	>12.7V
6	<12.7V	>12.6V
5	<12.5V	>12.4V
4	<12.3V	>12.2V
3	<12.1V	>12.0V
2	<11.9V	>11.8V
1	<11.5V	>11.3V
0	Never Shed	



Low Voltage Alarm

Whenever the system voltage drops below 11.9 VDC, a low voltage alarm output (ground) is activated. This complies with the NFPA 1901 requirements.

NOTE: SHED POINT is the voltage that will cause a load to be turned off if the system voltage drops to this point.

UNSHED POINT is the voltage that must be achieved before a load is turned back on once it has been shed.

Operational Voltage

7.5 to 20 VDC
7.5 to 20 VDC

Digital Inputs

The Super node II has twenty-four digital inputs. Each of the inputs can be configured for either positive or ground polarity. The super node II has twenty-four digital inputs. Each of the inputs can be configured for either positive or ground polarity.

▽ **Operation**

Outputs

There are eighteen high current power outputs capable of supplying 13 A continuously at an ambient temperature of up to 185° F.

There are six low current ground outputs capable of supplying 2A continuously at an ambient temperature of up to 185° F.

Each of the twenty-four outputs can be configured to turn off and on with any of the twenty-four digital inputs.

Outputs are protected against thermal overload and short circuits.

Electrical Protection

The Class 1 Programmable Load Manager features ESD, Transient, and Load Dump voltage protections to the SAE J1113 specification for heavy duty trucks (24V).age protections to the SAE J1113 specification for heavy duty trucks (24V).

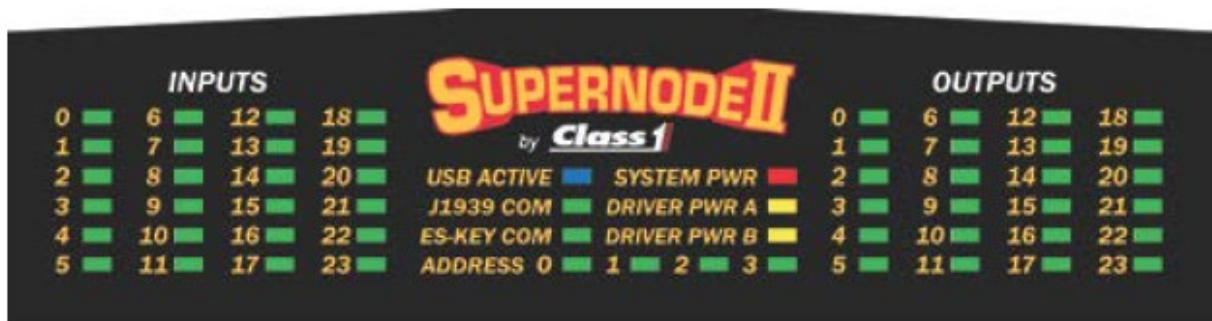
On-the-go troubleshooting

The current status of the inputs and outputs can be seen on the front of the Programmable Load Manager by viewing the indicator LEDs. The LEDs will be illuminated when the input or output assigned to it is active.

Note: Momentary-switched inputs will only be illuminated when the switch is depressed.

The current status of the inputs and outputs can be seen on the front of the Programmable Load Manager by viewing the indicator LEDs. The LEDs will be illuminated when the input or output assigned to it is active.

Note: Momentary-switched inputs will only be illuminated when the switch is depressed.





5.11 Interaxle Differential (Tandem Trucks Only)

Normal operation on dry, paved surfaces is in the UNLOCK position. This allows differential action between the tandems, which is easier on the rear axles and tires and gives better performance.

Shift into LOCK position for operating on slippery surfaces, such as:

- Ice or snow (with or without tire chains)
- Dirt roads, loose sand, mud, or other off-highway conditions

Do not exceed 25 mph with differential lock engaged, or damage will occur to differential. Lock in the interaxle differential before getting into slippery road conditions. Do not wait until tire grip is lost and the wheels are spinning. Any attempt to shift to LOCK with the tandems out of synch could result in rear axle damage.

When shifting to the LOCK or UNLOCK position, ease up on the throttle pedal to take the load off the drive train. The interaxle differential may be engaged or disengaged under normal operating conditions, provided the rear wheels are not slipping or spinning.

5.12 Rear Axles (Locking)

Some Arvin Meritor drive axles are equipped with a traction equalizer. It will maintain an appreciable amount of wheel end traction in all operating conditions while still allowing the vehicle to negotiate turns smoothly. This is accomplished with the ability of the traction equalizer to slip above a certain torque value and remain rigid below this torque value.



CAUTION

Tire sizes on both rear wheels should be the same on axles equipped with a traction equalizer. If not, excessive wear may occur to the traction equalizer.



WARNING

To avoid personal injury or property damage, pay strict attention to the following: If your vehicle is equipped with any type of locking or limited slip differential, power will be transmitted to the opposite wheel, should one of the wheels slip. Both wheels must be raised free of the ground, should it be necessary to operate one wheel with the vehicle stationary; otherwise the wheel that is not raised will pull the vehicle off its support, possibly resulting in personal injury. As with any vehicle, care should be taken to avoid sudden accelerations when both drive wheels are on a slippery surface. This could cause both drive wheels to spin and allow the vehicle to slide sideways on the crowned surface of a road or in a turn and possibly result in loss of vehicle control.

Arvin Meritor traction equalizers require an EP oil with a friction modifier added. Suitable concentrated additives that can be added to conventional EP oils are available from some oil suppliers.



Driver-Controlled Differential Lock

Some Rockwell drive axles have driver-controlled differential lock. The air actuated traction device can be manually shifted from the vehicle cab. By actuating a switch, mounted on the instrument panel, the driver can lock or unlock the differential when the vehicle is moving or stopped.

NOTE: IMPORTANT. When the differential is fully locked, the vehicle will have a slight understeer condition. This will increase the turning radius of the vehicle.

The driver must limit the use of the differential lock to low vehicle speeds under 25 mph. Also, the differential must not be locked when the vehicle is traveling down a steep grade and traction is minimal.

It is mandatory that the owner/operator refer to the separate driver-controlled main differential lock owners manual provided with the vehicle for additional instructions, warnings, and required operational tests.

5.13 Allison Automatic Transmission

The following basic operating techniques apply to all Allison automatic transmission, regardless of gear ranges or selector positions.

Care must be used to monitor the transmission temperature. TURN OFF if the temperature raises to the 300°F (149°C) level.

In case of an ABS event, the secondary brake will be turned off automatically.

CAUTION



The retarder will not bring the chassis to a stop. You must apply the chassis brake to bring the vehicle to a full stop.

WARNING



Vehicles equipped with a secondary braking device can loose control in wet or slippery road conditions if ABS system is in the failure mode. See manufacturer's manual for Safe Operating Practices.

NOTE: For information on Allison automatic transmissions, see Appendix A, 3000/4000 OPERATOR'S MANUAL - EMERGENCY VEHICLE SERIES.

5.14 Driving Off

1. Make sure overhead door is all the way up for complete clearance.
2. Push parking brake control IN to release parking brake before moving.
3. Make sure truck clears building completely before making turn.
4. Verify all warning indicators are “OFF”.
5. Verify overhead light bar status.
6. Put transmission into drive by touching the drive button in shift.
7. When driving, be alert to the following:
 - FUEL FUMES - Indicate a fuel leak and potential fire hazard. This condition should be corrected immediately.
 - EXHAUST FUMES - Indicate a leaking exhaust system. At first opportunity, have exhaust system checked and repaired.
 - EXHAUST SMOKE - Indicates excessive fuel consumption or a mechanical problem causing high oil consumption.
 - EXHAUST NOISE - Leaking manifold, joint, pipe, or muffler. Illegal if noise exceeds allowable limits.



5.15 VDR / Seat Belt Monitor

Overview

NFPA 1901 Standard for Automotive Fire Apparatus 2009 has mandated a Vehicle Data Recorder (VDR) (4.11) and Seat Belt Monitoring System (14.1.3.10) in every vehicle sold after January 1, 2009.

The VDR on Sutphen Vehicles is located under the rear facing officer seat. Communications from the vehicle's Controller Area Network and discrete wiring supply data about the vehicle's operation.

This data is stored and can be retrieved using the vendor's software.

The seat belt monitoring system is integrated into the VDR. This system monitors occupant status and audibly/visually alarms faults. Displays are mounted for the driver or officer to see. Audible alarms must be able to be heard from all seating positions.

Operation

Components

At this time, we offer two brands of systems - Weldon (standard) and FRC.



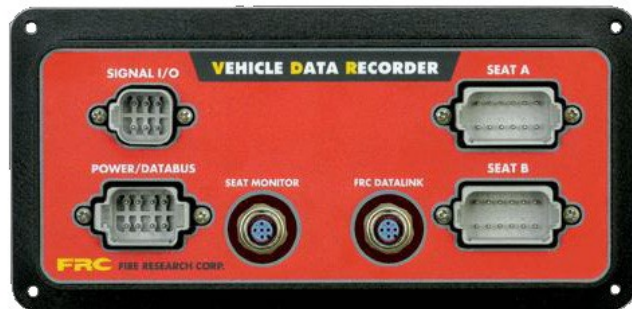
Weldon Display



Weldon VDR



FRC Display



FRC VDR

Operation

Seating

Seating status can be seen on the display. A sensor in the seat cushion will detect an occupant. A switch on the seat belt receptacle monitors the seat belt. The display will light red for an occupant present, but not buckled. Once buckled, the image goes to green.



FRC

When vehicle speed exceeds 5 MPH with an occupant not buckled, the audible alarm will sound.



Weldon

When the park brake is released with an occupant not buckled, the audible alarm will sound.

Buckling will silence the alarm.

If the seat cushion senses no occupant for more than five seconds (whether the seat is actually occupied or not), the red light will display. The seat belt must be released and reconnected in order to reset the red light to green.

VDR

While driving, the VDR will monitor and log the following data:

- Vehicle Speed
- Acceleration
- Deceleration
- Engine Speed
- Throttle Position
- Anti-lock Braking Event
- Seat Occupied Status
- Seat Belt Status
- Master Optical Status
- Time
- Date

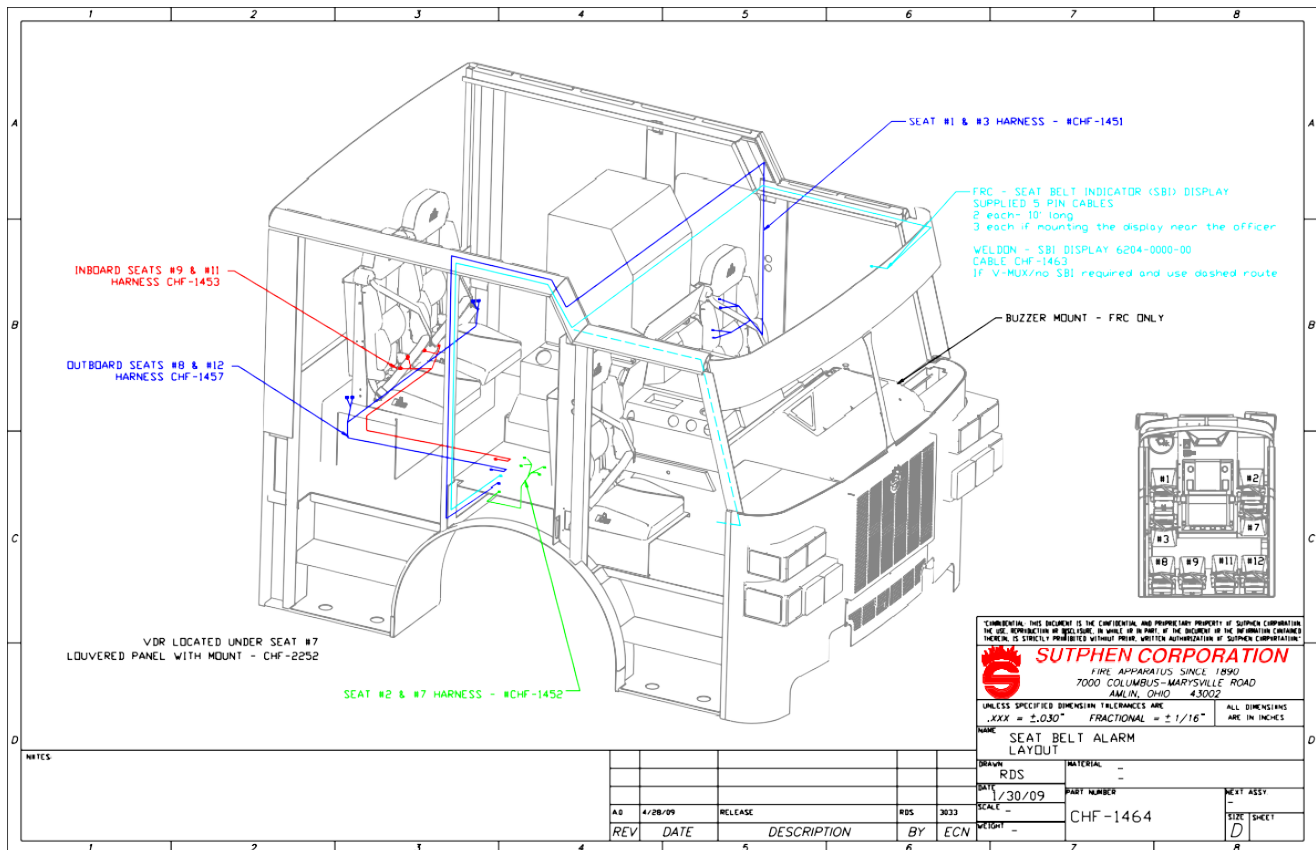
This data can be retrieved with software provided by the vendor's Web site.

NOTE: The monitoring and logging of the "Master Optical Status" is important for drivers to know. Any time the vehicle is responding to a call, the "Master Optical" must be on and all red lights on the cab light bar will be illuminated.

Operation

Engineering

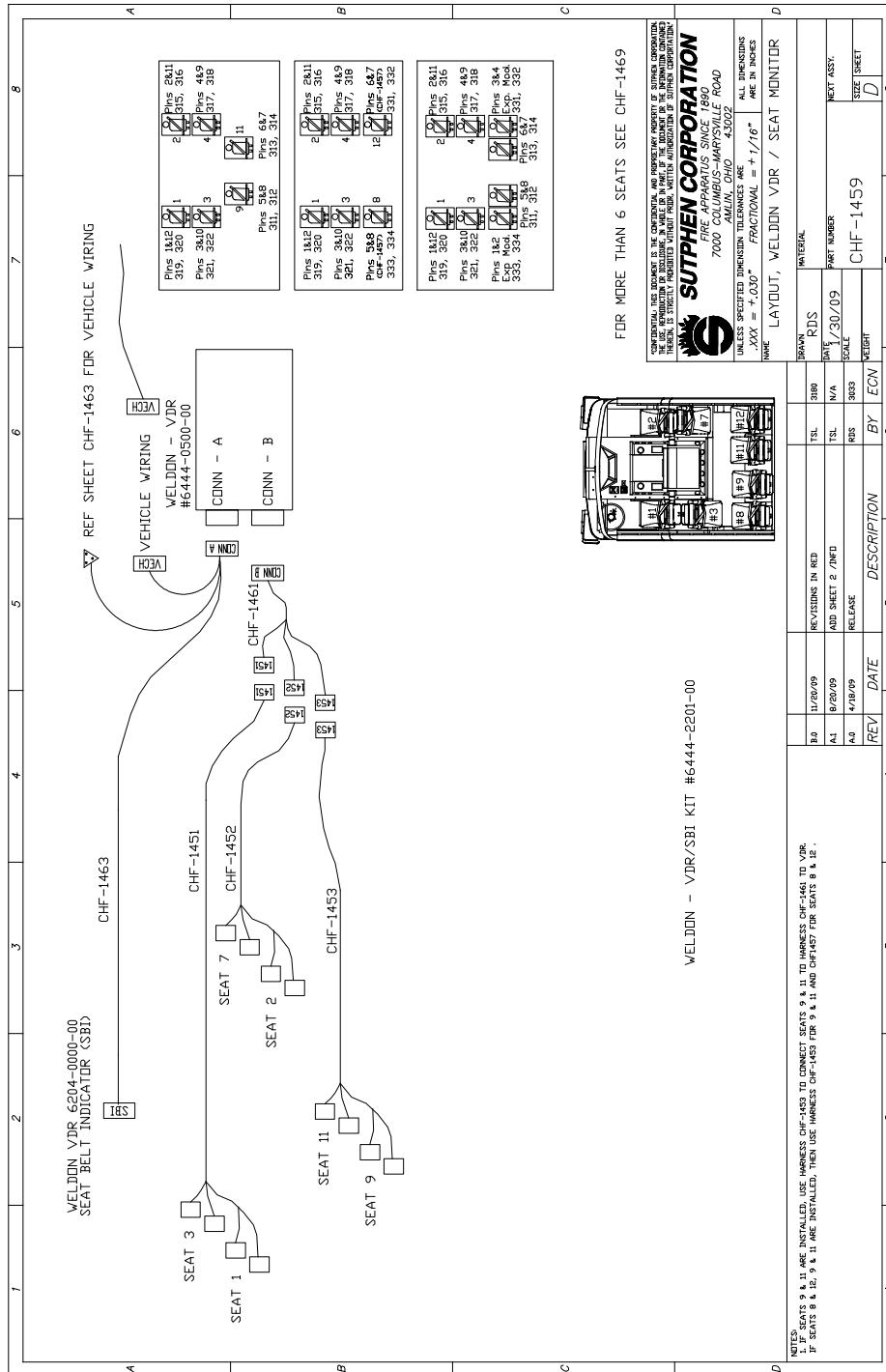
Wiring layout is shown below. Note the seating position numbering located on the overhead view insert.





Weldon System Layout

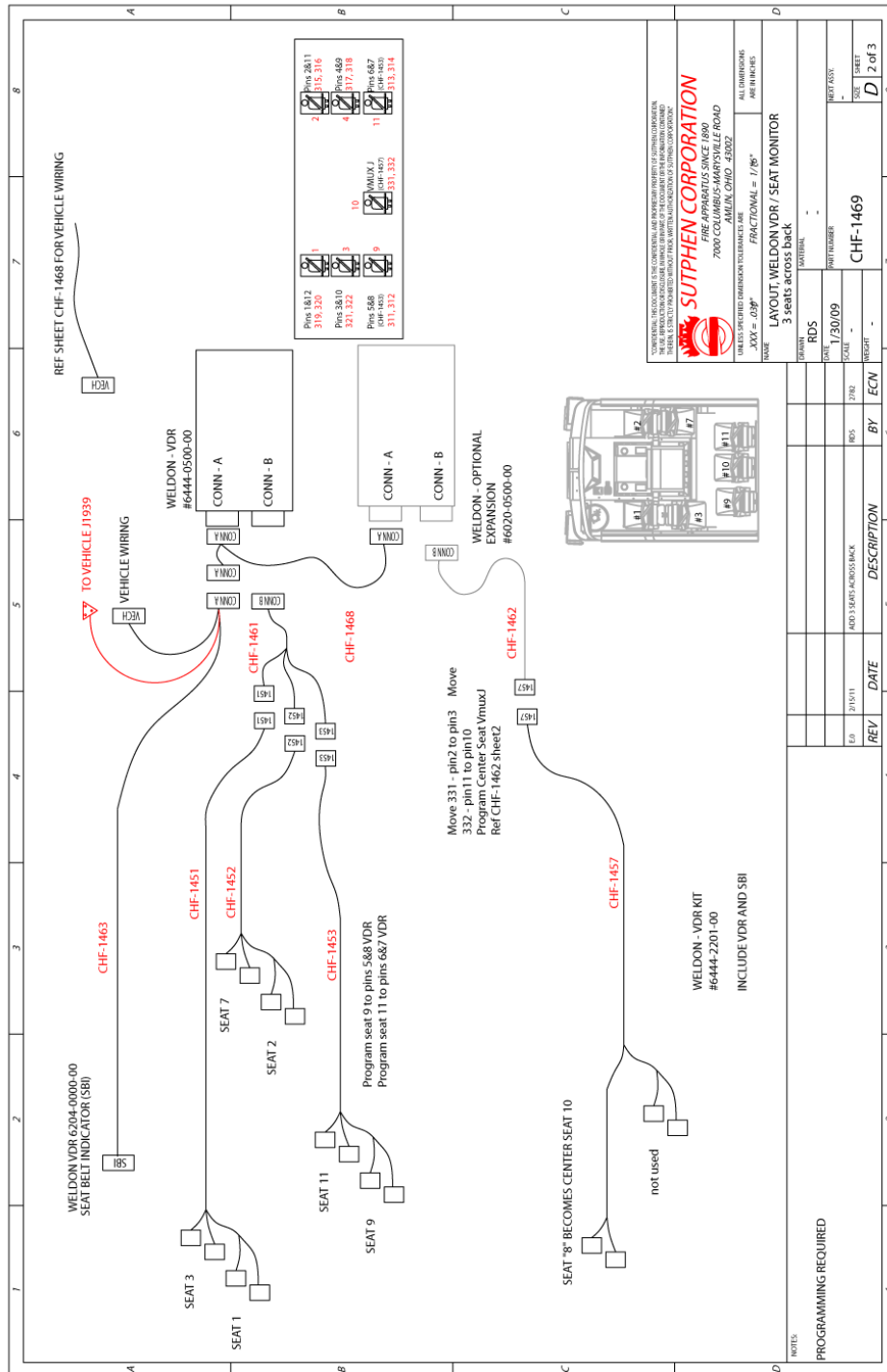
Less than 6 seats



All passwords for the Weldon System - VDR



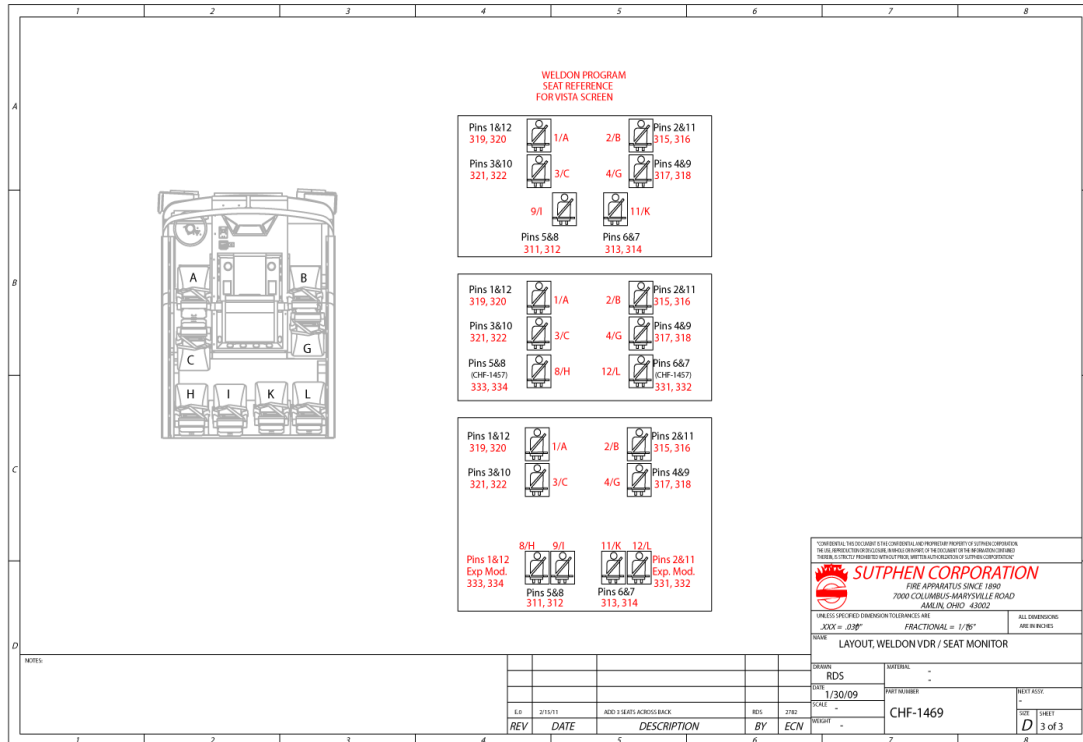
Three seats across back



All passwords for the Weldon System - VDR

Operation

FRC System Layout



FRC passwords are configured during software installation.

Contact Information / Factory Support

Technical Support (937)969-8851

Weldon

Additional information/downloads at www.weldoninc.com

FRC

Additional information/downloads at www.fireresearch.com



5.16 Accelerating

The practice of rapidly accelerating a loaded vehicle from a stand-still can cause severe damage to the propeller shaft, transmission and rear axle. Normal service life of these components can be greatly extended by gradual and smooth acceleration.

Engine torque is multiplied by the transmission, and rear axle gear ratios. Propeller shaft torque can be eight to ten times the crankshaft torque in first gear low range, depending upon the particular transmission installed. Axle shaft torque may be as much as thirty times that of the crankshaft torque.

If the driver were to unnecessarily accelerate a fully loaded vehicle with full throttle in the lower gears, the resulting propeller shaft and axle shaft torques would be tremendous and would certainly cause greatly reduced service life, if not immediate damage. It is possible to start any legal load smoothly without creating excessive strain on the driveline components.

NOTE: Always accelerate the vehicle gradually and smoothly, especially when in lower gears.

5.17 City Driving (Cruising)

Operate the engine in the preferred rpm range to obtain optimum performance and reduce stresses and wear. Avoid lugging the engine for any extended period of time, as this reduces engine life. Consult your engine manufacturer's operation manual for the preferred operating range.

Observe the tachometer and operate the engine within its economical rpm range with a minimum of gear shifting. It is not necessary to keep the engine revving in its high rpm range.

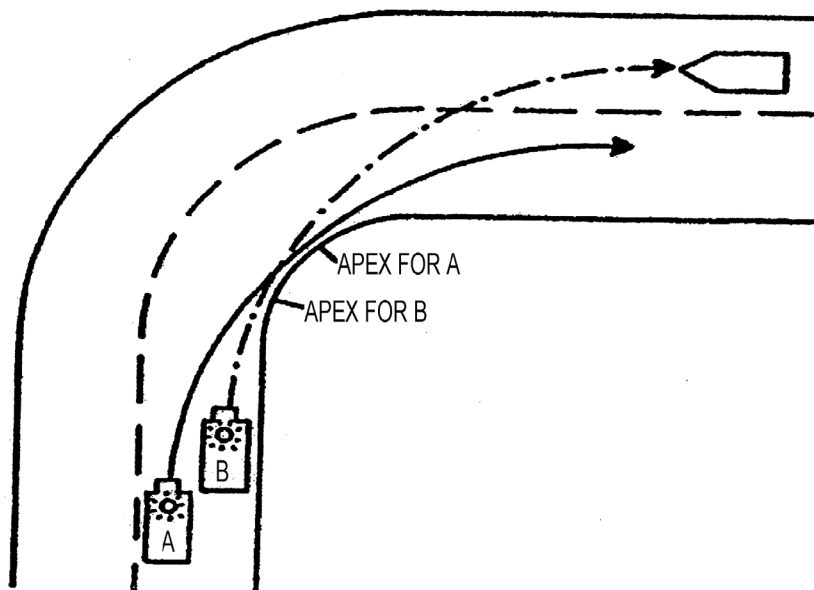
Cruise at partial throttle whenever conditions permit. When approaching an upgrade, smoothly apply full throttle, so that the climb will be started at full power. Downshift as necessary to maintain vehicle speed without lugging the engine.

For your particular engine and operating conditions, refer to the engine manufacturer's operating manual.

5.18 Techniques for Negotiating Curves at High Speed

The entire curve must be considered. Following are the three points which are critical when negotiating curves:

1. Proper speed and vehicle position for entry to curve.
2. Maintaining speed in curve.
3. Proper speed and vehicle position for exit from the curve.



a. A. Entry

- i. Brake or decelerate to the proper entry speed before entering the curve.

NOTE: Proper speed is different for every curve.

For any curve, the entry speed can be increased somewhat by entering the curve on the “high” or outside of the curve.

- ii. Enter the curve as far to the outside as possible.



NOTE: Entering on the outside of the curve effectively increases the radius of the track for the emergency vehicle. The greater the radius, the faster the turn can be safely negotiated.

iii. Begin turn as early as possible.

NOTE: Inexperienced drivers invariably go too deep into the curve before starting to corner vehicle.

4. Establish an apex (when beginning the turn) at last part of inside road edge (or centerline) that can be seen from the entry point.

**NOTE: The apex is the point on the inside of curve where vehicle comes closest to road edge or centerline.
Generally, the farther along the curve the apex is, the better.**

Be sure trainees understand the apex illustration. Key points:

- a. The assumed speed and the radius of vehicle track for both A and B are identical.
- b. A has started entry:
 - i. Early.
 - ii. On the high (out) side.
- c. Apex for A is farther along the curve than apex for B.
- d. B is going to have a serious accident.

Operation

5.19 Over speeding Engine

Exercise care when downshifting or when using the engine as a brake on downhill grades. Engine overspeed can occur under these conditions because the engine governor does not function as a brake. If engine rpm approaches the top limit, apply brakes or shift up to a higher gear.

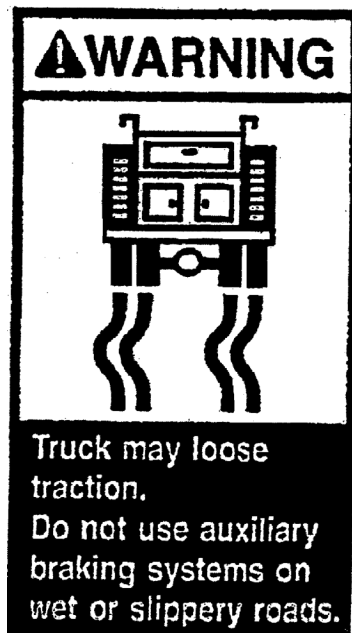
5.20 Jacobs Engine Brake



WARNING

Shut Jacobs brake off when roads are slippery, to prevent skidding.

The Jacobs Brake is coupled to the engine exhaust valve train. When actuated, it prevents power strokes from occurring, and the engine works as a retarding force on the vehicle.



The Jacobs Brake is controlled by a panel-mounted switch. With the control switch on, the engine brake will function whenever foot pressure is removed from the throttle. Depressing the throttle pedal will deactivate the engine brake.

Some engines offer a three-position control switch (LOW/MEDIUM/HIGH) to control braking force and others have a switch for ON/OFF to control braking force. Set the switch in desired position. Turn the control switch off when braking effect is not desired.



5.21 Exhaust or Compression Brake (Optional)

Jake Brake/Jacobs Extarder/Smart Brake



WARNING

Vehicles equipped with a secondary braking device can lose control in wet or slippery road conditions if ABS system is in the failure mode. See manufacturer's manual for safe operating practices.

Description: The secondary brake is a vehicle slowing device only, not a vehicle stopping device. It therefore is not a substitute for the service braking system. The vehicles, service brakes must be used to bring the vehicle to a complete stop.

Operations: Activating dash switch will create automatic braking when throttle is at 0 percent. This is a diesel engine retarder and is power absorbing by exhaust restriction similar to an air compressor or a vacuum pump.

The brake will operate with, or without, service brake application.

All brakes are most effective at governed engine speeds. Lower gear selection will give maximum retarding power.

In the case of an ABS event, the secondary brake will be turned off automatically.

Some secondary brake designs have a switch for selection of high, low, and/or medium-absorbing capacity.

The exhaust brake will also engage service brake lights.

 **Operation**

5.22 Electric Driveline Retarder (Optional)

Description

The Electric Driveline Retarder is an auxiliary braking device located in the driveline. Its purpose is to supply additional braking torque to avoid fading of the chassis brakes that results from frequent stopping. This will allow the chassis brakes to be more effective in the event of a braking event. The electric retarder must be used during normal driving conditions.

Operation

The Electric Driveline Retarder is activated through application of the brake pedal. The level of effectiveness is increased as the pedal is further depressed. The levels of progression are displayed by the four amber indicator lights on the instrument panel. Whenever the Retarder is activated, the brake lights will illuminate.

The toggle switch (on/off) located on the switch panel will enable or disable the retarder operation. This switch is used to disable the retarder in the event of wet or slippery road surfaces.

CAUTION



The retarder will not work when the apparatus speed is below 3 mph. You must apply the chassis brake to bring the apparatus to a full stop.

The Electric Driveline Retarder is also integrated with the Antilock Braking System (ABS). This will automatically disable the retarder should an ABS event occur. Monitoring of wheel rotation speed is continually performed by the ABS system at all times.

WARNING



Vehicles equipped with a secondary braking device can lose control in wet or slippery road conditions if ABS system is in the failure mode. See manufacturer's manual for safe operating practices.



5.23 Braking

The distance the brake pedal (treadle valve) is depressed regulates the amount of air pressure delivered to brake chambers, which, in turn, determines braking force.

Best stopping performance is achieved when the brakes are gradually applied as hard as vehicle speed and road conditions permit and are then gradually released as speed decreases. As the vehicle comes to a stop, there should be only enough air pressure in brake chambers to hold the vehicle stationary. Applying brakes lightly at first and then harder as speed decreases results in a rough stop. Do not pump the brake pedal as this wastes compressed air and increases stopping distance. Depress the brake pedal fully only in cases of emergency.

Use steady brake application, rather than snubbing, to slow the vehicle when descending a hill. The total brake energy is the same for intermittent snub as for steady brake application, but the rate of braking is higher when snubbing; therefore, lining and shoe temperatures will reach higher values and wear will be more rapid. Cooling between snubs is negligible.

There shall be 90 psi air pressure in the air brake system before the vehicle is moved. Parking brakes are not fully released at lower pressures.

CAUTION



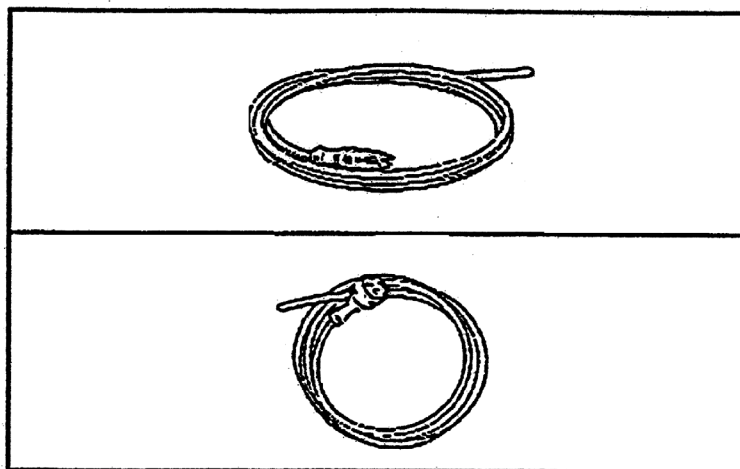
To avoid loss of vehicle control and possible personal injury, never operate the vehicle when insufficient air pressure [less than 70 psi (483 kPa)] is indicated for either system, since the volume of air required to stop the vehicle may be greater than that available. Have the brake system checked and repaired before returning the vehicle to service.

NOTE: For information on anti-lock braking system (ABS). See Appendix B, MERITOR WABCO MAINTENANCE MANUAL MM-0112

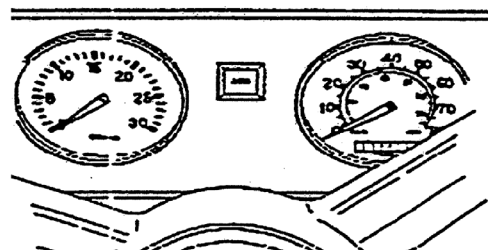
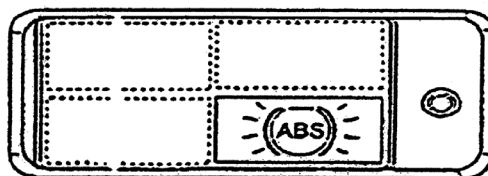
Operation

5.24 Antilock Braking Systems (ABS) for Trucks, Tractors, and Buses

NOTE: For more information refer to Appendix B - Anti-Lock Braking System (ABS) for Trucks, Tractors and Buses



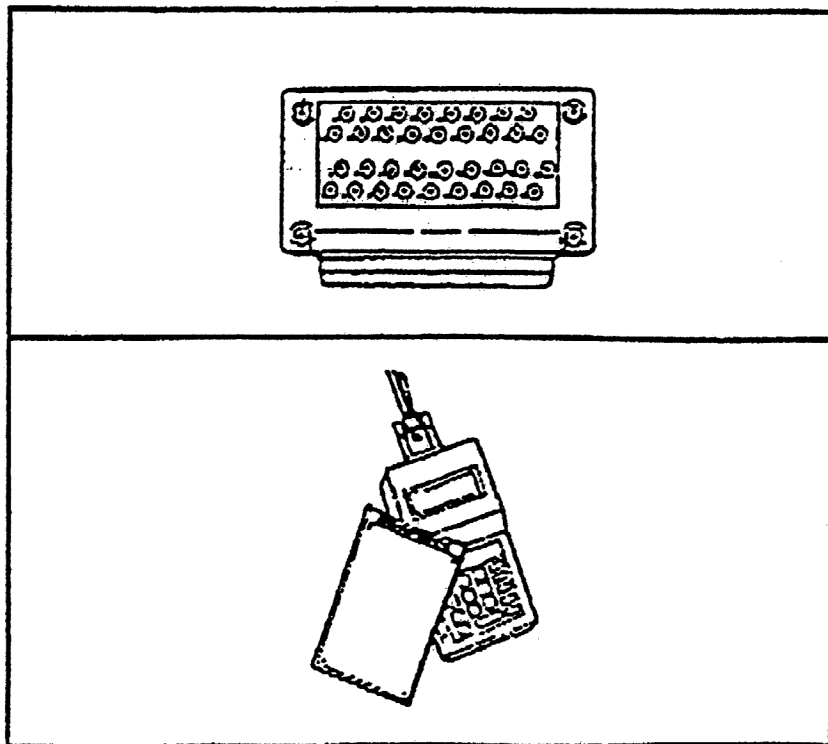
1. Sensor Extension Cables connect the sensor to the ECU.
2. The ABS Modulator Valve Cable connects the ABS valve to the ECU.



3. The ABS warning lamp comes on when the ignition switch is activated. The lamp goes out when the speed of the vehicle reaches approximately 4 mph (6km/h). If the warning lamp remains lit or comes on at any other time during vehicle operation, it signals a malfunction in the ABS.



Optional Test Equipment



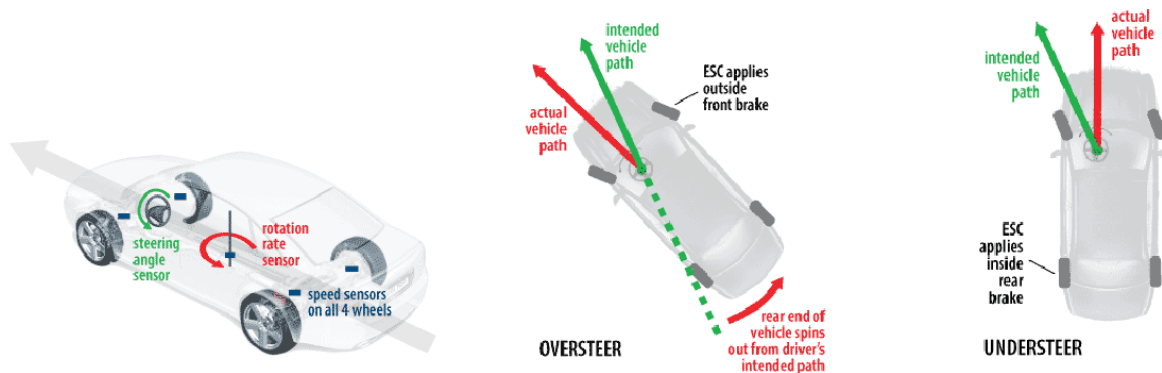
1. The Rockwell WABCO test adapter helps service and troubleshoot the ABS system. Use with cab-mounted ECUs only.
2. The MPSI Pro-Link® 9000 with the Rockwell WABCO cartridge, available from Kent-Moore, lets you test ABS components.

Operation

5.25 Electronic Stability Control (ESC)

Overview

Electronic Stability Control is integral to the anti-lock brake system (ABS). An accelerometer is mounted directly to the electronic control unit (ECU) to monitor the vehicle's lateral acceleration. An electronic stability control module (ESC) is mounted between the frame rails to provide yaw (horizontal-plane rotation) sensing. These systems focus on a vehicle's center of gravity, wheel speed, lateral acceleration threshold and rotational forces to determine if loss of control or a rollover is imminent. When critical thresholds are exceeded, ESC intervenes by reducing engine torque, engaging the engine retarder, and automatically applying the brakes as needed.



NOTE: While stability enhancement systems provide additional driver assistance, no system can prevent loss of control or rollover in all driving conditions. It remains the responsibility of the driver to ensure that the physical limits of a vehicle are not exceeded.

All vehicles equipped with ESC must have an End of Line Calibration Procedure performed prior to shipping. Also, this procedure must be performed in the field by a trained technician if components critical to the ESC are repaired or placed (these items include the Steering Angle Sensor (SAS), the Electronic Stability Control (ESC) module, or the Electronic Control Unit (ECU)).



Calibration is done with Meritor WABCO TOOLBOX software (Ver 8.12.2).

Reference the following web site for detailed information:

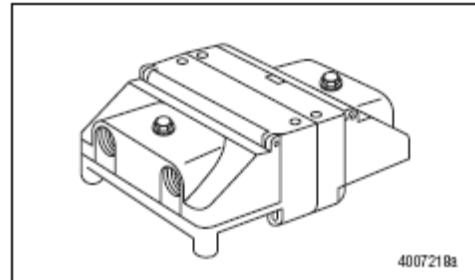
http://www.meritorwabco.com/MeritorWABCO_document/mm0112.pdf

Components

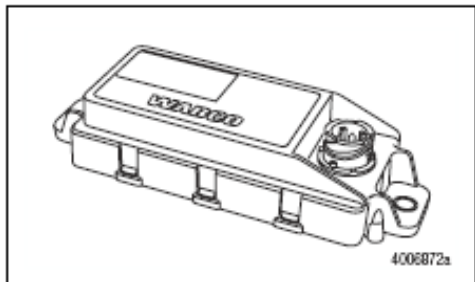
All components are supplied by **Meritor WABCO**.

In addition to the standard ABS components (ABS light, wheel sensors, brake packs), an ESC equipped vehicle will include the following:

- An ECU specifically programmed for that vehicle (part number critical).

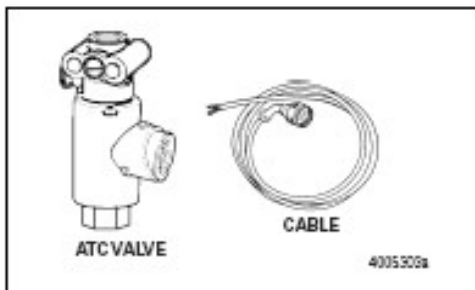


- An ESC module mounted between the frame rails to measure yaw rate and vehicle's rotation.



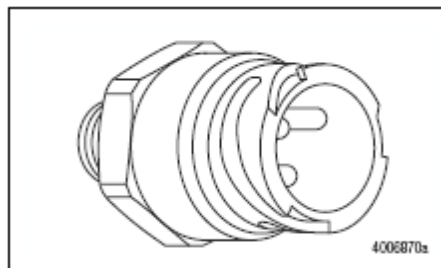
NOTE: Mounting location and orientation is critical.

- An ATC valve on the front and rear axles will control automatic braking.

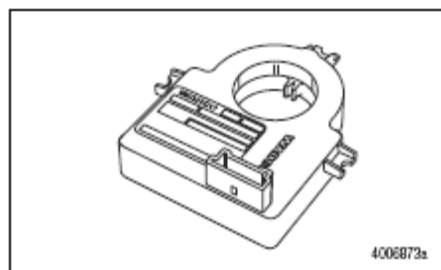


Operation

- A pressure sensor to monitor the driver brake demand in the front and rear axle circuits.



- A Steering Angle Sensor (SAS) to deliver the steering wheel position to the ECU. This sensor is mounted to the bottom of the steering column.



NOTE: Mounting location and orientation is critical.

- An ESC dash fault light is located directly to the right of the "ANTI-LOCK" dash fault light.

Operation

Upon ignition power up, the "ANTI-LOCK" and "ESC" lights will come on.

After a brief diagnostic system check, the "ANTI-LOCK" light will go out, with the "ESC" soon to follow.

In the event either light does not go out as noted above, a fault has been detected. The braking system of your vehicle will continue to operate but will not include the faulted enhancement. Contact your service representative as soon as possible.

If loss of control or a rollover condition is detected, the ESC light will come on during that event and go out when the condition has been averted. The ESC system may take control of your engine performance and control the brake system in an effort to restore control of the vehicle.



Reference drawing CHF-2381 for details.

NOTE: 315 tires = 488-519 rpm

385 tires = 488-519 rpm

425 tires = 459-487 rpm

445 tires = 432-458 rpm

Contact Information/Factory Support

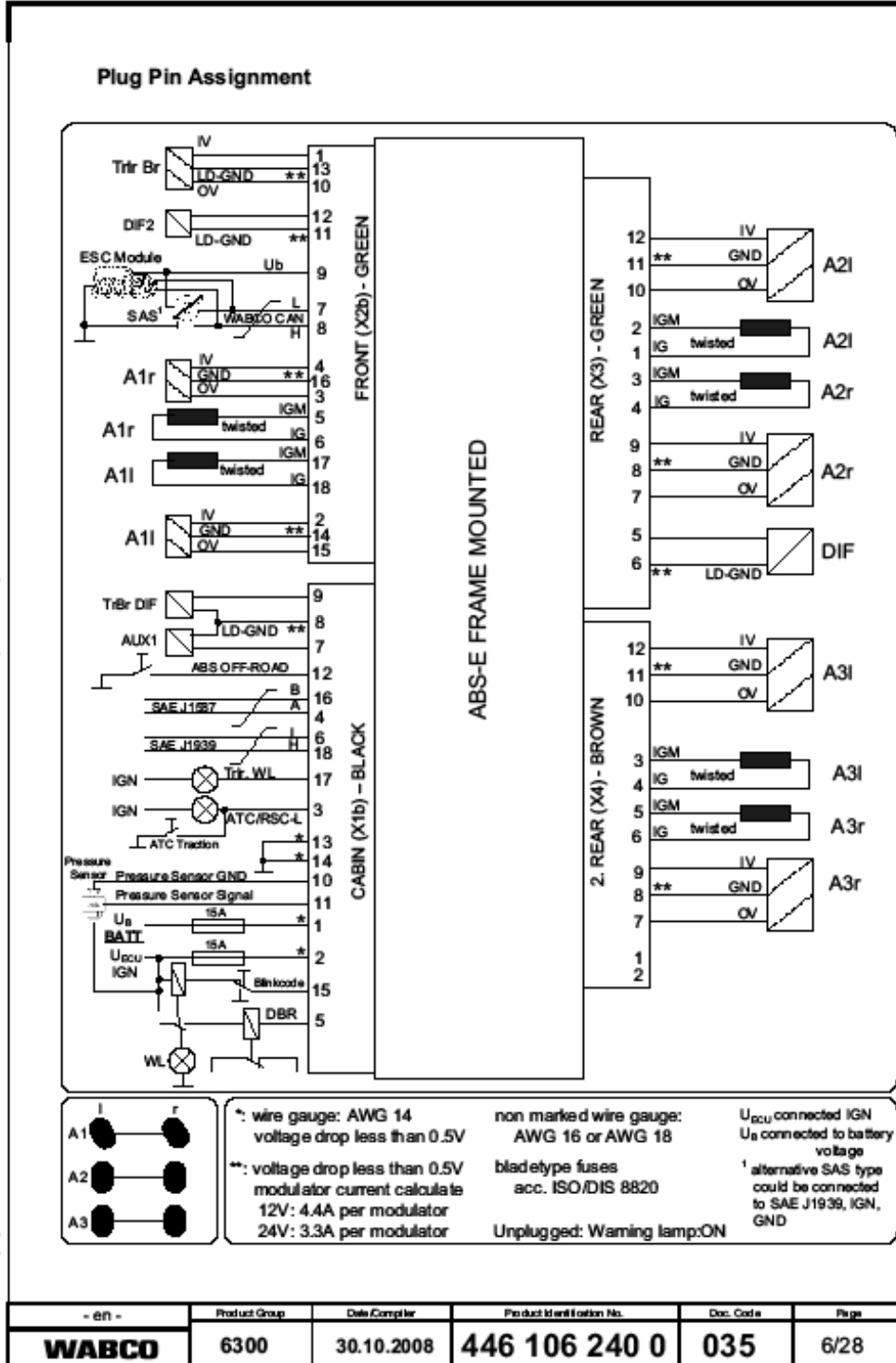
Technical Support (937)969-8851

Operation

Engineering

Pin out for a frame mounted ECU with ESC.

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5.26 Parking and Spring Brake

CAUTION



Do not pump brake pedal truck equipped with ABS. Normal operation light will go out at 4 mph.

The parking, or spring brake control valve, is mounted on the control panel. Placing the valve in RELEASE position delivers air pressure to the spring brake chambers, compressing the springs and releasing the brakes. Moving the valve to PARK position dumps air from the spring brake chambers, allowing the springs to extend and apply the brakes.

If system air pressure ever drops below the safe operating level, the spring brakes will apply automatically, bringing the truck to a safe smooth stop.

In the event the system air pressure cannot be built up to operating pressure because of an engine or compressor malfunction (or a bad air leak), the spring brakes may be released manually at the spring brake chambers.

WARNING



To avoid personal injury or property damage, when manually releasing the spring brakes, be sure to block the wheels, so that vehicle cannot move when the brakes are released.

NOTE: For towing, make sure the vehicle is securely connected to tow vehicle and tow vehicle parking brakes are applied before releasing the disabled vehicle's spring brakes.

1. Remove breather cap on back of spring brake chamber.
2. Tighten bolt under cap until tight; this releases parking brake. Use caution and ensure that truck does not move.

Reset Spring Brakes Manually



WARNING

Under no circumstances should a spring brake chamber assembly be disassembled without following the procedures described in the service manual. Bypassing these procedures may result in severe personal injury or death.

1. Loosen bolt until slight pressure is felt. Tighten the bolt to 40 to 50 lb./ft. (54 to 68 Nm) torque.

5.27 Water Fording

To avoid component damage, corrosion or potentially severe/catastrophic failure to the engine, transmission and/or electrical systems, water fording is not recommended.

Any depth of water which may partially submerge the axles or greater is to be avoided.

CAUTION



As a result of water fording, users may experience engine hydrostatic lock. Hydrostatic lock is caused by the entry of water through the engine air intake system and/or water contamination of the fuel system.

CAUTION



Water is drawn into the engine and may “lock-up” the engine. Hydrostatic lock most frequently occurs during or immediately following fording. Hydrostatic lock may result in severe or catastrophic engine damage.

While it is not recommended and is to be avoided, if accidental or emergency water fording occurs, and the rear axle breathers are submerged for more than a brief period, users should drain and replace the lubricant.

Users should see the axle manufacturer’s lubricant specifications found in the Maintenance chapter of the Operations Manual.

After the accidental or emergency water fording, lubricate all grease fittings below the forded depth to displace water and contaminated grease. Failure to follow these precautions may lead to premature wear or damage to the axles, suspension and driveline components.



If fording is unavoidable and your vehicle is equipped with electromagnetic driveline retarders, it is recommended to turn off the retarder prior to fording. After the accidental or emergency water fording, it is recommended to inspect for debris and inspect the grease unit before returning the vehicle to service. Failure to follow these precautions may lead to damage of the retarder.

The depth of the water that can be safely forded is affected by several factors including environmental and vehicle configuration. Therefore, no definitive fording capability can be established. Avoid depths of water which may partially or fully submerge the axles.

It is important to note the location of the air intake port on your Sutphen apparatus and avoid operation in standing water that will cause water ingestion into the engine. Even splashing water from a seemingly shallow depth can be ingested through the air intake and into the engine.

If water is to be forded, purposefully, accidentally or in an emergency, it is to be done at the operator's risk. If you must attempt water fording, follow the precautions:

- Never attempt water fording unless water depth is known to be a depth not exceeding the height of the axles and the bottom is known to be hard.
- Secure loose objects on the vehicle.
- Make sure battery caps are present and tight.
- Enter water slowly. Entering water too fast may cause water to splash into the air intake.
- Maintain an even vehicle speed while fording, not to exceed 5 MPH (8 KMPH)
- Exit water in area with a gentle slope

 **Operation**

If water ingestion into the air intake system is suspected, or the vehicle has been driven in high water conditions, then the following procedures should be followed:

1. Check air intake for moisture. Remove the air intake piping ahead of the air cleaner and check the filter for moisture. If the filter is only partially wet with some dry paper area, then chances are very good that no water entered the engine. Allow the filter to dry or install a new filter.
2. Inspect components for damage. If the entire filter element is saturated, the proceed to have the engine checked by an authorized service center. Check fan for cracks in blades or missing blades. Analyze samples of oil from the axles, engine and transmission for water content. Change fluids as required.

5.28 Pump Operation

See Hale pump book in back of manual.



5.29 Fire Pump Engagement With Allison EVS 3000/EVS 4000 Transmission with Air Pump Shift

Engine must be at idle rpm.

Place Main Fire Pump in Gear

CAUTION



Do not pump the truck unless light is on.

1. Truck must be stopped and parking brake set.
2. Truck transmission must be in NEUTRAL position.
3. Move the in-cab pump shift control valve from the ROAD position to the PUMP position. Pause in neutral position briefly before finishing full shift to deplete all air out of line. The shift warning lights should come on in a second or two, indicating a completed shift. (Wait about 2 seconds to allow pump gears to make full travel to complete engagement). At the same time the pump shift is activated, the lock-up for the automatic transmission has also been engaged but is delayed until this device will hold the transmission in the pumping gear position.
4. Shift transmission to D position. Power from the engine is now being transferred to the pump drive gear and pump impellers are turning. Check to make sure the pump is in gear. The green light must be on and speedometer registering. If not, repeat steps 2, 3, and 4 and see if light comes on. If light does not come on, inspect and correct problem and lockup light will come on when true lockup is obtained. Operator is free to move to pump operator's panel and the tachometer at pump panel is working, as it will not work unless in pump gear.

Optional Pump Shift Emergency Override Operation

1. Put transmission in NEUTRAL.
2. Put PUMP POWER SHIFT in the center position.
3. At pump panel, pull out on PUMP OVERRIDE CABLE.
4. In cab, shift transmission into 1-4 range.

Put PUMP POWER SHIFT in PUMP POSITION. That will transfer the power to pump panel.

5.30 Shifting Instructions



WARNING

Failure to properly shift transmission may result in unexpected truck movement, which may result in serious personal injury or death.

Pneumatic Pump Shift

Shift to PUMP as follows:

1. Bring truck to a complete stop.
2. Reduce engine to idle speed, put truck transmission in NEUTRAL.
3. Set truck parking brake.
4. Move pump shift control to PUMP position.
5. Wait at least four seconds.
6. Shift truck transmission into pumping gear.

CAUTION



Shifting truck transmission into pumping gear above engine idle speed may cause damage to the equipment.

7. Green PUMP ENGAGED and OK TO PUMP lights should be on.

CAUTION



If green OK TO PUMP light is not on, momentarily shift truck transmission into REVERSE, then NEUTRAL, then back into pumping gear. Green OK TO PUMP light should be on. If green light is not on, use manual override if so equipped.

8. Increase engine speed above idle and hold for a few seconds. Watch speedometer to make sure it shows some value of road speed.

NOTE: Some fire trucks have a speedometer that will not show a value of road speed in a stationary position.

WARNING



If the truck attempts to move, reduce engine speed to idle. Put truck transmission in NEUTRAL and repeat shifting instructions.

9. After leaving truck cab, block wheels using wheel chocks.



Shift to ROAD as follows:

1. With engine speed at idle, put truck transmission in NEUTRAL.
2. When speedometer slows to zero, move pump shift control to ROAD position.
3. Wait at least four seconds before engaging truck transmission.

CAUTION



If you hear a loud grinding noise when you attempt to move the truck, the shift to ROAD has not been completed. Shift into NEUTRAL, wait for grinding noise to stop and reengage truck transmission.

NOTE: If grinding is a common occurrence, it may be prevented by first shifting truck transmission into REVERSE after completing Step 3.

5.31 Heat Exchanger

This truck is equipped with an inline heat exchanger on the left top side of the engine to help cool the temperature of the cooling system while pumping by use of the cool water going through the pump. Engine coolant flows through the heat exchanger and outside water flows from the pump discharge through the tubes in the cooler in the exchanger and back into the pump suction. This system of auxiliary cooling prevents pump water from mixing with the coolant in the engine or radiator. This system is in the open position when it leaves the factory, but could be turned off if so desired. If so desired, it could be shut off in the winter time. This is done by turning the valve handle to the sides on the top of the heat exchanger.

5.32 Before Stopping Engine

ENGINE OPERATING GUIDELINES

1. AFTER FULL LOAD OPERATION, LET ENGINE IDLE FOR 3-5 MIN BEFORE TURNING OFF
2. TO IDLE FOR EXTENDED TIME, ENGAGE HIGH IDLE SWITCH
3. AFTER REGENERATION, IDLE FOR 30 MIN. TO COOL ENGINE
4. REFER TO SECTION 99-101-009 OF THE CUMMINS OWNER'S MANUAL FOR ADD'L INFO

 **Operation**

A hot engine has a great deal of heat stored up in its iron mass. Let the engine idle at 1000 rpm for 3-5 minutes, then at low idle for 30 seconds before shutting it down. This will allow circulating coolant and lubricating oil to carry heat away from cylinder head, valves, pistons, cylinder liners, and bearings, thus preventing warping of valve stems or distortion of other parts resulting from uneven cooling.

This rule is particularly important for obtaining best operation of turbocharged engines. The turbocharger contains bearings and seals that are subjected to high-temperature exhaust gases. While the engine is running, this heat is carried away by circulating oil. If the engine is stopped suddenly after a hard run, temperature of the turbocharger could rise as much as 100°F above that reached during operation. This could cause the bearings to seize or the oil seals to loosen.

Refuel Before Final Shutdown

The less air space in the fuel tank, the less opportunity there will be for water to condense in the tank.

5.33 Stopping the Engine

1. Bring truck to a complete stop using the service brakes.
2. Shift transmission into NEUTRAL. DO NOT SHIFT INTO NEUTRAL UNTIL VEHICLE IS STOPPED!
3. Set parking brake by pulling out control knob on dash.
4. Shut engine down by pushing in on Master Ignition on top left side of dash.
5. Turn off ignition.
6. After the engine has stopped, make sure Master Ignition switch is pushed all the way to top of switch.

NOTE: When setting the parking brake on a steep grade, do not rely on air brakes nor on engine compression to hold vehicle while parked. Chock the wheels when you park on steep grade.

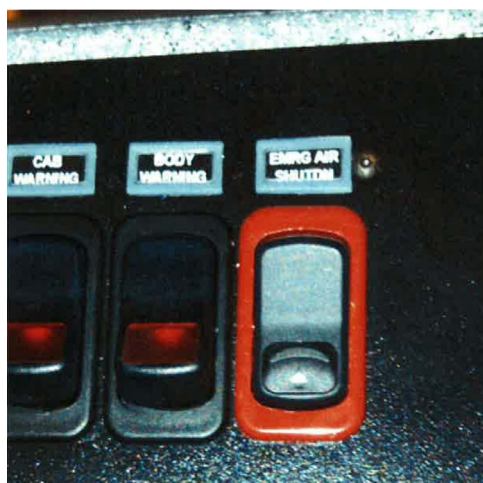


CAUTION



When parking on a grade with engine shutdown, never leave manual transmission in gear. If the vehicle should roll, the engine could start by heat of compression. ALWAYS CHOCK WHEELS.

Engine Shutdown



There is one switch that operates the Engine Shutdown function of the L9 engine. It is red and labeled EMRG AIR SHUTDN. Please familiarize yourself with the location of the switch on your dash.



To shut the engine down:

Push the switch up. The switch locks up and shuts down the engine.

Operation



To reset the engine to run:

Push the lock and rock the switch down.

This automatically resets the shutdown so you can restart the engine.

2018 X12 AND 2017 X15 AIR SHUTDOWN

ASO System Shutdown Operation

The Air Shutoff Valve (ASO) feature controls an intake Air Shutoff Valve mounted on the engine's intake manifold and activates the Valve when excessive engine speed is detected, resulting in immediate engine shutdown. This protection device would typically be installed when an engine operates in a potentially fuel rich ambient environment such as oil and gas fields.

The Air Shutoff Valve feature supports three modes of operation:

- Automatic Mode
- Manual Mode
- Test Mode

In Automatic Mode of Air Shutoff Valve feature, when engine speed exceeds a calibratable "Overspeed" threshold for a calibratable period of time, Air Shutoff Valve activates automatically. The engine typically may overspeed when combustible gases are present in the engine's intake air.



In Manual Mode of Air Shutoff Valve feature, the operator can manually activate the Air Shutoff Valve independent of engine operating conditions.

NOTE: The Air Shutoff Valve Manual Switch The should only be used during an emergency shut down situation and not for normal operation.

In Test Mode of Air Shutoff Valve feature, an Air Shutoff Valve Test Switch is used to activate the Air Shutoff Valve within normal engine operation conditions.

There are two switches in the cab used to activate the ASO and an indicator lamp for ASO status.

The Manual ASO Switch for the Air Shutoff Valve provides a means for the operator to manually activate the Air Shutoff Valve independent of engine operation conditions, such as engine speed. This switch serves the purpose of an emergency stop switch. The Air Shutoff Valve Manual Switch has two switch positions, ON or OFF.

NOTE: The Air Shutoff Valve Manual Switch should only be used during an emergency shut down situation and not for normal operation.

The Test Shut Dn Switch (Test Shut Down) of the Air Shutoff Valve feature, provides the means to demonstrate the Air Shutoff Valve is fully operational after component installation and any time thereafter, as system and safety check, throughout its life of service.

Should only be used during an emergency shut f the Air Shutoff Valve feature, provides the means to demonstrate the Air Shutoff Valve is fully operational after component installation and any time thereafter, as system and safety check, throughout its life of service.

Operation



Location: Cab-Driver side on ignition panel:

There are two switches and one red indicator lamp used for ASO.

1. Test Shut Down Switch: Used to test the ASO operation under normal conditions. Engine must be under 900 RPM to activate the test.
2. Manual ASO with red bezel: Used ONLY for emergency situations. The shutdown will occur at any engine speed immediately!
3. Red Indicator lamp. The lamp will be ON any time the valve is closed, whether Test or Manual mode is activated.



Automatic Mode

Automatic Mode activates the Air Shutoff Valve when engine speed exceeds a specified engine speed. This is the normal operating mode of the feature. For details on the ASO activation engine speed, please refer to the respective engine's Programming Guide. To prevent accidental engine shutdown while the vehicle is moving,

AUTOMATIC MODE IS SUPPRESSED WHEN THE VEHICLE SPEED EXCEEDS 40 km/h; THEREFORE, THE AIR SHUTOFF VALVE WILL NOT ACTIVATE IN AUTOMATIC MODE WHEN THE VEHICLE SPEED IS GREATER THAN 40 KM/H. IN THE EVENT OF ENGINE OVERSPEED, THE MANUAL MODE MAY BE USED TO ACTIVATE THE AIR SHUTOFF VALVE. In some applications when in PTO mode vehicle speed may indicate a value greater than zero even when the vehicle is stationery. In this case, when in PTO mode, vehicle speed will be ignored and will not inhibit the air shutoff system.

Test Mode

Test Mode activation of the Air Shutoff Valve occurs when the test switch is depressed and the engine speed is increased from low idle speed to above 1500 rpm. Test mode provides the ability to test the operation of the Air Shutoff Valve under non-overspeed conditions. Note: When using the test mode to activate the ASO valve the engine speed must be below 900 rpm when the Test Switch is depressed. While the Test Switch is depressed the engine speed increases to over 1500 rpm and actuates the ASO.

Manual Mode

Manual Mode activation of the Air Shutoff Valve occurs when the Manual Switch is activated, regardless of engine speed. When the manual switch is closed, the engine will be commanded shutdown immediately.

CAUTION: THE MANUAL SWITCH MUST NOT BE USED FOR NORMAL ENGINE SHUTDOWN. IT SHOULD ONLY BE USED DURING AN EMERGENCY SHUTDOWN SITUATION.

Automatic Health Check Mode

Automatic Health Check mode activates the Air Shutoff Valve performs a sweep at key-off only to auto-calibrate and check the span of the plate travel to ensure the Valve is healthy. If any issues are found then a fault code will be activated at next key-on cycle and flash an Engine Stop Red lamp. See Table 1 for ASO system faults.

 **Operation**

Whenever the Valve is activated, regardless of the mode, the ASO Lamp will be illuminated. When the Valve is actuated automatically by an engine overspeed condition or with the manual switch, the ECM will log a fault condition which will also illuminate the amber warning (check engine) lamp. The fault will turn inactive and the Check Engine Lamp will turn off when the ASO Valve is reset. This fault set when the valve is actuated by the test switch.

ASO System Reset Procedure

Valve Reset Procedure: With the key switch in the ON position and the engine stopped, hold ASO test switch in “On” position for 5 seconds. This will open the valve. ASO lamp will turn off indicating that reset was successful.

CAUTION: ASO valve is electrically actuated by the ECM. Electrical connections between the ASO valve and the ECM **Must Not** be modified.

ASO System Test Procedure

The purpose of the ASO system test is to allow end-of-line system test to ensure proper installation and function of the ASO system, and to allow the end user to test the system on regular basis.

1. With no engine faults, while the vehicle is stationary, in Park and the engine is running at idle below 900 rpm, activate the test mode by depressing the ASO test switch.
2. While holding down the ASO test switch, depress the accelerator and slowly increase engine rpm above 1500 rpm.
3. Verify immediate engine shutdown and release accelerator pedal. Verify ASO lamp is lit and there is no illuminated check engine light.
4. Reset the ASO valve by pressing and holding the Test Switch for approximately 5 seconds. The ASO Lamp will turn off and the valve will be open.

Test Passing Criteria

1. Engine shutdown after exceeding 1500 rpm.
2. ASO lamp is lit.
3. No fault/light indications.



5.34 Towing

Before towing a truck any distance, disconnect the driveshaft at the rear U-joint. This must be done to prevent damage to the transmission. All the reasons for transmission damage described under COASTING apply here. In the case of towing, however, damage can occur more rapidly, for two reasons: (1) the extended length of time on tow and (2) with the engine not running, the countershaft is stationary and no lubricant reaches the rotating mainshaft gears or bearings.

NOTE: When picking up the front of the truck, do not use the tow hooks/ eyes. These are designed for pulling from when towing the truck, not lifting from.

Attach the tow truck lifting device to the front axle. Put a block of wood under the bumper so not to damage the bumper (remove bumper preferably). Lift truck. Check to make sure it is secured properly.

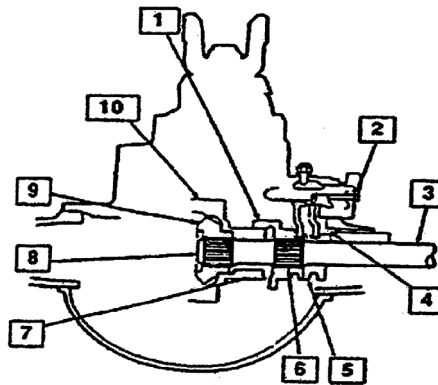

Operation

5.35 Towing Vehicles with Driver-Controlled Differential Lock Removing Axle Shafts Before Towing



CAUTION

If the vehicle must be towed to a service facility with the drive axle wheels on the ground, it is necessary to remove the axle shafts before the vehicle is towed.



- 1 Shift Collar in Locked Position
- 2 Actuator Assembly and Shift Fork
- 3 Shaft, Axle
- 4 Interference Between Shift Collar and Housing
- 5 Shift Collar in Unlocked Position
- 6 Outer Splines - Axle Shaft to Collar
- 7 Shift Collar and Differential Case Splines
- 8 Inner Splines - Axle Shaft to Side Gear
- 9 Gear, Side
- 10 Differential (Plain) Case Half

1. Shift main differential to the unlocked (disengaged) position. Differential lock light in the cab will go out.
2. Disconnect driveline universal joint from pinion input yoke or flange on carrier.
3. Remove capscrews and washers or stud nuts and washers from flanges of both axle shafts.
4. Loosen tapered dowels in flanges of both axle shafts by holding a 1 1/2-inch diameter brass drift or hammer against axle shaft center and hitting it with a five - to six - pound hammer.



CAUTION

Do not use a chisel or wedge to loosen axle shafts and dowels. The chisel or wedge can damage hub, axle shafts, and oil seals if used.

5. Remove tapered dowels and both axle shafts from axle assembly.

NOTE: Right-hand axle shaft has two sets of splines; One set to engage with differential side gear and one set to engage with shift collar for the differential lock. It may be necessary to rotate shaft slightly to align side gear spline teeth with clutch collar teeth in order to remove axle shaft.

6. Assemble a cover over openings of both wheel ends to prevent loss of lubricant and keep dirt from the wheel bearing cavities.

Installing Axle Shafts

1. Remove covers from wheel ends.
2. Shift differential lock to the unlocked (disengaged) position.
3. Install right-hand and left-hand axle shafts:
 - a. Place gaskets on both axle shafts.
 - b. Push right-hand axle shaft and gasket into wheel end and housing until shaft stops against differential shift collar.
 - c. Push down and in on axle shaft flange and rotate shaft until splines of shaft and shift collar are engaged.
 - d. Push axle shaft farther into housing until shaft stops against differential side gear.
 - e. Push down on axle shaft flange and rotate shaft until splines of shaft and side gear are engaged.
 - f. Push axle shaft completely into housing until axle shaft flange and gasket are flush against wheel hub.
 - g. Install left-hand axle shaft and gasket into wheel end.
 - h. Install capscrews and washers that hold axle shafts to wheel hub. Tighten to correct torque value. Refer to the appropriate service manual section.



Operation

4. If wheel hubs have studs, install tapered dowels at each stud and into flange of axle shaft. Use a punch or drift and hammer if needed.
5. Install nuts and washers on studs. Tighten nuts to correct torque value. Refer to the appropriate service manual section.



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6.1 Driver's Daily Checklist

To make sure your fire truck is ready for service, make the following daily inspections.

Daily Checks

Before starting each day, check or inspect the following to ensure trouble-free performance.

1. Make visual inspection of entire unit.
2. Check under vehicle for signs of leaks. If any are noted, correct condition causing leaks.
3. Check the following liquid levels on chassis: engine oil, transmission oil, and power steering fluid.

For more details, read below.

Engine Oil Level

With the engine stopped, check for oil leaks and oil quantity on the dipstick. If engine was running recently, allow five minutes for oil to drain into crankcase. Use only recommended engine oil. DO NOT mix engine oils, either by weights or type. Do not overfill the crankcase. NEVER operate the engine if oil quantity is below the low-level mark. Factory-delivered unit will be full of 15W40, 4-cycle oil.

Drive Belts

Check condition and tension of fan belt and accessory drive belts.

Fuel Tank

Visually check fuel level gauge. Visually check exterior of tank for any leaks.

NOTE: Topping off with fuel at the end of each work day will reduce water condensation in the tank.

Maintenance

Dry-Type Air Cleaner

When the air restriction light (green indicator) on the dash is on, it is time to change the filter. Remove the K & N filter and clean the filter element per K & N instructions.

Tires and Wheels



WARNING

Always maintain your tires in good condition. Frequently check and maintain correct inflation pressures as specified by the tire manufacturers. Inspect periodically for abnormal wear patterns and replace/repair cut or broken tire casing. Always use experienced, trained personnel with proper equipment and correct procedures to mount or remove tires. Failure to adhere to these warnings could result in tire malfunction, damage to the vehicle, personal injury, and possibly death.

Inspection

NOTE: Correct inflation pressure should be on sidewall of tire.

Check and maintain the correct inflation pressure for each tire every morning or when tires are cool. Check tire pressures **ONLY** when the tires are cool. Warm or hot tires cause pressure buildup. Do not deflate a warm tire to specified pressure. Tire thumping during the walk around inspection will tell you if a tire is deflated, but the only way to check tire pressure is with an accurate gauge. If any tires are found to be considerably under inflated, the vehicle should not be driven until cause of the leak is determined and repairs have been made.

Regular and frequent inspection and proper care will give you the assurance of safe, reliable tire operation. Most tire wear problems are caused by under inflation such as a slow leak. Low pressure is a tire's worst enemy. It allows tires to flex badly and this causes high temperatures to build up. Heat causes early tire damage, such as flex breaks, radial cracks, and ply separation. Furthermore, low tire pressures can affect control of your vehicle particularly at the frontwheels.



Look for bumps, blisters, cuts, punctures, cracks, proper inflation, uneven wearing, and tread depth. Rotate tire from front axle to rear axle position when tread is worn to 1/8 in. (3.175 mm). Replace tire on rear axle when tread is worn to 1/16 in. (1.588 mm).

Contrary to an old idea that refuses to die, letting air out of tires for more traction on ice or snow does not work. Low inflation actually reduces traction and steering control. Overloading your truck can be as hard on tires as under inflation. The following chart shows the proper air inflation of tires to increase the tire's life:

TIRE INFLATION GUIDE PER 2009 NFPA GUIDELINES PER GVWR

GOODYEAR	SINGLE AXLE	TIRE	MIN INFLATION IN PSI W/ MAX SPEED OF :		
			INT	60MPH	68MPH
FRONT	18,000	315/80R 22.5	125		130*
	20,000	385/65R 22.5	120		120
	22,000	425/65R 22.5	110		120
REAR	24,000	12R 22.5	90		105
	27,000	12R 22.5	115		120
	31,000	315/80R 22.5	120*	125*	
REAR	TANDEM AXLE				
	40,000	11R 22.5	80	90	
	48,000	11R 22.5	100	120	
	48,000	12R 22.5	90	105	
	52,000	12R 22.5	110	115	

MICHELIN	SINGLE AXLE	TIRE	SEE NOTES		
			50MPH	60MPH	68MPH
FRONT	18,000	315/80R 22.5	***		130
	20,000	385/65R 22.5	***		120
	22,000	425/65R 22.5	***		120
REAR	24,000	12R 22.5	***	105**	120
	27,000	12R 22.5	***	115**	120
	31,000	315/80R 22.5	***	120	
REAR	TANDEM AXLE				
	40,000	11R 22.5	***	95	
	48,000	12R 22.5	***	100	
	48,000	11R 22.5	***	120	
	52,000	12R 22.5	***	110	

Maintenance

Tire Pressure Indicators

NOTE: All 2009 NFPA compliant vehicles will be equipped with one of the following Tire Pressure Monitor Systems.

Real Wheels System

LED Tire Watch

Featuring LED Valve Cap Tire Pressure Monitors

6 Wheel Kit: RWTG1234-62 (for 2" round holes)
RWTG1234-65 (for 2.5" round holes)

10 Wheel Kit: RWTG1234-12 (for 2" round holes)
RWTG1234-15 (for 2.5" round holes)

LED Cap: RWTG1234 (sold individually)

Low tire pressure is DANGEROUS! Unfortunately, most tire leaks are slow, allowing the driver to gradually adapt to the vehicle's behavior, thus not realizing the extreme danger that is present. The LED TIRE WATCH system provides a quick and easy, visual inspection of each tire, alerting driver of pressure variations with a bright red LED light. RealWheels Corporation has made this system even easier to implement with these convenient kits.



- **Longer Tire Life** – According to the D.O.T. 95% of all pre-mature tire wear is caused by under inflation.
- **Safety** – Improper tire pressure has a detrimental effect on vehicle handling and control.
- **Improved Fuel Economy** – Proper tire inflation can save an estimated 3% -5% in fuels costs.
- **NFPA Guidelines** – The 1901 Standard for Automotive Fire Apparatus dictates that each tire shall be equipped with a visual indicator, or monitor that indicates tire pressure.
- **Long Battery life** – Sensor batteries are easily replaced after 4-5 years of continuous use.

LED Valve Cap Tire Pressure Monitors



The Valve Cap starts flashing RED if the tire pressure drops 4 psi/ 0.3 bar (8 psi /0.6 bar for trucks)

- **Long Battery life** – Sensor batteries are easily replaced after 3-4 years of continuous use.
- **Ultra-bright LED** allows for visual checks of each vehicle tire, even in daylight.
- **Self calibrating** – LED cap memorizes desired pressure when initially installed.
- LED caps can be used on any tire pressure between 10psi and 130psi.
- Detects pressure drop, as little as 4psi.
- Easily checked for functionality and battery condition by simply unscrewing cap.
- The casing is shock-resistant, polished stainless steel. Size 1" x 1/2" Weight 0.45 OZ



Cross Fire System

Crossfire is a pressure equalizing and monitoring valve that is mounted between dual tires. It bolts easily to the lug, hub cap, or drive axle end. Properly mounted, air freely flows from one tire to the other, maintaining equal tire pressure and load distribution.

To fully appreciate how the Crossfire system can add 20% or more life to your tires, let's look at a few problems.

Under-Inflation



20% under-inflation can cause a minimum 30% loss in tire life expectancy.

With just a glance from as far away as 20 feet, the Crossfire pressure equalizing valve indicates an under-inflation problem.

Over-Inflation



20% over-inflation can cause a minimum 10% loss in tire life expectancy.

Maintenance

The Crossfire pressure equalizing valve signals an over-inflation problem which can dramatically shorten tire life.

Proper Inflation



Mounted correctly, Crossfire's yellow indicator verifies that air is flowing freely from one tire to the other, equalizing the load.

Pressure Pro System

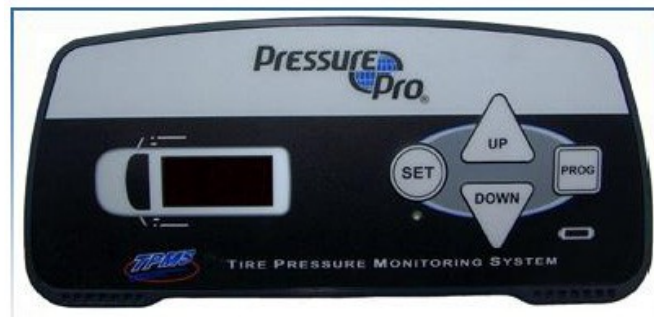
PRESSURE PRO 6 WHEEL MONITOR

Common uses:

Autos, SUVs, Small Heavy
Duty Equipment

Description:

PressurePro's 6 wheel Monitor allows users to monitor up to 6 wheel positions (single axle on front and rear duals).





General Information:

PressurePro Monitors are capable of reading pressures from 10 psi to 199 psi, are RS232 capable, and can display pressures in PSI, BAR, or kPa. All Monitors have two low pressure alert levels, the first at 12.5% and the second at 25% drop in pressure. They also have a variable high pressure alert that can be adjusted by users from 10% to 45% high (the high pressure alert comes factory set to alert at a 24 psi increase). Each Monitor has self-tests for signal strength and Sensor packet counts.

Recommended Tire Rotation

Intelligent tire rotation promotes even tread wear and can net a lot of extra miles in tread life.

Recommended Interval - take the rated mileage of the drive tires, divide by four, and rotate at those intervals.

Some fleets will run new steer tires in the drive position and take off 1/32-inch to 2/32-inch in tread depth to establish a good wear pattern.

Drive tires should be rotated between forward and back positions at least once to even out wear.

Wheel Nut Torque

Be sure to tighten wheel nuts to recommended nut torque. Do not over tighten. After the first 100 miles of operation recheck the retorque level and retighten nuts to proper torque.

Monitor every 5,000 miles. Maintain nut torque at the recommended level.

Two-piece metric nut, M22x1.5 Torque spec 450-500 FT/LB

Tightening Cap Nuts

CAUTION



Lubricants should not be applied to the cap nut seats or to the wheel. Lubricants must be wiped from the cap nut seats if applied accidentally.

Impact wrenches, if used, should be carefully adjusted to apply torques within the limits recommended. Torquing of cap nuts should be done in recommended sequence. Cap nuts must be kept tight, and studs and nuts should be checked frequently. At tire changes, nuts and studs should be inspected to be sure they are in good condition. If nuts require frequent tightening, studs break frequently or wheel nut seats are rounding out. Hardware and mounting practices should be reviewed.

CAUTION



Check all parts, including wheels, rings, mounting face of hubs, and studs. Check for dirt, corrosion, or damage. Remove dirt and rust; replace damaged parts. Follow the correct tightening sequence and recommended torque levels.

Overtorque can cause over stressed studs and cap nuts, damaged threads, and damaged wheels. Insufficient torque can cause stud breakage and damaged wheels.

Stud-located, ball seat mounting system. Inner and single cap nuts used with stud-located wheels should be tightened to a torque of 400 to 500 ft/lb if the threads are not lubricated and 300 to 375 ft/lb if the threads are lubricated.

NOTE: When dualing steel wheels with Alcoa aluminum wheels, follow the steel wheel manufacturer's recommendations regarding the proper torque and use of thread lubricants to mount the wheel.

On vehicles equipped to accept wheels manufactured for use with the stud-located ball seat mounting system, wheel studs on the right side of the vehicle have right-hand threads and those on the left have left-hand threads. The R and L on the studs and nuts indicate right and left hand threads respectively.



Hub-piloted Mounting System

Two-piece cone-lock cap nuts with a 33 mm hex head design, used with hub-piloted wheels, should be tightened to a torque of 400 to 500 ft/lb. Two-piece cone-lock cap nuts with 1 1/2-in. hex head design and other designs have different torque requirements. Check with the manufacturer for the proper torque values.

Before installing the two-piece cone-lock cap nuts, lubricate the contact surfaces between the cap nut and the washer with SAE 30W oil. This will minimize corrosion between the mating surfaces.

Wheel studs on both the right and left side hubs of vehicles utilizing the hub-piloted wheel system have right-hand threads.

Prior to mounting hub-piloted wheels, generously coat only the wheel pilot with a lubricant, such as Freylube or equivalent, to minimize corrosion product build up between the wheel and hub. An excessive buildup between the wheel pilot and hub can make wheel removal difficult.

Air System

Be sure all air tank reservoir drain cocks are shut off and check for any leaks. Repair if necessary.

Automatic Transmission

For information on checking transmission oil level, refer to Appendix A - ALLISON TRANSMISSION - Emergency Vehicle Series.

Fire Pump

On Hale pumps, check pump gear case oil level by pulling out plug on front-right, lower pump gearbox. On a Waterous gearbox, oil level is checked with a sight glass.

Check to be sure no water is mixed in.

Axle Alignment

The axles should be checked after 90 days of delivery of vehicle to make sure they are within the parameters noted in the **Axle Alignment** procedure. If they are not within the noted parameters, they must be adjusted.

 **Maintenance**

Miscellaneous Items to Check

1. Check low and high beam headlights.
2. Check operation of turn signals and emergency flashers and emergency warning lights.
3. Check driving mirrors for adjustment and clean.
4. Fuel tank cap secure.
5. All compartment doors shut tight.
6. All equipment is secured.
7. Check windshield washer fluid level.
8. Check to see if the air and electrical horns and siren work.
9. Check water tank level.
10. If engine has an air shutdown device, make sure it has been manually reset if pulled.

6.2 Preventive Maintenance

The Preventive Maintenance Program really starts with the daily checks that you perform. These checks are itemized in the Maintenance Schedule.

The following charts cover information on the lubrication of the chassis and periodic maintenance schedules, which must be performed on this vehicle. This information is put together to keep the truck in good running condition throughout the truck's life.

The maintenance schedule is set up using hourly intervals. It is divided into:

- Daily or every 10 hours
- Weekly or every 50 hours
- 250 hours
- 500 hours
- 3000 hours or annually

Severe service conditions may dictate more frequent intervals.

REMEMBER - PREVENTIVE MAINTENANCE IS LIKE BUYING TIME!



6.3 Maintenance Schedule

Schedule 1: Daily or Every 10 Hours

	Check	Clean	Lube	Replace	Adjust
Engine Oil Level	X				
Transmission Oil Level	X				
Safety Equip. Warning	X				
Light & Devices	X				
Instruments, Gauges, & Controls	X				
Check for Leakage Under Truck	X				
Engine Cooling Fan	X				


Maintenance

Schedule 2: Weekly or Every 50 Hours

	Check	Clean	Lube	Replace	Adjust
Complete Schedule 1	X				
Engine (See Engine Manual)	X				
Wheel Lugs (Torque)	X				X
Battery Fluid Level	X				
Fan Belt, Alternator Belt	X				X
Differential & Axle (Front & Rear) (See Axle Manual)	X				
Tire Pressure	X				
Drain Water From Fuel	X				
Separator - Racor	X				
Fire Pump, Oil Level & Priming	X				X
Pump Reservoir	X				
Manual Air Tank Drains	X				
Windshield Washer Fluid Level	X				
Driveshaft U-Joint Torque	X				



Schedule 3: Every 250 Hours

	Check	Clean	Lube	Replace	Adjust
Complete Schedules 1 & 2	X				
Lubricate Fittings (See Lubrication Chart)	X				
Engine Components (See Engine Manual)	X				
Power Steering Fluid Level	X				
Axle Components (See Axle Manual)	X				
Air Cleaner	X				
Modulator Cable, Cable Ends	X	X	X		
Pump Shifter Cable, Cable Ends	X	X	X		
Diesel Fuel Filters	X			X	
Engine Oil & Filter	X			X	
Air Dryer for Operation	X				
Radiator Coolant Level, Connections, and Coolant Filter	X			X	
Coolant SCA Concentration Level	X				
Intake Air Piping & CAC System	X				
Driveshaft U-Joint	X	X	X		X

Maintenance

Schedule 4: Every 500 Hours

	Check	Clean	Lube	Replace	Adjust
Complete Schedules 1, 2, & 3	X				
Engine Coolant	X			X	
Air Compressor Filter	X			X	
Automatic Slack Adjusters					X
Rear Tandem Rotation of Tires	X				X



Schedule 5: Semiannual or 1500 Hours

	Check	Clean	Lube	Replace	Adjust
Complete Schedules 1, 2, 3, & 4	X				
Engine Components (See Engine Manual)	X				
Wheel Bearings (See Axle Manual)	X				
Transmission Oil & Filter				X	
Clutch Pedal Travel/Clutch Lube	X		X		
Radiator Fins Clean	X	X			
Fire Pump Oil				X	
Axle Mounting U-Bolts	X				X
Cab Mounting Bolts (6)	X				X
All Bolts and Nuts	X				X
Steering Gear Mounting Bolts	X				X
Tightness of all Joints on Muffler System	X				X
Body Mounting bolts	X				X
Electric Lines for Connection	X				
Wear and Corrosion	X	X		X	
Air Line System	X				
Pump Mounting Bolts	X				
Body Mounting U-Bolts	X				
Power Wash Underbody and Cab with Wide Fan on Nozzle	X	X			
Wire Brush All Rust, Corrosion, and unpainted Areas and Touch Up These Areas with Primer, Paint, and Undercoating	X	X		X	
Power Steering Wheel Shaft Nut	X				X
Check & Retorque Bolts on Front & Rear Motor & Transmission Mounts to 210 ft/lb	X				X
Surge Tank Bracket Torque L9 - 40ft-lbs	X				X
Surge Tank Bracket Torque X12 - 50ft-lbs	X				X
Surge Tank Bracket torque X15 - 50ft-lbs	X				X


Maintenance

Schedule 6: Annual or 3000 Hours

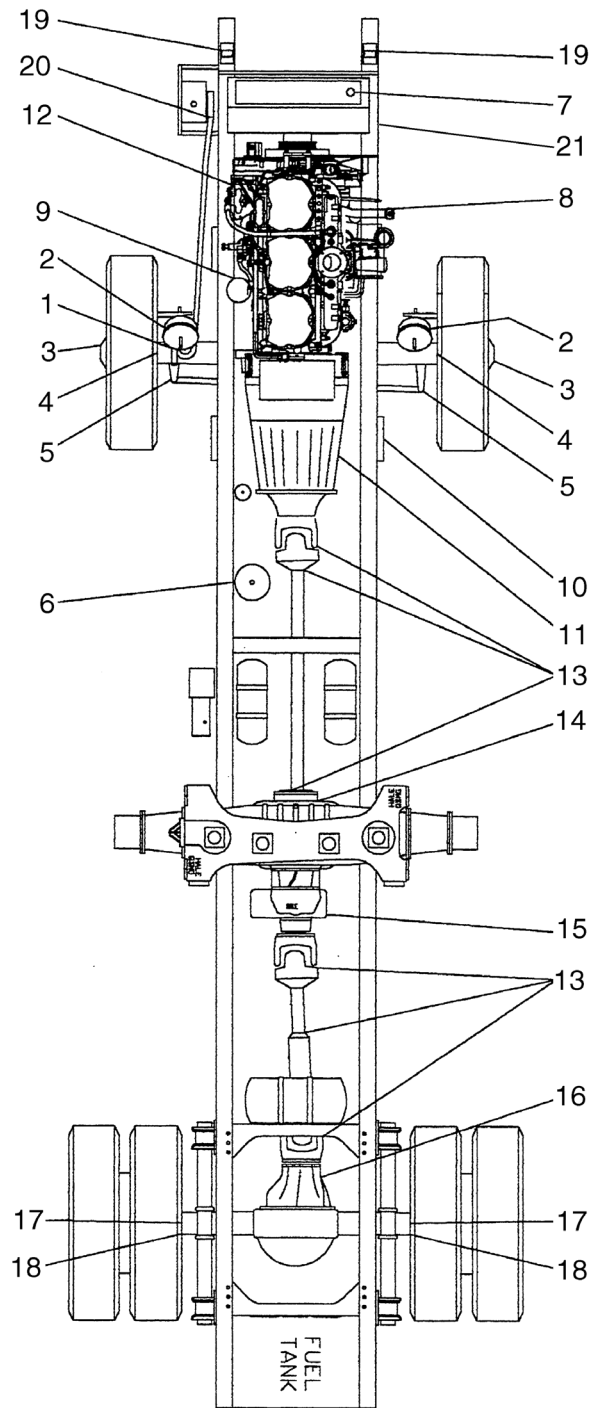
	Check	Clean	Lube	Replace	Adjust
Complete Schedules 1, 2, 3, 4, & 5	X				
Air Dryer Cartridge Element				X	
Tire Condition	X				
Manual Transmission Oil	X				
Brake Linkage, Controls, Lining, & Misc. Parts	X				
Radiator Coolant	X				
Pump Mounting Bolts Torque	X				
Body Mounting U-bolts Torque	X				
Power Wash Underbody and Cab with Wide Fan on Nozzle	X	X			
Wire Brush All Rust, Corrosion, and Unpainted Areas and Touchup These Areas with Primer, Paint, and Undercoating	X	X		X	
Take Truck to Ziebart for Inspection First 10 years Each Year		X			X
Inspect Air Intake Duct in Cab, Clean	X	X			X



Schedule 6 Continued: Annual or 3000 Hours
(Torque Specifications)

Clamp Type	Clamp Size	Torque Spec (in-lbs.)	Comments
Norma	8-16	26	L9 Coolant Filter Hoses
Breeze	Mini	10-15	Surge Tank Vent, Fuel Tank Vent
Breeze Constant Torque	5/16" Hex	40	Heater Hoses, Heat Exchanger
Breeze Constant Torque	3/8" Hex	100	Upper/Lower Radiator connec- tions & Associated Water Pipes
Breeze T-Bolt	1/4" Bolt	60	Air Intake Boots
Breeze T-Bolt	5/16" Bolt	150	
Breeze Spring	N/A	Tighten till spring collapses	Air Intake Pipe
V-Band & Maron w/ Gasket	N/A	10	Exhaust

Maintenance

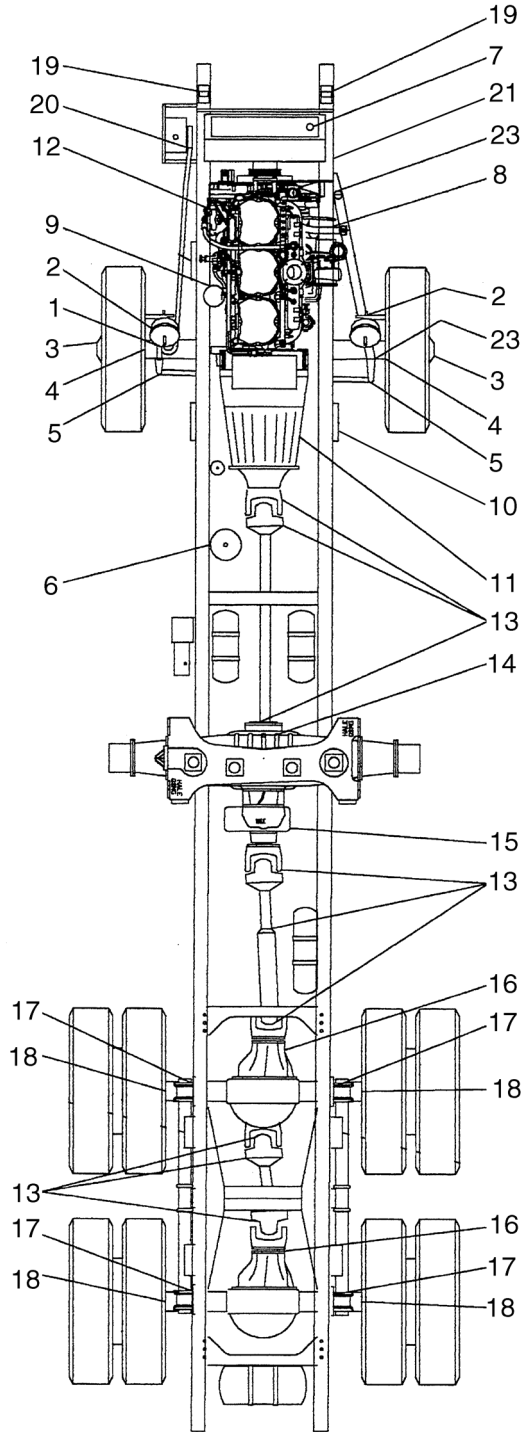


lubart1



ITEM #	ITEM	REMARKS	LUBE	FREQUENCY
1	DRAG LINK ENDS	1 FITTING EACH END	CL	2 MONTHS
2	BRAKE CAM SHAFT	1 FITTING EACH WHEEL	CL	2 MONTHS
3	FRONT WHEEL BEARINGS	CHECK LEVEL	GL1	2 MONTHS
4	KING PIN	2 FITTINGS EACH SIDE TOP AND BOTTOM	CL	2 MONTHS
5	STEERING TIE ROD	1 EACH SIDE	CL	2 MONTHS
6	AD-4 AIR DRYER FOR BRAKE SYSTEM	SEE REF. IN MANUAL		12 MONTHS
7	RADIATOR	CHECK LEVEL	AN	1 MONTH
		CHANGE FLUID	AN	12 MONTHS
8	ENGINE OIL	CHECK LEVEL	EO	DAILY
		CHANGE FLUID	EO	250 HRS
9	ENGINE OIL FILTER	CHANGE FILTER		12 MONTHS
10	TRANSMISSION FILTER	CHANGE FILTER		6 MONTHS
11	TRANSMISSION	CHECK LEVEL		DAILY
		CHANGE FILTER		12 MONTHS
12	POWER STEERING FLUID	CHECK LEVEL	ATF	1 MONTH
13	DRIVE SHAFT, U-JOINT& SLIP PIN	1 FITTING EACH JOINT	CL	2 MONTHS
14	PUMP AUTO LUBE	CHECK LEVEL	GL1	2 MONTHS
15	PUMP TRANSMISSION	CHECK LEVEL	GL1	1 WEEK
		CHANGE FLUID	GL1	12 MONTHS
16	REAR AXLE	CHECK LEVEL	GL1	2 MONTHS
		CHANGE FLUID	GL1	24 MONTHS
17	BRAKE CAM ROLLER PIN	1 FITTING EACH SIDE	CL	2 MONTHS
18	BRAKE CAM SHAFT	1 FITTING EACH SIDE	CL	2 MONTHS
19	TILT SUB FRAME PIVOT	1 FITTING EACH SIDE	CL	2 MONTHS
20	TILT CAB LIFT PUMP	CHECK LEVEL	ATF	2 MONTHS
21	AIR CLEANER	SEE REF. IN MANUAL		SEE REF. IN MANUAL
22	FUEL FILTER	SEE REF. IN MANUAL		SEE REF. IN MANUAL
ATF	AUTOMATIC TRANSMISSION FLUID			
CL	CHASSIS LUBE			
GL1	90WT. GEAR LUBE			
AN	ANTIFREEZE			

Maintenance



lubear2



ITEM #	ITEM	REMARKS	LUBE	FREQUENCY
1	DRAG LINK ENDS	1 FITTING EACH END	CL	2 MONTHS
2	BRAKE CAM SHAFT	1 FITTING EACH WHEEL	CL	2 MONTHS
3	FRONT WHEEL BEARINGS	CHECK LEVEL	GL1	2 MONTHS
4	KING PIN	2 FITTINGS EACH SIDE TOP AND BOTTOM	CL	2 MONTHS
5	STEERING TIE ROD	1 EACH SIDE	CL	2 MONTHS
6	AD-4 AIR DRYER FOR BRAKE SYSTEM	SEE REF. IN MANUAL		12 MONTHS
7	RADIATOR	CHECK LEVEL	AN	1 MONTH
		CHANGE FLUID	AN	12 MONTHS
8	ENGINE OIL	CHECK LEVEL	EO	DAILY
		CHANGE FLUID	EO	250 HRS
9	ENGINE OIL FILTER	CHANGE FILTER		12 MONTHS
10	TRANSMISSION FILTER	CHANGE FILTER		6 MONTHS
11	TRANSMISSION	CHECK LEVEL		DAILY
		CHANGE FILTER		12 MONTHS
12	POWER STEERING FLUID	CHECK LEVEL	ATF	1 MONTH
13	DRIVE SHAFT, U-JOINT& SLIP PIN	1 FITTING EACH JOINT	CL	2 MONTHS
14	PUMP AUTO LUBE	CHECK LEVEL	GL1	2 MONTHS
15	PUMP TRANSMISSION	CHECK LEVEL	GL1	1 WEEK
		CHANGE FLUID	GL1	12 MONTHS
16	REAR AXLE	CHECK LEVEL	GL1	2 MONTHS
		CHANGE FLUID	GL1	24 MONTHS
17	BRAKE CAM ROLLER PIN	1 FITTING EACH SIDE	CL	2 MONTHS
18	BRAKE CAM SHAFT	1 FITTING EACH SIDE	CL	2 MONTHS
19	TILT SUB FRAME PIVOT	1 FITTING EACH SIDE	CL	2 MONTHS
20	TILT CAB LIFT PUMP	CHECK LEVEL	ATF	2 MONTHS
21	AIR CLEANER	SEE REF. IN MANUAL		SEE REF. IN MANUAL
22	FUEL FILTER	SEE REF. IN MANUAL		SEE REF. IN MANUAL
23	POWER STEERING CYLINDER ENDS	1 EACH END	CL	2 MONTHS
ATF	AUTOMATIC TRANSMISSION FLUID			
CL	CHASSIS LUBE			
GL1	90WT. GEAR LUBE			
AN	ANTIFREEZE			

Maintenance

6.4 Details of Maintenance Schedule

Check: 250 Hours (Schedule 3)

1. CHECK OIL LEVELS and top off as necessary: transmission, pump, drive axle, power steering reservoir, and oil-lubricated wheel bearing.
2. ENGINE OIL AND FILTER: Change oil and filter.
3. FUEL FILTER: Drain, clean, and refill or replace as necessary.
4. RADIATOR COOLANT LEVEL:

A sight glass is provided on the recovery tank for checking coolant for proper level. Low coolant will set a fault code and bring on the check engine light.



WARNING

Check coolant when engine is cold. If cap must be removed when engine is hot, use extreme care. Place heavy cloth over cap and turn cap slowly, allowing radiator pressure to bleed off. If truck has surge tank on cooling system, check same as above.

NOTE: Coolant must contain some type of corrosion inhibitor. When operating in freezing weather, use ethylene glycol base antifreeze.



CAUTION

When draining and refilling the cooling system, use the following procedure to avoid air traps:

- a. Fill radiator until coolant is to top of sight glass.
 - b. Run the engine for one minute at 700-1000 rpm.
 - c. Stop engine and recheck coolant level. Top off as necessary to bottom of filler neck.
5. ENGINE AIR CLEANER: Service element - inspect.
 6. AIR INTAKE PIPING AND MOUNTING: Check for condition and security.
 7. STEERING LINKAGE: IMPORTANT! Check ALL connections for free play and wear. Check tie rod for straightness. Check drag link tube clamp for interference. Check steering for excessive play and adjust as necessary.



-
8. DRIVE SHAFT U-JOINTS: Check for wear before lubricating with chassis lube and tighten all bolts and nuts on flanges.

**COMPANION FLANGE AND DRIVE SHAFT TORQUE
SPECIFICATIONS**

- | | |
|----------|--|
| 6-73-220 | BOLT TO ATTACH 1710 COMPANION FLANGE - 40 to 48 FT/LB |
| 7-73-122 | BOLT TO ATTACH 1810 COMPANION FLANGE - 63 to 75 FT/LB |
| 8-73-316 | BOLT TO ATTACH 1710 HALF ROUND DRIVE SHAFTS - 115 to 135 FT/LB |
| 6-73-209 | BOLT TO ATTACH FULL ROUND DRIVE SHAFTS - 38 to 48 FT/LB |
9. FUEL TANK: Drain sediment from tank.
 10. BATTERIES: Check condition of terminals. Check electrolyte level (if possible).
 11. DRIVE BELTS: Check condition and adjust tension as necessary.
 12. When wing nuts are treated with thread locker, replace bolts. Used bolts are to be replaced.
 13. CLEAN ALL CABLES at both ends and grease.
 - Fire pump shifting cable
 14. AIR DRYER OPERATION (See Appendix C - MERITOR WABCO System Saver Series Single Cartridge Air Dryers).

Check: 500 Hours (Schedule 4)

1. Complete all of Schedule 3.
2. ENGINE OIL, FILTER: Change oil and filter.
3. ENGINE COOLANT: Check condition of antifreeze solution and corrosion inhibitor.
4. AIR COMPRESSOR AIR CLEANER: Inspect element and replace as necessary.
5. DRIVE BELTS: Check condition and adjust tension as necessary.
6. WHEEL BEARINGS: Check for end play and adjust as necessary.

 **Maintenance**

7. SLACK ADJUSTERS: Lubricate sparingly. **ALSO CHECK ADJUSTMENT WITH TEMPLATE.**
8. On trucks with disc brakes, check brake pad wear.
9. Check and retorque fire pump mounting bolts to 150 ft/lb.
10. Check and retorque all body mounting U-bolts and all bodybolts.



Check: 1500 Hours - (Schedule 5)

1. Complete all of Schedules 3 and 4.
2. ENGINE:
 - a. Clean with steam or solvent.
 - b. Clean crankcase breather, if applicable.
 - c. Tighten manifold nuts to specified torque.
 - d. Tighten oil pan capscrews to specified torque.
 - e. Check drive pulleys for tightness.
 - f. Check turbocharger manifolding, and mounting.
 - g. Check all lines and seals for leaks.

NOTE: For details on specific engine service requirements, refer to the engine manufacturer's maintenance manuals.

3. OIL CHANGES - TRANSMISSION, FIRE PUMP: Drain lubricant while warm. Refill. Check all drain and filler plugs for tightness.
4. AIR COMPRESSOR AIR CLEANER: Replace element.
5. CRANKING MOTOR AND ALTERNATOR: Check operating and output.
6. COOLING SYSTEM: Check radiator and all hoses for leaks, then drain. Correct any leak problems. Flush out system and refill with coolant mix. Check and clean radiator fins as needed.
7. AIR CLEANER: Change, if necessary. Otherwise, just clean the K & N filter with a K & N cleaning kit. Also clean the spark arrestor.
8. SUSPENSION U-BOLTS: Tighten U-bolt nuts to specified torque.
9. ENGINE AIR INTAKE TUBING: Check all tubing joints and mounting points for any leaks that would permit unfiltered air to enter the engine.
10. CHANGE AIR DRYER ELEMENT: Type Bendix-Westinghouse AD-IP or WABCO 1200 (for more information, see Bendix AD-IP or WABCO 1200 manual).

 **Maintenance**

11. WIRING: Check condition of all wiring. Repair or tighten loose terminals.
12. FRONT AXLE: Inspect bearings, knuckle pins, bushing, and spindles.
13. FRONT AND REAR WHEEL BEARINGS (OIL OR GREASE LUBRICATED): Disassemble, clean, inspect, and refill or repack. Adjust bearing play.
14. POWER STEERING RESERVOIR: Change fluid.
15. PARKING (SPRING) BRAKES: Inspect release bolts, clamp rings and bolts, mounting studs, and air lines.
16. CHECK ALL FUEL LINES and other lines for wear.

Check: Annually (Schedule 6)

1. Complete Schedules 3, 4, and 5.
2. HEATER - DEFROSTER: Check function of all controls in both modes.
3. AIR CONDITIONING: Check Freon level for full charge.
4. MOUNTINGS - ENGINE, TRANSMISSION, SUSPENSION, FUEL TANK, AND BATTERY: Check for condition and tightness.
5. FRONT AXLE STEERING SPINDLES: Clean and check for excessive wear and looseness after assembly.
6. FRONT END ALIGNMENT: Check and adjust as necessary.
7. On cabs with side screens, once a year (or more if needed), use a hose and clean out any debris or salt in the passage to engine on both sides of the cab.

Make sure drains are draining properly, front and rear, in the air intake area above fender.

If any surface is not undercoated or painted, it should be touched up with paint and undercoated, and caulk all seams.

If it is required to remove grills, reuse treated screws with green nylon under head (red on thread part of screw). If you should need a new screw, contact Sutphen Corporation to order. Do not use Loctite, as it eats paint, causing corrosion.



6.5 Servicing System and Units

Steering

Frequent visual check on the steering gear and components are vital to driving safety. Check the tie-rod for straightness. Check drag link ends, ball joints, and steering U-joints for looseness or interference. Check steering wheel free-play.

Normally, any change in steering behavior due to mechanical wear is so gradual that it will go unnoticed by anyone driving the vehicle on a regular schedule until the condition becomes obvious. It is important to keep alert to steering response and handling characteristics.

If, at any time, the steering doesn't feel natural, check the simplest probable causes first, such as unequal tire pressures, loose stud nuts, bent tie rod or lack of lubrication. If these check out unsatisfactory, do not hesitate to have the problem diagnosed and corrected.

Maximum steering angle must be limited by the adjustable axle stops, not by the internal limits of the steering gear. If the tire on the steering side rubs against the drag link or brake chamber in an extreme left or right turn, have the axle stops adjusted. This is a fairly simple procedure, and if you want to do it yourself, proceed as follows:

1. Park the vehicle on a hard, level surface. Set the parking brakes and place chocks under the rear wheels to prevent accidental movement.
2. Jack both front wheels off the ground and insert jack stands. (Use two jacks – one under each spring perch.)
3. Loosen the locknut on the axle stop bolt and adjust the axle stop to provide a minimum of 1/2-inch clearance between the tire and the drag link or brake chamber. Adjust the other axle stop to provide the same turning angle in the opposite direction. Be sure to tighten both locknuts. Before lowering the wheels, swing them slowly and gently from stop to stop as a final check on steering angle and clearance.


Maintenance

4. The power steering pressure relief valve must be reset so as not to damage the steering gear (see ROSS literature).

The steering gear assembly has several items which are torqued. These should be checked (semiannually) to make sure they meet the specifications (see list below for reference).

STEERING GEAR	DRY (ft/lb)
TAS85 Gear mounting four (4) 7/8" bolts	225 to 250
Steering Shaft (Pitman arm) 3/4"	155 to 210
Steering Wheel Nut	54

Power Steering Reservoir (Check Monthly)

To check the fluid level, remove fill cover and dipstick. If level is below FULL mark, add recommended fluid. The engine should be running at idle and the wheels centered when checking or adding fluid. Use care in checking or adding fluid to keep dirt and foreign matter out of the system. If contamination is found, the system must be drained, flushed, and refilled.

Axle Alignment

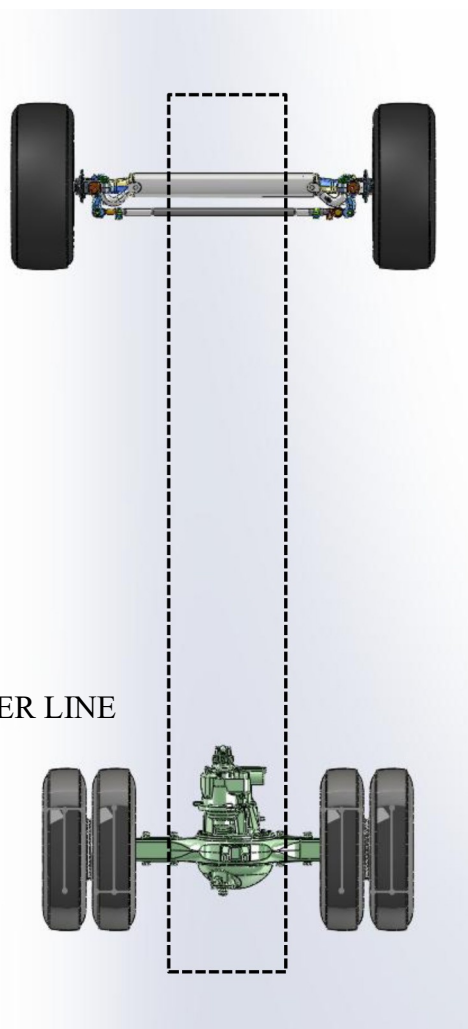
It is sometimes possible for continued road shock and load stresses to force axles out of alignment. Evidence of this would be in the form of rapid tire wear on the axles. If you suspect this condition, it is a simple matter to have the axle alignments checked and adjusted as needed.

NOTE: The axles should be checked after 90 days of delivery of vehicle to make sure they are within the following parameters. If they are not within the following parameters, they must be adjusted.



Single Rear Axle

Parameters are for a completed/loaded vehicle.



AXLE CENTER LINE

+/- 1/8 inch

TOE

1/8 inch TOE IN +/- 1/16 inch

(+.12° +/- .06°)

CASTER

Positive 4° +/- 1/8°

(Axle is ordered with 4° shims)

DRIVE AXLE

PERPENDICULAR TO FRAME

0 inch +/- 1/4 inch

(0° +/- .2°)

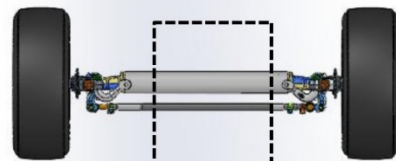
Maintenance

Tandem Rear Axles

Parameters are for a completed / loaded vehicle.

TOE

1/8 inch TOE IN +/- 1/16 inch
(+.12° +/- .06°)

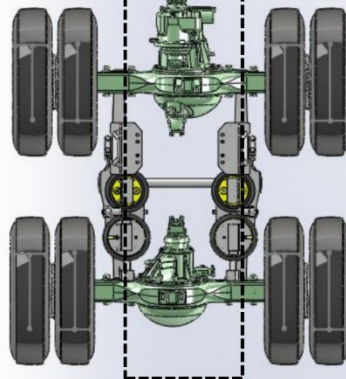


CASTER

Positive 4° +/- 1/8°
(Axle is ordered with 4° shims)

AXLE
LINES

CENTER



DRIVE AXLE

PERPENDICULAR TO FRAME
0 inch +/- 1/2 inch
(0° +/- .2°)

DRIVE AXLE

PERPENDICULAR TO FRAME
0 inch +/- 1/2 inch
(0° +/- .2°)



Alignment Tandem Axle (In-Service Recommendations)

1. Confirm loaded ride height is 40 inches.
 - On level surface
 - Measured between rear axles
 - Measured from ground to top of frame rails
2. Remove both transverse torque rods from rear axles.
3. With front wheels straight, move truck forward and backward to center axles (+/- 1/8 inch to chassis centerline).
4. Check frame height. Reinstall both transverse torque rods.
Adjustments may be required to torque rods to maintain axle centers.
5. Proceed with attached alignment values.
 - Front axle camber (not adjustable)
 - Front axle toe in (- 1/8 inch)
 - Front axle caster (+ 4°)
 - Drive axle thrust (square /0°/0 inch)
 - Drive axle scrub (parallel /0° /0 inch)
 - Drive axle lateral offset (0 inch)

U-bolt Tension for Front and Rear Axle and Body Mounts

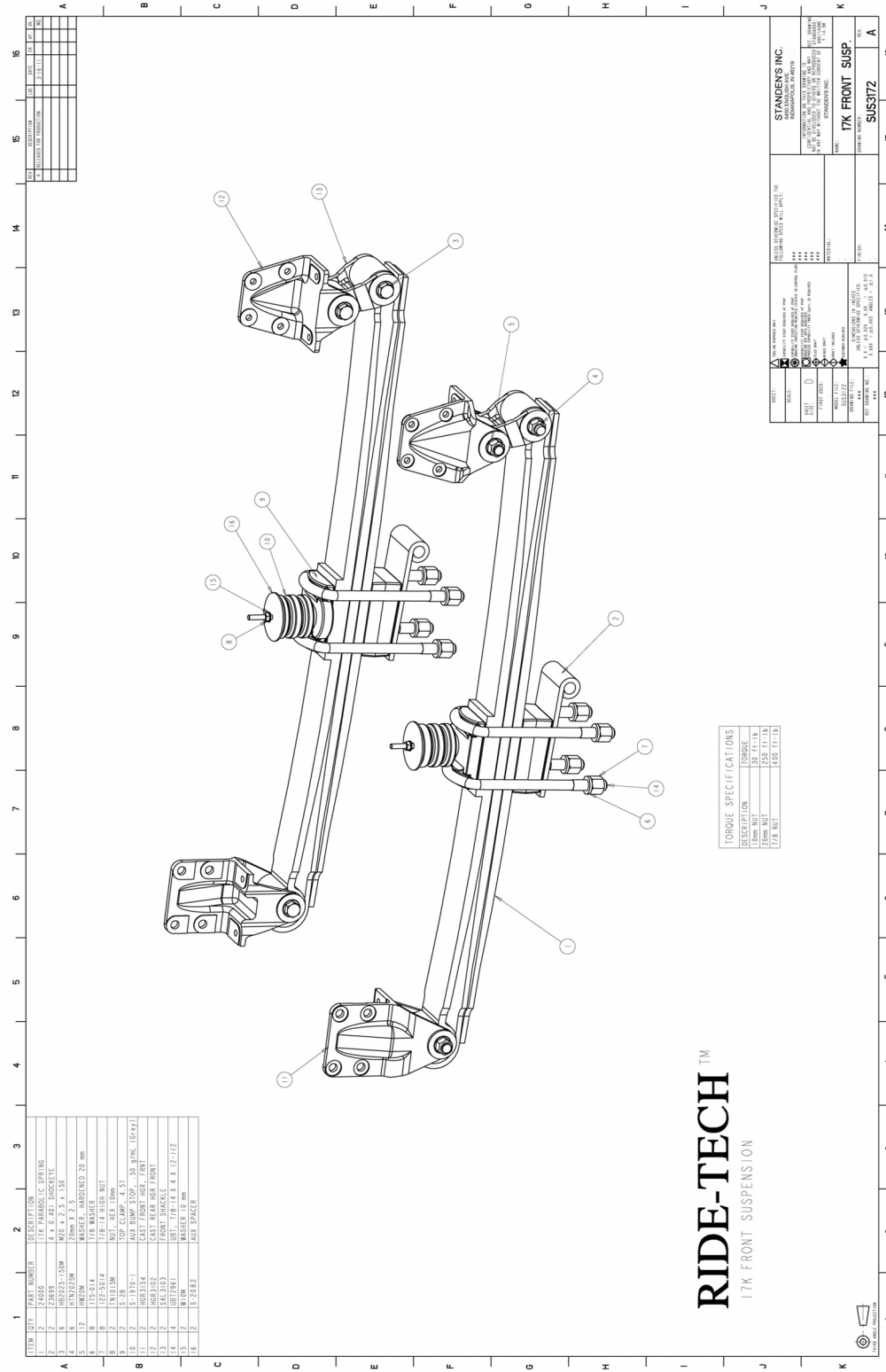
Tighten U-bolts after the first 500 miles then semiannually. This is very important to maintain. To check U-bolt tension properly, the vehicle must be loaded to its normal gross weight. Tighten the nuts evenly and gradually, up to the specified torque. When replacing a U-bolt or nut, first clean the threads then lubricate with clean lubricating oil. Then torque the U-bolt per the specifications. The following table specifies torque values for the various-size U-bolts.

NOTE: Never reuse a self-locking nut.

AXLE	DRY (ft/lb)	LUBE (ft/lb)
Front - FG941or MFS18 Pumper 3/4" U-bolt	-	200 to 230
Front - FL941 or MFS20 Aerial Tower & Pumper 7/8" U-bolt	-	225 to 250
Rear - RS24160 Pumper 7/8" U-bolt	325 to 350	275 to 300
Rear - RS26185 Pumper 7/8" U-bolt	325 to 350	275 to 300
Pumper Body 5/8" U-Bolt	125 to 150	-
Pumper Pump Module 5/8" U-Bolt	125 to 150	-
Aerial Body 5/8" U-Bolt	125 to 150	-
Aerial Pump Module to Frame 5/8" U-Bolt	125 to 150	-
Aerial Hydraulic Module to Frame 5/8" U-Bolt	125 to 150	-



Front Suspension



16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

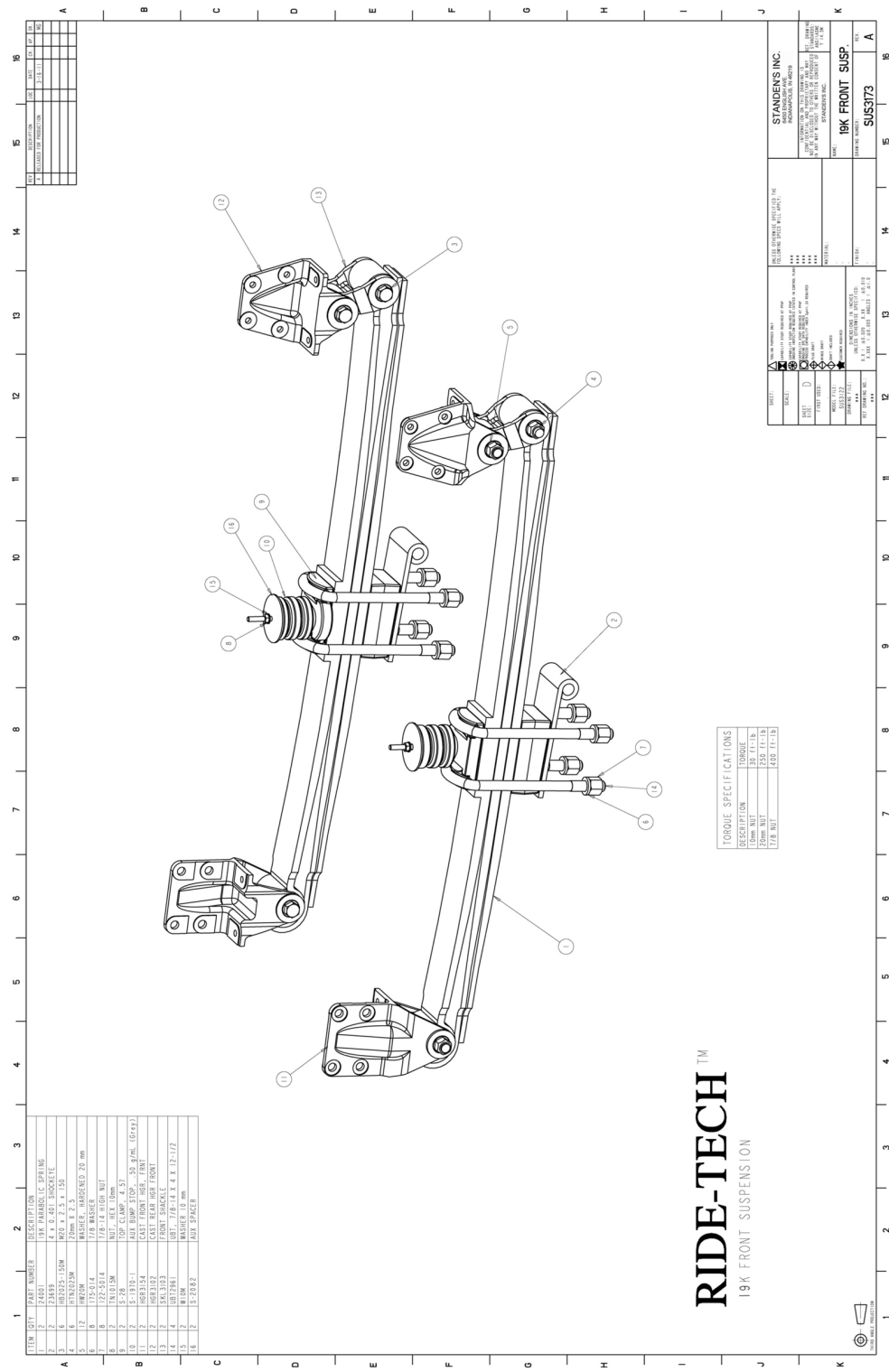
ITEM	QTY	PART NUMBER	DESCRIPTION
1	2	24200	17K PARABOLIC SPRING
2	2	23683	4 X 6-401 SHOCKEYE
3	2	1550M	1550M
4	6	11K2222M	22mm X 2.5 1/2"
5	12	10K220M	WASHER - HARDENED 20 mm
6	2	11K2222M	11K2222M
7	8	122-5014	7/16 X 4 X 1/2 NUT
8	2	1M115M	NUT - HEX 10mm
9	2	E-287	E-287
10	1	11K2222M	TOP CLAMP - 2.5"
11	2	11K2222M	11K2222M
12	2	10K2102	CAST FRONT HUB, FRNT
13	2	10K2102	CAST REAR HUB, FRNT
14	4	10K2102	10K2102
15	2	10K2102	10K2102
16	2	10K2102	10K2102
17	2	10K2102	10K2102
18	2	E-2887	AXLE SPACER

TORQUE SPECIFICATIONS	
REAR HUB NUT	150 FT-LB
25mm NUT	125 FT-LB
7/8" NUT	600 FT-LB

RIDE-TECH™
17K FRONT SUSPENSION

STANDEN'S INC. 17K FRONT SUSP.SUS3172	STANDEN'S INC. 17K FRONT SUSP. SUS3172
--	--

Maintenance

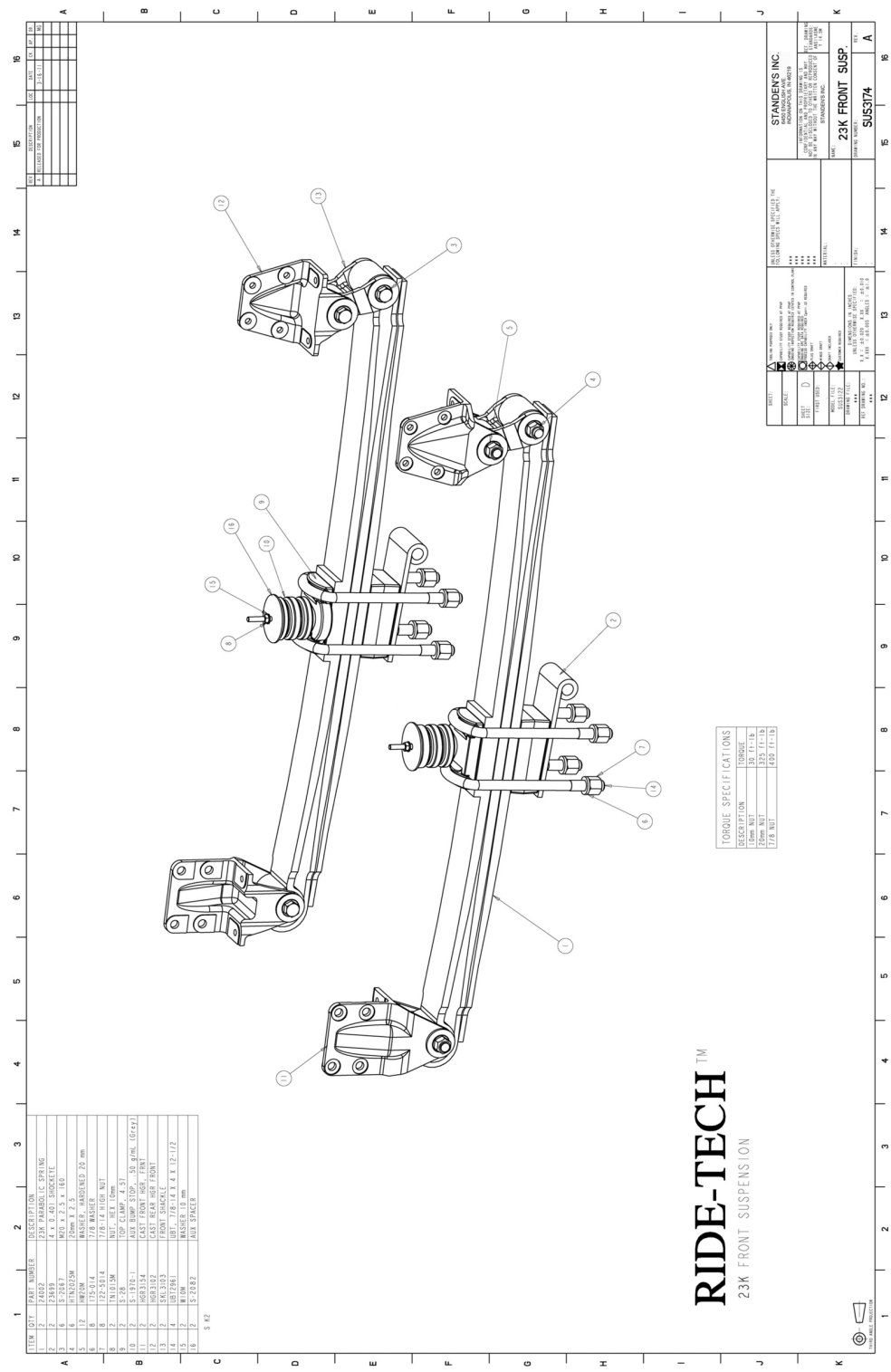


ITEM	QTY	PART NUMBER	DESCRIPTION
1	2	23411	4 X 8.001 SHOCKLETS
2	2	23419	4 X 8.001 SHOCKLETS
3	4	052022-150M	500 X 2.5 X 1.50
4	4	052022-150M	500 X 2.5 X 1.50
5	12	052020	WASHER, HARDENED 20 MM
6	8	175-014	1/8 WASHER
7	8	052020	WASHER, HARDENED 20 MM
8	2	052020	WASHER, HARDENED 20 MM
9	2	5-28	TOP CLAMP, 4.53
10	2	052020	WASHER, HARDENED 20 MM
11	2	052020	WASHER, HARDENED 20 MM
12	2	052020	WASHER, HARDENED 20 MM
13	2	052020	WASHER, HARDENED 20 MM
14	2	052020	WASHER, HARDENED 20 MM
15	2	052020	WASHER, HARDENED 20 MM
16	2	5-20R2	AXL SPACER

TORQUE SPECIFICATIONS	
DESCRIPTION	TORQUE
Upper Nut	250 Ft-Lb
Lower Nut	400 Ft-Lb

RIDE-TECH™
19K FRONT SUSPENSION

STANDARDS INC. 19000 19TH AVE. SUITE 100 BROOKLYN, NY 11234	19K FRONT SUSP.
DATE: 05/20/02	REV: A
BY: J. J. STANLEY	APP: J. J. STANLEY
CHECKED: J. J. STANLEY	DATE: 05/20/02
APPROVED: J. J. STANLEY	DATE: 05/20/02



ITEM	QTY	DESCRIPTION
1	2	UPPER CONTROL ARM
2	2	LOWER CONTROL ARM
3	2	COIL SPRING
4	2	SHOCK ABSORBER
5	2	STEERING KNUCKLE
6	2	SPACER
7	2	WASHER
8	2	CLAMP
9	2	WASHER
10	2	WASHER
11	2	WASHER
12	2	WASHER
13	2	WASHER
14	2	WASHER
15	2	WASHER
16	2	WASHER
17	2	WASHER
18	2	WASHER

ITEM	QTY	DESCRIPTION
1	2	UPPER CONTROL ARM
2	2	LOWER CONTROL ARM
3	2	COIL SPRING
4	2	SHOCK ABSORBER
5	2	STEERING KNUCKLE
6	2	SPACER
7	2	WASHER
8	2	CLAMP
9	2	WASHER
10	2	WASHER
11	2	WASHER
12	2	WASHER
13	2	WASHER
14	2	WASHER
15	2	WASHER
16	2	WASHER
17	2	WASHER
18	2	WASHER

SKZ

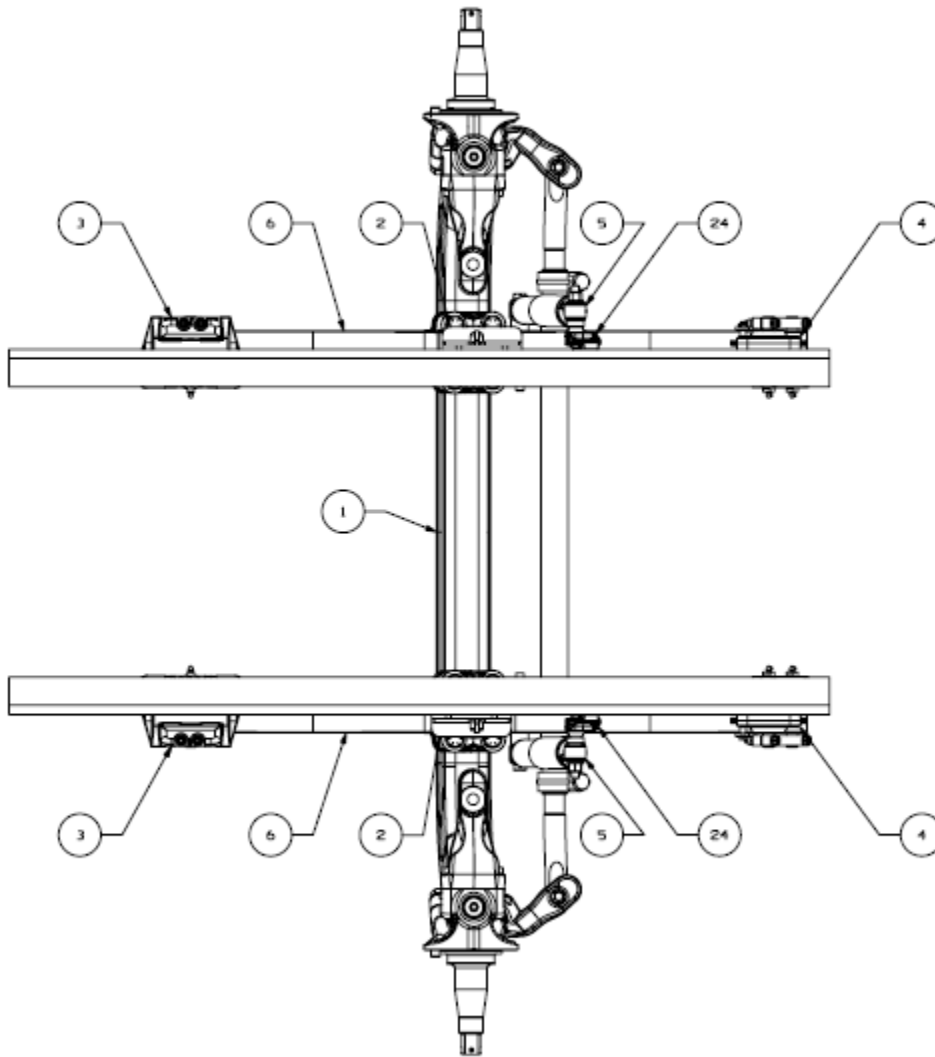
RIDE-TECH™

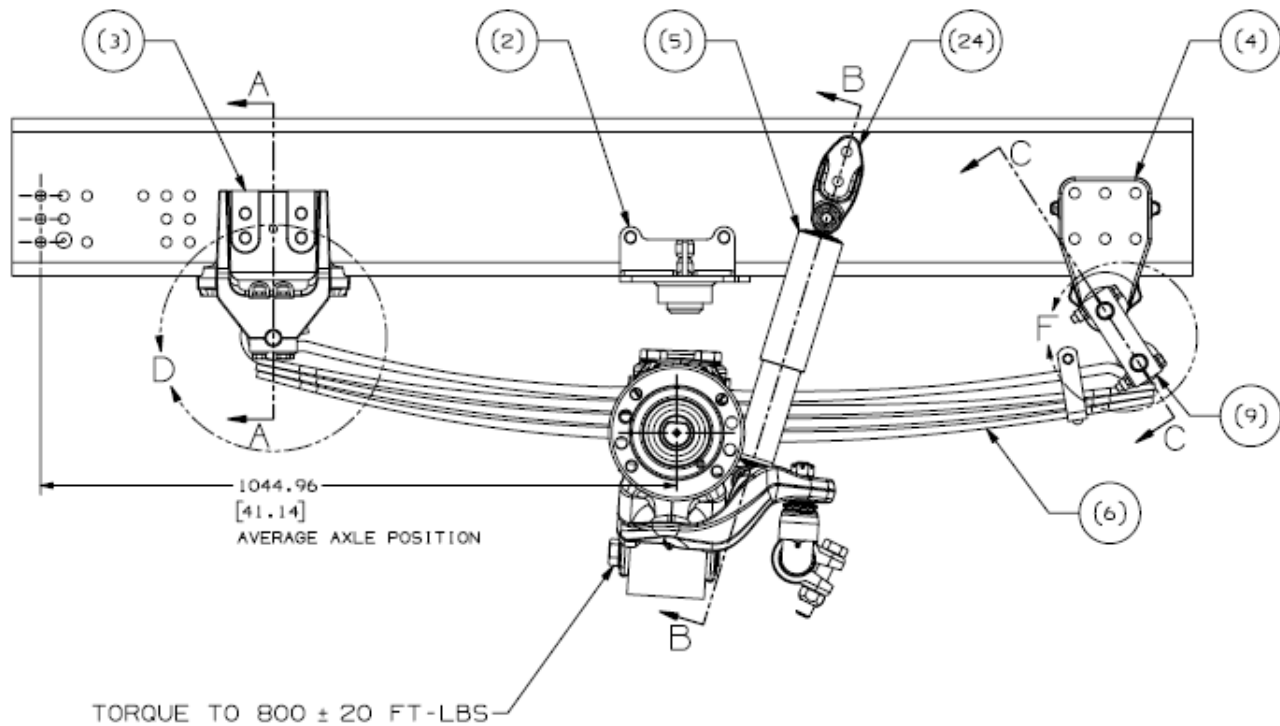
23K FRONT SUSPENSION

TORQUE SPECIFICATIONS	
DESCRIPTION	TORQUE
1/2" NUT	325 FT-LB
1/2" BUSH	400 FT-LB

STANDENS INC.	
DATE	10/15/13
REV	1
DESCRIPTION	23K FRONT SUSP.
ITEM NO.	SUS3174
REV	A

STEER TEK





ITEM	QTY REQ'D	PART NUMBER	DESCRIPTION	IN KIT	IN KIT
1	1	091366-XXX	AXLE AND BRAKE ASSEMBLY	-----	-----
2	2	079854-000	JOUNCE STOP ASSEMBLY	-----	INSTALLATION KIT 069921-XXX
3	2	079894-004	FRAME HANGER - FRONT	-----	
4	2	080159-003	FRAME HANGER - REAR	-----	
5	2	080606-001	SHOCK ABSORBER	-----	
6	2	091367-XXX	SPRING/CLAMP GROUP	-----	
7	16	022962-014	1/2 FLAT WASHER	SHACKLE KIT 034013-257	
8	8	017700-034	1/2-20 UNC-2B NUT		
9	4	079888-001	SHACKLE		
10	6	079891-000	THREADED PIN		
11	8	080362-002	1/2-20 X 3.25 HEX BOLT		
12	6	091123-000	GREASE FITTING		
13	16	022962-014	1/2 FLAT WASHER	FRONT HANGER - KIT 034013-258	
14	8	017700-034	1/2-20 UNC-2B NUT		
15	4	079843-000	CAP		
16	8	080362-001	1/2-20 X 4.5 HEX BOLT		
17	4	022962-001	3/4 FLAT WASHER	SHOCK KIT 034013-317	
18	4	049842-000	3/4-10 UNC-2B NUT		
19	2	050764-008	3/4-10 X 5.0 HEX BOLT		
20	2	050764-014	3/4-10 X 8.5 HEX BOLT		
21	2	059946-005	SHOCK SPACER 3MM		
22	2	059946-006	SHOCK SPACER 13.2MM		
23	2	059946-015	SHOCK SPACER 28MM		
24	2	078250-002	SHOCK BRACKET		

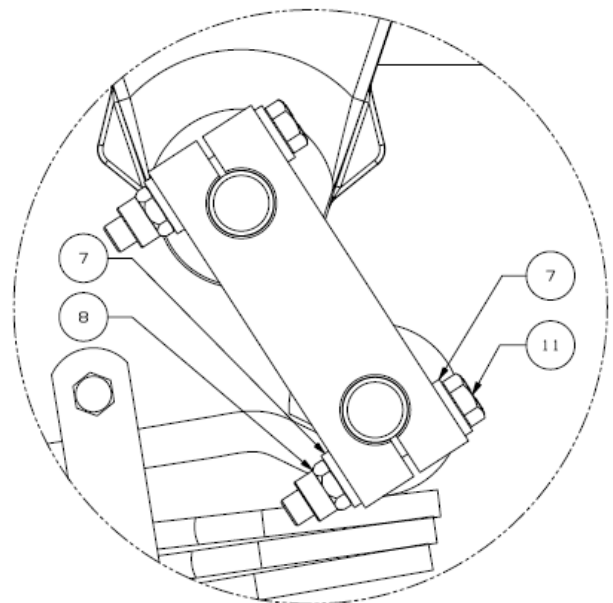
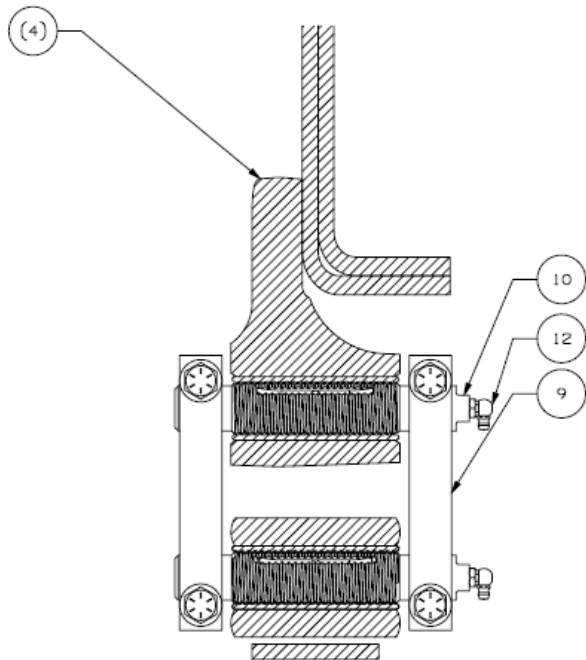
Maintenance

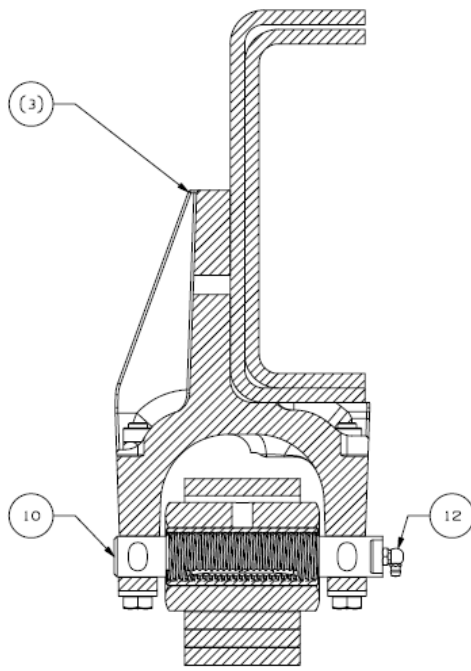
(E-2)

AVAILABLE INSTALLATION KITS								
PART NUMBER		DESCRIPTION	CAPACITY	RIDE HEIGHT	SPRING/CLAMP GROUP ASSEMBLY	FRAME PIERCING	APPLICATION	
HENDRICKSON	SUTPHEN							
(E-1)	069921-049	10132667	INSTALLATION KIT	19K	8.0	091367-002	LOW PROFILE	-
	069921-029	10127398	INSTALLATION KIT	19K	10.1125	091367-001	STANDARD	-
(E-1)	069921-050	10132668	INSTALLATION KIT	20K	8.2	091367-102	LOW PROFILE	-
	069921-030	10127399	INSTALLATION KIT	20K	10.1125	091367-101	STANDARD	-
	069921-031	10127400	INSTALLATION KIT	24K	9.2125	091367-201	STANDARD	-
	069921-032	10127401	INSTALLATION KIT	24K	11.2125	091367-202	STANDARD	-
	069921-033	10127402	INSTALLATION KIT	24K	11.2125	091367-301 (LH) 091367-302 (RH)	STANDARD	AERIAL

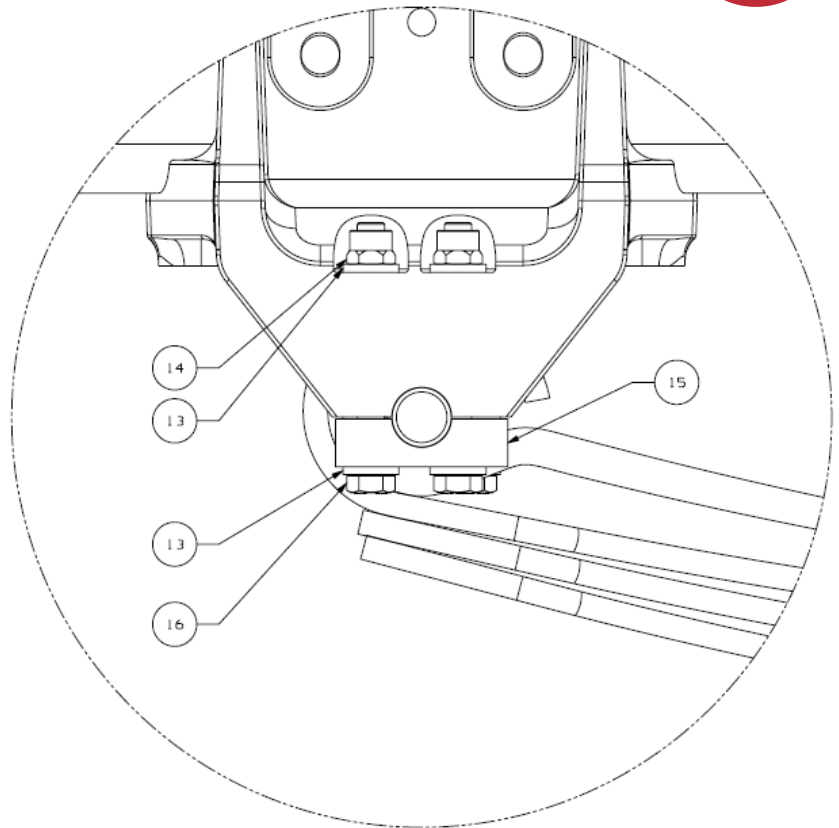
(D)

AVAILABLE AXLES						
PART NUMBER		DESCRIPTION	BRAKES	STEERING CONFIG	WHEEL BASE	
HENDRICKSON	SUTPHEN					
	091366-001	10127388	AXLE ASSEMBLY	DISC	SINGLE	170-195
(C-1)	091366-006	10132250	AXLE ASSEMBLY	DISC	DUAL	170-195
	091366-002	10127389	AXLE ASSEMBLY	DISC	SINGLE	196-220
	091366-003	10127390	AXLE ASSEMBLY	DISC	DUAL	196-220
	091366-004	10127391	AXLE ASSEMBLY	DISC	DUAL	221-250
	091366-005	10127392	AXLE ASSEMBLY	DISC	DUAL	251-280
	091366-101	10127393	AXLE ASSEMBLY	DRUM	SINGLE	170-195
(F) (C-2)	091366-106	10133921	AXLE ASSEMBLY	DRUM	DUAL	170-195
	091366-102	10127394	AXLE ASSEMBLY	DRUM	SINGLE	196-220
	091366-103	10127395	AXLE ASSEMBLY	DRUM	DUAL	196-220
	091366-104	10127396	AXLE ASSEMBLY	DRUM	DUAL	221-250
	091366-105	10127397	AXLE ASSEMBLY	DRUM	DUAL	251-280



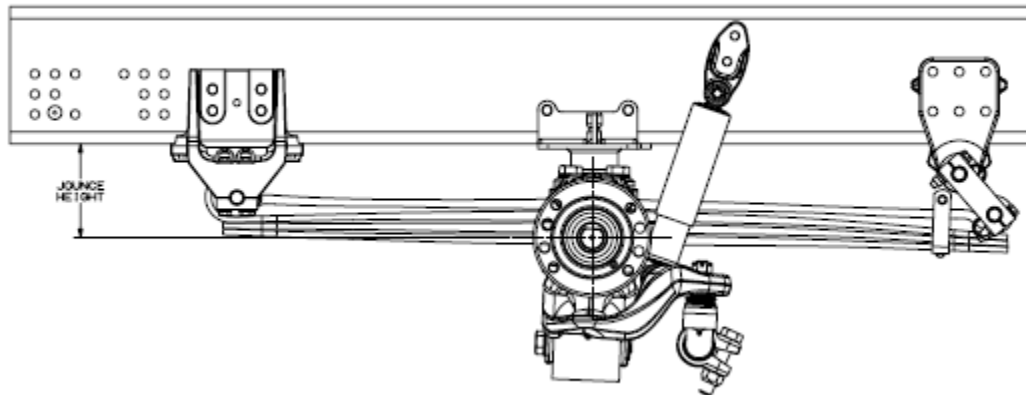


SECTION A - A
(LEFT SIDE SHOWN)



DETAIL D
SCALE 1:1

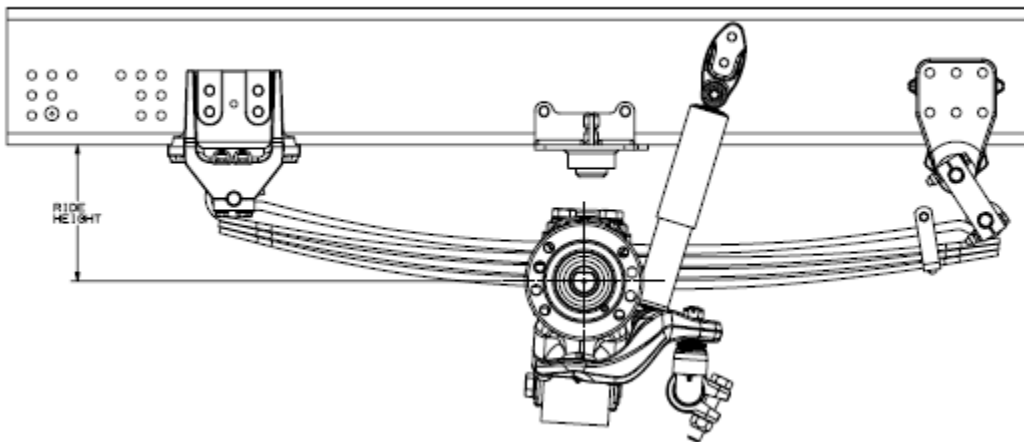
JOUNCE



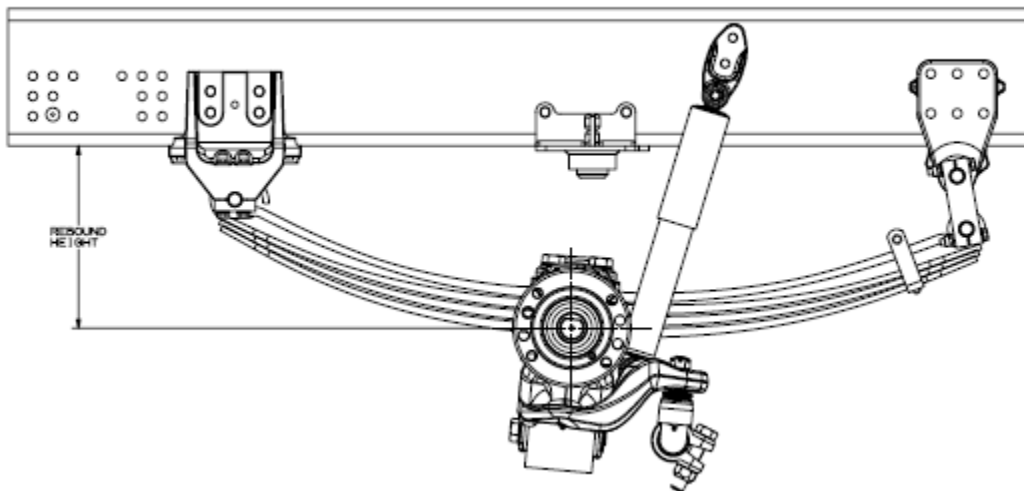
Maintenance

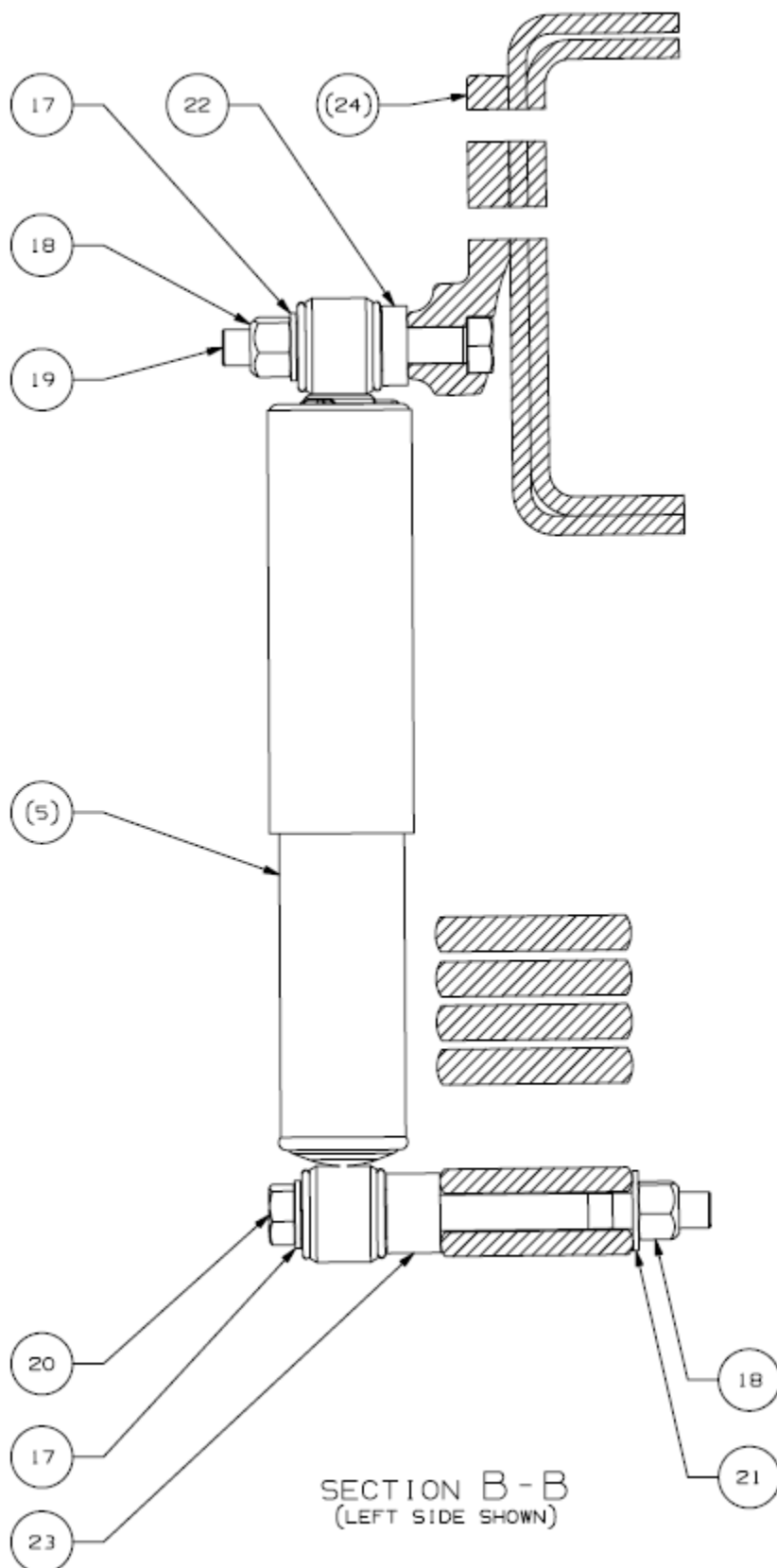
CAPACITY	JOUNCE		RIDE	REBOUND	
	POSITION	TRAVEL	POSITION	POSITION	TRAVEL
19K	126.17 [4.97]	77.0 [3.03]	203.2 [8.0]	293.7 [11.57]	90.6 [3.57]
	179.8 [7.08]	77.0 [3.03]	256.9 [10.1125]	347.4 [13.68]	90.6 [3.57]
20K	128.5 [5.06]	79.7 [3.14]	208.3 [8.2]	294.1 [11.58]	85.8 [3.38]
	177.12 [6.97]	79.7 [3.14]	256.9 [10.1125]	342.7 [13.49]	85.8 [3.38]
24K	153.7 [6.05]	80.27 [3.16]	234.0 [9.2125]	323.1 [12.72]	89.2 [3.51]
	204.5 [8.05]	80.27 [3.16]	284.8 [11.2125]	373.9 [14.72]	89.2 [3.51]

RIDE



REBOUND



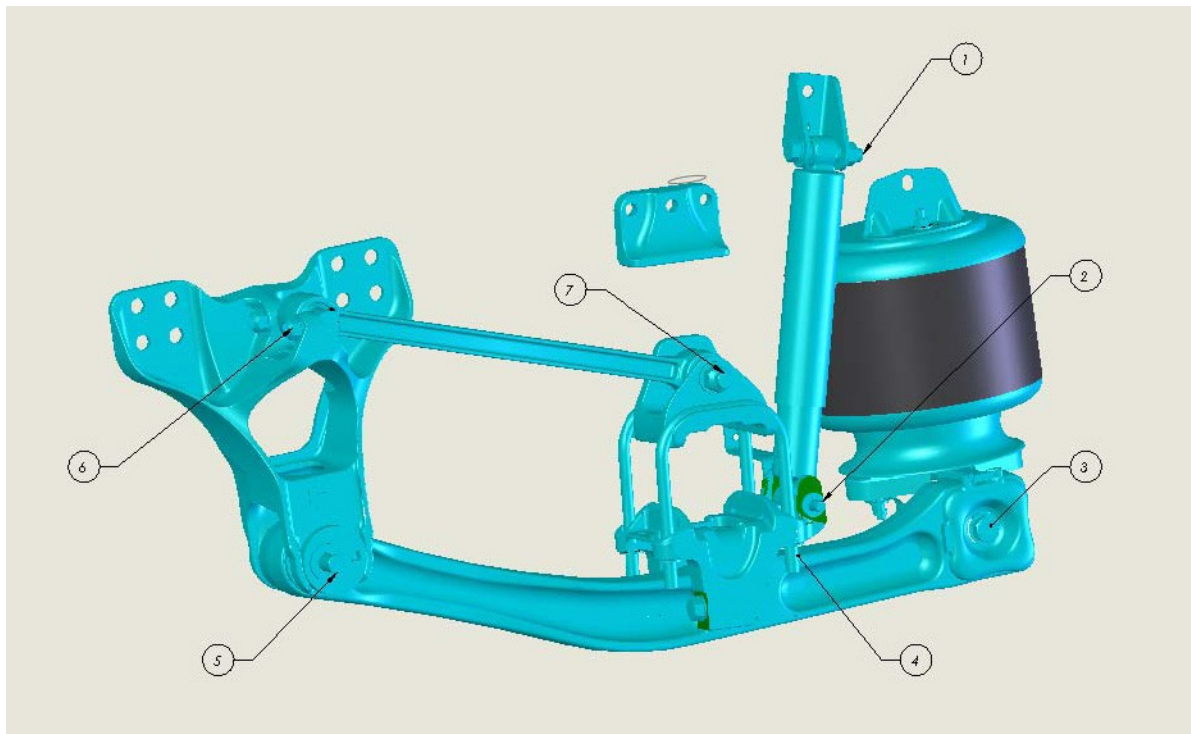


Maintenance

Air Ride Suspension Options

- All trucks have air ride suspension as standard
- Single axles with 24K/27K/31K ratings use the Hendrickson Firemaax
- Raydan Air Link suspension is standard for tandem axle2

Hendrickson Firemaax



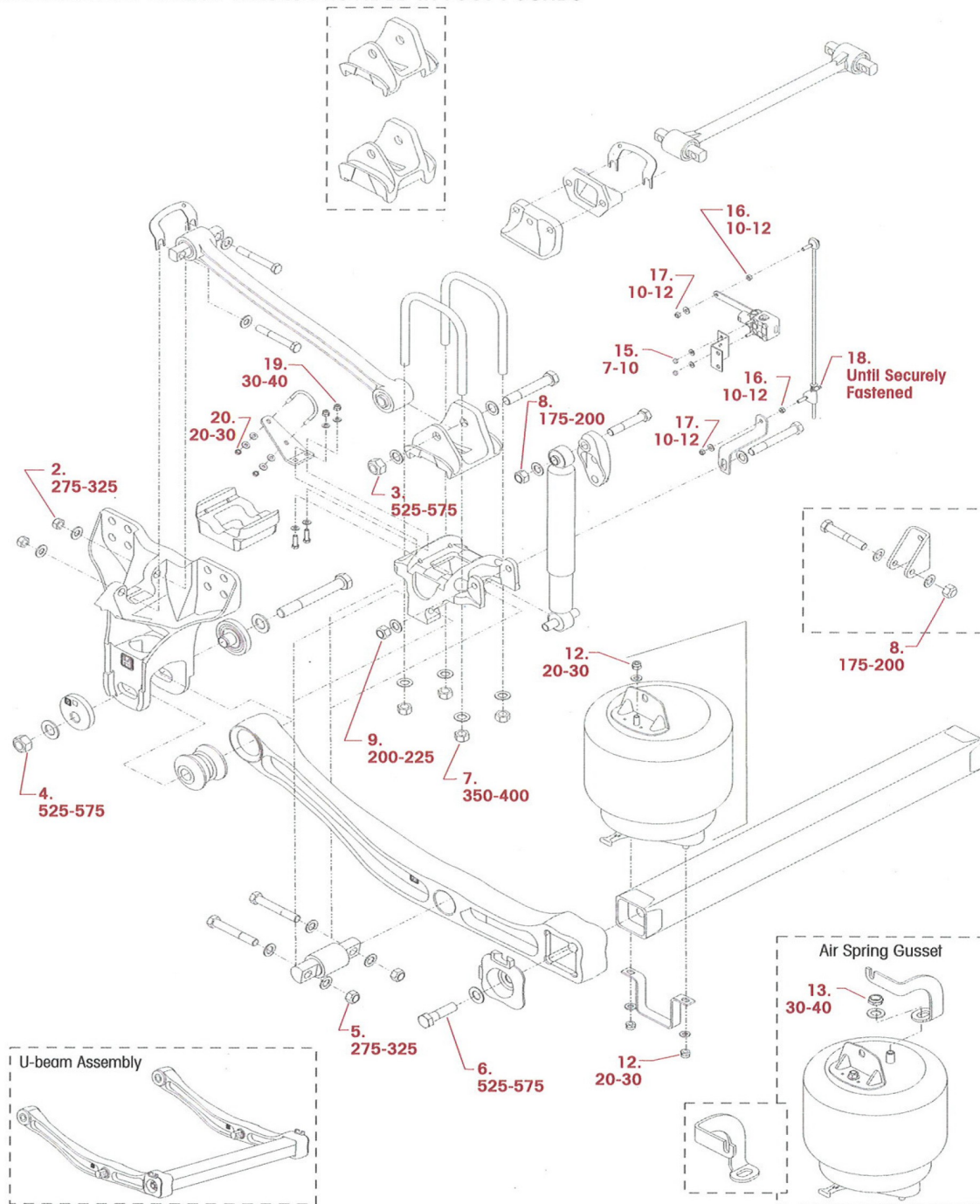
1. Upper shock - 225 ft/lb (305 N•m)
2. Lower shock - 200 ft/lb (271 N•m)
3. End cap - 550 ft/lb (746 N•m)
4. U-bolt - 375 ft/lb (508 N•m)
5. Quick align nut - 575 ft/lb (780 N•m)
6. Front torque rod nuts - 300 ft/lb (407 N•m)
7. Rear torque rod bolt - 550 ft/lb (746 N•m)



PRIMAAX® EX • FIREMAAX® EX



**PRIMAAX 230/460/690 • FIREMAAX 240/480, 8½"-10" Ride Height
RECOMMENDED TORQUE VALUES PROVIDED IN FOOT POUNDS**




Maintenance


PRIMAAX® EX•FIREMAAX® EX

PRIMAAX 230/460/690 • FIREMAAX 240/480**8½"-10" RIDE HEIGHT****HENDRICKSON RECOMMENDED TORQUE SPECIFICATIONS**

NO.	COMPONENT	*QUANTITY	SIZE	TORQUE VALUE (in foot pounds)
1	Frame Hanger to Frame	16	¾"-10 UNC	**350-400
2	Longitudinal Torque Rod To Forward Hanger Mount	4	¾"-16 UNF	275-325
3	Longitudinal Torque Rod To Rear Top Pad Mount	2	7/8"-14 UNF	525-575
4	Beam Assembly To QUIK-ALIGN Bushing	2	1"-14 UNF	525-575
5	Beam Assembly To Center D-Pin Bushing	4	¾"-16 UNF	275-325
6	Beam Assembly To Cross Tube End Cap	2	7/8"-9 UNC	525-575
7	U-bolt Locknuts	8	¾"-16 UNF	350-400
8	Upper Shock Mount Locknuts	2	¾"-10 UNC	175-200
9	Lower Shock Mount Locknuts	2	5/8"-11 UNC	200-225
10	Upper Shock Bracket to Frame	4	5/8"-11 UNC	**200-225
11	Air Spring Assembly To Frame	2	5/8"-11 UNC	**200-225
12	Lower Air Spring Assembly To Cross Tube	4	½"-13 UNC	20-30
13	Air Spring Assembly to Air Spring Gusset	2	¾"-16 UNF	30-40
14	Axle Stop to Frame	6	5/8"-11 UNC	**200-225
15	Height Control Valve to HCV Frame Bracket	2	¼"-20 UNC	7-10
16	HCV Linkage Jam Nut	2	5/16"-18 UNC	10-12
17	HCV Linkage To HCV	2	5/16"-18 UNC	10-12
18	HCV Linkage Clamp	1		Until Securely Fastened
19	S-cam Support Bracket To Bottom Cap Mount	4	3/8"-16 UNC	30-40
20	S-cam Support Bracket To U-bolt Locknuts	4	5/16"-18 UNC	20-30

NOTE: * Quantities shown are per axle. Double for Tandem, Triple for Tridem, except for items 15 to 18.

** All hardware grayed in the matrix denotes items not shown on illustration. For torque requirements see the vehicle manufacturer. Torque values listed above apply only if Hendrickson supplied fasteners are used. If non Hendrickson fasteners are used, follow torque specification listed in vehicle manufacturer's service manual.

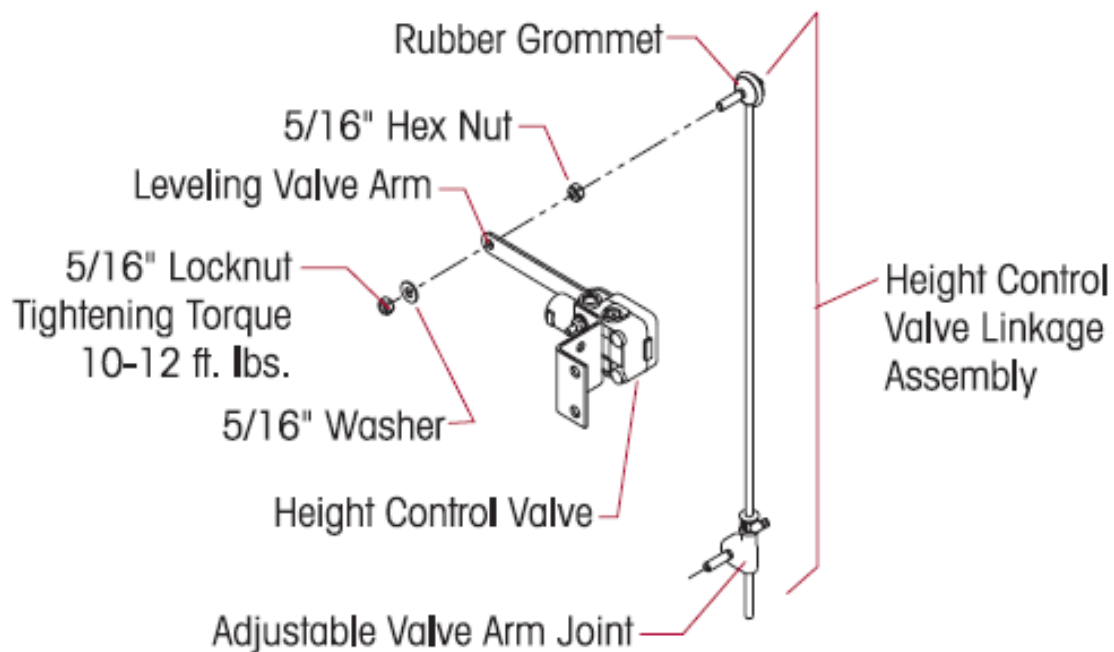


6.6 Alignment and Adjustments

Ride Height Adjustment

The 10" PRIMAXX suspension is equipped with a height control valve located on the front drive axle. Please refer to **Plumbing the Air System** for more information.

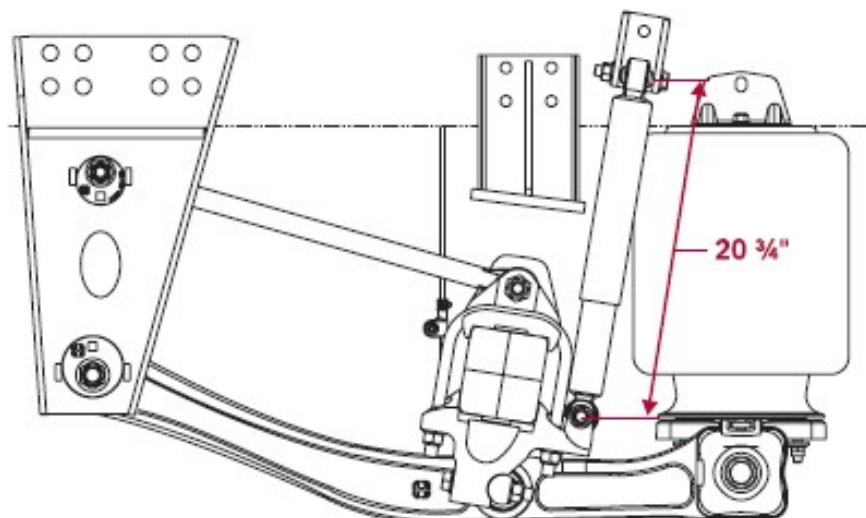
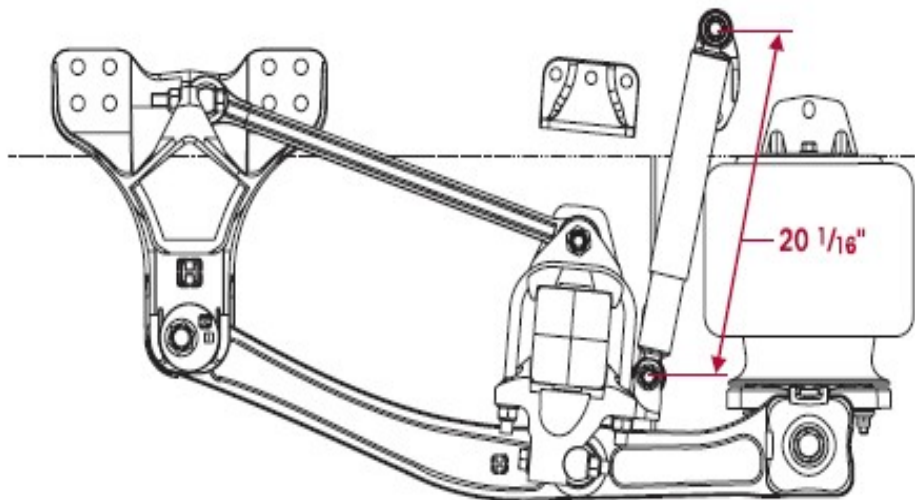
1. Use a work bay with a level floor. Drive the vehicle slowly, straight ahead. Try to slacken or loosen the suspension as the vehicle is positioned. End with all wheels positioned straight ahead. Try to roll to a stop without the brakes being used.
2. Chock the front wheels of the vehicle. Do not set the parking brake.
3. See Cautions and Warnings in the Safety Section of this publication prior to deflating or inflating the air system. Cycle the air system. Disconnect the leveling valve arm(s) from the rubber grommet. Lower the leveling valve arm(s) to exhaust the air in the air springs and deflate the suspension. Reconnect the leveling valve arm(s) to the rubber grommet to inflate the suspension.



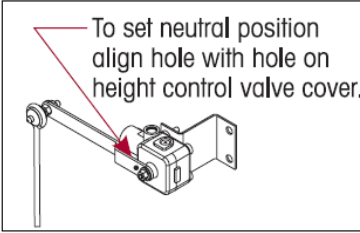
Maintenance

4. Using a tape measure, measure the referenced vertical ride height on the **(front drive axle STANDARD Ride Height)** or the **(rear drive axle 14-3/8" to 15-1/2" Ride Height)** from the centerline of the upper shock mounting bolt to the centerline of the lower shock mounting bolt. The specific running length of the shock absorber varies per specific OEM applications. The referenced ride height measurement is as follows:

- Standard Ride Height - $20\text{-}1/16\text{''} \pm 1/8\text{''}$
- 14 -3/8" to 15-1/2" Ride Height - $20\text{-}3/4\text{''} \pm 1/8\text{''}$





5. If an adjustment is required, verify that the air system is at full operating pressure.
 6. See Cautions and Warnings in the Safety Section of this publication prior to deflating or inflating the suspension system. Disconnect the height control valve leveling arm(s) from the rubber grommet. Lower the leveling valve arm(s) to exhaust the air from the air springs and deflate the rear suspension.
 7. Refill the suspension by raising the height control valve arm(s) by hand, so that the air springs are above the proper ride height.
 8. Lower the leveling valve arm(s) to exhaust the air system until the suspension is at proper ride height.
 9. Use a 1/8" wooden dowel rod (golf tee) to set the neutral position for the height control valve by aligning the hole in the leveling arm(s) with the hole in the height control valve cover, as shown in figure. **DO NOT** use a metal rod or nail as this may cause damage to the height control valve.
- 
10. Adjust the extension rod(s) so the rubber grommet(s) can be reconnected to the height control valve arm(s) at the proper height. Check the rubber components for any tearing or damage, replace as necessary.
 11. Connect the height control valve arm(s) to the rubber grommet(s).
 12. Tighten the clamp(s) on the adjustable valve arm(s) joint with a screwdriver until securely fastened. Remove the dowel from the height control valve.
 13. If equipped with a suspension dump system in the cab, cycle the suspension air system by using the cab dump valve control. If not equipped, cycle the height control valve leveling arm(s) as stated in step number 3.
 14. Recheck the ride height.
 15. Repeat steps 3 through 14 until the ride height is within specification.

NOTE: It is very important that the leveling valve(s) be cycled completely before and after any ride height adjustments. The cycling of the leveling valve will help to make the adjustment more accurate.

Lateral Alignment

If it is necessary to check the lateral alignment, measure from the outside of the frame rail to the rim flange of the inner tire. Record the measurement. Measure the same distance on the opposite side of the same axle. Record the measurement. Subtract the two measurements to get a difference between the two. If the difference is greater than 1/8", it will be necessary to correct the lateral alignment. This is accomplished by adding or removing shims that are located between the transverse torque rod and the bottom cap. A general rule of thumb is to use a shim with a thickness that is half of the difference between the two measurements.

Example: If the lateral alignment is out of specification by 1/4" of an inch, remove or install a 1/8" shim.

The 5/8" mounting fasteners used with the straddle mount transverse torque rod are furnished by the vehicle manufacturer. It is important to check the locknuts for proper torque specification during preventive maintenance service intervals.

Follow the vehicle manufacturer's specifications for tightening torque values.

All torque rods should be inspected for looseness, torn or shredded rubber, and proper torque every six months. A lever check can be made with a long pry bar placed under each rod end and pressure applied. Rod ends can be renewed by pressing out the worn bushing, and installing a replacement bushing. In the event of structural damage the entire torque rod assembly should be replaced. The torque rods are made to a specified length or a two-piece torque rod that can be cut and welded to the desired length (if available), see Hendrickson publication no. 59310-001.

NOTE: Hendrickson recommends the use of Grade 8 bolts and Grade C locknuts be used for all torque rod attachments.



Pinion Angle

Drive axle pinion angles are established by the vehicle manufacturer. The suspension axle brackets are machined to specific angles to meet the vehicle manufacturer specified requirements. If it is necessary to fine tune the pinion angle see the Alignment section of this publication.

To check the pinion angle, verify first that the suspension is at the proper ride height (see Ride Height Adjustment in this section). Install a digital protractor on the axle housing. Check that the pinion angle is correct to the vehicle manufacturer's specifications.



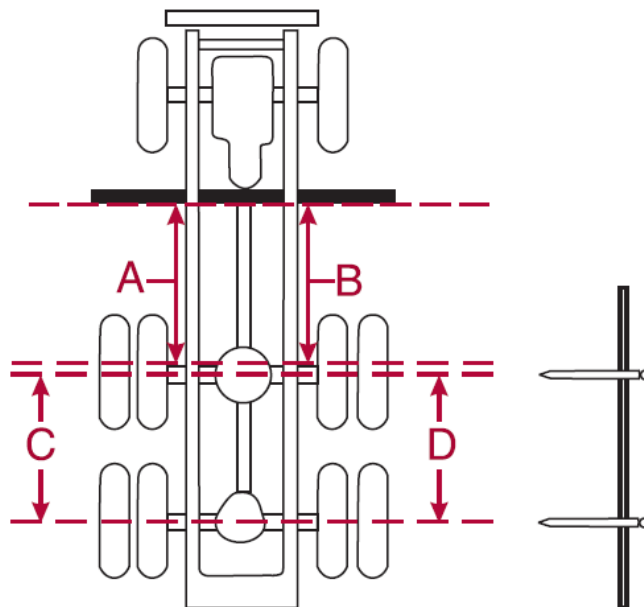
Rear Axle Alignment Inspection

Proper alignment is essential for maximum ride quality, performance, and tire service life. The recommended alignment procedure is described below. This procedure should be performed if excessive or irregular tire wear is observed, or any time the QUIK-ALIGN connection is loosened or removed.

1. Use a work bay with a level floor. Drive the vehicle slowly, straight ahead. Try to slacken or loosen the suspension as the vehicle is positioned. End with all wheels positioned straight ahead. Try to roll to a stop without the brakes being used.
2. Chock the front wheels of the vehicle. Do not set the parking brake.

 **Maintenance**

3. Verify that the proper ride height is set. For the proper ride height instructions see Ride Height Adjustment in this section of this publication.
4. If axle alignment equipment is not available, using "C" clamps, securely clamp a six-foot piece of STRAIGHT bar stock or angle iron across the lower frame flange as shown in the figure below. Select a location for the angle iron as far forward of the drive axle as possible where components will not interfere.

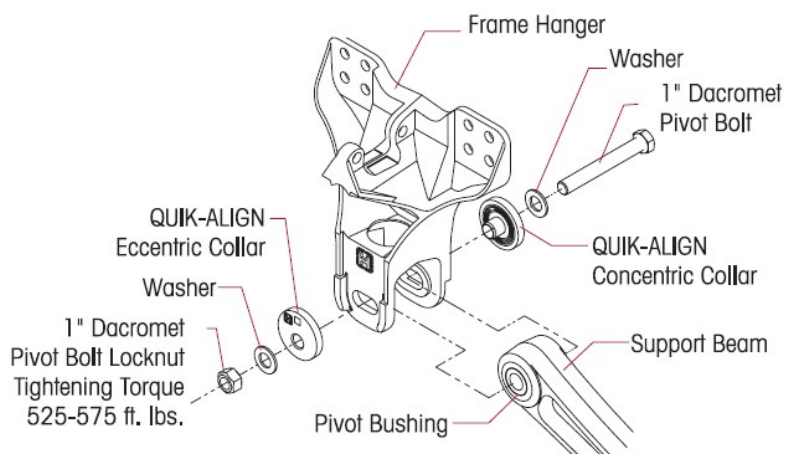


5. Accurately square the straight edge to the frame using a carpenter's square.
6. Using a measuring tape, measure from the straight edge to the forward face of the front drive axle arms at the centerline on both sides of the vehicle as shown the figure above, **A** and **B**. If both sides measure within the vehicle manufacturer's specifications, alignment of the front drive axle is acceptable.
7. If the front drive axle is within specification, proceed to check the rear drive axle.
8. Using a trammel bar, measure from spindle center to spindle center on both sides of the vehicle. See figure above, **C** and **D**. If both sides measure within original equipment manufacturer's specifications, alignment of the rear drive axle is acceptable.
9. If not within specifications, perform the correct alignment procedure detailed by the suspension ride height.



Alignment Instructions 10" Ride Height

NOTE: Use a new QUIK-ALIGN pivot bolt kit for any axle alignment or disassembly of the QUIK-ALIGN connection. This ensures that the proper clamp load is applied to the connection, so that the joint will not slip in service.



NOTE: The Eccentric collars (with the square drive feature) are located on the outboard side of the frame hangers with the concentric collars on the inboard side. The total range of fore/aft axle adjustment is 1.0".

NOTE: A suspension equipped with eccentric QUIK-ALIGN collars on both sides of an axle can be adjusted on both sides. A suspension equipped with an eccentric QUIK-ALIGN collar on only one side of the axle can be adjusted only on the side that has the eccentric QUIK-ALIGN collar. Contact the vehicle manufacturer for specifications.

1. To allow the axle to move freely, it is important to have all 1" QUIK-ALIGN pivot bolt locknuts snugged tight (approximately 100 ft/lbs of torque) on the axle that is being aligned. See previous figure. This will hold the eccentric flanged collar in place against the hanger face, and within the adjustment guide, but loose enough to permit the eccentric flanged collar to rotate freely.

Maintenance

2. The 3/4" longitudinal torque rod to frame hanger locknuts must be loose to allow the axle to move during the alignment process. All other suspension fasteners must be tightened to their specified torque values.



3. Use a QUIK-ALIGN socket tool and impact gun, or a 3/4" square drive socket and breaker bar to rotate the QUIK-ALIGN eccentric collar to align the axle. A 180° rotation of the QUIK-ALIGN collar, from the nominal position (see next figure), will move the axle aft up to a maximum of 1 inch. A general rule of thumb is to adjust half the distance out of specification.

Example: 1/4" out of specification would require a 1/8" adjustment of the QUIK-ALIGN to bring the axle square to the centerline of the vehicle.

NOTE: If the axle can be adjusted on both sides, begin the adjustment on the side that is furthest out of specification.

4. The nominal position of the QUIK-ALIGN collars is for the axle to be in the full forward position. The square drive on the QUIK-ALIGN collars will be in the aft position.

Axle Full Forward (Nominal) Position



Axle Full Aft Position



Axle Center Position





WARNING

DO NOT ASSEMBLE THE QUIK-ALIGN JOINT WITHOUT THE PROPER FASTENERS. USE ONLY HENDRICKSON DACROMET PLUS XL PLATED FASTENERS TO SUSTAIN THE PROPER CLAMP FORCE. FAILURE TO DO SO CAN CAUSE LOSS OF VEHICLE CONTROL, PROPERTY DAMAGE OR PERSONAL INJURY.



WARNING

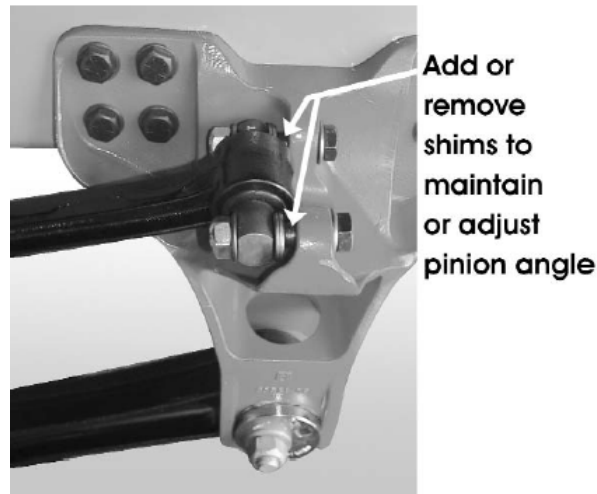
ENSURE THAT THE QUIK-ALIGN FASTENERS TORQUE VALUE IS SUSTAINED AS RECOMMENDED IN THE TORQUE REQUIREMENTS SECTION OF THIS PUBLICATION, FAILURE TO DO SO CAN CAUSE LOSS OF VEHICLE CONTROL RESULTING IN PERSONAL INJURY OR PROPERTY DAMAGE.

NOTE: Prior to tightening the 1" QUIK-ALIGN locknuts to torque specifications, it is mandatory that the vehicle is at the proper ride height.

5. Once the correct axle alignment is achieved, use a calibrated torque wrench to tighten the 1" QUIK-ALIGN locknuts to 525 to 575 ft/lbs torque to complete the alignment.
6. Re-check the ride height and the axle alignment to verify that it is within specifications, see Rear Axle Alignment Inspection in this section.
7. Check the pinion angles with a digital protractor. Refer to the vehicle manufacturer specifications for the required pinion angles.
8. If the pinion angles are within vehicle manufacturer's specifications, fill the gap between the bar pin torque rod and frame hanger with shims. Tighten the 3/4" longitudinal 275 to 325 ft/lbs torque.

Maintenance

9. If it is necessary to fine tune the pinion angle it is possible to increase or decrease the pinion angle by using one of the following appropriate procedures.



PINION ANGLE ADJUSTMENT FOR LESS THAN 1.5 DEGREES

Install or remove shims between the longitudinal torque rod and the frame hanger to achieve the recommended pinion angle. To increase the pinion angle install shims and to decrease the pinion angle remove shims. A general rule of thumb is, 1/8" change in the shim pack thickness will increase or decrease the pinion angle by 1/2 degree.

PINION ANGLE ADJUSTMENT FOR MORE THAN 1.5 DEGREES

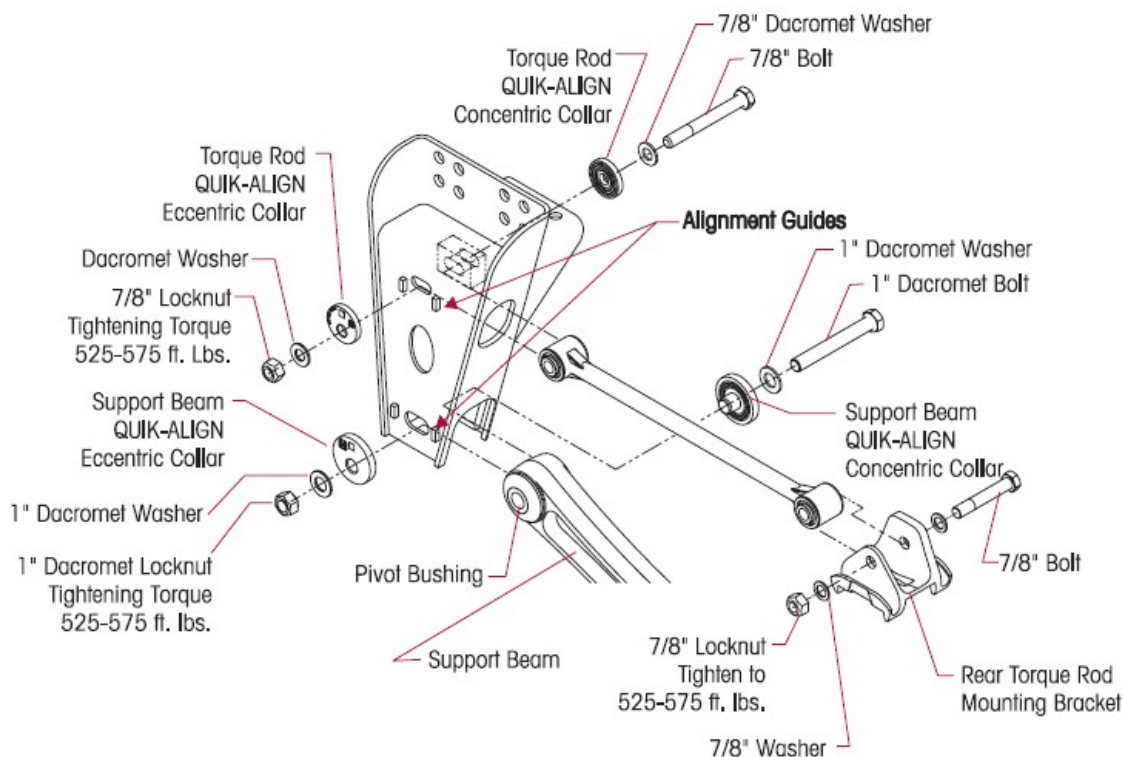
It will be necessary to replace the bottom cap with a bottom cap that will achieve the desired pinion angle.

10. After pinion angle adjustment, use a calibrated torque wrench to tighten the 3/4" longitudinal torque rod to frame hanger 275 to 325 foot pounds torque.
11. Following the alignment of the axles, move the vehicle back and forth several times prior to removing the straight edge from the frame, and recheck measurements to confirm adjustments.
12. Repeat steps 1 through 11 until the correct alignment and pinion angle is achieved.



Alignment Instructions 14-3/8" to 15-1/2" Ride Height

NOTE: Use a new support beam QUIK-ALIGN pivot bolt kit and a new longitudinal torque rod QUIK-ALIGN bolt kit, for any axle alignment or disassembly of the QUIK-ALIGN connection. This ensures that the proper clamp load is applied to the connections, so that the joints will not slip in service.



NOTE: The Eccentric collars (with the square drive feature) are located on the outboard side of the frame hangers with the concentric collars on the inboard side. The total range of fore/aft axle adjustment from center is $\pm 1/2"$.

NOTE: A suspension equipped with eccentric QUIK-ALIGN collars on both sides of an axle can be adjusted on both sides. A suspension equipped with an eccentric QUIK-ALIGN collar on only one side of the axle can be adjusted only on the side that has the eccentric QUIK-ALIGN collar. Contact the vehicle manufacturer for specifications.

Maintenance

1. To allow the axle to move freely, it is important to have the 1" pivot bolt QUIK-ALIGN locknuts snugged tight (approximately 100 ft/lbs) on the axle that is going to be aligned. This will hold the eccentric flanged collar in place against the hanger face, and within the adjustment guide, but loose enough to permit the eccentric flanged collar to rotate freely.
2. To allow the axle to move freely, and not change the pinion angle, loosen the 7/8" longitudinal torque rod QUIK-ALIGN to frame hanger connection locknuts to snug (approximately 50 ft/lbs) on the axle being aligned. All other suspension fasteners must be tightened to their specified torque values.
3. Use a QUIK-ALIGN socket tool and impact gun or a 3/4" square drive socket and breaker bar to rotate the QUIK-ALIGN eccentric collar to align the axle. The square drive on the QUIK-ALIGN collar will rotate fore and aft above the centerline of the bolt. A 90° rotation of the QUIK-ALIGN collar, from the center (nominal) position will move the axle fore or aft up to a maximum of 1/2". A general rule of thumb is to adjust half the distance out of specification.



Example: 1/4" out of specification would require a 1/8" adjustment of the QUIK-ALIGN to bring the axle square to the centerline of the vehicle.

NOTE: If the axle can be adjusted on both sides, begin the adjustment on the side that is furthest out of specification.



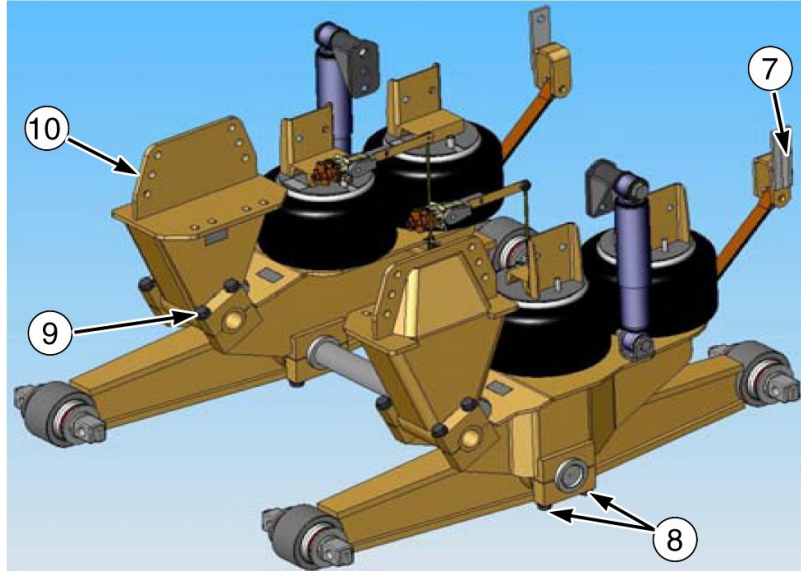
The nominal position of the support beam QUIK-ALIGN collars for the (14-3/8" to 15-1/2" ride height) is for the QUIK-ALIGN collars to be in the center position as shown below. The square drive on the support beam QUIK-ALIGN collars will rotate the axle fore and aft above the centerline of the bolt.



WARNING DO NOT ASSEMBLE THE QUIK-ALIGN JOINT WITHOUT THE PROPER FASTENERS. USE ONLY HENDRICKSON DACROMET PLUS XL PLATED FASTENERS TO SUSTAIN THE PROPER CLAMP FORCE. FAILURE TO DO SO CAN CAUSE LOSS OF VEHICLE CONTROL, PROPERTY DAMAGE OR PERSONAL INJURY. ENSURE THAT THE QUIK-ALIGN FASTENERS TORQUE VALUE IS SUSTAINED AS RECOMMENDED IN THE TORQUE REQUIREMENTS SECTION OF THIS PUBLICATION, FAILURE TO DO SO CAN CAUSE LOSS OF VEHICLE CONTROL RESULTING IN PERSONAL INJURY OR PROPERTY DAMAGE. PRIMAAX™

Maintenance

Rayden Air Link



- 7. Air bag - 30 ft/lb (41 N•m)
- 8. 3/4" cap bolts - 250 ft/lb (339 N•m)
- 9. 5/8" frame bolts - 212 ft/lb (287 N•m)
- 10. 3/4" frame bolts - 325 ft/lb (441 N•m)

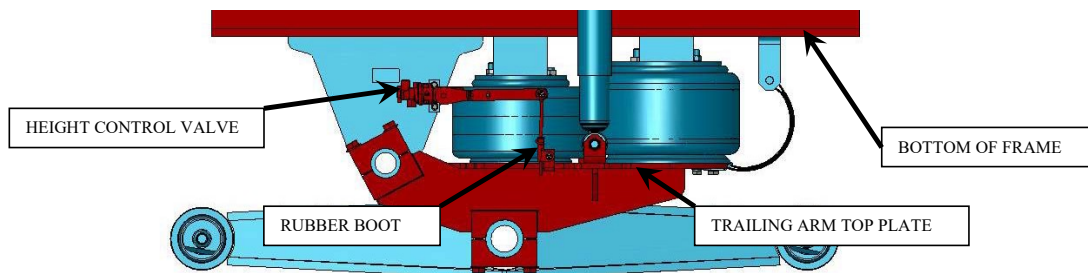


RAYDAN MANUFACTURING INC.	Procedure No: WI-2006102	Date: January 2, 2006
	Title: Adjusting the ride height & axle stops on a new installation	
WORK INSTRUCTIONS	Issued By: DG Approved By:	
	Revision: 0	Page: 1 of 1

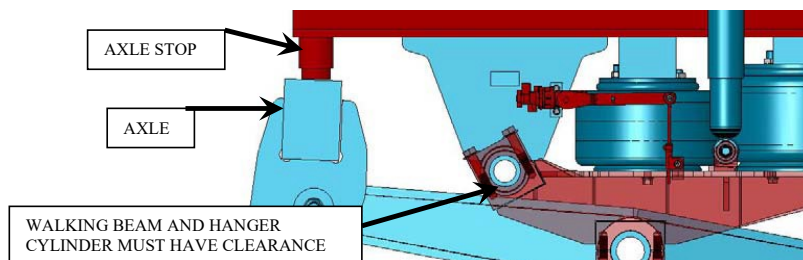
Process Steps *NOTE: This procedure is provided with the understanding that the work will be performed by qualified heavy duty mechanics, using appropriate industry safety standards. It does not replace common sense when working with heavy equipment.*

ADJUSTING THE RIDE HEIGHT & AXLE STOPS ON A NEW INSTALLATION

- 1) Adjust the height control valve linkage rod to the position that the trailing arm top plate is parallel with the vehicle frame rail. (The suspension must be aired up when adjusting the ride height)
 - To adjust the height control valve linkage rod; loosen the hose clamp on the rubber boot attached to the trailing arm, slide the rod through the boot, tighten the hose clamp



- 2) At the operating ride height, rotate the walking beam so that the front axle touches the axle stop. Check that the top of the walking beam does not touch the hanger cylinder. Adjust axle stops if necessary



- 3) Install the wheels and lower the truck to the ground. Air up the suspension and re-adjust the height control valve linkage to maintain the correct ride height
- 4) Measure the driveline angles and compare measurements to the vehicle manufacturers specifications
 - Adjust the driveline angles with torque rods if necessary
- 5) Road test and adjust the ride height if necessary. If possible adjust the ride height with a loaded vehicle
- 6) Perform a wheel alignment

Maintenance

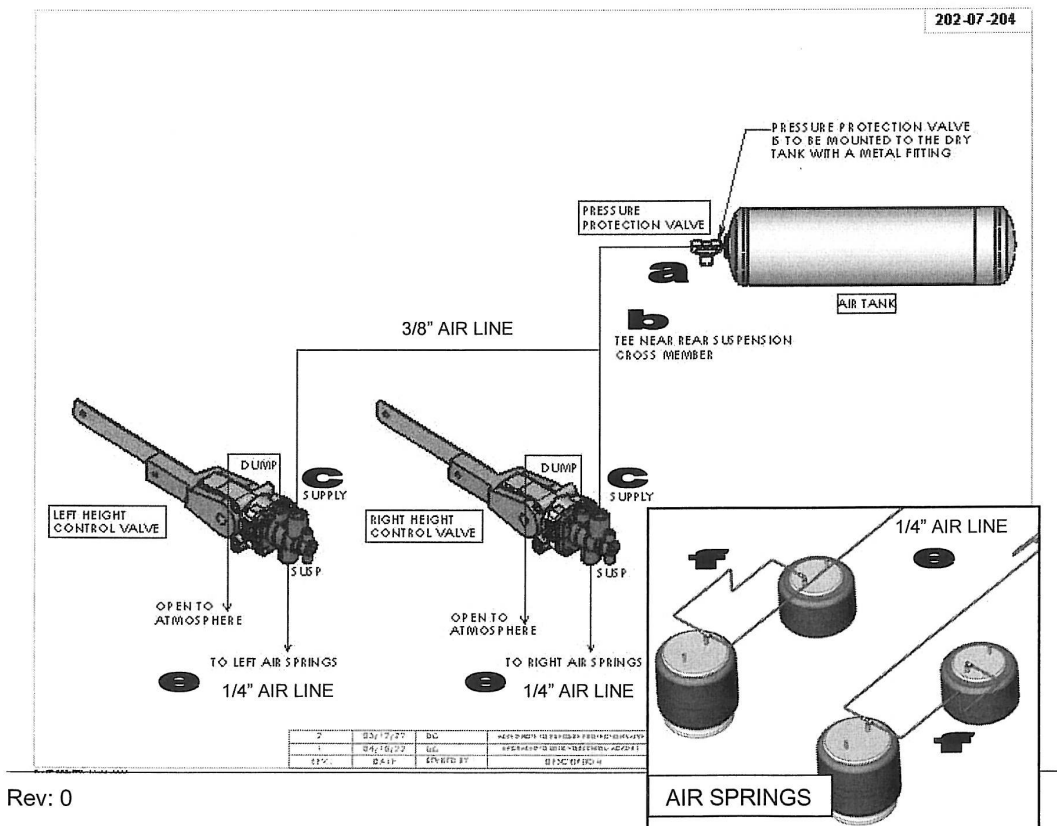
RAYDAN MANUFACTURING INC.	Procedure No: WI-2006101	Date: January 2, 2006
	Title: Plumbing the air system	
WORK INSTRUCTIONS	Issued By: DG Approved By:	
	Revision: 0	Page: 1 of 3

Process Steps *NOTE: This procedure is provided with the understanding that the work will be performed by qualified heavy duty mechanics, using appropriate industry safety standards. It does not replace common sense when working with heavy equipment.*

The air system can be plumbed with or without dump valves. Three methods of installation are outlined in this document: Basic installation without a dump valve, Installation with a toggle operated dump valve, and Installation with an electric operated dump valve.

1) Basic installation without a dump valve (see drawing 202-07-204 below)

- a) Install a pressure protection valve on the dry tank with a metal fitting
- b) Split the 3/8" air line after the pressure protection valve with a tee fitting
- c) Install a 3/8" fitting on the height control valve supply & a 1/4" fitting on the suspension outlet
- d) Run a 3/8" line to the supply port on each height control valve
- e) Install 1/4" tee fittings on the rear air springs & 1/4" elbow fittings on the front air springs
- f) Run a 1/4" air line from each height control valve to the tee fitting on each rear spring
- g) Run a 1/4" air line from the tee fitting on the rear air spring to the elbow on the front air spring

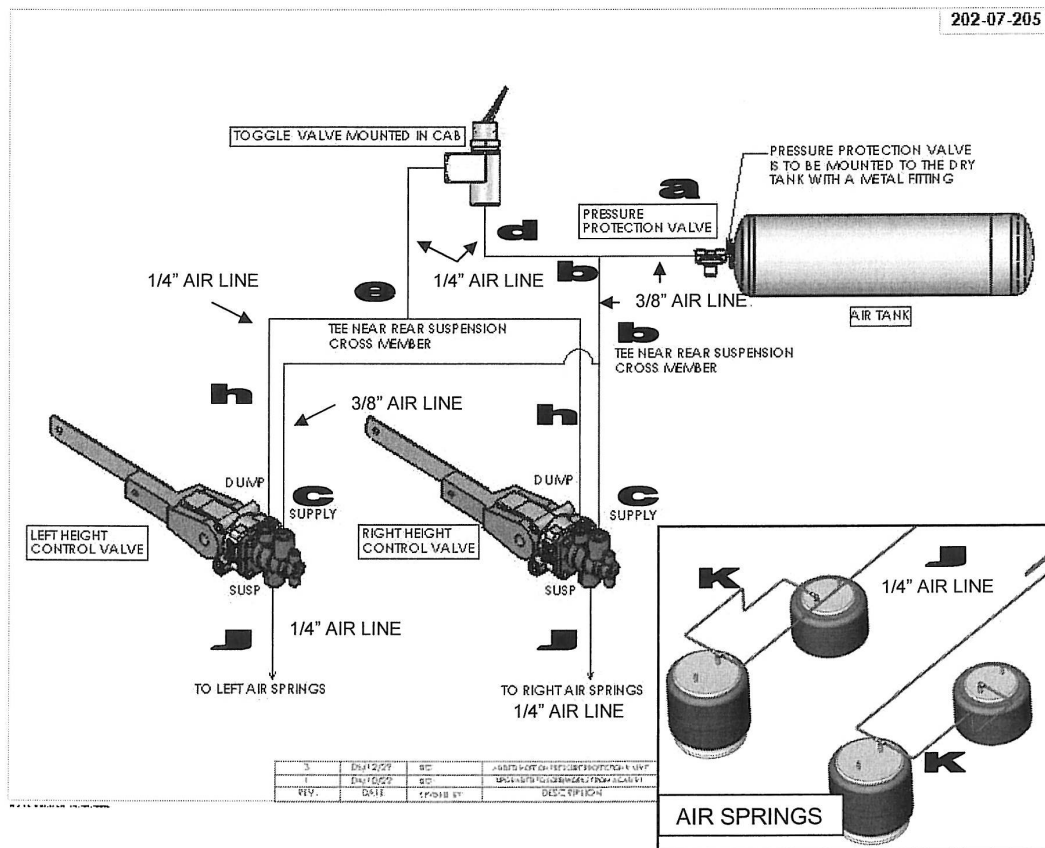




2) Installation with a toggle operated dump valve (drawing 202-07-205 below)

The Hadley 500c height control valve has built in air system dump capability. A pressure signal is required to activate the built in dump valve. Both electric and toggle style valves can be used to send the pressure signal.

- Install a pressure protection valve on the dry tank with a metal fitting
- Split the 3/8" air line after the pressure protection valve with two consecutive tee fittings
- Install a 3/8" fitting on the height control valve supply port, 1/4" fitting on the dump port and a 1/4" fitting on the suspension outlet
- Run a 3/8" air line to the supply port on each height control valve
- Run a 1/4" air line to the toggle switch in the vehicle cab
- Run a 1/4" air line from the toggle switch in the vehicle cab to a tee fitting near the height control valves
- Remove the plastic fittings and 8" line from the "dump" ports on the height control valves
- Install an elbow fitting on the "dump" port
- Run 1/4" lines from the tee to the "dump" ports on the height control valves
- Install 1/4" tee fittings on the rear air springs & elbow fittings on the front air springs
- Run a 1/4" air line from each height control valve to the tee fitting on each rear air spring
- Run a 1/4" air line from the tee fitting on the rear air spring to the elbow on the front air spring

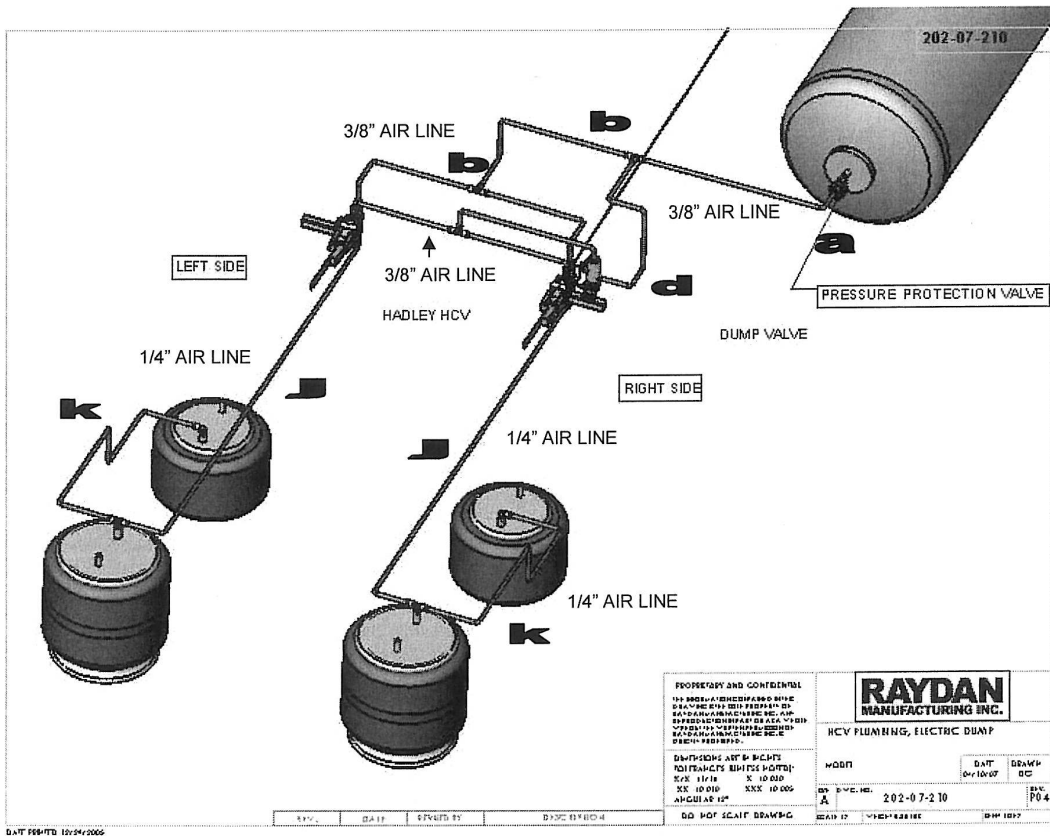


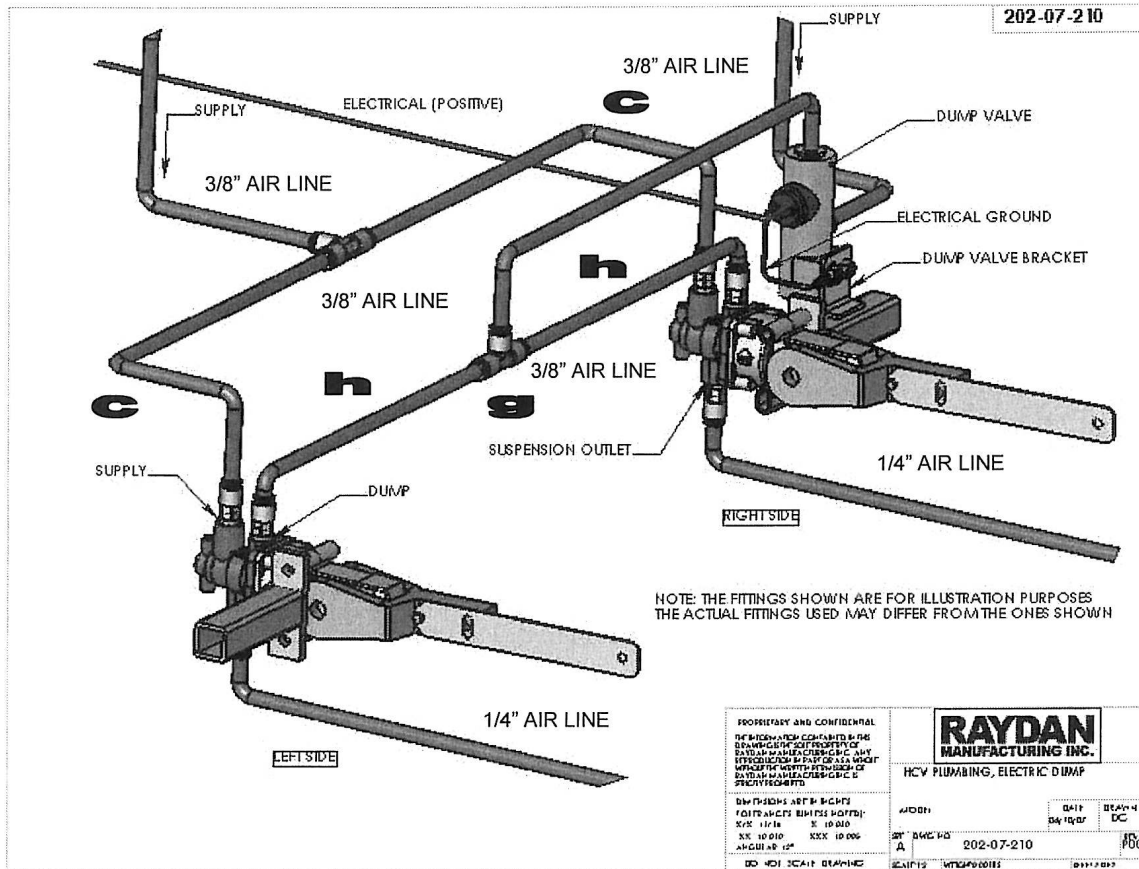
Maintenance

3) Installation with an electric operated dump valve (dwg 202-07-210 2 pages)

The Hadley 500c height control valve has built in air system dump capability. A pressure signal is required to activate the built in dump valve. Both electric and toggle style valves can be used to send the pressure signal.

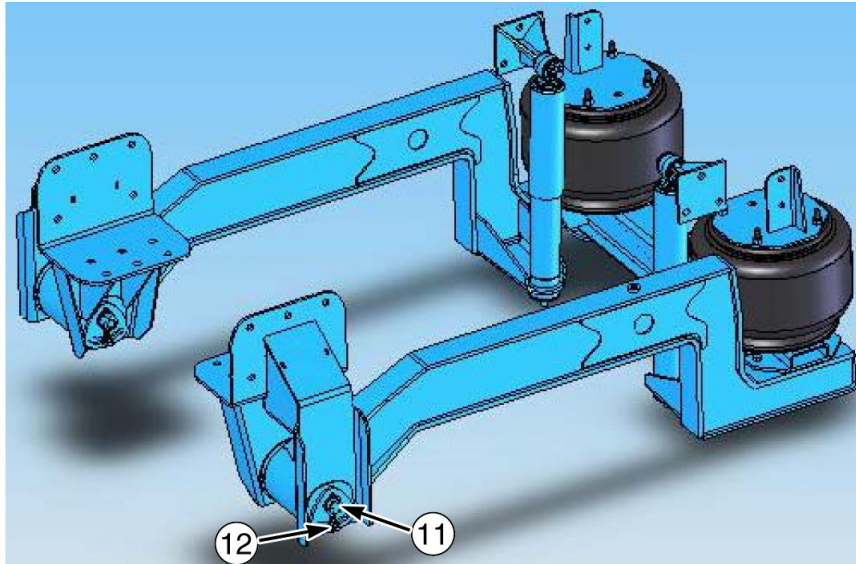
- a) Install a pressure protection valve on the dry tank with a metal fitting
- b) Split the 3/8" air line after the pressure protection valve with two consecutive tee fittings
- c) Install a 3/8" fitting on the height control valve supply port, 3/8" fitting on the dump port and a 1/4" fitting on the suspension outlet
- d) Run a 3/8" air line to the supply port on each height control valve
- e) Run a 3/8" air line to the electric dump valve located near the height control valves
- f) Remove the plastic fittings and 8" line from the "dump" ports on the height control valves
- g) Install an elbow fitting on the "dump" port
- h) Run a 3/8" line from the dump valve to a tee located near the height control valves
- i) Run 3/8" lines from the tee to the "dump" ports on the height control valves
- j) Install 1/4" tee fittings on the rear air springs & 1/4" elbow fittings on the front air springs
- k) Run a 1/4" air line from each height control valve to the tee fitting on each rear air spring
- l) Run a 1/4" air line from the tee fitting on the rear air spring to the elbow on the front air spring
- m) Wire the electric valve to an appropriate switch located in the vehicle cab





Maintenance

Ridewell RAD241



- 11.** Torque pivot - 450 to 520 ft/lb (441 N•m to 705 N•m)
- 12.** Torque pivot plate - 55 to 60 ft/lb (75 N•m to 82 N•m)

Refer to APPENDIX E - RIDEWELL SUSPENSIONS - The Engineered Suspension Company - RAD-241 Owner's Manual for more information.



Brakes

Dual air brake system - Sutphen fire truck chassis are equipped with a dual brake system that provides a means of braking the vehicle even when one of the systems becomes inoperative. The brake system complies with Federal Motor Vehicle Safety Standards in effect at the time of manufacture.

The dual brake system separates the front and rear brakes into two systems and provides an air pressure gauge for each system. As a safety measure, a red Low Air Pressure warning light and an audible signal buzzer come on whenever the air pressure in either system is below 72 psi. Normal operating pressure for both systems is 115 to 125 psi. If the air pressure in both systems falls below 45 psi, the rear axle spring brakes will automatically apply.

The spring-set parking brakes are applied by pulling out the yellow button on the dashboard or engine hood next to the shift pad. The parking brakes are released by pushing in the yellow button. This control will not stay depressed and the spring brakes will not be fully released until the rear system pressure reaches approximately 72 psi. The red parking brake light remains on until the spring brakes are fully released. Once this light goes out, the truck may be driven. It should be noted that the Low-Air warning light and buzzer may still be on, since both systems (front and rear) must reach approximately 75 psi before the light and buzzer go off.

If the Low-Air Pressure warning light or signal buzzer comes on, maintain a check on the air gauges to make sure that the air pressure rebuilds. If you experience a continuing loss of pressure, you should pull the truck off the road and take corrective action.

Dual Air Brake System - If the air pressure in both systems drops below 45 psi, the spring brakes will automatically apply. Care should be taken to prevent this from happening while the truck is being driven.

 **Maintenance**

To provide fast release of the rear spring brakes, the brake system has been designed to build up air pressure in the rear system first. If air pressure in the rear system is down, accelerate the engine to approximately 1400 rpm or more. This gives you maximum output from the compressor and will build up the rear system pressure quickly. Once the rear system is pressurized to approximately 60 psi, the spring brakes can be released. The truck may be driven, and the front system will start to charge. When both systems reach approximately 75 psi, the Low Air Pressure warning light and buzzer will go off and the pressure in both systems will continue to build to 120 to 125 psi. Do not release the spring brakes until you have a minimum of 60 psi in the rear system. Excessive use of air-operated accessories without adequate air pressure may result in automatic application of the spring brakes.

When applying the service brakes during normal operation, do not pump (fan) the air brake pedal. The best way to make a stop is to first apply the brakes as hard as the road and other conditions permit, gradually reducing the pressure so that, at the end of the stop, there is sufficient air pressure to hold the vehicle. Improper application of brakes will glaze the brake linings. This will cause squealing and/or chattering.

Brake adjustment must be set carefully so that stopping forces will be equal at all wheels. Check shoes and automatic slack adjusters periodically for wear and function. Change brake shoes as needed. (See Air System Troubleshooting.)

Wheel Bearing Adjustment

For safe, reliable operation and adequate service life, wheel bearings must be checked and properly adjusted.



Welding

CAUTION



When welding (other than with flame torches) on vehicles equipped with any control module (Allison transmission module, ABS module, or ECM), disconnect the electrical system prior to welding on the truck. It is essential that the proper electrical systems be disconnected to protect the system from stray voltage spikes, which commonly occur during welding with current A/C voltage-type welders.

When welding on the trucks, it is no longer necessary to unplug each computer. Instead, use the following instructions:

1. Remove both the positive (+) and negative (-) computer lead wires.
2. The welder ground cable must be in close proximity to the welding location. NEVER use the engine or transmission as a grounding point.
3. Welding on the engine or engine-mounted components is NEVER recommended.
4. Welding on the frame is NOT recommended.
5. See wiring diagrams.

6.7 Tighten Spring Brake Actuator Clamp Bands for MGM Models E & E-T

In the event a clamp band needs to be tightened due to air leakage, it is advisable to perform the following procedure:



WARNING

Do not attempt to remove spring chamber clamp band. If not properly caged, the power spring could hurtle the head with damaging force causing personal injury. When working on the spring brake, exercise extreme caution by standing to the side of the unit.

Brake Actuator Mounted on Vehicle

1. Chock wheels with vehicle on level surface to prevent vehicle runaway.
2. Apply system air pressure to spring port to fully release parking brakes.
3. Cage parking brake by inserting release bolt into piston and rotating clockwise until fully engaged. Place washer and nut on bolt and tighten down nut. When fully caged, the release bolt will extend approximately 3 3/4 inches above the head. If leak is too great for applied air pressure to fully retract the parking brake, install release bolt and cage power spring by tightening the nut to draw spring up.
4. Release air pressure.
5. Tap clamp band completely around periphery with hammer and tighten nuts clockwise to 30-35 ft/lb torque.
6. Reapply air pressure and remove release bolt by reversing installation Step 3.
7. Unit may be checked for air leak by applying air pressure and then spraying a leak detection solution around clamps. Formation of air bubbles indicates a leak.

Brake Actuator Not Mounted (on Bench)

1. The parking brake should be caged as received. However, if not caged, follow Steps 2 and 3.
2. Tighten clamp per Step 5.
3. Remove release bolt per Step 6.
4. Leak test per Step 7.



6.8 Air Intake System

Engine heat, and vibration, and age combine to loosen air intake connections and cause cracks in the tubing and elbows. Leaks in the intake system will allow abrasive dust to get into the engine and quickly do expensive damage. During the walk around inspection, carefully check all tubing, elbows, clamps, supports, and fasteners for condition and tightness

Complete disassembly and cleaning is recommended at each 6000 hours interval. Under severe operating conditions, this should be done more frequently. Damaged or defective parts should (with the possible exception of mounting brackets) be replaced – not patched or repaired.

Air Cleaners

The following service information is basic to all makes and models.

Dry-Type

Filter elements should be serviced when the air inlet restriction indicator warning light comes on. Your vehicle is equipped with either a dry-type air cleaner or a K & N filter that can be cleaned. We recommend you replace it with the same Farr air cleaner as on your truck or clean the K & N filter with a K & N filter cleaning kit.

6.9 Exhaust System

Manifold

Check for exhaust leaks and condition of gaskets. Replace any blown gaskets. Use a torque wrench to check all capscrews, including those at the flanges. Refer to the engine manufacturer's service manual for proper tightening sequence and torque values.

Joints and Clamps

Check for leaks and tighten as necessary. Check for deterioration or dents in pipes and clamps which could allow exhaust to escape.

Maintenance

Piping

Check for rust, corrosion, and damage. If piping is perforated at any point, temporary patching or lagging is acceptable until permanent repairs can be made.

Mufflers

Check clamps and mounting brackets for security. Check internal baffling for security. This can be accomplished by listening for rattling sounds while tapping the muffler with a rubber mallet or revving the engine up and down through its normal operating range.

Exhaust Extension

Check for security of mounting.

6.10 Turbocharger

For vehicles equipped with a turbocharger, check the following when servicing the air intake and exhaust systems. If deficiencies are detected, do not hesitate to take the vehicle to a authorized engine dealer for servicing. Putting off corrective action could cause severe damage.

Lubricating System

Check oil lines and connections for leaks, damage or deterioration.

Manifolding

With engine running, check for leaking manifold or flange gaskets.

Turbocharger

Check for signs of leaking from turbocharger housing. This may indicate a seal problem.

High Frequency Vibration

This could be an indicator of turbo rotor imbalance and should be checked immediately.



6.11 Cooling System

WARNING



Use extreme caution when removing the radiator cap if the engine has been recently operated (within the previous 30 minutes). Scalding hot coolant could cause injury.

In addition to regular checks on the condition of the total cooling system, such as radiator hoses, radiator cap, and water pump, there are several important points to consider regarding the coolant.

Water

Water should be clean and free of corrosive and scale-forming chemicals. Even drinking water may not be suitable in its raw state, but approved additives help neutralize harmful effects on the cooling system.

Coolant should be premixed for refills. It is equally important that makeup coolant be premixed to keep the antifreeze and corrosion-inhibitor chemicals in the correct proportion.

If, in an emergency, you must fill the radiator with water known to contain gypsum, sulfur, or chlorine, drain the water as soon as practicable, flush the system, and refill with premixed coolant.


Maintenance

Antifreeze

NOTE: Use low silicate antifreeze.

The following chart shows the temperature protection afforded by ethylene glycol antifreeze in relation to the proportion mixed with water.

Antifreeze (% by vol.)	10	20	30	40	50	60	68	70	80	90	100
Temperature °C	0-4	-9	-15	-24	-36	-47	-68	-65	-49	-35	-16
Protection °F	+3 2	+2 4	+1 6	+4 -12	-34	-63	-92	-85	-57	-31	+4

A 50 percent mixture of antifreeze is considered optimum for year-round, normal operation, for both low-temperature and boil-over protection. Note in the chart that 100 percent antifreeze is no more effective than a 30 percent mixture.

NOTE: If frequent topping off becomes necessary and there are no visible signs of water leaks when the engine is cold, then check for leaks with the engine running at normal operating temperature. The system could be leaking when pressurized.

Standard System

With the engine cold, top off with premixed coolant, only enough to bring the level up to the bottom of the filler tube.

1. Install appropriate amount of ethylene glycol antifreeze at a ratio of 50/50 mix with water.
2. Install an equal amount of water which will give you -34°F freeze point.

Radiator Cap

The radiator cap should be a 16-psi, non-vented cap.



Refilling

Standard System

1. Check that the radiator and engine block drains are closed. Move the heater control to Maximum Heat position and fill the system through the radiator with premixed coolant, in an uninterrupted flow, until the radiator is full.
2. Start the engine, idle at low rpm, and complete the filling as quickly as possible.
3. Let the engine idle for several minutes and fill as necessary to bring coolant level up to the bottom of the filler neck. Replace the radiator cap.
4. Check coolant level after each run, when the engine has cooled down, and add coolant as necessary. It may take a while for all the entrapped air to be purged from the system.

Maintenance

6.12 Fuel System

Fuel Specifications

Use only diesel fuel, Grade 2-D, as recommended by engine manufacturers. Consult your Engine Operation Manual if information on Grade 2-D fuel specifications is required.

Fuel Tank Capacity	Aerial Tower -	65 gallons
	Mini Tower -	65 gallons
	Pumper -	65 gallons

Fuel Filters

Follow these recommendations when changing fuel filter elements:

1. Cover any electrical equipment and wiring that might get soaked with fuel when removing filters. Diesel fuel can permanently damage electrical insulation.
2. When installing spin-on (throw-away) filters, fill filter full of diesel fuel and hand-tighten only to the recommended 1/2 to 2/3 turn after gasket contact. Mechanical tightening can distort or crack the filter head.
3. After starting engine, check for any leaks around the filter.
4. If truck has Racor fuel/water separator, clean bowl before remounting.

<u>2022 Cummins Engines Fire Trucks</u>	L9	X12	X15
<u>FUEL FILTER</u>			
<u>PRIMARY</u>	FS20121	FS19763G	FS19763G
<u>SECONDARY</u>	FF63041NN	FS5825NN	5575143 OR FF5971NN
<u>OIL Filter</u>	LF14002NN	5575298 OR LF14001NN	5575298 OR LF14001NN

Fuel Priming System (Optional)

Racor Separator

Drain weekly to increase filter life and get better performance out of the engine. Drain water and dirt out of filter by the self-venting drain on bottom of plastic bowl.

Drain into can.... NOT ON ENGINE.



Auxiliary Fuel Pump Operation (optional)

To operate the fuel priming system after changing filters or when losing your prime, perform the following steps:

1. The primer motor switch is located on driver's side of the truck on the engine hood.
2. Turn switch ON for approximately two minutes.
3. After turning switch OFF, remove the secondary filter, which is the small filter, to be sure it is full.
4. If filter is not full, repeat Steps 1 and 2.
5. Start truck and hold engine at about 1500 rpm.
6. If system does not hold prime, repeat the Steps above.

Battery Care

Regular attention to the charging system will help prolong the service life of batteries. Common causes for battery failure are:

1. Overcharge
2. Improper voltage regulator setting. Results in overheating, warped plates, and “blowing off” of electrolyte.
3. Undercharge
4. Voltage regulator faulty or improperly set, drive belt slipping, long periods of standing idle or short-distance driving. Results in battery plates becoming sulfated with a hard coating.
5. Vibration
6. Loose battery hold-downs. Results in possible battery plate failure.
7. Short circuits
8. Run battery down through electrical leaks.
9. Dirty or loose connections can stop the flow of electrical power to and from the battery.

Recharging Batteries



CAUTION

Use care when fast-charging. Watch for fumes. Check electrolyte. If it starts fuming violently, reduce the charging rate. Battery voltage should not exceed 14.5 VDC.

Slow Charging

Best if battery has lost charge gradually over a long period of time. Recharge at 6 to 8 amps for about 8 to 10 hours.

Fast Charging

Best if battery lost charge rapidly, such as from cranking an engine that failed to start. Recharge at 30 to 40 amps for 1 to 2 hours.

A rapid charge rate generates an explosive mixture of hydrogen and oxygen gas. A spark or flame near a battery on charge could cause the battery to explode with considerable force. When fast-charging, remove caps, so that pressure does not build up.

Battery Charging

When using battery charger to charge batteries, set on 12 VDC low charge only for a maximum of 16 VDC.

Electrical damage or battery explosion can occur when charging or boosting batteries.

To prevent a battery explosion, observe the following precautions:

1. Always be sure battery charger is OFF before connecting or disconnecting the cable clamps.
2. Allow no sparks or open flame near the charging area.
3. Keep the charging area well ventilated.
4. Keep electrolyte level up. This reduces volume of gas in cells.



Removing and Installing Batteries



WARNING

To prevent severe injury to the eyes, face, and body, it is imperative that lighted cigarettes, pipes, flames, and sparks be kept from vent openings of the battery. The gas mixture, which escapes from the vent opening, is highly flammable and could explode if ignited. This is particularly true when jumper cables or battery chargers are used. The inhaling of this gas could cause respiratory problems or damage. Whenever disconnecting battery cables, always disconnect ground cable first. When reconnecting always connect ground cable last. Wear eye protection at all times when working with batteries. If any part of your body should come in contact with electrolyte (acid), flush with copious amounts of water. If any painted surface or other part of the apparatus comes in contact with electrolyte, flush with water.

1. Ensure all switches on vehicle are turned off.
2. Disconnect ground cable FIRST when removing battery.
3. Connect ground cable LAST when battery is installed.

Use of Battery Booster and Jumper Cables

To start a truck with a run - down battery, use the following procedure:

1. Ensure booster battery voltage is same as vehicle electrical system voltage.
2. Use jumper cables to connect booster battery to vehicle battery. Hook the jumper cables to the booster battery first (keep opposite jumper cable ends separate). Be sure to connect positive (+) terminal of the booster and vehicle batteries to one cable (usually red) and the negative (-) booster and vehicle battery terminals to the other cable (usually black).

Use of other than the above procedures will damage charging system and could result in personal injury caused by electrolyte squirting out of the vents or explosion of the battery.

Jump Starting and Charging Precautions



WARNING

Jump starting with voltages greater than 16 VDC or reversing the polarity will damage the engine computer. Before attempting to jump start the engine, make sure jumper cables are connected properly (positive to positive, negative to negative) and in the proper sequence (positive to positive first). Failure to observe this precaution can result in alternator and/or equipment damage. Reversing battery polarity can also result in personal injury caused by sudden discharge of electrolyte from the battery vents or from the rupture of the battery caused by explosion of internal hydrogen gas. Engine system power and ground lines must be disconnected and computer connectors on engine unplugged prior to any welding on vehicle. Damage to electronic control module may otherwise occur.

Battery Charging



WARNING

When using battery charger to charge batteries, set on 12 volt low charge only or maximum of 16 VDC. Electrical damage or battery explosion can occur when charging or boosting batteries. Charging at rates higher than stated can cause electronic component failure. i.e., DDEC, Antilock brakes, world transmission.



110 Volt Circuit Breakers

Sutphen's standard circuit breaker is Westinghouse. It can be purchased in any electrical retail store using the part number on your breaker.

Should they not carry this item, the following are possible breaker substitutes:

- GE Type THQL
- Siemens Type Q
- Challenger Type C
- Square D Type HOMCab Heater

6.13 Cab Heater

The combination heater or air conditioning unit provides comfort for the operator through accurate control of the cab environment. Regular attention to the items below will help ensure reliable operation.

Check all heater controls for full-range operation. Check hoses, connections, and heater core for condition and leaks.

NOTE: A leaking heater core can be repaired by a reliable radiator shop.

Check water shutoff valves for summer operation or for leaks and A/C use.

Check heater core for debris blocking airflow and clean if necessary. If heater is not operating properly and the blower functions normally, probable causes could be air in heater hoses, heater core clogged internally, or the hot water valve clogged or closed.

6.14 Accessory Drive Belts

The reliability and service life of drive belts can be extended with proper attention to installation, adjustment, and maintenance. Neglect in these matters could cause belt failure, resulting in potential hazards through loss of the electrical system and possible engine damage due to overheating.

Installation

1. Loosen pulley bracket(s) and shorten the distance between pulley centers. Install new belt without forcing it. Do not roll or pry the belt over the pulley.
2. Check pulley alignment and adjustment if necessary. Pulley misalignment must not exceed 1/16 inch for each foot of belt span. Belt free-span is measured between pulley centers.
3. Check riding depth. Belt riding depth should not vary more than 1/16-inch on matched belt sets.
4. Check that the belt does not ride on the bottom of the pulley groove and that the outside edge of the belt does not intrude more than 1/16-inch beyond the outside edge of the pulley.

Belt Tension

A satisfactory alternative is to tighten the belt until deflection at midpoint is equal to the thickness of the belt for each 12 inches of free-span.

Tension: New Belts

New belts will loosen after running for an hour or more. Be sure to check the tension after the first period of operation. If the belt can be deflected 1/8 inch more than specified above, tighten as described under belt tension. Do not tighten belts beyond specified limits or damage to bearings and/or the belts could result.



Drive Belts

New standard V-belts will stretch after the first few hours of operation. Run the engine for 10 to 15 minutes at 1200 rpm to seat the belts, then readjust the tension. Check the belts and tighten the fan drive, battery charging generator or alternator, and other accessory drive belts after 1/2 hour or 15 miles and again after 8 hours or 250 miles (402 km) of operation. Thereafter, check the tension of the drive belts every 100 hours or 7,500 miles (12,000 km) and adjust, if necessary. Belts should be neither too tight nor too loose. Belts that are too tight impose excess loads on the crankshaft, fan and/or alternator bearings shortening both belt and bearing life. Excessively over tightened belts can result in crankshaft breakage. A loose belt will slip and may cause damage to accessory components. Single belts of similar size should not be used as a substitute for a matched belt set; premature belt wear can result because of belt length variation. All belts in a matched belt set are within .032 in. of their specified center distances. With a belt tension gauge, 541251, or equivalent, adjust the belt tension as listed in the following table.

Fan Drive	Fan Drive	New Alternator Belts	Used Alternator Belts
Single Belt	2 or 3 Belts	2 1/2 in.	2 1/2 in.
80-100 lb	60-80 lb	125 lb	100 lb
(355-455 N)	(266-355 N)	(566 N)	(445 N)

Belt Tensions

If a belt tension gauge is not available, adjust the belt tension so that a firm push with the thumb, at a point midway between the two pulleys, will depress the belt 0.500 to 0.750 in. (12.70 to 19.05 mm).

Drive belts (V and Poly-V) should be replaced every 2,000 hours or 100,000 miles (160,000 km).


Maintenance
Drive Belt Tension

SAE Belt Size	Belt Tension Gauge Part No		Belt Tension New		Belt Tension	Range Used*
	Click-type	Burroughs	N	lbf	N	lbf
0.380 in.	3822524		620	140	270-490	60-110
0.440 in.	3822524		620	140	270-490	60-110
1/2 in.	3822524	ST-1138	620	140	270-490	60-110
11/16 in.	3822524	ST-1138	620	140	270-490	60-110
3/4 in.	3822524	ST-1138	620	140	270-490	60-110
7/8 in.	3822524	ST-1138	620	140	270-490	60-110
4 - rib	3822524	ST-1138	620	140	270-490	60-110
5 - rib	3822524	ST-1138	670	150	270-530	60-120
6 - rib	3822525	ST-1293	710	160	290-580	65-130
8 - rib	3822525	ST-1293	890	200	360-710	80-160
10 - rib	3822525	3823138	1110	250	440-890	100-200
12 - rib	3822525	3823138	1330	300	530-1070	120-240
12 - rib K section	3822525	3823138	1330	300	890-1070	200-240

NOTE: This chart does not apply to automatic belt tensioners.

* A belt is considered used if it has been in service for ten minutes or longer.

* If used belt tension is less than the minimum value, tighten the belt to the maximum used belt value.



6.15 Drive Belt Maintenance

New Belt Break-in

New standard drive belts will stretch after the first few hours of operation. Run the engine for 10-15 minutes at 1200 rpm to seat the belts, then readjust the tension. Check the belts and tighten the fan drive, battery-charging generator or alternator, and accessory drive belts after 1/2 hour or 15 miles and again after 8 hours or 250 miles of operation. Thereafter, check the tension of the drive belts every 100 hours or 7,500 miles and adjust, if necessary. Belts should be neither too tight nor too loose. Belts that are too tight impose excess loads on the crankshaft, fan, and/or alternator bearings, shortening belt and bearing life. Excessively overtightened belts can result in crankshaft breakage. A loose belt will slip and may cause damage to accessory components.

NOTE: Replace all belts in a set when one is worn. Single belts of similar size should not be used as a substitute for a matched belt set. Premature belt wear can result because of belt length variation. All belts in a matched belt set are within 0.032in. of their specified center distances.

NOTE: When installing or adjusting an accessory drive belt, be sure the bolt at the accessory adjusting pivot is properly tightened, as well as the bolt in the adjusting slot.

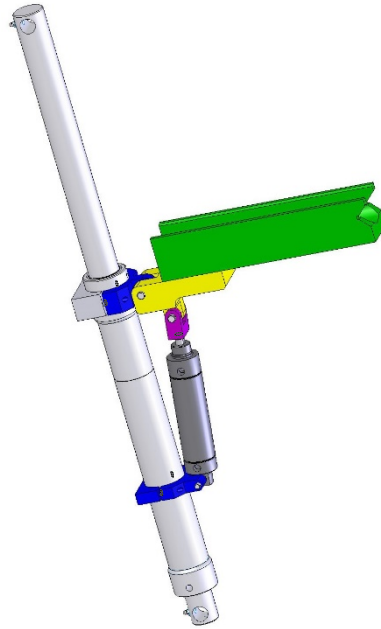
NOTE: Drive belts (V and Poly-V) should be replaced every 2,000 hours or 100,000 miles.

NOTE: Check the engine manufacturer's manual before replacing belts.



6.16 Cab Tilt System

Cab Tilt Safety Latch



- Controls located on left side pump panel
- Latch located on right side front tilt cylinder

WARNING



Pressure bleed off will lower cab (see manual pump). Anytime cab is lifted, cab tilt safety latch must be engaged. Failure to engage latch could result in serious personal injury or death.

Manual Lower Override

1. Electrically jump lower solenoid.
2. Release pressure at manual pump.

WARNING



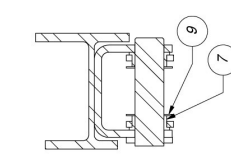
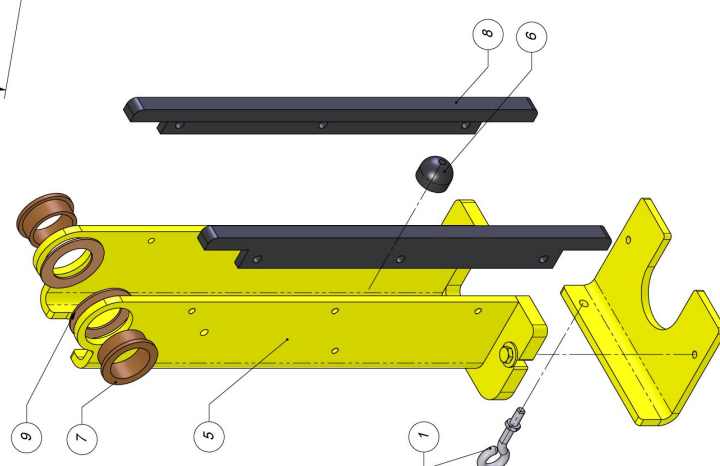
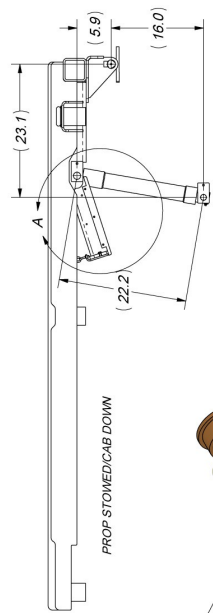
Before raising or lowering the cab, safety precautions must be taken to avoid personal injury or equipment damage. Ensure frontal and overhead clearance is sufficient to fully raise cab without hitting electrical wires or dangerous overhead objects that could result in serious personal injury or death.



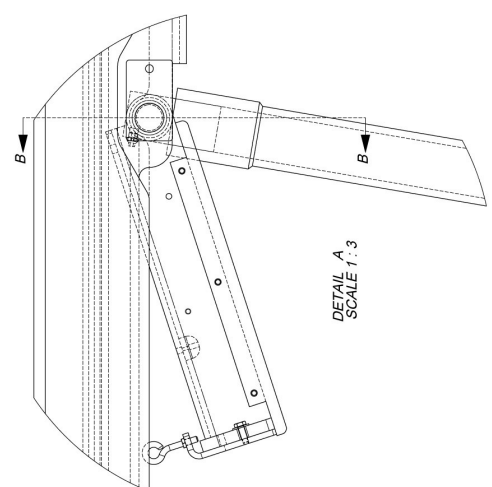
Cab Tilt Gravity Set Safety Prop

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	9469718	EYEBOLT, 1/4-20 S.S. MCMASTER	1
2	CHF-2930	TAG, CAB SAFETY PROP (DROF DOWN)	1
3	3177711 / Equal	Rubber Lined Clamp, 3/8"	
4	CHF-3205	CABLE, PULL	1
5	CHF-2756	PROP, CAB SAFETY	1
6	HUDSON-197	STOPPER, HUDSON RUBBER	1
7	FF1505-05	BEARING, 1.25 ID X 1.5 OD X .50 LG (MOTION)	2
8	CHF-2854	GUIDE, CAB SAFETY PROP SIDE	2
9	CHF-3413	BEARING, 1.25 ID, 1/16 THK, 2 OD SLEEVE	2

SEE SHT. 2 FOR INSTALLATION OF ITEMS #2, #3 & #4



SECTION B-B
SCALE 1:3



DETAIL A
SCALE 1:3

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SUTPHEN CORPORATION FIRE APPARATUS SINCE 1890 DUBLIN, OH 43016 800-848-5860		INSTALL, CAB SAFETY PROP	
DIMENSIONAL TOLERANCES UNLESS OTHERWISE NOTED .XX = ±.06 ANGLE = ±1° .XXX = ±.031 FRACT = ±1/16		DIMENSIONS ARE IN INCHES	
NEXT ASSY USED ON	FIRST APPLICATION	REV C.1	DATE 07/06/2011
MATERIAL	FINISH	ECN 5304	REVISION LEVEL
WEIGHT 11.895260 LBS	DRAWN BY J. MADDALENA	DOCUMENT NUMBER CHF-3096	SHEET 1 OF 2

GENERAL NOTES: UNLESS OTHERWISE SPECIFIED
 1. DEBURR ALL SHARP EDGES .01R OR EQUIVALENT
 2. TAG OR INDELIBLY MARK PARTS WITH PART NUMBER AND REV./LTR

Maintenance

NOTE - MOUNT ITEM #3 CLAMP (OR SIMILAR) SECURELY TO CHASSIS OR CAB TO RESTRAIN CAB AND RUSH THAT THE CABLING DOES NOT PULL ON AND DURING CAB AND PROP ARTICULATION

APPLY TO PUMP PANEL ADJACENT TO PULL CABLE

CLAMP ITEM #4 IN PUMP PANEL FRAME ON OFFICER SIDE - CLEARANCE FOR 5/8" Ø CUT OUTER CONDUIT LEAD TO CLAMP TO PASS OVER ROAD BASE USING ITEM #7 CLAMP/THIMBLE STOP PART OF 79000-TSK

DETAIL C SCALE 1:4

GENERAL NOTES: UNLESS OTHERWISE SPECIFIED
 1. DRAWING ALL SHARP EDGES .015" OR EQUIVALENT
 2. TAG OR INDELIBLY MARK PARTS WITH PART NUMBER AND REV. JTR

DIMENSIONAL TOLERANCES UNLESS OTHERWISE NOTED		NOT ASSY	USED ON
XX = ±.06	ANGLE = ± 1°	FIRST APPLICATION	
XXX = ±.031	FRACT = 1/16		
DIMENSIONS ARE IN INCHES			
C/J	REV	DATE	ECN
		07/03/2017	5309
REVISION LEVEL		REV	
		11.09.049	LBS
			2 CF 2

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INSTALL, CAB SAFETY PROP

J. MADOLENA
 07/03/2017
CHF-3096



Cab Tilt Operation

1. Vehicle must be parked on level ground with park brake on.
2. No personnel or loose equipment should remain in cab during tilt system operations. The cab tilt system is designed to tilt the cab structure only! Additional loads may cause system failure. Self Contained Breathing Apparatus (SCBA) must always be strapped in seat
3. Cab doors must be securely closed prior to tilt operations.
4. All items in the tilt arch (suction swivels, hoses, etc.) must be removed from bumper apron.
5. Master electrical switch must be in the ON position.
6. Ignition switch must be in the ON' position.
7. All personnel must remain clear of cab at any time that the tilt system is in operation.

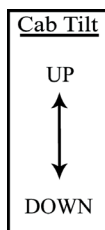
! Safety Instructions !

Before raising cab:

1. Read operator manual
2. Provide sufficient cab clearance
3. Secure or remove any loose items
4. Make sure nothing is on the front bumper
5. Make sure doors are shut and latched
6. Make sure cab tilts fully
7. Engage the "Cab Tilt Safety Latch"
8. Visually verify the "Cab Tilt Safety Latch" is engaged

Before lowering cab:

1. Make sure all service items are removed from engine area
2. Raise cab to maximum height
3. Disengage "Cab Tilt Safety Latch"
4. Visually verify "Cab Tilt Safety Latch" is disengaged



8. Cab safety support mechanism must be fully engaged before personnel go under cab (Absolutely DO NOT partially raise without safety support channel engaged.)

9. DO NOT disengage cab tilt safety latch unless cab is intended to be lowered and all personnel are clear of cab.

Cab Tilt Safety Latch

Engage

Disengage

Manual Cab Tilt System

All cabs are equipped with a manual tilt hand pump system located near the front bumper. During normal operation and when raising the cab using the manual pump, the pump handle must be tight. This prevents bleed off of pressure.

In the event the cab needs lowered manually, loosening the manual tilt hand pump handle will allow pressure to bleed off and cab to lower.

If you find the cab wants to lower or not raise at all, verify the manual pump handle is tight.

Raising Cab

1. Secure or remove all loose items (helmets, masks, handlights, tools, etc.).
2. Make sure all objects on front bumper are removed or otherwise stowed (tilt bells, sirens, tools, etc.).
3. Make sure all cab doors are closed, all personnel are in the clear, and there is sufficient overhead clearance for raised cab.
4. Activate switch to raise position. Hold until cab is raised to the limit of cylinders.
5. Engage cab tilt safety latch.
6. Verify cab tilt safety latch is engaged.

Lowering Cab

1. Make sure all tools, spray cans, drop lights, etc., are removed from engine area.
2. Raise cab to maximum height to release automatic safety latch.
3. Make sure all personnel are clear of cab.
4. Disengage cab tilt safety latch.
5. Visually verify cab tilt safety latch is disengaged.
6. Press cab tilt switch to down until cab comes to rest in normal position.



6.17 Tires And Wheels

Tire Rotation

Tires wear differently on all trucks. It is necessary to rotate the tires on the rear of the tandem truck to keep even tread wear and get a longer life out of the tandem tires. Tires must be rotated every 6 months and/or 2,500 to 3,000 miles, whichever comes first. Snow tires will wear the outside lug quicker on the rear tires of tandems.

Tire Chains

Tire chains, when needed, must be installed on both sides of each driving axle. Chains on the tires of only one tandem axle can damage driveline U-joints and the interaxle differential.

Matching Tires

In addition to having tires balanced and having their radial and lateral run-out checked, we recommend that you have a tire dealer match your tires, particularly on the rear axles. Mismatched tires can cause interaxle fight and unusually high axle lubricant temperatures. Matched tires will definitely help lengthen driveline service life and tire mileage.

You must replace tires with same size as originally supplied or the ABS brakes will not work correctly,

Replacing Tires



CAUTION

Regrooved tires, or tires with reinforcement repairs, are not permitted for use on steering axles. You must replace tires with same size as originally supplied or the ABS brakes will not work correctly.

Front tires should be replaced when less than 4/32 in. of tread remains. (This does not include tiebars or tread wear indicators.)

Check tread depth in any major tread groove at three locations around the tire, spaced 120-degrees apart.

Tires on drive axles must be replaced when less than 2/32 in. of tread depth remains in any major groove, as checked at 120-degree locations around the tire.

Maintenance

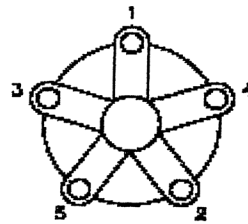
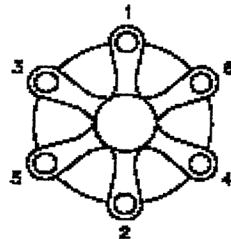
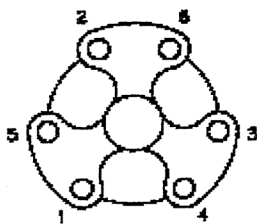
Installation and Tightening

Before installing the wheels, clean the mounting surfaces of the rims, wheels, spacer rings, and clamps with a wire brush. Check to make sure the threads on the mounting stud and the nut are clean. Do not use any lubricant on the threads. Mounting nuts must be torqued dry.

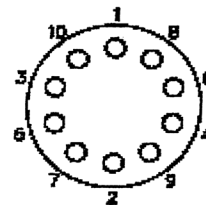
Disc Wheels

Slide front or inner rear wheel in position over studs and push it back into place while being careful not to damage the stud threads. Install the outer wheel nuts or inner wheel nuts, if a dual wheel application, until nuts contact the wheel. Rotate the wheel a half turn to allow the wheel to seat. Tighten all the nuts, using the pattern shown below, to 50 ft/lb. Tighten all the nuts, using the same pattern, to the torque value specified in the torque chart below. Install the outer wheel in a dual wheel application and repeat the just-described installation procedure. After 50 miles (80 km), check the nuts for tightness in the same tightening sequence. To check and tighten the inner wheel to the proper torque, first loosen the outer wheel nuts several turns, then tighten the inner nuts and tighten the outer nuts. To prevent losing the seating of the outer wheel when checking the inner wheel torque, first, loosen alternate outer nuts, torque the inner nut and the loosened outer nuts, then, loosen the remaining outer nuts, tighten the inner nuts, and then tighten the outer nuts.

NUT TIGHTENING SEQUENCE



VARIOUS SPOKE WHEELS



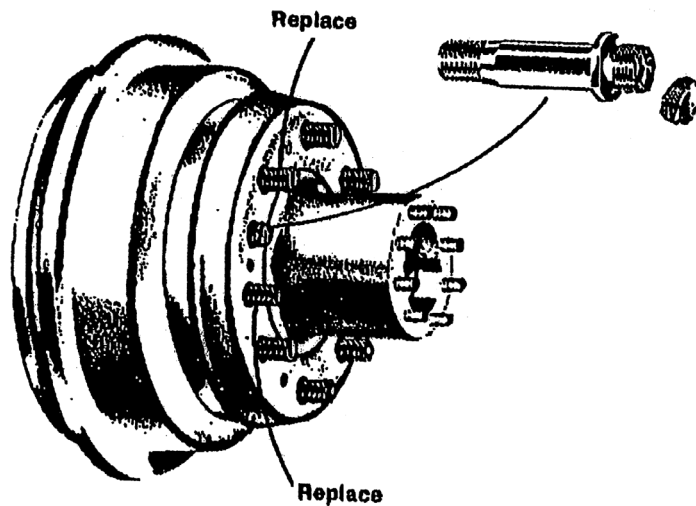
DISC WHEEL



6.18 Wheel Mounting Torque

Budd Recommended Wheel Mounting Torque				
	Application	Wheel Stud Thread Size	Torque Ft/lb	
L I G H T D U T Y	Passenger Car	7/16"-20	70-90	
		1/2"-20	70-90	
		9/16"-18	70-90	
	Light Trucks	Passenger Type Mtg	1/2"-20	70-90
			9/16"-18	110-140
			5/8"-18	125-140
			9/16"-18	175-225
			5/8"-18	175-225
			5/8"-18	275-325
H E A V Y D U T Y	Highway Vehicles	Budd Std, SCN Mtg.	11/16"-16 300-400	
			3/4"-16 450-500	
		Budd Std, DCN Mtg.	3/4"-16 450-500	
			1-1/8"-16 450-500	
	Off-the-Road Vehicles	Budd Std, DCN Mtg.	3/4"-16	450-500
			1-1/8"-16	450-500
			1-1/8"-16	650-750
			Budd Heavy Duty, DCN Mtg.	15/16"-12 750-900
		1-5/16"-12 750-900		
	Backnut (Inner End of Wheel Stud)	3/4"-16	175-200	
		7/8"-15	175-200	
		1"-14	175-300	
SCN=Single Cap Nut Mounting DCN=Double Cap Nut Mounting		*When using shoulder studs with 7/8" and 1" thread back nuts or headed studs.		

6.19 Replacing Studs



When a broken stud is replaced, the stud on each side of it should also be replaced. If more than one stud is broken, replace all studs.

Use the correct stud.

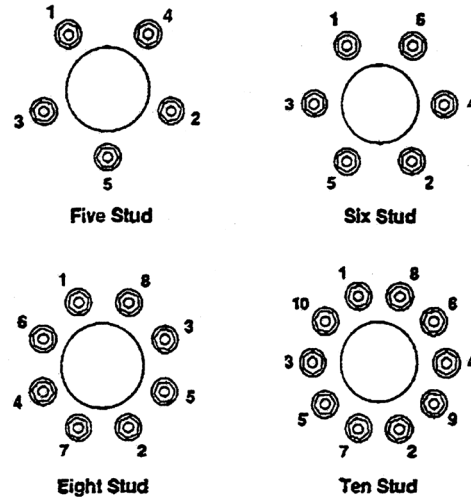
If the correct length stud is not used, the back nut (jam nut) may not seat firmly against the drum.

Too much "standout" from the mounting face of the hub may make it impossible to secure the inner wheel against the hub face.

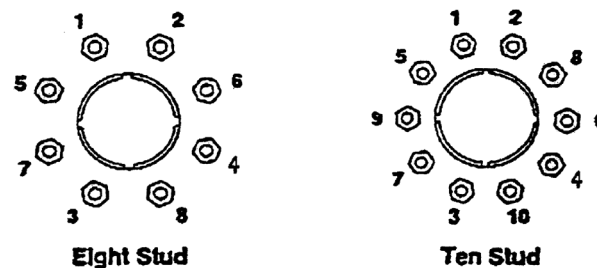
In replacing studs, remember that right-hand studs go on the right-hand side of the vehicle and left-hand studs on the left-hand side when facing forward.



Tightening Sequence



Stud located, ball seat tightening sequences. After mounting a wheel over the studs, snug up the capnuts in the order shown in the illustrations below. After all the cap nuts have been snugged, tighten the cap nuts to the recommended torques, following the same tightening sequence.



Hub-piloted tightening sequence. Position one of the hub pilot pads at the 12o'clock position. After positioning wheels on the pilot pads, hand-tighten all cone lock cap nuts to the recommended torque, following the proper sequence shown below for your type wheel.

Maintenance

6.20 Installation of RealWheels LED AirGuard™

RWTG1234



Installation of RWTG1234 RealWheels LED AirGuard™

Read instructions carefully before installation. If you have questions call 1-800-982-1180.

- **Set tire to the recommended pressure before attaching LED AirGuard.**
- Use the LED AirGuard only with ISO 9413 approved valve stems. These are the most common vehicle valve stems.
- The recommended temperature range is -40°F to +275°F. The batteries do not give full capacity in very cold or hot temperatures, yet the batteries will regain their strength when temperatures return to normal.
- The LED is not designed to be seen inside the vehicle.
- An 8psi (0.6 bar) drop from the original calibration pressure will trigger the LED flashing.
- Recommended pressure range: 10psi–200psi
- Expected battery life: Standby 2–3 years / Flashing 3 weeks
- We suggest that, from time to time, you verify the functionality and condition of the batteries by simply unscrewing the LED AirGuard and verifying that it flashes.
- Pressure peaks: LED AirGuard can handle pressure peaks up to 200psi/13.7bar above calibration pressure. A pressure peak can occur for example when the tire hits a hole in the road or is driven over the edge of the curb.
- Do not drive even short distances with severely underinflated tires, since it is extremely unsafe and it will ruin your tire.
- When the ambient temperature drops, the tire pressure will also drop. Make sure you do not drive with underinflated tires even when it is cold outside. Since the LED AirGuards are using air pressure in a pressure chamber inside the LED AirGuards as a reference point, the LED AirGuard will automatically adjust for low temperature to minimize giving false warnings for sudden temperature drops due to the outside weather.
- It is recommended that the LED AirGuards are used only in conjunction with RealWheels Brand of Air Valve Extensions.

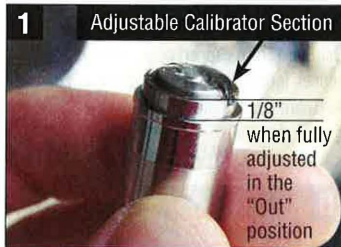
- Since the tires naturally lose some pressure, we suggest that if you are going to put your tires or vehicle in storage you remove the LED AirGuards and recalibrate to zero. Or with the LED AirGuards attached, you overinflate the tires by about 2 psi (0.15 bar) per month of intended storage. (e.g., add 12 psi — or 0.9 bar — for 6 months of storage. This will ensure that the LED AirGuards will not flash and use up the batteries while in storage).

Liability

- The LED AirGuards are only an aid in monitoring low tire pressure. Even when using the LED AirGuards you should still follow the instructions in your vehicle's owner's manual regarding tires and tire pressure maintenance.
- The LED AirGuards do not relieve you from your obligations of regularly checking your tire pressure. We limit our maximum liability to the purchase price of this product.

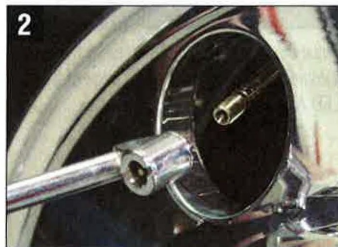
Limited Warranty

- **In order to be eligible for service under this warranty you MUST fill out the warranty information at www.RealWheels.com/twr within 30 days of purchasing the product.**
- The LED AirGuards come with a 2-year limited manufacturer warranty. We guarantee that this product is free from any manufacturing defects. If found defective, return to your Authorized RealWheels Dealer or directly to RealWheels at the address below with a copy of the purchase receipt. We will examine the unit and replace or reimburse you for the units if found faulty under the warranty.
- Battery standby time is warranted for 2 years from the date of purchase.
- This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.



1. Familiarize

Before installing the LED AirGuard, look it over and become familiar with the moving parts and how it works. The LED AirGuard is an Active Tire Pressure Monitoring System packed with technology. The LED AirGuard comes ready to install (the batteries are already in the unit). Begin by finding the Adjustable Calibrator Section of the LED AirGuard (See Photo 1). This section is the smooth area around the clear lens and has two small slots on each side. Practice turning the Adjustable Calibrator Section by hand, threading it in and out (counter-clockwise out, clockwise in). **Note:** You will not see any exposed threads when you turn it in and out. Also when doing this by hand it will only make 2-1/2 revolutions before coming to a stop when it's in its fully adjusted "Out" position. Also when it is fully "Out" the smooth area will measure approximately 1/8" (See Photo 1).



2. Check Tire Pressure

Set tire to the recommended pressure for your vehicle **before** attaching the LED AirGuard.



3. Install LED AirGuard

With the Adjustable Calibrator Section in its full "Out" position. Grasp the LED AirGuard body, and by hand, fully thread it onto the tire air valve (See Photo 3).



4. Tighten Adjustable Calibrator Section

Next, using the included key, insert the key into the two slots of the Adjustable Calibrator Section and tighten the Adjustable Calibrator (See Photo 4A). **Note:** Using the key, the Adjustable Calibrator Section will now turn approximately 2-1/2 full revolutions (5 half turns) when it is fully tight. The LED AirGuard is now completely installed and calibrated to your tire pressure (See Photo 4B).



Continued on back...



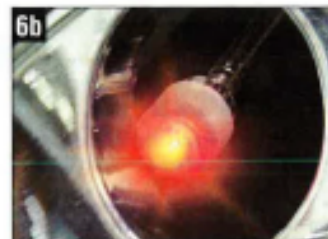
5. Verify Calibration

To verify the LED AirGuard has been calibrated and installed properly, simply grasp the body of the LED AirGuard and unthread it turning it counter-clockwise. Once it's unthreaded the LED light should begin to flash (See Photo 5). This is your indication the LED AirGuard has been calibrated to your tire pressure and was installed properly. You can do this at any time to verify the LED AirGuard is working properly.



6. Slide LED Enhancing Cover Over The LED AirGuard

Slide the LED Enhancing Cover over the LED AirGuard. This cover protects the LED AirGuard and enhances the flashing LED light, making it visible from any angle (See Photos 6A & 6B).



Instructions To Replace Batteries

Replacement Battery Model Number: RWTG1234B



Place the cut-out area in the center the key (provided) around the bottom edge of the LED AirGuard body. (See Photo A).



Using a 15mm wrench or a 15mm-6 point socket, loosen the top body of the LED AirGuard (See Photo B).

Instructions To Recalibrate



OPTION 1: With LED AirGuard On Valve Stem

Using the included key, insert the key into the two slots of the Adjustable Calibrator Section and loosen the Adjustable Calibrator (See Photo 1). **Note:** Using the key, the Adjustable Calibrator Section will now turn approximately 2-1/2 revolutions when it is fully out. The LED AirGuard is now calibrated back to zero.

OPTION 2: With LED AirGuard Off Valve Stem

Remove LED AirGuard from valve stem. It will begin to flash. Using the included key, insert the key into the two slots of the Adjustable Calibrator Section and loosen the Adjustable Calibrator (approximately 2-1/2 revolutions when it is fully out). It will still be flashing. Reinstall LED AirGuard back onto a pressurized air valve stem. It will stop flashing and can be removed from the valve stem. The LED AirGuard is now calibrated back to zero.



Holding the LED AirGuard upside down, separate the body (See Photo C).



The LED AirGuard has two 80mAh batteries. When replacing the batteries, be sure to replace all components in correct order and orientation. Rethread the two body parts and tighten with 15mm wrench. **Note:** You will need to recalibrate the LED AirGuard after replacing the batteries.



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7/24/13

Maintenance



Installation of RWTG1235 LED AirGuard Set & Go

Read instructions carefully before installation.
If you have questions call 1-800-982-1180.

At a glance: how the LED AirGuard Set & Go works.
The LED AirGuard Set & Go is an active tire pressure monitor, it allows for easy installation and accurate monitoring.
Out of the package and whenever the LED AirGuard Set & Go is not installed on a pressurized tire it will always be set at zero and not calibrated to any pressure. Once it is securely threaded onto a tire valve stem, it will automatically calibrate and sets itself to that tire pressure. At that point if the tire pressure drops between 5 to 10 psi the LED AirGuard Set & Go will begin to flash and will continue to flash for up to 3 weeks, until it is removed and the tire pressure is replenished to the previous tire pressure setting, or a new tire pressure setting. **Note:** If the LED AirGuard is flashing and you remove it from the tire air valve and do not replenish the tire pressure back to your desired amount, when you reinstall the Set & Go it will automatically recalibrate to the lower tire pressure, not the previous tire pressure setting that your tire was originally inflated to.



1. Check Tire Pressure

Set tire to the recommended pressure for your vehicle before attaching the LED AirGuard Set & Go.



LED AirGuard Set & Go



Spot-Check Rubber Tester

- Recommended pressure range: 10psi–200psi
- Expected battery life: Standby 2–3 years / Flashing 3 weeks
- Pressure peaks: LED AirGuard Set & Go can handle pressure peaks up to 200psi/13.7bar above calibration pressure. A pressure peak can occur for example when the tire hits a hole in the road.
- Do not drive even short distances with severely underinflated tires, since it is extremely unsafe and it will ruin your tire.
- It is recommended that the LED AirGuard Set & Go is used only in conjunction with RealWheels Brand of Air Valve Extensions.
- Since the tires naturally lose some pressure, we suggest that if you are going to put your tires or vehicle in storage you remove the LED AirGuard Set & Go.

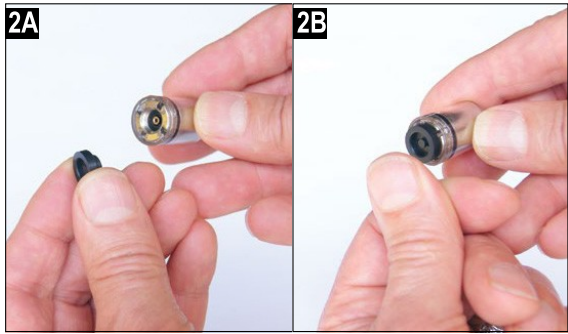
Liability

- The LED AirGuard Set & Go is only an aid in monitoring low tire pressure. Even when using the LED AirGuard Set & Go you should still follow the instructions in your vehicle's owner's manual regarding tires and tire pressure maintenance.
- The LED AirGuard Set & Go does not relieve you from your obligations of regularly checking your tire pressure. We limit our maximum liability to the

purchase price of this product.

Limited Warranty

- In order to be eligible for service under this warranty you **MUST fill out the warranty information at www.RealWheels.com/twr within 30 days of purchasing the product.**
- The LED AirGuard Set & Go comes with a 2-year limited manufacturer warranty. We guarantee that this product is free from any manufacturing defects. If found defective, return to your Authorized RealWheels Dealer or directly to RealWheels at the address below with a copy of the purchase receipt. We will examine the unit and replace or reimburse you for the units if found faulty under the warranty.
- Battery standby time is warranted for 2 years from the date stamped on the LED AirGuard Set & Go.
This warranty gives you specific legal rights, and you may also have other
- rights which vary from state to state.



2. Install Spot-Check Rubber Tester

Find the Spot-Check Rubber Tester located in its own Zip-Lock plastic bag. Next insert the Spot-Check Rubber Tester into the threaded end of the LED AirGuard Set & Go. (See Photos 2A & B.)

Note: Instructions continued on back.



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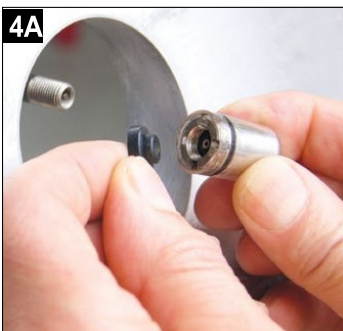
RWTG1236



3. Test the LED AirGuard Set & Go Using the Spot-Check Rubber Tester

Place the LED AirGuard Set & Go with the Spot-Check onto the wheel air valve and push. (See Photo 3A & 3B.) The LED will light up red and flash. This is your indication that the LED AirGuard Set & Go's batteries are good and the unit is functioning properly.

Note: If the LED AirGuard Set & Go does not light up and flash you may have to push harder or the batteries maybe exhausted.



4. Remove Spot-Check Rubber Tester and Install the LED AirGuard Set & Go

Remove the Spot-Check Rubber Tester. (See Photo 4A) **Note:** At this point the LED AirGuard Set & Go is now again set to zero and automatically recalibrates to the tire pressure that has been set in the tire.

Now install the LED AirGuard Set & Go by threading it on by hand until it is **securely tight**, and you're finished. (See photos 4B & 4C)

Important Note: Keep the Spot-Check Rubber Tester in the included Zip-Lock bag, so it is available for future Spot-Checks or if the tire pressure needs to be changed. To be safe it is recommended to verify the tire pressure and the LED AirGuard Set & Go functionality every month.

5. To Reset the LED AirGuard Set & Go to Zero and Recalibrate for a Different Tire Pressure

To reset the LED AirGuard Set & Go to zero, simply unthread and remove the LED AirGuard Set & Go from the wheel air valve.

The LED AirGuard Set & Go will automatically go back to a zero setting every time it is removed. It should not flash when removed from the air valve.

To recalibrate, simply set the tire pressure to the desired air pressure and rethread the LED AirGuard Set & Go back onto the air valve.

The LED AirGuard Set & Go will automatically calibrate to the new tire pressure.

Note: If you need assistance contact RWC's Customer Service at 1-800-982-1180.

Maintenance



Installation of RWTG1236 LED AirGuard Set & Go

Read instructions carefully before installation.
If you have questions call 1-800-982-1180.

At a glance: how the LED AirGuard Set & Go works.
The LED AirGuard Set & Go is an active tire pressure monitor, it allows for easy installation and accurate monitoring.
Out of the package and whenever the LED AirGuard Set & Go is not installed on a pressurized tire it will always be set at zero and not calibrated to any pressure. Once it is securely threaded onto a tire valve stem, it will automatically calibrate and sets itself to that tire pressure. At that point if the tire pressure drops between 5 to 10 psi the LED AirGuard Set & Go will begin to flash and will continue to flash for up to 3 weeks, until it is removed and the tire pressure is replenished to the previous tire pressure setting, or a new tire pressure setting. **Note:** If the LED AirGuard is flashing and you remove it from the tire air valve and do not replenish the tire pressure back to your desired amount, when you reinstall the Set & Go it will automatically recalibrate to the lower tire pressure, not the previous tire pressure setting that your tire was originally inflated to.



1. Check Tire Pressure

- Expected battery life: Standby 2–3 years from the date stamped on the LED AirGuard Set & Go. Flashing battery life: 3 weeks.
- Pressure peaks: LED AirGuard Set & Go can handle pressure peaks up to 200psi/13.7bar above calibration pressure. A pressure peak can occur for example when the tire hits a hole in the road.
- Do not drive even short distances with severely underinflated tires, since it is extremely unsafe and it will ruin your tire.
- It is recommended that the LED AirGuard Set & Go is used only in conjunction with RealWheels Brand of Air Valve Extensions.
- **Since the tires naturally lose some pressure, we suggest that if you are going to put your tires or vehicle in storage you remove the LED AirGuard Set & Go.**
- Harsh chemicals should never come in contact with the clear plastic of the LED AirGuard Set & Go. For example, brake cleaner and chemical thread-lock (such as Loctite) will cause the plastic to become brittle and crack and may result in product failure. We suggest removing the LED AirGuard Set & Go before using any type of chemicals on or around the wheels.



Set tire to the recommended pressure for your vehicle **before** attaching the LED AirGuard Set & Go.

LED AirGuard Set & Go

Spot-Check Rubber Tester



Liability

- The LED AirGuard Set & Go is only an aid in monitoring low tire pressure. Even

when using the LED AirGuard Set & Go, you should still follow the instructions in your vehicle's owner's manual regarding tires and tire pressure maintenance.

- **The LED AirGuard Set & Go does not relieve you from your obligations of regularly checking your tire pressure. We limit our maximum liability to the purchase price of this product.**

Limited Warranty

- The LED AirGuard Set & Go comes with a one (1) year limited manufacturer warranty. We guarantee that this product is free from any manufacturing defects. If found defective, return to your Authorized RealWheels Dealer or directly to RealWheels at the address on back with a copy of the purchase receipt. We will examine the unit and replace or reimburse you for the units if found faulty under the warranty.
- This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.



2. Install Spot-Check Rubber Tester

Find the Spot-Check Rubber Tester located in its own Zip-Lock plastic bag. Next insert the Spot-Check Rubber Tester into the threaded end of the LED AirGuard Set & Go. (See Photos 2A & B.)

Note: Instructions continued on back.



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12/8/15



3. Test the LED AirGuard Set & Go Using the Spot-Check Rubber Tester

Place the LED AirGuard Set & Go with the Spot-Check onto the wheel air valve and push. (See Photo 3A & 3B.) The LED will light up red and flash. This is your indication that the LED AirGuard Set & Go's batteries are good and the unit is functioning properly.

Note: If the LED AirGuard Set & Go does not light up and flash you may have to push harder or the batteries maybe exhausted.



4. Remove Spot-Check Rubber Tester and Install the LED AirGuard Set & Go

Remove the Spot-Check Rubber Tester. (See Photo 4A) **Note:** At this point the LED AirGuard Set & Go is now again set to zero and automatically recalibrates to the tire pressure that has been set in the tire.

Now install the LED AirGuard Set & Go by threading it on by hand until it is **securely tight**, and you're finished. (See photos 4B & 4C)

Important Note: Keep the Spot-Check Rubber Tester in the included Zip-Lock bag, so it is available for future Spot-Checks or if the tire pressure needs to be changed. To be safe it is recommended to verify the tire pressure and the LED AirGuard Set & Go functionality every month.

5. To Reset the LED AirGuard Set & Go to Zero and Recalibrate for a Different Tire Pressure

To reset the LED AirGuard Set & Go to zero, simply unthread and remove the LED AirGuard Set & Go from the wheel air valve.

The LED AirGuard Set & Go will automatically go back to a zero setting every time it is removed. It should not flash when removed from the air valve.

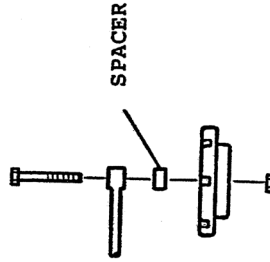
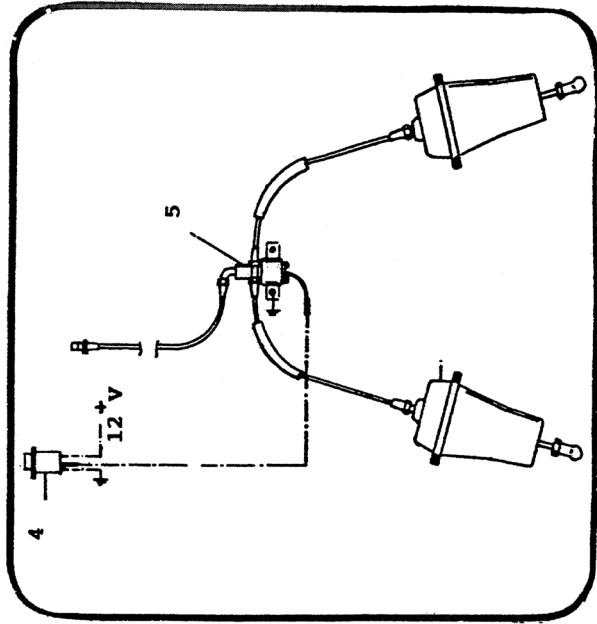
To recalibrate, simply set the tire pressure to the desired air pressure and rethread the LED AirGuard Set & Go back onto the air valve. The LED AirGuard Set & Go will automatically calibrate to the new tire pressure.

Note: If you need assistance contact RWC's Customer Service at 1-800-982-1180.

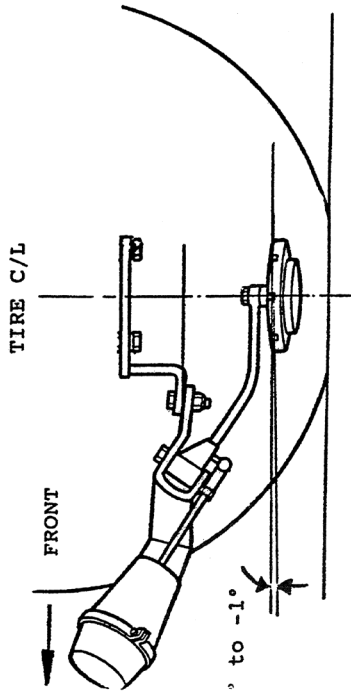


Maintenance

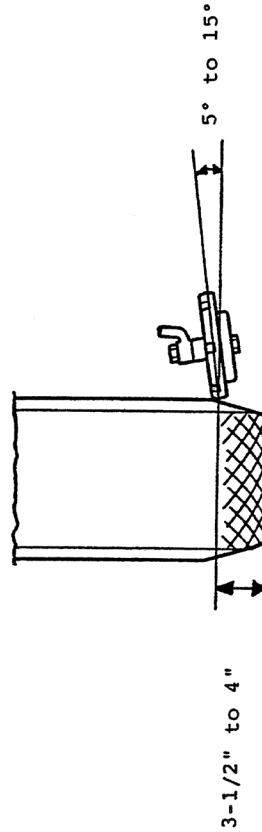
6.21 Onspot Chain Unit Mounting Instructions



Chain units may be mounted in front of or behind the rear axle depending on application.



PITCH



OPERATING ANGLE



Installation

1. Install mounting brackets per the instructions provided with the brackets.

NOTE: Any hardware substitutions must be made with Grade 8 hardware only.

2. Ensure the vehicle's U-bolts and adapter nuts are torqued to manufacturer's specification. If you do not have the manufacturer's specification, use the included Torque Table.
3. Using two 5/16 x 11 Grade 8 bolts, mount the ONSPOT chain unit to the bottom side of the bracket. Locknuts should be used. The mounting bolts should be left loose at this time, so adjustments can be made later.

NOTE: The red chainwheel is for the left (driver's) side, the blue chainwheel is for the right (passenger's) side of the vehicle.

4. Using shop air at 100 psi, engage the chain unit so the chainwheel contacts the tire. The point of attack should fall within the following parameters:
 - a. Chainwheel should contact the tire at the vertical centerline of the tire. Contact may be up to 3/4 inch in front of, but not behind, the centerline.
 - b. The pitch of the chainwheel should be 0 degrees to -1 degree.
 - c. Operating angle of chainwheel should be 5 degrees to 15 degrees.
 - d. Vertical distance from the ground to the chainwheel contact point should be 3-1/2 in. to 4 in. with the vehicle unloaded.

Adjustments to height may be made via the two chainwheel spacers. Additional adjustments may be made by movement of the mounting brackets.

5. Once the chainwheel is correctly positioned, torque the mounting bolts to 150 ft/lbs. Torque the chainwheel bolts to 150 ft/lbs.

NOTE: If the application is a school bus, consult the specific instructions enclosed, or the vehicle Body Builder Manual for the proper procedure for connecting into the vehicle's air and electrical systems.

 **Maintenance**

6. Install the electric toggle switch in the cab of the vehicle. Connect the switch to a fused 12-VDC power source coming through the ignition switch. The proper wiring of the ONSPOT switch is as follows:
 - F terminal - negative (ground)
 - D terminal - solenoid valve
 - O terminal - positive (power)
 - F terminal - positive (power)

When the switch is wired correctly, it will glow white any time the ignition switch is in the ON position. When the Onspot switch is put in the ON position, the switch color will change to RED.

NOTE: An existing rocker switch in the vehicle may be used, but we recommend that a switch guard be used.

7. Choose a protected area (on a crossmember or a frame rail) to mount the air/electric solenoid. Remove any undercoating or protective coating that inhibits proper grounding of the solenoid. Install the air/electric solenoid in the vertical position. Connect the solenoid to the electric switch (reference Figure 3).
8. A pressure protection valve **MUST** be used at the air source. This valve will prevent a complete loss of air from the air source should an ONSPOT airline leak or break.
9. Install the air lines and fittings provided. The line from the air source must be connected to the top of the solenoid valve.
10. Use the two 90-degree fittings for the connection at the air cans. Slide the protective tubing over the air lines where chassis contact may occur. Place the sticker labeled Operating Instructions on the dashboard in plain sight of the operator.
11. Once the installation is complete, engage the chain units and, using a fish scale, pull the chainwheel away from the tire. This should require at least 20 lbs. of effort.



CAUTION

Due to high spring tension, disassembly/assembly of the air cylinder should be done only by qualified personnel.

U-Bolt Nut Torque Specification

Ensure that suspension U-bolts are torqued to the Triangle Suspension specification. If you do not have the manufacturer's specification, use the following table:

NOTE: The following torques are with a light coat of oil, commonly referred to as a "wet" torque.

U-Bolt Thread	U-bolt Grade	Wet Torque (ft/lb)
1/2 - 20	5	92
	8	129
9/16 - 18	5	131
	8	185
5/8 - 18	5	181
	8	256
3/4 - 10	8	178
	8	446
7/8 - 9	8	315
	8	710
1 - 14	8	1,057
1-1/8 - 12	8	1,522
1-1/4 - 12	8	2,107

To check for proper clamping torque, rap the U-bolt with a brass hammer after torquing. The U-bolt should ring. If it gives a dull thud, it is not clamping the suspension system properly. Road-test the vehicle, then retorque the U-bolts.

NOTE: L Grade 5 U-bolts are used in general automotive and pickup truck/van applications. Grade 8 U-bolts are used in all medium and heavy duty applications. If you suspect that you may have stretched or inferior quality U-bolts on your vehicle, they should be replaced with new U-bolts.

6.22 Monthly Body Preventive Maintenance (Check List)

1. Door latches on truck greased and adjusted.
2. Check door seals on all doors. Glue or change rubber as needed.
3. All bolts and nuts on body in place and tight.
 - a. Example: Running boards, catwalk, header, and other miscellaneous places on body and chassis.
4. Replace or tighten bolts as needed.
5. Clean body, compartments, and battery box. For more information, see Paint Maintenance.
6. Make sure booster reels and electric reels work properly, clean and grease chain and linkage with multipurpose oil. Tighten if necessary. Check performance of rewind button and rollers.
7. Make sure brackets and springs are working properly on hard suction and ladder mountings.
8. Check operation on all electric lights on truck for bulbs burned out and make sure they are working properly.
9. Check all electrical receptacles on truck, and make sure they are working properly.
10. Make sure all compartment lights work.
11. Check/start-up generator, and make sure it is working properly.
12. Make sure all equipment on truck is cleaned, greased, and works properly.
13. Check for rust or chipped paint anywhere on body, chassis, or underbody or in compartments. If rust or corrosion starts, clean, wire brush, prime, and paint. Semiannually, before and after winter, power wash underbody chassis and cab and do above steps, then undercoat to seal up areas to prevent return of damage in the future.
14. Remove all equipment from all compartments monthly. Clean out dirt and touch up paint and wax inside compartment. Check to see if all seams are caulked to prevent water leaking between seams. Replace caulking as needed.
15. Touch up paint on overall truck as soon as paint is chipped. Clean, prime, and paint.
16. Take truck to Ziebart for inspection once a year for first 10 years.



6.23 Information on Magnesium Chloride and Calcium Chloride

Users of Sutphen Fire Truck products should be aware of damage that can occur due to chemicals used to de-ice roads. State maintenance crews use several different chemicals as liquid anti-ice or snow and ice clearing chemicals. These chemicals are often sprayed on roadways prior to arrival of storms, thereby having longer exposure and not being immediately diluted by snow or water. See list below.

Chemical Name	Abbreviation
Calcium Chloride	CaCl ₂
Sodium Chloride (road salt)	NaCl
Magnesium Chloride	MgCl ₂
Calcium Magnesium Acetate	CaMg ₂ (CH ₃ COO) ₂
Potassium Acetate	KC ₂ H ₃ O ₂

Of these, calcium chloride is probably the most destructive because it attracts moisture more readily. Calcium chloride absorbs water vapor from air at 40% humidity versus magnesium chloride at 75%.

Corrosion from these chemicals is seen on chrome, aluminum, and even stainless steel and concrete. Significant damage can result from as little as a single winter season.

Since the magnesium chloride solution has higher viscosity and stronger hydrophilicity properties than sodium chloride, for example, it adheres and crystallizes on the surfaces of metals under dry conditions and then becomes a corrosive agent when wetted.

 **Maintenance**

If these chemicals are deposited on painted surfaces that have been pitted by rocks or gravel or scratched, thereby exposing bare metal, the chemically induced corrosion will eat away at the metal substrate undetected until the paint starts blistering. Therefore, it is very important to replace chipped or scratched paint immediately through use of touch-up painted provided with each unit.

A very aggressive vehicle washing practice is the most effective preventative maintenance tool available to operators. It is important to note that a coating of magnesium chloride is extremely difficult to get clean and keep clean. It is also important to note that the washing system should not use recycled water because it generally contains a higher percentage of sodium chloride than water straight from the source. Other corrosion fighting techniques include:

- Frequently inspect and clean entrapment areas of debris. It is best not to block off or try to seal entrapment areas because despite your best efforts, corrosion could get started and remain unnoticed.
- Drain holes should be inspected and cleared frequently.
- Properly use a common ground.
- Frequently inspect and spray electrical connectors with moisture inhibitors.
- Frequently inspect structural and safety-related components for corrosion and take immediate corrective action when corrosion is observed.
- Replace chipped or scratched paint immediately after thoroughly cleaning the bare metal and surrounding surface, using touch-up paint provided with each unit.
- Frequently wax painted surfaces.

Sutphen Corporation strongly recommends that our products be frequently inspected and maintained. It is extremely important to frequently and thoroughly wash these products to remove the corrosive chemicals deposited as a result of the use of the corrosive snow and ice clearing chemicals. Not doing so will result in unwanted corrosion which may cause unsafe conditions and deteriorate the product appearance, including promoting bubbling of paint coatings.



6.24 Truck Washing and Care Instructions



WARNING

Failure to follow procedures may void warranty.

New Vehicles - First 90 Days:

1. Do not wax painted surfaces.
2. Use mild automotive soap with fresh, non-recycled, water and a terry cloth/microfiber cloth.
3. Remove bugs with a terry/microfiber cloth and an ammonia free, foaming window cleaner.

All Vehicles - After 90 Days:

1. Wax painted surfaces with a quality carnauba paste or liquid wax.
2. Use mild automotive soap with fresh, non-recycled water and a terry/microfiber cloth.
3. Remove bugs with a terry/microfiber cloth and an ammonia free, foaming window cleaner.

Tips and Suggestions:

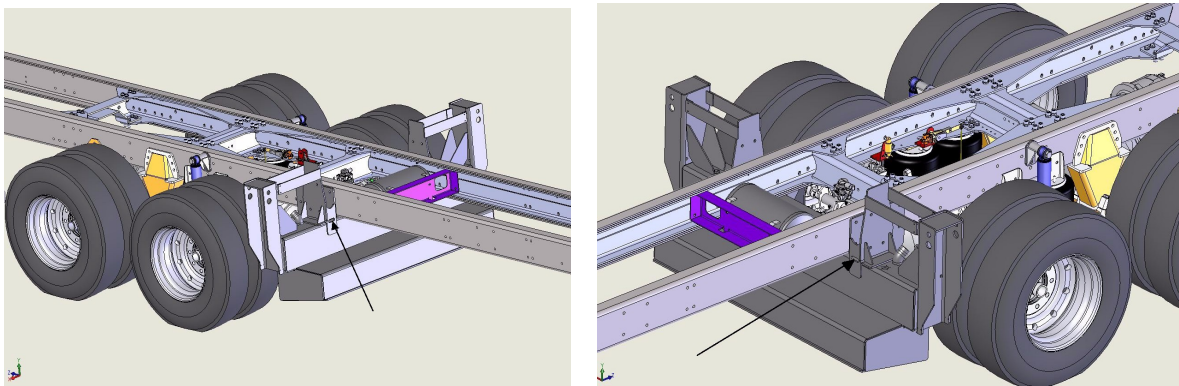
1. Use a clean cloth on painted surfaces that does not come in contact with areas such as bumpers, tread plate, steps, fender wells, wheels, etc. These areas may leave abrasive materials on the cloth that could scratch paint.
2. Remove road salts, de-icing agents, grit, petroleum products, industrial fallout, and other chemicals as soon as possible. All exterior surfaces should be washed (top, sides, under cab and body) first with soap and water. Stubborn residue can be removed with bug and tar remover or a minimally abrasive rubbing compound. Wash and re-wax after use of this chemical.
3. When washing, do not use pressurized water on decals, electrical connections, window seals, and door seals. Use care where equipment penetrates cab or body surfaces.
4. After washing, always wipe dry with 100% cotton towels or a chamois. Never allow a vehicle to stand wet in a closed station. Wipe or blow out all compartments after washing or using the vehicle in wet conditions.

Maintenance

5. The entire exterior surface of the apparatus should be waxed a minimum of once every three months or more often in winter months due to the use of destructive road chemicals. This includes tread plate, aluminum panels, stainless steel, or chrome surfaces.
6. If equipment is mounted on the apparatus, be certain that all holes are primed, painted and caulked to prevent corrosion under the paint. Remove all metal or aluminum particles and residue after drill and sanding to prevent corrosion.
7. Thoroughly wash the underside of the apparatus frequently with plain water and a salt eliminating chemical to minimize corrosion.

NOTE: Use care when using high water pressure. All grease fittings outside and underneath the chassis must be lubricated to dissipate water and contaminated grease. Too much pressure can remove protective undercoating.

8. Before undercoating, make sure all dirt and corrosion is removed.
9. Inspect undercarriage frequently and remove any potential for corrosion as early as possible.
10. Hose out the radiator with clean water and low pressure.
11. Keep mud flaps in good repair to minimize salt/chemical spray.
12. Use shrink wrap to insulate wiring if spliced into or modified.
13. Repair chips and scratches in the paint immediately to minimize exposure of the base substrate to the elements.
14. If apparatus has Ziebart® undercoating applied, have it inspected by an authorized Ziebart® dealer yearly for the first 10 years. Any touch-up needed is covered under their 10 year warranty.
15. **Aerial Towers** - Make sure that all dirt/salt is removed and prevented from collecting on the top corners of the rear fuel beam every 6 months. Prime and touch up, when dry, to minimize rust.





6.25 Appearance - Cleaning Body

Painted Surfaces

See cleaning policy for more detail and also check policy located on inside front-left compartment door.

Wash frequently to remove grime and caustic deposits, which could stain the finish. Use cool or lukewarm water. A mild soap may be used. Avoid washing in bright sunlight. Dry truck, especially all compartments and seams. Road tar can be removed with a special commercial tar remover or mineral spirits. Waxing offers added protection against staining and oxidation. Wait approximately 30 days after date of manufacture before waxing to give the finish a chance to cure.

DO NOT WAX IN HOT SUN. If a buffing machine is used, take care not to friction-burn the paint. DO NOT BUFF OVER GOLDLEAF. Wax truck monthly to keep the good finish.

Cleaning Underbody, Chassis, and Cab

See monthly body inspection numbers 13, 14, 15, and 16.

Stainless Steel, Aluminum, and Chrome Surfaces

Aluminum wheels and stainless bumpers can be cleaned with warm water. Tar remover will remove deposits of road grime. For added appearance, wipe surfaces dry after washing to prevent spotting. Under corrosive conditions, such as driving on salted roads, clean parts with steam or high pressure water from a hose. Mild soap solution will help. Rinse thoroughly.

Chrome surfaces are best cleaned with fresh water. Wipe dry to preserve luster. Light rust can be successfully removed with any commercial chrome cleaner. After cleaning, wax flat surfaces and apply a thick coat of rust preventive lubricant around bolts or other fasteners.



WARNING

Do not use a hose to clean wheels or undercarriage if truck has just been on a run or driven. Cold water can crack hot brake drums or rotors. Wait until wheels are cool to the touch.

Cab Interior

NOTE: The use of improper cleaning solvents may cause damage. Read directions on solvents prior to using to make sure they will not cause damage to the interior.

The chrome-plated door hardware and inside door panels should be washed as needed with a mild, non-caustic car wash solution. The chrome door hardware should be waxed at least every three months to reduce the chance of corrosion. The top of the engine hood and cab splatter finish paint should be washed as needed with a mild, non-caustic car wash solution and hand dried.

Vinyl upholstery and lining should be wiped clean with any good grade commercial vinyl upholstery cleaner. DO NOT use such chemicals as acetone or lacquer thinner.

Seat Care and Cleaning

About Durawear™

Durawear™ is an engineered seat covering material with superior thread density, weight, strength, and surface abrasion. A high-wear and high-strength composite, Durawear™ is also unique compared to other seat coverings due to its waterproof nature. The underside surface of the composite construction is a continuous PVC vinyl layer which creates this waterproofing. Unlike traditional vinyl seat covers which use the water barrier as the wear surface, the wear surface of Durawear™ is made from high-count polyester which is wear resistant and protects the PVC vinyl layer. The overlapping polyester construction of Durawear™ keeps accidental punctures from opening up into long cuts. Durawear™ is ideal for outdoor or other wet applications such as in firefighting, and meets FMVSS 302 flammability standards.

Care and Cleaning Recommendations

1. First vacuum the seat cover with an industrial vacuum with a high-quality filter in order to remove debris and small soot particles that may have collected on the seat.



-
2. To clean soils, the following are suggested cleaning methods (if one method is not successful, try the next method):
 - Wipe the soiled area with warm water, a mild detergent soap and a soft cotton cloth.
 - Spray soiled area with household cleaner and wipe with warm water using a soft cotton cloth.
 - Dab soiled area with solution of 50 percent Isopropyl Alcohol and 50 percent warm water using a soft cotton cloth.
 - Dab soiled area with 100 percent Isopropyl Alcohol using a soft cotton cloth.
 - Dab soiled area with 15 percent solution of Acetone and warm water.
 3. After each process, rinse the cleaned area well with warm water.
 4. Let the material air dry - do not dry in a dryer.

NOTE: H.O. Bostrom is not responsible for any defect caused by misuse of cleaning solutions.

Care of Naugahyde in Dash Shroud

NOTE: Do not use high solvents on dash to clean.

Do not use Armorall Cleaner or Armorall on dash.

Use of the above material will lead to breakdown of Naugahyde.

Be extra careful not to get any overspray of paint on dash, as it will not be able to be cleaned by solvents.

Background Information

1. There are numerous different types of stains. The nature of the stain, its interaction with the vinyl coated fabric, and other variables may make it impossible to totally remove certain stains.
2. There also are numerous different types of commercially available cleaning agents (i.e., Formula 409, Fantastic). Their composition can be changed by the manufacturer without public notice. Because of this, we recommend using these in an inconspicuous spot and check for damage before using these elsewhere. Extended use of these materials is not recommended and usually not needed.
3. This information is provided in good faith. Due to the wide variance in the nature and type of stains and their setting time, in the interactions between the vinyl coated fabric and the staining material, and in the nature and type of cleaning agents, this is only a recommendation offered with no warranty.



Recommended Cleaning Procedure

NOTE: Cleaning should proceed in these steps. Proceed to the next step only if needed.

1. Use a clean wiping material (i.e., paper towel, sponge) to soak up and remove as much of the staining material as possible immediately after the spill occurs. Avoid grinding in the stain in this process
2. Clean the stained area with warm (not hot) mild soap (i.e., Ivory, Dermassage, or similar hand dishwashing soap, not dishwasher soap, or Pine Sol or similar pine oil cleaner) and water solution.
3. Expose the stain to concentrated hand dishwashing liquid (not dishwasher soap) or pine oil cleaner and rub mildly. Follow with warm water wash.
4. Expose the stain to lighter fluid or naphtha (CAUTION this is flammable). Follow with warm, soapy water wash.

NOTE: We recommend that you use the following cleaning agents only after you have tried them in an inconspicuous location and ensure yourself that the agent will not damage anything. These agents should be used for occasional cleaning of stubborn dirt and stain. For everyday cleaning, we recommend a warm water and mild dishwashing liquid. Clean in the following order:

- a. Expose the stain to waterless hand cleaner (i.e., DL Hand Cleaner DL Group, Banite Industries, GOOP, or similar) and rub mildly. Follow with warm, soapy water wash.
- b. Expose the stain to commercially prepared cleaning solution (i.e., Formula 409, Fantastik) per manufacturer's recommendation. Follow with warm, soapy water wash.
- c. Expose the stain to rubbing (70 percent isopropyl alcohol or 70 percent isopropanol). This is available at drug and grocery stores.
- d. If Naugahyde appears dull or flat, you may use Johnson Spray Furniture Wax to bring to a shine. NOT ARMORALL

 **Maintenance**

Occasionally spray weather stripping on doors and windows and fender rubber with silicone compound to help preserve resiliency. This is especially useful in freezing weather to keep doors and windows from sticking shut with ice.

It is good practice to hose the dirt and grime from the whole chassis and body. If a leak develops, it will be more easily detected and will not let dirt accumulate under the truck, causing rust.

Goldleaf Maintenance - Hand-applied

1. When washing, avoid any direct spray of goldleaf.
2. Avoid any hard rubbing of goldleaf when washing, so as not to scratch or damage the goldleaf.
3. Once a year, or more, clear coat all goldleaf with a clear polyurethane to protect the finish. If annually, we recommend this be done in the fall to protect goldleaf from salt and winter harshness. Warranty is voided if not properly maintained.

Laminated Gold Leaf

Proper maintenance will offer you a lifetime of satisfaction! The following will aid in keeping your application looking brand new:

1. No pressure washing of any kind. Sponge wash only!
2. Use straight wax; no polish or abrasive cleaners.
3. Annual inspections, after the initial 6 month requirement.

Not Covered

Damages caused by abuse or failure to perform normal maintenance or any other expense. This warranty shall NOT apply to ANY defect, malfunction or failure to conform with the warranty provisions (not resulting from defect or malfunction) due to unreasonable use by the purchaser.

Consequential damages, incidental damages, or expenses, including damage to property.



Cleaning Graphics

Use a cleaner designed for high-quality painted surfaces. The cleaner must be wet, nonabrasive, without strong solvents, and have a pH value between 3 and 11 (neither strongly acidic nor strongly alkaline).

Hand Washing Exterior Graphics

1. Flush the graphic with clean water to remove loose dirt particles. A trigger-type hose nozzle is convenient for this purpose.
2. Use a mild liquid detergent and water solution and wash the graphic with a soft brush, rag, or sponge.
 - a. Wash thoroughly from the top down.
 - b. Avoid abrading the graphic by unnecessary scrubbing.
 - c. After applying the cleaning solution, keep a steady stream of water flowing on the graphic to wash away dirt particles.
3. Rinse the entire graphic thoroughly with clean water. Allow to dry naturally.

6.26 Graphics Material Warranty

All warranty coverage needs to be verified with the Warranty Department.

Coverage:

Warranty coverage is subject to an initial six-month inspection and the completion and return of the service card to keep your warranty valid. All validations are subject to inspection by a master sign craftsman, with written acknowledgment of this action forwarded to Associated Graphics Inc. Proper maintenance will offer you a lifetime of satisfaction! The following will aid in keeping your application looking brand new:

1. No pressure washing of any kind - SPONGE WASH ONLY!
2. Use straight, nonabrasive wax - NO polish or abrasive cleaners.
3. Annual inspections after the initial six-month inspection requirement.

Not Covered:

Damages caused by abuse, failure to perform normal maintenance or faulty or improper installation, whether by purchaser or third-party contractor, will void warranty.

Normal fading, lightening, or discoloration due to exposure to natural or artificial light, elements, normal wear, chemical washes, or acts of God.

AGI is not responsible for any loss, damage, travel expense, labor, or any other consequential damage arising from use or misuse of our products.



CAUTION

Before handling any chemical products, always read the container label and the Material Safety Data Sheet (MSDS).



6.27 R•O•M Roll-Up Shutter Door

The R•O•M Roll-Up Shutter Door is Made of Anodized Aluminum

Anodized aluminum is extremely hard and resistant to abrasion. Anodized aluminum can retain its original appearance indefinitely if you follow a sound cleaning and maintenance program. All surfaces are likely to collect dirt and pollutants over time. In some parts of the country, this soiling happens rather quickly due to the level of pollution and proximity to humid coastal regions.

With frequent cycles of condensation and drying as experienced in a humid coastal region, salts and pollutants build up very quickly on exterior surfaces. Contamination in recessed areas that are not exposed to the washing effects of rains also builds up more quickly. These soils can become more and more concentrated as they go through cycles of re-wetting and drying. Eventually mild acid pollutants become harsh acid pollutants. These strong acids can attack aluminum causing a pitting type of corrosion. It is important to begin a cleaning maintenance program as soon as you receive your vehicle to prevent soil build-up.

Cleaning And Maintenance

The R•O•M Roll-Up Shutter Door needs very little maintenance, and cleaning is very simple. To wash the anodized shutter slats, use a mix of water and mild soap or detergent with a PH range between 6 and 9, such as Ivory Liquid, Joy, Lux Liquid, or Dove Liquid. This should be performed without the aid of a high-pressure sprayer.

A 50/50 isopropyl alcohol and water mixture is recommended for cleaning anodized slats prior to applying decals and for cleaning the weather-stripping (bulb seal).

If your R•O•M Roll-Up Shutter Door has been finished with a polyurethane solvent-based paint, then it needs to be cured according to the paint manufacturers recommendation. All solvent-based paints require several weeks to fully cure and harden depending on temperature and humidity.

 **Maintenance**

All washing should be performed using a mix of water and mild soap or detergent, without the aid of a high-pressure sprayer.

The tracks should be frequently cleaned to get the best performance and longest life. To clean the track use a mild soap and water to remove any dirt or grime build-up. Spraying the tracks with dry (non-petroleum based) silicone is recommended; this will enhance the smooth opening and closing of the shutter. Do not use any type of petroleum-based lubricant in the tracks, this only attracts dirt and grime and creates an abrasive surface, making it hard to operate the door thus shortening the life of the shutter.

The lift bar should move freely when pulled out and when released should snap back to its rest position.

Cleaning the Friction Areas

In the operation of the shutter there are friction areas that will need to be cleaned. After cleaning these points, they need sprayed with dry silicone to increase the ease of operation. (Never use lithium or grease)

The friction areas on the shutter are as follows:

1. The pennant plates where the end shoes rub against them
2. The roller that the end shoes roll on
3. The nylon end shoes
4. Inside the sidetrack channels
5. The back side of the rubber side seal
6. Outside of the pivot block
7. The drip rail seal at the top of the opening.

(Note: If the drip rail is rubbing against the shutter, the drip rail seal can be trimmed. However, excessive trimming may allow weather and dust to infiltrate the compartment.



Tension Adjustment

The R•O•M Roll-Up Shutter Door has been set in our factory, so the spring tension of the operator is at equilibrium; meaning approximately the same force is required to open or close. This counterbalance setting will ensure the maximum life expectancy of the roll-up door and provide consistent operation. Too much tension creates too much force to close the door thus creating more stress on the operator spring, end shoes, and slats. If you feel it is necessary to adjust the operator tension due to a variance in compartment size and actual installation, this can be done easily by following the steps below:

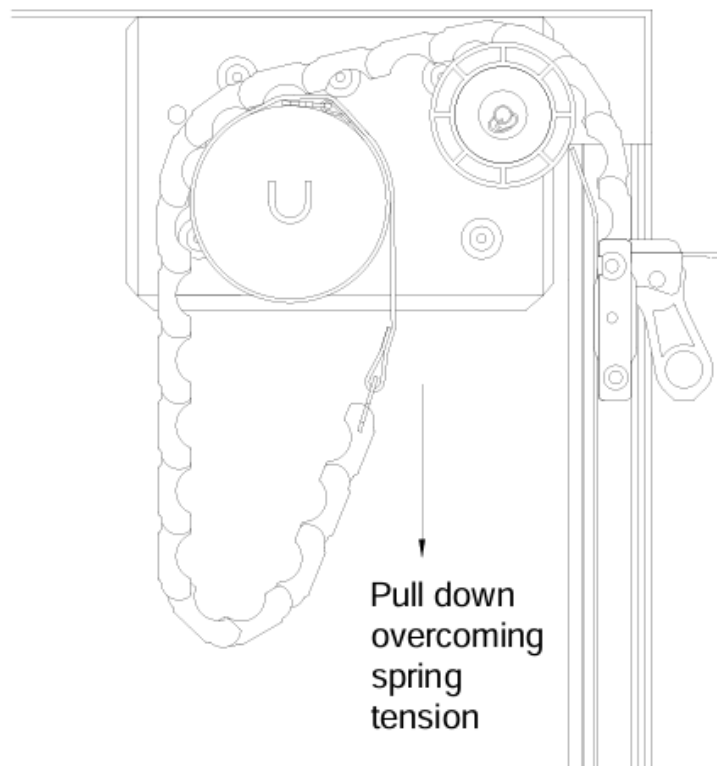
Before Making any Adjustment to the R•O•M Roll-Up Shutter Door Please Read the Following:

- Make sure all screw heads on the pennant plates and sidetrack channels are not protruding; the nylon end shoes should not touch the screws during operation.
- Check the compartment to see if it is square. The door will work much easier if the compartment is square. Ideally the roll-up door should have 1/4" of the total side play when moved laterally at any point. Check the alignment of the pennant plates. They should be parallel and equal distance from the front and bottom of the opening.
- If the door is difficult to open and close, the roll-up door may need to be lubricated.
- If the door opens easily and is difficult to close there may be too much tension. If the door is difficult to open and easy to close and/or the curtain drapes loosely around the operator drum, there is not enough tension. If the roll-up door does not perform to your satisfaction, the tension of the operator may need adjustment.

NOTE: The factory number of turns is identified on a label located on the right side of operator drum.

Adjusting the Tension if the Compartment is Easily Accessible

1. Open the roll-up door completely.
2. Pull down on the bottom of the roll inside the compartment (Ref. Fig. 1) overcoming spring tension. Pull the curtain of the roll-up door all the way down so that the operator can be reached.



Ref. Fig. 1

3. Put the tension pin (nail) back into the hole of the nylon end cap that is located on the right side of the roll-up door while looking into the compartment. You may need to slightly turn the operator clockwise (towards back of compartment) to align the holes of the end cap with the shaft. The tension pin is always oriented horizontally.
4. Remove the operator securement fasteners (Hex Head Cap Screw; 1/4-20 x 1 1/4" & 1/4-20 nut) at each end of the operator shaft.



-
5. Turn operator clockwise one or one-half turn to decrease tension or counterclockwise one or one-half turn to increase tension.
 6. Replace the operator securement fasteners at each end of operator shaft.
 7. Remove the tension pin and slowly allow tension to be transferred back onto the roll-up door curtain.

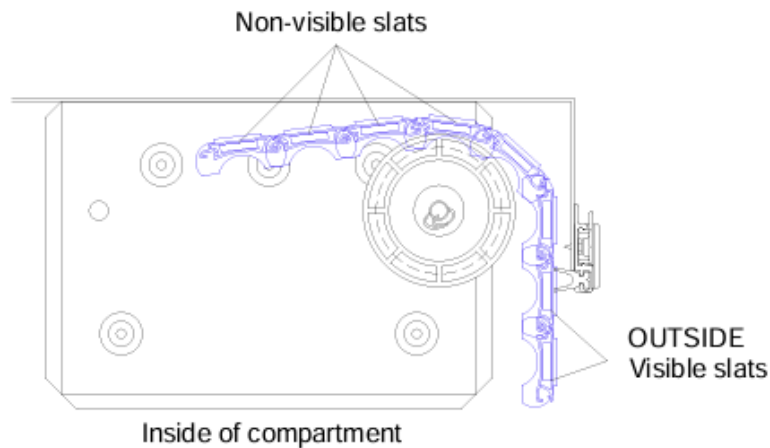
Adjusting the Tension From Outside the Compartment

If you cannot physically access the operator using the method shown in Section “A”, you must remove the roll-up door’s track and curtain.

1. Raise the roll-up door to its open position. Remove all of the fasteners from the track and pull the track out and away from the compartment.
2. Carefully pull the roll-up door down until the top slat with the strap attachment is sufficiently exposed and the operator can be reached.
3. Put the tension pin back into the hole of the nylon end cap that is located on the right side of the roll-up door while looking into the compartment. You may need to slightly turn the operator clockwise to align the holes of the end cap with the shaft. The tension pin is always oriented horizontally.
4. Remove the curtain by separating the t-clip strap connection. To separate, lift up on the roll-up door, rotate clip, and push down and away on the clip.
5. Grip the operator firmly with both hands and have someone remove the locking nail. Turn operator clockwise one or one-half turn to decrease tension or counterclockwise one or one-half turn to increase tension.
6. Replace the tension pin and re-attach the straps to the top slats.
7. Remove the tension pin and slowly allow tension to be transferred back onto the roll-up door curtain. Route the curtain over the nylon rollers and raise the curtain up to the header. Re-install track.

Slat Replacement

If the R•O•M Roll-up Shutter Door needs slats replaced, they can be replaced with the slats that are non-visible (Ref. Fig. 2). Do not use the first slats closest to the operator for they have been specifically cut to accommodate the t-clips.

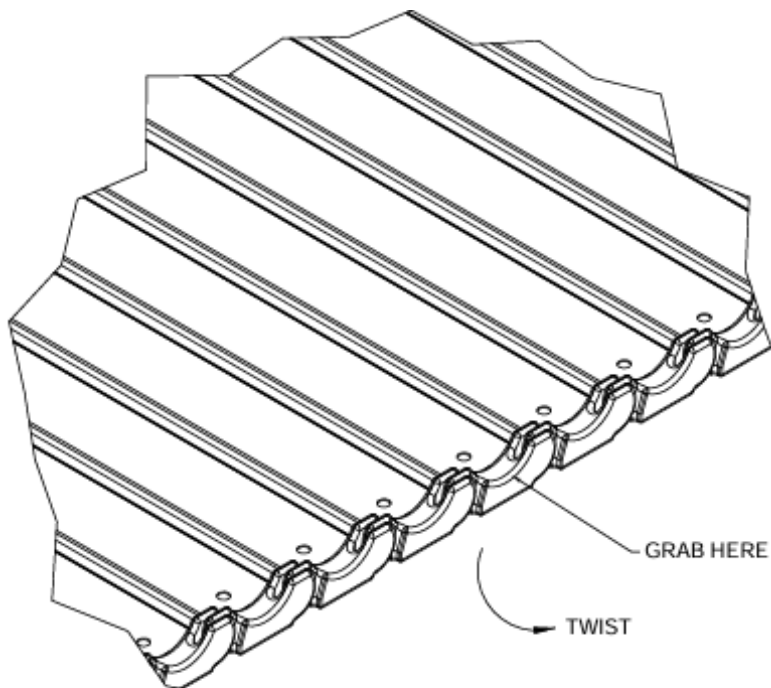


Ref. Fig. 2

Before You Begin

This procedure requires that you lay the curtain and track on its face. Always remember to protect the face of the curtain and any other visible parts.

1. To remove the drip rail assembly, refer to step 12 to see how it was installed.
2. To remove the track assembly, refer to step 11 to see how the track was installed. Remember to remove the sealant used to seal the track. This will ensure that the new sealant will adhere correctly during the track reinstallation.
3. To detach the curtain assembly, refer the step 6 to see how the curtain was attached. Once the curtain assembly has been detached you will need to lay it on its face using a blanket, rug, towel, or any other kind of soft material that will prevent the curtain from being scratched.
4. To remove the end shoes, grasp the middle of the end shoe with a vise grip and twist out until the end shoes slides out of the end of the slat. (See Ref. Fig 3.)



Ref. Fig. 3

5. After removing the end shoes on both sides slide out the damaged slat and the hidden slat.
6. Replace the damaged slat with the hidden slat and reassemble.
7. Place one end of the curtain against a back stop. Then, install the end shoes on the opposite side by tapping the end shoes with a small hammer. The end shoes should be tapped in until flush and look like they did prior to taking them off. Rotate the curtain around and repeat.
After the slats and end shoes have been replaced, re-install the shutter following steps 6, 11 and 12 of the installation instructions.

R•O•M ROLL-UP SHUTTER DOOR™ SERIES IV - ASSEMBLY DRAWING

ITEM	DESCRIPTION	SELLABLE PART NUMBER	QTY
13	SIDE SEAL LOW PROFILE	YES R00095	2
12	STRIKE BLOCK (USED WITH R00781)	YES R00671	1
12	STRIKE BLOCK (USED WITH R03996)	YES R03996	1
11	DOOR AJAR SWITCH (5 WIRE DAS)	YES R00781	1
11	DOOR AJAR SWITCH (3 WIRE DAS)	YES R03995	1
10	HAIRPIN CLIP	YES R00355	2
9	RIVET BLIND ALL ALUM 3/16X.575 CSK	YES R00091	4
8	CONFIGURABLE TRACK	YES R04025	1
7	LH PENNANT PLATE ASSEMBLY	YES VARIES	1
6	RH PENNANT PLATE ASSEMBLY	YES VARIES	1
5	CONFIGURABLE SILL PLATE	YES R00029	1
4	DRIP RAIL ASSEMBLY CONFIGURABLE	YES R00038	1
3	OPERATOR ASSY REPLACEMENT	YES R00163	1
2	SLAT ASSEMBLY SHUTTER	YES R00072	1
1	CONFIGURABLE BOTTOM RAIL	YES R04024	1

ROM A Safe Fire® Brand 6900 E. 163rd Street Indian, MO 64112-5483 (816) 318-8000 (800) 827-3692 Fax (816) 318-8100 www.romcorp.com		Date: 7/17/2015 Drawn: RDS Checked: RDS Sheet: 1 Drawing No: R04030
Copyright © 2015 ROM Corporation. All Rights Reserved. This drawing and the contents hereof are the property of ROM Corporation and should not be disclosed to any third party without the prior written consent of ROM Corporation.		Scale: NTS Size: B Part No: R04030

PENNANT PLATE REF DWGS:
 R04031-R04038 FRONT ROLL
 R01040-R01047 FRONT ROLL W/ DRIP PAN
 R04155 LH REAR ROLL
 R04156 RH REAR ROLL

NOTE:
 R04074 3 WIRE DAS KIT
 INCLUDES R03995 SWITCH & RIVETS
 R01078 5 WIRE DAS KIT
 INCLUDES R00781 SWITCH AND RIVETS

NOTE:
 R04079 3 WIRE DAS STRIKE BLOCK KIT
 INCLUDES R03996 STRIKE BLOCK & RIVETS
 R01711 5 WIRE DAS STRIKE BLOCK KIT
 INCLUDES R00671 STRIKE BLOCK & RIVETS

UNSPECIFIED TOLERANCES:
 -ANGULAR TOLERANCE ±1°
 -DECIMAL DIMENSIONS:
 0.001 ±.001
 0.002 ±.002
 0.005 ±.005
 -DIMENSIONS ARE NON-DESCRIPTIVE
 -ALL DIMENSIONS UNLESS OTHERWISE NOTED
 -REMOVE BURRS FROM FABRICATED PART
 -DIMENSIONS ARE IN INCHES, UNLESS OTHERWISE NOTED



6.28 AMDOR Roll-Up Doors

Cleaning And Maintenance

AMDOR brand roll-up doors are designed as a relatively maintenance-free product. The primary construction materials are anodized aluminum and self-lubricating Nylon 6. Roll-up doors should be thoroughly cleaned on a daily basis with a mild detergent and clean water in the same manner as the remainder of your apparatus. Do not utilize high-pressure equipment including pressure or steam washers as these may damage the door assembly and will void the manufacturer's warranty.

In order to ensure years of problem-free service, it is essential that the doors and their tracks are kept clean and free of debris. Door tracks should NOT be lubricated in any fashion. The majority of lubricants will attract and retain salt, sand, road grit, and debris. The existence of any foreign matter within the door tracks will impact negatively upon door performance as well as service life.

So long as the door tracks are absolutely clean you may use a very thin application of silicone applied to the seals indirectly via a clean dry cloth. Only dry film silicone is recommended for this purpose.

Seals are an important component within the roll-up door system. All seals should be inspected regularly. This wear item should be replaced when torn or damaged in any way.

In the event that maintenance is required please contact your apparatus manufacturer in order to determine your closest authorized Dealer. You may also contact AMDOR Toll-Free at 1-877-GO AMDOR. (877- 462-6367).

6.29 Weekly Pump Preventive Maintenance (Check List)

1. All valves - discharge and suction lubricate - see pump manufacturer's service manual for more information.
2. Both pump in-gear lights work.
3. Tank level gauge works.
4. All gauges work properly on pump panel.
5. Test relief valve system or governor.
6. Check all piping for leaks.
7. Check truck to see if it will hold vacuum.
8. Check all valve control linkages for proper travel, tightness, and smoothness of operation. Adjust as necessary.
9. Ensure Pressure Governor is working properly.
10. Check pump packing drips (see pump manufacturer's manual for more information).
11. Heat exchanger works properly.
12. Pump shifts in and out of gear smoothly and transmission locking up properly.
13. Grease pump shift cables (both ends).
14. All drains and multidrains are draining properly.
15. Check performance on transfer valve (if applicable).
16. All gauges and controls are properly labeled.
17. Proper lubrication for the valves is to take off the discharge cap and squirt vegetable-based mineral oil through the discharge outlet, working the ball back and forth as you do this. This will lubricate it and make the valve work more freely and also saves the life of the seal.
18. On a deck gun, pour a little oil down the nozzle tube and work the valve back and forth.



-
19. If you have a multiversal, pour 1 quart or 1/2 gallon down the multiversal and engage the pump with the valves closed and work the valve back and forth and then open each valve with the cap on it to get the lubricant into the seals and work it back and forth.
 20. Check drive shaft and pump flange bolts. Must be checked with wrench.

NOTE: For more information on monthly and annual maintenance, see pump manufacturer's manual.



6.30 Hale Products, Inc. Service Bulletins

HALE Hale Products, Inc. Service Bulletins

Bulletin#: Revision#: Date:

Product Type Covered: Hale Pump Hurst Tool Lukas Tool

Product Covered:

Problem Statement:

Written by: Date:

Approved by:

Product Manager:

Customer Service Designee:

Body of the Bulletin

The SVS Torrent Valve is designed to use grease. The recommended types of grease are outlined below and can be found in Section 4, Routine Maintenance, of the SVS Installation and Service Manual, Hale p/n: 029-0020-90-0. Lubrication intervals vary dependent upon operating conditions (amount of usage, water conditions, etc.). When SVS Torrent Valves are inadequately lubricated it shortens the life span of smooth operation and causes unnecessary "downtime." The warranty on the SVS Torrent Valve is ten (10) years workmanship and two (2) years on the seals. **FAILURE TO PROPERLY MAINTAIN and LUBRICATE VALVES COULD RESULT IN WARRANTY DENIAL.**

LUBRICANTS:

Use one of the following lubricants. DO NO substitute other lubricants.

- **Never-Seez** - White Food Grade with PTFE, manufactured by:
 Bostik Findley, Inc.
 211 Boston Street
 Middleton, MA. 01949-2128
 Web: www.bostikfindley-us.com
- **White Knight**™ - Food Grade Anti-Seize Compound, manufactured by:
 Jet Lube Inc.
 4849 Homestead Road
 Suite 500
 Houston, TX 77028
 Web: www.jetlube.com
- **Anti-Seize**™ - manufactured by:
 U.S. Valve Service & Training, Inc.
 11875 West Little York
 Suite 502
 Houston, TX. 77041
 Web: www.usvalveservices.com/prod7.htm

Also see SVS Torrent Installation and Service Maintenance Manual, Hale p/n: 029-0020-90-0, Section 4 "Routine Maintenance" for additional information.



Hale Products, Inc. Service Bulletins

Bulletin#: Revision#: Date:

Product Type Covered: Hale Pump Hurst Tool Lukas Tool

Product Covered:

Problem Statement:

Written by: Date:

Approved by:

Product Manager:

Customer Service Designee:

Body of the Bulletin

The air compressor oil filter that is used on all Hale CAFSPro systems is a Fram Racing HP6A oil filter. When performing scheduled maintenance on a Hale CAFSPro system use only a Fram Racing HP6A filter. A substitute oil filter must not be used.

All Fram brand Racing filters (HP6A) are Heavy duty steel body oil filters to resist high pressure surges and external impact. These oil filters are of a high flow design. Other filters that may fit do not have the same construction. A bypass valve within the filter allows full oil flow to the compressor should the media become blocked or during initial operations during cold weather.

Another feature that sets the Fram Racing HP6A apart from the HP6 is a screen over the bypass valve to provide protection against larger contaminants when oil is bypassing the filter.

Our research indicates there is no direct substitute for the Fram Racing HP6A. The Fram Racing HP6 or listed substitutes do not offer the additional screen over the bypass valve therefore the potential for large particles entering the air compressor assembly exists with these substitute filters. This can adversely affect the life of the compressor.

For the correct replacement oil filter contact the nearest Hale Authorized Parts Service Center or Hale Products Customer Service and order Hale Part Number: 010-0650-01-0 Oil filter. This will ensure proper protection of the CAFSPro air compressor. Many local auto parts dealers and speed shops stock or can also order the correct Fram HP6A oil filter. Do not allow substitution of an alternate filter even if it is listed in an auto parts book as an interchange.

Using the correct filter and following the correct maintenance schedule can help ensure long and trouble-free service life of your CAFSPro system. Using the incorrect filter can affect the warranty coverage on the compressor.

Endnote: At the time of the issue of this service bulletin, there has not been a compressor failure on a Hale CAFSPro system. One of the reasons why this is true is the integrated system of components working together. Any substitutions or changes can adversely affect the entire system. Always use factory authorized parts for best performance.



Maintenance



Hale Products, Inc. Service Bulletins

Bulletin#: **SB-89** Revision#: **A** Date: **10/12/2006**

Product Type Covered: **Hale Products** **Class 1**

Product Covered:

Hale Pump Gearbox and Drive Unit Lubrication Recommendations

Problem Statement:

A consolidated list of recommended oil and approximate capacities for Hale Pump Gearboxes, including Sealant and Cleaners - requested by end-users as a ready reference.

Written by: **Len Hartman** Date: **10/10/2006**

Approved by: **Paul Wentz**

Product Manager: **Gary Handwerk**

Customer Service Designee: **Shawn Kelly**

BODY OF THE BULLETIN

The recommended grade of oil for Hale gearboxes is provided in the table attached (Table C1: Oil Capacity and Recommendations). See next page, **Appendix C1: Lube and Sealant Specifications**. This table is also found in your product Installation, Operation and Service Maintenance Manual.

The Oil Capacity and Recommendations Table lists the grade of oil and approximate capacities required, as tested by Hale and found suitable for normal operating conditions.

Hale does not recommend any particular supplier / manufacturer of oil for Hale gearboxes as long as the proper grade / weight and service ratings are used.

IMPORTANT !

SHOULD THE PUMP BE OPERATING UNDER EXTREME ENVIRONMENTAL CONDITIONS (I.E., AMBIENT TEMPERATURES BELOW 0° [-18C]), CONTACT HALE PRODUCTS, INC. FOR PROPER GRADE / WEIGHT OIL TO BE USED.

Hale Products, Inc.
A Unit of IDEX Corporation
700 Spring Mill Avenue
Conshohocken, PA 19428
U.S.A.
Telephone:.....610-825-6300
Fax:610-825-6440
Web: www.haleproducts.com



Hale Products, Inc. Service Bulletins

Bulletin#: Revision#: Date:

Product Type Covered: Hale Pump Hurst Tool Lukas Tool

Product Covered:

Problem Statement:

Primer vane life degrades if the recommended annual maintenance is not performed. To provide prolonged primer life Hale recommends the primer be disassembled and cleaned annually or after 500 operational cycles. At this time primer power and ground connections should be checked.

Written by: Date:

Approved by:

Project Manager:

Customer Service Designee:

Body of the Bulletin

Hale ESP rotary vane primers are reliable environmentally friendly devices that with normal use and if properly maintained will provide years of reliable operation. This reliable operation can only be maintained if proper service, as recommended by Hale products is performed.

Failure to perform this required maintenance could void the primer warranty.

Repeated in this document is the recommended annual maintenance for Hale ESP primers. These maintenance procedures are applicable to both 12 VDC and 24 VDC primer models.

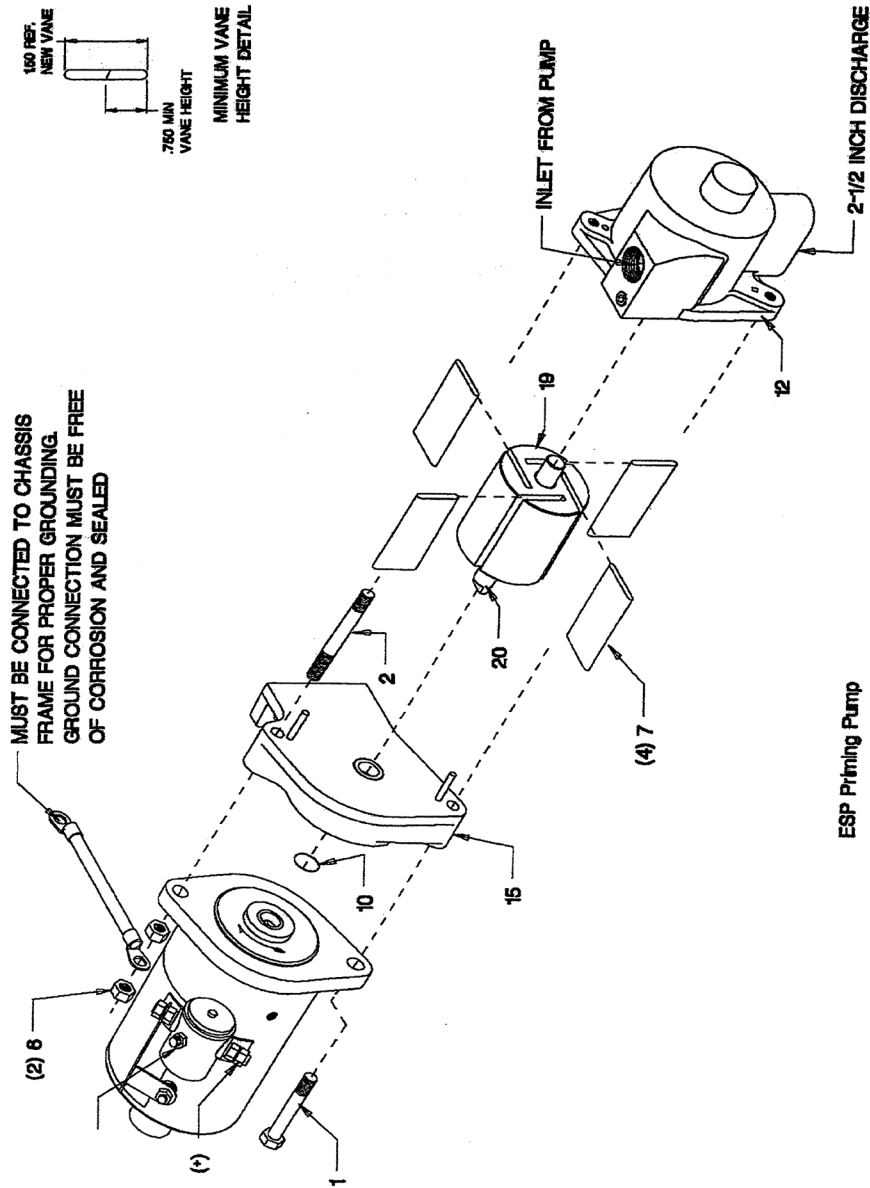
The following text is from PL821, PL938 and Figure 3-2 of 029-0020-63-0:

"To aid in long primer life and proper performance, it is recommended that the priming pump be cleaned yearly or after 500 cycles of use. Separate the pump body and head from the motor and remove any black build-up or contaminants with Safety Kleen™ or Stoddard Solvent. Use care to reinstall the vanes in the same orientation and to grease the shaft seal."

Also included in this service bulletin is an updated Midship Pump Maintenance Checklist

The procedure for disassembly, cleaning, vane replacement and reassembly of the priming pump can be found in the Hale muscle pump manual (Hale P/N 029-0020-63-0) and is reprinted here for easy reference.

6.31 Primers ESP Priming Pump



The Hale ESP primer is relatively maintenance free. If, after testing of the priming system, the primer fails to pull the required vacuum, the primer vanes may be worn and require replacement.



The following procedures should be used to replace the primer vanes.

1. Place apparatus out of service in accordance with departmental procedures.
2. De-energize apparatus electrical system.

NOTE: Before beginning disassembly, make note of the position and locations of components to ensure correct reassembly.

3. Tag and disconnect wires from battery connection, solenoid connection, and ground connection point.
4. Tag and disconnect hose from suction connection.
5. Loosen nuts on studs or bolts that hold primer assembly to mounting pad. Remove primer to suitable work area.
6. Remove the 3/8-16 UNC x 2-1/2 inch-long capscrew and remove the 3/8-16 UNC nut from stud. Carefully separate pump assembly from motor.
7. Using a nonmarring mallet, carefully separate the pump head from the pump body.
8. Mark the location of each primer vane. Remove the shaft and rotor assembly and the vanes from the pump body.
9. Remove the seal from the pump head assembly.
10. Inspect all components for corrosion and abnormal wear. Clean all components using Safety Kleen™ or Stoddard Solvent. Obtain new components as necessary.
11. Carefully press new seal into the pump head assembly.
12. Insert rotor and shaft assembly into pump body assembly. Slide new vanes into the slots in the rotor. Rotate the rotor and shaft making sure the vanes move freely in the slots.
13. If necessary, install new pins into the pump head assembly. Align the pins with the holes in the pump body assembly and slide pump head over rotor shaft. Once head is seated against the pump body, make sure the rotor assembly turns freely in the pump assembly.

 **Maintenance**

14. Install motor on pump assembly and secure in place using 3/8-16 UNC x 2-1/2 inch-long capscrew and 3/8-16 UNC nut on the stud. Tighten the nut and capscrew.
15. Place primer assembly on the mounting point and tighten capscrews or nuts.
16. Reconnect suction hose making sure the connection is tight.
17. Reconnect ground wire, battery connection, and solenoid connection.
18. Energize apparatus electrical system.
19. Test operate the primer to ensure it is working correctly.
20. Return apparatus to normal operation



6.32 Hale Midship Pump Maintenance Checklist

Truck Manufacturer _____

Pump Model & Serial Number _____

Year _____ Unit# _____

Recommended Weekly Procedures

- Test relief valve system or governor at 150, 200, 250 psi. If pump is equipped with TPM, you will need to have positive pressure.
- Operate transfer valve and check clapper valves for proper operation on two stage pumps.
- Test the priming system and check lubrication level in priming tank (if applicable).
- Operate all valves, discharge, suction, hose, drain, and multidrain.
- Check pump shift indicator lights.

Recommended Monthly Procedures	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Complete weekly checks												
Lubricate threads on PM relief valve panel control and check light. DO NOT USE GREASE												
Lubricate remote valve controls and all valves												
Check controlled drip rate and adjust if necessary (8-10 drops per minute @ 100-150 psi)												
Perform dry vacuum test*												
Check drive flange bolts to ensure tightness. Lubricate U-joint.												
Lubricate suction tube threads. DO NOT USE EXCESSIVE GREASE.												
Clean and inspect inlet strainers (Examine for loss of zinc)												
Inspect cap gaskets. Replace if cracked or damaged.												
Check oil level in pump gearbox; add oil as necessary or replace oil with SAE EP 90 oil if contamination is found.												

*Per NFPA-1911, para. 3-32, 22 inches minimum vacuum; loss not to exceed 10 inches vacuum in 5 minutes

Recommended Annual Procedures

- Complete all previous checks.
- Check gauge calibration.
- Check oil level in AutoLube assembly (SEA-EP 90 oil). Pump must be drained of water prior to checking oil. See operation and maintenance manual for details.
- Lubricate power transfer cylinder, VPS shift cylinder, and shift control valve with air tool oil.
- Drain pump gearbox oil and refill (use SAE-EP 90 oil). Examine magnetic plug.
- Check individual drain lines from pump to multidrain to ensure proper drainage and protection from freezing.
- Lubricate transfer valve mechanism on two-stage pump. Dry molyspray is preferred.
- Perform yearly standard pump test (per NFPA-1911) to test pump performance levels.
- Repacking of pump is recommended every two or three years.
- Service ESP primer as per bulletin
- Remove and clean relief valve strainers

NOTE: The above general recommendations are provided for normal use and conditions. Extreme conditions or variables may indicate a need for increased maintenance. Good preventive maintenance lengthens pump life and ensures greater dependability. Consult Service or Diagnostic Chart in Operator's Manual for detailed information.

Hale Products Inc., A unit of IDEX Corporation, 700 Spring Mill Avenue, Conshohocken, PA 19428 Tel: 610/825-6300 Fax: 610/825-6440 Bulletin 889, Rev 1 11/05, Copyright 2005, Hale Products Inc.



6.33 Hale Midship Pump Maintenance

An Easy Way to Save Money

It seems we often give proper attention to the chassis, body and drive train, but neglect the pump. This is a serious oversight because if the pump does not operate properly, we probably will not be able to extinguish the fire. Complete preventive maintenance is important in keeping apparatus at peak efficiency throughout its career.

All of us understand that water remains the most cost-effective extinguishing agent available to the firefighter. However, the cost of apparatus needed to put the water on the fire has continued to rise in most cases, lengthening the time a pumper must remain in service before it can be replaced.

So who cares? If yours is a typical department, your pumper is in front-line service until it fails (usually at the worst possible moment). And nobody is happy when a pumper or engine goes down. The captain has to make excuses, the deputy chief has to move another engine in to cover and the chief usually has to explain to the commissioners or city manager why a new parking lot was created.

Prevent Problems

We can prevent this by the establishment, in writing, of a complete preventive maintenance program including pumps. This is the first step in discovering minor problems and defects before they turn into major ones. Sound like a monumental task? In reality it is as simple as consulting the operation and maintenance manual that came with your apparatus. In the case of pumps, all six major pump manufacturers in the United States list in their operating manuals the periodic maintenance needed to ensure continued operation of their pumps. These instructions are usually divided into segments covering the maintenance required after each use as well as weekly, monthly, and yearly. Hale Pump Company and Waterous also provide a reminder plate for mounting on the pump panel.

Every pump manufacturer has weekly, monthly and annually recommended checks or tests for their pumps. At a very minimum, you should follow their recommendations. After all, they manufacture the equipment, and they should know best what should be done to keep it in peak condition.

Pumping System Failures

Probably 60 percent of pumping system failures are caused by ancillary equipment and not the major pump. Pump manufacturers' maintenance schedules list the required maintenance for the relief valve, transfer valve (if applicable), primer, and packing glands. Because each unit is different, it is best to consult the specific pump manual before undertaking the maintenance. A general rule of thumb, proven by many years of experience, is that the more you use the accessory, the better it will perform.

Several different configurations of pump packing are used by pump manufacturers. but they all serve the same purpose – to seal out air along the pump shaft. Due to the lubrication properties of the packings, they must have cooling water to avoid losing their lubrication, thus rendering the packing useless. This lubrication is accomplished by allowing water to flow through the lantern rings in the packing and allowing a small amount to follow the shaft of the pump onto the ground. The rate of flow must be regulated to prevent too much or too little leakage. Usually, 10 drops a minute at 70-psi discharge pressure is ideal. Once again, consult your manual for proper adjustment of packing. The manual will also make a recommendation as to how often to replace the packing.

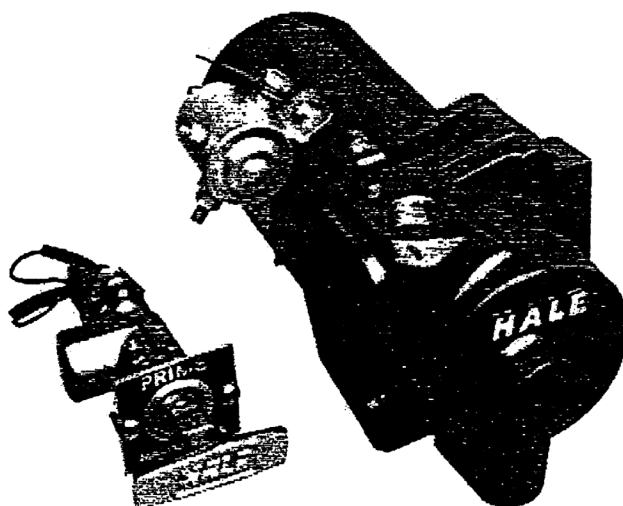
You should be aware that most of the portable and engine-driven pumps produced today are using mechanical seals to seal out the air in lieu of packing. Self-adjusting (they are spring loaded) mechanical seals do not require a separate cooling line nor water to be dropped outside the pump case. If you have portables that use mechanical seals, you should not have water dripping around the shaft unless the seal is damaged. A damaged seal can prevent priming and should be replaced as soon as possible.



Midship pumps could use mechanical seals, but, unless the fire service pushes for this change, it probably will not happen in the near future.

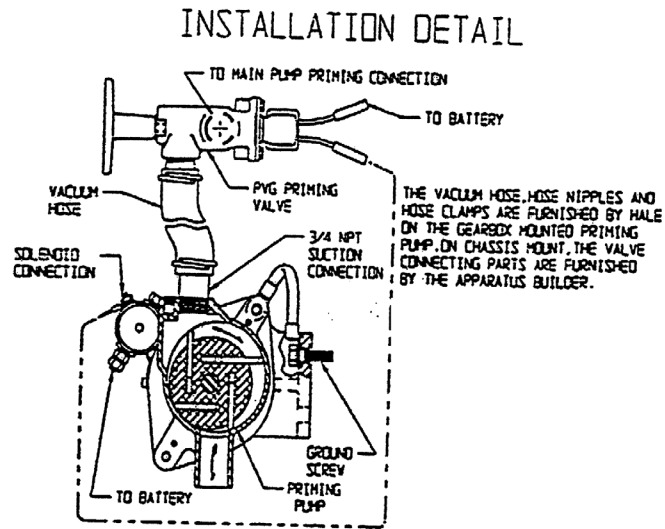
The drive unit of the pump is not only responsible for providing power to the pump; it also transmits power to the rear axle for road operation of the apparatus.

6.34 Environmentally Safe Priming System (Model ESP) Hale's New Oil-less Priming System



Hale's new Model ESP priming system provides the ultimate in fast priming, high vacuum performance, and reliability without the use of a lubricant. Technologically advanced and environmentally safe, the Model ESP is self-lubricating. There is no oil tank to check; no oil is expelled to the ground. The Model ESP is a semiautomatic priming system with a single-action control valve which simultaneously activates the entire system, ensuring fast, consistent air evacuation. Hale's electric rotary vane-type positive displacement primer operates with 12-VDC or 24-VDC power.

Maintenance



The Model ESP features a totally enclosed motor to prevent dust, dirt, and water from entering. All system components, motor/pump unit, and control valve are supplied ready for assembly.



6.35 Hale Model Esp Priming System Specifications

- Performance: Vacuum Capability of 24 in. Hg (610 mm Hg)
- Pump Type: Heat-treated anodized aluminum specially coated for wear and corrosion resistance
- Motor: Direct current, totally enclosed; 4.5 in. (114mm) diameter
- System Weight: 27 lb (12.2 kg)
- Control Valve Single-action, push-pull control valve, all bronze construction. Designed for mounting on pump or panel for remote control operation.

VDC Amps	Priming Amps	Max
12	210	300
24	80	150

Contrary to what some believe, the oil in the pump gearcase is not transmitted nor is it a part of the engine oil system. It is entirely separate and it does require some specialized maintenance to keep it in peak operating condition. It always must be kept full with clean oil of the proper EP rating. By checking periodically (each month or 20 operating hours), you can watch for proper level as well as for foreign particles or water entering the drive unit. Water is a drive unit's worst enemy and is usually caused by excessive leakage from the packing.

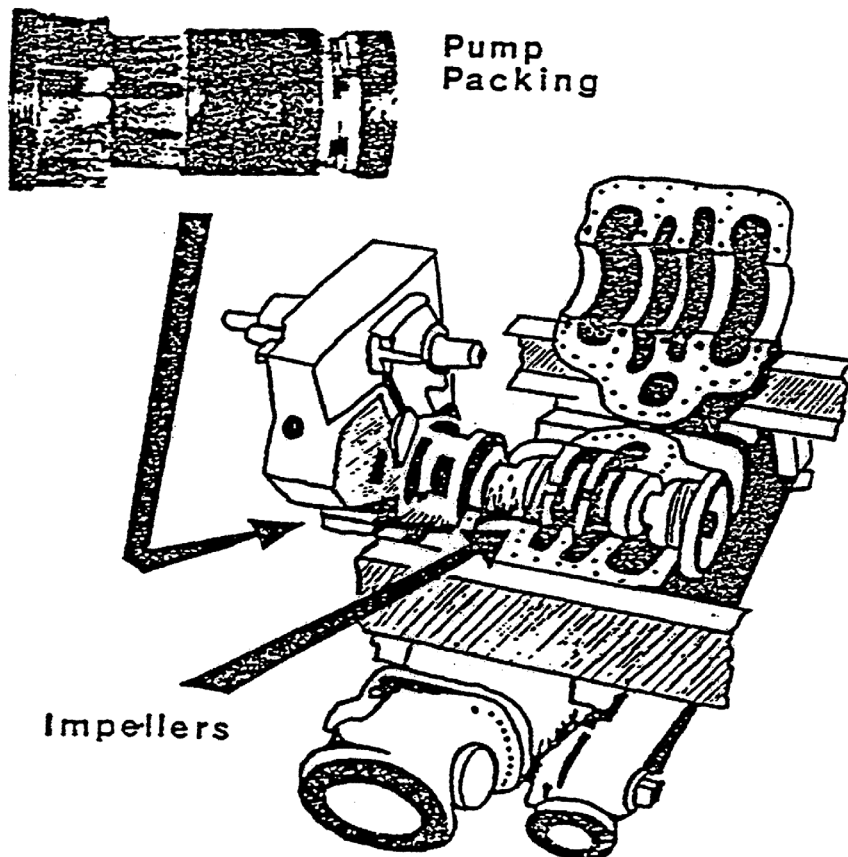
 **Maintenance**

It's interesting to note that many think that water enters a gearbox by following the pump shaft and entering the top of the gearbox through the water and oil seal near the pump shaft gear. Our experience at Hale would indicate that this is probably not the case. Most likely, the water from the packing or from other pump leaks (flanges, fittings, etc.) falls on the input drive shaft. When the shaft is hot, the water is drawn into the pump (almost like a siphon) along the shaft. A rain shield or cover over the input shaft as well as a flinger ring (water-repelling ring) on this shaft will in most cases eliminate the problem. A 2 1/2-inch hose gasket on the input shaft will act as a flinger ring.

While under the apparatus checking the drive unit oil level, it is a good idea to check the driveline bolts. They should be snugged up and the flanges inspected for any signs of wear. Also, check the journals (crosses) and lubricate as required. Remember, if you replace the driveline bolts, always use at least Grade 5 case-hardened bolts. They have three lines on the top.



Priming Systems



A majority of pumping system failures are caused by ancillary equipment, including the pump packing, and not the major pump. Consult the manual for proper adjustment of packing.

The priming systems on all pumpers should be checked and operated at least on a monthly basis. If you carry and use a hard suction hose you should be doing a priming check with the hose attached every six months. A proper priming check is done as follows:

1. Close the discharge gates and remove caps. Close all drains.
2. Remove the suction tube cap and connect the suction hose.
3. Install the cap on the suction hose.
4. Activate the primer and run it until you get 22 inches on your vacuum gage.

CAUTION



Operate primer no more than 30 seconds. Release the primer and stop the engine.

5. Check for leaks. If the pump does not lose more than 10 inches in 5 minutes, your pump and accessories are tight enough to provide good suction capabilities under most conditions.
6. If the pump cannot hold a vacuum, disconnect the suction hose and repeat the above test. If the pump holds vacuum, then the suction hose or suction hose couplings are causing a vacuum leak. Replace hose or gaskets as necessary.
7. Repeat the test with the suction tube capped.
8. If you still have a vacuum leak, listen for air leaks. If none is heard, you might try pressurizing the pump from another pumper (about 150 to 200 psi). Watch for leaks at flanges or pipe junctions.
9. If the leak cannot be found, you might try tightening the packing a bit. Do not tighten packing except as a last resort.
10. Refill the priming oil tank with the proper grade oil before placing the engine back in service. Check to ensure that the small vacuum breaker hole in the priming line near or on the primer tank top is open.
11. On an annual basis, preferably right before the cold season, you should disconnect the lines from your pump to the multidrain and blow them clear with an air gun. This removes any clogs and debris and ensures you of proper drainage of all cavities when you activate the multidrain. Also, this is a good time to change the gearbox oil and run a yearly performance test to determine the overall condition of the pump.

The general maintenance tips shown here are nothing special and should be familiar to you if you have an effective maintenance program in your department. If all this is new to you, then it is time for you to sit down and draw up a workable program

Consult the manufacturer of your pump. Provide them with the pump serial number and they will be able to send you all the information you need to enable you to get your pump on the right track to a long, healthy life.



6.36 Trident Primer Air Switch Connections

Service Bulletin

Trident Emergency Products, LLC
2940 Turnpike Drive, Suite 9
Hatboro, PA 19040



Subject: PRIMER AIR SWITCH CONNECTIONS	Bulletin No: 002
	Issue Date: 31March2008

APPLICABLE PRODUCTS

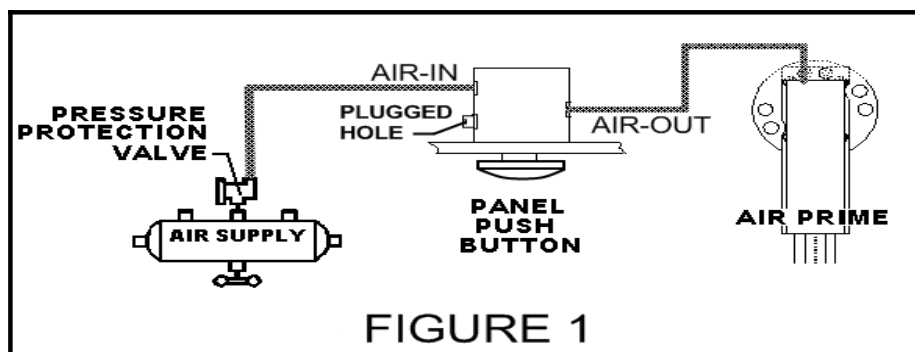
All Trident AirPrime Models controlled with panel mounted air push-button switch. We are advising all customers to visually double-check the air switch **air-in** and **air-out** connections for proper orientation, and switch them if they are incorrect. The switch will initially work either way, but will be more reliable over time when connected the proper way.

DESCRIPTION

The push-button panel air switch is spring-loaded and should move back out to the “closed” position after the operating force to push it is removed. We have seen some switches that do not consistently return to the “closed” position after the push-button is released. This has been due to the way the switch was plumbed when installed. The installation instructions now clearly show which holes in the switch should be used for **air-in** and **air-out** as well as the hole that is permanently plugged. If the switch is connected as shown below the air-in pressure will actually help the spring move the push-button back to the “closed” position.

IDENTIFICATION OF PROPER CONNECTIONS

The figure 1 below shows the **PROPER** connections for the panel mounted air push-button switch:



INSPECTION

Note that the air-switch has two connections on one side and one connection on the other. Check to see that the hole closer to the panel on the side with two connections is **PLUGGED**. Then check to see that the second hole on that side is coming from the air supply, or **AIR-IN**. Finally the connection on the side with one hole should be to the AirPrime which is **AIR-OUT** of the switch.

REPAIR

If the connections are as shown in the figure and INSPECTION paragraph above, no repair is required as the connections are correct. If the connections are not correct, they should be changed to correspond to the Figure 1 orientation which will increase the long term reliability of the air-switch operation.

NOTICE: The information and instructions in this bulletin are intended for use by skilled technicians. All customers should not assume this bulletin applies to their equipment and will develop the described concern.

6.37 Trident Air Prime

Airprime Operation

The Manual Air Prime is operated simply by increasing the engine speed to a maximum of 1000 rpm and depressing the push button on the panel. Hold the button down until the discharge pressure gauge begins to rise. The primer will stop running when the push button is released. Never run a dry pump at engine speeds above 1000 rpm.



Operational (Ramp) Test

The Air Prime integrity and operation can be quickly checked (on a daily or weekly basis) as outlined below:

1. Close all valves, and drains. Cap all suction openings and the outlet of the suction side relief valve (if so equipped).
2. Start the Air Prime with the air tanks fully charged, and the engine running at idle.
3. Verify that the reading on the pump intake gauge reaches an operational vacuum of at least 15 in.-Hg.
4. Stop running the primer.

Annual Priming Tests

There are two tests that should be performed at least on an annual basis, or whenever major repairs or modifications have been made to the pump or plumbing. They are the “Dry Vacuum Test”, and the “NFPA Priming Time Test”.

The **Dry Vacuum Test** checks the primer's ability to produce a 22in.-Hg vacuum, and the pump and plumbing's ability to hold that vacuum.

1. Close all valves and drains. Cap all suction openings and the outlet of the suction side relief valve (if so equipped).



2. Connect a test vacuum gauge or manometer to the intake test gauge connection on the pump panel.
3. Start with the air tanks fully charged, and run the primer until the gauge or manometer indicates 22 in.-Hg or more of vacuum.
4. Watch the gauge. If the vacuum falls more than 10 in.-Hg in 5 minutes, it is a certain indication of at least one air leak. Vacuum leaks may be detected by ear if the engine is turned off. Correct leaks immediately to return the pump to a serviceable condition.

When running this Operational Test at higher elevations, the maximum attainable vacuum should be reduced by 1 in.-Hg for each 1000 feet of elevation over 2000 feet. For example, at 5000 feet elevation, the maximum vacuum is reduced by 3 in.-Hg because the difference between 5000 feet and 2000 feet is 3000.

The **NFPA 1901 Priming Time Test** demonstrates the primer's ability to lift water into the pump and create discharge pressure within the allowable time. This test is also conducted by the apparatus builder prior to delivery. The test is often run as part of an annual pump performance test, and is performed as follows:

1. Set up the apparatus in accordance with the pumping test outlined in the NFPA 1901 standard.
2. Engage the pump, and increase the throttle to a maximum engine speed of 1000 rpm.
3. With the air tanks fully charged, start the primer. Release the push button when a discharge pressure over 20 psig is obtained.
4. The time to prime should not exceed 30 seconds for 1250 gpm and smaller pumps. The time to prime should not exceed 45 seconds for 1500 gpm and larger pumps. An additional 15 seconds is allowed for pumps with auxiliary suction having a volume of 1 cubic foot or more.

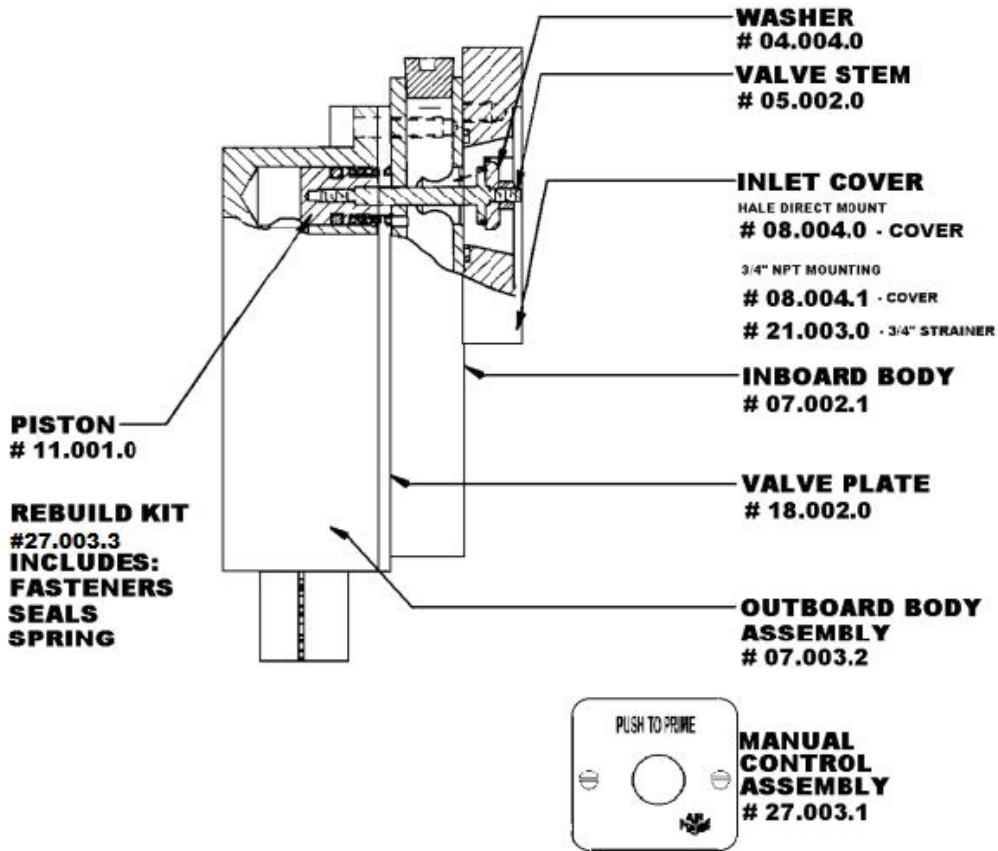


Maintenance

The Air Prime is designed to meet the NFPA requirements. Higher lifts and operating at higher elevations will slow down the time to prime. The air compressor rating for lifts in excess of 15 feet and elevations over 4000 feet must be at least 18.7-CFM. Operation at these extremes may require the primer to be operated at engine speeds in excess of 1000 rpm without spinning the pump, until water reaches the impeller.

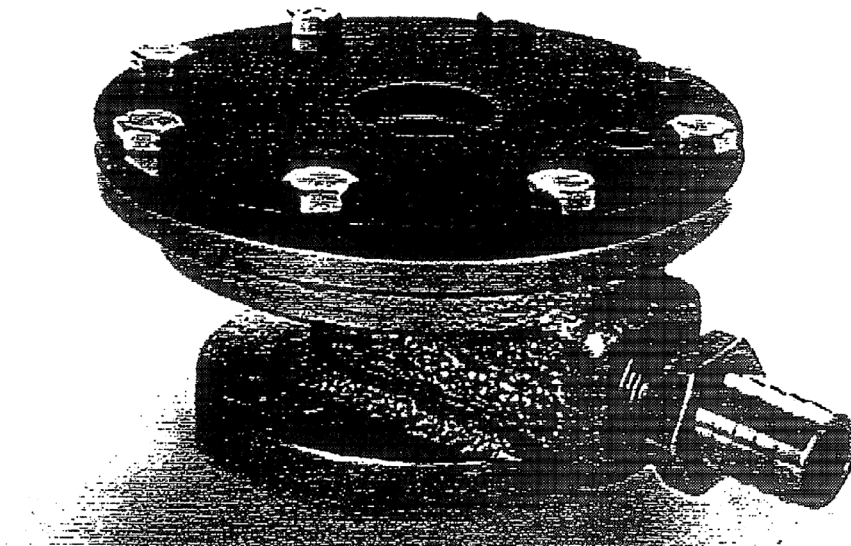
NOTE: Never run a dry pump at engine speeds above 1000 rpm.

Replacement Parts





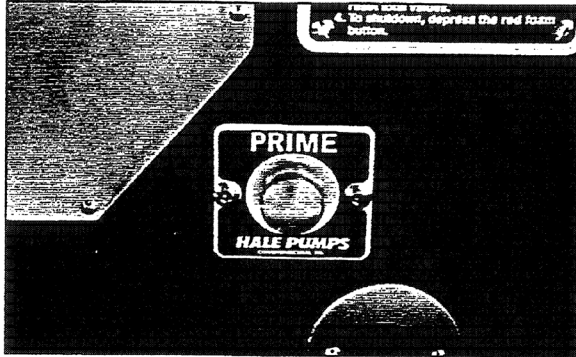
6.38 Hale Fire Pumps



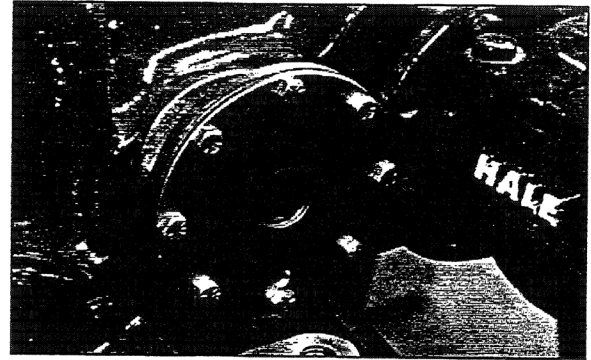
Model SPV Hale Semiautomatic Priming Valve

Hale's new Semiautomatic priming valve, Model SPV, simplifies the priming operation of your pump. The innovative design replaces the standard priming valve while saving space on the pump panel. Easily activated by a push-button control, the electric button activates the primer motor creating a vacuum. The vacuum acts on the diaphragm in the valve causing the port to open to allow priming.

Features



Pump panel push-button activated primer motor



Midship pump valve is premounted to pump body

- Automatic priming valve actuator
- Direct mounted on midship pumps
- Easy installation
- Replaces standard priming valve
- Remote mounted on front mount and PTO pumps
- Saves space on the pump panel
- Push-button operation
- Tested to 600 psi pressure and 29 in Hg vacuum
- Available for retrofit

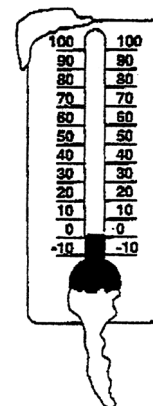


6.39 Freezing Gauges? Never!

If you have SPAN/CLASS 1 GAUGES and follow these simple hints:

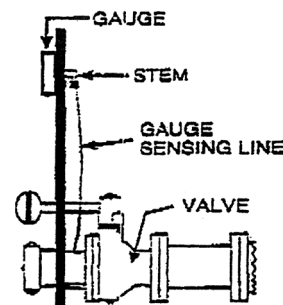
NEWSFLASH...Winter of '93-'94 in a Word - FRIGID!

In some areas of Canada, the Midwest, and Eastern parts of the U.S., the winter of 1993-94 was one of the most severe on record. Temperatures of 20, 30, even 40 degrees below normal were new experiences for fire departments operating in these areas. Needless to say, the cold temperatures caused many problems, not the least of which was a rash of what was described as freezing gauges.



Understanding the Purported Freezing Gauge Problem...

To better understand some of the possible causes of the problems, let's explore what happens between the pump and the gauge. Except for the master gauges, all sensing lines are tapped into the discharge piping downstream of the discharge valve. That's so the sensing line and the gauge only see pressure when the discharge is open. Take a minute to study the drawing of the sensing line routing in the pump enclosure.



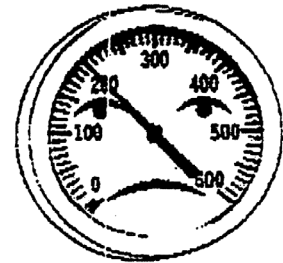
An off-zero pressure gauge reading is an indication that the working part of the gauge has been damaged and the gauge should be repaired or replaced. However, installing a new gauge without determining and correcting the problem may lead to the same damage again. This issue of the FLOW LINE describes some of the causes of the wandering or stuck pointers and offers suggestions to prevent re- occurrences of the problems.

Here's a Quick Summary of this FLOW LINE ...

Pump panel pressure gauge pointers stuck at other than zero (200 to 300 to 400 psi or higher) could be caused by any of the following:

Maintenance

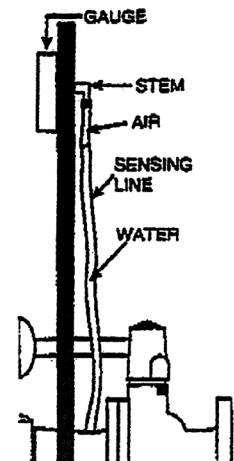
1. The sensing lines froze while pumping because the pump enclosure was too cold.
2. Low spots exist in your sensing lines that trap water and freeze (even when you are not pumping).
3. The working part of the gauge (the Bourdon tube) deformed because it contained water, which froze when the gauge temperature dropped below freezing (it was not a SPAN/Class 1 Fire Gauge).
4. A water hammer occurred when a valve or valves flowing high volumes of water were closed very rapidly (slammed shut), thereby causing a momentary, but sizable jump in pressure.



Woe is me -
I'm stuck at 200 PSI!!!

Charging a Discharge Line Fills Sensing Line...

When the discharge valve is opened, water rushes through the sensing line pushing a slug of air toward the gauge (this is just like the first slug of air that is heard when a hydrant supply line is opened). Once the pressure has stabilized, there is little or no movement in the water line.

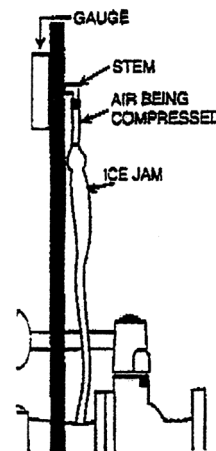




Ice Jams Can Form in Sensing Lines Even While Pumping...

In the winter of '93-'94, there were many instances where the temperatures in fire truck pump enclosures were much lower than ever before, allowing the water in the sensing lines to freeze. When this happened, an ice jam was created, which expanded toward the gauge compressing the ever present air slug.

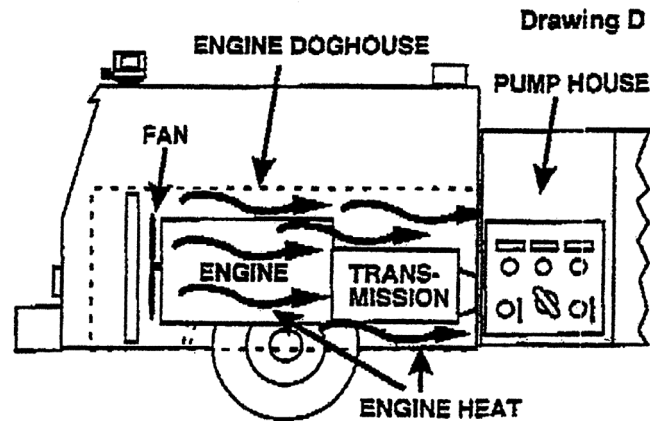
Since air is compressible, the ice jam kept forcing (compressing) the air into a smaller area.



This raised the pressure at the instrument two to three times higher than the maximum rated pressure for that gauge. Once the internal pressure exceeded the pressure on the face of the gauge, permanent deformation of the Bourdon tube (the working element) occurred. With the Bourdon tube deformed, the needle did not return to 0 (it was stuck at some pressure reading). The gauge must then be repaired or replaced.

The point is...it was the sensing line that froze, not the gauge. Any manufacturer's gauge can experience an overpressure condition from the compressed air/water mixture. With a SPAN/Class 1 gauge, there is no water in the stem or Bourdon tube because of our Sub-Z II feature.

6.40 Three Ways to Eliminate the Sensing Line Freeze-up Problem...



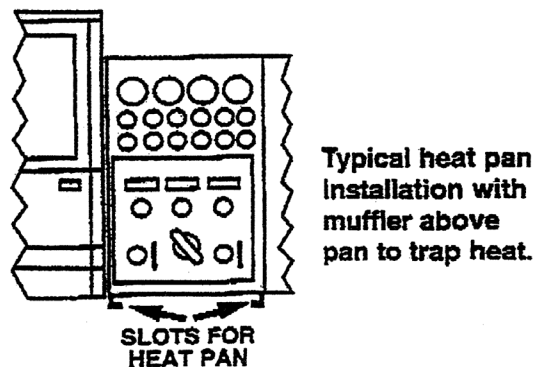
With pumps located directly behind the engine and with more typical winter temperatures, the engine heat keeps components sufficiently warm to prevent freezing. Since you probably cannot move the pump closer to the engine on an existing fire truck, let's examine ways to prevent freezing the sensing lines.

Use Heat Tape

Perhaps the easiest fix is to install a heat tape along the entire length of the sensing line. Be certain to install it strictly in accordance with the manufacturers' directions and don't forget to protect the stem at the back of the gauge.



Install Heat Pans

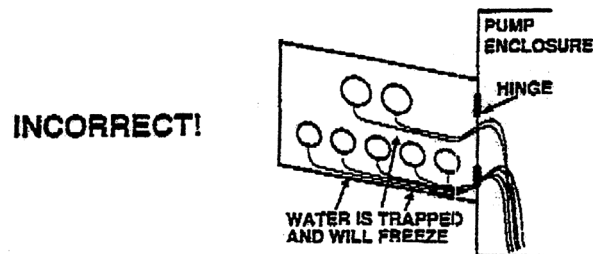
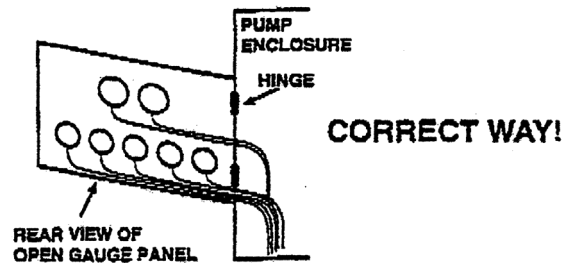


Where temperature extremes are the norm (such as below 0°F for extended periods), metal heat pans can be installed under the pump enclosure to contain engine and exhaust heat. They are relatively easy to install by the apparatus builder or by a reasonably competent mechanic. They do a very good job of keeping the pump and plumbing warm in all but the coldest temperatures. Heat pans should be made so they can be removed in the summer to free circulation of cooling air. Please note, it may require a combination of both heat pans and heat tapes to prevent sensing line freeze-up.

Install Pump Compartment Heaters

If you already have a heat pan that did not keep the pump house warm enough, you might want to consider installing a hot water heater similar to what is in the apparatus cab. This uses engine hot water to circulate through coils in the heater and a fan to transfer this heat to the pump house.

6.41 Three Other Ways Gauges Can Be Overpressurized Trapped Water That Freezes

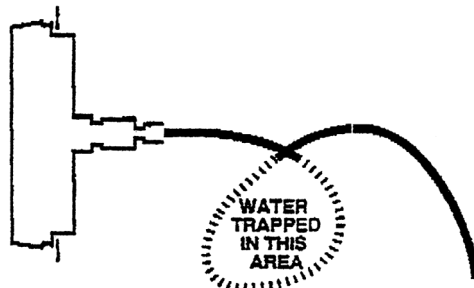


Loops and low spots allow water to be trapped in the sensing lines. This trapped water can then freeze (whether or not you are pumping) and allow ice jams to compress the air slugs and overpressurize the gauge.

With some installations, finding the low spots can be a real challenge. As a start, if your apparatus has a hinged pump panel, it is likely that all the gauge sensing lines are directed to the hinge area before they drop down to the individual discharges. If proper installation techniques were used, the lines point downward and continue downward from each gauge, so they will be evacuated when the pump is drained. However, sometimes they are run uphill to the hinge and then drop down. This traps water in the line, which will then freeze when the temperature drops.

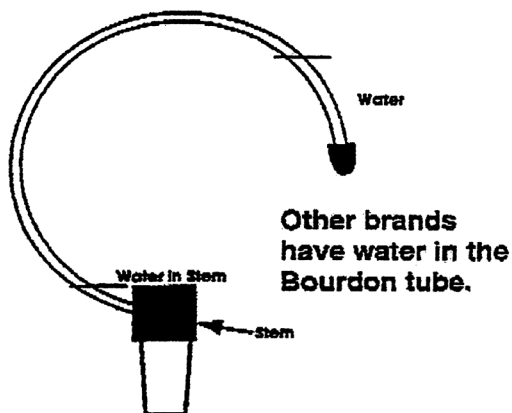


6.42 Remove Loops and Low Spots



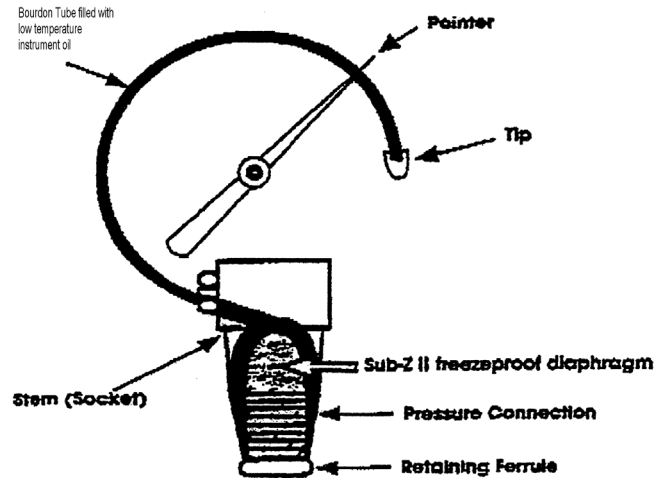
Loops are generally more evident and usually easy to correct. Some of the older installers fall back to an old wives tale that looping a line as it enters the gauge will absorb pressure surges and prevent water hammer. It's just that; an old tale that has no basis in fact. Find and eliminate the loops before you install your new SPAN/CLASS 1 gauge!

Water in the Bourdon Tube



With a gauge that is not made by SPAN/Class 1 (low bid, imported varieties, and others), water actually enters the Bourdon tube and becomes trapped in the tip and part of the stem. This trapped water could freeze causing permanent damage to the gauge.

6.43 Use Only SPAN/Class 1 Gauges



All SPAN/Class 1 fire gauges have our exclusive Sub-Z II feature, which uses a durable diaphragm as a barrier to prevent water from entering the gauge. This eliminates damage due to ice formation in the Bourdon tube. The Sub-Z II also keeps out dirt, rust, and mineral deposits to increase the life of the gauge.

Pressure Spikes From Water Hammers

Rapid and severe spikes in pressure can sometimes deform the Bourdon tube requiring the replacement of the gauge. Span/Class 1 gauges are much more forgiving than ones made by other companies because our fire gauge cases are filled with silicone. The Bourdon tubes contain low-temperature oil and there is a resistor in the stem to retard the movement of oil into the tube. However, that does not completely immunize them from this problem. Water hammers are rapid spikes in pressure generally caused by slamming a valve or nozzle closed, thereby stopping large volumes of water almost instantaneously. This sends a pressure wave to the hose, supply pump, plumbing, and any associated water piping, including street water mains.



6.44 Teach Good Pump Operator Techniques

Teaching and promoting good pump operation techniques is absolutely the best way to prevent water hammers. If you have valves on your engine that are larger than 2 1/2 inches, you should consider retrofitting them with a slow close/open feature to reduce or eliminate the shock that occurs when high volume valves are closed rapidly.

6.45 About Class 1

SPAN/Class 1 gauges are designed and manufactured in Plano, Texas USA by firefighters to standards set by the American Society of Mechanical Engineers, American National Standards Institute (ASME ANSI) (ASME B40.1 1991), and the Fire Department Apparatus Committee of the National Fire Protection Association (NFPA). Our company personnel belong to, and participate with, ASME, ANSI, and NFPA, as well as the Fire Apparatus Manufacturers' Association.

We welcome any suggestions for new instrumentation and for the improvement of our existing product. Please call us on our toll free Flow Line. 1-800-FLOW

6.46 Akron Swing-Out Valve



AKRON SWING-OUT™ VALVE INSTALLATION AND OPERATING INSTRUCTIONS

INSTALLATION INSTRUCTIONS

A. GENERAL GUIDELINES

The Swing-Out valve can be installed in either direction. All Swing-Out valves have two Seats and will hold pressure or vacuum in either direction.

1 1/2" through 3 1/2" Swing-Out Valves are designed to withstand hydrostatic pressures up to 500 psi. The 1" Valve is designed to withstand hydrostatic pressures up to 1000 psi.

Each Valve is factory tested in both directions. Therefore, if possible, do not disassemble the valve before installation. If it is necessary to disassemble the valve, verify the Valve is in the open position before removing the Flange Bolts. When reassembling the Valve, the Ball must be in the closed position before tightening the Flange Bolts. If the Valve position is not known, the groove in the top of the Handle Trunnion should be noted. The groove indicates the direction of the waterway.

3" valves are now protected with plastic end caps when they leave the plant. These are intended to prevent debris from entering the valve during transport, storage and installation. They should not be removed until necessary. Even after one cap has been removed to install the valve onto a pump module, the other cap should remain until downstream fittings are to be installed.

Drilling an extra hole in the R-1 Handle will not adversely affect the strength of the Handle. However, placing the actuator too close to the center of the Valve can adversely affect the Valve's operation. When using Remote Control Rods, Akron Brass recommends the distance between the centerline of the Valve Trunnion and the centerline of the Handle hole be at least 5" for 2 1/2" - 3 1/2" Valves.

⚠ CAUTION: The Valve is configured for optimum performance. Do not alter in any manner.

⚠ CAUTION: When installing threaded Adapters, always use a wrench on the Adapter adjacent to the pipe being connected. DO NOT TIGHTEN THE PIPE WITH A WRENCH ON THE VALVE BODY, OPPOSITE ADAPTER OR PIPE AT THE OTHER END OF THE VALVE. The Flange Bolts are not designed to withstand the stress of tightening pipes.

⚠ CAUTION: Foreign material, such as metal chips from welding, left in the plumbing can jeopardize the sealing capability of the valve. To avoid valve failure, the pump and entire system should be flushed before the valves are installed.

If a valve fails testing and can be flushed with water prior to removal, it should be cycled a few times and re-tested. Flushing the valve can remove debris that may be preventing the ball and seat from sealing properly. If it is suspected that the seats are damaged or otherwise faulty they should be replaced. Upon removal of the faulty seats care should be taken to prevent causing further damage to the seats so that they can be analyzed upon return to Akron Brass.

DO NOT DRILL OR TAP HOLES IN THE PIPING ONCE THE VALVE HAS BEEN INSTALLED.

Be sure the water used to flush the system does not have debris that may cause damage to the Ball or Seats.

B. CHANGING THE HANDLE POSITION

The handle position on Swing-Out Valves with manual Handles (R-1, TS, TSC or SZ) can be easily adjusted to any one of 8 different positions by removing and repositioning the Handle. Repositioning the Stop Plate can make additional adjustments to the Handle position.

109896



C. SZ HANDLE ADJUSTMENT

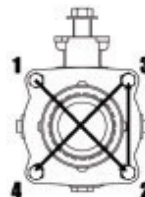
The Bolt on top of the Valve that secures the SZ handle must not be over tightened. To adjust, turn the Handle to the fully unlocked position. Then tighten until a slight drag is felt while opening and closing the Valve. The Valve should lock within 2 turns of the Handle Knob. Additional adjustments may be necessary to compensate for future wear. Always be sure the handle is tightened whenever the Valve is left partly open.

Adapter Torque Requirements

Following are torque requirements for attaching Adapters to 1" - 3 1/2" Valves:

Valve Size	Torque
1"	100-120 inch pounds
1 1/2"	216-240 inch pounds
2" & 2 1/2"	25-30 foot pounds
3" & 3 1/2"	38-40 foot pounds

Bolts should be tightened evenly in a diagonal sequence



OPERATING INSTRUCTIONS

1 1/2" through 3 1/2" Swing-Out Valves are designed to operate at pressures up to 250 psi. The 1" Valve is designed for pressures up to 500 psi.

- ⚠ **CAUTION:** Always open and close valves slowly to avoid water hammer. NFPA 1901 Standards specify a minimum of 3 seconds is required to open or close any 3" or larger discharge valve. Akron's Slo-Cloz™ device, as well as Electric and Manual Actuators, when installed on Akron Swing-Out Valves will help meet this requirement.

MAINTENANCE INSTRUCTIONS

- ⚠ **CAUTION:** Do not lubricate the Ball or Seats. Lubricants can collect dirt and grit, which can cause excessive wear.

Water is a natural lubricant. Periodic actuation of the valve will help prevent sticking. Periodic Flushing is recommended to remove dirt and debris which may cause excessive Valve wear and premature failure.

Field Service Kits

If it becomes necessary to repair a Swing-Out Valve, Akron offers the following Kits:

Valve with white Norkalon™ Ball	Kit*	Valve with Metal Ball	Kit without Ball**	Kit with Ball
1"	9135	1"	9208	8803
1 1/2"	9136	1 1/2"	9209	8804
2"	9137	2"	9204	8805
2 1/2"	9138	2 1/2"	9205	8806
3" & 3 1/2"	9139	3" & 3 1/2"	9206	8807

*These Kits include a new Norkalon Ball.

The 8803-8807 Kits can also be used to change to a Metal Ball.

**Often, the valve can be rebuilt by replacing the Seats only. Thus saving time and cost.



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Available in Canada through AKRON MANUFACTURING COMPANY
PHONE: 519.773.8431 | FAX: 519.773.3794

REVISED 8/07

WARRANTY AND DISCLAIMER: We warrant Akron Brass products for a period of five (5) years after purchase against defects in materials or workmanship. Akron Brass will repair or replace product which fails to satisfy this warranty. Repair or replacement shall be at the discretion of Akron Brass. Products must be promptly returned to Akron Brass for warranty service. We will not be responsible for: wear and tear; any improper installation, use, maintenance or storage; negligence of the owner or user; repair or modification after delivery; damage; failure to follow our instructions or recommendations; or anything else beyond our control. WE MAKE NO WARRANTIES, EXPRESS OR IMPLIED, OTHER THAN THOSE INCLUDED IN THIS WARRANTY STATEMENT, AND WE DISCLAIM ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. Further, we will not be responsible for any consequential, incidental or indirect damages (including, but not limited to, any loss of profits) from any cause whatsoever. No person has authority to change this warranty.

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6.47 Akron Style 7875 Slo-Cloz



STYLE 7875 SLO-CLOZ FOR USE ON 7820-7835 AND 8820-8835 SWING-OUT™ VALVES INSTALLATION AND ADJUSTMENT INSTRUCTIONS

The Akron Brass Slo-Cloz device is designed for installation on 2" through 3 1/2" Akron Swing-Out Valves with self locking handles (R-1 and TS Handles).

The Slo-Cloz mechanism bolts to the top of the Valve above the Handle. Before attempting to install the Slo-Cloz, be sure there is enough room above the Valve to allow the unit to be installed. Once installed, the Slo-Cloz will add 1 1/2" to the Valve height.

INSTALLATION

Note the position of the Bleed Screw (#1) on the top of the Slo-Cloz, the 4 Pins on the bottom of the unit and the 4 holes in the underside of the "skirt" of the Slo-Cloz. The Bleed Screw should be positioned opposite of the Set Screw (#2).

1. Locate the Roll Pin (p/n 7-84-088) found in the plastic bag.
2. Open the Valve half way.
3. Remove and discard the Bolt and Washer securing the Handle but do not remove the Handle.
4. Place the Slo-Cloz on the Valve handle with the 4 Pins fit into the empty cavities of the star pattern on the Handle. The Bleed Screw should be either over the Handle or 45° to either side.
5. Visually match up one hole in the "skirt" of the Slo-Cloz with a hole in the Handle assembly. (Depending on the type of Valve, the hole may be in the Trunnion Retaining Plate or in the Valve Body.)
6. Remove the Slo-Cloz and install the Roll Pin in the matching holes noted above and reinstall the Slo-Cloz.
7. Install the new Washer and longer Bolt and tighten.

Installation of the Slo-Cloz is now complete. Operate the Valve handle from fully open to fully close to be sure the Valve is operating properly.

Troubleshooting:

Be sure the Bleed Screw is within 45° of the Handle. If the Handle is hitting the side of the Slo-Cloz Body relocate the Roll Pin.

110005



ADJUSTMENT INSTRUCTIONS

The Slo-Cloz device is designed to retard the speed on manual valves. Each Slo-Cloz is factory set to go from full open to full close in no less than 5 seconds and no more than 12 seconds. It is not recommended the retardation capability be increased in the field.

Due to various applications such as valve size, handle type and length, linkage, water pressure and other factors, it may be necessary to reduce the retardation.

The retarding capability of the unit is determined by the position of the Adjustment Plug (#3) located on the boss extending from the body. Note the "indents" on the edge of the face of the Adjustment Plug and the "X" stamped on the Body. These 2 marks should be in line. This marks the maximum setting on the unit. To reduce the retardation, the Adjustment Plug can be turned counterclockwise. The further the Adjustment plug is turned the less the retardation. The 2 "indents" to the left of the "X" are for reference. It is not recommended the device be retarded past these marks.

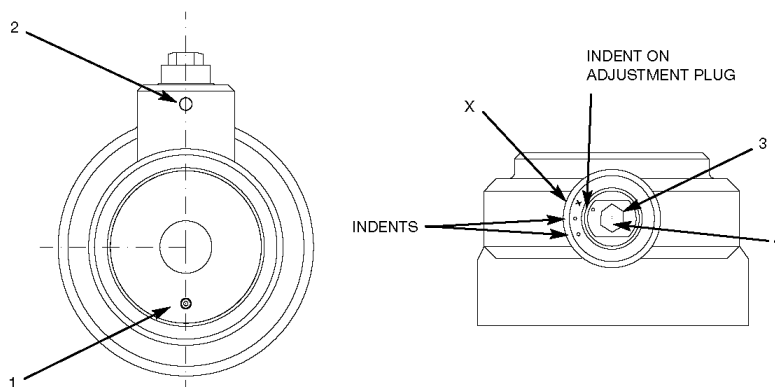
ADJUSTMENT PROCEDURE

1. Be sure the Slo-Cloz is properly installed on the Valve.
2. Loosen the Set Screw (#2).
3. To decrease the retarding force, turn the Adjustment Plug counterclockwise.
4. Once the desired setting is achieved, retighten the Set Screw.

Note: Do not use a wrench on the Hex Plug (#4) while adjusting the Adjustment Plug

MAINTENANCE

Under normal conditions, the Slo-Cloz device does not require maintenance. If maintenance is required, contact Akron Brass Customer Service.



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REVISED 03/04

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We will not be responsible for: wear and tear; any improper installation, use, maintenance or storage; negligence of the owner or user; repair or modification after delivery; damage; failure to follow our instructions or recommendations; or anything else beyond our control. WE MAKE NO WARRANTIES, EXPRESS OR IMPLIED, OTHER THAN THOSE INCLUDED IN THIS WARRANTY STATEMENT, AND WE DISCLAIM ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. Further, we will not be responsible for any consequential, incidental or indirect damage (including, but not limited to, any loss of profits) from any cause whatsoever. No person has authority to change this warranty.

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**WALK-AROUND CHECKS
FOR MOBILE FIRE APPARATUS**

Fire Department Name:	Date:	Special Instructions:
Truck Model:	HS #:	
Truck Number:	Station #:	
Start Mileage:	Start Engine Hours:	
End Mileage:	End Engine Hours:	

Legend: Rec Min. = Recommended Minimum Interval for Inspection

OPERATIONS	Daily	Weekly	Monthly	6 Months	Annual
Engine – Tilt Cab – Make sure safety prop is engaged and there are no obstructions on the bumper or in the cab.					
1. Check engine oil and transmission level. Check for leaks (see Manual).	Rec Min.				
2. Check engine coolant level – sight glass. Check for leaks.	Rec Min.				
3. Check for integrity of frame and suspension, as well as motor assembly and mount. Check for loose bolts.			Rec Min.		
4. Check power steering fluid level and look for leaks at fitting or hoses. Transynd	Rec Min.				
5. Check belts for tightness and wear.	Rec Min.				
6. Check steering shafts.			Rec Min.		
7. Check for exhaust leaks. Check heat shields are in place.			Rec Min.		
Outside					
1. Check for fluid leaks under vehicle.	Rec Min.				
2. Check steering shafts and linkages.			Rec Min.		
3. Check wheels and lug nuts for tightness.			Rec Min.		
4. Check tire condition. – Tread Depth. (wear/damage)	Rec Min.				
5. Check tire air pressure.	Rec Min.				
6. Verify all warning label & placards are in place (see Manual).		Rec Min.			
7. Check driveline U-joints and slip joints. Lubricate if necessary. Check for tightness on all universal bolts. Visual check.			Rec Min.		
Cab – lower cab					
1. Check seats and seat belts (damage/warning system) and ensure working properly.	Rec Min.				
2. Start engine, check all gauges, switches, & controls.	Rec Min.				
3. Check windshield wipers & washer fluid level check	Rec Min.				
4. Check rear view mirrors adjustment and operation. R & L	Rec Min.				
5. Check horn, air horn, siren and backup alarm.	Rec Min.				
6. Check all gauges for correct reading after start. Fuel Level Check.	Rec Min.				
7. Check cab glass and mirrors.	Rec Min.				
Body					
1. Check steps and running boards. (damage/loose hardware)	Rec Min.				
2. Check body condition. (doors/latching)	Rec Min.				
3. Check grab handles. (hardware tight secure)	Rec Min.				
Electric					
1. Check battery voltage and charging system voltage, 13 +VDC.	Rec Min.				
2. Check all lights (ICC and warning); headlights.	Rec Min.				

OPERATIONS	Daily	Weekly	Monthly	6 Months	Annual
3. Check operation of battery charger and receptacle.	Rec Min.				
Brakes					
1. Check air system for proper air pressure. (see tech manual)	Rec Min.				
2. Check parking brake operation.	Rec Min.				
3. Check air compressor operations. Cut in _____ Cut out _____	Rec Min.				
4. Check hoses or lines for rubbing.			Rec Min.		
5. Drain wet air tank to make sure air dryer is working properly			Rec Min.		
Pump					
1. Operate pump, check pump panel engine gauges.	Rec Min.				
2. Check pump for pressure operation.	Rec Min.				
3. Check discharge relief or pressure governor operation.	Rec Min.				
4. Check all pump drain valves.		Rec Min.			
5. Check all discharge and intake valve operation.		Rec Min.			
6. Check pump and tank for water leaks.		Rec Min.			
7. Check all valve bleeder/drain operation.		Rec Min.			
8. Check primer pump operation.			Rec Min.		
9. Check system vacuum hold.			Rec Min.		
10. Check water tank level indicator.	Rec Min.				
11. Check primer oil level (if applicable).		Rec Min.			
12. Check transfer valve operation (if equipped).			Rec Min.		
13. Check booster reel operation (if equipped).		Rec Min.			
14. Check all pump pressure gauge operation.	Rec Min.				
15. Check all cooler valves.			Rec Min.		
16. Check for oil leaks in pump area.	Rec Min.				
17. Check oil level of pump transmission.			Rec Min.		
18. Check hour meter operation (If equipped)	Rec Min.				
19. Check operation of valve linkage.	Rec Min.				
20. Check ball valves for leaks.		Rec Min.			
21. Check drain valves.		Rec Min.			
Generator					
1. Operations – Hydraulic, Gas, or Diesel	Rec Min.				
2. Fluid levels	Rec Min.				
3. Breakers, Receptacles, lighting for operations		Rec Min.			
4. Voltage Reading, 240V AC		Rec Min.			
Amp Reading		Rec Min.			
HTZ Reading, 60HTZ		Rec Min.			
Aerial Devices (AERIAL TRUCKS ONLY BELOW)					
1. Visually inspect aerial structure, slide blocks, cables, sheaves, lacing bolts/ huck bolts and any moving assembly.		Rec Min.			
a. Sheaves – lubed and look for signs of wear		Rec Min.			
b. Slide blocks – all in place (no visible signs of excess wear or damage)		Rec Min.			
2. Check aerial operation – all controls, bucket & pedestal.		Rec Min.			
3. Elevation cylinder, check for leaks & wiper seal (check RAM for pits and/or damage).		Rec Min.			
4. Extension cylinder, check for leaks & wiper seal (check RAM for pits and/or damage).		Rec Min.			
5. Lines & hoses – check for leaks and cuts.		Rec Min.			
6. Check aerial hour meter operation and record hours.		Rec Min.			

OPERATIONS	Daily	Weekly	Monthly	6 Months	Annual
7. Check breathing air system.		Rec Min.			
8. Cable adjustment not too tight and not too loose check all cables and sections. Review tolerance. (See directions in manual)			Rec Min.		
9. Observe operation of cable track system check for debris and/or damage.		Rec Min.			
Waterway					
1. Check waterway system operation, alignment, and check for damage.		Rec Min.			
Hydraulic System					
1. Check aerial hydraulic fluid level. Dextron III		Rec Min.			
2. Check high pressure filter under load to ensure it is still in the green and not in bypass as well as return the filter.		Rec Min.			
3. Turn on auxiliary hydraulic power pump – check operation.		Rec Min.			
Turntable					
1. Operate aerial hydraulics + PTO operation (check for leaks or damaged hoses). Verify Indicator Light is functional.		Rec Min.			
2. Rotation		Rec Min.			
3. Rotation hydraulic swivel, check for leaks		Rec Min.			
4. Lines and hoses (for leaks & cuts)		Rec Min.			
5. Pivot pin bolts tight on boom to turn table pivot bearing plate (Heal Pin).			Rec Min.		
6. Check manual overrides.			Rec Min.		
7. Check cradle alignment light and mounting.		Rec Min.			
8. Check pinion and rotation bearing (Winsmith/rotation drives).			Rec Min.		
Turntable Components or Hydraulic Compartment					
1. Safety signs			Rec Min.		
2. Communication system or intercom		Rec Min.			
3. Interlock systems - operational		Rec Min.			
4. High-speed button operational		Rec Min.			
Platform/Bucket					
1. Leveling cylinders, leaks and wiper seal		Rec Min.			
2. Lines and hoses, cuts & leaks		Rec Min.			
3. Check operation of high speed.		Rec Min.			
4. Check operation of intercom system		Rec Min.			
Platform/Bucket (continued)					
5. Check breathing air system in platform - check for leaks and hose condition		Rec Min.			
6. Inspect monitors/turret for operation		Rec Min.			
7. Verify cab avoidance system is operational		Rec Min.			
8. Verify bucket leveling system is operational		Rec Min.			
9. Verify all accessories are secure in the platform		Rec Min.			
Structural Fasteners - See Manual for Reference					
1. Turntable mounting bolts - visual check for tightness				Rec Min.	
2. Chassis Suspension system bolts – visual check for tightness				Rec Min.	
Stabilizers					
1. Check aerial outrigger operation		Rec Min.			
2. Check aerial jack & rotation interlocks for operation		Rec Min.			
3. Indicator lights working		Rec Min.			
4. Jack pads in proper location & serviceable		Rec Min.			
5. Mounting bolts – visual check for tightness		Rec Min.			
6. Verify safety lock pins operation in aerial jacks and in location		Rec Min.			

OPERATIONS	Daily	Weekly	Monthly	6 Months	Annual
7. Cylinders – check for leaks & wiper seals		Rec Min.			
8. Control valve – smooth operation		Rec Min.			
9. Lines & hoses – check for leaks and cuts		Rec Min.			
10. Diverter valve – check for leaks		Rec Min.			
Lubrication					
Grease Parts and Assemble as Required per the Trucks Maintenance Manual:					
1. Sheaves - Min. Wkly or more if hours of operation dictate		Rec Min.			
2. Cables, wipe down with oil, ATF/Dextron III		Rec Min.			
3. ProOne Grease on boom section, Review and add where needed per manual		Rec Min.			
4. Rotation gear and bearing				Rec Min.	
5. Rotation gear reduction box				Rec Min.	
6. Extension cylinder pins, grease pivot				Rec Min.	
7. Stabilizer extension cylinder pins				Rec Min.	
8. Aerial waterway pipe sections, wipe with ATF/Dextron III		Rec Min.			
9. Grease turret guns		Rec Min.			
10. Lightly apply ATF/Dex III to Cable trough sections - Do Not Over Apply		Rec Min.			
Indicators					
1. Validate rung alignment operation; pedestal and bucket		Rec Min.			
2. PTO engaged in cab		Rec Min.			
3. Aerial alignment light for cradle bedding		Rec Min.			
4. Elevation/inclometer in bucket		Rec Min.			
5. Inclometer in turntable area for truck level.		Rec Min.			
Comments:					



FAMILY OWNED
SINCE 1890

Draining & Winterizing Trucks

It is critical, especially during the cold months, to exercise caution when it comes to leaving trucks outside, transporting trucks, or accepting trucks into our possession. Anyone who gets behind the wheel of a truck is responsible for ensuring the truck is properly drained and stored.

Sutphen Guidelines for Draining and Winterizing Trucks

1. Communicate to all that water and foam tanks must be emptied prior to dropping any truck off to Sutphen for service.
2. Drain all trucks left outside completely, including water tanks, pumps, gauges and valves.
3. Ensure all valves (outboard and inline) are open 50% to drain trapped water.
 - Use caution if valve appears to be frozen in place; do not force a valve open or closed. Trucks may need warmed-up prior to operating frozen valves.
4. Run "RV antifreeze" through the foam pump and systems immediately after foam testing (approx. 3 gal.) from October through April.
5. Any truck being "Road Tested" needs to have all valves and drains open 50% to drain any trapped water. After road testing, the tank fill needs to be opened 100% to allow draining back into the pump. Ensure tank fill is turned back to 50% open after tank has fully drained back into the pump.

Please ensure everyone is fully aware of the expectations and follows the same guidelines. Thank you for your cooperation and dedication to avoiding costly repairs.



Chapter 7 Troubleshooting

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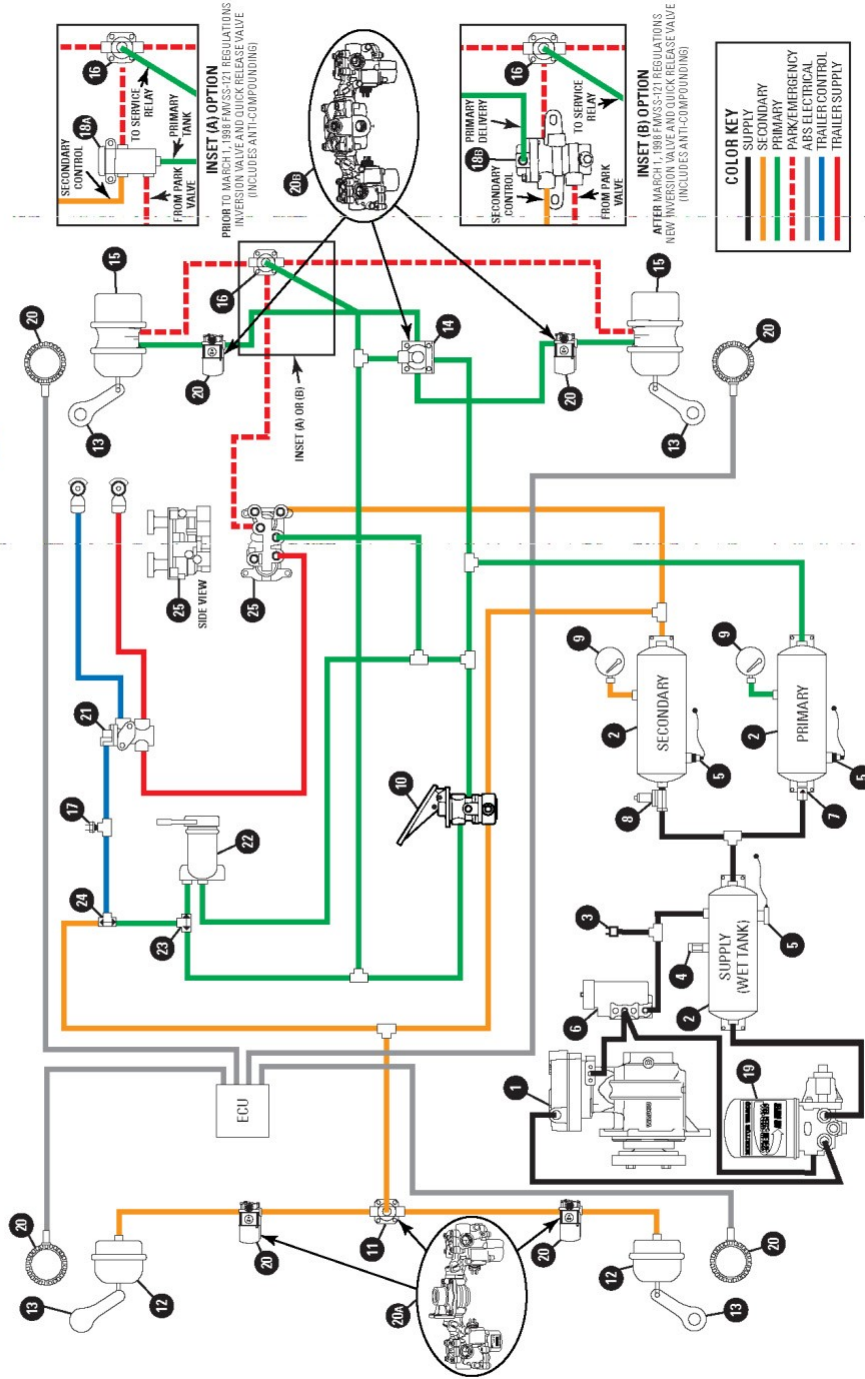

Troubleshooting
7.1 Air System Troubleshooting

PROBLEM	POSSIBLE CAUSE	REMEDY
A. Air pressure too low	<ol style="list-style-type: none"> 1. Defective air pressure gauge 2. Excessive leakage 3. Air reservoir drain cock open 4. Air compressor drive 5. Defective or improperly adjusted governor 	<ol style="list-style-type: none"> 1. Replace gauge 2. Locate and correct leak 3. Close drain cock 4. Adjust or replace drive 5. Adjust, repair, or replace governor
B. Air pressure too high	<ol style="list-style-type: none"> 1. Defective air pressure gauge 2. Defective or improperly adjusted compressor governor 	<ol style="list-style-type: none"> 1. Replace gauge 2. Adjust, repair, or replace governor
C. Air pressure rises to normal too slowly	<ol style="list-style-type: none"> 1. Excessive leakage 2. Engine speed too low 3. Compressor discharge valves leaking 4. Worn compressor 	<ol style="list-style-type: none"> 1. Locate and correct leakage 2. Increase engine speed 3. Clean and/or lap valves and valve seats 4. Replace compressor
D. Air pressure drops quickly with engine stopped and brakes released	<ol style="list-style-type: none"> 1. Leaking tubing or hoses 2. One-way check valve stuck open or leaking 3. Compressor discharge valve leaking 4. Compressor governor leaking 5. Reservoir leaking 6. Reservoir drain cock leaking 	<ol style="list-style-type: none"> 1. Locate leak and repair or replace tube or hose 2. Repair or replace check valve 3. Repair or replace valve 4. Repair or replace governor 5. Repair or replace reservoir 6. Repair or replace drain cock
E. Air compressor knocks continuously or intermittently	<ol style="list-style-type: none"> 1. Loose drive pulley 2. Worn bearings 3. Excessive carbon deposits in compressor cylinder head 4. Worn compressor 5. Inadequate lubrication to air compressor 	<ol style="list-style-type: none"> 1. Tighten or replace pulley 2. Replace air compressor 3. Clean cylinder head 4. Replace compressor 5. Check oil passages to compressor for oil flow
F. Excessive oil or water in system	<ol style="list-style-type: none"> 1. Air reservoirs must be drained more often 2. Compressor passing excessive oil 3. Dirty compressor air filter 	<ol style="list-style-type: none"> 1. Drain daily 2. Repair or replace compressor 3. Clean or replace element
G. Service brakes do not release	<ol style="list-style-type: none"> 1. Defective service brake control valve 2. Restricted tubing or hose 	<ol style="list-style-type: none"> 1. Repair or replace control valve 2. Locate and correct restriction
H. Parking brake will not release	<ol style="list-style-type: none"> 1. Defective Maxi-Brake 2. Low air pressure 3. Faulty parking brake control 4. Restricted or clogged air line to spring brake chamber. 5. Incorrect Maxi-Brake linkage adjustment 	<ol style="list-style-type: none"> 1. Repair or replace Maxi-Brake 2. See Air Pressure Too Low 3. Repair or replace control valve 4. Clean or replace air line 5. Adjust Maxi-Brake linkage
I. Parking brake will not apply	<ol style="list-style-type: none"> 1. Defective Maxi-Brake 2. Defective parking brake control valve 3. Restriction in air line 4. Maxi-Brake linkage improperly adjusted 	<ol style="list-style-type: none"> 1. Repair or replace Maxi-Brake 2. Repair or replace valve 3. Clean or replace air line 4. Adjust brake linkage



MERITOR WABCO

Tractor Troubleshooting Guide



ISSUED 10/99 TP-9973

Tractor Troubleshooting Guide

CONDITION/REMEDY	CONDITION/REMEDY	CONDITION/REMEDY	
<p>1 COMPRESSOR</p> <ul style="list-style-type: none"> FOR TROUBLESHOOTING INFORMATION REFER TO THE OEM OPERATING INSTRUCTIONS. Check oil level. NOTE: In the Maintenance Manual, 31 (298 Compressor for Mack C Dash Engines) or contact the Mentor Customer Support Center for additional information. <p>2 SUPPLY, PRIMARY AND SECONDARY AIR TANKS</p> <ul style="list-style-type: none"> FOR TROUBLESHOOTING INFORMATION REFER TO THE OEM OPERATING INSTRUCTIONS. <p>3 LOW PRESSURE INDICATOR SWITCH</p> <ul style="list-style-type: none"> BLOWER OR LIGHT INOPERABLE Check for loose electrical connections, which and buzzer/light. Replace switch or buzzer/light. WONT OPERATE AT PRESSURES BELOW 80 PSI Check dash gauge for accuracy. Check for blower/light. <p>4 SAFETY VALVE</p> <ul style="list-style-type: none"> Check for EXCESSIVELY HIGH PRESSURE Valve operating properly when venting at 140/150 PSI. Check for EXCESSIVELY LOW PRESSURE Check for EXCESSIVELY HIGH or LOW PRESSURE "POPS" OFF AT LESS THAN 140 PSI. Replace. WONT FUNCTION Check for loose electrical connections. Periodic test, remove and test above 100 PSI, with shop air. <p>5 DRAIN VALVES - MANUAL</p> <ul style="list-style-type: none"> Check for loose. <p>5 DRAIN VALVES - AUTOMATIC</p> <ul style="list-style-type: none"> Check for loose. Check for plugged. WONT DRAIN IN COLD WEATHER Check for plugged drain unit. Check for plugged drain unit. Repair or replace. Periodic test, with system pressure stabilized (compressor shut off) check for proper operation to reduce wet suit pressure. Moisture should drain from discharge port. <p>6 GOVERNOR</p> <ul style="list-style-type: none"> FLOUTERS Check gauge. Check ammeter (less than 15/16" x 5" maximum). Check for plugged governor reservoir. Check for plugged governor reservoir line. WONT PASS AIR TO VALVE TO "OUT-OUT" COMPRESSOR Check governor reservoir line. Repair or replace. <p>7 SINGLE CHECK VALVE</p> <ul style="list-style-type: none"> ALLOW BLEED BACK TO SUPPLY RESERVOIR Check for plugged. Check valves should maintain primary and secondary reservoir pressure. Replace if test results are negative. <p>8 PRESSURE CONTROL CHECK VALVE</p> <ul style="list-style-type: none"> WONT PERMIT AIR FLOW REQUIRED TO PURGE AIR DRYER Make sure the single check valve has been removed. <p>9 AIR GAUGE</p> <ul style="list-style-type: none"> FOR TROUBLESHOOTING INFORMATION REFER TO THE OEM OPERATING INSTRUCTIONS. 	<p>10 DUAL SYSTEM FOOT BRAKE VALVE</p> <ul style="list-style-type: none"> LEAKS AT EXHAUST WITH ALL BRAKES RELEASED Check for air in line. Check #2 and #8A & #8B for back flow into service control line. Check trailer air system for back flow into tractor's service line. Check seal in spring brake to back-flow of spring "hold-off" pressure through service ports to open exhaust on valve. CAUTION: CHECK WHEELS - REPAIR AND REPLACE ITEMS AS NECESSARY. LEAKS AT EXHAUST WITH HAND VALVE APPLIED Check for air in line. Check for valve defective. Repair or replace. LEAKS AT EXHAUST WITH FOOT BRAKE APPLIED Check for air in line. Check for valve defective. Repair or replace. POSITION AND FOOT BRAKE RELEASED Foot valve defective. Repair or replace. <p>11 QUICK RELEASE VALVE</p> <ul style="list-style-type: none"> LEAKS AT EXHAUST PORT WITH ALL BRAKES RELEASED Check and replace #18A & #18B if back flow occurs into line. LEAKS WHEN SERVICE BRAKES ARE APPLIED Repair or replace. <p>12 SERVICE BRAKE CHAMBER</p> <ul style="list-style-type: none"> FOR TROUBLESHOOTING INFORMATION REFER TO THE OEM OPERATING INSTRUCTIONS. <p>13 SLACK ADJUSTER</p> <ul style="list-style-type: none"> FOR TROUBLESHOOTING INFORMATION REFER TO THE OEM OPERATING INSTRUCTIONS. NOTE: this slack adjuster are made by the Mentor Vehicle Control Systems (Mentor Vehicle Control Systems, 445550) or contact the Mentor Customer Support Center at 800-535-5560 (801-800-895-1934 inside Mentor). <p>14 RELAY VALVE</p> <ul style="list-style-type: none"> LEAKS AT EXHAUST PORT WITH ALL BRAKES RELEASED Check seal in spring brake to back-flow of spring "hold-off" pressure through service ports to open exhaust on valve. Repair #15 Spring Parking Brake Check reservoir port for evidence of contamination, check for leaks. Check lines for rusty fittings or carbon deposits. Repair or replace. LEAKS AT EXHAUST PORT WITH SERVICE BRAKES APPLIED Exhaust valve not seating properly. Repair or replace. <p>15 SPRING PARKING BRAKE (SERVICE ONLY SERVICE CHAMBER SIDE OF SPRING BRAKE)</p> <ul style="list-style-type: none"> FOR TROUBLESHOOTING INFORMATION REFER TO THE OEM OPERATING INSTRUCTIONS. <p>16 QUICK RELEASE AND DOUBLE CHECK VALVE COMBINATION</p> <ul style="list-style-type: none"> FOOT VALVE EXHAUST LEAKS (PARK BRAKES RELEASED YELLOW DASH CONTROL VALVE EXHAUST LEAK IN PARK POSITION AND SERVICE BRAKES APPLIED) Check for air in line. Check for dash control valve. Repair or replace. <p>17 STOP LIGHT SWITCH</p> <ul style="list-style-type: none"> LOOSE Replace. FALLS TO SIGNAL A GOOD BULL THROUGH SOUND WIRING AT 30 FPS Replace. 	<p>18a INVERSION RELAY VALVE WITH THE LOSS OF REAR SERVICE BRAKES.</p> <ul style="list-style-type: none"> APPLICATION OF SPRING BRAKE BY USING THE EMERGENCY SECTION SHOULD BE AVAILABLE ALONG WITH FRONT SERVICE BRAKE BY APPLYING FRONT VALVE PERIODICALLY TEST BY BLEEDING REAR SERVICE TANK AND APPLYING FRONT VALVE PRESSURE FOOT PEDAL. REPAIR OR REPLACE. IF AFTER CHECKING INVERSION VALVE IS NOT FUNCTIONING PROPERLY. Repair or replace. <p>19 AIR DRYER</p> <ul style="list-style-type: none"> AIR LEAKING CONSTANTLY FROM PURGE VALVE Purge valve seal damaged. Replace. Purge valve frozen. HEATER INOPERATIVE (heater problems) Blow down. Check fuse and replace with 10 amp fuse. Blow down or poor connections. Repair or replace wiring. SLOW SUPPLY (WET TANK) BUILD-UP Purge and/or desiccant plugged. Service air dryer. If a System Malfunction Indicator (SMI) is present, refer to the Maintenance Manual 34 (Single Controller) or 35 (TWIN) for additional troubleshooting information or contact the Mentor Customer Support Center at 800-535-5560 (801-800-895-1934). <p>20 ABS ELECTRONIC CONTROL UNIT, MODULATOR VALVES, SENSORS, AND TOOTH RINGS</p> <ul style="list-style-type: none"> FOR TROUBLESHOOTING INFORMATION REFER TO THE OEM OPERATING INSTRUCTIONS. <p>20a FRONT AXLE VALVE PACKAGE (OPTIONAL)</p> <ul style="list-style-type: none"> COMBINE TWO MODULATOR VALVES AND QUICK RELEASE VALVE. <p>20b REAR AXLE VALVE PACKAGE (OPTIONAL)</p> <ul style="list-style-type: none"> NOTE: If the vehicle has Mentor WABCO ABS, refer to Mentor WABCO Maintenance Manual 28 (Compressor/ABS) or 30 (D-10 version ABS). COMBINE TWO MODULATOR VALVES AND RELAY VALVE. <p>21 TWO-LINE TRACTOR PROTECTION VALVE (NON-AUTOMATIC TYPE)</p> <ul style="list-style-type: none"> WILL NOT RESPOND TO TRAILER CHARGE VALVE SUPPLY LINE TO TRAILER WITH SLOW BLEED-DOWN DOES NOT STOP PS. Check trailer charge valve AS, it should "pop" to let P valve vent trailer supply. Repair or replace. LEAKS AT EXHAUST PORT OR TRACTOR SERVICE BACK (CHECK FOR LEAKS AT EXHAUST PORT VALVE OR TRAILER SUPPLY) Check for air in line. Repair or replace. 	<p>22 BRAKES</p> <ul style="list-style-type: none"> LEAKS AT EXHAUST PORT WHEN RELEASED AND FOOT VALVE IS APPLIED Check for air in line. Repair or replace. PARKING BRAKES ALSO RELEASED Check #2 for normal backflow into service control line, or check #2 for normal backflow into service control line, or ALL PARKING BRAKES IN PARKED POSITION Front controller is defective. Repair or replace. <p>23 DOUBLE CHECK VALVE SEPARATES TRAILER HAND VALVE PRESSURE FROM REAR FOOT BRAKE PRESSURE FOR DELIVERY TO TRAILER</p> <ul style="list-style-type: none"> FOOT VALVE EXHAUST PORT LEAKS WHEN HAND VALVE IS APPLIED Check for air in line. Repair or replace. EXHAUSTIVE EXHAUST PORT LEAKS WHEN FOOT VALVE IS APPLIED Repair. <p>24 DOUBLE CHECK VALVE SEPARATES FRONT AXLE FOOT BRAKE PRESSURE FROM REAR AXLE FOOT BRAKE PRESSURE AND/OR TRAILER HAND VALVE PRESSURE FOR DELIVERY TO TRAILER</p> <ul style="list-style-type: none"> LEAKS THROUGH FOOT VALVE EXHAUST WITH HAND VALVE APPLIED Check #2 or #4. Periodic test. Alternatively loosen each inlet line and apply pressure to other. If leak is detected, replace. <p>25 MANIFOLD DASH VALVE WITH BUILT-IN TWO-WAY CHECK (RED OCTAGON) TRAILER CHARGE (YELLOW DIAMOND) TRACTOR PARK</p> <ul style="list-style-type: none"> TRAILER CHARGE WITHOUT RELEASE Check for plugged orifice. Repair or replace. PARK BRAKE WONT APPLY Check for plugged orifice in PARK POSITION AND SERVICE BRAKES APPLIED Check #18 anti-compound double check valve Check #18 anti-compound double check valve Check for plugged orifice in PARK POSITION AND SERVICE BRAKES RELEASED WONT APPLY TRAILER IMMEDIATELY WHEN "PULLER" IS PRESSED Check for plugged orifice. Repair or replace #17 #25 is functioning properly. PRIMARY TANK BLEED-DOWN ALSO BLEEDS SECONDARY TANK Periodic test. Pressure should remain in one tank after the other is drained. Replace, if inoperative.

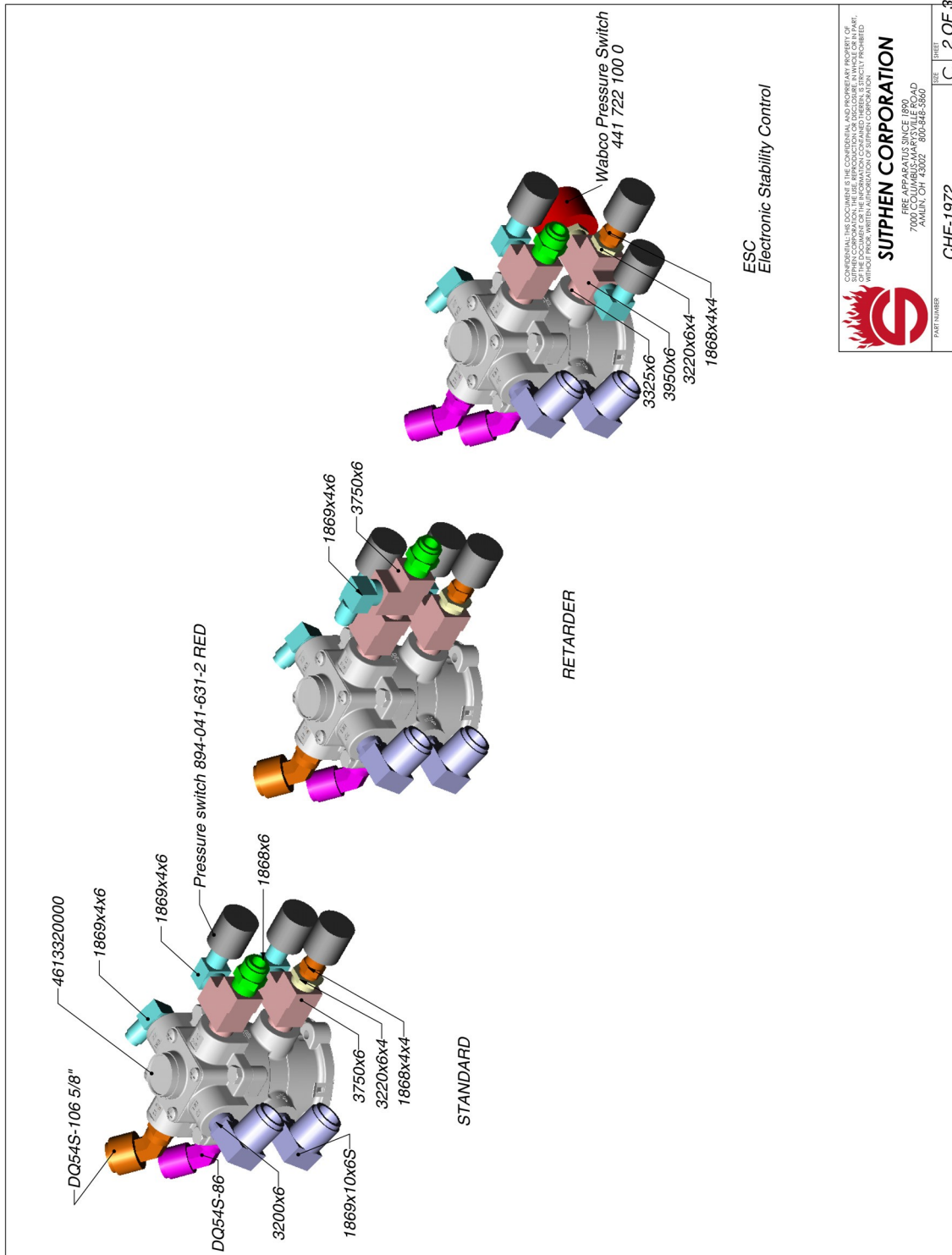
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Troubleshooting





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PART NUMBER	CHF-1972	REV	C	SHEET	2 OF 3
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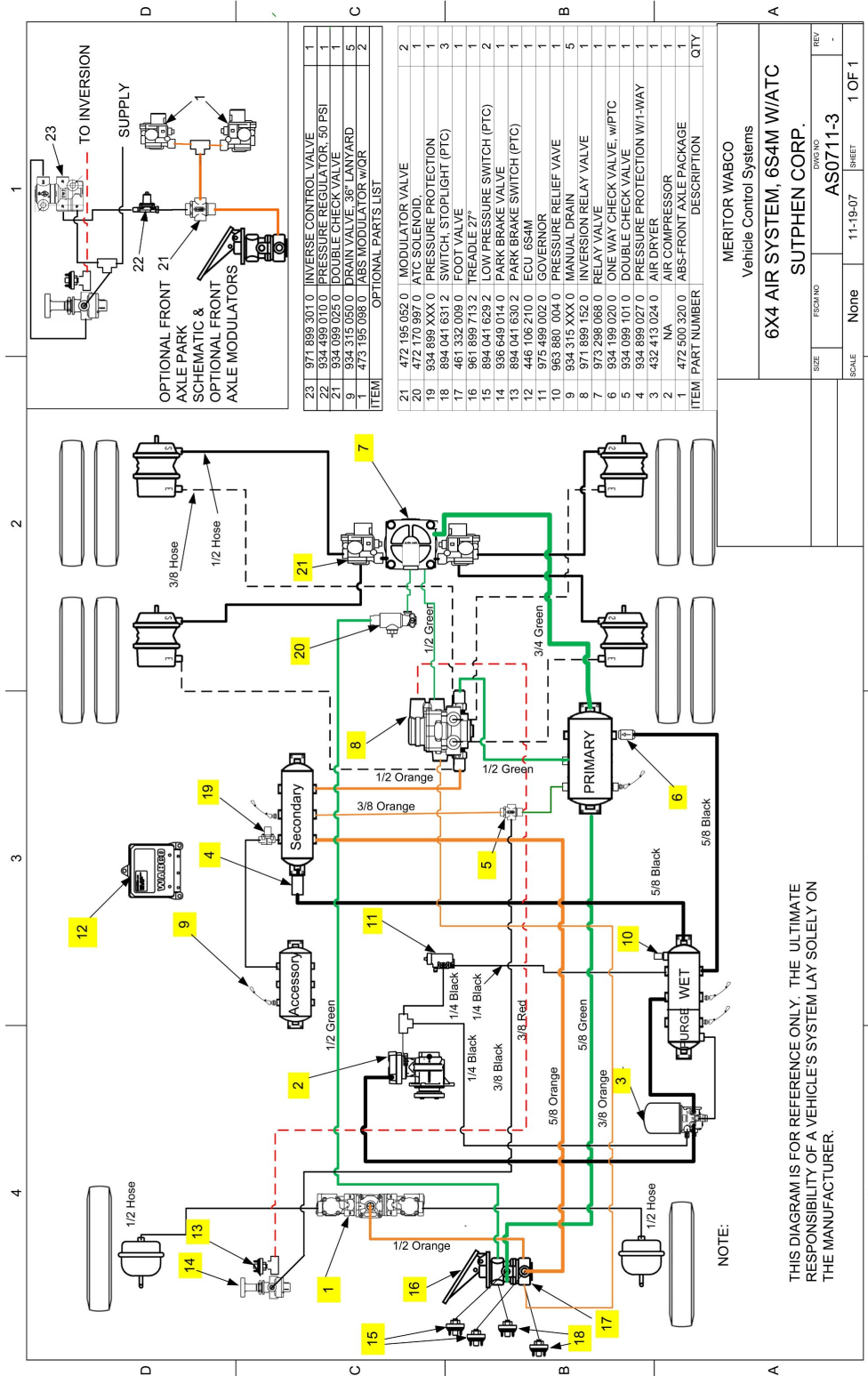


7.2 Spring Parking Brakes

Spring Parking Brakes - all rear brakes have spring parking brakes. In the event of air loss, the rear brakes will lock up.

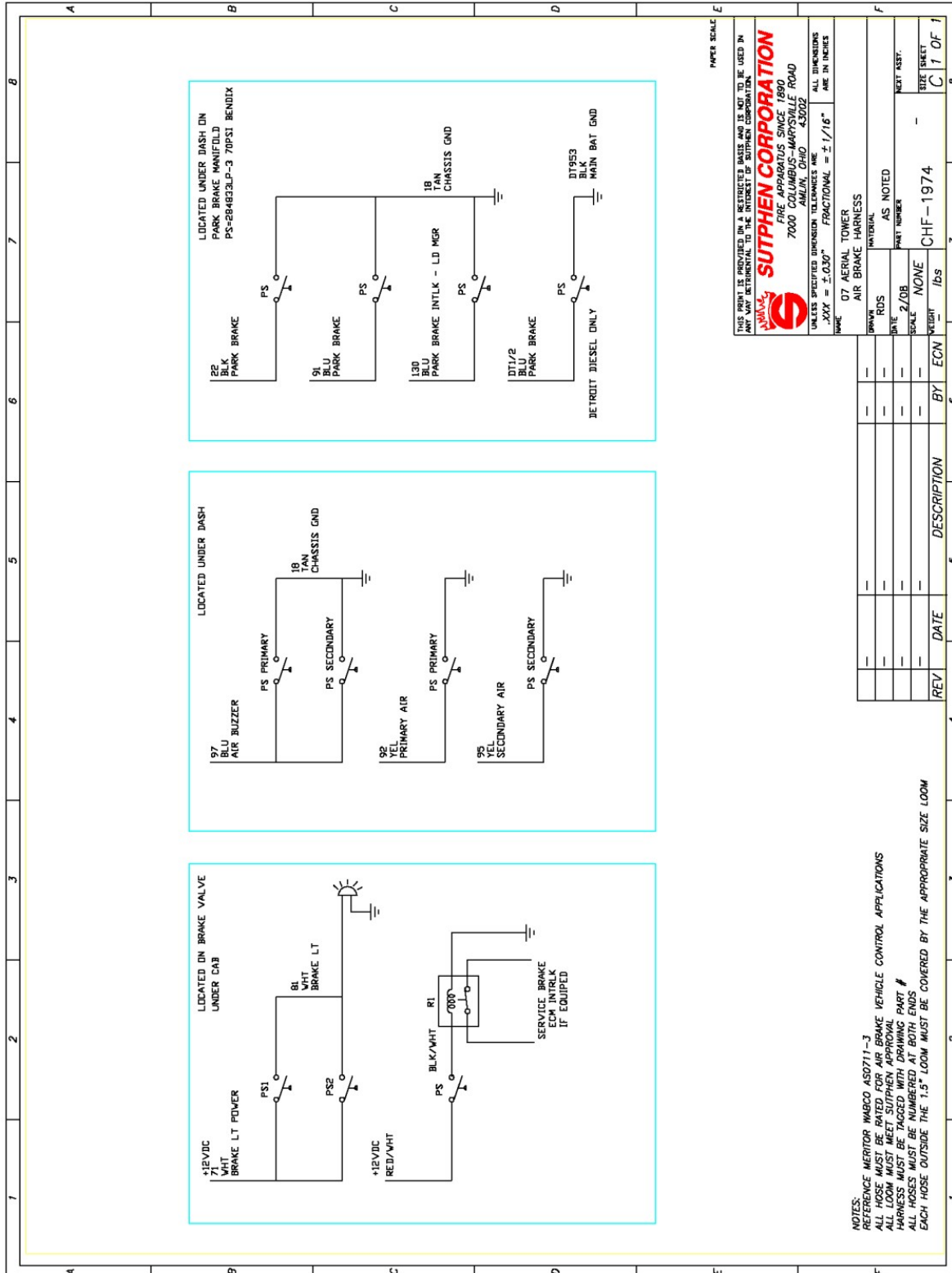
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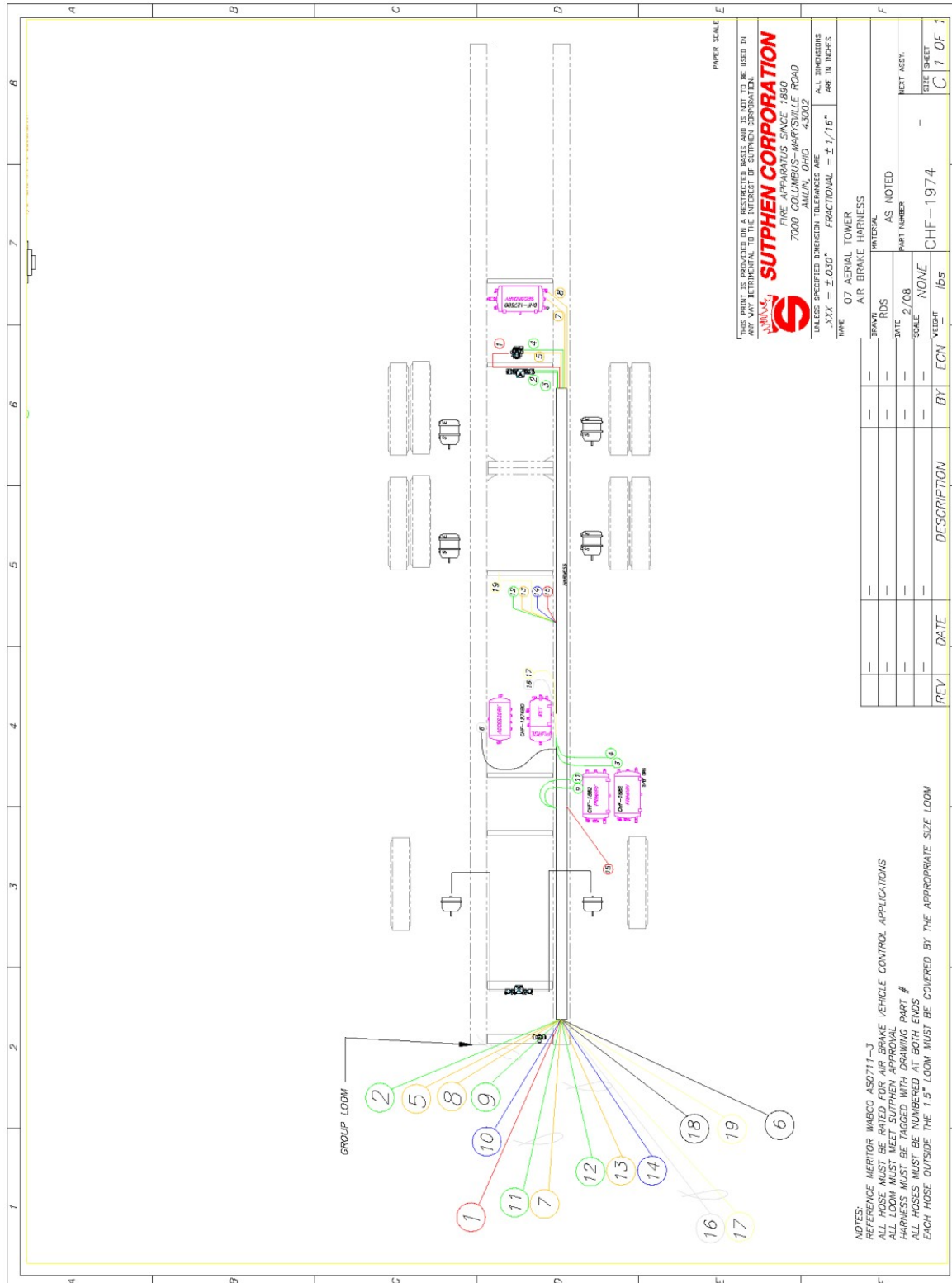
7.3 Aerial Tower Air Brake



NOTE:
THIS DIAGRAM IS FOR REFERENCE ONLY. THE ULTIMATE RESPONSIBILITY OF A VEHICLE'S SYSTEM LAY SOLELY ON THE MANUFACTURER.

Troubleshooting





THIS DRAWING IS UNLESS OTHERWISE SPECIFIED TO BE USED IN CONFORMANCE WITH THE NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) STANDARD 1911-1, STANDARD FOR AERIAL TOWER LADDERS.

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 WILMINGTON, OHIO 45392

UNLESS SPECIFIED DIMENSION TOLERANCES ARE: ALL DIMENSIONS ARE IN INCHES
 FRACTIONAL = 1/16"

NAME: 07 AERIAL TOWER
 AIR BRAKE HARNESS

REV	DATE	DESCRIPTION	BY	ECN	WEIGHT	UNIT
1	2/08	AS NOTED	CHF	1974	lbs	

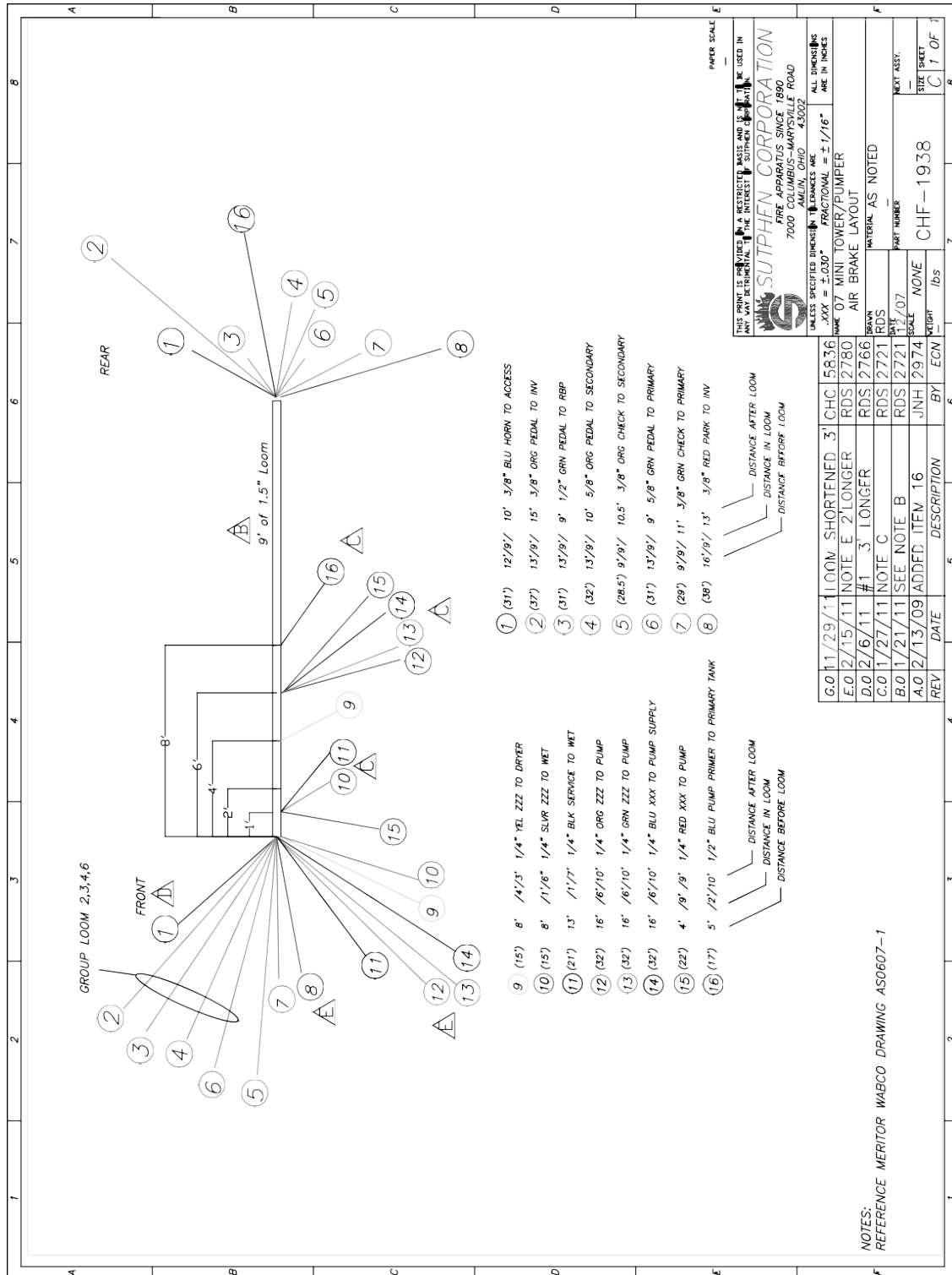
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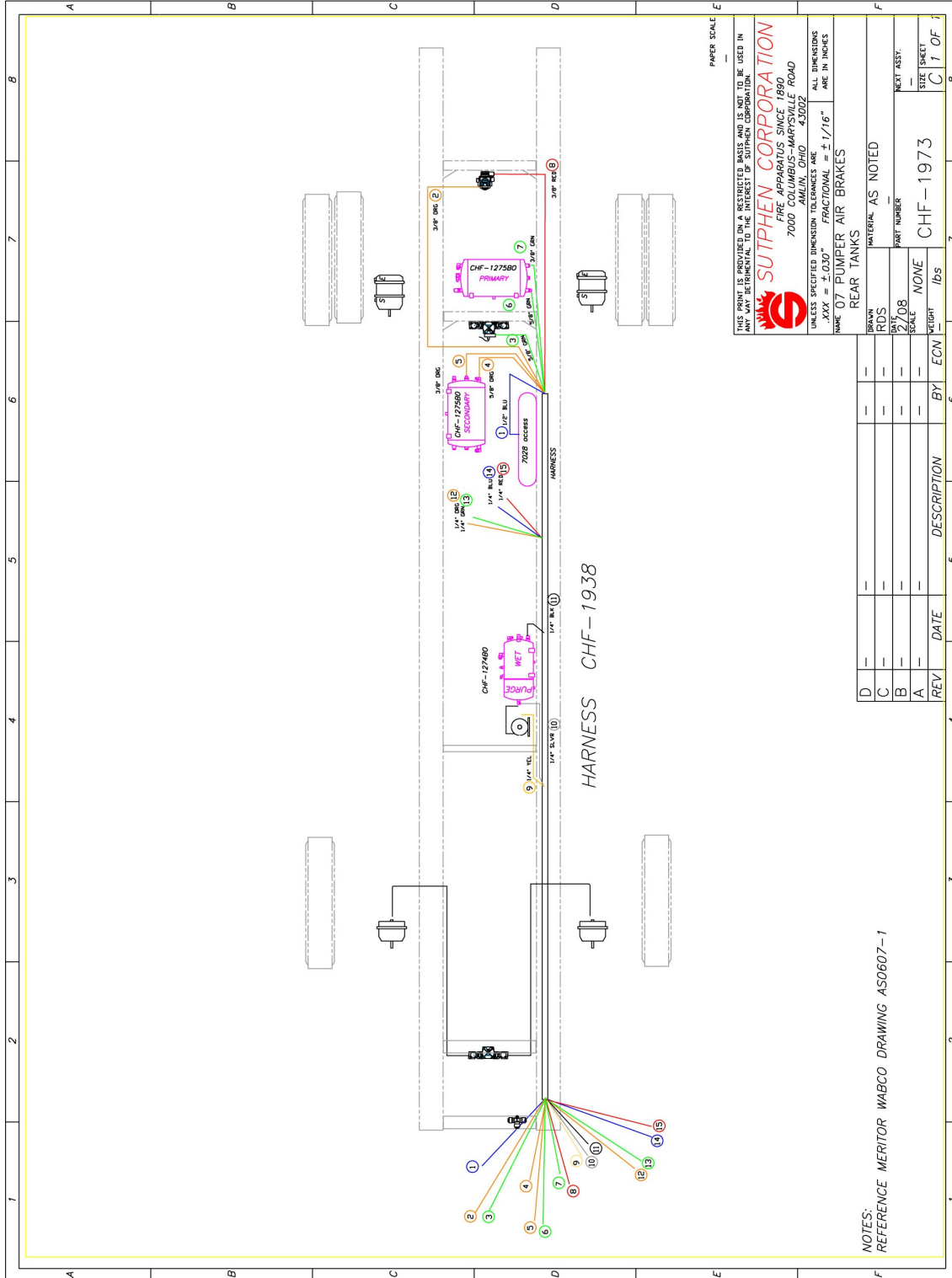
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NOTES:
 REFERENCE MERITOR WABCO ASD711-3 VEHICLE CONTROL APPLICATIONS
 ALL HOSE MUST BE RATED FOR AIR BRAKE APPLICATIONS
 ALL LOOM MUST MEET SUTPHEN APPROVAL
 HARNESS MUST BE TAGGED WITH DRAWING PART #
 ALL HOSES MUST BE NUMBERED AT BOTH ENDS
 EACH HOSE OUTSIDE THE 1.5" LOOM MUST BE COVERED BY THE APPROPRIATE SIZE LOOM

Troubleshooting

7.4 Single Rear Axle Air Brakes





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 .XXX ± .030" FRACTIONAL = ± 1/16"
 ALL DIMENSIONS ARE IN INCHES

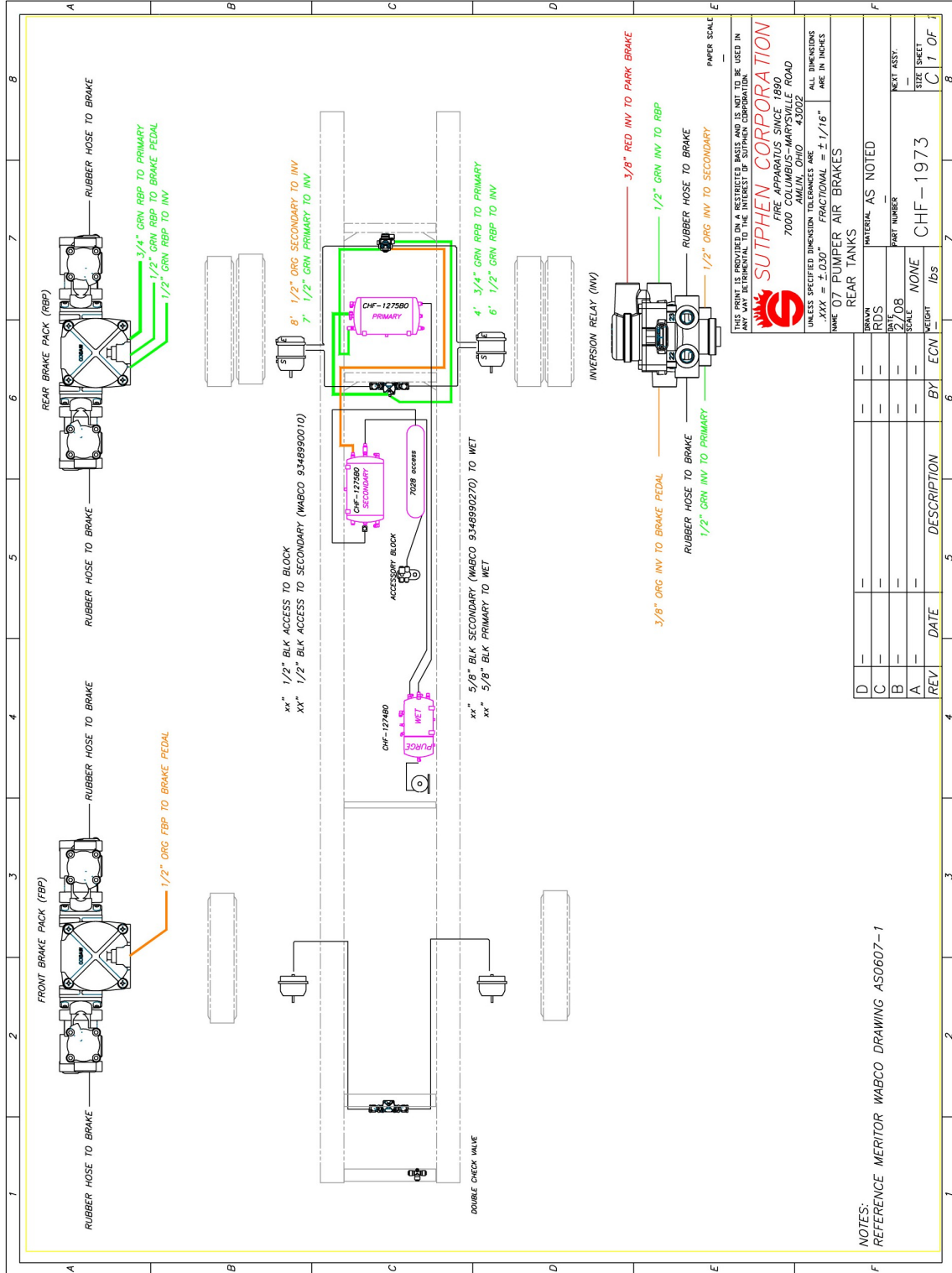
NAME: 07 PUMPER AIR BRAKES
 REAR TANKS

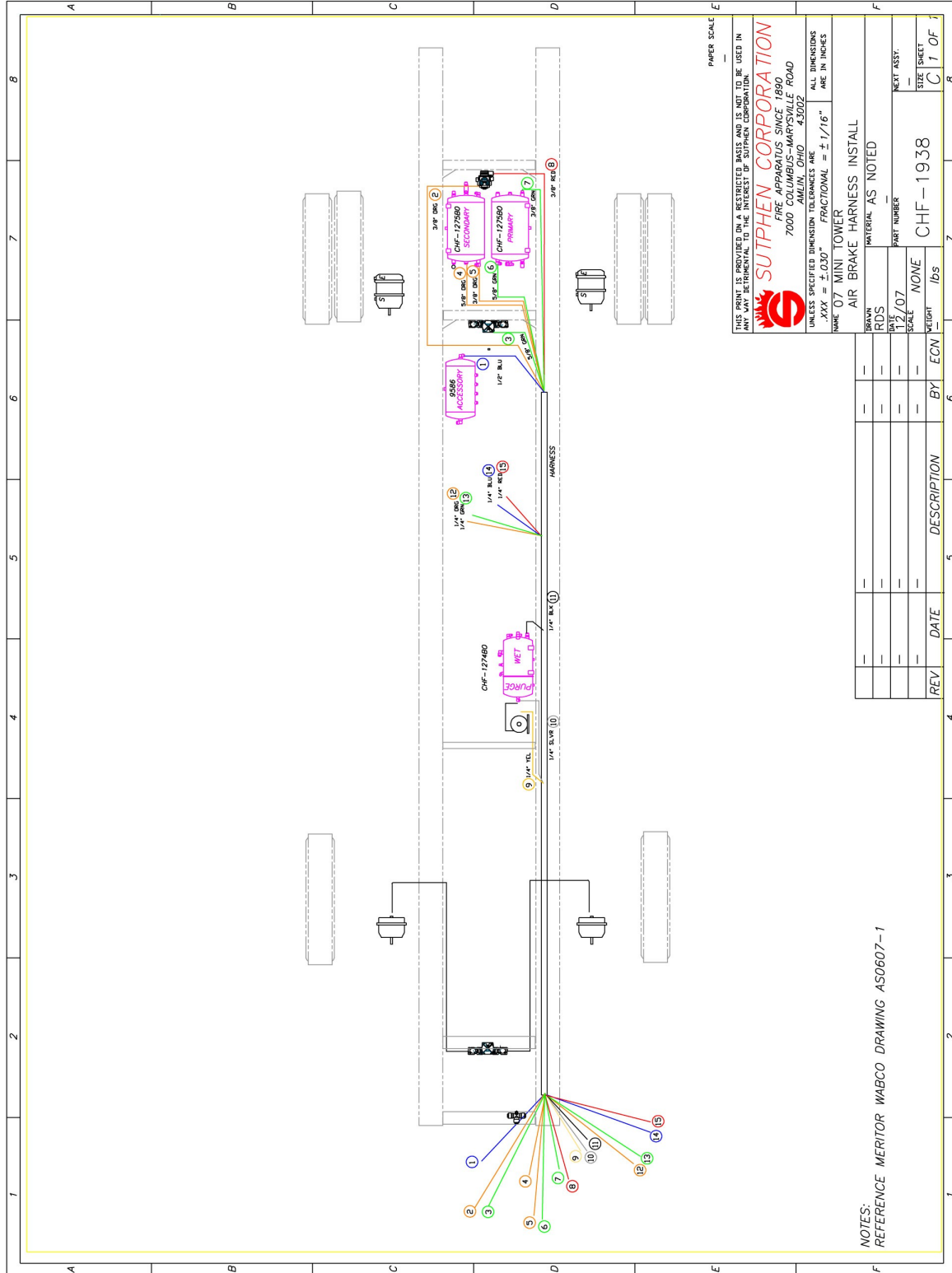
DRAWN	MATERIAL	AS NOTED
RDS		
DATE	PART NUMBER	NEXT ASST.
SCALE		
REV	DESCRIPTION	BY
DATE		
ECN	WEIGHT	lbs

REV	DATE	DESCRIPTION	BY	ECN	WEIGHT	lbs
D	—	—	—	—	—	—
C	—	—	—	—	—	—
B	—	—	—	—	—	—
A	—	—	—	—	—	—

NOTES:
 REFERENCE MERITOR WABCO DRAWING AS0607-1

Troubleshooting





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 AMELIN, OHIO 43002

UNLESS SPECIFIED DIMENSIONS IN THIS DRAWING ARE IN INCHES
 UNLESS SPECIFIED DIMENSIONS IN METERS ARE IN MILLIMETERS

NAME: 07 MINI TOWER
 AIR BRAKE HARNESS INSTALL

MATERIAL AS NOTED

DATE: 12/07
 SCALE: NONE
 WEIGHT: lbs

REV: 1
 DATE: 12/07
 DESCRIPTION: 07 MINI TOWER AIR BRAKE HARNESS INSTALL

NOTES:
 REFERENCE MERITOR WABCO DRAWING AS0607-1



7.5 Electrical System

This chassis has four harnesses for ease of troubleshooting and replacement. There are several plugs at the connections of the harnesses which tie the harness together. All the wires on the truck are colorcoded and heat stamped with number and function every 4 inches for ease of troubleshooting. You will find prints and information on the wiring harnesses on the CD supplied with your vehicle to help on troubleshooting and adding or changing wires.

Breakers

The various electrical circuits on this truck are protected by individual circuit breakers conveniently located behind cover on right side of cab front wall. These breakers are fixed on a panel and are thermo reset type. There is a print on the back of the removable panel for quick reference on what wires are tied to the breaker and its amp rating and electric component layout. There is also a page in this manual

Troubleshooting

For troubleshooting the wiring system, you should determine what wires you are having trouble with, then look at the print to see where the wire runs in the harness and find its breakouts. Then, check all connections for good contact. If this does not work, check the wire itself to see that it has not been cut or damaged. Repair wire or connection as needed to fix problem.

Check breaker panel to make sure all breakers are good and not burned out. For more information, see Breakers.

If the problem is not found, check electric supply at various breakouts with ohm meter. Check wire harness plug connectors as last resort (see next page).

 **Troubleshooting**

The plug connectors are located behind the dash on the truck. There is a harness for the instrument panel and one for the breaker panel. If, for some reason, you have some electrical components not working and you could not find anything wrong with the wire or connection, check the plug connection as a last resort. Do this by unscrewing the plug counterclockwise, being careful not to put into a bind. Take the plug apart, making sure the pins in both sides are in all the way by pushing the pins into correct depth in the plug. Reassemble plug, being careful not to put into a bind.

Troubleshooting (No Electrical Power)

1. Check batteries for full charge.
2. Check connections of all battery cables.
3. Check the ground between starter and frame for good connection. What sometimes seems like a loss of power, may be a bad negative ground.

Interlock Black Box for Pump and PTO

For troubleshooting procedures for pump and PTO, check with the specific manufacturer.



7.6 Electrical Drawing Cross-Reference

NOTE: Refer to CD supplied with manual.

CHF-5105	Brow Overhead
CHF-1401	Cab Warning Upper Cluster
CHF-5100	Main Cab on Outside
CHF-1403	Light Bar
CHF-1404	Anti Lock Brake Harness
CHF-1405	Main Transmission Harness
CHF-3859	Shifter Harness
CHF-3848	Transmission Power and VIM
CHF-1408	Transmission Adapter Harness
CHF-1409	Anti Lock Brake Adapter Harness
CHF-1412	Rear Upper Cab Interior
CHF-1413	Adapter Antilock Brake Cab and Brake Pedal
CHF-6210	Relay Board Harness Behind Gauges
CHF-6208	Engine Harness Cab
CHF-6200	J1939 Communication Harness
CHF-5109	Single Axle Frame Harness
CHF- 5112	Tandem Axle Frame Harness



Troubleshooting

CHF-5118	Frame Engine Harness
CHF-6244	Dash Harness
CHF-1431	ProAir Heat Only
CHF-1432	ProAir With A/C
CHF- 5103	Inner Cab Harness

7.7 Allison Transmission - 4th Generation

Troubleshooting

Refer to Appendix D - ALLISON TRANSMISSION TROUBLESHOOTING MANUAL.



Chapter 8 Warranty

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STANDARD VEHICLE WARRANTY

NOTES

SUTPHEN CORPORATION (Sutphen) warrants to the original purchaser of a Sutphen vehicle, that it will provide for repairs to the Sutphen vehicle during the warranty period, in accordance with the following items, conditions, limitations and exclusions.

1. ---What is covered except as otherwise stated below: Sutphen shall provide repair or replacement, at the sole option of Sutphen, of any part of a Sutphen vehicle in which a defect in materials or workmanship appears under normal use, maintenance or service.
2. ---Warranty period: This limited warranty is in effect for a period of twelve (12) months or 24,000 miles, whichever comes first. The warranty period will begin on the date the vehicle is delivered to the original purchaser. This limited warranty is void if the odometer has been disconnected, its reading has been altered, or true and accurate mileage cannot be otherwise determined by Sutphen.
3. ---Other warranties: The manufacturers of other equipment and components, installed on the vehicle, including but not limited to engine, transmission, axles, pumps, tanks, and signaling devices and other installed equipment, may provide their own warranties. These warranties are separate from this limited warranty and shall constitute the sole and exclusive warranty for those specific covered components. Sutphen shall have no duty or obligation to repair or replace such components. Please review each manufacturer's warranty for descriptions and details of their respective warranty.
4. ---Purchaser responsibilities: Normal maintenance such as those detailed in the Sutphen Operation and Maintenance Manuals are the responsibility of the purchaser. A copy of maintenance documentation may be requested before approval is given for warranty repair. Failure to comply with such maintenance voids this limited warranty.
5. ---What is NOT covered: This limited warranty covers only repair or replacement of any part of a Sutphen vehicle in which a defect in materials or workmanship appears within the limited warranty period.
Examples of items not covered include, but are not limited to:
 - A. Major components or trade accessories such as purchased chassis, engines, signaling devices, transmission, pump, tank, or generator that have a separate warranty by the original manufacturer, or equipment used in fire fighting.
 - B. Unauthorized alteration or modification to the vehicle, including the body, chassis, components, electrical components and or electrical systems after completion of the vehicle assembly by Sutphen and any problems that occur as a result of such alterations or modifications. This includes but is not limited to aftermarket parts and accessories.
 - C. Damage caused by collision, fire, theft, freezing, vandalism, riot, explosion, acts of God, war or objects striking the vehicle or any damage covered by owner insurance.
 - D. Damage caused by misuse or improper operation of the vehicle such as driving over curbs, overloading, racing or off-road use.
 - E. Damage caused by failure to follow the requirements of the maintenance schedule, failure to maintain proper fluid and lubricant levels and failure to follow operating instructions.
 - F. Normal maintenance such as lubrication, filter replacement, fluid replacement, belts, hoses, clutch, brake linings, brake drums, or disc brake rotors and electric accessories, etc.
 - G. Batteries, tires, light bulbs.
 - H. Towing charges and storage expenses.
 - I. Incidental expenses such as loss of vehicle use, inconvenience, loss of time, vehicle rental, lodging or travel costs, vacation pay, etc.
 - J. Discharge and compound gauges from freezing.
 - K. Leaking seals on discharge and suction valves.
 - L. Damage caused from exposure to road de-icing compounds or use in an acidic environment.
 - M. Hydraulic failures caused by incorrect or contaminated oil.
 - N. This warranty terminates upon transfer of ownership of the vehicle from the original purchaser.
 - O. Damage caused from not following cab and body washing and care procedures located on truck and in operation and maintenance manual.
6. ---Obtaining repairs:
 - A. All limited warranty work must be authorized by Sutphen prior to repairs being attempted.
 - B. To obtain limited warranty repairs the vehicle must be taken by customer to an Authorized Sutphen Service Center within the limited warranty period. To find the name and location of the nearest Authorized Sutphen Service Center in your area, call 1-866-287-5549 or write Sutphen Corporation / Warranty Admin, PO Box 1845, Springfield, OH 45501.
 - C. Sutphen reserves the right to inspect the vehicle before repairs are made and Sutphen shall be deemed the sole judge as to whether there is a defect in materials or workmanship under normal use, maintenance or service.

continued

- D. Any part or parts considered to be covered by the conditions of this limited warranty shall be returned, freight prepaid, to Sutphen, or to such other location as may be approved by the company. Replacement or repair of parts determined to be within this limited warranty shall be F.O.B. at Sutphen.
- E. In an emergency, where an Authorized Sutphen Service Center is not reasonably available, contact Sutphen Service Department for instructions. Repairs may be performed, at purchaser's risk, at any available service establishment chosen by purchaser. Purchaser must contact Sutphen Service Department the first business day after completion of repairs. Approved repair invoices must be received by Sutphen within sixty (60) days of repairs. Upon Sutphen's receipt of invoice, Sutphen will review the invoice for reimbursement to the purchaser. Any reimbursement will consist only of the reasonable and customary repair expenses normally covered under this limited warranty. Sutphen will assume no liability and will not warrant the workmanship or components which are the subject of any reimbursement under this policy.

7. ---Warranty limitations:

- A. Nothing contained in this warranty shall make Sutphen liable beyond the express limitations hereof, for loss, injury or damage of any kind to any person or entity resulting from any defect or failure in the machine.
- B. To the extent permitted by law, this limited warranty is also in lieu of all other obligations or liabilities on the part of Sutphen or the Seller, including liability for incidental and consequential damages.
- C. Sutphen makes no representation that the machine has the capacity to perform any functions other than as contained in the company's written literature, catalogs or specifications accompanying delivery of the machine.
- D. No person or affiliated company representative is authorized to give any other warranties or to assume any other liability on behalf of Sutphen in connection with sale, service or repair of any apparatus manufactured by the company.
- E. Sutphen reserves the right to make design changes or improvements in it's products without imposing any obligation upon itself to change or improve previously manufactured products.

THIS WARRANTY IS PROVIDED IN EXCLUSION OF ANY AND ALL OTHER REPRESENTATIONS, EITHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS, AND SUITABILITY FOR BUYER'S INTENDED USE. NO PERSON IS AUTHORIZED TO MAKE ANY REPRESENTATIONS OR WARRANTIES ON BEHALF OF SUTPHEN CORPORATION OTHER THAN SET FORTH HEREIN. ANY MODIFICATION TO THIS WARRANTY MUST BE IN WRITING AND APPROVED BY THE PRESIDENT OF SUTPHEN CORPORATION. THE PROVISIONS OF THIS LIMITED WARRANTY SHALL CONSTITUTE THE SOLE AND EXCLUSIVE REMEDIES OF A SUTPHEN VEHICLE PURCHASER.

For more information contact:
Sutphen Corporation / Warranty Admin.
49 N. Ludlow Road • Urbana, OH 43078
Phone (937) 969-8851 • Toll Free (866) 287-5549

March 1, 2012 Supersedes All Previous Warranties



APPARATUS BODY STRUCTURAL INTEGRITY WARRANTY TEN (10) YEARS

SUTPHEN CORPORATION (Sutphen) warrants each new body and heavy duty rescue body manufactured by Sutphen to be free of structural failures caused by defective design or workmanship for a warranty period of ten (10) years after the date on which the vehicle is first delivered to the original purchaser or 100,000 miles, whichever occurs first. This warranty is limited to body tubular support and mounting structures and other structural components.

Sutphen's obligation under this warranty is limited to repairing or replacing, as Sutphen may elect, without charge to the original purchaser, the structural component or components which Sutphen, after examination, finds, to Sutphen's satisfaction, to have structurally failed due to defective design or workmanship.

Sutphen's obligation under this limited warranty is subject to the conditions precedent (1) that the claimed failure shall have first appeared during the warranty period; (2) that the original purchaser shall have notified Sutphen in writing of the claimed failure within thirty (30) days after the claimed failure shall have first appeared, and (3) that, unless Sutphen directs otherwise, the claimed failed item or items shall have been returned to Sutphen, or to Sutphen designee, promptly after the notification, with transportation charges prepaid. Sutphen reserves the right to thoroughly examine the vehicle or parts thereof, prior to conducting or approving any repair or replacement, to determine whether the claimed failure is covered by this warranty. Sutphen's obligation under this warranty is strictly limited to repair or replacement as the company may elect. The warranty is pro-rated for a period of ten (10) years from the date of delivery, as follows: first five years, one hundred percent (5-100%); sixth year, seventy-five percent (6-75%); seventh and eight years, fifty percent (7/8-50%); ninth and tenth years, twenty five percent (9/10-25%).

In advance of the original purchaser effecting repair or replacement of a structural component or components found by Sutphen to have structurally failed due to defective design or workmanship, approval for the repair or replacement must be obtained from Sutphen's Customer Service Department. Repair or replacement must be made by a facility approved in advance by Sutphen. Failure to obtain either or both of the advance approvals voids this warranty. Coverage under this warranty of labor for repair or replacement is limited to the time or amounts reasonably necessary, as determined by Sutphen, to make the repair or replacement. Labor time or amounts deemed excessive by Sutphen are not covered under this warranty.

Any repair or replacement effected by Sutphen under this limited warranty is itself warranted under this warranty for the duration of the warranty period subject, however, to the provisions of this warranty as are applicable to the structural component or components or replaced by Sutphen. Further, this warranty shall be void if the vehicle is involved in an accident, shows signs of abuse, or evidence of being operated in an improper manner.

This limited warranty covers only repair or replacement of any part of a Sutphen vehicle in which a defect in materials or workmanship appears within the limited warranty period. Examples of items not covered include, but are not limited to:

- A. ---Major components or trade accessories that have a separate warranty by the original manufacturer, or to equipment used in fire fighting.
- B. ---Unauthorized alteration or modification to the vehicle, including the body, chassis or components, after completion of the vehicle assembly by Sutphen and any problems that occur as a result of such alterations or modifications.
- C. ---Damage caused by collision, fire, theft, freezing, vandalism, riot, explosion, acts of God, war or objects striking the vehicle or any damage covered by owner insurance.
- D. ---Damage caused by misuse or improper operation of the vehicle such as driving over curbs, overloading, racing or off-road use.
- E. ---Damage caused by failure to follow the requirements of the maintenance schedule, failure to maintain proper fluid and lubricant levels and failure to follow operating instructions.
- F. ---Towing charges and storage expenses.
- G. ---Incidental expenses such as loss of vehicle use, inconvenience, loss of time, vehicle rental, lodging or travel costs, vacation pay, etc.
- H. ---Damage caused from exposure to road de-icing compounds or use in an acidic environment.
- I. --- (1) Normal maintenance services or adjustments; (2) any item that has been repaired, replaced or altered by a facility not approved in advance by Sutphen Customer Service Department or in a manner which in Sutphen's judgment, may adversely affect the operation or longevity of the vehicle or item; (3) special, incidental or consequential damages including, but not limited to, loss of time, inconvenience, loss of use, or lost profits; (4) any malfunction resulting from misuse, negligence, alternation accident, or lack of operational knowledge or normal maintenance or adjustments; (5) time required to unload or reload the vehicle or item; (6) nonstructural breakage or cracking; (7) material bending, buckling or other metal deformation unless caused by a structural failure of a structural component as identified in Sutphen's specifications, of the body due to defective design or workmanship; or (8) transportation fees or charges to or from any facility.

continued

J.----This limited warranty is void if Sutphen determines that the vehicle or item has been neglected, misused, altered, overloaded, loaded beyond specified compartment weight limits, loaded to a state of excessive imbalance side to side, or damaged. This warranty is also void if Sutphen determines that the warranty claim is false or misrepresented, that the vehicle or item has been damaged in an accident or by an act of God, or that the structural failure is attributable to use or operation of the vehicle or item in a manner or for a purpose other than that for which Sutphen intended or designed the vehicle or item.

This warranty terminates upon transfer of possession or ownership of the vehicle from the original purchaser.

THIS WARRANTY IS PROVIDED IN EXCLUSION OF ANY AND ALL OTHER REPRESENTATIONS, EITHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS, AND SUITABILITY FOR BUYER'S INTENDED USE. NO PERSON IS AUTHORIZED TO MAKE ANY REPRESENTATIONS OR WARRANTIES ON BEHALF OF SUTPHEN CORPORATION OTHER THAN SET FORTH HEREIN. ANY MODIFICATION TO THIS WARRANTY MUST BE IN WRITING AND APPROVED BY THE PRESIDENT OF SUTPHEN CORPORATION. THE PROVISIONS OF THIS LIMITED WARRANTY SHALL CONSTITUTE THE SOLE AND EXCLUSIVE REMEDIES OF A SUTPHEN VEHICLE PURCHASER.

For more information contact:
Sutphen Corporation / Warranty Admin.
49 N. Ludlow Road • Urbana, OH 43078
Phone (937) 969-8851 • Toll Free (866) 287-5549

March 1, 2012 Supersedes All Previous Warranties



CAB STRUCTURAL INTEGRITY WARRANTY TEN (10) YEARS

SUTPHEN CORPORATION (Sutphen) warrants the cab of each new custom fire and rescue vehicle manufactured by Sutphen to be free of structural failures caused by defective design or workmanship for a warranty period of ten (10) years after the date on which the vehicle is first delivered to the original purchaser or 100,000 miles, whichever occurs first. This warranty is limited to the cab tubular support and mounting structures and to the other structural components.

Sutphen's obligation under this warranty is limited to repairing or replacing, as Sutphen may elect, without charge to the original purchaser, the structural component or components which Sutphen, after examination, finds, to Sutphen's satisfaction, to have structurally failed due to defective design or workmanship.

Sutphen's obligation under this limited is subject to the conditions precedent: (1) that the claimed failure shall have first appeared during the warranty period; (2) that the original purchaser shall have notified Sutphen in writing of the claimed failure within thirty (30) days after the claimed failure shall have first appeared, and (3) that, unless Sutphen directs otherwise, the claimed failed item or items shall have been returned to Sutphen, or to Sutphen's designee, promptly after the notification, with transportation charges prepaid. Sutphen reserves the right to thoroughly examine the vehicle or parts thereof, prior to conducting or approving any repair or replacement, to determine whether the claimed failure is covered by this warranty. Sutphen's obligation under this warranty is strictly limited to repair or replacement as the company may elect. The warranty is pro-rated for a period of ten (10) years from the date of delivery as follows: first three years, one hundred percent; four years, seventy-five percent; five years, fifty percent; six years, forty percent; seven years, twenty-five percent; eight years, twenty percent; nine years, fifteen percent; ten years, ten percent.

In advance of the original purchaser effecting repair or replacement of a structural component or components found by Sutphen to have structurally failed due to defective design or workmanship, approval for the repair or replacement must be obtained from Sutphen's Customer Service Department. Repair or replacement must be made by a facility approved in advance by Sutphen. Failure to obtain either or both of the advance approvals voids this warranty. Coverage under this warranty of labor for repair or replacement is limited to the time or amounts reasonably necessary, as determined by Sutphen, to make the repair or replacement. Labor time or amounts deemed excessive by Sutphen are not covered under this warranty.

Any repair or replacement effected by Sutphen under this limited warranty is itself warranted under this warranty for the duration of the warranty period subject, however, to the provisions of this warranty as are applicable to the structural component or components repaired or replaced by Sutphen. Further, this warranty shall be void if the vehicle is involved in an accident, shows signs of abuse, or evidence of being operated in an improper manner.

This limited warranty covers only repair or replacement of any part of a Sutphen vehicle in which a defect in materials or workmanship appears within the limited warranty period. Examples of items not covered include, but are not limited to:

- A. ---Major components or trade accessories that have a separate warranty by the original manufacturer, or equipment used in fire fighting.
- B. ---Unauthorized alteration or modification to the vehicle, including the body, chassis or components, after completion of the vehicle assembly by Sutphen and any problems that occur as a result of such alterations or modifications.
- C. ---Damage caused by collision, fire, theft, freezing, vandalism, riot, explosion, acts of God, war or objects striking the vehicle or any damage covered by owner insurance.
- D. ---Damage caused by misuse or improper operation of the vehicle such as driving over curbs, overloading, racing or off-road use.
- E. Damage caused by failure to follow the requirements of the maintenance schedule, failure to maintain proper fluid and lubricant levels and failure to follow operating instructions.
- F. ---Towing charges and storage expenses.
- G. ---Incidental expenses such as loss of vehicle use, inconvenience, loss of time, vehicle rental, lodging or travel costs, vacation pay, etc.
- H. ---Damage caused from exposure to road de-icing compounds or use in an acidic environment.
- I. ----(1) Normal maintenance services or adjustments;(2) any item that has been repaired, replaced or altered by a facility not approved in advance by Sutphen Customer Service Department or in a manner which in Sutphen's judgment, may adversely affect the operation or longevity of the vehicle or item; (3) special, incidental or consequential damages including, but not limited to, loss of time, inconvenience, loss of use, or lost profits; (4) any malfunction resulting from misuse, negligence, alternation accident, or lack of operational knowledge or normal maintenance or adjustments; (5) time required to unload or reload the vehicle or item; (6) nonstructural breakage or cracking; (7) material bending, buckling or other metal deformation unless caused by a structural failure of a structural component as identified in Sutphen's specifications, of the cab due to defective design or workmanship; or (8) transportation fees or charges to or from any facility.

continued

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1-800-848-5860

J.----This limited warranty is void if Sutphen determines that the vehicle or item has been neglected, misused, altered, overloaded, loaded beyond specified compartment weights limits, loaded to a state of excessive imbalance side to side, or damaged. This warranty is also void if Sutphen determines that the warranty claim is false or misrepresented, that the vehicle or item has been damaged in an accident or by an act of God, or that the structural failure is attributable to use or operation of the vehicle or item in a manner or for a purpose other than that for which Sutphen intended or designed the vehicle or item.

This warranty terminates upon transfer of possession or ownership of the vehicle from the original purchaser.

THIS WARRANTY IS PROVIDED IN EXCLUSION OF ANY AND ALL OTHER REPRESENTATIONS, EITHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS, AND SUITABILITY FOR BUYER'S INTENDED USE. NO PERSON IS AUTHORIZED TO MAKE ANY REPRESENTATIONS OR WARRANTIES ON BEHALF OF SUTPHEN CORPORATION OTHER THAN SET FORTH HEREIN. ANY MODIFICATION TO THIS WARRANTY MUST BE IN WRITING AND APPROVED BY THE PRESIDENT OF SUTPHEN CORPORATION. THE PROVISIONS OF THIS LIMITED WARRANTY SHALL CONSTITUTE THE SOLE AND EXCLUSIVE REMEDIES OF A SUTPHEN VEHICLE PURCHASER.

For more information contact:
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March 1, 2012 Supersedes All Previous Warranties



FRAME WARRANTY LIFETIME

SUTPHEN CORPORATION (Sutphen) warrants to the original user/purchaser only of a Sutphen chassis, that the frame or frame members are free of defects in material and workmanship, ordinary wear and tear excepted, for the lifetime of the vehicle.

Sutphen's obligation under this warranty is strictly limited to repairing, as the company may elect, any part or parts of such frame or frame members which the company's examination discloses to be defective in material or workmanship. The company reserves the right to require any such repairs to be made either at a company owned service facility or another approved service facility at the company's option. Transportation cost to and from the servicing location will be the responsibility of the user/purchaser.

Sutphen's obligation under this limited warranty is subject to the conditions (1) the claimed failure shall have first appeared during the warranty period; (2) the original purchaser shall have notified Sutphen in writing of the claimed failure within thirty (30) days after the claimed failure shall have first appeared, and (3) unless Sutphen directs otherwise, the claimed failed item or items shall have been returned to Sutphen, or to Sutphen designee, promptly after the notifications, with transportation charges prepaid. Sutphen reserves the right to thoroughly examine the vehicle or parts thereof, prior to conducting or approving any repair or replacement, to determine whether the claimed failure is covered by this limited warranty. Sutphen's obligation under this warranty is strictly limited to repair or replacement as the company may elect.

This warranty shall be null and void if the frame shows any evidence of alterations, cutting, splicing, additional welding or drilling of rails or flanges without the written authorization of Sutphen. Further, this warranty shall be void if the vehicle is involved in an accident, shows signs of abuse, or evidence of being operated in an improper manner. The frame and under carriage shall be washed and painted, by the owner, where needed, semi-annually or as conditions require; if rust starts, it must be properly primed and painted or this warranty shall be voided.

Periodically check apparatus for chips and scratches in the paint and repair them with touch-up paint furnished upon delivery, or equal. Several times a year wash underneath the apparatus, especially during winter months. If power wash is used, use a fan spray only or it may damage the undercoating or paint. If damage of undercoating or paint occurs, prime, paint, and re-undercoat areas where bare metal is showing, or warranty shall be void.

If optional Ziebart undercoating is provided on the apparatus, purchaser is required to have undercoating inspected annually by an Authorized Ziebart Dealer for a minimum of 10 years.

This limited warranty covers only repair or replacement of any part of a Sutphen vehicle in which a defect in materials or workmanship appears within the limited warranty period. Examples of items not covered include, but are not limited to:

- A. --- Unauthorized alteration or modification to the vehicle, including the body, chassis or components, after completion of the vehicle assembly by Sutphen and any problems that occur as a result of such alterations or modifications.
- B. --- Damage caused by collision, fire, theft, freezing, vandalism, riot, explosion, acts of God, war or objects striking the vehicle or any damage covered by owner insurance.
- C. --- Damage caused by misuse or improper operation of the vehicle such as driving over curbs, overloading, racing or off-road use.
- D. --- Damage caused by failure to follow the requirements of the maintenance schedule.
- E. --- Towing charges and storage expenses.
- F. --- Incidental expenses such as loss of vehicle use, inconvenience, loss of time, vehicle rental, lodging or travel costs, vacation pay, etc.
- G. --- Damage caused from exposure to road de-icing compounds or use in an acidic environment.

This warranty terminates upon transfer of possession or ownership of the vehicle from the original purchaser.

THIS WARRANTY IS PROVIDED IN EXCLUSION OF ANY AND ALL OTHER REPRESENTATIONS, EITHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS, AND SUITABILITY FOR BUYER'S INTENDED USE. NO PERSON IS AUTHORIZED TO MAKE ANY REPRESENTATIONS OR WARRANTIES ON BEHALF OF SUTPHEN CORPORATION OTHER THAN SET FORTH HEREIN. ANY MODIFICATION TO THIS WARRANTY MUST BE IN WRITING AND APPROVED BY THE PRESIDENT OF SUTPHEN CORPORATION. THE PROVISIONS OF THIS LIMITED WARRANTY SHALL CONSTITUTE THE SOLE AND EXCLUSIVE REMEDIES OF A SUTPHEN VEHICLE PURCHASER.

For more information contact:
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October 25, 2016 Supersedes All Previous Warranties



PLUMBING WARRANTY TEN (10) YEARS

SUTPHEN CORPORATION (Sutphen) warrants the stainless steel pipe and ancillary brass fittings used in the construction of the water plumbing system, for a period of ten (10) years, provided the vehicle is used in a normal and reasonable manner. This limited warranty is extended only to the original user/purchaser.

Sutphen's obligation under this warranty is strictly limited to repairing or replacing as the company may elect. The company reserves the right to require any such repairs to be made either at a company owned service facility or another approved service facility at the company's option. Transportation cost to and from the servicing location is the responsibility of the user/purchaser. Further, this warranty shall be void if the vehicle is involved in an accident, shows signs of abuse, or evidence of being operated in an improper manner.

This limited warranty covers only repair or replacement of above mentioned item(s) in which a defect in materials or workmanship appears within the limited warranty period.

This warranty terminates upon transfer of possession or ownership of the vehicle from the original purchaser.

THIS WARRANTY IS PROVIDED IN EXCLUSION OF ANY AND ALL OTHER REPRESENTATIONS, EITHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS, AND SUITABILITY FOR BUYER'S INTENDED USE. NO PERSON IS AUTHORIZED TO MAKE ANY REPRESENTATIONS OR WARRANTIES ON BEHALF OF SUTPHEN CORPORATION OTHER THAN SET FORTH HEREIN. ANY MODIFICATION TO THIS WARRANTY MUST BE IN WRITING AND APPROVED BY THE PRESIDENT OF SUTPHEN CORPORATION. THE PROVISIONS OF THIS LIMITED WARRANTY SHALL CONSTITUTE THE SOLE AND EXCLUSIVE REMEDIES OF A SUTPHEN VEHICLE PURCHASER.

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March 1, 2012 Supersedes All Previous Warranties



PAINT WARRANTY TEN (10) YEARS

SUTPHEN CORPORATION (Sutphen) warrants vehicle exterior paint finish of fire apparatus against peeling, cracking, and lack of adhesion, provided the vehicle is used in a normal and reasonable manner. This limited warranty is extended only to the original user/purchaser.

Sutphen's obligation under this warranty is strictly limited to repairing or replacing as the company may elect. The company reserves the right to require any such repairs to be made either at a company owned service facility or another approved service facility at the company's option. Transportation cost to and from the servicing location is the responsibility of the user/purchaser. Further, this warranty shall be void if the vehicle is involved in an accident, shows signs of abuse, or evidence of being operated in an improper manner.

Periodically check apparatus for chips and scratches in the paint and repair them with touch-up paint furnished upon delivery, or equal paint. Several times a year wash underneath the apparatus, especially during winter months. If power wash is used, use a fan spray only or it may damage the undercoating or paint. If damage of undercoating or paint occurs, prime, paint, and re-undercoat areas where bare metal is showing.

Sutphen's obligation under this limited warranty is subject to these conditions:

1. The claimed failure shall have first appeared during the warranty period;
2. The original purchaser shall have notified Sutphen in writing of the claimed failure within thirty (30) days after the claimed failure shall have first appeared, and
3. Unless Sutphen directs otherwise, the claimed failed item or items shall have been returned to Sutphen, or to Sutphen designee, promptly after the notification, with transportation charges prepaid.

Sutphen reserves the right to thoroughly examine the vehicle or parts thereof, prior to conducting or approving any repair or replacement, to determine whether the claimed failure is covered by this limited warranty. Sutphen's obligation under this warranty is strictly limited to repair or replacement as the company may elect.

The warranty is pro-rated for a period of Ten (10) years from the date of delivery as follows: first year, one hundred percent; second year, one hundred percent; third year, one hundred percent; fourth year, fifty percent; fifth year, forty percent; sixth year, twenty five percent; seventh year, ten percent, eighth year, paint only, ninth year, paint only, tenth year, paint only. Paint only coverage from the paint manufacturer covers top coat and appearance only (gloss and color retention).

This limited warranty covers only repair or replacement of any part of a Sutphen vehicle in which a defect in materials or workmanship appears within the limited warranty period. Examples of items not covered include, but are not limited to:

- A. ---Major components or trade accessories that have a separate warranty by the original manufacturer, or to equipment used in fire fighting.
- B. ---An unauthorized alteration or modification to the vehicle, including the body, chassis or components, after completion of the vehicle assembly by Sutphen and any problems that occur as a result of such alterations or modifications.
- C. ---Damage caused by collision, fire, theft, freezing, vandalism, riot, explosion, acts of God, war or objects striking the vehicle or any damage covered by owner insurance.
- D. ---Damage caused by misuse or improper operation of the vehicle such as driving over curbs, overloading, racing or off-road use.
- E. ---Damage caused by failure to follow the requirements of the maintenance schedule, failure to maintain proper fluid and lubricant levels and failure to follow operating instructions.
- F. ---Incidental expenses such as loss of vehicle use, inconvenience, loss of time, vehicle rental, loading or travel costs, vacation pay, etc.
- G. ---Gold leaf or striping and Scotchlite emblems or decals, except that which is affected by repair.
- H. ---Damage caused from exposure to road de-icing compounds or use in an acidic environment.
- I. ---Damage caused from not following cab and body washing procedures on truck and in Operation and Maintenance manual.
- J. ---Defects if vehicle is damaged, dented, scratched or rusted from severe salt or road corrosive materials, or faded or discolored by exposure to heat or severe sun conditions or environmental conditions.
- K. ---This warranty shall not apply to non-exterior surface areas (i.e. compartment interiors, undercarriages).
- L. ---This warranty shall only apply to exterior coatings applied by Sutphen Corporation and specifically excludes all coating applications applied by other manufacturers including chassis and chassis compartments.

continued

- O. --- This warranty shall exclude accessory vendor equipment that is painted to match the finished vehicle.
- P. --- This warranty shall exclude painted roll-up doors.
- Q. --- Hazing, chalking or loss of gloss caused by improper care, abrasive polishes, cleaning agents, heavy duty pressure washing or aggressive mechanical wash system.
- R. --- Paint deterioration caused by abuse, accidents, acid rain, chemical fallout or acts of nature.
- S. --- Accidents, scratches, chips, bruises and gloss reduction due to normal vehicle use and maintenance.
- T. --- Third party undercoatings like Ziebart or Krown are not covered in this warranty.

This warranty terminates upon transfer of possession or ownership of the vehicle from the original purchaser.

THIS WARRANTY IS PROVIDED IN EXCLUSION OF ANY AND ALL OTHER REPRESENTATIONS, EITHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS, AND SUITABILITY FOR BUYER'S INTENDED USE. NO PERSON IS AUTHORIZED TO MAKE ANY REPRESENTATIONS OR WARRANTIES ON BEHALF OF SUTPHEN CORPORATION OTHER THAN SET FORTH HEREIN. ANY MODIFICATION TO THIS WARRANTY MUST BE IN WRITING AND APPROVED BY THE PRESIDENT OF SUTPHEN CORPORATION. THE PROVISIONS OF THIS LIMITED WARRANTY SHALL CONSTITUTE THE SOLE AND EXCLUSIVE REMEDIES OF A SUTPHEN VEHICLE PURCHASER.

For more information contact:
Sutphen Corporation / Warranty Admin.
49 N. Ludlow Road • Urbana, OH 43078
Phone (937) 969-8851 • Toll Free (866) 287-5549

September 12, 2019 Supersedes All Previous Warranties

▼ **Warranty**

List of Vendors You Should Contact Directly for Warranty Parts/Repair
Akron Brass
800-228-1161
http://onlinerepair.akronbrass.com/
Allison
317-242-5000
www.allisontransmission.com/
Amdor
877-462-6367
http://amdor.com/warranty
Cummins
1-800-CUMMINS
www.care.cummins.com
Federal Signal
800-433-9132
empserviceinfo@fedsig.com
Kussmaul
800-346-0857
www.kussmaul.com/parts%20return.html
Meritor
866-668-7221
OnTrac@Meritor.com
Pro Air
574 264 5494 or 800 338 8544
www.proairllc.com/index.php?route=information/contact
Safety Vision
800-880-8855
www.safetyvision.com/warranty-request

Appendix A

ALLISON TRANSMISSION

EMERGENCY VEHICLE SERIES

3000/4000

ALLISON 5th GENERATION CONTROLS

OPERATOR'S MANUAL



DRIVING TRANSMISSION TECHNOLOGY®

3000/4000

OPERATOR'S MANUAL

ALLISON 5th GENERATION CONTROLS

EMERGENCY VEHICLE SERIES

DECEMBER 2012

Operator's Manual

2012 DECEMBER
OM7154EN

Allison Transmission

Allison 5th Generation Controls

3000 and 4000 Product Families



Allison
Transmission

Allison Transmission, Inc.
P.O. Box 894 Indianapolis, Indiana 46206-0894
www.allisontransmission.com

IMPORTANT SAFETY INFORMATION

IT IS YOUR RESPONSIBILITY to be completely familiar with the warnings and cautions in this manual. These warnings and cautions advise of specific methods or actions that can result in personal injury, equipment damage, or cause the equipment to become unsafe. These warnings and cautions are not exhaustive. Allison Transmission could not possibly know, evaluate, or advise the service trade of all conceivable procedures by which service might be performed or of the possible hazardous consequences of each procedure. Accordingly, **ANYONE WHO USES A SERVICE PROCEDURE OR TOOL WHICH IS NOT RECOMMENDED BY ALLISON TRANSMISSION MUST** first be thoroughly satisfied that neither personal safety nor equipment safety will be jeopardized by the service methods used.

Vehicle manufacturers integrate Allison transmissions into vehicles used for a variety of vocations and services. The vehicle manufacturer is responsible for identifying the specific operating conditions to which the vehicle will be subjected and to communicate the appropriate means for preventing unintended vehicle movement within those conditions, in order to ensure vehicle and operator safety. The vehicle owner and operator should be aware of and follow the vehicle manufacturer's operating instructions and warnings related to parking and preventing unintended vehicle movement.

Proper service and repair is important to the safe and reliable operation of the equipment. The service procedures recommended by Allison Transmission (or the vehicle manufacturer) and described in this manual are effective methods for performing service and diagnostic operations. Some procedures require using specially designed tools. Use special tools when and in the manner recommended.

The **WARNINGS, CAUTIONS, and NOTES** in this manual apply only to the Allison transmission and not to other vehicle systems which may interact with the transmission. Be sure to review and observe any vehicle system information provided by the vehicle manufacturer and/or body builder at all times the Allison transmission is being serviced.

WARNINGS, CAUTIONS, NOTES

Three types of headings are used in this manual to attract your attention:



WARNING: A warning is used when an operating procedure, practice, etc., which, if not correctly followed, could result in personal injury or loss of life.



CAUTION: A caution is used when an operating procedure, practice, etc., which, if not strictly observed, could result in damage to or destruction of equipment.



NOTE: A note is used when an operating procedure, practice, etc., is essential to highlight.

ABBREVIATIONS AND ACRONYMS

• ABP	Acceleration Based Pattern
• ABS	Anti-lock Brake System
• C1	Clutch 1
• C5	Clutch 5
• CMC	Customer Modifiable Constant
• DMD	Display Mode/Diagnostic
• DTC	Diagnostic Trouble Code
• DTCs	Diagnostic Trouble Codes
• EVS	Emergency Vehicle Series
• FCC	Federal Communications Commission
• FLGS	Full Load Governed Speed
• FLI	Filter Life Indicator
• FM	Filter Life Monitor
• I/O	Input/Output
• LBSS	Load-Based Shift Scheduling
• LU	Lockup
• OEM	Original Equipment Manufacturer
• OFS	Oil Field Series
• OLS	Oil Level Sensor
• OM	Oil Life Monitor
• PCS1	Pressure Control Solenoid 1
• PCS2	Pressure Control Solenoid 2
• PS1	Pressure Switch 1
• PTO	Power Takeoff
• rpm	Revolutions Per Minute
• SAE	Society of Automotive Engineers
• SESS	Super Economy Shift Schedule
• TCM	Transmission Control Module
• TM	Transmission Health Monitor
• VAC	Vehicle Acceleration Control
• VFD	Vacuum Fluorescent Display
• VIM	Vehicle Interface Module
• WOT	Wide Open Throttle

TRADEMARK USAGE

The following trademarks are the property of the companies indicated:

- Allison DOC[®] is a Registered Trademark of Allison Transmission, Inc.

LIST OF WARNINGS

This manual contains the following warnings—

IT IS YOUR RESPONSIBILITY TO BE FAMILIAR WITH ALL OF THEM.

- **When starting the engine, make sure the service brakes are applied. Failure to apply service brakes may result in unexpected vehicle movement.**
- **If you leave the vehicle and the engine is running, the vehicle can move unexpectedly and you or others could be injured. If you must leave the engine running, DO NOT LEAVE the vehicle until you have completed all of the following procedures:**
 - **Put the transmission in N (Neutral).**
 - **Be sure the engine is at low idle (500–800 rpm).**
 - **Apply the parking and emergency brakes and make sure they are properly engaged.**
 - **Chock the wheels and take other steps necessary to keep the vehicle from moving.**
- **The vehicle service brakes, parking brake, or emergency brake must be applied whenever N (Neutral) is selected to prevent unexpected vehicle movement. Selecting N (Neutral) does not apply the vehicle brakes unless an auxiliary system to apply the parking brake is installed by the OEM.**
- **Using the retarder on wet or slippery roads may cause loss of traction on the drive wheels—your vehicle may slide out of control. To help avoid injury or property damage, turn the retarder enable to OFF when driving on wet or slippery roads.**
- **To help avoid injury or property damage caused by sudden movement of the vehicle, do not make shifts from N (Neutral) to D (Drive) or R (Reverse) when the throttle is open. The vehicle may lurch forward or rearward and the transmission can be damaged. Avoid this condition by making shifts from N (Neutral) to a forward range or R (Reverse) only when the throttle is closed and the service brakes are applied.**

LIST OF WARNINGS (cont'd)

This manual contains the following warnings—
IT IS YOUR RESPONSIBILITY TO BE FAMILIAR WITH ALL OF THEM.

- To help avoid unexpected vehicle movement that might cause death, serious injury, or property damage, always have your foot on the brake, the throttle released, and the engine at idle before making a N (Neutral) to D (Drive); N (Neutral) to R (Reverse); D (Drive) to R (Reverse); or R (Reverse) to D (Drive) selection.
- R (Reverse), R1 (Deep Reverse), or R2 (Standard Reverse) may not be attained due to an active inhibitor. Always apply the service brakes when selecting R (Reverse), R1 (Deep Reverse), or R2 (Standard Reverse) to prevent unexpected vehicle movement and because a service brake inhibit may be present. When R, R1, or R2 is flashing, it indicates the shift to R (Reverse), R1 (Deep Reverse), or R2 (Standard Reverse) is inhibited. Determine if diagnostic codes are active if R (Reverse), R1 (Deep Reverse), or R2 (Standard Reverse) is not attained. Refer to **7.5 SELECTOR DISPLAY DESCRIPTIONS FOR ACTIVE DIAGNOSTIC TROUBLE CODES (DTCs) AND INHIBITS**
- When starting the engine, make sure the service brakes are applied. Failure to apply the service brakes can result in unexpected vehicle movement.
- If you let the vehicle coast in N (Neutral), there is no engine braking and you could lose control. Coasting can also cause severe transmission damage. To help avoid injury and property damage, do not allow the vehicle to coast in N (Neutral).
- D (Drive) may not be attained due to an active inhibitor. Always apply the service brakes when selecting D (Drive) to prevent unexpected vehicle movement and because a service inhibit may be present. When the selected range is flashing, it indicates the shift to D (Drive) is inhibited. Determine if diagnostic codes are active if D (Drive) is not attained. Refer to **7.5 SELECTOR DISPLAY DESCRIPTIONS FOR ACTIVE DIAGNOSTIC TROUBLE CODES (DTCs) AND INHIBITS.**

LIST OF WARNINGS (cont'd)

This manual contains the following warnings—

IT IS YOUR RESPONSIBILITY TO BE FAMILIAR WITH ALL OF THEM.

- To avoid loss of control, use a combination of downshifting, braking, and other retarding devices. Downshifting to a lower transmission range increases engine braking and can help you maintain control. The transmission has a feature to prevent automatic upshifting above the lower range selected. However, during downhill operation, if engine governed speed is exceeded in the lower range, the transmission will upshift to the next higher range to prevent engine damage. This will reduce engine braking and could cause a loss of control. Apply the vehicle brakes or other retarding device to prevent exceeding engine governed speed in the lower range selected.
- **DO NOT USE THE RETARDER DURING INCLEMENT WEATHER OR WHEN ROAD SURFACES ARE SLIPPERY.**

Use of the hydraulic retarder during inclement weather or when road surfaces are slippery could result in death, serious injury, or property damage. On vehicles which have a primary retarder control based upon closed throttle position, brake pedal position, or brake apply pressure, always manually disable the retarder controls during inclement weather or slippery road conditions, using the OEM provided retarder enable switch if present.

If the transmission retarder does not apply, death, serious injury, or property damage may occur. Operator should be prepared to apply vehicle brakes or other retarder device if the transmission retarder does not apply.

If the transmission retarder does not function, death, serious injury, or property damage may occur. Be sure to test for proper retarder function periodically. If a retarder is present but is not detected by “autodetect,” the retarder will not function. Whenever the retarder does not apply, seek service help immediately.

- Avoid contact with the hot fluid or the sump when draining transmission fluid. Direct contact with the hot fluid or the hot sump may result in bodily injury.

LIST OF WARNINGS (cont'd)

This manual contains the following warnings—
IT IS YOUR RESPONSIBILITY TO BE FAMILIAR WITH ALL OF THEM.

- **Without the J1939 communication datalink, the shift selector cannot display the selected transmission range. Vehicle operation will be affected.**
- **Assuming proper installation of direction signal wire 134, most Allison shift selectors may still be used to command transmission direction changes in these circumstances. Due to the failure of the SAE J1939 datalink communication, however, the shift selector cannot display the selected range. When this condition exists, it is advisable to slowly and carefully apply the throttle each time a change of direction has been selected in order to verify the direction of operation before accelerating the vehicle.**

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1.1 SCOPE OF MANUAL

1.2 SCOPE OF MANUAL

This Operator's Manual contains a variety of information about the Allison 3000 and 4000 Product Families Transmission, and its Allison 5th Generation Controls features. Refer to the Table of Contents to locate information by subject in this publication.

Additional information about your transmission is available at www.allisontransmission.com using the publications links shown on the home page. Refer to the Sales and Service Locator at www.allisontransmission.com to find contact and location information for Allison Transmission distributors and dealers.

If you need to contact an Allison Transmission representative, refer to the Customer Service section at the end of this publication for contact information.

2.1 INTRODUCTION

2.2 KEEPING THAT ALLISON ADVANTAGE



V01724

Emergency Vehicle Series (EVS) transmissions are ideally suited to meet the special needs of fire and emergency vehicles. Refer to [Figure 2-1](#) and [Figure 2-2](#) for non-PTO applications and [Figure 2-3](#) and [Figure 2-4](#) for PTO applications. Refer to [Figure 2-5](#) and [Figure 2-6](#) for 4700/4800 EVS transmissions.

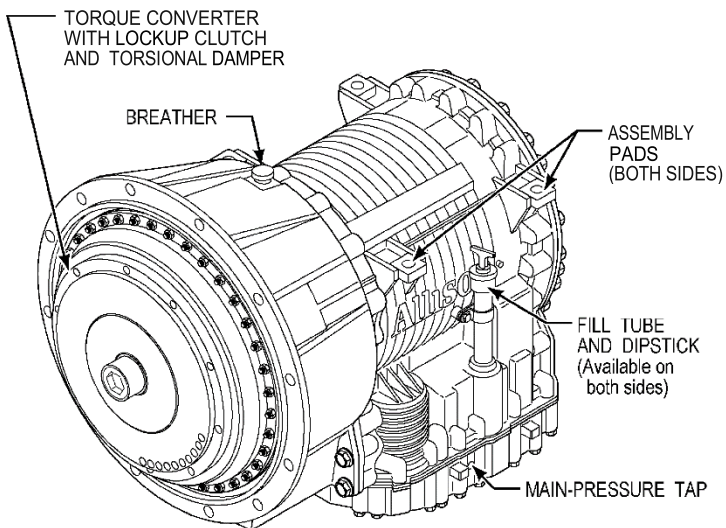
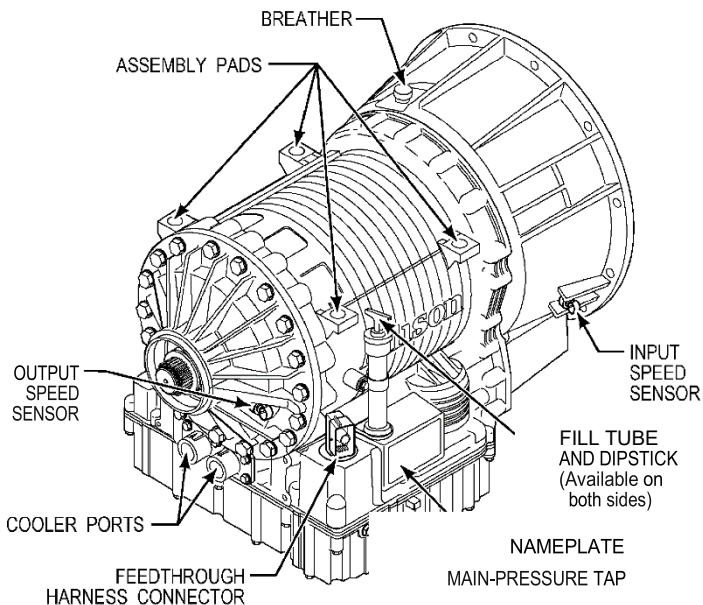
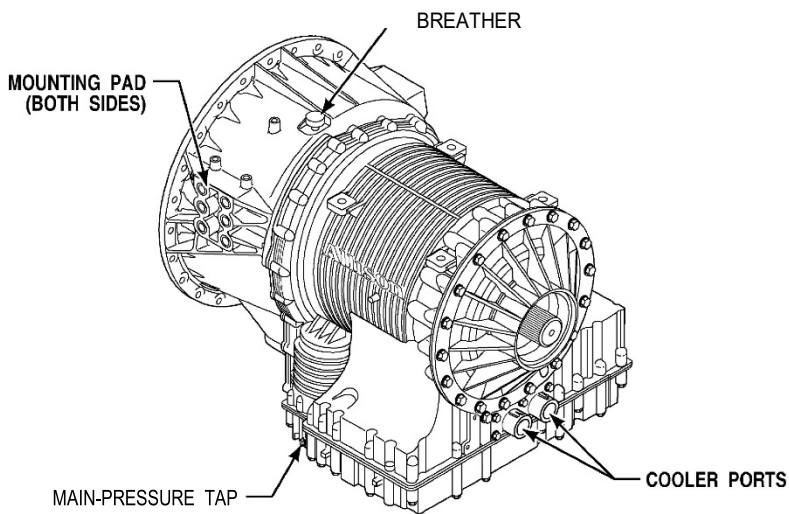
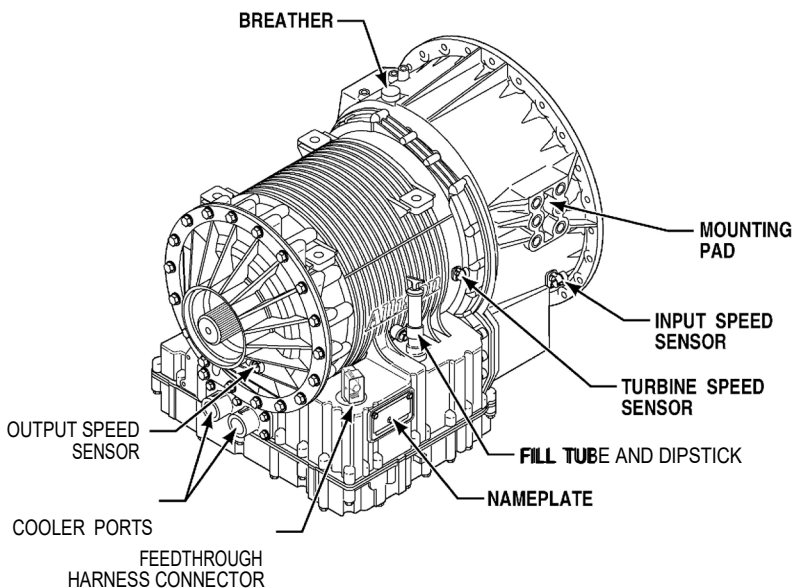


Figure 2-1. 3000/3500 EVS



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Figure 2-2. 4000/4500 EVS

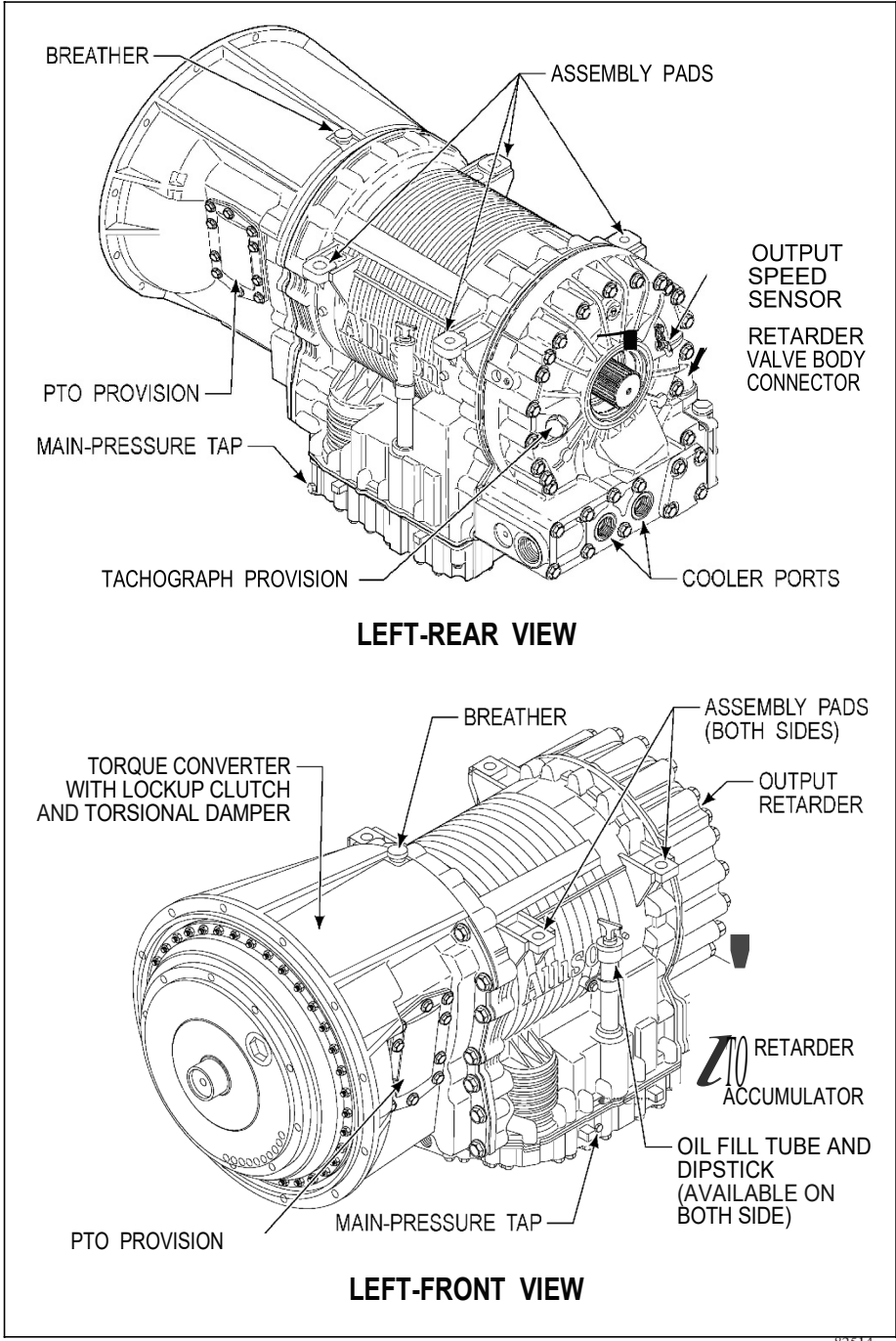
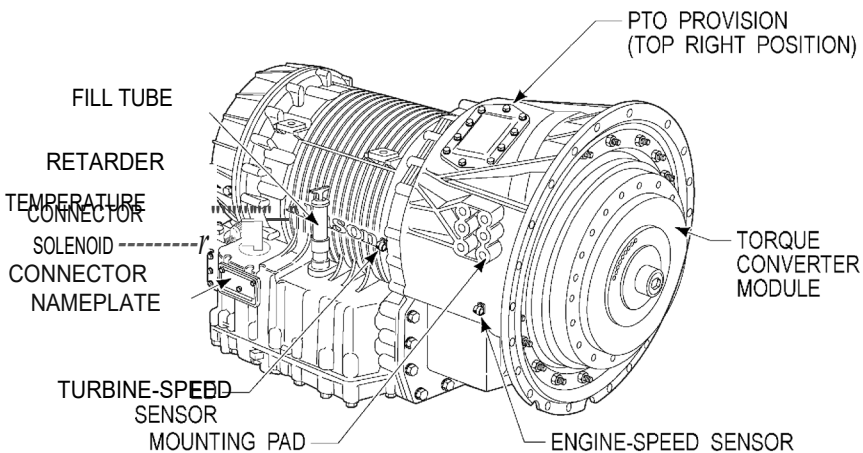
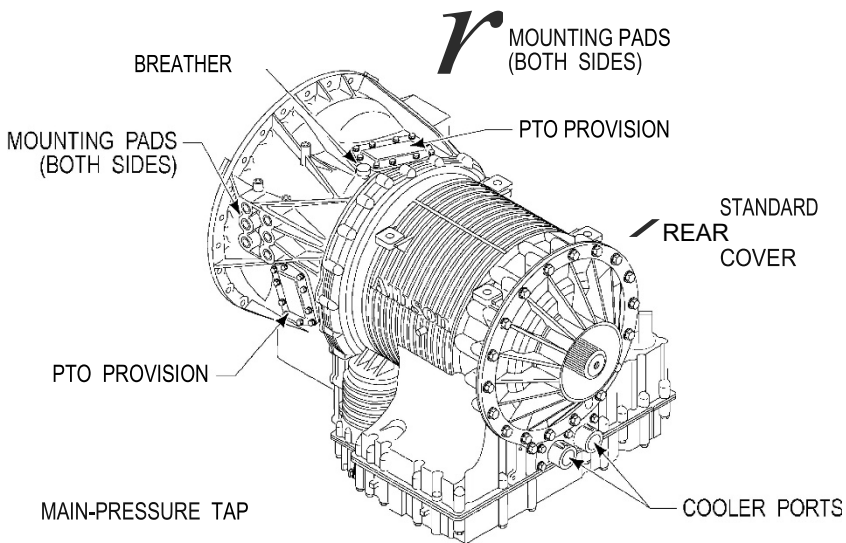


Figure 2-3. 3000/3500 EVS with PTO and Retarder



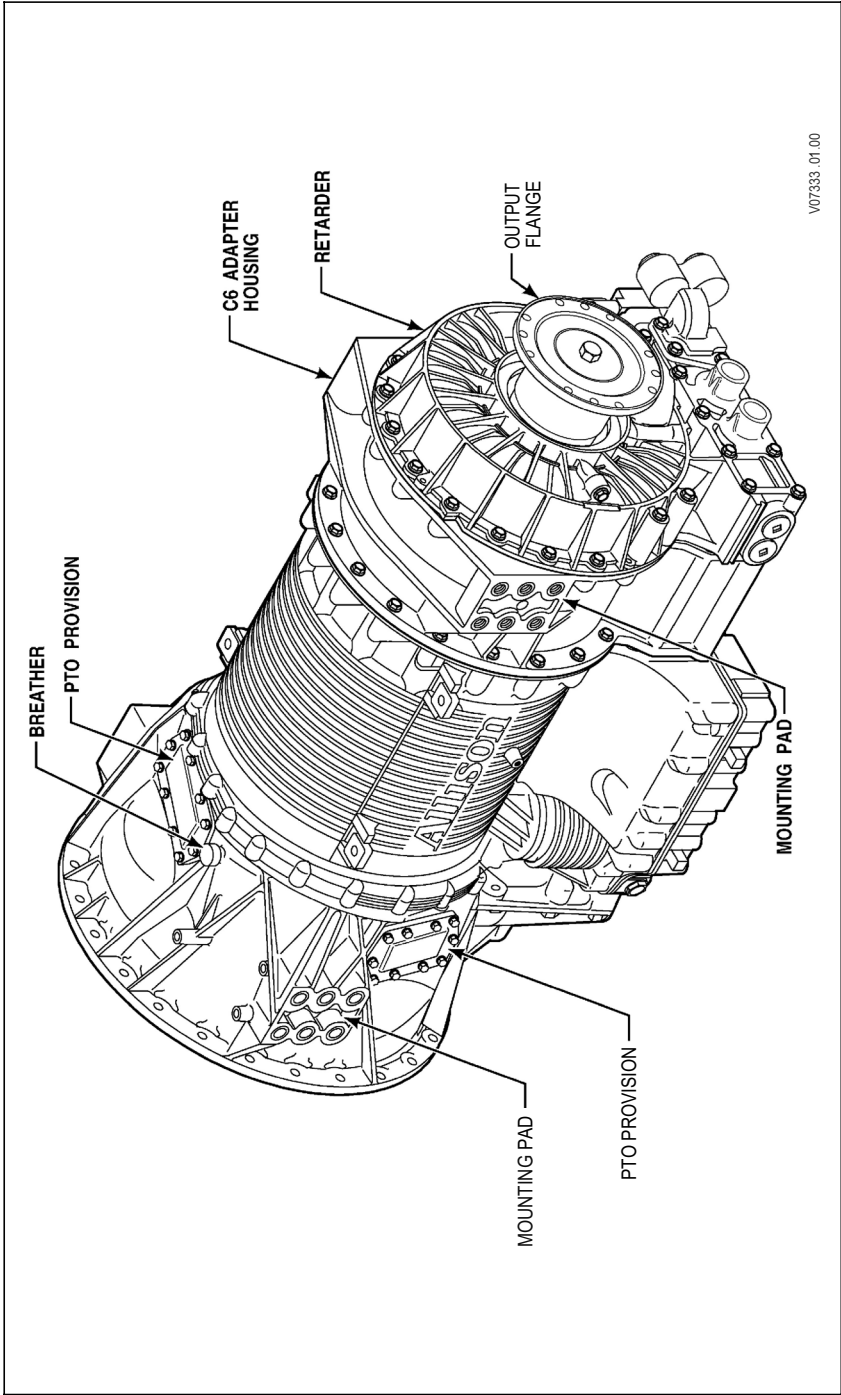
RIGHT-FRONT VIEW



LEFT-REAR VIEW

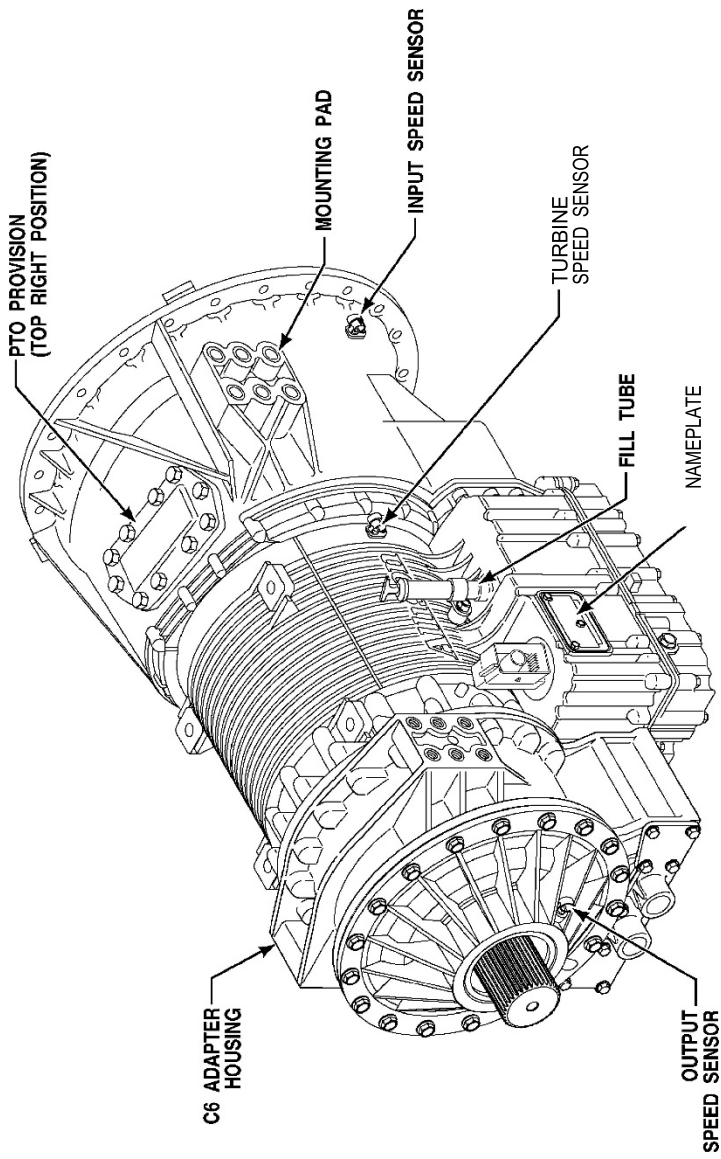
82520

Figure 2-4. 4000/4500 EVS with PTO and Retarder (Right-Front View) with PTO and without Retarder (Left-Rear View)



V07333 01.00

Figure 2-5. 4700/4800 EVS with PTO and Retarder



22067

Figure 2-6. 4700/4800 EVS with PTO

Typical vocations for this model include:

- Aerial Ladder Platform
- Aircraft Rescue and Fire-Fighting Vehicle
- Ambulance
- Hazardous Material Vehicle
- Mobile Command Center Pumper – With Split Shaft PTO
- Pumper – Without Split Shaft PTO
- Support Vehicle
- Tanker

3.1 DRIVING TIPS

3.2 THE AUTOMATIC EXPERIENCE

Smooth automatic upshifts and downshifts, without interruption of power to the wheels, occur in your Allison automatic transmission based on engine rpm, throttle position, vehicle load, road speed, and driver or feature request, such as manually preselecting ranges.

Allison automatic transmissions, along with a vehicle specification appropriate for the particular duty cycle, can provide superior fuel efficiency and optimum fuel economy. In vehicles with a manual or automated manual transmission, the power interrupts that occur during shifts reduce the engine's inertia energy, resulting in lower average wheel horsepower. Because the engine is not working efficiently, it cannot run at full load. With an Allison automatic transmission, there is no power interrupt during shift changes. The inertia energy built up by the engine is maintained, equating to higher wheel horsepower. As a result, not as much engine horsepower is needed to get the job done. Allison automatic transmissions provide smooth, seamless shifts at all points of the power curve, there is no jarring power interrupts to jostle the driver. Allison automatic transmission equipped vehicles are more nimble in traffic and easier to maneuver on congested routes. Allison EVS series fully automatic transmissions vehicles keep you on schedule with maximum operating economies and improved vehicle performance.

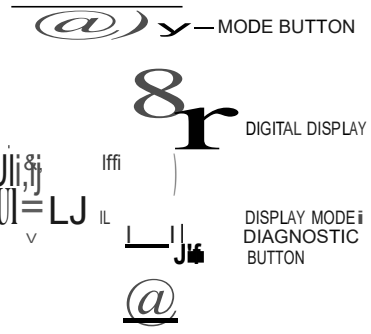
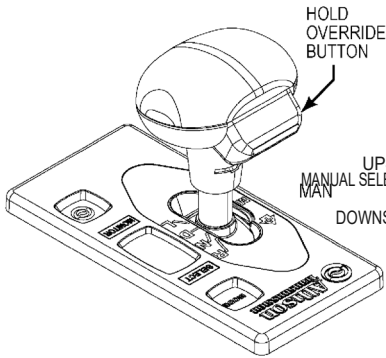
3.3 STARTING THE ENGINE



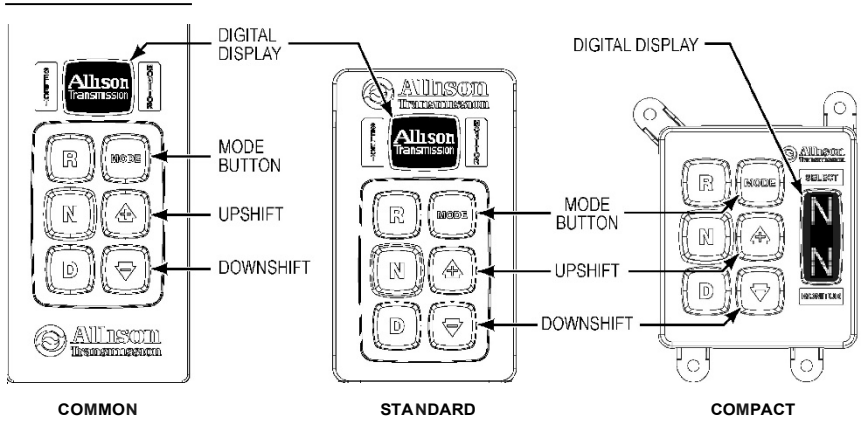
WARNING: When starting the engine, make sure the service brakes are applied. Failure to apply service brakes may result in unexpected vehicle movement.

No special procedure is required. If the vehicle is equipped with a bump-shift lever selector, the driver must simply verify that the brakes are applied and **N** (Neutral) has been selected. The keypad and strip pushbutton selectors will automatically initialize in **N** (Neutral) when the ignition is turned on. For keypad pushbutton and bump-shift lever selectors, the Vacuum Fluorescent Display (VFD) will display "N N" for Neutral between the **SELECT** and **MONITOR**

labels. This indicates that Neutral has been selected and attained, and the engine may now be started. Strip pushbutton selectors illuminate a lamp in the corner of the N button since they do not have a VFD. Refer to [7.0 ALLISON 5th GENERATION SHIFT SELECTORS COMPONENTS AND FUNCTIONS](#), [Figure 3–1](#), [Figure 3–2](#), and [Table 4–1](#) for additional information.

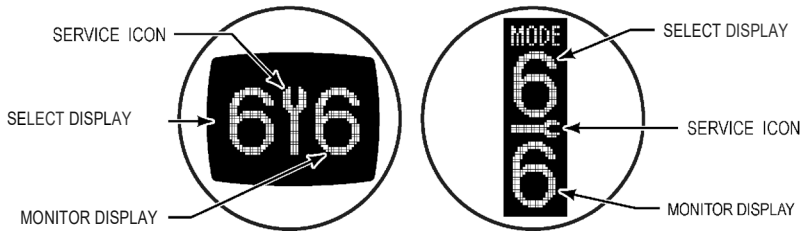


SHIFT SELECTORS



***NOTE:** The first number displayed in the digital display is the highest forward range available and second number is range attained in selected position .

Visually confirm that the range selected was attained. If display is flashing, shift is inhibited.



Location of service icon on vertical and horizontal digital display

348374

Figure 3-1. Typical Allison 5th Generation Shift Selectors

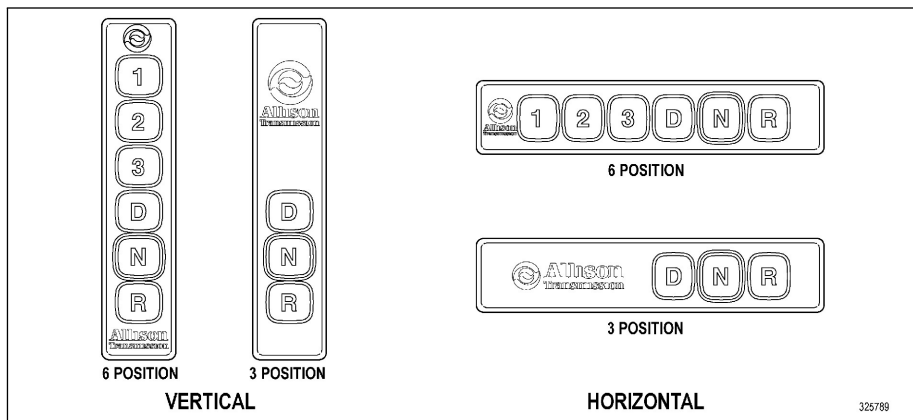


Figure 3–2. Typical Allison 5th Generation Strip Pushbutton Shift Selectors

3.4 COLD WEATHER STARTS

If the Transmission Fluid Temperature (TFT) sensor detects the transmission fluid is below -7°C (20°F), the transmission is programmed to start in 2nd gear (3rd gear for the 4700/4800 EVS transmission).

If the transmission fluid temperature is below 10°C (50°F) follow these procedures when making directional shift changes:

- To shift from forward to reverse, select **N** (Neutral) and then **R** (Reverse).
- To shift from reverse to forward, select **N** (Neutral) and then **D** (Drive) or another forward range.



NOTE: During cold fluid conditions, always place the transmission in **N** (Neutral) prior to any direction changes.



NOTE: Failure to follow these procedures during cold fluid conditions, may cause the **CHECK TRANS** light to illuminate and the transmission to be restricted to **N** (Neutral).

Transmission operation at extremely cold ambient temperatures may require preheating or the use of a TES 295 transmission fluid. Refer to [3.3.1 PREHEATING REQUIREMENT](#).

3.3.1 PREHEATING REQUIREMENT. If ambient temperatures drop below the specified minimum levels for the fluid type, preheat the transmission fluid before beginning transmission operation. The minimum fluid temperatures at which the transmission may be safely operated without preheating are shown in [Table 3-1](#).

Table 3-1. Fluid Type Specifications for Minimum Temperature

Fluid Type	Minimum Temperature	
	Celsius	Fahrenheit
TES 295	-35	-31
TES 389	-25	-13

Preheat the transmission fluid using one of the following methods:

- Use an auxiliary heat source such as a sump heater.
- Operate the transmission in **N** (Neutral) with the engine running at idle for a minimum of 20 minutes before attempting range operation.



CAUTION: Transmission malfunction or damage may occur if you operate the transmission with the fluid temperature below the minimum fluid temperature specification limit.

3.4 HIGH FLUID TEMPERATURE

The transmission is considered to be overheated when any of the following temperatures are exceeded:

Sump fluid	121°C (250°F)
Fluid to cooler	149°C (300°F)
Retarder out fluid	165°C (330°F)

Typical continuous sump temperature is 93°C (200°F).

If the transmission overheats during normal operation, make sure the transmission fluid level is correct. Refer to [5.8 PERIODIC FLUID LEVEL CHECKS](#).



CAUTION: The engine should never be operated for more than 10 seconds at full throttle with the transmission in range and the output stalled. Prolonged operation of this type will cause the transmission fluid temperature to become excessively high and will cause severe overheat damage to the transmission.

If the engine temperature gauge indicates a high temperature, the transmission is probably overheated. Stop the vehicle and check the cooling system. If it appears to be functioning properly, run the engine at 1200–1500 rpm with the transmission in **N** (Neutral). This should reduce the transmission and engine temperatures to normal operating levels in 2 or 3 minutes.

If the transmission and engine temperatures do not decrease, reduce the engine rpm. If the engine temperature indicates a high temperature, an engine or radiator problem is indicated. If high temperature in either the engine or transmission persists, stop the engine and have the overheating condition investigated by maintenance personnel.



NOTE: Some shift schedules may be inhibited as a result of operating conditions, such as engine or transmission fluid temperature.

3.5 TURNING OFF THE VEHICLE

Always select **N** (Neutral) before turning the vehicle off.

3.6 PARKING BRAKE



WARNING: If you leave the vehicle and the engine is running, the vehicle can move unexpectedly and you or others could be injured. If you must leave the engine running, **DO NOT LEAVE** the vehicle until you have completed all of the following procedures:

- Put the transmission in **N** (Neutral).
- Be sure the engine is at low idle (500–800 rpm).
- Apply the parking and emergency brakes and make sure they are properly engaged.
- Chock the wheels and take other steps necessary to keep the vehicle from moving.

The parking brake is only intended to secure an unattended vehicle with the ignition **off**. Always maintain the vehicle parking brake system according to

the manufacturer's specifications. The parking brake may not have sufficient capacity to restrain a vehicle with the engine running and the transmission in a forward or reverse range. When the vehicle is unattended and the engine is running, the transmission **must be in N** (Neutral) with the **brakes fully applied** and the **wheels chocked**.



WARNING: The vehicle service brakes, parking brake, or emergency brake must be applied whenever **N** (Neutral) is selected to prevent unexpected vehicle movement. Selecting **N** (Neutral) does not apply the vehicle brakes unless an auxiliary system to apply the parking brake is installed by the OEM.

3.7 ENGINE-DRIVEN POWER TAKEOFF (PTO)



CAUTION: Do not exceed the engagement and operational speed limits imposed on the driven equipment during the operation of the PTO. Exceeding the speed limits produces high hydraulic pressure in the PTO that can damage the PTO components. Consult the vehicle manufacturer's literature for these speed limits.

If a PTO is present, it is normally mounted on either the left or right side of the 3000 Product Family transmission. On the 4000 Product Family transmission, the PTO is located on the left side or on the top of the transmission. The PTO drive gear is engine-driven and therefore provides direct engine power. The PTO can be operated when the vehicle is either moving or stopped.

The PTO gear is in constant mesh with the drive gear in the converter housing. However, the PTO may either be constant-drive (output always powered) or clutch-driven. When the PTO is clutch-driven, the clutch is part of the PTO, not the transmission. A clutch-driven PTO is powered only when the PTO clutch is engaged.

All Allison Transmission-equipped vehicles with PTO enabled have engagement and operational speed limits programmed into the Transmission Control Module (TCM) to help protect PTO equipment. Be sure the limits for PTO engagement and operational speeds are not exceeded. Consult the vehicle manufacturer's literature for these speed limits. Some speed limits have default values which are programmed out of the operating range and need to be set for your particular PTO duty cycle. Consult your vehicle manufacturer to see if your transmission has been programmed and what operational limits have been established.

When the programmed engagement speed is exceeded, the PTO will not engage. The PTO engagement must be retried after the speed has been reduced. When operational speeds (either engine or transmission output) are exceeded, the PTO deactivates and the PTO engagement process must be repeated.

3.8 DRIVING ON SNOW OR ICE



WARNING: Using the retarder on wet or slippery roads may cause loss of traction on the drive wheels—your vehicle may slide out of control. To help avoid injury or property damage, turn the retarder enable to OFF when driving on wet or slippery roads.



NOTE: The retarder is disabled automatically whenever the vehicle ABS is active. However, in the event the ABS malfunctions, it is recommended that the retarder enable switch, if equipped, be disabled.

If possible, reduce vehicle speed and select a lower range before losing traction. Select the range that will not exceed the speed expected to be maintained.

Accelerate or decelerate very gradually to prevent the loss of traction. It is very important to decelerate gradually when a lower range is selected. It is important that you reach the selected lower range before attempting to accelerate. This avoids an unexpected downshift during acceleration.

3.9 ROCKING OUT



WARNING: To help avoid injury or property damage caused by sudden movement of the vehicle, do not make shifts from **N** (Neutral) to **D** (Drive) or **R** (Reverse) when the throttle is open. The vehicle may lurch forward or rearward and the transmission can be damaged. Avoid this condition by making shifts from **N** (Neutral) to a forward range or **R** (Reverse) only when the throttle is closed and the service brakes are applied.



CAUTION: DO NOT make **N** (Neutral) to **D** (Drive) or directional shift changes when the engine rpm is above idle. Also, if the wheels are stuck and not turning, do not apply full power for more than 10 seconds in either **D** (Drive) or **R** (Reverse). Full power for more than 10 seconds under these conditions causes the transmission to overheat. If the transmission overheats, shift to **N** (Neutral) and operate the engine at 1200-1500 rpm until it cools (2-3 minutes).

If the vehicle is stuck in deep sand, snow, or mud, it may be possible to rock it out using the following procedure:

1. Shift to **D** (Drive) and apply a steady, light throttle (never full throttle).
2. When the vehicle has rocked forward as far as it will go, apply and hold the vehicle service brakes.
3. When engine has returned to idle, select **R** (Reverse).
4. Release the vehicle service brakes and apply a steady, light throttle (never full throttle) allowing the vehicle to rock in **R** (Reverse) as far as it will go.
5. Apply and hold the vehicle service brakes and allow the engine to return to idle.

This procedure may be repeated in **D** (Drive) and **R** (Reverse) if each directional shift continues to move the vehicle a greater distance.

3.10 TOWING OR PUSHING



CAUTION: Failure to lift the drive wheels off the road, disconnect the driveline or remove the axle shafts before towing or pushing can cause serious transmission damage.



NOTE: The engine cannot be started by pushing or towing.



NOTE: When the axle shafts are removed, make sure the wheel openings are covered to prevent loss of lubricant and entry of dust and dirt.

Before pushing or towing a vehicle with a 3000 or 4000 series transmission, do one of the following:

- Lift the drive wheels off the road.

- Disconnect the driveline, or
- Remove the axle shafts.

An auxiliary air supply is usually required to actuate the vehicle brake system.

3.11 USING 2ND REVERSE (4700/4800 ONLY)

Selected calibrations for the 4700/4800 models offer an option for two reverse gears – a standard reverse gear ratio of 4.80 (shown as R2 in the selector display) and the optional deeper reverse ratio of 17.12 (shown as R1 in the selector display).

The Allison 2nd Reverse feature offers these operational benefits:

- Greater control and engine braking during operation on steep grades.
- More maneuverability when operating in confined spaces.
- Slow creep capability with high engine speeds.

Refer to [4.1 SELECTING RANGE](#) and [7.0 ALLISON 5th GENERATION SHIFT SELECTORS COMPONENTS AND FUNCTIONS](#) for additional information.

4.1 SELECTING RANGE AND SHIFT SCHEDULES

4.2 SELECTING RANGE



WARNING: To help avoid unexpected vehicle movement that might cause death, serious injury, or property damage, always have your foot on the brake, the throttle released, and the engine at idle before making a **N** (Neutral) to **D** (Drive); **N** (Neutral) to **R** (Reverse); **D** (Drive) to **R** (Reverse); or **R** (Reverse) to **D** (Drive) selection.



NOTE: Conditions responsible for illuminating the **CHECK TRANS** indicator will not allow any shift selector changes until the DTC related to the condition goes inactive. The MONITOR display shows the range the transmission has locked in because of an active DTC. The SELECT display goes blank when the **CHECK TRANS** indicator is on. Move the vehicle to a safe location before turning off the vehicle and seek qualified assistance if needed. Even if the transmission is not in **N** (Neutral), the operator will be able to view DTCs by simultaneously pressing the ↑ (Upshift) and ↓ (Downshift) arrows, if equipped with the keypad pushbutton shift selector, or by pressing the **DISPLAY MODE/DIAGNOSTIC** (DMD) button, if equipped with the bump-shift lever selector.

With an Allison Transmission, the shift selector is used by the operator to select **N** (Neutral), **R** (Reverse), or a range of forward gears. When a forward range has been selected, the transmission starts in the lowest gear of the range and, as conditions permit, automatically upshifts to the highest gear in the selected range. Selected 7-speed models in the 4000 Product Family offer an option for two reverse gears – the standard reverse gear ratio and an optional deeper reverse ratio. During certain operating conditions the control system may inhibit transmission operation or range shifts.

4.2.1 USING KEYPAD PUSHBUTTON SHIFT SELECTOR TO SELECT RANGE. Refer to [Figure 4-1](#).

- **R – REVERSE:** selects Reverse gear.
- **N – NEUTRAL:** selects Neutral. The area around the N button is a raised ridge so the driver can identify the pushbuttons by touch, without looking at the display. It is not necessary to press this button prior to starting the vehicle.
- **D – DRIVE:** selects the highest available forward range. The transmission shifts to the starting gear and will automatically upshift through the gears, as operating conditions permit, until the highest available gear is attained.

4.2.1.1 USING UPSHIFT AND DOWNSHIFT ARROW BUTTONS

The ↑ (Upshift) and ↓ (Downshift) arrows are used to change the range selected to a higher or lower forward range:

- One press of the ↓ (Downshift) arrow sets range **SELECT** to the same forward range as the current forward range attained shown in the **MONITOR** position on the display. This type of preselect is called an Express Preselect.
- Each subsequent press of the ↓ (Downshift) arrow decreases the range selected by one range.
- One press of the ↑ (Upshift) arrow increases the range selected by one range.
- If the ↑ (Upshift) or ↓ (Downshift) arrow is held continuously, the selected range will continue to change up or down until the button is released or until the highest or lowest possible range of gears is selected.



NOTE: Pressing the ↓ (Downshift) arrow while in R2 (Standard Reverse) will select R1 (Deep Reverse) in select 4700/4800 model calibrations when the vehicle is stopped.

4.2.2 USING BUMP-SHIFT LEVER SELECTOR TO SELECT RANGE.

Refer to [Figure 4-1](#).

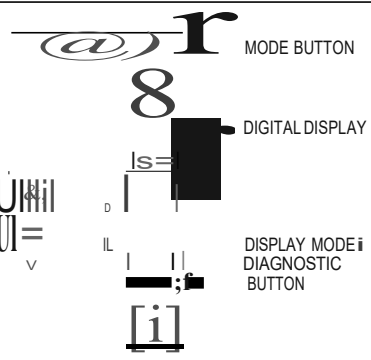
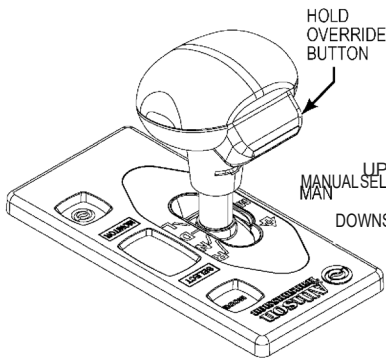
- **R – REVERSE:** selects Reverse gear. Bumping the lever toward R will select the alternate reverse gear range in select 4700/4800 model calibrations.
- **N – NEUTRAL:** must be selected prior to starting the engine.
- **D – DRIVE:** selects the highest available forward range. Transmission shifts to starting gear and will automatically upshift through the gears, as operating conditions permit, until the highest available gear is attained.

- **L – LOW RANGE:** selects the lowest available forward range. The transmission will automatically downshift to the lowest range using the preselect downshift schedule. Once attained, the transmission will hold the low range until another range is selected.
- **M – MANUAL SELECT:** moving the lever from the Drive position into the Manual Select position allows the operator to select a lower or higher forward gear range.
- Initially moving the lever to M sets the Range Selected to the same forward range as the current Range Attained, shown in the **MONITOR** position on the display, also referred to as an Express Preselect.
- Each DOWNSHIFT (-) bump decreases the Range Selected by one forward range.
- Each UPSHIFT (+) bump increases the Range Selected by one forward gear range.
- These are momentary bump positions – when the operator releases the lever, the lever returns to the Drive position.
- The Manual Select position is accessible only from the Drive position and affects only forward gear ranges.

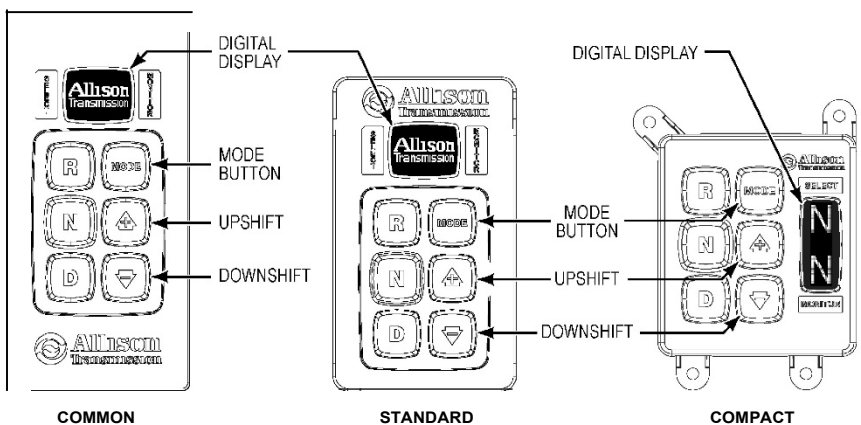
Detent: The lever selector features a detent to prevent inadvertent shifting between **R** (Reverse), **N** (Neutral), **D** (Drive), and **L** (Low). To release the lever from any of these positions, the detent must first be unlocked by depressing the finger release button on the shifter handle.

The bump-shift lever selector is available in the following configurations:

- Lever Right-hand, Reverse to Front (LRRF)
- Lever Right-hand, Reverse to Rear (LRRR)
- Lever Left-hand, Reverse to Front (LLRF)
- Lever Left-hand, Reverse to Rear (LRRR)



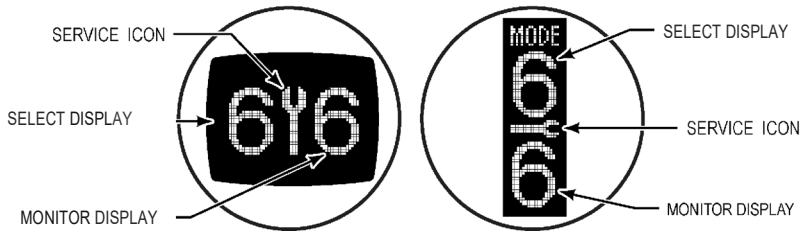
SHIFT SELECTORS



PUSHBUTTON SELECTORS

***NOTE:** The first number displayed in the digital display is the highest forward range available and second number is range attained in selected position .

Visually confirm that the range selected was attained. If display is flashing, shift is inhibited.



Location of service icon on vertical and horizontal digital display

348374

Figure 4-1. Typical Allison 5th Generation Prognostics Shift Selectors

4.2.2.1 USING STRIP PUSHBUTTON SELECTOR TO SELECT RANGE

Refer to [Figure 4-2](#).



NOTE: The strip pushbutton selectors do not include a Vacuum Fluorescent Display (VFD). These installations require the installation of a separate SAE J1939-compatible displays to alert the operator of conditions monitored by the optional prognostics feature.

- **R – REVERSE:** selects Reverse gear.
- **N – NEUTRAL:** it is not necessary to press this button prior to starting the vehicle.
- **D – DRIVE:** selects the highest available forward range. Transmission shifts to the starting gear and will automatically upshift through the gears, as operating conditions permit, until the highest available gear is attained.



NOTE: When a button is pressed by the operator, a light in the upper right corner of the button is illuminated. Pushing buttons labeled 1, 2, or 3 selects those ranges.

The strip pushbutton selector is available in four configurations:

- Three horizontal buttons – R,N,D
- Three vertical buttons – R,N,D
- Six horizontal buttons – R,N,D,3,2,1
- Six vertical buttons – R,N,D,3,2,1

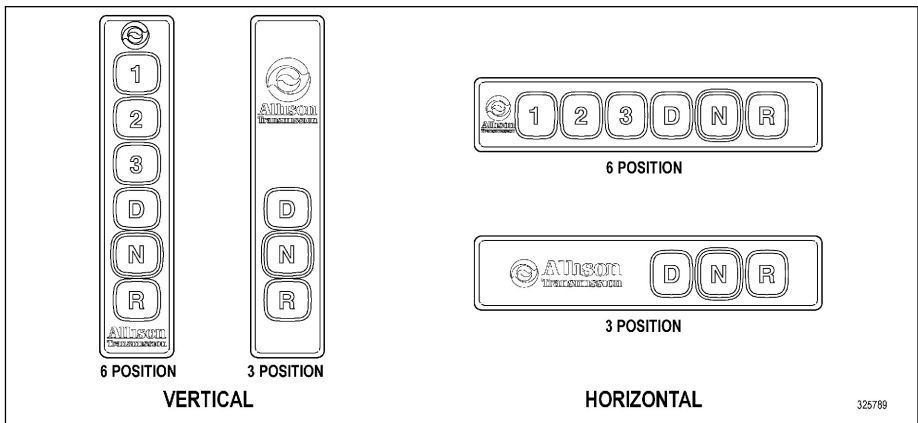


Figure 4–2. Typical Allison 5th Generation Strip Pushbutton Shift Selectors

4.2.3 SELECTOR DISPLAY FLASHING (INHIBITS). When appropriate, the transmission control system automatically invokes an inhibit to protect against certain types of abusive operation, such as:

- **Engine speed inhibit:** prevents shift from neutral to either a forward range or reverse if the engine speed is above 900 rpm. This feature is disabled in emergency vehicles and some other types of specialized equipment.

If the engine speed drops below the inhibit speed within a specified grace period of 3-seconds, the inhibit will self-clear and the requested shift will be commanded. The same 3-second grace period is permitted for applications with an enabled Neutral Indicator for PTO output function.

- **Neutral-to-Range Assist:** in vehicles with optional Neutral-to-Range Assist feature. Engine management commands are sent from the transmission controller which will attempt to reduce the engine speed when the engine speed is greater than the transmission’s allowable limit and a shift from Neutral to forward or reverse has been requested with the shift selector. The operator must have the service brakes applied. This feature must be specified when the TCM calibration is defined.
- **Direction change inhibit:** prevents shifting the transmission from forward-to-reverse or from reverse-to-forward if transmission output speed or throttle percentage is present. Rocking out by shifting from **D** (Drive) to **R** (Reverse) and **R** (Reverse) to **D** (Drive) is still available to the operator provided these parameters are below the limit allowed for rocking out the vehicle.



NOTE: If the elevated output speed or throttle position drops below the inhibit threshold within a specified grace period of 3 seconds, the inhibit will self-clear and the requested shift will be commanded.



NOTE: The flashing of the SELECT range indicates a requested shift is either temporarily or permanently inhibited. The inhibit may clear if the cause of the inhibit clears within 3 seconds of the shift request. Otherwise, the operator must re-select the desired range.

Inhibit Rolling Direction Changes: This optional feature inhibits forward/reverse directional change shifts unless the output shaft speed is nearly stopped. The TCM will indicate that the shift is inhibited by flashing the range SELECT digit on the shift selector. If the elevated output speed or throttle position drops below the inhibit threshold within a specified grace period of 3 seconds, the inhibit will self-clear and the requested shift will be commanded.







NOTE: This feature is typically used in vehicles that are geared for relatively low road speed, such as street sweepers and dock spotters. This optional feature must be specified when defining the TCM calibration.

Shifts from **N** (Neutral) to **D** (Drive) or **N** (Neutral) to **R** (Reverse) are also inhibited when the TCM has been programmed (by input/output function) to detect that auxiliary equipment is in operation and the shift should not be allowed.



NOTE: If the controls have set a diagnostic code that holds the transmission in the current range, the **SELECT** display on the shift selector will be blank. The **MONITOR** display will indicate the range in which the transmission is locked. The **CHECK TRANS** indicator will also be activated.

Table 4–1. DESCRIPTION OF AVAILABLE RANGES

Description of Available Ranges (refer to Figure 4–1)	
	<p>WARNING: If you leave the vehicle and the engine is running, the vehicle can move unexpectedly and you or others could be injured. If you must leave the engine running, DO NOT LEAVE the vehicle until you have completed all of the following procedures:</p> <ul style="list-style-type: none"> • Put the transmission in N (Neutral). • Be sure the engine is at low idle (500–800 rpm). • Apply the parking and emergency brakes and make sure they are properly engaged. • Chock the wheels and take other steps necessary to keep the vehicle from moving.
	<p>WARNING: R (Reverse), R1 (Deep Reverse), or R2 (Standard Reverse) may not be attained due to an active inhibitor. Always apply the service brakes when selecting R (Reverse), R1 (Deep Reverse), or R2 (Standard Reverse) to prevent unexpected vehicle movement and because a service brake inhibit may be present. When R, R1, or R2 is flashing, it indicates the shift to R (Reverse), R1 (Deep Reverse), or R2 (Standard Reverse) is inhibited. Determine if diagnostic codes are active if R (Reverse), R1 (Deep Reverse), or R2 (Standard Reverse) is not attained. Refer to 7.5 SELECTOR DISPLAY DESCRIPTIONS FOR ACTIVE DIAGNOSTIC TROUBLE CODES (DTCs) AND INHIBITS</p>
	<p>CAUTION: Do not idle in R (Reverse), R1 (Deep Reverse, or R2 (Standard Reverse) for more than five minutes. Extended idling in these ranges can cause transmission overheating and damage. Always select N (Neutral) whenever time at idle exceeds five minutes.</p>
	<p>NOTE: Check the shift selector to verify the selected range whenever a button is pushed or the lever is moved to be sure the range selected is indicated. A flashing range select character in the VFD indicates the range selected was not attained due to an active inhibit. Refer to 4.1.3 SELECTOR DISPLAY FLASHING (INHIBITS) for additional information.</p>

Description of Available Ranges (refer to [Figure 4-1](#))




<p align="center">R or R2</p>	<p>Completely stop the vehicle and let the engine return to idle before shifting from a forward range to R (Reverse) or R2 and from R (Reverse) or R2 to a forward range. The keypad pushbutton and bump-shift lever selector displays show R when R (Reverse) is selected, except for some 4700/4800 models that have the optional feature "2nd Reverse" allowing two reverse ranges. These models show R2 in the selector display when standard reverse (4.80 mechanical ratio) is selected. A strip pushbutton shift selector illuminates a light in the upper right corner of the R button after R (Reverse) is selected.</p>
<p align="center">R1</p>	<p>This optional feature for 4700/4800 models provides a deep reverse gear (17.12 ratio). Refer to 3.11 USING 2ND REVERSE (4700/4800 ONLY) for additional information.</p>
<p align="center"></p>	<p>WARNING: When starting the engine, make sure the service brakes are applied. Failure to apply the service brakes can result in unexpected vehicle movement.</p>
<p align="center"></p>	<p>WARNING: The vehicle service brakes, parking brake, or emergency brake must be applied whenever N (Neutral) is selected to prevent unexpected vehicle movement. Selecting N (Neutral) does not apply the vehicle brakes unless an auxiliary system to apply the parking brake is installed by the OEM.</p>
<p align="center"></p>	<p>WARNING: If you let the vehicle coast in N (Neutral), there is no engine braking and you could lose control. Coasting can also cause severe transmission damage. To help avoid injury and property damage, do not allow the vehicle to coast in N (Neutral).</p>
<p align="center">N</p>	<p>Use N (Neutral) when starting the engine to check vehicle accessories and for extended periods of engine idle operation (longer than five minutes). For vehicles equipped with the keypad pushbutton or strip pushbutton selector, N (Neutral) is selected by the TCM during start-up. For vehicles equipped with the bump-shift lever selector, the vehicle will not start unless N (Neutral) has been selected. If the vehicle starts in any range other than N (Neutral), seek service immediately. N (Neutral) is also used during stationary operation of the Power Takeoff (PTO) (if the vehicle is equipped with a PTO). The digital display shows N when N (Neutral) is selected. Always select N (Neutral) before turning off the vehicle engine.</p>

Table 4–1. DESCRIPTION OF AVAILABLE RANGES (cont'd)





Description of Available Ranges (refer to Figure 4–1)	
	<p>WARNING: D (Drive) may not be attained due to an active inhibitor. Always apply the service brakes when selecting D (Drive) to prevent unexpected vehicle movement and because a service inhibit may be present. When the selected range is flashing, it indicates the shift to D (Drive) is inhibited. Determine if diagnostic codes are active if D (Drive) is not attained. Refer to 7.5 SELECTOR DISPLAY DESCRIPTIONS FOR ACTIVE DIAGNOSTIC TROUBLE CODES (DTCs) AND INHIBITS.</p>
	<p>CAUTION: Do not idle in D (Drive) for more than five minutes. Extended idling in D (Drive) may cause transmission overheating and damage. Always select N (Neutral) if time at idle exceeds five minutes.</p>
	<p>NOTE: If equipped with a HIGH IDLE switch, turn the HIGH IDLE switch off before shifting from N (Neutral) to D (Drive) or R (Reverse). D (Drive) or R (Reverse) may not be attained unless the shift is made with the engine at idle. Also, be aware of other interlocks that would prevent attaining D (Drive) or R (Reverse). Example: “service brakes not applied” (service brake interlock present).</p>
D	<p>The transmission initially attains its lowest programmed range when D (Drive) is selected. As vehicle speed increases, the transmission upshifts automatically through each range. As the vehicle or equipment slows down, the transmission automatically downshifts to the correct range. The keypad pushbutton and bump-shift lever display shows the highest range available in D (Drive). The strip pushbutton illuminates the upper right corner of the D button when pushed.</p>
	<p>WARNING: To avoid loss of control, use a combination of downshifting, braking, and other retarding devices. Downshifting to a lower transmission range increases engine braking and can help you maintain control. The transmission has a feature to prevent automatic upshifting above the lower range selected. However, during downhill operation, if engine governed speed is exceeded in the lower range, the transmission will upshift to the next higher range to prevent engine damage. This will reduce engine braking and could cause a loss of control. Apply the vehicle brakes or other retarding device to prevent exceeding engine governed speed in the lower range selected.</p>

Table 4–1. DESCRIPTION OF AVAILABLE RANGES (cont'd)

Description of Available Ranges (refer to Figure 4–1)	
<p>7** 6*** 5*** 4*** 3 2</p>	<p>Selecting lower ranges provide greater engine braking for going downgrades (the lowest range delivers the greatest braking effect). Occasionally, it may be desirable to restrict automatic shifting to a lower range because of:</p> <ul style="list-style-type: none"> • Road conditions • Load • Traffic conditions, etc.
<p>1</p>	<p>First-range provides the vehicle with its maximum driving torque and engine braking effect. Use first-range when:</p> <ul style="list-style-type: none"> • Pulling through mud and deep snow. • Maneuvering in tight spaces. • Driving up or down steep grades.
<p>**Only available in 3700/4700/4800 models *** Actual ranges available depend on programming by vehicle manufacturer.</p>	

4.2 SHIFT SCHEDULES AND AUTOMATIC RANGE SHIFTS

Each transmission shift calibration includes multiple shift schedules which are used to control transmission shifts in various operating conditions. The shift schedules affect the timing of shifts between gears. The actual number of forward gears is determined based on the transmission model and the selected range position of the shift selector.

Vehicle performance may be affected when shift schedules change. The transition between shift schedules can be initiated by several different actions.

The transmission initially attains first range when **D** (Drive) is selected (except for those units programmed to start in 2nd range). As vehicle speed increases, the transmission automatically upshifts through each range. As the vehicle or equipment slows down, the transmission automatically downshifts to the correct range. The SELECT display shows the highest range available in **D** (Drive).



NOTE: The vehicle OEM or bodybuilder is responsible for evaluating the driveability of shift schedules in the intended vehicle and duty cycle. For additional details regarding these shift schedules and/or other options for primary and secondary shift schedules, contact a qualified Allison Transmission service outlet for further information.

4.2.1 UPSHIFTING. As long as the Transmission Control Module (TCM) calculates that there is enough vehicle power and vehicle acceleration available to grant and keep the next upshift, then there are no other limitations imposed on upshifting until the vehicle attains its top range displayed in the SELECT display on the selector. Vehicle power and acceleration characteristics are monitored by the transmission controls to attempt to eliminate shift cycling. Shift cycling is an upshift followed closely by a downshift, which is then followed by another upshift, and so on.



NOTE: If shift cycling is noted, use the alternate shift schedule by pressing the **MODE** button. The operator can also manually select the next lower range (using the shift selector) to hold that lower range until conditions are met to grant the upshift point again without shift cycling.

4.2.1.1 HOLD SCHEDULE FOR UPSHIFTS

As a standard feature of each shift calibration, the transmission controls incorporate a "**hold upshift**" shift schedule, which the operator may select if the transmission is not operating in its highest range. When this schedule is active, the shift points for upshifts are raised in order to hold the transmission in its current gear and inhibit upshifting beyond the current range. Holds are activated by selecting the current range or a lower range on the shift selector.



CAUTION: A typical use of the "hold" feature is to maximize engine braking when operating downhill. However, in order to prevent over-speeding the engine, the hold function is not infinite. It will permit shifts from the hold range to the next higher range at some speed above the shift calibration speed.

4.2.2 DOWNSHIFTING. Downshifts are allowed to occur as long as transmission output speed is low enough to keep from over-speeding the engine after completing the downshift. When a range downshift is manually selected by the operator, but the transmission output speed is determined to be above the limits, the transmission remains in the range even though a lower range was requested by the operator. A shift to a lower range can occur when the operator applies the vehicle service brakes or a retarding device, such as an exhaust brake, engine brake, or retarder. This action reduces the transmission output speed which in turn lowers the vehicle speed, allowing the transmission to shift to the lower range.

4.2.2.1 PRESELECT SCHEDULE FOR DOWNSHIFTS

The preselect downshift schedule is similar to the hold feature. The operator may initiate the preselect downshift shift schedule by selecting any forward gear on the shift selector that is lower than the gear currently in use. When a range has been "preselected" in this manner, shifts to and from gears above the preselected gear range occur at higher than normal engine speeds. Shifts below the preselected range are not affected.

Preselect downshifting is beneficial in maintaining higher engine speed, resulting in increased engine braking or engine brake performance during downhill operation or vehicle deceleration cycles. However, preselect shifts are permitted only if an engine over-speed condition will not occur after completion of the downshift.



NOTE: Preselecting during normal operation may result in reduced fuel economy.

4.2.2.2 NON-ENGINE BRAKE OPERATION

Two choices of preselect shift schedules are available for governing preselected downshifts during normal transmission operation. One of the following choices is selected when the TCM is programmed by the vehicle OEM:

- **Standard Preselects** – downshifts occur so the engine speed after the shift is approximately 300 rpm above the engine governed speed
- **Low Preselects** – downshifts occur so the engine speed after the shift is approximately 150 rpm above the engine governed speed

4.2.2.3 ENGINE BRAKE OR EXHAUST BRAKE OPERATION

When the TCM detects the engine brake is enabled, it commands use of a preselect shift schedule in order to enhance engine brake performance. The default speeds for these shifts are known as the Alternate Engine Brake Preselects.

- **Alternate Engine Brake Preselects** – downshifts occur at engine speeds approximately midway between 1000 rpm and the Standard Preselects for your transmission model

As an option, the preselect shift points during engine brake operation can be specified to be the same schedule selected when the TCM is programmed by the vehicle OEM for non-engine brake operation:

- **Standard Preselects** – downshifts occur so the engine speed after the shift is approximately 300 rpm above the engine governed speed

- **Low Preselects**– downshifts occur so the engine speed after the shift is approximately 150 rpm above the engine governed speed



NOTE: Specify Standard or Low Preselects when the TCM is programmed.

The preselect schedule chosen above will be activated for downshifts that occur while the engine brake is active and until operation in a specified gear is reached. This specified gear is the Engine Brake Preselect Range CMC that is programmable using Allison DOC[®] for PC–Service Tool. If this CMC is set to a value higher than 2nd gear, then downshifts from the Engine Brake Preselect Range to 2nd gear will be made as standard (non-engine brake) closed throttle downshifts. Additionally, if the TCM is programmed to make engine brake preselect downshifts at Standard Preselects or Low Preselects speeds, downshifts between the Engine Brake Preselected Range to an even lower gear can be specified to use the Alternate Engine Brake Preselect downshift speeds. The lowest gear to use this downshift schedule is also a CMC (Alternate Engine Brake Preselect Range). If this option is specified and the Alternate Engine Brake Preselect Range CMC is higher than 2nd gear, downshifts from the Alternate Engine Brake Preselect Range to 2nd gear uses normal (non-preselect) closed throttle shift speeds.



NOTE: If an exhaust brake or engine compression brake is installed on the engine, then they must be integrated to the transmission controls. Shift quality issues will arise if not properly integrated to the transmission controls.

4.2.2.4 RETARDER MODE SHIFT SCHEDULE

The retarder mode shift schedule is automatically activated when the retarder is switched on in order to raise closed throttle downshifts for additional cooling during retarder operation. Retarder closed throttle downshifts occur at speeds approximately halfway between the normal closed throttle downshift and the preselect downshift for each range. Refer to [4.3 USING THE HYDRAULIC RETARDER](#).

4.2.3 ACCELERATOR CONTROL. The position of the accelerator pedal influences when automatic shifting occurs. An electronic throttle position signal tells the TCM how much the operator has pressed the pedal. When the pedal is fully pressed, upshifts occur automatically at higher engine speeds. A partially pressed position of the pedal causes upshifts to occur at lower engine speeds.

4.2.3.1 KICKDOWN SHIFT SCHEDULE

Kickdown is an optional shift schedule which is activated when the kickdown input function is enabled. If shift schedule S2, S3, or S4 is in use and kickdown is active, all shifts revert to schedule S1, Wide Open Throttle (WOT) shift points. Similarly, if shift schedule S6, S7, or S8 is in use and kickdown is active, all shifts revert to schedule S5, WOT shift points.

4.2.4 PRIMARY AND SECONDARY SHIFT SCHEDULES. The primary shift schedule is normally used each time the vehicle is started and is specified in such a way to accommodate normal vehicle operation.

The secondary shift schedule is an alternate shift schedule that the TCM only uses upon request. The request for this schedule can be a dedicated request from the operator or it can be interlocked with the operation of another vehicle system.

Primary and secondary shift schedules may be changed using the **MODE** button, but some applications may use a dash-mounted switch. The MODE display illuminates while in secondary shift schedule. The vehicle might also have a dash-mounted light that illuminates when the secondary mode schedule is active.

Frequently, either performance or economy shift points are selected for the primary shift schedule (reflecting the most commonly used state of the vehicle), and the other set of shift points are selected for the secondary shift schedule.

The primary and secondary shift schedules must be specified when the TCM is programmed. The vehicle OEM determines which primary/secondary shift schedule combination they would like the transmission to have when the vehicle is built.

4.2.5 PERFORMANCE/ECONOMY SHIFT SCHEDULES. Currently, Allison Transmission offers the following commonly available shift schedules to the OEM(s):

- **S1 & S5** - Performance: WOT upshifts near Full Load Governed Speed (FLGS)
- **S2 & S6** - Performance: WOT upshifts at a fixed (less than 100) percent of FLGS
- **S3 & S7** - Economy: Upshifts at speeds which pull engine down to a fixed rpm after the shift
- **S4 & S8** - Economy: Upshifts at speeds which pull engine down to a fixed rpm (and less than S3) after the shift

- **S9** - Economy: Upshifts and downshifts occur at speeds that are even lower than the S4 shift strategy
- **SA** - Economy: WOT upshifts are similar to S1 & S5. The SA part-throttle upshifts and downshifts occur at significantly lower speeds than the S5 part-throttle shifts.
- **SB** - Economy: WOT upshifts and downshifts similar to SA. The SB part-throttle upshifts occur at slightly higher speeds than the SA part-throttle upshifts.
- **SC** - Economy: WOT upshifts are similar to S3 & S7. The SC part-throttle and closed-throttle upshifts and downshifts are similar to the SA part-throttle and closed-throttle shifts.
- **SD** - Economy: WOT upshifts and downshifts similar to S3 & S7. The SD part-throttle and closed-throttle upshifts and downshifts are similar to the SB part-throttle and closed-throttle shifts.

Schedules S1 through S4 are typically used with engines using variable speed or all-speed governors. The differences between the schedules is typically close to full throttle. Schedules S5 through S8 are designed to provide the same WOT upshifts as the corresponding S1 through S4 schedules. However, the S5 through S8 part throttle shift schedules have been modified.

4.2.6 LOAD-BASED SHIFT SCHEDULING (LBSS). The LBSS shifting strategy option combines the advantages of both performance and economy shift schedules. The controls automatically select the economy shift schedule when an unloaded state of the vehicle is detected (based on capability of the vehicle to accelerate quickly), then automatically switch to performance shift points when the vehicle is loaded and its ability to accelerate is reduced. The resulting operation can continuously modify transmission shifting to keep the engine near its more efficient speeds, which can produce improved overall vehicle fuel economy while still enabling high productivity during loaded conditions. LBSS is available for all transmission models, except the OFS. LBSS requires that the Primary and Secondary shift schedules have the same number of forward gear ranges.

LBSS is implemented two different ways depending on whether the vehicle has Engine Management Integration between the engine and transmission controls the LBSS is implemented two different ways:

- **Torque-Based LBSS:** In vehicles where the engine and transmission have Engine Management integration, the LBSS algorithm will use the SAE J1939 engine torque messages to estimate the vehicle load. Torque-based LBSS includes an additional shift mode which is a more aggressive economy shift schedule. The Super Economy Shift Schedule (SESS) works in the background of the selected Economy and

Performance shift schedules. SESS allows the vehicle to cruise at the lowest possible engine speed without lugging the engine. LBSS will shift based on the SESS when the vehicle meets the following conditions:

- Constant throttle position
- Very low tractive effort
- Steady cruise operation

Any sudden change in throttle position or tractive effort will cause the TCM to exit SESS and return to the basic Economy and Performance shift schedules. SESS is standard in all torque-based LBSS-active calibrations.

- **Acceleration-Based LBSS:** In vehicles without Engine Management Integration between the engine and transmission, the LBSS algorithm uses throttle position and output acceleration to estimate the vehicle load. SESS is not available with acceleration-based LBSS. In addition, LBSS uses an inclinometer/accelerometer in the TCM to refine the selection of the appropriate shift schedule based on vehicle operating requirements.

The TCM will initialize in the same mode, Economy or Performance, that it was in when last shutdown. The vehicle load is re-estimated during the first high throttle acceleration and the appropriate mode is commanded. The mode is also reset to Performance when one of the following is detected:

- An engine de-rate condition
- The loss of torque data from the engine

In addition to providing the capability to automatically switch between performance and economy schedules, the availability of economy mode in LBSS is selectable as a CMC with Allison DOC® for PC–Service Tool within the shift calibration as follows:

Table 4–2. LBSS ECONOMY MODE

CMC Setting	Selection	Description
1	Reserved 1	Reserved for future use
2	Reserved 2	Reserved for future use

Table 4–2. LBSS ECONOMY MODE (cont'd)

CMC Setting	Selection	Description
3	Low	This setting keeps the vehicle in economy mode when lightly loaded or on low upgrades. The vehicle will always be in performance mode if carrying a load or when negotiating moderate grades.
4	Medium	This is the default value. This setting keeps the vehicle in economy mode more than the default setting. When the vehicle is empty, even on moderate grades, economy mode is normally in use. Likewise, economy mode also is used on nearly-level grades with moderate loads. Performance mode will be commanded when heavily loaded or with moderate loads on larger grades.
5	High	This setting keeps the vehicle in economy mode in most circumstances. Performance will typically be commanded only when negotiating severe when heavily loaded. This setting permits higher powered vehicles to be in economy mode for most operations except during the most demanding operating conditions.

4.2.7 OVER-TEMPERATURE SHIFT SCHEDULE. Regardless of operator request, the TCM automatically limits transmission operation to 4th range or below during oil over-temperature conditions. If the transmission is above 4th range when over-temperature occurs, the preselect shift schedule is used for all downshifts until 4th range is reached.

4.2.8 CRUISE MODE SHIFT SCHEDULE. This shift schedule is activated when a SAE J1939 datalink message is received to indicate that cruise control is active. Shift points for this operation are modified in order to reduce the frequency of upshifts and downshifts during cruise operation. This shift schedule is a standard feature of each shift calibration.

The vehicle cruise control features interact with retarder activation/deactivation and are determined by calibration and CMC(s). Refer to [4.3.2 RETARDER/CRUISE CONTROL INTERACTIONS](#).

4.2.9 ACCELERATION-BASED PATTERN (ABP).

All calibrations include the ABP feature. ABP raises the full throttle upshift and downshift points under the following conditions:

- The throttle position is at or near 100%.
- The vehicle is not accelerating. An example of these conditions is a loaded vehicle climbing a grade. ABP will downshift the transmission at higher output shaft speeds than the standard full throttle downshifts. Downshifting the transmission increases the output torque and allows the vehicle to maintain road speed.

4.2.10 VEHICLE ACCELERATION CONTROL (VAC).

VAC is an engine management function where the TCM manages engine torque to limit vehicle acceleration to a calibrated rate. This function may be used for the following:

- To improve fuel efficiency.
- To reduce tire wear.
- To reduce acceleration aggressiveness.
- To provide for consistent acceleration in loaded and unloaded conditions.

VAC may be used in conjunction with LBSS.

VAC offers the levels of acceleration control shown in [Table 4–3](#). The acceleration control setting is a CMC.

Table 4–3. VAC Level Description Acceleration Rate Comments

Setting	Selection	Description
5	Ultra Economy	Provides the slowest acceleration rate. Offers the highest potential for fuel savings
4	Super Economy	
3	High Economy	
2	Intermediate Economy	
1	Base Economy	Provides acceleration closest to normal vehicle acceleration. Offers the lowest potential for fuel savings

Table 4–3. VAC Level Description Acceleration Rate Comments (cont'd)

Setting	Selection	Description
9	Off	Default Setting

4.2.11 LOW SPEED GRADE ASSIST.

When the engine is being sluggish during full throttle operation, Low Speed Grade Assist allows a quicker transition into first lockup from second converter in 6-speed transmissions, and a quicker transition into second lockup from third converter in 7-speed models. Low Speed Grade Assist is available in 3000 and 4000 Product Family applications that have Engine Management Integration between the transmission controls and the engine controls. This feature must be specified when the TCM calibration is defined.

4.3 USING THE HYDRAULIC RETARDER

A hydraulic retarder is optional on most models covered in this manual. The purpose of the retarder is to assist in stopping the vehicle during stop-and-go driving and to control the downhill speed of the vehicle on a grade. For both of these uses, the retarder extends the life of the service brakes and enhances vehicle control. The retarder automatically disengages when the vehicle approaches a stop.

When the retarder enable switch is turned on to enable the retarder system, a special retarder mode shift schedule is activated. This shift schedule allows downshifts at higher than the normal road speeds. Increased coolant flow through the transmission cooler and engine radiator occurs due to the raised downshift points. Refer to [4.3.1 RETARDER CAPACITY REDUCTION](#).



NOTE: The transmission retarder is configured as either a low, medium, or high capacity retarder by TCM calibration. Allison Transmission requires written vehicle OEM approval before a service outlet increases the retarder capacity at a customer's request. Existing vehicle drivelines, differentials, axles, and the cooling system must be designed for the additional retarder torque generated if a higher capacity retarder calibration is installed. The cost to modify retarder capacity is the responsibility of the customer.

The amount of Retarder Modulation Request (RMR) is controlled by the operator and depends on the type of retarder control used in the vehicle. Various hand, foot and automatic control techniques are used. Refer to [Table 4–4](#). In Allison 5th Generation Controls, the TCM also activates or limits retarder operation in response to torque speed control or electronic retarder

control messages received on the vehicle's SAE J1939 Datalink. Contact your OEM to understand how the retarder controls have been integrated into your vehicle.

The presence of a retarder must be autodetected as part of Allison 5th Generation Controls.



NOTE: The retarder enable switch is used to turn the retarder off for slippery road conditions.



WARNING: DO NOT USE THE RETARDER DURING INCLEMENT WEATHER OR WHEN ROAD SURFACES ARE SLIPPERY.

Use of the hydraulic retarder during inclement weather or when road surfaces are slippery could result in death, serious injury, or property damage. On vehicles which have a primary retarder control based upon closed throttle position, brake pedal position, or brake apply pressure, always manually disable the retarder controls during inclement weather or slippery road conditions, using the OEM provided retarder enable switch if present.

If the transmission retarder does not apply, death, serious injury, or property damage may occur. Operator should be prepared to apply vehicle brakes or other retarder device if the transmission retarder does not apply.

If the transmission retarder does not function, death, serious injury, or property damage may occur. Be sure to test for proper retarder function periodically. If a retarder is present but is not detected by "autodetect," the retarder will not function. Whenever the retarder does not apply, seek service help immediately.

Regardless of the type of Allison retarder controls on your vehicle (refer to [Table 4-4](#)), the following safety features are common to each configuration:

- The retarder can be disabled when inclement weather or slippery road conditions are present.
- Vehicle brake lights should always be on when the retarder is applied (periodically verify they are working).
- Anti-lock Brake System (ABS) sends a signal to the TCM to indicate the brake system is activated.



NOTE: The retarder is automatically disabled and the lockup clutch is disengaged whenever the ABS is active. If the ABS malfunctions, it is recommended the retarder enable switch be disabled, if equipped.



NOTE: If your transmission has a retarder but it is not functioning, it may not have been autodetected during vehicle manufacture. Consult the nearest Allison Transmission service outlet to have autodetect reset or the retarder enabled using the Allison DOC[®] for PC-Service Tool.



NOTE: A common cause for retarder performance complaints is incorrect transmission fluid level. Fluid level must be set correctly for maximum retarder effectiveness. As little as 2 liters (2 quarts) too high or too low can reduce retarder effectiveness and increase transmission temperature. Refer to [5.8 PERIODIC FLUID LEVEL CHECKS](#).



NOTE: The retarder requires about two seconds to reach full capacity. Be sure to anticipate this delay when using the retarder to prevent unnecessary service brake applications during non-emergency stops.



NOTE: When the transmission fluid or engine water temperature (an OEM option) exceeds programmed limits, retarder capacity automatically reduces gradually to minimize or avoid system overheating.



CAUTION: Observe the following cautions when driving a vehicle equipped with a retarder:

- THE RETARDER WORKS ONLY WHEN THE ENGINE IS AT CLOSED THROTTLE.
- OBSERVE TRANSMISSION AND ENGINE TEMPERATURE LIMITS AT ALL TIMES. Select the lowest possible transmission range to increase the cooling system capacity and total retardation available.
- In the event of OVERHEATING, DECREASE THE USE OF THE RETARDER; USE THE SERVICE BRAKES TO SLOW THE VEHICLE.
- OBSERVE THE RETARDER/SUMP “OVERTEMP” LIGHT to be sure it responds properly to retarder temperature.

Table 4–4. Types of Retarder Control

Type	Description	Amount of Application
Manual	Separate apply pedal	Zero to Full apply
	Hand lever*	Six levels based on lever position
Automatic	Auto “Full On”	“Full On” when closed throttle sensed
Brake Pressure Apply**	Single pressure switch	Off or “Full On” (based on brake pressure)
	Three pressure switches	1/3, 2/3, or “Full On” (based on brake pressure)
Pedal Position**	Special brake pedal	1/3, 2/3, or “Full On” (based on brake pressure)
J1939 Data Link	Digital message from engine controller	Zero to Full Apply

Table 4–4. Types of Retarder Control (cont'd)

Type	Description	Amount of Application
Combinations of the above systems**	Auto “half-on” plus pressure switch*	Half capacity at closed throttle or “Full On” with brake pressure
	Auto “1/3 on” plus two pressure switches*	1/3 capacity at closed throttle or 2/3 and “Full On” with brake pressure
	Hand lever plus pressure switch*	6 levels of modulation with lever, or “Full On” with brake pressure
	Foot pedal plus pressure switch	Full modulation with separate pedal, or “Full On” with brake pressure
	Hand lever plus interface for special pedal*	6 levels of modulation with lever, or 3 levels of modulation based on pedal position
<p>* These control systems may apply the retarder at high speed on grades when the vehicle has road speed limiting and the retarder is enabled.</p> <p>** For retarder apply systems integrated with the service brake system, the retarder is most effective when applied with light brake pedal pressure for 1–2 seconds to allow the retarder to fully charge. Added pedal pressure can be applied when more aggressive braking is desired.</p>		

4.3.1 RETARDER CAPACITY REDUCTION.



NOTE: In the event of excessively high temperatures in the transmission fluid and/or engine coolant during retarder operation, the maximum available retarder capacity may be reduced, affecting vehicle operation.

Retarder capacity is reduced if the transmission retarder-out or transmission sump temperature exceeds specified limits, as detected by temperature sensors which are integral to the transmission. In addition, retarder capacity is reduced in the event of elevated engine water temperature based on:

- engine water temperature as communicated to the TCM with an engine coolant sensor or via an SAE J1939 datalink, or
- detection by an engine water temperature sensor which provides an analog input signal to the TCM. This sensor is supplied and installed by the vehicle builder.

4.3.1.1 BASED ON RETARDER TEMPERATURE

If the retarder temperature exceeds 143°C (290°F), the TCM raises the closed throttle downshift points by activating the preselect downshift schedule. Use

of the preselect downshift schedule forces downshifts to occur at higher than normal road speeds, increasing coolant flow through the transmission cooler and engine radiator.

If the retarder temperature exceeds 149°C (300°F), retarder capacity begins to reduce. Capacity reduction continues until it is reduced to approximately 27% of the maximum available retarder capacity.



NOTE: If the output speed increases 300 rpm above the speed at which capacity reduction starts, full retardation is restored.

If the retarder temperature exceeds 166°C (330°F), the retarder temperature indicator output activates. This illuminates a retarder over-temperature light that alerts the operator of excessive retarder temperature. The retarder temperature light deactivates when the retarder temperature drops below 159°C (318°F). If the retarder temperature remains above 166°C (330°F) for ten consecutive seconds, an active DTC P273F (Retarder Oil Temperature Sensor Over Temperature Condition) is logged by the TCM. When the temperature drops and remains below 166°C (330°F) for ten consecutive seconds, the DTC becomes inactive and is stored in memory.

4.3.1.2 BASED ON TRANSMISSION SUMP TEMPERATURE

Independent of the retarder temperature, if the transmission sump temperature exceeds 117°C (240°F), retarder capacity will similarly be reduced as described above. The over-temperature indicator is activated and the over-temp DTC is logged if the sump temperature exceeds 121°C (250°F) for fifteen minutes, exceeds 128°C (262°F) for more than one minute, or instantaneously reaches 132°C (270°F).

4.3.1.3 BASED ON ENGINE WATER TEMPERATURE

If optional engine water capacity reduction and/or preselect downshifts are used, similar responses occur based on excessive engine water temperature. The capacity is reduced at the rate/slope programmed into the calibration and may continue to be reduced at this rate until:

- The retarder is operating at approximately 27.5% of its maximum capacity.
- The retarder is deactivated by the operator or by vehicle operating conditions which eliminate the need for retardation.
- Engine water temperature is returned to a level that does not invoke the capacity reduction.



NOTE: Full retardation is restored if the output speed increases 300 rpm above the speed at which water capacity reduction starts.

4.3.2 RETARDER/CRUISE CONTROL INTERACTIONS. Two control features affect retarder operation when the vehicle is equipped with cruise control:

- Feature 1: Cruise Control Retarder Auto On Disable

This feature only applies to electronic engines that communicate with the transmission on the SAE J1939. The TCM calibration must specify this feature to be either on or off. If the feature is on in the calibration, the TCM prohibits retarder operation when cruise control is active but the throttle is closed, which implies downhill coasting operation. This feature is highly recommended if the retarder apply system automatically applies the retarder at high levels at closed throttle.

If the feature is off in the calibration or the engine is not electronic, the TCM commands retarder operation whenever the cruise control goes to zero throttle. This mode of operation is only acceptable if the subsequent level of retarder apply is less than 25%.

- Feature 2: Retarder Cancel Cruise Control

This feature provides for a short flash of the retarder indicator output whenever the requested retarder level is increased. The retarder indicator output must be wired to the engine cruise control to turn off cruise control when the level of retardation requested is changed. This operation emulates the effect of applying the service brakes. Feature 2 is an optional feature that must be specified for the controls calibration.

5.1 CARE AND MAINTENANCE

5.2 PERIODIC INSPECTIONS



NOTE: The terms fluid and oil are used interchangeably in this publication. Both terms refer to the fluid or oil in the transmission and nowhere else.

It is very important to continually monitor the fluid level and connections for the electronic and hydraulic circuits. Keep the transmission clean to make inspection easier. Make regular periodic inspections for:

- Proper transmission fluid fill. Refer to [5.8 PERIODIC FLUID LEVEL CHECKS](#).
- Transmission fluid that is discolored, has a strong odor, or exceeded oil analysis limits.
- Presence of engine coolant in the transmission fluid.



NOTE: Transmission overhaul is required when the transmission has been contaminated with engine coolant. Allison Transmission recommends all clutch friction plates, lockup clutch, solenoids, and rusted/damaged parts be replaced during the rebuild.

- Presence of transmission fluid in the engine cooling system.
- Leaking fluid around fittings or hydraulic lines.
- Dripping oil from the transmission or output seal area.
- Debris that is blocking the breather located on top of the torque converter housing.
- Loose bolts securing transmission to engine or vehicle components attached to the transmission.
- Loose engine and transmission mounts.
- Harnesses interfacing with transmission controls and vehicle function are still in good condition.

Report any abnormal condition to service management. Immediately correct any problems found during this inspection to prevent further vehicle and/or transmission damage.

5.3 PREVENT MAJOR PROBLEMS

You can help keep minor problems from becoming major problems by contacting an Allison Transmission distributor or dealer when one of these conditions occur:

- A shift quality issue
- A driveability issue such as a vibration
- Transmission, hydraulic line or fitting is leaking fluid



NOTE: Dampness around the breather and output seal is normal. If there is a drip associated with the dampness at the breather, output seal, or elsewhere on the transmission then repair the cause of the leak.

- **CHECK TRANS** light illuminates

5.4 IMPORTANCE OF TRANSMISSION FLUIDS

Proper transmission fluid selection is important to transmission performance, reliability, and durability. The fluid used in the transmission does the following:

- Provides the working medium for the torque converter, controls, and clutch application
- Transfers heat from the transmission to the cooler
- Lubricates gears and bearings
- Carries rust inhibiting chemicals throughout the transmission
- Achieves optimum coefficient of friction for the clutch application
- Maintains clutch engagement
- Carries contaminants to the filters

5.5 RECOMMENDED AUTOMATIC TRANSMISSION FLUIDS

Only use fluids meeting Allison Transmission specification TES 295 or TES 389 in your transmission. For a list of currently approved transmission fluids, go to the Allison Transmission web site at: www.allisontransmission.com, select SERVICE, Fluids.

Allison Transmission recommends you take the following into consideration when selecting the appropriate fluid type for your transmission:

- Fluids meeting specification TES 295 are preferred over TES 389 fluids for use in all 3000 and 4000 Product Families transmission applications.
- TES 295 fluids are fully qualified for Severe Duty and Extended Drain intervals.
- A TES 295 fluid allows you to operate at a lower ambient temperature than a TES 389 type fluid. Refer to [Table 5–1](#).
- A TES 389 fluid is the minimum fluid requirement approved for use in 3000 and 4000 Product Families transmissions.
- To extend the TES 389 fluid drain intervals beyond the recommended mileage or hours change interval, use a fluid analysis program. Refer to [5.6 FLUID ANALYSIS](#).
- When choosing a fluid type to use, consider what the minimum fluid operating temperature of the fluid will be based on the ambient temperatures reached in the geographical location for the vehicle. Refer to [3.3.1 PREHEATING REQUIREMENT](#).

Table 5–1. Transmission Fluid Minimum Operating Temperature Requirements

Fluid Type	Minimum Operating Conditions	
	Celsius	Fahrenheit
TES 295	–35	–31
TES 389	–25	–13

5.6 KEEPING FLUID CLEAN



CAUTION: Containers or fillers that have had antifreeze solution or engine coolant in them must NEVER be used to hold transmission fluid. Antifreeze and coolant solutions contain ethylene glycol and water which, if put into the transmission, can cause damage.

Make sure that transmission fluid is clean, free of chemical contaminants, and within fluid specification limits. Refer to [Table 5–2](#).

Handle transmission fluid in clean, residue-free containers and fillers to prevent any foreign material or chemical contamination of the transmission fluid.

5.7 FLUID ANALYSIS

Transmissions used in high cycle rate applications should use fluid analysis to make sure fluid is changed as soon as needed. Transmission protection and fluid change intervals may be optimized by monitoring fluid oxidation according to the tests and limits. Refer to [Table 5–2](#). Consult your local telephone directory for firms in your area that provide a fluid analysis service. Use only one fluid analysis firm to ensure consistent and accurate fluid analysis. Refer to Technician’s Guide for Automatic Transmission Fluid, GN2055EN, for additional information.

Table 5–2. Fluid Oxidation Measurement Limits

Test	Limit
Viscosity	±25 change from new fluid
Total Acid Number (TAN)	+3.0* change from new fluid
Solids	2 percent by volume
* mg of potassium hydroxide (KOH) to neutralize a gram of fluid.	

5.8 TRANSMISSION FLUID REFILL

The fluid refill volume will be less than the volume listed for the initial fill due to some fluid remaining in the external circuits as well as in various transmission component cavities. After refill, verify the fluid level is correct. Refer to [5.8 PERIODIC FLUID LEVEL CHECKS](#).



NOTE: Quantities listed in [Table 5–3](#) are approximate and do not include external lines and cooler hoses.

Table 5–3. Transmission Fluid Capacity

Transmission	Sump	Initial Refill		Refill	
		Liters	Quarts	Liters	Quarts
3000 Product Family	4 inch	27	29	18	19
	2 inch	25	26	16	17
4000 Product Family*	4 inch	48	51	40	42
	2 inch	41	43	33	35
* Subtract 2.8 Liters (3 Quarts) for transmissions without PTO.					

5.9 PERIODIC FLUID LEVEL CHECKS

Even though transmission fluid is not consumed during transmission operation as engine oil might be, periodic fluid level checks should be made prior to placing the vehicle in service or just after returning from service. Periodic fluid level checks help prevent mechanical failure of a vehicle or transmission component. Periodic checks also help to detect fluid leaks, cooler failure (contaminating the transmission fluid), fluid overfill, fluid underfill or the wrong kind of fluid used the last time the transmission was serviced.

Check the transmission fluid level by one of the following methods:

- Dipstick
- Using Allison 5th Generation shift selector to electronically check the Oil Level Sensor (OLS) located in the transmission control valve module
- Using Allison DOC[®] for PC–Service Tool to check the level with the OLS



NOTE: OLS is not available for the 4700/4800 transmission equipped with the retarder option.

The dipstick is marked with temperature bands for a COLD and HOT fluid level check. The fluid check marked COLD is designed to allow the fluid level to be checked from 16°C (61°F) to 60°C (140°F).



NOTE: Only use this check to confirm adequate fluid volume for a cold start-up and not to set fluid levels for continued operation.

The OLS is designed to automatically compensate for fluid temperature fluctuations (thermal expansion) within its operating band parameters for fluid temperature. Allison Transmission recommends using the Allison 5th Generation controls shift selector to check the OLS. This method is more accurate than the dipstick method.

Use the dipstick method if any of the following situations exist:

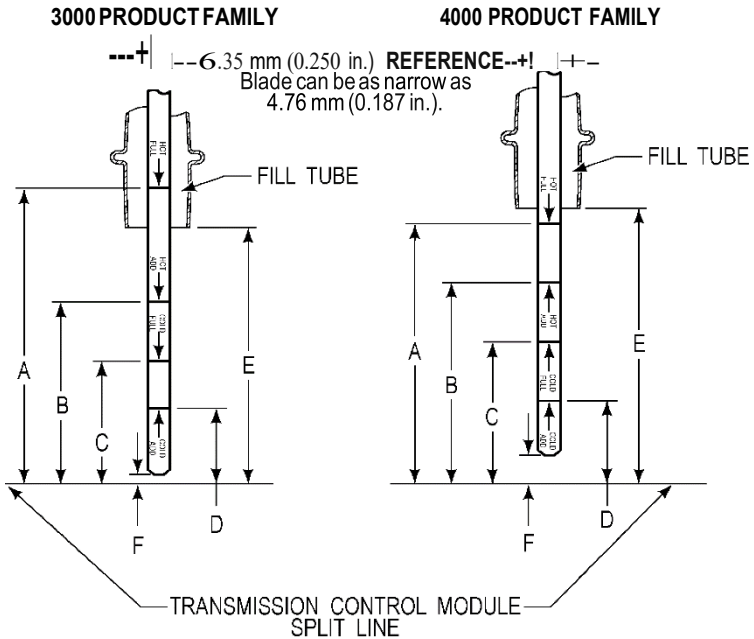
- If transmission fluid temperature is below the temperature to check it electronically, conduct a COLD CHECK to determine whether there is enough fluid to start and move the vehicle.
- If the vehicle does not have an Allison 5th Generation shift selector or the OEM has not integrated the electronic messages regarding oil level into their selector.
- If the OLS or vehicle wiring is defective, or the OLS was not auto detected, preventing electronic access to fluid level.

5.9.1 FLUID CHECK USING DIPSTICK.

There are two temperature bands marked on the dipstick to allow for transmission fluid expansion when the temperature increases. The lower band, referred to as COLD CHECK, is used when the transmission fluid is below operating temperature. The upper band, referred to as HOT CHECK, is used when the transmission fluid is at normal operating temperature. The OEM may refer to these as COLD FULL/COLD ADD (COLD CHECK) and HOT FULL/HOT ADD (HOT CHECK). Refer to [Figure 5-1](#) for further information on dipstick markings.



NOTE: For the location of the fill tube and dipstick, refer to [Figure 2-1](#) and [Figure 2-2](#) for non-PTO applications and [Figure 2-3](#) and [Figure 2-4](#) for PTO applications. For 4700/4800 Models, refer to [Figure 2-6](#) for the location of the fill tube and dipstick.



OIL SUMP	TRANSMISSION/SUMP DESCRIPTION	DIMENSION	DIMENSION	DIMENSION	DIMENSION	DIMENSION	DIMENSION
		A	B	C	D	E	F**
2.00 in. and 4.00 in.	4000 PRODUCT FAMILY	106.7 mm (4.20 in.)	76.2 mm (3.00 in.)	66.0 mm (2.60 in.)		132.6 mm (5.22 in.)	13.8mm (0.54in.)
2.00 in.	3000 PRODUCT FAMILY	101.6mm (4.00 in.)	73.7 mm (2.90 in.)	50.8 mm (2.00 in.)		86.6 mm (3.41 in.)	5.9 mm (0.23 in.)
4.00 in.	3000 PRODUCT FAMILY	101.6mm (4.00 in.)	63.5 mm (2.50 in.)	45.7 mm (1.80 in.)		86.6 mm (3.41 in.)	5.9 mm (0.23in.)

NOTE: Calibrate level marking locations with respect to transmission control module split line and fill tube.

Scale none.

*Dimension determined by installation.

**Reference dimension only. Actual dimension to be determined by installation.

Figure 5-1. Standard Transmission Dipstick Markings

COLD CHECK: The COLD CHECK band verifies the transmission has adequate fluid for start-up and operation until it can be checked at the operating (hot) temperature. Only use this check to confirm adequate fluid level for a cold start-up and not to set fluid levels for continued operation. Typically, the check is most accurate with fluid temperatures of 16-49°C (61-120°F).



NOTE: With engine off, the fluid level should reach the hot run band or higher on the dipstick even at cold ambient temperatures. The cold check band is calibrated on the stick for the fluid level attained while the transmission is running and in **N** (Neutral). Do not move the vehicle until the fluid level reaches the cold full mark with engine running and transmission in **N** (Neutral).

HOT CHECK: The HOT CHECK band checks the fluid level at the normal operating temperature, 71-93°C (160-200°F). Fluid level checks at operating temperature offer the best assurance of maintaining the correct fluid level. Typically, the transmission is at operating temperature at the end of the shift or at the end of the day.

The fluid must be maintained above the COLD CHECK mark to assure the fluid is above the charging pump suction port inside the transmission. This prevents charging pump cavitation which causes aeration of the fluid and erratic operation of the transmission. If the fluid is above the HOT CHECK mark, it may contact the rotating parts of the transmission causing fluid aeration which results in erratic transmission operation, and may cause overheating and power loss.



CAUTION: Transmission damage can result from extended operation at low fluid level conditions.



NOTE: Do not overfill the transmission. Overheating, oil foaming out of the breather, and power loss may occur if driven while transmission is overfilled.

5.9.1.1 COLD CHECK PROCEDURE



NOTE: The correct fluid level cannot be determined unless the transmission is in a level position.



CAUTION: DO NOT start the engine until the presence of sufficient transmission fluid has been confirmed. Remove the transmission fluid dipstick and be sure the static fluid level is near the HOT FULL mark.



WARNING: If you leave the vehicle and the engine is running, the vehicle can move unexpectedly and you or others could be injured. If you must leave the engine running, **DO NOT LEAVE** the vehicle until you have completed all of the following procedures:

- Put the transmission in **N** (Neutral).
- Be sure the engine is at low idle (500–800 rpm).
- Apply the parking and emergency brakes and make sure they are properly engaged.
- Chock the wheels and take other steps necessary to keep the vehicle from moving.

A COLD CHECK determines if the transmission has enough fluid to be operated safely until a HOT CHECK can be made. Complete a COLD CHECK after the presence of transmission fluid has been confirmed with the engine off. The transmission fluid temperature should be between 16-49°C (61-120°F).



NOTE: Always check fluid level with the dipstick in the unscrewed or loose position.

Complete a COLD CHECK procedure using the dipstick as follows:

1. Move the vehicle to a level surface, put the transmission in **N** (Neutral) and set the parking brake.
2. With the engine idling (500–800 rpm), shift to **D** (Drive) and then to **R** (Reverse) to clear air from the hydraulic circuits.
3. Run the engine at idle (500–800 rpm) in **N** (Neutral) for about one minute.
4. Clean debris from around the end of the fill tube before removing the dipstick.
5. Remove the dipstick and wipe it clean.
6. Insert the dipstick into the fill tube, pushing down until it stops, but still in its loose or unscrewed position.
7. Remove the dipstick and observe the fluid level. If the fluid on the dipstick is within the COLD CHECK band (refer to [Figure 5–1](#)), the level

is satisfactory. If the fluid level is not within this band, add or drain (refer to [5.7 TRANSMISSION FLUID REFILL](#) as necessary to bring the level within the COLD CHECK band.

8. Perform a HOT CHECK at the first opportunity after normal operating temperature (71-93°C (160-199°F)) is reached.



CAUTION: DO NOT operate the transmission for extended periods of time until a HOT CHECK has verified proper fluid level. Transmission damage can result from extended operation at improper fluid level conditions.



CAUTION: The fluid level rises as fluid temperature rises. **DO NOT** fill the transmission above the COLD CHECK band if the transmission fluid is below normal operating temperatures. During operation, an overfull transmission can become overheated, leading to transmission damage.



CAUTION: Obtain an accurate fluid level by imposing the following conditions:

- Engine is idling (500–800 rpm) in **N** (Neutral)
- Transmission fluid is at the normal operating temperature
- The vehicle is on a level surface
- Apply the parking brake and chock the wheels

5.9.1.2 HOT CHECK PROCEDURE



NOTE: Always check fluid level with the dipstick in the unscrewed or loose position.

To complete a HOT CHECK procedure using the dipstick, do the following:

1. Be sure fluid has reached normal operating temperature of 71-93°C (160-200°F). If a transmission temperature gauge is not present, measure fluid level when the engine water temperature gauge has stabilized.
2. Park the vehicle on a level surface and shift to **N** (Neutral).
3. Apply the parking brake and allow the engine to idle (500–800 rpm).
4. Clean debris from around the end of the fill tube before removing the dipstick.

5. Remove the dipstick and wipe it clean.
6. Insert the dipstick into the fill tube, pushing down until it stops, but still in its loose or unscrewed position.
7. Remove the dipstick and observe the fluid level. The safe operating level is anywhere within the HOT RUN band on the dipstick. Refer to [Figure 5-1](#).
8. If the level is not within the HOT RUN band, add or drain fluid as necessary to bring the level within the HOT RUN band. Refer to [5.7 TRANSMISSION FLUID REFILL](#).
9. Measure fluid level more than once. Be sure fluid level measurements are consistent. If readings are not consistent, be sure the transmission breather is clean and not clogged.
10. If readings are still not consistent, contact your nearest Allison distributor or dealer.

5.9.1.3 TRANSMISSION DIPSTICK MARKINGS ILLUSTRATION

Refer to [Figure 5-1](#).

5.8.2 FLUID LEVEL CHECKS USING ALLISON 5TH GENERATION SHIFT SELECTORS.

The OLS is standard in all models except the 4700/4800 models equipped with a retarder. With the OLS and an Allison 5th Generation shift selector, you can get a more accurate electronic fluid level check than with a dipstick.

5.8.2.1 ELECTRONIC FLUID LEVEL CHECK PREREQUISITES

- OLS is functional and is auto-detected by the TCM.
- Vehicle has an Allison 5th Generation shift selector with VFD.



NOTE: The strip button selector cannot display oil level.

5.8.2.2 ELECTRONIC FLUID LEVEL CHECK PROCEDURE



NOTE: The TCM delays the fluid level check until the following conditions are met:

- The fluid temperature is above 40°C (104°F) or below 104°C (220°F).
- The transmission is in **N** (Neutral).
- The vehicle has been stationary for approximately two minutes to allow the fluid to settle.
- The engine is at idle. When fluid level check is delayed by the TCM, a countdown timer in minutes and seconds appears in the selector graphics display.

When fluid level check is delayed by the TCM, a countdown timer in minutes and seconds appears in the selector graphics display.

The OLS is designed to measure transmission fluid level. To check the fluid level electronically from the shift selector, do the following:

1. Park the vehicle on a level surface and shift to **N** (Neutral).
2. Apply the parking brake and allow the engine to idle (500–800 rpm).
3. Make sure vehicle is stopped with transmission output shaft speed at 0 rpm.
4. Allow a settling period of two minutes to facilitate oil drain back time. The TCM communicates status once fluid level request is initiated.
5. Fluid level measurement and readout may be initiated by pressing once on:
 - Bump-Shift Lever selector— press the **DISPLAY MODE/DIAGNOSTIC** (DMD) button once. Refer to [Figure 5–5](#).
 - Keypad Pushbutton shift selector— simultaneously press the ↑ (Upshift) and ↓ (Downshift) arrows once. Refer to [Figure 5–5](#).
6. Correct fluid level is displayed as shown in [Figure 5–2](#).



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Figure 5–2. Correct Fluid Level Display

7. Low fluid level is displayed and the number indicates the number of quarts of fluid the transmission requires (refer to [Figure 5–3](#)).



NOTE: Confirm a low fluid level condition by making a manual fluid level check.



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Figure 5–3. Low Fluid Level Display

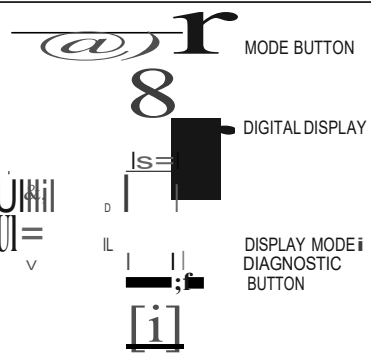
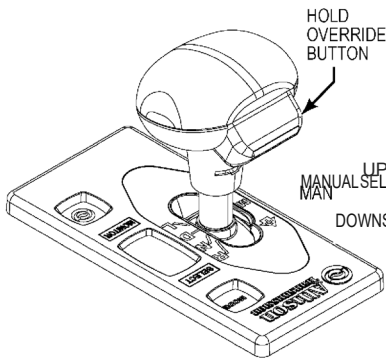
8. High fluid level is displayed followed by a number and the number indicates the number of quarts the transmission is overfilled (refer to [Figure 5–4](#)).



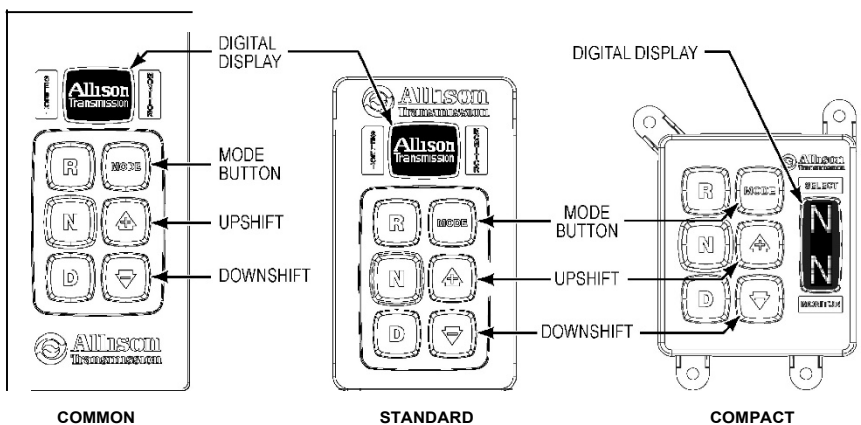
344502

Figure 5–4. High Fluid Level Display

9. To exit the fluid level display mode, press any range button on the pushbutton shift selector or press the **DISPLAY MODE/DIAGNOSTIC (DMD)** button twice on the bump-shift lever selector.



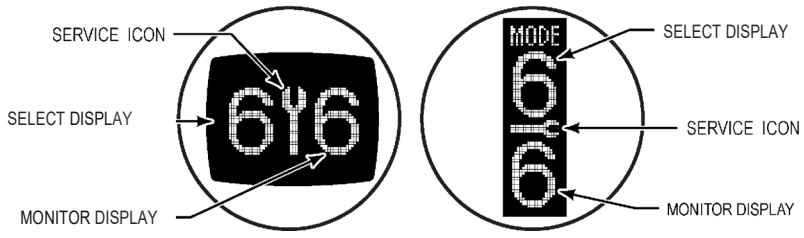
SHIFT SELECTORS



PUSHBUTTON SELECTORS

***NOTE:** The first number displayed in the digital display is the highest forward range available and second number is range attained in selected position .

Visually confirm that the range selected was attained. If display is flashing, shift is inhibited.



Location of service icon on vertical and horizontal digital display

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Figure 5-5. Typical Allison 5th Generation Shift Selectors

5.8.2.3 FLUID RANGE DETECTED FOR OIL LEVEL SENSOR (OLS)

The OLS has a detection range of LO 4 to HI 3 that can display on the selectors. The actual oil level to add may be greater than 4 liters (4.22 quarts) if the transmission is more than 4 liters (4.22 quarts) low from the full mark. The actual fluid volume to drain may be more than 3 liters (3.17 quarts) if the transmission is overfilled by more than 3 liters (3.17 quarts).

5.8.2.4 INVALID FOR DISPLAY CODES

Invalid for Display is activated when conditions do not allow the fluid level to be determined. Refer to [Table 5-4](#) to review the codes and conditions, and correct as necessary. If these conditions cannot be corrected, contact the nearest distributor or dealer in your area (look in the telephone directory for the Allison Transmission service outlet nearest you).

Table 5-4. Invalid for Display Codes

Code	Cause of Code
SETTLING / OK	Settling time too short
ENG RPM / TOO LOW	Engine rpm too low
ENG RPM TOO HIGH	Engine rpm too high
MUST BE / IN NEU	N (Neutral) must be selected
OIL TEMP / TOO LOW	Sump fluid temperature too low
OIL TEMP / TOO HIGH	Sump fluid temperature too high
VEH SPD / TOO HI	Output shaft speed
SENSOR FAILED	Sensor failure

5.9 PROGNOSTICS FEATURES

The Prognostics package contains functions that maximize fluid and filter use, as well as a feature which provides an indication of when the clutch system wear is significant enough to warrant transmission repair. You can then schedule the repair at your convenience. Refer to [Table 5-5](#) for Prognostics Function Description.

Table 5-5. Prognostics Function Description

Prognostics Function Name	Description
Oil Life Monitor (OM)	Displays the percentage of fluid life remaining

Table 5–5. Prognostics Function Description (cont'd)

Prognostics Function Name	Description
Filter Life Monitor (FM)	Notifies that main and lube filters need changing
Transmission Health Monitor (TM)	Notifies that one or more clutches, C1-C5, needs replacement

Allison Transmission 5th Generation Controls with Prognostics uses a wrench icon (**TRANS SERVICE** indicator) located on the shift selector display (refer to [Figure 5–6](#)). The OEM may choose to use their own selector but provide the **TRANS SERVICE** indicator for Prognostics as a lamp or a message on a display unit.



NOTE: A wrench icon display on the face of the selector serves as the **TRANS SERVICE** indicator on the keypad pushbutton and bump-shift lever selectors.

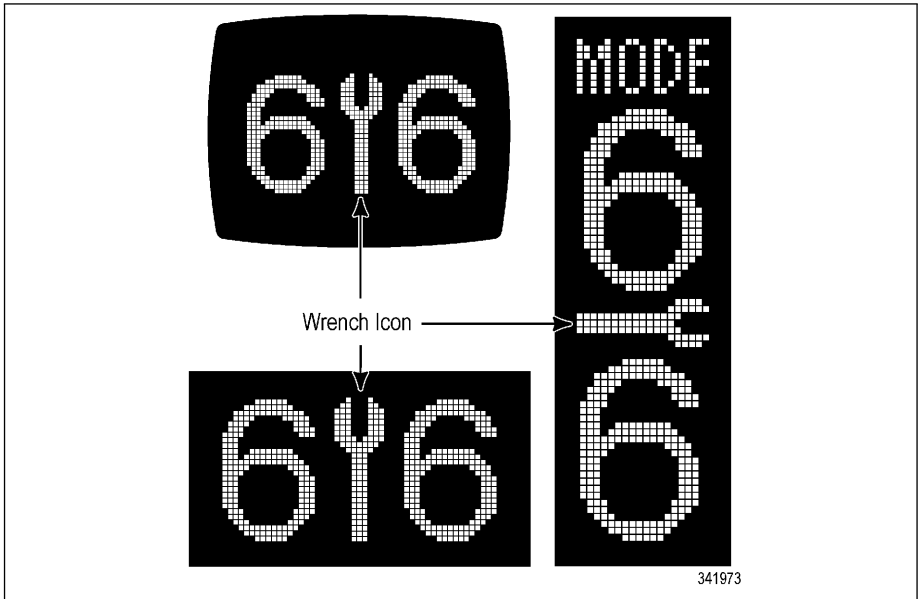


Figure 5–6. Typical Allison 5th Generation Trans Service Indicator

When a specified threshold is detected for any of the serviceable conditions, the **TRANS SERVICE** indicator is illuminated to alert the operator. Failure to attend to the service condition and reset the **TRANS SERVICE** indicator within a defined operating period results in illumination of the **CHECK TRANS**

light, indicating the increased probability that the service condition will develop into a more serious condition. Refer to [6.2.1 CHECK TRANS LIGHT](#).

5.9.1 PROGNOSTICS PREREQUISITES. The following requirements must be met to use the Prognostics features and functions:

- Vehicle harness has a wire for the filter life indicator switch (wire 118).
- The OEM has ordered your calibration from Allison Transmission with Prognostics enabled.



NOTE: It is important to note that if Prognostics is **disabled**, it is not available in the calibration. This is different than the OEM ordering a calibration with Prognostics off. Defaulting Prognostics off means it could be enabled in the future without recalibrating to a different calibration, provided the other conditions are met to use Prognostics.

-
- Using a TES 295 or TES 389 transmission fluid
 - Using Allison Transmission High Capacity Main and Lube Filters



NOTE: Allison Transmission may approve some OEM selectors for Prognostics, provided the **TRANS SERVICE** indicator or message display is integrated by the OEM. At the time of this publication there are no capable OEM selectors for Prognostics.

5.9.2 PROGNOSTICS FEATURES AVAILABILITY. The vehicle manufacturer specifies whether they want Allison Prognostics Feature Package to be made available in the calibration and in what configuration; for example, defaulted on or off. The OM, FM, and TM are the individual functions included in the Allison Prognostics Feature Package. These individual functions cannot be turned on or off separately within the Allison Prognostics Feature Package.

The transmission calibration can be made for the vehicle manufacturer (or the customer) so the Prognostics Feature is in one of the following states:

- Available and the Prognostics Features are defaulted on and therefore monitoring OM, FM, and TM presently.
- Available and the function is defaulted off and therefore available but not monitoring OM, FM, and TM presently.
- Disabled and therefore not available within this Transmission Control Module (TCM) calibration.

Methods to turn the Prognostics Package Features on or off (provided all other requirements are met), include the following:

- Through the shift selector (if allowed by TCM programming). Refer to [5.9.3 PROCEDURE TO TURN PROGNOSTICS ON AND OFF](#).
- Using the Allison DOC® for PC–Service Tool, Customer Modifiable Constant (CMC) can be toggled to enabled or disabled for the Allison Prognostics Feature Package, provided the OEM ordered a calibration that has the Allison Prognostics Feature Package as a programmable feature.
- Recalibrate the TCM, provided wire 118 is in the harness. This can be done at an authorized Allison distributor or dealer.



NOTE: Prognostics should not be turned on after recalibration of the TCM until all other requirements for the fluid filters, selector, and harness are met. If wire 118 is not in the vehicle harness, DTC P0848, Transmission Fluid Pressure Switch 2 Circuit High, will be active. Verify prognostics setting for fluid type, displayed in Allison DOC® for PC–Service Tool, matches type of fluid in the transmission. Refer to [5.9.5 SETTING FLUID TYPE FOR PROGNOSTICS](#) for additional information.

The OEM initially specifies how they want the calibration configured for operator access regarding reset for Prognostics functions through the selector. The vehicle owner may then have the CMC toggled to either enabled or disabled to allow or disallow the Prognostics Package reset from the shift selector via programming features in Allison DOC® for PC–Service Tool.

Reset methods for the Prognostics Package and reset of individual features in the package include the following: (Refer to [5.9.3 PROCEDURE TO TURN PROGNOSTICS ON AND OFF](#).)

- OM and FM may be reset through the selector by different shift pattern sequences.
- OM and FM may be reset by SAE J1939 datalink messages.
- OM, FM, and TM may be reset individually with Allison DOC® for PC–Service Tool.
- TM is always manually reset with Allison DOC® for PC–Service Tool and cannot be manually reset through the selector. Individual clutch reset is allowed with Allison DOC® for PC–Service Tool.
- The Prognostics CMC can be set to restrict Prognostic Package resets to the Allison DOC® for PC–Service Tool only. Individual functions, such as the OM, FM, and TM may not be restricted individually for reset by the service tool. Restriction to reset by the service tool only affects the

whole Prognostics Package, which is handled by a single Prognostics CMC.

- FM and TM automatically reset themselves if monitored conditions allow.



NOTE: An Allison service outlet can assist with programming and recalibration to enable Prognostics, at customer expense, as long as all Allison Transmission requirements are met prior to the enabled feature being turned on.



NOTE: The three Prognostics functions, OM, FM, and TM, are enabled or disabled as a group and cannot be enabled or disabled individually.



CAUTION: Prognostics requires the use of Allison approved TES 295 or TES 389 fluids and Allison High Capacity Filters if turned ON. If any other fluids or filters are used, the Prognostics feature **MUST BE** turned OFF. Prognostics information will not be accurate with any other transmission fluids and could result in missed maintenance activities resulting in transmission damage. If Prognostics functions are not programmed or are turned OFF, refer to [5.0 CARE AND MAINTENANCE](#) and review the miles/hours/months fluid and filter change interval charts or visit www.allisontransmission.com, click Service, Fluid/Filter Change Interval, then Fluids, and read the current revision of Service Tips 1099 for details.

5.9.3 PROCEDURE TO TURN PROGNOSTICS ON AND OFF.



WARNING: To help avoid unexpected vehicle movement that might cause death, serious injury, or property damage, always have your foot on the brake, the throttle released, and the engine at idle before making a **N** (Neutral) to **D** (Drive); **N** (Neutral) to **R** (Reverse); **D** (Drive) to **R** (Reverse); or **R** (Reverse) to **D** (Drive) selection.

The Prognostics feature can be turned on with the Allison DOC® for PC–Service Tool or, if the specific calibration allows it, the operator can do the following:

1. Set the vehicle brakes to prevent movement of the vehicle.

2. With engine off, turn the ignition on (do not start the engine). Wait for initialization to complete (wait for N N to display in the selector).
3. Move the bump-shift lever selector or press the keypad (pushbutton) through the following sequence of range positions, pausing no more than three (3) seconds between consecutive shifts:
N-D-N-R-N-D-N-R-N-D-N-R-N.
4. Watch for the **TRANS SERVICE** indicator located in the shift selector display to illuminate and then turn off. This indicates that the operator has successfully enabled the Allison Prognostics Feature Package, consisting of the OM, FM, and TM.

If another **TRANS SERVICE** indicator is installed in the dash or incorporated in an OEM message display, it should also briefly illuminate in similar fashion as the **TRANS SERVICE** indicator.

Disabling the Prognostics feature can be done with Allison DOC® for PC–Service Tool or, if the specific calibration allows it, the operator can do the following:

1. Set the vehicle brakes to prevent movement of the vehicle.
2. With engine off, turn the ignition on (do not start the engine). Wait for initialization to complete (wait for N N to display in the selector).
3. Move the bump-shift lever selector or press the keypad (pushbutton) through the following sequence of range positions, pausing no more than three (3) seconds between consecutive shifts:
N-D-N-R-N-D-N-R-N-D-N-R-N.
4. Watch for the **TRANS SERVICE** indicator located in the shift selector display to illuminate and then turn off. This indicates that the operator has successfully enabled the Allison Prognostics Feature Package, consisting of the OM, FM, and TM.

If another **TRANS SERVICE** indicator is installed in the dash or incorporated in an OEM message display, it should also briefly illuminate in similar fashion as the **TRANS SERVICE** indicator.

5.9.4 NORMAL PROGNOSTICS INDICATION AT ENGINE START. Once Prognostics is monitoring the system, normal operation at engine start is as follows:

1. A system bulb check illuminates the **TRANS SERVICE** indicator located in the shift selector display for approximately 0.5 seconds.
2. If Prognostics features are enabled, the **TRANS SERVICE** indicator illuminates again for 3 seconds after the bulb check.

- If Prognostics features are disabled, the **TRANS SERVICE** indicator does not illuminate again after the bulb check.



NOTE: If the shift calibration permits a maximum allowable gear in primary mode that is different than the maximum allowable gear in secondary mode, Prognostics enabling/disabling is only permitted in the shift mode with the highest maximum allowable range. If you have a higher range set of gears in secondary mode than in primary mode to enable Prognostics, push the **MODE** button so **MODE** appears on the selector display first.



NOTE: The three Prognostics functions, OM, FM, and TM, are enabled or disabled as a package and cannot be enabled or disabled individually.

5.9.5 SETTING FLUID TYPE FOR PROGNOSTICS. The fluid type can be programmed with the Allison DOC® for PC–Service Tool or, if the specific calibration allows it, the operator can do the following:

- With the engine off and ignition on, perform the following sequence on the selector, **N-R-N-D-N-R-N-D-N-R-N-D-N**.



NOTE: Verify prognostics fluid type setting matches transmission fluid type in transmission. OM notifications will be inaccurate when mismatched. This could result in transmission damage from running a TES-389 fluid too long or cause shortened TES-295 fluid changes to occur.

After recalibration of a TCM always verify prognostics fluid type setting is correct using Allison DOC® for PC–Service Tool. Change the fluid type setting using Allison DOC® for PC–Service Tool if incorrect.

The **TRANS SERVICE** indicator flashes if TES 389 is the current setting and illuminates solidly if TES 295 is the current setting. To change the transmission fluid type, wait 5 seconds after entering transmission fluid type mode and perform one of the following sequences to select the proper transmission fluid type:

- **N** (Neutral) **R** (Reverse) **N** (Neutral) to select TES 295 (the **TRANS SERVICE** indicator illuminates solidly showing TES 295 has been selected).

- **N** (Neutral) **D** (Drive) **N** (Neutral) to select TES 389 (the **TRANS SERVICE** indicator begins to flash showing TES 389 has been selected).

The selector exits 30 seconds after entering transmission fluid type mode or the ignition may be turned off to exit earlier. Only one transmission fluid type selection may be made after entering transmission fluid type mode. All other attempts will be ignored. Transmission fluid type mode needs to be entered again if the wrong type of transmission fluid is selected.

5.9.6 OIL LIFE MONITOR (OM). Based on the vehicle's duty cycle, this feature determines fluid life and alerts you when a fluid change is required. Not only does it help you get maximum fluid life while providing the maximum protection for the transmission, the OM also saves you money by preventing unnecessary fluid changes.

Oil life is calculated based on hours of engine and transmission operation. Miles are approximated from the hours and calibrated information. The number of shifts per mile (shift density) determines the duty cycle of the transmission and the oil life limits are based on the observed duty cycle. Hours are accumulated when the engine is running, including when the vehicle is stationary for Power Takeoff (PTO) operation, or for extended idle time.



NOTE: Oil life is continuously calculated on the following cumulative effects:

- Operating hours
- Output revolutions
- Shift density (shifts per mile)
- Retarder accumulator applies (if equipped)

5.9.6.1 FLUID CHANGE NOTIFICATION

The **TRANS SERVICE** indicator illuminates when remaining fluid life reaches 1%. Afterwards, every time the vehicle is started and **D** (Drive) is selected, the **TRANS SERVICE** indicator illuminates again and stays on for two minutes to remind the operator a fluid change is needed. This occurs until service is performed and the OM is reset.



NOTE: If the OM mode has been accessed via the shift selector, a number between 0 and 99 is displayed indicating the percentage of fluid life remaining before a change is required.

Calendar based fluid requirements still apply with OM (refer to [5.0 CARE AND MAINTENANCE](#)). If the OM has not indicated the need for a fluid change before 60 months for TES 295 fluid, or 24 months for TES 389 fluid, it is necessary to change the fluid and filters per calendar requirements and then reset the OM. Calendar requirements are not required if a fluid analysis program is in place. Refer to [5.6 FLUID ANALYSIS](#).

5.9.6.2 READ AND RESET OIL LIFE MONITOR (OM) FROM SELECTOR

READ OM. With engine off and ignition on, push the **DISPLAY MODE/DIAGNOSTIC** (DMD) button twice on the bump-shift lever selector to enter OM mode. With engine off and ignition on, push the ↑ (Upshift) and ↓ (Downshift) arrows simultaneously twice on the keypad pushbutton selector to enter OM mode. The oil life left is displayed as a percentage between 0 and 99 in the shift selector display window.

RESET OM. The OM may be reset back to 99% by either of these methods:

- Display the OM information and press and hold the **DISPLAY MODE/DIAGNOSTIC** (DMD) button for 10 seconds.
- With ignition on and the engine off, shift between **N-D-N-D-N-R-N** to reset the value displayed to 99 pausing no more than 3 seconds between consecutive shifts.

The **TRANS SERVICE** indicator illuminates briefly following a reset to acknowledge the reset was successful.

RESET with Allison DOC® for PC–Service Tool. If the value displayed remains unchanged, then it is possible the reset may be restricted to Allison DOC® for PC–Service Tool only.

HISTORY. Allison DOC® for PC–Service Tool may also be used to review reset history and the mileage recorded at the time of reset. Fluid life remaining will be displayed from 100% down to –100% when viewing records in the service tool. A negative % indicates how far an oil change is past due. A historical record of the last six resets, including mileage at the time of each reset, may also be viewed using the Allison DOC® for PC–Service Tool Diagnostics Program.

DTC P0897. If transmission maintenance continues to be unattended, the **CHECK TRANS** light illuminates and DTC P0897, Transmission Fluid Deteriorated, sets.



CAUTION: Transmission fluid and filter change frequency is determined by the severity of transmission service. To help avoid transmission damage, more frequent changes may be necessary than recommended in the general guidelines due to operating conditions and duty cycle.

For the appropriate recommended change interval guidelines for your specific transmission configuration, refer to [Table 5–6](#), [Table 5–7](#) and [Table 5–8](#).

5.9.7 FILTER LIFE MONITOR (FM). This feature provides an alert when the transmission’s fluid filters need to be replaced. It helps extend filter change intervals to reduce routine maintenance downtime and saves you money in the long run, all while providing maximum protection for the transmission. The FLI pressure switch signals the TCM when fluid exiting the main filter drops below a predetermined pressure. Both the main and lube filters **must be changed** when the **TRANS SERVICE** indicator in the selector display indicates that the main filter should be changed. The differential pressure limit is verified for a period of time to be sure there is no false indication of the need to change filters.



NOTE: The 3700/4700/4800 models do not have the FLI pressure switch and valve body. FM is based on transmission duty cycle and other measured transmission parameters, instead of an FLI pressure switch.

5.9.7.1 FILTER CHANGE NOTIFICATION

The **TRANS SERVICE** indicator flashes on and off for 2 minutes after **D** (Drive) is selected. Once the FM mode has been accessed via the shift selector, the “OIL FILTER OK” or “REPLACE FILTERS” message is displayed in the selector display window. An acceptable filter life status is displayed as “OIL FILTER OK”. An unacceptable filter life status is displayed as “REPLACE FILTERS”.

DTC P088A, Transmission Filter Maintenance Alert, sets along with the **TRANS SERVICE** indicator illuminating for filter restriction, but this DTC does not illuminate the **CHECK TRANS** light.

DTC P088B, Transmission Filter Maintenance Required, illuminates the **CHECK TRANS** light if filter service is not performed within a certain period of time of the **TRANS SERVICE** indicator illuminating.

5.9.7.2 READ AND RESET FILTER LIFE MONITOR (FM) FROM SELECTOR

Read FM. With engine off and ignition on, push the **DISPLAY MODE/DIAGNOSTIC** (DMD) button three times on the bump-shift lever selector to enter FM mode. With engine off and ignition on, push the ↑ (Upshift) and ↓ (Downshift) arrows simultaneously three times on the keypad pushbutton selector to enter FM mode.

The message “FILTERS OK” or “REPLACE FILTERS” is displayed in the selector display window. An acceptable filter life status is displayed as “FILTERS OK”. An unacceptable filter life status is displayed as “REPLACE FILTERS”.

Reset FM. The FM automatically resets once the new filters have been installed and the FLI pressure switch no longer detects low pressure at the filter.

The FM can also be reset manually by either of these methods:

- Press and hold the **MODE** button for 10 seconds while in FM mode.
- With ignition on and engine off, shift between **N-R-N-R-N-D-N** to reset the FM, pausing no more than 3 seconds between consecutive shifts.

The **TRANS SERVICE** indicator illuminates briefly following a reset to acknowledge the reset was successful.

If the value displayed remains unchanged, it is possible the reset may be restricted to Allison DOC® for PC–Service Tool only. The FM still resets automatically even if restricted from manual reset through the selector.

History. Allison DOC® for PC–Service Tool Diagnostics Program may be used to display the amount of transmission operation from the initial service indication until the filter reset occurred.



CAUTION: Transmission fluid and filter change frequency is determined by the severity of transmission service. To help avoid transmission damage, more frequent changes may be necessary than recommended in the general guidelines due to operating conditions and duty cycle.

For the appropriate recommended change interval guidelines for your specific transmission configuration, refer to [Table 5–6](#), [Table 5–7](#), or [Table 5–8](#).

5.9.8 TRANSMISSION HEALTH MONITOR (TM). This prognostic feature determines clutch life status of the transmission's clutches and alerts you when clutch maintenance is required. It helps avoid costly repairs and downtime by taking the guesswork out of scheduling routine transmission maintenance, and it ensures your transmission is operating at its maximum performance level. The clutch life status is determined by monitoring the cumulative changes and the calculated running clearance of the transmission clutches.

5.9.8.1 CLUTCH MAINTENANCE NOTIFICATION

The TM feature determines when clutch maintenance is needed. If any of the clutches (except lockup) reaches a remaining life of approximately 10% or if any of the clutch running clearances (except lockup) exceeds a maximum value, then the **TRANS SERVICE** indicator in the shift selector is steadily illuminated from just after ignition on until ignition is turned off. If TM mode has been accessed via the shift selector, a "TRANS HEALTH OK" or "TRANS HEALTH LO" is displayed. An acceptable clutch life status is displayed as "TRANS HEALTH OK". An unacceptable clutch life status is displayed as "TRANS HEALTH LO".

DTC P2789, Transmission Clutch Life Expired (Clutch Adaptive Learning at Limit), sets if multiple warnings have occurred due to the TM actively detecting issues with the clutch system and illuminating the **CHECK TRANS** light.

5.9.8.2 READ AND RESET TM FROM SELECTOR

Read TM. With engine off and ignition on, push the **DISPLAY MODE/DIAGNOSTIC** (DMD) button four times on the bump-shift lever selector to enter TM mode. With engine off and ignition on, push the ↑ (Upshift) and ↓ (Downshift) arrows simultaneously four times on the keypad pushbutton selector to enter TM mode.

The message "TRANS HEALTH OK" or "TRANS HEALTH LO" is displayed in the selector display window. An acceptable clutch life status is displayed as "TRANS HEALTH OK". An unacceptable clutch life status is displayed as "TRANS HEALTH LO".

Reset. The TM feature automatically resets when appropriate conditions are detected. TM can only be manually reset using Allison DOC® for PC–Service Tool. When resetting TM with the service tool, individual clutches or all clutches can be reset. Operator reset through the shift selector is not allowed.

History. The Allison DOC® for PC–Service Tool may be used to display the amount of transmission operation from the initial service indication until the service reset.

5.9.9 FLUID AND FILTER CHANGE INTERVAL RECOMMENDATIONS.



CAUTION: Transmission fluid and filter change frequency is determined by the severity of transmission service. To help avoid transmission damage, more frequent changes may be necessary than recommended in the general guidelines due to operating conditions and duty cycle.

For the appropriate recommended change interval guidelines for your specific transmission configuration, refer to [Table 5-6](#), [Table 5-7](#), or [Table 5-8](#).



CAUTION: Transmission fluid and filters **must be changed** whenever there is evidence of dirt or high temperature conditions. A high temperature condition is indicated when the transmission fluid is discolored, has a strong odor, or has exceeded oil analysis limits.

There are three methods recommended by Allison Transmission to help you determine when to change the fluid and filters in your Allison Transmission. The methods are as follows:

- When a Prognostics indicator becomes active (shown by illuminating the **TRANS SERVICE** indicator in the selector VF display).



NOTE: The strip pushbutton selector has no display and is not prognostics capable.

- When recommendations listed in the Fluid and Filter Change Interval Tables are met. Refer to [Table 5-6](#), [Table 5-7](#), or [Table 5-8](#).
- When a fluid analysis program indicates a fluid change is necessary. Filter changes must still occur based on either of the events occurring above.

5.9.9.1 FLUID AND FILTER CHANGE INTERVAL SCHEDULES WITH PROGNOSTICS TURNED ON



NOTE: Calendar-based change intervals must still be adhered to for both fluid and filter changes even if Prognostics has not indicated the need for either fluid or filter maintenance, unless fluid analysis is used. If maintenance is done because the fluid or filters reached the calendar-based change interval, the OM and FM should be manually reset at that time. Refer to [5.9.6 OIL LIFE MONITOR \(OM\)](#) and [5.9.7 FILTER LIFE MONITOR \(FM\)](#).



NOTE: Allison Transmission High Capacity filters are required in order to use FM feature with Prognostics on maintenance schedule as shown in [Table 5–6](#).



NOTE: Either TES 295 or TES 389 fluid types are required to use the OM feature with Prognostics on. A mixture of TES 389 and TES 295 fluid must continue to use the TES 389 fluid change intervals until two fluid changes with only TES 295 fluid have occurred, at which time the TES 295 schedule may be used.



NOTE: Look at OM % left and/or fluid condition at the time of filter change to determine if it is in the best interest of the customer to change the fluid.

Table 5–6. Prognostics On Fluid and Filter Change Intervals

	Fluid Change Intervals	High Capacity** Main and Lube Filter Change Intervals	Suction Filter Assembly Change Interval
TES 295 Fluids*	<p>Whichever is first of the following:</p> <ul style="list-style-type: none"> If the TRANS SERVICE indicator in the shift selector is illuminated steady for 2 minutes after D (Drive) is selected 60 calendar months** <p>NOTE: Always replace main and lube filters with the fluid change**.</p>	<p>Whichever is first of the following:</p> <ul style="list-style-type: none"> If the TRANS SERVICE indicator in the shift selector is flashing on and off for 2 minutes after D (Drive) is selected Any time the fluid is changed 60 calendar months** 	At time of transmission overhaul

Table 5–6. Prognostics On Fluid and Filter Change Intervals (cont'd)

	Fluid Change Intervals	High Capacity** Main and Lube Filter Change Intervals	Suction Filter Assembly Change Interval
TES 389 Fluids*	<p>Whichever is first of the following:</p> <ul style="list-style-type: none"> • If the TRANS SERVICE indicator in the shift selector is illuminated steady for 2 minutes after D (Drive) is selected • 24 calendar months** <p>NOTE: Always replace main and lube filters with the fluid change**.</p>	<p>Whichever is first of the following:</p> <ul style="list-style-type: none"> • If the TRANS SERVICE indicator in the shift selector is flashing on and off for 2 minutes after D (Drive) is selected • Any time the fluid is changed • 24 calendar months** 	At time of transmission overhaul

* Either TES 295 or TES 389 fluid types are required to use the Oil Life Monitor (OM) feature with Prognostics on as shown in this table. A mixture of TES 389 and TES 295 fluid must continue to use the TES 389 schedule shown in this table until two fluid changes with only TES 295 fluid have occurred, at which time the TES 295 schedule may be used.

** Allison Transmission High Capacity filters are required in order to use the Filter Life Monitor (FM) feature with Prognostics as shown in this table.

5.9.9.2 FLUID AND FILTER CHANGE INTERVAL SCHEDULES WITH PROGNOSTICS DISABLED OR TURNED OFF



NOTE: A mixture of TES 389 and TES 295 fluid must continue to use the TES 389 fluid change intervals until two fluid changes with only TES 295 fluid have occurred, at which time the TES 295 schedule may be used.



CAUTION: Transmission fluid and filter change frequency is determined by the severity of transmission service. To help avoid transmission damage, more frequent changes may be necessary than recommended in the general guidelines due to operating conditions and duty cycle.

For the appropriate recommended change interval guidelines for your specific transmission configuration, refer to [Table 5-6](#), [Table 5-7](#), or [Table 5-8](#).



NOTE: Change fluid/filters at or before recommended mileage, months, or hours have elapsed, whichever occurs first. For vehicles that average less than 40 km/h (25 mph), operating hours represent a more reliable measure of fluid life; therefore, fluid change intervals should not be based on mileage only.

Table 5-7. Prognostics Disabled or Turned Off Fluid and Filter Change Intervals

General Vocation* Refer to Table 5-8 for additional information on severe vocations.			
	Fluid Change Intervals	High Capacity Main*** and Lube Filter Change Intervals	Suction Filter Assembly Change Interval
TES 295 Fluids**	Whichever is first of the following: <ul style="list-style-type: none"> • 480 000 km (300,000 miles) • 6000 hours of operation • 48 calendar months NOTE: Always replace main and lube filters with the fluid change***.	Whichever is first of the following: <ul style="list-style-type: none"> • Any time the fluid is changed • 120 000 km (75,000 miles) • 3000 hours of operation • 36 calendar months 	At time of transmission overhaul

Table 5–7. Prognostics Disabled or Turned Off Fluid and Filter Change Intervals (cont'd)

General Vocation* Refer to Table 5–8 for additional information on severe vocations.			
	Fluid Change Intervals	High Capacity Main*** and Lube Filter Change Intervals	Suction Filter Assembly Change Interval
TES 389 Fluids**	Whichever is first of following: <ul style="list-style-type: none"> • 40 000 km (25,000 miles) • 1000 hours of operation • 12 calendar months NOTE: Always replace main and lube filters with the fluid change***.	Whichever is first of the following: <ul style="list-style-type: none"> • Any time the fluid is changed • 40 000 km (25,000 miles) • 1000 hours of operation • 12 calendar months 	At time of transmission overhaul
* General Vocation includes all non-retarder transmissions not identified as severe, and intercity coaches with duty cycles of less than one stop per mile. ** A mixture of TES 389 and TES 295 fluid must continue to use the TES 389 schedule shown in this table until two fluid changes with only TES 295 fluid have occurred, at which time the TES 295 schedule may be used. *** This information is based on using Allison Transmission High Capacity filters and a TES 389 or TES 295 fluid type with Prognostics Features not available or turned off.			

Table 5–8. Prognostics Disabled or Turned Off Fluid and Filter Change Intervals

Severe Vocation*			
	Fluid Change Intervals	High Capacity** Main and Lube Filter Change Intervals	Suction Filter Assembly Change Interval
TES 295 Fluids***	Whichever is first of the following: <ul style="list-style-type: none"> • 240 000 km (150,00 miles) • 6000 hours of operation • 48 calendar months NOTE: Always replace main and lube filters with the fluid change **.	Whichever is first of the following: <ul style="list-style-type: none"> • Any time the fluid is changed • 120 000 km (75,000 miles) • 3000 hours of operation • 36 calendar months 	At time of transmission overhaul
TES 389 Fluids***	Whichever is first of the following: <ul style="list-style-type: none"> • 20 000 km (12,000 miles) • 500 hours of operation • 6 calendar months NOTE: Always replace main and lube filters with the fluid change **.	Whichever is first of the following: <ul style="list-style-type: none"> • Any time the fluid is changed • 20 000 km (12,000 miles) • 500 hours of operation • 6 calendar months 	At time of transmission overhaul
* Severe Vocation includes all retarder-equipped transmissions, or vocations for On/Off Highway, Refuse, Transit, and Intercity Coach with duty cycle greater than one (1) stop per mile. ** This information is based on using Allison Transmission High Capacity filters and a TES 389 or TES 295 fluid type with Prognostics Features not available or turned off. *** A mixture of TES 389 and TES 295 fluid must continue to use the TES 389 schedule shown in this table until two fluid changes with only TES 295 fluid have occurred, at which time the TES 295 schedule may be used.			

5.9.9.3 FLUID AND FILTER CHANGE PROCEDURE



NOTE: Do not drain the transmission fluid if only filters are being replaced.



WARNING: Avoid contact with the hot fluid or the sump when draining transmission fluid. Direct contact with the hot fluid or the hot sump may result in bodily injury.

Drain Fluid

1. Drain the fluid when the transmission is at operating temperature of 71–93°C (160–200°F). Hot fluid flows quicker and drains more completely.
 2. Remove the drain plug from the control module and allow the fluid to drain into a suitable container.
 3. Examine the fluid for contamination.
-



NOTE: At each fluid change, examine the drained fluid for evidence of dirt or water. A normal amount of condensation appears in the fluid during operation.

Replace Filters (Refer to [Figure 5–7](#)).

1. Remove 12 bolts (1), two filter covers (2), two gaskets (3), two O-rings (4), two O-rings (5), and two filters (6) from the bottom of the control module.
2. When reinstalling parts, lubricate and install new O-rings (4) and (5) on each cover (2). Lubricate O-ring inside filter (6) and push filter onto cover (2). Install new gaskets (3) on cover (2) and align holes in gaskets with holes in cover.



CAUTION: Do not use the bolts to draw the filter covers to the control module. Do not use an impact wrench to tighten the bolts. Using an impact wrench to tighten the bolts may cause stripped threads and expensive parts replacement. Use a torque wrench to tighten the bolts.

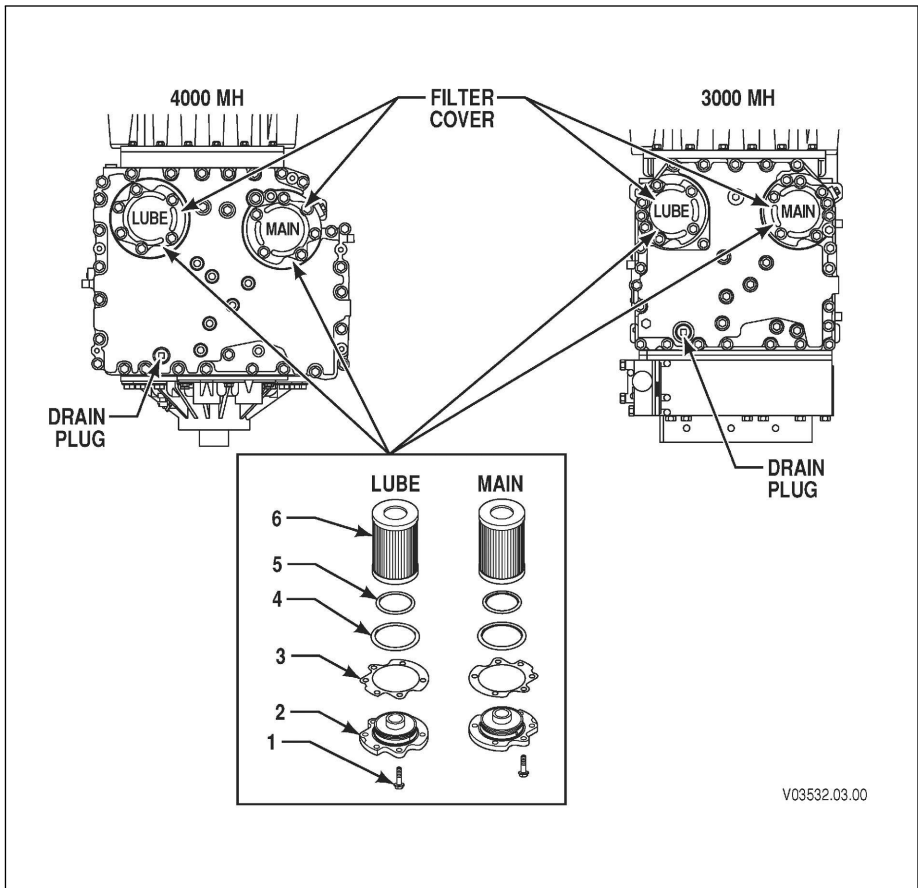


Figure 5-7. Location of Filters for Service

3. Install filter and cover assemblies into the filter compartment. Align each filter/cover assembly with the holes in the channel plate/sump. Push the cover assemblies in by hand to seat the seals.
4. Install 12 bolts into cover and tighten to 51–61 N•m (38–45 lb ft).
5. Replace the drain plug O-ring. Install the plug and tighten to 25–32 N•m (18–24 lb ft).

5.9.9.4 REFILL TRANSMISSION

Refer to [5.7 TRANSMISSION FLUID REFILL](#).

6.1 DIAGNOSTICS

6.2 OVERVIEW

Diagnostic features are provided with the transmission control system to assist in troubleshooting of malfunctions and/or the monitoring of specific operating parameters. When a control system malfunction is detected, a series of Diagnostic Trouble Codes (DTCs) are used to identify and clarify the nature of the malfunction. These DTCs are each named by a 5 character alphanumeric string that refers to a diagnostic algorithm running pass/fail tests to help identify a malfunction in the transmission or vehicle operation. Most DTCs have some kind of diagnostic response that the operator notices, such as an illuminated **CHECK TRANS** light, selector display change, lock in range, or inhibit shifts condition.

DTCs are logged in the Transmission Control Module (TCM) memory by severity and by their active/inactive status with the most severe and active codes listed first. A maximum of five DTCs (numbered d1–d5) from most recent to oldest may be read from the shift selector. As DTCs are added, the oldest inactive DTC (historic) is dropped from the list. If all DTCs are active, the DTC with the lowest priority is dropped from the list.

An active code is any code that is current in the TCM decision-making process and has failed the DTC test(s) associated with that specific diagnostic algorithm. Historical codes, which are by definition inactive, are codes that are no longer failing their algorithm but are retained in the TCM in order to help the technician analyze possible causes and provide them direction if the vehicle is brought in before they are cleared from the queue.

DTCs can be cleared manually by the operator or they clear automatically from last (d5) to first (d1) in the queue after a number of engine starts, without becoming active again.

6.3 DIAGNOSTIC TROUBLE CODE RESPONSE

The electronic control system is programmed to inform the operator of a problem with the transmission system via the **CHECK TRANS** light and shift selector display while it automatically takes action to protect the operator, vehicle, and transmission. When the Transmission Control Module (TCM)

flags a Diagnostic Trouble Code (DTC) as active, the TCM may take a combination of diagnostic responses as listed in the table below. Refer to Table 6–1.

Table 6–1. Diagnostic Trouble Code (DTC) Response

Category of Response	Actions Taken
Do Not Shift (DNS)	Release lockup (LU) clutch and inhibit LU operation
	Inhibit shifts from the current attained range
	Turn on the CHECK TRANS light
	Display the current attained range in the MONITOR window of the shift selector
	Blank the SELECT window of the shift selector
	Disable ability for shift selectors to respond to any range change request from the operator using the shift selector(s).
Solenoids OFF (SOL OFF)	All solenoids are commanded off resulting in hydraulic default operation of the transmission - PCS1 and PCS2 are on hydraulically when off electrically.
Return to Previous Range (RPR)	When speed sensor ratio or PS1 tests do not pass, the TCM commands the same range as commanded before the shift.
Neutral No Clutches (NNC)	When certain speed sensor ratio or PS1 tests do not pass, the TCM commands a neutral condition with no clutches applied.
Do Not Adapt (DNA)	The TCM stops adaptive shift control while the code is active.

6.2.1 CHECK TRANS LIGHT. Each time the engine is started, the **CHECK TRANS** light illuminates briefly for a bulb check. After a few seconds it should turn off. If the **CHECK TRANS** light does not illuminate briefly after the ignition is turned on, or if the **CHECK TRANS** light remains steadily on after ignition and engine start, have the vehicle and transmission system checked by a qualified Allison Transmission technician.

If the **CHECK TRANS** light is steadily illuminated due to an active DTC, the shift selector blanks the SELECT and only shows a range the transmission has locked into in the MONITOR window of the selector, seek immediate attention from a qualified Allison Transmission technician. Perform service as soon as possible in order to minimize the potential for damage to the transmission or vehicle. The transmission can be operated for a short time in the current attained range in order to get the vehicle to a safe location

for service assistance. If the vehicle engine is turned off, prepare for the possibility that at engine restart the transmission may be locked in **N** (Neutral) and will not accept operator requests to change range if a DTC that causes a **CHECK TRANS** light is active at time of engine restart.



NOTE: Some DTCs may be logged without the TCM activating the **CHECK TRANS** light. Contact your Allison Transmission authorized service outlet whenever there is a transmission-related concern. They have the equipment to access and troubleshoot DTCs.

6.3 USING SHIFT SELECTOR FOR ACCESSING DIAGNOSTICS INFORMATION

DTCs can be displayed on the display portion of the shift selector. A DTC is either active or historic. An active DTC is a DTC that is current in the TCM decision-making process. Historic DTCs are retained in the TCM memory and do not necessarily affect the TCM decision-making process.

6.3.1 DISPLAY SEQUENCE.

Up to five DTCs may be displayed one at a time from the selector once the diagnostic display mode has been initiated by the operator. Each DTC is 5 characters in length. The DTC status active or inactive is shown below the DTC (refer to [Figure 6-1](#)).



Figure 6-1. DTC Display

The operator presses the **MODE** button to read the next DTC in the queue (if any) or requests to exit diagnostics mode. The diagnostics mode times out and returns the selector to normal operating mode after approximately 10 minutes of operator inactivity.

6.3.2 READ/CLEAR DTCs WITH KEYPAD PUSHBUTTON SELECTOR.



NOTE: The strip button shift selector has no display or diagnostic capabilities.

6.3.2.1 READING DTCs WITH PROGNOSTICS PACKAGE ON

To read DTCs with prognostics on using the keypad pushbutton shift selector:

- Simultaneously press the ↑ (Upshift) and ↓ (Downshift) arrows five times to enter diagnostic mode.
 - Press the **MODE** button to read the next code in the queue, if any.
-



NOTE: For 4700/4800 transmissions equipped with a retarder, press the **MODE** button once.

6.3.2.2 READING DTCs WITH PROGNOSTICS PACKAGE OFF

To read DTCs with prognostics off using the keypad pushbutton shift selector:

- Simultaneously press the ↑ (Upshift) and ↓ (Downshift) arrows two times to enter diagnostic mode.
 - Press the **MODE** button to read the next code in the queue, if any.
-



NOTE: For 4700/4800 transmissions equipped with a retarder, press the **MODE** button once.

6.3.2.3 CLEARING DTCs

While in diagnostic mode, clear all active codes by pressing and holding the **MODE** button for approximately three seconds until the MODE message flashes. Release the **MODE** button. The MODE message should not remain illuminated if the active DTC shown in the display has cleared.

To clear all stored DTCs, press and hold the **MODE** button for ten seconds. The MODE message flashes a second time indicating all codes are cleared from the queue.



NOTE: Any codes that cause the **CHECK TRANS** light are considered severe enough to warrant immediate attention from a qualified repair facility. Schedule repair as soon as possible.



NOTE: If an active indicator is cleared while the transmission is locked in range because of the diagnostic response to an active DTC, the transmission remains in that locked range even after clearing the active indicator. **N** (Neutral) must be manually selected or the ignition must be cycled.



NOTE: Some codes will self-clear once the conditions that caused the active code are not present. These codes are stored as inactive in the DTC queue. Some DTCs require an ignition cycle before they can be cleared from active status.



NOTE: If the condition(s) that caused the active code are still present, the code becomes active again.

6.3.2.4 EXITING DIAGNOSTIC MODE

Exit the diagnostic mode by one of the following methods:

- Momentarily press the ↑ (Upshift) and ↓ (Downshift) arrows once.
- Press any range button, **D** (Drive), **N** (Neutral), **R** (Reverse).
- After approximately 10 minutes of inactivity at the pushbutton shift selector, the diagnostic mode automatically exits and returns to normal operating mode.

6.3.3 READ/CLEAR DTCs WITH BUMP-SHIFT LEVER SELECTOR.

6.3.3.1 READING DTCs WITH PROGNOSTICS PACKAGE ON

To read DTCs with prognostics on using the bump-shift lever selector:

- Press the **DISPLAY MODE/DIAGNOSTIC** (DMD) five times to enter diagnostic mode.
- Press the **MODE** button to read the next code in the queue, if any.



NOTE: For 4700/4800 transmissions equipped with a retarder, press the **MODE** button four times.

6.3.3.2 READING DTCs WITH PROGNOSTICS PACKAGE OFF

To read DTCs with prognostics off using the bump-shift lever selector:

- Press the **DISPLAY MODE/DIAGNOSTIC** (DMD) two times to enter diagnostic mode.

- Press the **MODE** button to read the next code in the queue, if any.



NOTE: For 4700/4800 transmissions equipped with a retarder, press the **MODE** button once.

6.3.3.3 CLEARING DTCs

While in diagnostic mode, clear all active codes by pressing and holding the **MODE** button for approximately three seconds until the MODE message flashes. Release the **MODE** button. The MODE message should not remain illuminated if the active DTC shown in the display has cleared.

To clear all stored DTCs, press and hold the **MODE** button for ten seconds. The MODE message flashes a second time indicating all codes are cleared from the queue.



NOTE: Any codes that cause the **CHECK TRANS** light are considered severe enough to warrant immediate attention from a qualified repair facility. Schedule repair as soon as possible.



NOTE: If an active DTC is cleared while the transmission is locked in range because of the diagnostic response to an active DTC, the transmission remains in that locked range even after clearing the active DTC. **N** (Neutral) must be manually selected or the ignition must be cycled.



NOTE: Some codes will self-clear once the conditions that caused the active code are not present. These codes will be stored as inactive in the DTC queue. Some DTCs require an ignition cycle before they can be cleared from active status.



NOTE: If the condition(s) that caused the active code are still present, the code becomes active again.

6.3.3.4 EXITING DIAGNOSTIC MODE

Exit the diagnostic mode by one of the following methods:

- Momentarily press the **MODE** button once.
- Move the bump-shift lever selector to any range.

- After approximately 10 minutes of inactivity at the bump-shift lever selector, the diagnostic mode automatically exits and returns to normal operating mode.

6.3.3.5 DTC LIST AND DESCRIPTION

Table 6–2. DTC List and Descriptions

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
C1312	Retarder Request Sensor Circuit Low	No	May inhibit retarder operation if not using J1939 datalink
C1313	Retarder Request Sensor Circuit High	No	May inhibit retarder operation if not using J1939 datalink
P0122	Pedal Position Sensor Circuit Low Voltage	No	Use default throttle values. Freezes shift adapts.
P0123	Pedal Position Sensor Circuit High Voltage	No	Use default throttle values. Freezes shift adapts.
P0218	Transmission Fluid Over Temperature	Yes	Use default sump temp
P0562	System Voltage Low	No	Inhibit TCC Operation, DNA
P0602	TCM Not Programmed	Yes	Lock in Neutral
P0604	Control Module Random Access Memory (RAM)	Yes	Lock in Neutral
P0614	Torque Control Data Mismatch—ECM/TCM	Yes	Allows operation only in reverse and second range
P0634	TCM Internal Temperature Too High	Yes	SOL OFF (hydraulic default)
P0642	Sensor Reference Voltage “A” Circuit Low	Yes	Default sensor data used
P0643	Sensor Reference Voltage “A” Circuit High	Yes	Default sensor data used

Table 6–2. DTC List and Descriptions (cont'd)

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
P0657	Actuator Supply Circuit Voltage 1 Open (HSD1)	Yes	SOL OFF, DNA, Inhibit TCC operation, Inhibit main modulation
P0658	Actuator Supply Circuit Voltage 1 Circuit Low (HSD1)	Yes	DNS, SOL OFF (hydraulic default)
P0659	Actuator Supply Circuit Voltage 1 Circuit High (HSD1)	Yes	DNS, SOL OFF (hydraulic default)
P0703	Brake Switch Circuit	No	No Neutral to Drive shifts for refuse packer. TCM inhibits retarder operation if a TPS code is also active.
P0708	Transmission Range Sensor Circuit High	Yes	Ignore defective strip selector inputs
P070C	Transmission Fluid Level Sensor Circuit Low	No	None
P070D	Transmission Fluid Level Sensor Circuit High	No	None
P0712	Transmission Fluid Temperature Sensor Circuit Low	Yes	Use default sump temp
P0713	Transmission Fluid Temperature Sensor Circuit High	Yes	Use default sump temp
P0715	Turbine Shaft Speed Sensor Circuit	Yes	DNS, Lock in current range
P0716	Turbine Shaft Speed Sensor Circuit Performance	Yes	DNS, Lock in current range
P0717	Turbine Shaft Speed Sensor Circuit No Signal	Yes	DNS, Lock in current range
P071A	RELS Input Failed On	Yes	Inhibit RELS operation
P071D	General Purpose Input Fault	Yes	None

Table 6–2. DTC List and Descriptions (cont'd)

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
P0720	Output Shaft Speed Sensor Circuit	Yes	DNS, Lock in current range
P0721	Output Shaft Speed Sensor Circuit Performance	Yes	DNS, Lock in current range
P0722	Output Shaft Speed Sensor Circuit No Signal	Yes	DNS, Lock in current range
P0725	Engine Speed Sensor Circuit	No	Default to turbine speed
P0726	Engine Speed Sensor Circuit Performance	No	Default to turbine speed
P0727	Engine Speed Sensor Circuit No Signal	No	Default to turbine speed
P0729	Incorrect 6 th Gear Ratio	Yes	DNS, Attempt 5 th , then 3 rd
P0731	Incorrect 1 st Gear Ratio	Yes	DNS, Attempt 2 nd , then 5 th
P0732	Incorrect 2 nd Gear Ratio	Yes	DNS, Attempt 3 rd , then 5 th
P0733	Incorrect 3 rd Gear Ratio	Yes	DNS, Attempt 4 th , then 6 th
P0734	Incorrect 4 th Gear Ratio	Yes	DNS, Attempt 5 th , then 3 rd
P0735	Incorrect 5 th Gear Ratio	Yes	DNS, Attempt 6 th , then 3 rd , then 2 nd
P0736	Incorrect Reverse Ratio	Yes	DNS, Lock in Neutral
P0741	Torque Converter Clutch (TCC) System Stuck Off	Yes	None
P0752	Shift Solenoid 1 Valve Performance–Stuck On	Yes	DNS
P0776	Pressure Control Solenoid (PCS) 2 Stuck Off	Yes	DNS, RPR

Table 6–2. DTC List and Descriptions (cont'd)

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
P0777	Pressure Control Solenoid (PCS) 2 Stuck On	Yes	DNS, RPR
P077F	Incorrect Reverse 2 Ratio	Yes	DNS, Lock in Neutral
P0796	Pressure Control Solenoid (PCS) 3 Stuck Off	Yes	DNS, RPR
P0797	Pressure Control Solenoid (PCS) 3 Stuck On	Yes	DNS, RPR
P0842	Transmission Fluid Pressure Switch 1 Circuit Low	Yes	DNS, Lock in current range
P0843	Transmission Fluid Pressure Switch 1 Circuit High	Yes	DNS, Lock in current range
P0847	Transmission Fluid Pressure Switch 2 Circuit Low	Yes	None
P0848	Transmission Fluid Pressure Switch 2 Circuit High	Yes	None
P0880	TCM Power Input Signal	No	None
P0881	TCM Power Input Signal Performance	No	None
P0882	TCM Power Input Signal Low	Yes	DNS, SOL OFF (hydraulic default)
P0883	TCM Power Input Signal High	No	None
P088A	Transmission Filter Maintenance Alert	No	None
P088B	Transmission Filter Maintenance Required	No	None
P0894	Unexpected Mechanical Gear Disengagement	Yes	DNS, Lock in first

Table 6–2. DTC List and Descriptions (cont'd)

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
P0897	Transmission Fluid Deteriorated	No	None
P0960	Main Pressure Modulation Solenoid Control Circuit Open	Yes	None
P0962	Main Pressure Modulation Solenoid Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P0963	Main Pressure Modulation Solenoid Control Circuit High	Yes	None
P0964	Pressure Control Solenoid (PCS) 2 Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P0966	Pressure Control Solenoid (PCS) 2 Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P0967	Pressure Control Solenoid (PCS) 2 Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P0968	Pressure Control Solenoid (PCS) 3 Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P0970	Pressure Control Solenoid (PCS) 3 Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P0971	Pressure Control Solenoid (PCS) 3 Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P0973	Shift Solenoid 1 Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P0974	Shift Solenoid 1 Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P0976	Shift Solenoid 2 Control Circuit Low	Yes	7-speed: Allow 2 through 6, N, R. Inhibit TCC operation

Table 6–2. DTC List and Descriptions (cont'd)

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
P0977	Shift Solenoid 2 Control Circuit High	Yes	7-speed: Allow 2 through 6, N, R
P097A	Shift Solenoid 1 Control Circuit Open	Yes	Lock in range
P097B	Shift Solenoid 2 Control Circuit Open	Yes	7-speed: Allow 2 through 6, N, R
P0989	Retarder Pressure Sensor Circuit Low	No	None
P0990	Retarder Pressure Sensor Circuit High	No	None
P1739	Incorrect Low Gear Ratio	Yes	Command 2nd and allow shifts 2 through 6, N, R
P1790	Gear Shift Module 1 Calibrated Invalid	Yes	Shift selector language or units incorrect
P1791	Gear Shift Module 2 Calibrated Invalid	Yes	Shift selector language or units incorrect
P1891	Throttle Position Sensor PWM Signal Low	No	Use default throttle values
P1892	Throttle Position Sensor PWM Signal High	No	Use default throttle values
P2184	Engine Coolant Temperature Sensor 2 Circuit Low	No	Use default engine coolant values
P2185	Engine Coolant Temperature Sensor 2 Circuit High	No	Use default engine coolant values
P2637	Torque Management Feedback Signal A	Yes	Inhibit SEM
P2641	Torque Management Feedback Signal B	Yes	Inhibit LRTP
P2669	Actuator Supply Circuit Voltage 2 Open (HSD2)	Yes	SOL OFF, Inhibit TCC operation, Inhibit Main modulation, DNA
P2670	Actuator Supply Circuit Voltage Low (HSD2)	Yes	DNS, SOL OFF (hydraulic default)

Table 6–2. DTC List and Descriptions (cont'd)

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
P2671	Actuator Supply Circuit Voltage 2 High (HSD2)	Yes	DNS, SOL OFF (hydraulic default)
P2684	Actuator Supply Circuit Voltage 3 Open (HSD3)	Yes	SOL OFF, Inhibit TCC operation, Inhibit Main modulation, DNA
P2685	Actuator Supply Circuit Voltage 3 Low (HSD3)	Yes	DNS, SOL OFF (hydraulic default)
P2686	Actuator Supply Circuit Voltage 3 High (HSD3)	Yes	DNS, SOL OFF (hydraulic default)
P2714	Pressure Control Solenoid (PCS) 4 Stuck Off	Yes	DNS, RPR
P2715	Pressure Control Solenoid (PCS) 4 Stuck On	Yes	DNS, SOL OFF (hydraulic default)
P2718	Pressure Control Solenoid (PCS) 4 Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P2720	Pressure Control Solenoid (PCS) 4 Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P2721	Pressure Control Solenoid (PCS) 4 Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P2723	Pressure Control Solenoid (PCS) 1 Stuck Off	Yes	DNS, RPR
P2724	Pressure Control Solenoid (PCS) 1 Stuck On	Yes	DNS, RPR
P2727	Pressure Control Solenoid (PCS) 1 Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P2729	Pressure Control Solenoid (PCS) 1 Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)

Table 6–2. DTC List and Descriptions (cont'd)

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
P2730	Pressure Control Solenoid (PCS) 1 Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P2736	Pressure Control Solenoid (PCS) 5 Control Circuit Open	Yes	Inhibit retarder operation
P2738	Pressure Control Solenoid (PCS) 5 Control Circuit Low	Yes	Allow 2 through 6, N, R. Inhibit retarder and TCC operation
P2739	Pressure Control Solenoid (PCS) 5 Control Circuit High	Yes	Inhibit retarder operation
P273F	Retarder Oil Temperature Sensor Over Temperature Condition	No	None
P2742	Retarder Oil Temperature Sensor Circuit Low	No	Use default retarder temp values
P2743	Retarder Oil Temperature Sensor Circuit High	No	Use default retarder temp values
P2761	Torque Converter Clutch (TCC) Pressure Control Solenoid (PCS) Control Circuit Open	Yes	Inhibit TCC operation
P2763	Torque Converter Clutch (TCC) Pressure Control Solenoid (PCS) Control Circuit High	Yes	Inhibit TCC operation
P2764	Torque Converter Clutch (TCC) Pressure Control Solenoid (PCS) Control Circuit Low	Yes	7-speed: allow 2 through 6, N, R. Inhibit TCC operation
P2789	Transmission Clutch Life Expired (Clutch Adaptive Learning at Limit)	Yes	None
P2793	Gear Shift Direction Circuit	Yes	Ignores PWM input from shift selector

Table 6–2. DTC List and Descriptions (cont'd)

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
P2808	Pressure Control Solenoid (PCS) 6 Stuck Off	Yes	DNS, RPR
P2809	Pressure Control Solenoid (PCS) 6 Stuck On	Yes	DNS, RPR
P2812	Pressure Control Solenoid (PCS) 6 Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P2814	Pressure Control Solenoid (PCS) 6 Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P2815	Pressure Control Solenoid (PCS) 6 Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
U0073	CAN Communication Bus 1 Off	No	Use default values
U0074	CAN Communication Bus 2 Off	No	Use default values
U0100	Lost Communications with ECM A	Yes	Use default values
U0103	Lost Communication With Gear Shift Module 1	Yes	Maintain range selected, observe gear shift direction circuit
U0291	Lost Communication With Gear Shift Module 2	Yes	Maintain range selected, observe gear shift direction circuit
U0304	Gear Shift Module 1 Incompatible	Yes	Ignore shift selector inputs
U0333	Gear Shift Module 2 Incompatible	Yes	Ignore shift selector inputs
U0404	Gear Shift Module 1 Invalid Data	Yes	Maintain range selected, observe gear shift direction circuit

Table 6–2. DTC List and Descriptions (cont'd)

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
U0592	Gear Shift Module 2 Invalid Data	Yes	Maintain range selected, observe gear shift direction circuit

7.1 ALLISON 5th GENERATION SHIFT SELECTORS COMPONENTS AND FUNCTIONS

7.2 SELECT/MONITOR DISPLAY

A two-character vacuum fluorescent blue-green display is included on the face of each bump-shift lever and keypad pushbutton shift selector. The strip button selector does not have a VFD. The left character, called the SELECT display appropriately designates **N** (Neutral), **R** (Reverse), or the highest gear available of the selected forward range. The right character of the display, called the MONITOR display, designates the actual gear being commanded by the TCM. The display of any other character in the SELECT or MONITOR display denotes a non-standard operating condition.

7.3 BACKLIGHTING

During normal vehicle operation, backlighting is provided for all keypad buttons of the pushbutton shift selector, and buttons on the strip pushbutton selector.

The **MODE** button and the **DISPLAT MODE DIAGNOSTIC** (DMD) button with the Allison logo are continually backlit during normal vehicle operation.

7.4 MODE BUTTON



NOTE: There is no **MODE** button located on the strip button selector.

The **MODE** button is located on the bezel face of the bump-shift lever selector or keypad pushbutton shift selector. The **MODE** button can be pressed any time after engine start to activate the alternate shift schedule or special function.

The **MODE** button performs the following functions:

- Activates a special function programmed into the TCM, which is typically an alternate ECONOMY or PERFORMANCE shift schedule.
- Toggles to the next DTC while in DTC display mode.
- Clears (erases) active and inactive DTCs from TCM memory.



NOTE: DTCs cannot be cleared individually. All active DTCs clear first, followed by the inactive (historic) DTCs, provided the **MODE** button is pressed long enough while in the DTC display mode. Refer to [6.0 DIAGNOSTICS](#) for information and the procedure on reading and clearing (erasing) DTCs.

A MODE display is located near the **MODE** button to identify the purpose associated with the **MODE** button selection. Refer to [Figure 7-1](#) for the location of the **MODE** button and MODE display on a bump-shift lever selector. Refer to [Figure 7-2](#) for the location of the **MODE** button and MODE display on a pushbutton shift selector.

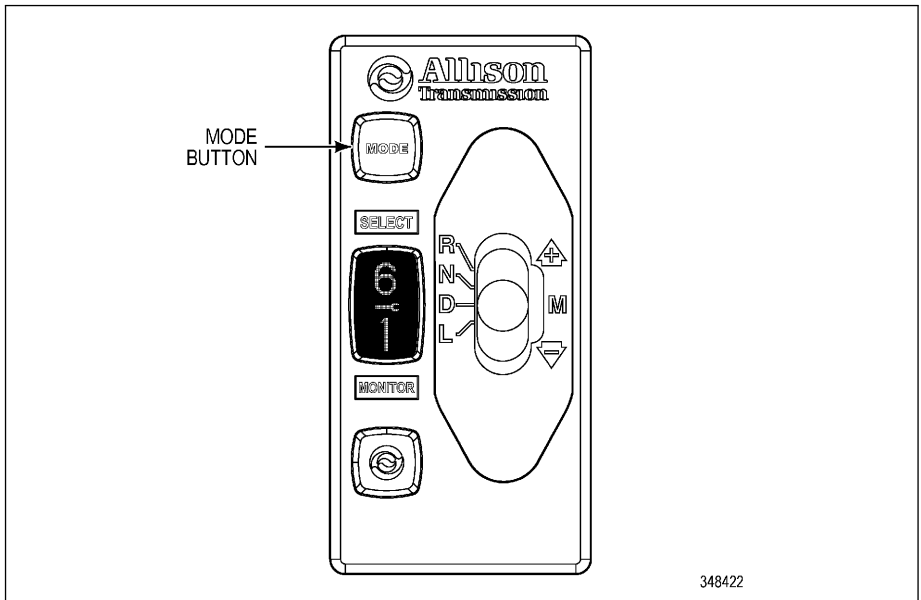


Figure 7-1. MODE Button and Display On a Bump-Shift Lever Selector

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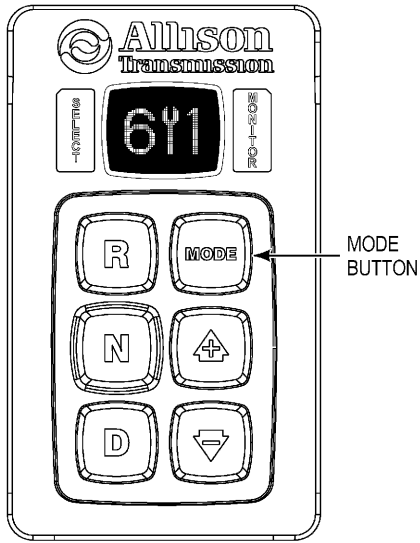


Figure 7–2. MODE Button and Display On a Pushbutton Shift Selector

7.5 TRANS SERVICE INDICATOR (WRENCH ICON)

The **TRANS SERVICE** (wrench icon) indicator illuminates in the event a service condition relating to a transmission clutch, fluid or filter life occurs. The **TRANS SERVICE** indicator is located on the shift selector display (refer to [Figure 7–3](#)).

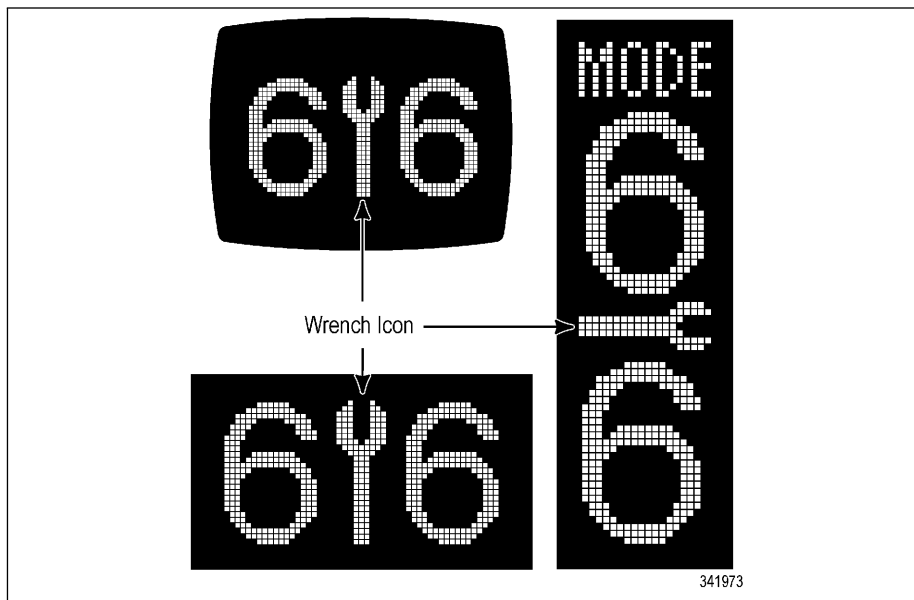


Figure 7-3. Typical Allison 5th Generation Trans Service Indicator


For additional information regarding these conditions, refer to [5.9.6 OIL LIFE MONITOR \(OM\)](#), or [5.9.7 FILTER LIFE MONITOR \(FM\)](#), or [5.9.8 TRANSMISSION HEALTH MONITOR \(TM\)](#).

7.5 SELECTOR DISPLAY DESCRIPTIONS FOR ACTIVE DIAGNOSTIC TROUBLE CODES (DTCs) AND INHIBITS


RANGE SELECT Blank: With an active DTC, the SELECT display on the shift selector is blank. The MONITOR display indicates the range in which the transmission is locked. The **CHECK TRANS** light is also activated. Refer to [6.0 DIAGNOSTICS](#).

RANGE SELECT Flashing: The flashing display indicates a requested shift is either temporarily or permanently inhibited. The inhibit may clear if the cause of the inhibit clears within 3 seconds of the shift request. Otherwise, the operator must re-select the desired range.

Wrench Icon (TRANS SERVICE) Illuminated: This indicator is only functional if prognostics are enabled in the TCM controls calibration. This indicator is illuminated upon the detection of a service issue relating to clutch, filter, or fluid life. The appearance of the indicator (lit steadily or flashing) varies for each of the conditions monitored by the system. Refer to [7.4 TRANS SERVICE INDICATOR \(WRENCH ICON\)](#).

 **All Segments Illuminated:** If all segments of the display are on for more than 12 seconds, the TCM has not completed initialization. A DTC is associated with this condition. It is normal for all segments to illuminate for a brief time during initialization of the selector and controls.

SELECT/MONITOR BOTH BLANK: This condition indicates either a lack of power to the selector or the SAE J1939 communication datalink has failed. Continuous blank indicates loss of power to the selector. If the blank display changes to a double cat-eye display, other conditions exist. Refer to double cat-eye discussion below.

 **Double Cat-Eyes:** This display indicates a failure of the SAE J1939 communication link and is always accompanied by a DTC. The cat-eyes are illuminated in both the SELECT and MONITOR locations after approximately 12 seconds of blank display.



WARNING: Without the J1939 communication datalink, the shift selector cannot display the selected transmission range. Vehicle operation will be affected.

7.6 SELECTOR DISPLAY IS INOPERATIVE

In the event communication with the SAE J1939 datalink is lost, limited communication between the TCM and the Allison keypad pushbutton and lever shift selectors continues through direction signal wire 134. This limited communication allows the operator to select **D** (Drive), **N** (Neutral), or **R** (Reverse) in order to get the vehicle to a service location. Operator requests for range upshifts and downshifts will not be recognized, and the shift selector display will not display the selected transmission range due to the lack of a SAE J1939 datalink signal, but displays double cat-eyes.



WARNING: Assuming proper installation of direction signal wire 134, most Allison shift selectors may still be used to command transmission direction changes in these circumstances. Due to the failure of the SAE J1939 datalink communication, however, the shift selector cannot display the selected range. When this condition exists, it is advisable to slowly and carefully apply the throttle each time a change of direction has been selected in order to verify the direction of operation before accelerating the vehicle.

7.7 BUMP-SHIFT LEVER SELECTOR

The Allison Bump-Shift Lever selector (refer to [Figure 4–1](#)) is an electromechanical control that has locked positions to prevent accidentally selecting **R** (Reverse), **N** (Neutral), or **D** (Drive).

Bump-Shift Lever selector positions are:

- **R** (Reverse): selects reverse gear. Bumping the lever forward will select the alternate reverse gear range in select models. For more information on 2nd Reverse for the 4000 7-speed models, refer to Technical Document (TD) 188, Application and Installation Requirements for 2nd Reverse.
- **N** (Neutral): must be selected prior to starting the engine.
- **D** (Drive): selects the highest available forward range. Transmission shifts to starting gear and will automatically upshift through the gears, as operating conditions permit, until the highest available gear is attained.
- **L (Low)**: selects the lowest available forward range. The transmission will automatically downshift to the lowest range using the preselect downshift schedule. Once attained, the transmission will hold the low range until another range is selected.
- **M (Manual)**: moving the bump-shift lever from the Drive position into the Manual Select position allows the operator to select a lower or higher forward gear range.
 - Initially moving the bump-shift lever to M (Manual) sets the Range Selected to the same forward range as the current Range Attained, shown in the MONITOR position on the display. Referred to as Express Preselect.
 - Each DOWNSHIFT (-) bump decreases the Range Selected by one forward range.
 - Each UPSHIFT (+) bump increases the Range Selected by one forward gear range.
 - These are momentary bump positions – when the operator releases the bump-shift lever, the bump-shift lever returns to the Drive position.
 - The M (Manual) position is accessible only from the Drive position and affects only forward gear ranges.

In addition to the features listed in [7.0 ALLISON 5th GENERATION SHIFT SELECTORS COMPONENTS AND FUNCTIONS](#), the bump-shift lever selector also includes the following features:

- **HOLD OVERRIDE BUTTON:** The **HOLD OVERRIDE** button is a finger-controlled button integrated into the top and front side of the bump-shift lever selector knob. This button uses a detent feature with locked positions to prevent accidental range selection. Press the **HOLD OVERRIDE** button to release the detent and move the bump-shift lever from any of these locked positions.
- **DISPLAY MODE/DIAGNOSTIC (DMD):** The DMD button, when pressed, allows access to fluid level information, prognostics information, and DTC information, depending on how many times it was pressed. Refer to [Figure 4–1](#) and [Table 4–1](#).

7.8 KEYPAD PUSHBUTTON SHIFT SELECTOR

The Allison keypad pushbutton shift selector (refer to [Figure 4–1](#) and [Table 4–1](#)) has six buttons on the keypad that cause the following transmission operations to occur:

- **R:** Press to select reverse
- **N:** Press to select neutral
- **D:** Press to select drive
- **Upshift and Downshift Arrow Buttons**

These buttons are used to change the Range Selected to a higher or lower forward range:

- One press of the **DOWNSHIFT** button sets range **SELECT** to the same range as the current range attained, shown in the **MONITOR** position on the display (refer to [Figure 4–1](#)). Referred to as Express Preselect.
- Each subsequent press of the **DOWNSHIFT** button decreases the range selected by one range.
- One press of the **UPSHIFT** button increases the range selected by one range.
- If the **UPSHIFT** or **DOWNSHIFT** button is held continuously, the selected range will continue to change up or down until the button is released or until the highest or lowest possible range of gears is selected.
- **MODE:** Multi-functional use. Refer to [7.3 MODE BUTTON](#).

Except for some 4700/4800 models with a 2nd Reverse feature, the ↑ (Upshift) and ↓ (Downshift) arrows are only functional while in a forward range, and not in **N** (Neutral) or **R** (Reverse).

Pressing both the ↑ (Upshift) and ↓ (Downshift) arrows simultaneously when the transmission is in Neutral invokes requests for reading oil level, prognostics information or DTCs. Refer to [7.0 ALLISON 5th GENERATION SHIFT SELECTORS COMPONENTS AND FUNCTIONS](#). If the transmission is locked in range due to an active DTC, the system still allows the operator to review the DTC in the selector with simultaneous button presses on the ↑ (Upshift) and ↓ (Downshift) arrows even though the transmission is not in **N** (Neutral).

Conditions which illuminate the **CHECK TRANS** indicator disable the shift selector. The SELECT display is blank and the MONITOR display shows the range actually attained. For a detailed explanation, refer to [6.2.1 CHECK TRANS LIGHT](#).

7.9 STRIP PUSHBUTTON SHIFT SELECTOR

Function of these selectors is similar to the keypad pushbutton selectors. Buttons on the strip selectors, however, are arranged in a single horizontal row or a single vertical column. When one of the buttons is pressed, a light in the upper right corner of the button indicates the selected range. These selectors do not have a **MODE** button to select a secondary shift schedule. These selectors have no VFD and cannot display prognostic, fluid fill, or diagnostic information.

8.1 CUSTOMIZING CONTROLS AND TCM PROGRAMMING

8.2 VEHICLE AND TRANSMISSION SIGNAL INTERFACE OVERVIEW

This section describes the vehicle interface connections to the transmission controls and transmission signals. The vehicle interfaces discussed in this section may be provided through a SAE J1939 vehicle communications interface and include:

- **CHECK TRANS** indicator
- Wrench Icon. Used for Prognostics features for needed scheduled transmission maintenance
- **RANGE INHIBITED** or **RANGE INHIBIT** indicator
- Neutral Start
- Speedometer signal
- Reverse Warning
- Anti-Lock Brake System (ABS) status
- Service Brake status
- Retarder Modulation signals (if equipped)
- Engine Water Temperature signal
- Range Request signals
- Other miscellaneous Transmission Input/Output (I/O) signals that control Auxiliary Vehicle functions by using either discrete electrical signals, J1939 messages, or a combination of both

8.3 INPUT AND OUTPUT FUNCTIONS OVERVIEW

Input and Output (I/O) functions are built into each transmission control system to allow additional functional controls of specialized transmissions and/or auxiliary vehicle operations that are tailored for the expected vocation of the vehicle.

Control signals are generally needed by each I/O function to work. These control signals, known as inputs, may be a combination of the following:

- Discrete analog switched signal voltages or switched-to-ground signals that control the on/off state of the needed input(s) that in turn allow the enabled I/O function to switch to on or off. Each input(s) must be wired to the correct vehicle circuits and the correct TCM pins through the correct OEM supplied switches, relays, connectors, and other components as needed.
- Various vehicle controller datalink messages from various controllers on the vehicle communications datalink such as SAE J1939.
- Use of monitored vehicle and/or transmission data such as, temperatures, various speeds, and specific range attained that are then compared with program limits and CMC parameters within the TCM to turn the I/O function on and off.

Various combinations of these I/O functions are assembled into I/O packages. The I/O package is contained in your TCM as part of its calibration and software for the exact vocation of your vehicle. This strategy allows the vehicle OEM(s) maximum flexibility for choosing which I/O functions and discrete input circuits, labeled by wire number and TCM pin assignments, they want to control the I/O functions on your vehicle. To provide flexibility to the OEM(s) and customer, specific discrete input circuits to specific TCM pins vary between vocations and I/O packages.

The calibration of each TCM, which also contains the programming of how your I/O is configured by the package, was selected for your vehicle by your vehicle OEM. To fit a customer's exact I/O requirement for their vehicle it may be necessary for the TCM to have individual I/O functions or packages re-programmed, or possibly recalibrate the TCM, for a different I/O package. You will have to take your vehicle to a qualified technician if you need to determine what I/O has been enabled or disabled by your OEM, bodybuilder, or service location. A qualified Allison or OEM technician can download and review your calibration information within the "I/O Wires Report" Section that is part of "Diagnostic Reports" contained in the Allison DOC[®] for PC-Service Tool. Your vehicle I/O or body builder should be consulted as well for information such as wiring diagrams, regarding how individual I/O functions were integrated in your vehicle.



NOTE: At the customer's request, and usually at the customer's expense, an Allison Service Outlet can:

- Run a report showing the present vehicle I/O configuration
- Enable/disable different I/O features and set the related CMC(s)
- Calibrate the TCM in order to get a different I/O packages

Proper chassis wiring and connectors, switches, relays, lamps, indicators, datalink messages, and CMC(s) must all be integrated into the vehicle and verified to be working properly before a newly programmed I/O feature or function works. If components for I/O functions are not integrated correctly in the vehicle, some of the enabled I/O features can inhibit the transmission from going to range or cause active DTCs.



NOTE: All feature-related components must be integrated in the vehicle build prior to enabling the I/O feature. Features listed as "Not Enabled" must be enabled by Allison reprogramming-certified personnel.

8.4 CONTROLS SYSTEM OVERVIEW

The Allison 5th Generation Controls system provides the functional control for Allison transmissions. The transmission control system consists of the components shown in [Figure 8-1](#) for the 3000 and 4000 Product Families.

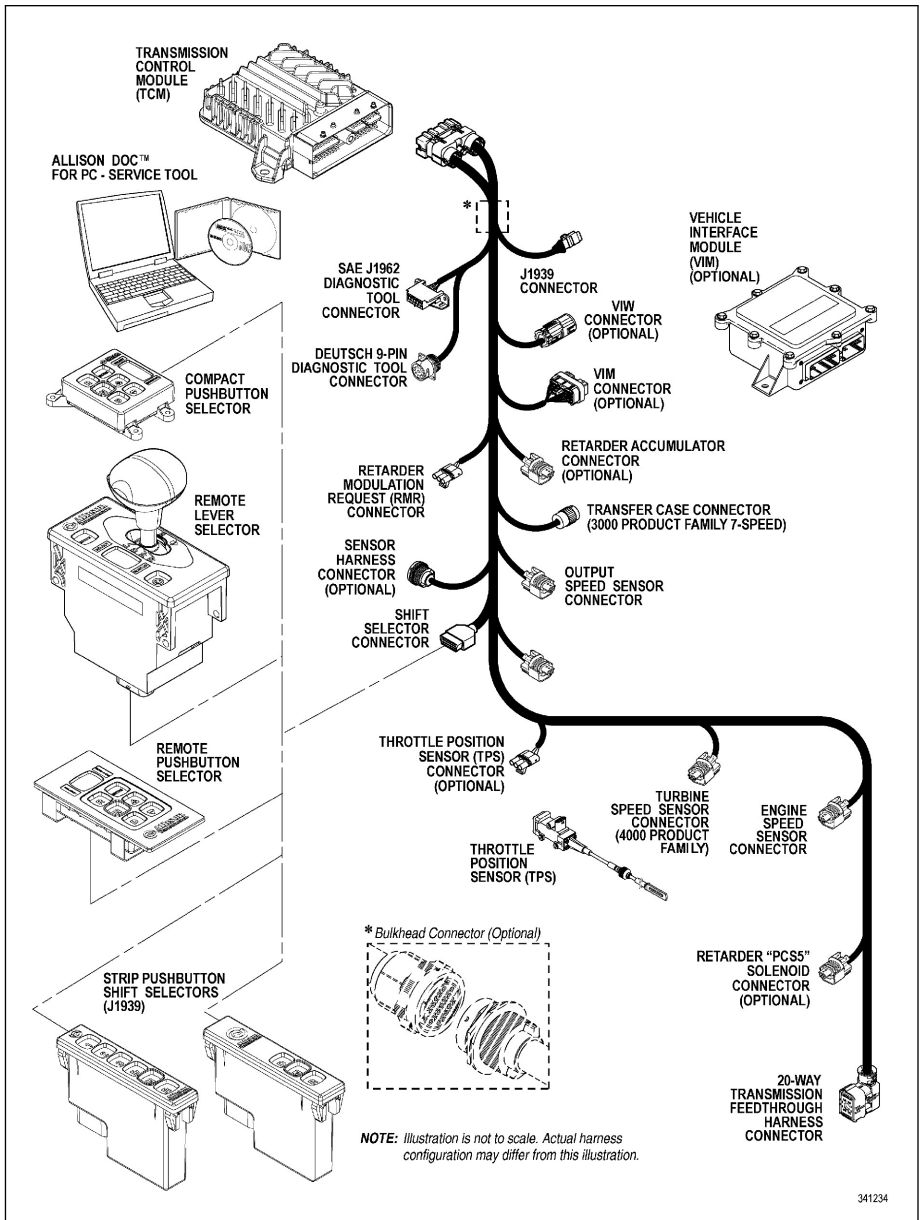


Figure 8–1. Typical Allison 5th Generation Controls Components

8.5 TRANSMISSION CONTROL MODULE (TCM) HARDWARE DESCRIPTION

Harness Connector- the TCM interfaces to your vehicle harness with one connector and uses an 80-pin connector interfaced to the vehicle harness. Refer to [Figure 8–1](#).

TCM Power Requirements- TCM models A61, A62, and A63 are offered to the OEM(s) for the 3000 and 4000 Product Families transmissions. All A61, A62, and A63 TCM configurations are compatible with 12-volt vehicle electrical systems. However, the A63 Max-Feature TCM is also compatible with 24-volt vehicle electrical systems. See your vehicle dealer if you need assistance in determining which TCM is installed in your vehicle.



NOTE: Allison electronic controls are designed and manufactured to comply with all FCC and other guidelines regarding radio frequency interference/electromagnetic interference (RFI/EMI) for transportation electronics. Manufacturers, assemblers, and installers of radio-telephone or two-way communication radios have the sole responsibility to correctly install and integrate those devices into Allison Transmission-equipped vehicles to the customer's satisfaction.

8.6 TRANSMISSION CONTROL MODULE (TCM) PROGRAM AND CALIBRATION OVERVIEW

The TCM program includes the basic logic and algorithms which command all of the various elements of transmission operation. The program is an integral element of the TCM structure and is defined as having a specific software level.

The TCM calibration includes all of the variables pertaining to the specific vehicle in which the TCM will be installed. Each calibration is based on input from the vehicle manufacturer and, once compiled, must be downloaded into the TCM to make it operational. Refer to [4.2 SHIFT SCHEDULES AND AUTOMATIC RANGE SHIFTS](#) for additional information regarding the shift calibration.

Functional control of the transmission results from the integration of the calibration data sets with the elements of the software program, in conjunction with the following:

- Automatic detection of other features (Autodetect). Refer to [8.6 AUTODETECT](#).
- Adaptive shifting. Refer to [8.7 ADAPTIVE SHIFTING](#).

- Transmission and controls diagnostics. Refer to [6.0 DIAGNOSTICS](#).
- Transmission prognostics. Refer to [7.0 ALLISON 5th GENERATION SHIFT SELECTORS COMPONENTS AND FUNCTIONS](#).
- Communication via vehicle datalinks. Refer to [7.5 SELECTOR DISPLAY DESCRIPTIONS FOR ACTIVE DIAGNOSTIC TROUBLE CODES \(DTCs\) AND INHIBITS](#).
- Shift inhibits. Refer to [4.1.3 SELECTOR DISPLAY FLASHING \(INHIBITS\)](#).
- Control of the retarder. Refer to [4.3 USING THE HYDRAULIC RETARDER](#).

8.7 AUTODETECT

The Autodetect software feature automatically detects the presence of transmission components or input signals, thus permitting the use of different features or input signals with a common TCM. Autodetect checks for the presence of a valid input signal denoting the presence of each of the features listed. Diagnostic functions relating to each of these items are executed if the feature is detected and used. Refer to [Table 8–1](#) for the presence of the following transmission components or data inputs.

Table 8–1. Autodetect Features

Output Retarder Presence	Autodetect
Oil Level Sensor (OLS) Presence	Autodetect

8.8 ADAPTIVE SHIFTING

Adaptive shifting is a basic design feature of the shift controls which optimizes shift quality. This is accomplished by frequent monitoring of critical characteristics in the clutch engagement process and making continuous adjustments to certain characteristics which improve subsequent shifts.

The transmission shift calibration is based on several different types of shifts, such as full throttle, part throttle, closed throttle, upshifts, and downshifts. Each shift is associated with specific speed and throttle position parameters. To optimize each type of shift for normal driving, it is necessary for the shift controls to have experienced operation and shifting in a wide variety of operating conditions. A drive-in period under various driving conditions is required before the adaptive controls can be expected to optimize each and every shift. You should begin to see shift quality converge to the adapted level after five shifts of a particular shift type.

8.9 COMMUNICATION THROUGH VEHICLE DATALINKS

The Communication Interface combined with the SAE Datalink Protocols enables various body, transmission, brake system, and engine controllers of a vehicle system to exchange information between these modules in the vehicle. Use of a network, or datalink, for on-vehicle communication can greatly reduce the amount of wiring in a vehicle and provide access to a wider range of information for many different components and subsystems.

Check with your vehicle OEM or Allison Transmission distributor or dealer for the capabilities of the TCM in your vehicle, or if you need assistance in determining the datalink types available for your vehicle.

8.10 INFORMATION DISPLAYS

The OEM may supply and install a remote display for use in displaying transmission status and service information broadcast over the vehicle datalink. This information may include the transmission range selected, transmission range attained, sump temperature indicator, prognostic information, and DTCs. Refer to [7.5 SELECTOR DISPLAY DESCRIPTIONS FOR ACTIVE DIAGNOSTIC TROUBLE CODES \(DTCs\) AND INHIBITS](#) for additional information.

9.1 EXTERNAL WIRE HARNESES, VEHICLE INTERFACE MODULE, AND RETARDER CONTROLS

9.2 WIRE HARNESES



NOTE: The external harness connecting transmission controls is part of the vehicle chassis harness and typically will not have an Allison Transmission part number. The harness parts are usually only available through the vehicle manufacturer and their vendors. Check with the OEM or dealer first to determine their wire harness service parts availability. Any Allison distributor or dealer can assist with determining serviceability of the external harness as well. The internal transmission harness inside the transmission is an Allison part and only available from an Allison distributor or dealer.

The transmission controls require the use of wiring harnesses to connect the various system components, including:

- Transmission Control Module (TCM)
- Main connector on the transmission
- Engine speed sensor
- Turbine shaft speed sensor (4000 Product Families)
- Output shaft speed sensor
- Serial communication datalink
- Shift selector
- Diagnostic connector
- Retarder controls (if equipped)
- Vehicle interface wiring
- Throttle Position Sensor (TPS) (only with mechanically controlled engines)
- Optional Vehicle Interface Module (VIM)

All wiring harnesses and connectors which mate to Allison connectors/components are typically supplied and installed by the vehicle manufacturer. Harnesses may consist of a single piece, or may be divided into multiple segments joined by bulkhead connectors.

9.3 VEHICLE INTERFACE MODULE (VIM)

The VIM contains relays and fuses necessary to interface the transmission controls with the vehicle wiring system. When ordering the VIM, specify 12 or 24 volts to properly match the vehicle electrical system.

In some cases, the OEM or body builder may choose not to use the Allison VIM. In these cases, the OEM must specify and install components which provide a proper interface between vehicle wiring and the transmission control system.

9.4 RETARDER CONTROLS

In order to meet the needs of operators in a wide variety of applications, vocations, and vehicle configurations, several retarder apply systems are offered for transmission models in the Allison 3000 and 4000 Product Families.

Certain types of apply systems may not be recommended for specific vocations. For example, factors such as retarder performance that may not be appropriate for the class or vehicle type or difficulty in installation. However, there are typically two or more apply types available for most vehicles.

In addition to the standard analog controls approach, the possible integration of the retarder with numerous other vehicle systems through a common SAE J1939-based vehicle controller creates additional design flexibility when determining methods of potential operator control of the transmission retarder.

The Transmission Control Module (TCM) must be calibrated to the proper method to ensure desired retarder operation. Operator controls of the retarder can be accomplished by either of the following methods:

- **Both Analog and J1939.** Input is based on a Retarder Enable switch for activation, plus one or more Allison Retarder Modulation Request (RMR) components to select the desired level of retardation. In addition, retardation is requested or limited based on messages from an SAE J1939-based vehicle controller.
- **J1939 Only.** Retardation is requested or limited based on messages from an SAE J1939-based vehicle controller.

The analog components that can be used with the 3000 and 4000 Product Families retarder are available from Allison Transmission. These components provide control over retarder operation and include various types of retarder

operator and vehicle interface controls. Some of the available operator controls, known also as Retarder Modulation Request (RMR) devices include:

- Foot pedal
- Hand lever
- Automatic apply at closed throttle
- Apply integrated with service brakes
- One-step, two-step or three-step applies

Refer to [Table 4–4](#) for the various types of retarder controls available.

The retarder apply system does not actuate the retarder directly. The driver uses the retarder operator controls to request a desired level of retardation, ranging from none, up to the maximum available from the specific retarder/transmission configuration in use. The TCM processes the request in conjunction with other input data which defines the current operating status of the transmission and vehicle. The TCM turns the retarder on at the requested level when conditions are appropriate for retarder operation.

Refer to [4.3 USING THE HYDRAULIC RETARDER](#) for additional information about the retarder controls, retarder performance, and retarder usage.

10.1 TRANSMISSION COMPONENTS

10.2 TORQUE CONVERTER

The torque converter multiplies engine torque and transfers smooth, uninterrupted power to the wheels quickly. The torque converter consists of these four components:

- Pump—input element driven directly by the engine
- Turbine—output element hydraulically driven by the pump
- Stator—reaction (torque multiplying) element
- Lockup Clutch—mechanically couples the pump and turbine when commanded by the Transmission Control Module (TCM).

When the pump turns faster than the turbine and the stator is stationary, the torque converter is multiplying torque. When the turbine approaches the speed of the pump, the stator starts to rotate with the pump and turbine. When this occurs, torque multiplication stops and the torque converter functions as a fluid coupling. The lockup clutch is located inside the torque converter and consists of the following components:

- Piston and backplate—driven by the engine
- Clutch plate/damper (located between the piston and the backplate)—splined to the converter turbine

The lockup clutch/torsional damper is engaged and released in response to electronic signals from the TCM. Lockup clutch engagement provides a direct drive from the engine to the transmission input. This eliminates converter slippage and maximizes fuel economy and vehicle speed. The lockup clutch releases at lower speeds or when the TCM detects conditions requiring it to be released.

The torsional damper tries to absorb engine torsional vibration in an attempt to prevent transmitting engine torsional vibration on through to transmission components (clutches, etc), or items bolted to the transmission.

10.3 PLANETARY GEARS AND CLUTCHES

A series of three helical, constant mesh planetary gear sets and shafts provides the mechanical gear ratios and direction of travel for the vehicle. The planetary gear sets are controlled by five multi-plate clutches that work in pairs to produce up to six forward speeds and one reverse speed. The clutches are applied and released hydraulically in response to electronic signals from the Transmission Control Module (TCM) to the appropriate solenoids.

10.4 COOLER CIRCUIT

The transmission fluid is cooled by an integral (transmission-mounted) or remote-mounted oil cooler. Connections to the cooling circuit are located at the front or rear of the transmission to facilitate installation of remote cooler lines. On retarder models, only the rear cooler ports may be used. The integral cooler is mounted on the lower rear portion of the transmission, replacing the remote cooler manifold. Integral cooler oil ports are internal requiring coolant to be routed to and from the cooler.

10.5 RETARDER

The self-contained retarder is at the output of the transmission and consists of a vaned rotor which rotates in a vaned cavity. The rotor is splined to and driven by the output shaft. When the retarder is activated, the fluid in the accumulator is displaced into the retarder cavity. The pressurized fluid in the cavity acting against the rotating and stationary vanes causes the retarder rotor and output shaft to reduce speed, slowing the vehicle or limiting speed on a downhill grade. Refer to [4.3 USING THE HYDRAULIC RETARDER](#) for additional information. When the retarder is deactivated, the retarder cavity is evacuated and the accumulator is recharged with fluid.

The retarder housing also allows the addition of either a remote or integral cooler for transmission sump fluid in addition to retarder out fluid. A bypass cover is placed over the sump cooling ports when the provision is not used. The sump cooler ports are located on the lower right rear face of the retarder housing. Refer to [Figure 2–3](#) and [Figure 2–4](#).

10.6 CONTROL VALVE MODULE

The 3000 and 4000 Product Family Transmission control valve module is bolted to the transmission main housing, and contain the main and lube filters. The control valve module also contains a main valve body assembly and solenoid valve body assembly. The Transmission Control Module (TCM) issues commands that actuate the range clutch solenoids to govern fluid

flow to the commanded range clutches and lockup clutch contained in the torque converter.

The control valve module contains the following components:

- Various valves and valve bodies controlling and routing hydraulic pressure to the rest of the transmission
- Range clutch and lockup clutch solenoids
- Diagnostic valve, valve body, and diagnostic pressure switch
- Main filter life indicator valve, valve body, and filter life pressure switch
- Turbine speed sensor (3000 Product Family only)
- Sump temperature sensor

10.7 TRANSMISSION SPEED SENSORS

Three speed sensors are integral to the transmission assembly. The speed sensors provide the transmission input speed, converter turbine speed, and transmission output speed signals to the Transmission Control Module (TCM). For the specific location of the speed sensors, refer to [Figure 2-1](#) and [Figure 2-2](#) for non-PTO applications, and [Figure 2-3](#) and [Figure 2-4](#) for PTO applications. For the 4700/4800 EVS transmission, refer to [Figure 2-6](#).

The transmission input speed sensor is located on the converter housing and the transmission output speed sensor is located on the output housing. Both speed sensors require connection to the wiring harness.

The mounting provision for the turbine speed sensor differs between the transmission model families:

- For transmission models in the 3000 Product Families, the turbine speed sensor is internal to the transmission and does not require an external connection
- For transmission models in the 4000 Product Families, the turbine speed sensor is external to the transmission and requires connection to the wiring harness

11.0 GENERAL GUIDELINES

11.1 WELDING ON VEHICLE

Observe the following precautions when welding on the vehicle:

- Disconnect the wiring harnesses from the Transmission Control Module (TCM).
- Disconnect the TCM power and ground circuits from the battery, and any electronic control ground wires connected to the frame or chassis.
- Do not connect welding cables to electronic control components.
- Do not weld on electronic control components.
- Cover electronic control components and wiring to protect them from hot sparks, heat, etc.

11.2 PAINTING ON VEHICLE

11.2.1 ELECTROSTATIC PAINTING. If the vehicle chassis or body is painted using an electrostatic painting process, electrical voltage must not be discharged through the Transmission Control Module (TCM). To prevent this possibility, Allison recommends installing the TCM after the electrostatic paint process is complete. If the TCM is installed prior to electrostatic painting, make sure:

- the TCM is not painted.
- the elements being painted are properly and continuously grounded during the entire painting process.



NOTE: Allison Transmission is not responsible for TCM damage resulting from improper grounding during electrostatic painting of the vehicle.

During electrostatic painting, the paint droplets receive an electrostatic charge attracting them to the grounded surfaces. Voltages at the spray gun can exceed several thousand volts. The charge which builds up on an improperly

grounded chassis or body can be discharged through the TCM, resulting in damage to the TCM.

11.2.2 PAINTING OF TRANSMISSION CONTROL COMPONENTS. While it may be desirable to paint chassis-mounted components to enhance the overall vehicle appearance and/or provide corrosion protection, the transmission control components **must not** be painted. Painting transmission control components can:

- compromise the integrity of connectors and connector seals.
- reduce thermal conductivity from inside the TCM to ambient air.
- cover labels or other identification, hindering the process to service these components.

11.3 ENVIRONMENT

Allison Transmission designed the Allison controls and components to operate in normal vehicle cab and chassis environments. The Allison controls and components can withstand moisture, direct light, heat, and shock loads. The Transmission Control Module (TCM), Allison shift selectors and their connectors are sealed, but are not considered immersible. Installation of the Allison controls and components must meet the environmental requirements in Allison 5th Generation Controls Data. In addition, mount the Allison controls and components away from direct exposure to road hazards and weather. In order to meet the temperature limits listed in Allison 5th Generation Controls Data, allow for free air movement around each component. The air movement dissipates heat away from the components. Exceeding the temperature limits reduces the life of the components.

11.4 COMPONENT ACCESS REQUIREMENTS

Access to service the controls and components is necessary throughout the life of the vehicle. Consider service access to transmission components when installing auxiliary vehicle controls and components, including the effort required to remove covers, body parts, or chassis members to gain access to the transmission component(s) being serviced.

12.0 CUSTOMER SERVICE

12.1 ORDERING PARTS

12.1.1 TRANSMISSION NAMEPLATE. The nameplate (refer to [Figure 12–1](#)) is located on the right side of the transmission and is imprinted with the following:

- Transmission model (for Specialty Series vocation models)
- Serial number
- Date code
- Engineering groups (for Specialty Series vocation models)

Use all of these numbers when ordering replacement parts or requesting service information.

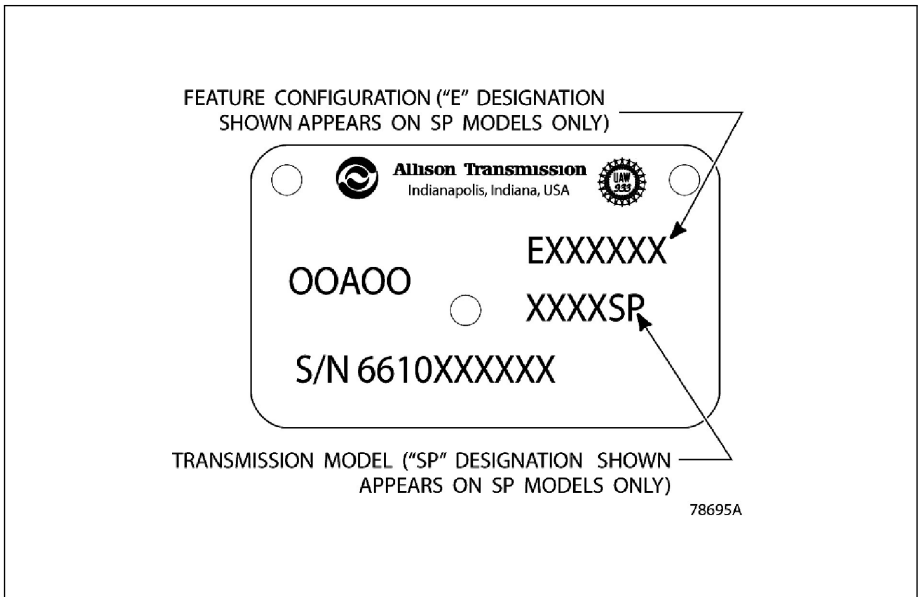


Figure 12–1. Transmission Nameplate

12.1.2 GENUINE PARTS. Allison Transmission recommends that only Allison genuine parts be used in an Allison Transmission. Order all replacement parts from an authorized distributor or dealer. Service outlets can be located on the Allison Transmission web site at www.allisontransmission.com. Additionally, distributors and dealers are listed in the yellow pages under Transmission - Truck, Tractor, Etc.

12.2 OWNER ASSISTANCE

The satisfaction and goodwill of the owners of Allison transmissions are of primary concern to Allison Transmission, its distributors, and their dealers.

As an owner of an Allison transmission, you have service locations throughout the world that are eager to meet your parts and service needs with:

- Expert service by trained personnel.
- Emergency service 24 hours a day in many areas.
- Complete parts support.
- Sales teams to help determine your transmission requirements.
- Product information and literature.

Normally, any situation that arises in connection with the sale, operation, or service of your transmission will be handled by the distributor or dealer in your area. Check the telephone directory for the Allison Transmission service outlet nearest you or use Allison Transmission's Sales and Service Locator tool on the Allison Transmission web site at www.allisontransmission.com. You may also refer to Allison Transmission's Worldwide Sales and Service Directory (SA2229EN).

We recognize, however, that despite the best intentions of everyone concerned, misunderstandings may occur. To further assure your complete satisfaction, we have developed the following three-step procedure to be followed in the event a problem has not been handled satisfactorily.

Step One—Discuss your problem with a member of management from the distributorship or dealership. Frequently, complaints are the result of a breakdown in communication and can be resolved quickly by a member of management. If you have already discussed the problem with the Sales or Service Manager, contact the General Manager. All Allison Transmission dealers are associated with an Allison Transmission distributor. If the problem originates with a dealer, explain the matter to a management member of the distributorship with whom the dealer has his service agreement. The dealer will provide his Allison Transmission distributor's name, address, and telephone number on request.

Step Two—When it appears the problem cannot be readily resolved at the distributor level without additional assistance, **contact the Allison Technical Assistance Center at 800-252-5283**. They will place you in contact with the Regional Customer Support Manager for your area.

For prompt assistance, please have the following information available:

- Name and location of authorized distributor or dealer.
- Type and make of vehicle/equipment.
- Transmission model number, serial number, and assembly number (if equipped with electronic controls, also provide the Transmission Control Module (TCM) assembly number).
- Transmission delivery date and accumulated miles and/or hours of operation.
- Nature of problem.
- Chronological summary of your transmission's history.

Step Three—If you are still not satisfied after contacting the Regional Customer Support Manager, **present the entire matter to the Home Office by writing to the following address:**

Allison Transmission
Attn: Manager, Warranty Administration
PO Box 894, Mail Code PF9
Indianapolis, IN 46206-0894

The inclusion of all pertinent information will assist the Home Office in expediting the matter.

When contacting the Home Office, please keep in mind that ultimately the problem will likely be resolved at the distributorship or dealership using their facilities, equipment, and personnel. Therefore, it is suggested that **Step One** be followed when experiencing a problem.

Your purchase of an Allison Transmission product is greatly appreciated, and it is our sincere desire to assure complete satisfaction.

12.3 SERVICE LITERATURE

This service literature provides fully illustrated instructions for operation, maintenance, service, overhaul, and parts support for your transmission. For maximum performance and service life from your unit, you may order additional publications via web, fax or phone.

WEB: www.allisontransmissionpublications.com

FAX: 317-471-4996

TOLL FREE: 888-666-5799

INTERNATIONAL: 317-471-4995

(surcharge will be applied for orders placed via phone or FAX)

For more information about Allison products please visit
www.allisontransmission.com.

12.4 ALLISON TRANSMISSION DISTRIBUTORS



NOTE: For a complete and up-to-date listing of Allison Transmission Service Centers, go to www.allisontransmission.com/locator/

EASTERN REGION

**Atlantic Detroit Diesel-Allison,
LLC**

19 C Chapin Road
Pine Brook, NJ 07058
973-575-0309

Clark Power Services

8015 Piedmont Triad Parkway
Greensboro, NC 27409
336-292-9240

Wajax Power Systems

2997 Avenue (rue) Watt
Quebec, Quebec G1X 3W1
418-651-5371

Florida Detroit Diesel-Allison, Inc.

2277 N.W. 14th Street
Miami, FL 33125-0068
305-638-5300

Wajax Power Systems–Central

10 Diesel Drive
Toronto, Ontario M8W 2T8
416-259-3281

Johnson & Towers, Inc.

2021 Briggs Road
Mount Laurel, NJ 08054
856-234-6990

**New England Detroit
Diesel-Allison, Inc.**

90 Bay State Road
Wakefield, MA 01880-1095
781-246-1810

Penn Detroit Diesel-Allison, LLC

8330 State Road
Philadelphia, PA 19136-2986
215-335-0500

Western Branch Diesel, Inc.

3504 Shipwright Street
Portsmouth, VA 23703
757-673-7000

W.W. Williams S.E., Inc.

3077 Moreland Avenue
Conley, GA 30288
404-366-1070

CENTRAL REGION

Central Power Systems & Services, Inc.

9200 Liberty Drive
Liberty, MO 64068
816-781-8070

Stewart & Stevenson Power Products, LLC

1000 Louisiana, Suite 5900
Houston, TX 77002
713-751-2600

Clarke Power Services, Inc.

3133 East Kemper Road
Cincinnati, OH 45241
513-771-2200

United Engines, LLC

5555 West Reno Street
Oklahoma City, OK 73127
405-947-3321

Inland Power Group, Inc.

13015 West Custer Avenue
Butler, WI 53007-0916
262-781-7100

Wajax Power Systems–West

10025 – 51 Avenue
Edmonton, Alberta T6E OA8
780-437-8200

Interstate PowerSystems, Inc.

2501 American Boulevard, East
Minneapolis, MN 55425
952-854-5511

W.W. Williams M.W., Inc.

1176 Industrial Parkway, North
Brunswick, OH 44212-2342
330-225-7751

MEXICO REGION

Detroit Diesel-Allison de Mexico

S.A.de C.V.

Av. Santa Rosa No. 58 Col.
Ampliacion Norte
San Juan Ixtacala, Tlalnepantla C.P.
54160, Estado de Mexico
525-5-5333-1800

WESTERN REGION

ABC Transmissions, Ltd
9357 – 193rd Street

Surrey, British Columbia V4N 4E7
604-888-1211

Allison West
14775 Wicks Boulevard
San Leandro, CA 94577–6779
510–351–6101

Pacific Power Products Company
7215 South 228th Street
Kent, WA 98032
253-854-0505

Smith Power Products, Inc.
3065 West California Avenue
Salt Lake City, UT 84104
801-415-5000

**Stewart & Stevenson Power
Products, LLC**

5170 E 58th Place
Commerce City, CO 80022
303-287-7441

Valley Power Systems, Inc
425 South Hacienda Boulevard
City of Industry, CA 91745-1123
626-333-1243

W.W. Williams S.W., Inc.
2602 S. 19th Avenue
Phoenix, AZ 85009
602-257-0561

NOTES

Ask for the Allison

EMERGENCY VEHICLE SERIES

Ask your truck dealer for a complete listing of vehicle models featuring Allison Emergency Vehicle Series transmissions, or contact your Authorized Allison Distributor. For the representative close to you, visit www.allisontransmissionpublications.com.

DRIVING TRANSMISSION TECHNOLOGY®



Information highway.

Visit www.allisontransmissionpublications.com for a comprehensive library of informational brochures, including Mechanic's Tips, Parts Catalogs, Troubleshooting Manuals and Service Manuals.



Appendix B

MERITOR WABCO

Anti-Lock Braking System (ABS) for Trucks, Tractors and Buses

Maintenance Manual MM-0112

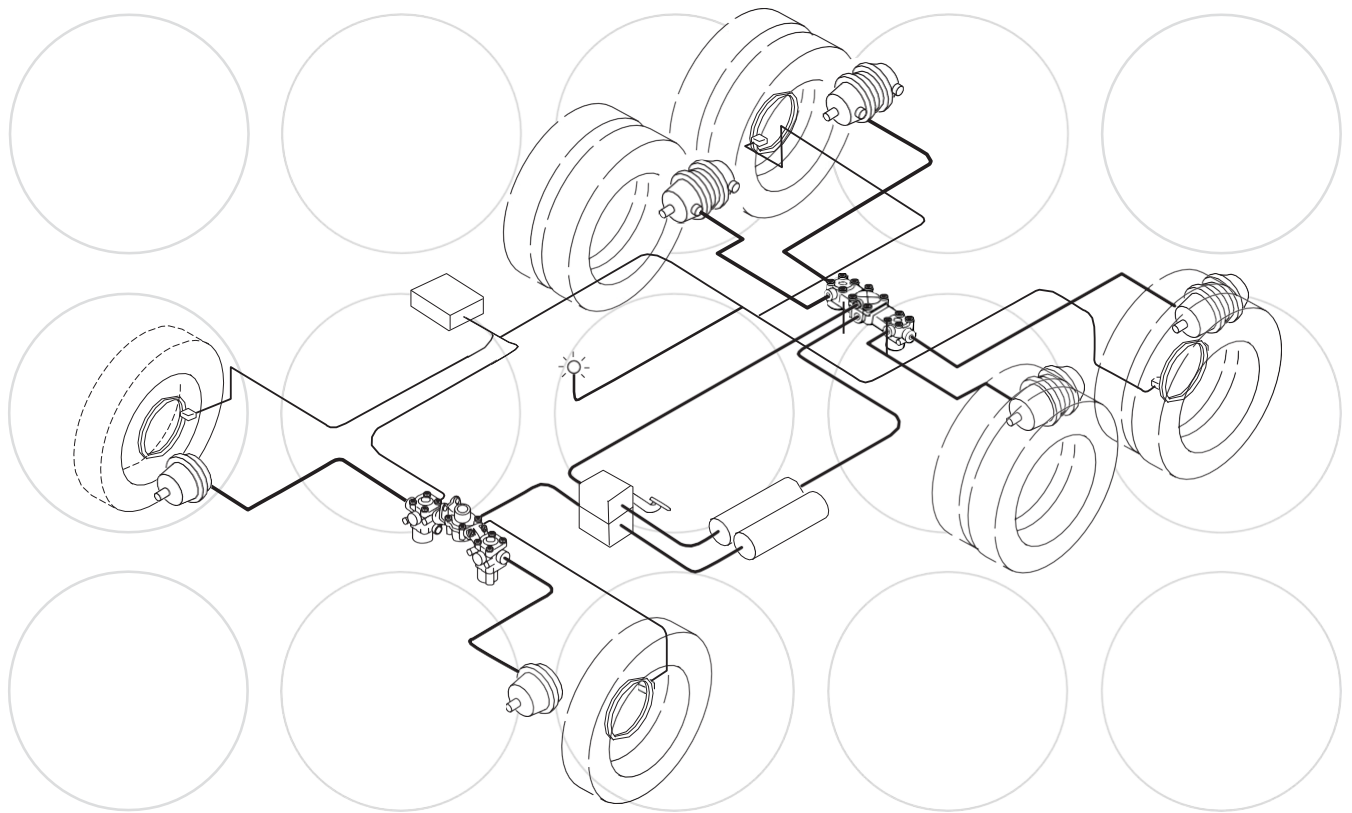
Maintenance Manual MM-0112

Anti-Lock Braking System (ABS) for Trucks, Tractors and Buses

For E Version ECUs

12-Volt and 24-Volt Systems

Revised 01-11



Service Notes

About This Manual

This manual contains maintenance procedures for Meritor WABCO's Anti-Lock Braking System (ABS) for trucks, tractors and buses.

Before You Begin

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.
3. Follow your company's maintenance and service, installation and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Hazard Alert Messages and Torque Symbols

WARNING

A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.

CAUTION

A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components.

@ This symbol alerts you to tighten fasteners to a specified torque value.

How to Obtain Additional Maintenance and Service Information

On the Web

Visit Literature on Demand at arvinmeritor.com to access and order product, service, aftermarket, and warranty literature for ArvinMeritor's truck, trailer and specialty vehicle components.

Literature on Demand DVD (LODonDVD)

The LODonDVD contains product, service and warranty information for ArvinMeritor components. To order the DVD, visit Literature on Demand at arvinmeritor.com and specify TP-0742.

How to Obtain Tools and Supplies Specified in This Manual

Call ArvinMeritor's Commercial Vehicle Aftermarket at 888-725-9355 to obtain Meritor tools and supplies.

Information contained in this publication was in effect at the time the publication was approved for printing and is subject to change without notice or liability. Meritor WABCO reserves the right to revise the information presented or to discontinue the production of parts described at any time.

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ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from ArvinMeritor.

Hazard Summary

Because some brake linings contain asbestos, workers who service brakes must understand the potential hazards of asbestos and precautions for reducing risks. Exposure to airborne asbestos dust can cause serious and possibly fatal diseases, including asbestosis (a chronic lung disease) and cancer, principally lung cancer and mesothelioma (a cancer of the lining of the chest or abdominal cavities). Some studies show that the risk of lung cancer among persons who smoke and who are exposed to asbestos is much greater than the risk for non-smokers. Symptoms of these diseases may not become apparent for 15, 20 or more years after the first exposure to asbestos.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons. OSHA has set a maximum allowable level of exposure for asbestos of 0.1 f/cc as an 8-hour time-weighted average and 1.0 f/cc averaged over a 30-minute period. Scientists disagree, however, to what extent adherence to the maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling asbestos dust. OSHA requires that the following sign be posted at the entrance to areas where exposures exceed either of the maximum allowable levels:

DANGER: ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA.

2. Respiratory Protection. Wear a respirator equipped with a high-efficiency (HEP A) filter approved by NIOSH or MSHA for use with asbestos at all times when servicing brakes, beginning with the removal of the wheels.

3. Procedures for Servicing Brakes.

a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c. If an enclosed vacuum system or brake washing equipment is not available, employers may adopt their own written procedures for servicing brakes, provided that the exposure levels associated with the employer's procedures do not exceed the levels associated with the enclosed vacuum system or brake washing equipment. Consult OSHA regulations for more details.

d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents,ammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos. When you replace a HEPA filter, wet the filter with a ne mist of water and dispose of the used filter with care.

5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

NON-ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to non-asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from ArvinMeritor.

Hazard Summary

Most recently manufactured brake linings do not contain asbestos fibers. These brake linings may contain one or more of a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers and silica that can present health risks if inhaled. Scientists disagree on the extent of the risks from exposure to these substances. Nonetheless, exposure to silica dust can cause silicosis, a non-cancerous lung disease. Silicosis gradually reduces lung capacity and efficiency and can result in serious breathing difficulty. Some scientists believe other types of non-asbestos fibers, when inhaled, can cause similar diseases of the lung. In addition, silica dust and ceramic fiber dust are known to the State of California to cause lung cancer. U.S. and international agencies have also determined that dust from mineral wool, ceramic fibers and silica are potential causes of cancer.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to non-asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons.

2. Respiratory Protection. OSHA has set a maximum allowable level of exposure for silica of 0.1 mg/m³ as an 8-hour time-weighted average. Some manufacturers of non-asbestos brake linings recommend that exposures to other ingredients found in non-asbestos brake linings be kept below 1.0 f/cc as an 8-hour time-weighted average. Scientists disagree, however, to what extent adherence to these maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling non-asbestos dust.

Therefore, wear respiratory protection at all times during brake servicing, beginning with the removal of the wheels. Wear a respirator equipped with a high-efficiency (HEP A) filter approved by NIOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. Even when exposures are expected to be within the maximum allowable levels, wearing such a respirator at all times during brake servicing will help minimize exposure.

3. Procedures for Servicing Brakes.

a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c. If an enclosed vacuum system or brake washing equipment is not available, carefully clean the brake parts in the open air. Wet the parts with a solution applied with a pump-spray bottle that creates a ne mist. Use a solution containing water, and, if available, a biodegradable, non-phosphate, water-based detergent. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents,ammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA, to minimize exposure. When you replace a HEPA filter, wet the filter with a ne mist of water and dispose of the used filter with care.

5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

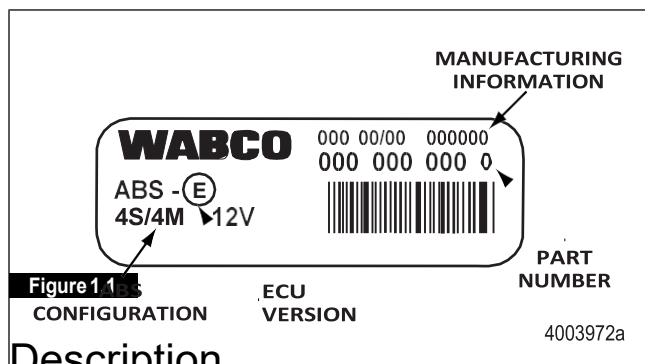
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Contents

This manual contains service information for E version Meritor WABCO Anti-Lock Braking System (ABS) and ABS with Automatic Traction Control (ATC) for trucks, tractors and buses. E version ABS incorporates Power Line Carrier Communication (PLC), an optional feature that allows tractor/trailer communication. For the driver, this means that a trailer ABS indicator lamp located on the vehicle dash will come on if a trailer ABS fault occurs on a trailer equipped with PLC.

NOTE: For diagnostic and testing procedures for systems with C version ECUs, use Maintenance Manual 28, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses. For D version ECUs, use Maintenance Manual 30, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses. The ABS version is marked on the ECU. Figure 1.1. If you cannot identify the ECU version installed on your vehicle, contact ArvinMeritor's Customer Service Center at 866-OnTrac1 (668-7221).



Description

How ABS Works

Meritor WABCO ABS is an electronic system that monitors and controls wheel speed during braking. The system works with standard air brake systems.

ABS monitors wheel speeds at all times and controls braking during wheel lock situations. The system improves vehicle stability and control by reducing wheel lock during braking.

The ECU receives and processes signals from the wheel speed sensors. When the ECU detects a wheel lockup, the unit activates the appropriate modulator valve, and air pressure is controlled.

In the event of a malfunction in the system, the ABS in the affected wheel(s) is disabled; that wheel still has normal brakes. The other wheels keep the ABS function.

Two ABS indicator lamps, one for tractor and one for trailer, let drivers know the status of the system. The tractor ABS lamp is also used to display tractor blink code diagnostics. Figure 1.2. The location of the ABS indicator lamps varies depending on the make and model of the vehicle.

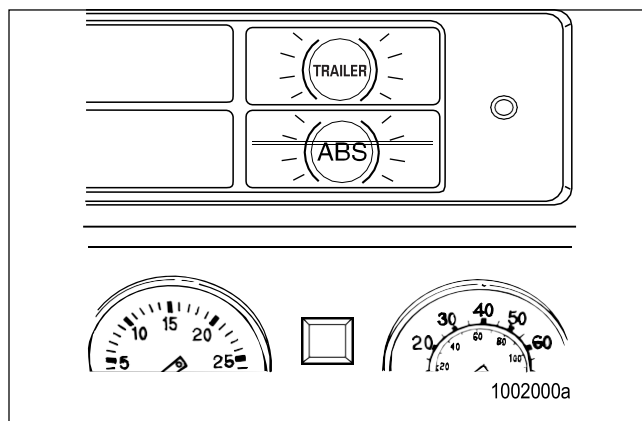


Figure 1.2

Do not open the ECU. Opening the ECU to gain access to the internal components will void the warranty.

If the vehicle is equipped with optional Automatic Traction Control (ATC), with ATC and Roll Stability Control (RSC), or with ATC and Electronic Stability Control (ESC), the ATC indicator lamp is used to indicate ATC, RSC or ESC. Refer to Section 2.

Blink code diagnostics information for trailer ABS is not included in this manual. Refer to Maintenance Manual 33, Easy-Stop™ Trailer ABS, or Maintenance Manual MM-0180, Enhanced Easy-Stop™ Trailer ABS with PLC, for trailer diagnostics.

1 Introduction

ABS Configuration

With the E Basic ECU, 4S/4M is the only configuration used.

Figure 1.3.

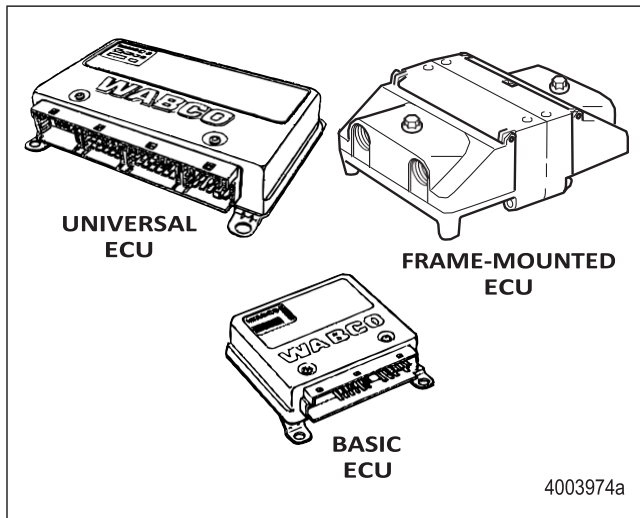


Figure 1.3

The ABS configuration is defined by the number of wheel-end sensors and modulator valves. There are three common ABS configurations used with E version ECUs.

- 4S/4M (4 wheel speed sensors, 4 modulator valves). Figure 1.4.
- 6S/4M (6 wheel speed sensors, 4 modulator valves)
- 6S/6M (6 wheel speed sensors, 6 modulator valves)

Typical illustrations in this manual use the 4S/4M configuration as a sample. Layouts for 4S/4M, 6S/4M and 6S/6M configurations are included in Section 5.

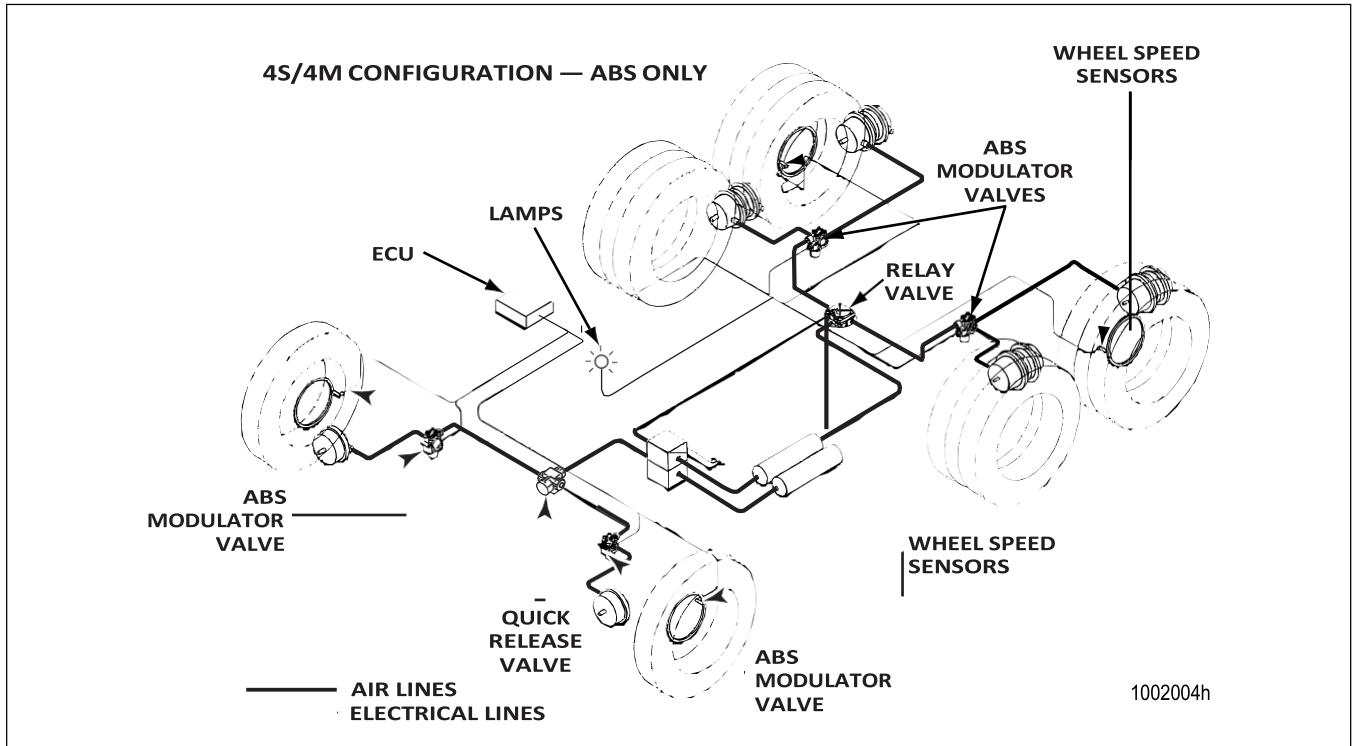
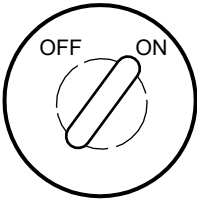


Figure 1.4

ABS Indicator Lamp

The ABS indicator lamp works as follows:

Ignition ON	Normal Operation	ABS lamp comes on at ignition momentarily for a bulb check, then goes out.	System is OK.
	After servicing ABS	ABS lamp does not go out at ignition.	When vehicle is driven at speeds above 4 mph (6 km/h), lamp goes out. System is OK.
1002005a	Off-road ABS operation. Refer to the off-road ABS information in this section.	ABS lamp flashes during vehicle operation.	The vehicle's normal ABS function is being modified due to road conditions.
	Existing Fault	ABS lamp does not go out at ignition.	Lamp does not go out at speeds above 4 mph (6 km/h)—a fault exists in the ABS system.

NOTE: If the ECU senses a tractor ABS fault during normal vehicle operation, the ABS indicator lamp will come on and stay on.

1 Introduction

Trailer ABS Indicator Lamp

The trailer ABS indicator lamp on the vehicle dash applies to Trailer ABS only. The lamp is controlled by a signal to the tractor ECU, sent over the power line (PLC function). When a trailer ABS fault is detected, an ON message is sent; when no fault is detected, the ECU receives an OFF message. Table A illustrates trailer ABS lamp operation at power-up, or ignition on. Table B depicts lamp responses that occur during operation.

Lamp turn ON and OFF messages do not turn the lamp ON or OFF instantly. The delay between the receipt of the message and the lamp response time is intentional. It prevents erratic lamp activity.

NOTE: For doubles or triples, the lamp does not distinguish between trailers. A system fault in any of the trailers will activate the trailer ABS indicator lamp.

Table A: Dash-mounted Trailer ABS Indicator Lamp Operation — Bulb Check (Information for Drivers)

Signal from Trailer to Tractor ECU	Status of Trailer ABS Lamp on Vehicle Dash	Explanation
<p>Single or Multiple Trailers</p> <p>message OFF OFF OFF OFF OFF OFF OFF</p> <p>4003977a</p>	<p>Trailer ABS lamp comes on at ignition, OFF message is detected within three seconds of ignition,</p> <p>Trailer ABS lamp goes out.</p>	<p>Bulb Check performed AND Trailer ABS system is OK. In this case, the lamp is ON for a Bulb Check only.</p>
<p>Single or Multiple Trailers</p> <p>message No ON or OFF messages</p> <p>4003978a</p>	<p>Trailer ABS lamp does not come on within three seconds of ignition.</p>	<p>No Bulb Check, trailer added after initial power-up, system OK. There was no trailer PLC message for at least three seconds following ignition ON.</p>

ON = Turn ON message to the “trailer ABS” lamp

OFF = Turn OFF message to the “trailer ABS” lamp

Removing a trailer with a fault will cause the ABS lamp to turn off. Remember to have the trailer with the fault repaired as soon as possible before returning it to service.

Table B: Dash-mounted Trailer ABS Indicator Lamp Operation (Information for Service Technicians)

Signal from Trailer to Tractor ECU	Status of Trailer ABS Lamp on Vehicle Dash	Explanation	Action
<p>Single or Multiple Trailers</p> <p>message No ON or OFF messages</p> <p>lamp on</p> <p>lamp off</p> <p>0.5 sec</p> <p>4003979a</p>	<p>Trailer ABS lamp does not come on within three seconds of ignition.</p>	<p>Not using the PLC system (no trailer connected) or trailer not equipped with PLC or fault in PLC system.</p>	<p>Use lamp on side of trailer to identify fault.</p> <p>Make necessary repairs.</p>
<p>Single Trailer</p> <p>message OFF OFF OFF ON ON ON ON ON</p> <p>lamp on</p> <p>lamp off</p> <p>0.5 sec</p> <p>4003980a</p>	<p>Trailer ABS lamp comes on.</p>	<p>Trailer ABS fault(s) occurred during operation and still exists.</p>	
<p>Multiple Trailers/Dollies</p> <p>message OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF ON ON ON ON</p> <p>lamp on</p> <p>lamp off</p> <p>0.5 sec</p> <p>4003981a</p>			
<p>Single Trailer</p> <p>message ON ON OFF OFF OFF OFF OFF OFF</p> <p>lamp on</p> <p>lamp off</p> <p>0.5 sec</p> <p>t + 2.5</p> <p>4003982a</p>	<p>Trailer ABS lamp comes on but goes out after 2.5 seconds after fault is detected.</p>	<p>Trailer ABS fault occurred during operation and the fault was corrected.</p>	<p>None</p>
<p>Multiple Trailers/Dollies</p> <p>message OFF OFF OFF OFF OFF OFF OFF OFF ON ON OFF OFF OFF OFF OFF OFF</p> <p>lamp on</p> <p>lamp off</p> <p>0.5 sec</p> <p>t + 2.5</p> <p>4003983a</p>			
<p>Single Trailer</p> <p>message ON ON ON No ON or OFF messages</p> <p>lamp on</p> <p>lamp off</p> <p>0.5 sec</p> <p>t</p> <p>t + 10 sec</p> <p>4003984a</p>	<p>ABS lamp is off, comes on, then goes off, 10 seconds after loss of messages.</p>	<p>ABS fault existed, then signal was lost because trailer disconnected or PLC fault.</p>	<p>Use lamp on side of trailer to identify fault.</p> <p>Make necessary repairs.</p>

Table B: Dash-mounted Trailer ABS Indicator Lamp Operation (Information for Service Technicians)

Signal from Trailer to Tractor ECU	Status of Trailer ABS Lamp on Vehicle Dash	Explanation	Action
<p>Single Trailer to Multiples</p>	<p>ABS lamp is on and stays on when a new trailer with no new fault is added.</p>	<p>There was a fault in existence before the new trailer was added AND the ignition was not turned off before the trailer was added.</p>	<p>Use lamp on side of trailer to identify fault. Make necessary repairs.</p>
<p>Single Trailer to Multiples</p>	<p>ABS lamp is on and stays on when a new trailer with a new fault is added.</p>	<p>ABS fault was in existence before the new trailer was added AND the ignition was not turned off before the trailer was added AND the new trailer has an ABS fault.</p>	

ON = Turn ON message to the “trailer ABS” lamp

OFF = Turn OFF message to the “trailer ABS” lamp

Removing a trailer with a fault will cause the ABS lamp to turn off. Remember to have the trailer with the fault repaired as soon as possible before returning it to service.

ABS Modulator Valves

Modulator valves control the air pressure to each affected brake during an ABS function.

Valve Arrangement Option

In Figure 1.4, the modulator valves on the rear axle are mounted separately and a relay valve is used to deliver air pressure to the modulator valves. There is also an optional valve package available from Meritor WABCO, the ABS valve package, which may be found on certain vehicle models. The ABS valve package may be used on all D and E version units, including D and E Basic, and is available for front or rear axle installation.

Easy Listening Tip!

To ensure the ABS valves are working — just listen! Figure 1.5.

1 Introduction

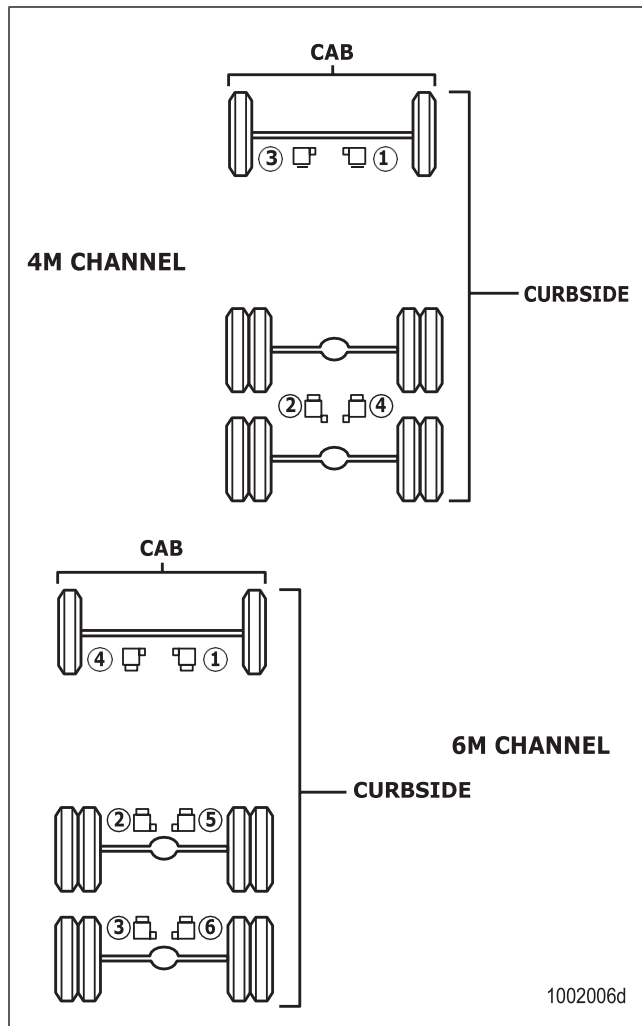


Figure 1.5

1. Apply the brakes.
2. Turn on the ignition.
3. Wait for the ABS indicator lamp to come on.

NOTE: In previous versions of ABS, the valves are cycled diagonally. Diagonal cycling does not occur with E version ABS.

4. Listen to the valves cycle one by one as follows:
 - 4M (channel) valve cycle order:
1 – 2 – 3 – 4
 - 6M (channel) valve cycle order:
1 – 2 – 3 – 4 – 5 – 6

ABS Valve Packages

The front ABS valve package can consist of either a quick release valve or a relay valve with two ABS modulator valves and is mounted in the front of the vehicle. The rear ABS valve package combines a service brake relay valve with two ABS modulator valves and is mounted in the rear of the vehicle. Depending on the application, these valve packages may or may not have a 3/2 solenoid valve (active braking valve) mounted to the quick release or relay valve. Figure 1.6.

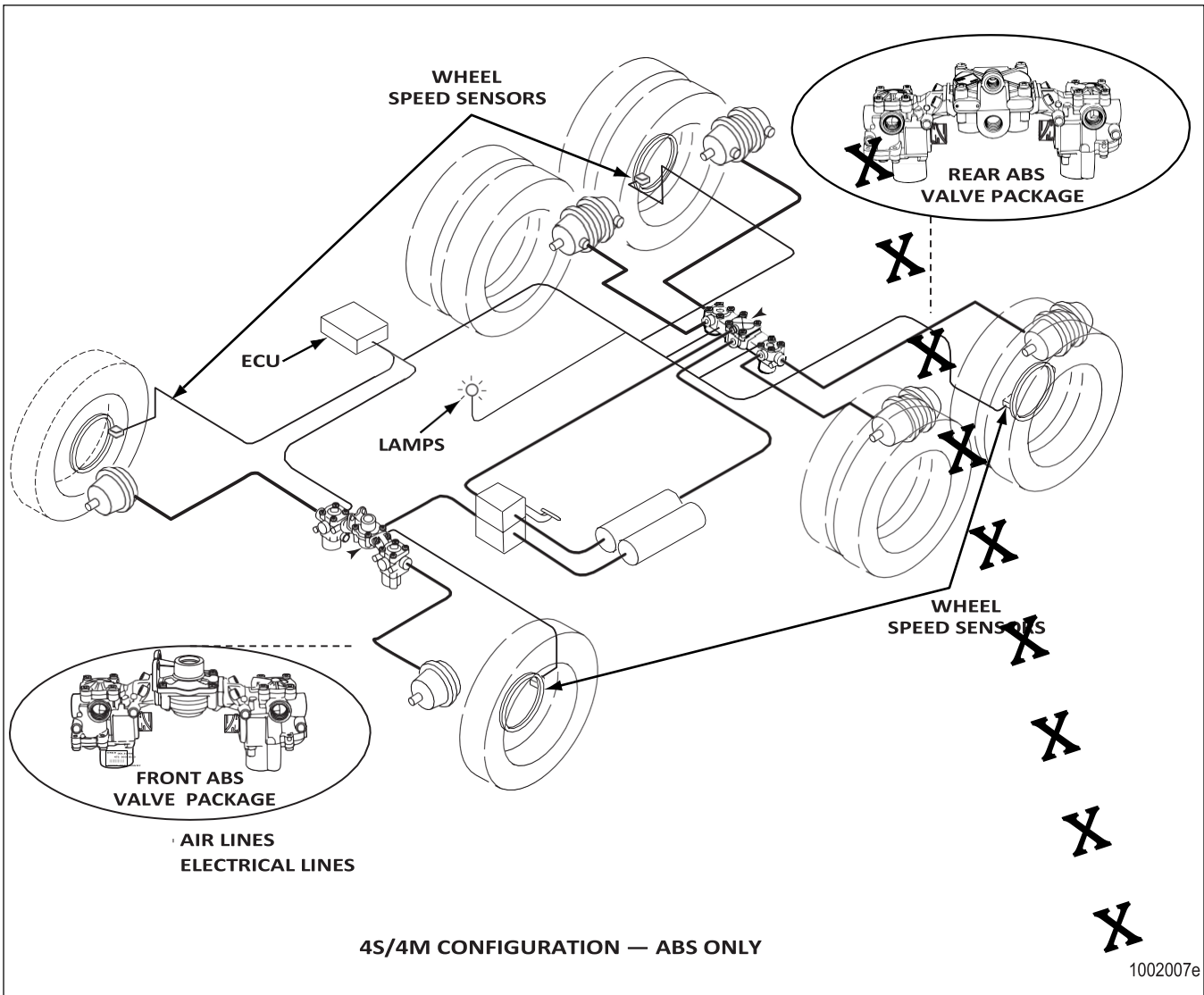


Figure 1.6

ABS Sensors

ABS sensor systems consist of a tooth wheel mounted on the hub or rotor of each monitored wheel and a sensor installed so that its end is against the tooth wheel. The sensor continuously sends wheel speed information to the ECU. A sensor clip holds the sensor in place at the tooth wheel.

The type of axle determines sensor mounting location.

- Steering axle sensors are installed in the steering knuckle or in a bolted-on bracket.
- Drive axle sensors are mounted in a block attached to the axle housing or in a bolted-on bracket.

Check the wheel speed sensors for correct alignment and apply lubricant to the sensor and sensor clip whenever wheel-end maintenance is performed. Refer to Section 3 and Section 4.

Off-Road ABS

On some vehicles, an off-road ABS function may be selected. Off-road ABS improves vehicle control and helps reduce stopping distances in off-road conditions or on poor traction surfaces such as loose gravel, sand and dirt.

1 Introduction

NOTE: On vehicles equipped with an off-road switch, the off-road ABS mode is manually selected by the driver. On some vehicles, the off-road mode may be fully automatic. Refer to the vehicle specifications for information about the off-road ABS feature.

The ABS indicator lamp on the dash will flash while the vehicle is in the off-road mode. This alerts the driver that the vehicle's normal ABS function is being modified.

Automatic Traction Control (ATC)

ATC is an option with Basic and frame-mounted E version ECUs and is available with all Universal ECUs. ATC can be used with individual valves, or with an integrated ABS/ATC valve package. Universal and frame-mounted E version ECUs with ATC may have stability control. Basic ECUs with ATC do not have RSC or ESC. Section 2 describes ATC, RSC and ESC in detail.

System Components

The ECU is the brain of the ABS system. It receives information from the sensors and sends signals to the ABS valves. ECUs are available for cab- or frame-mounted applications. Basic and universal ECUs are cab-mounted. Universal and frame-mounted E version ECUs with ATC may have Roll Stability Control (RSC) or Electronic Stability Control (ESC). Basic ECUs with ATC do not have RSC or ESC. Figure 1.7.

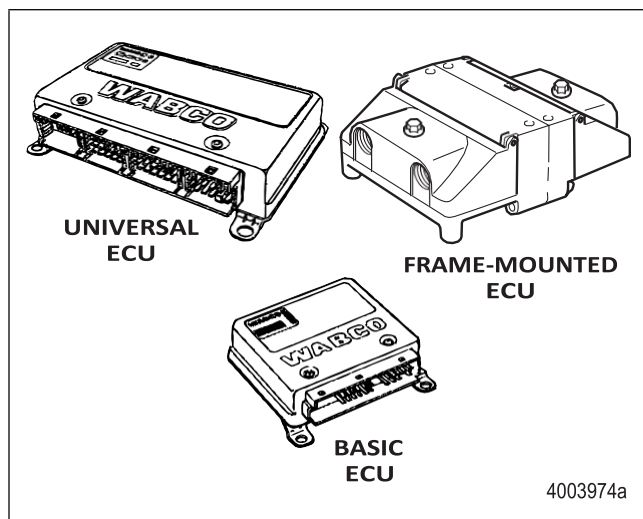


Figure 1.7

A tooth wheel is mounted at, or cast in, the hub or rotor of each sensed wheel, with a sensor installed so that its end is against the tooth wheel. A sensor clip holds the sensor in place at the tooth wheel. Figure 1.8.

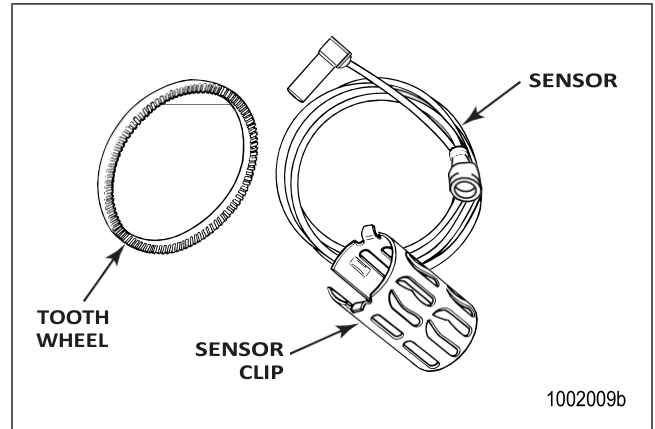


Figure 1.8

NOTE: The sensor and clip must be greased with Meritor WABCO-recommended lubricant whenever wheel-end maintenance is performed. Refer to Section 4 for lubrication specifications.

An ABS modulator valve controls air pressure to each affected brake during an ABS event. The modulator valve is usually located on a frame rail or cross member near the brake chamber. The modulator valve is available in bayonet-style, Figure 1.9, or open-style connector.

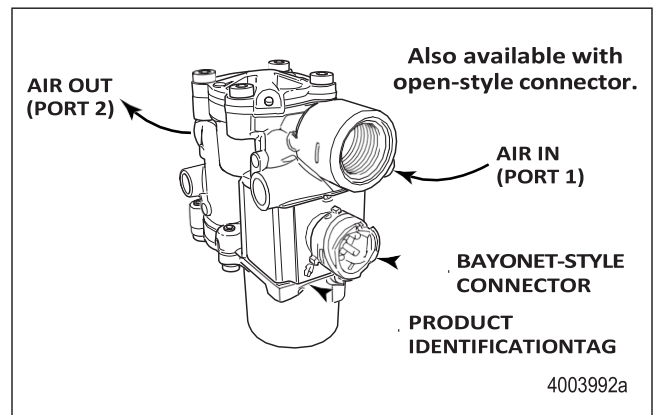


Figure 1.9

The ABS valve package is an alternative to individual valves.

The rear ABS valve package combines two modulator valves, one service relay valve, and depending on the vehicle configuration, an active braking valve (ABV). Figure 1.10.

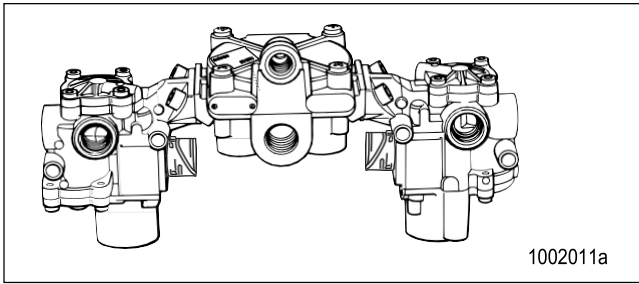


Figure 1.10

The front ABS valve package combines two modulator valves, a quick release valve or a relay valve, and depending on the vehicle configuration, an active braking valve (ABV). Figure 1.11.

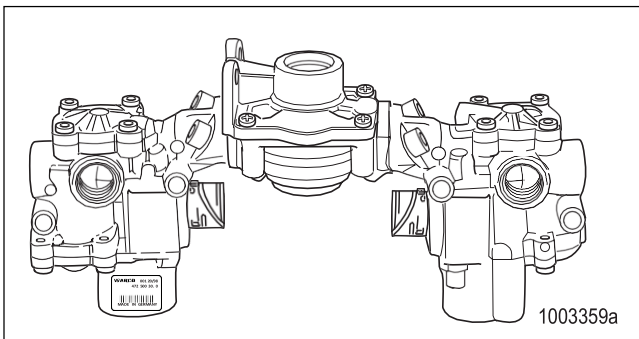


Figure 1.11

Sensor cables connect the sensor to the ECU. Figure 1.12.

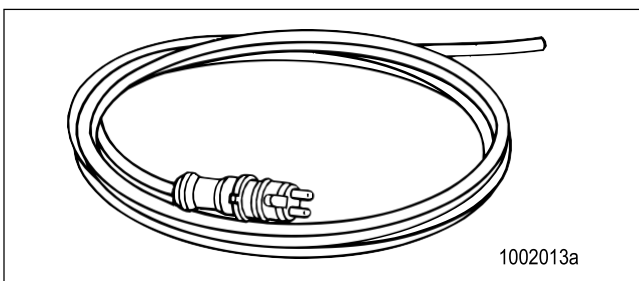


Figure 1.12

ABS modulator valve cables connect the modulator valve to the ECU. Figure 1.13.

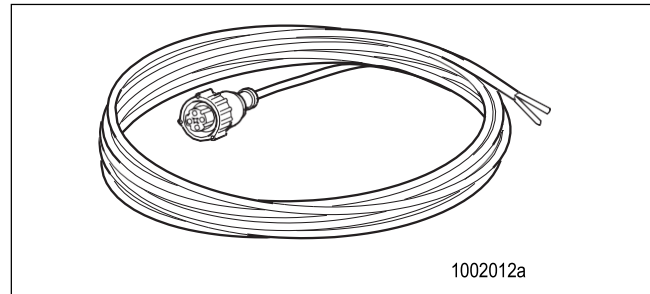


Figure 1.13

TOOLBOX™ Software is a PC-based diagnostics program that can display wheel speed data, test individual components, verify installation wiring and more. Runs in Windows® 2000, NT, XP and Vista. Internet Explorer version 3.02 or higher must be installed. RS232 to J1708 convertor box is required. Figure 1.14.

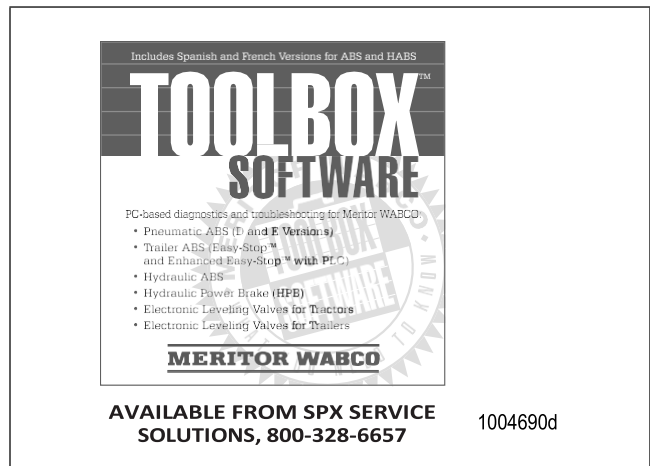


Figure 1.14

The MPSI Pro-Link® Plus with a multiple protocol cartridge (MPC) and Meritor WABCO applications card, version 2.0 or higher, provides diagnostic and testing capabilities for the E version ABS. Figure 1.15.

1 Introduction



Figure 1.15

NOTE: The RSC/ESC functions of E version ABS cannot be tested with the Pro-Link[→] Plus.

2 Stability and Safety Enhancement Systems: Automatic Traction Control (ATC), Roll Stability Control (RSC), Electronic Stability Control (ESC) and Hill Start Aid (HSA)

ATC

Automatic traction control is available as an option on all E version ABSECU's and is standard on most. ATC helps improve traction when vehicles are on slippery surfaces by reducing drive wheel overspin. ATC works automatically in two different ways.

- A. If a drive wheel starts to spin, ATC applies air pressure to brake the wheel. This transfers engine torque to the wheels with better traction.
- B. If all drive wheels spin, ATC reduces engine torque to provide improved traction.

ATC turns itself on and off, drivers do not have to select this feature. If drive wheels spin during acceleration, the ATC indicator lamp comes on, indicating ATC is active. It goes out when the drive wheels stop spinning. Figure 2.1.

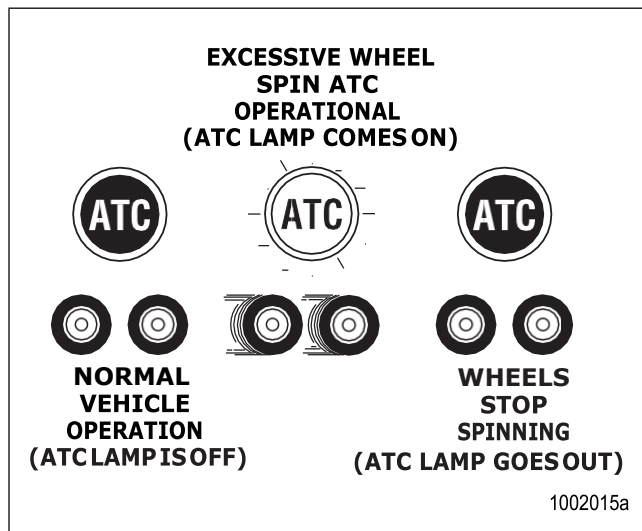


Figure 2.1

NOTE: Some vehicle manufacturers may refer to ATC as Anti-Spin Regulation (ASR).

If ATC is installed, there will be an indicator lamp on the vehicle dash or instrument panel marked ATC, ASR, or potentially Stability Control, depending on the application.

An ATC installation may use an individually mounted valve, or the valve may be part of the ABS valve package. Figure 2.2.

2 Stability and Safety Enhancement Systems: Automatic Traction Control (ATC), Roll Stability Control (RSC), Electronic Stability Control (ESC) and Hill Start Aid (HSA)

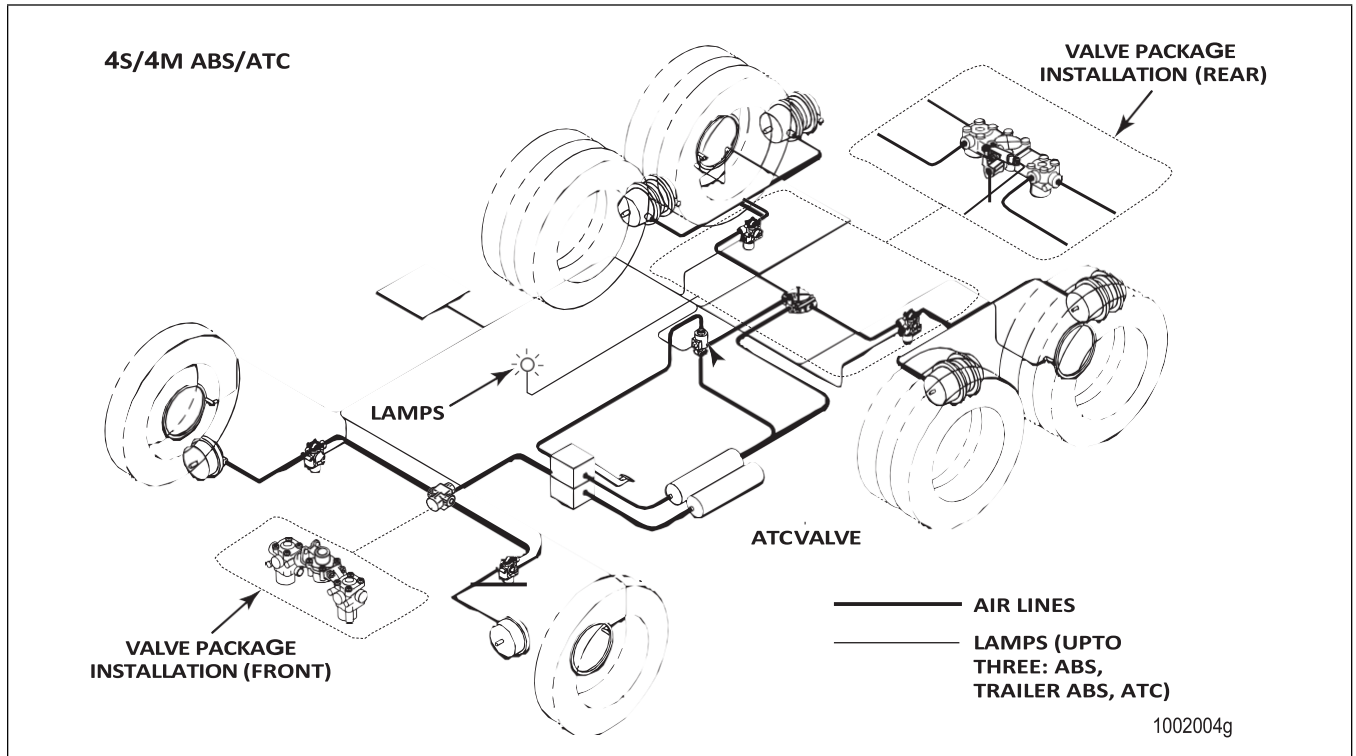


Figure 2.2

ATC Components

ATC may be used with individual ABS modulator valves, or installed with the ABS valve package.

When installed with individual ABS modulator valves, an ATC solenoid valve is mounted on the frame or cross member, near the rear of the vehicle.

When it is part of the ABS valve package, an ATC valve is attached to the relay valve.

A cable connects the ECU to the ATC valve.

ATC components are illustrated in Figure 2.3.

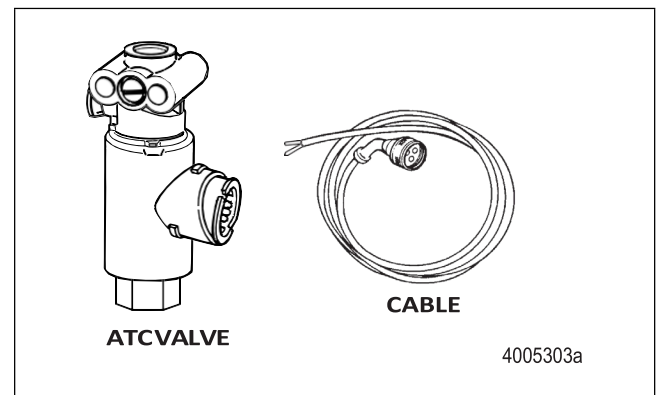


Figure 2.3

Deep Snow and Mud Switch

A deep snow and mud option switch is included with ATC. This function helps to increase available traction on extra soft surfaces like snow, mud or gravel, by slightly increasing the permissible wheel spin.

Drivers use a deep snow and mud switch to select this feature. When this function is in use, the ATC indicator lamp blinks continuously. Figure 2.4.

2 Stability and Safety Enhancement Systems: Automatic Traction Control (ATC), Roll Stability Control (RSC), Electronic Stability Control (ESC) and Hill Start Aid (HSA)

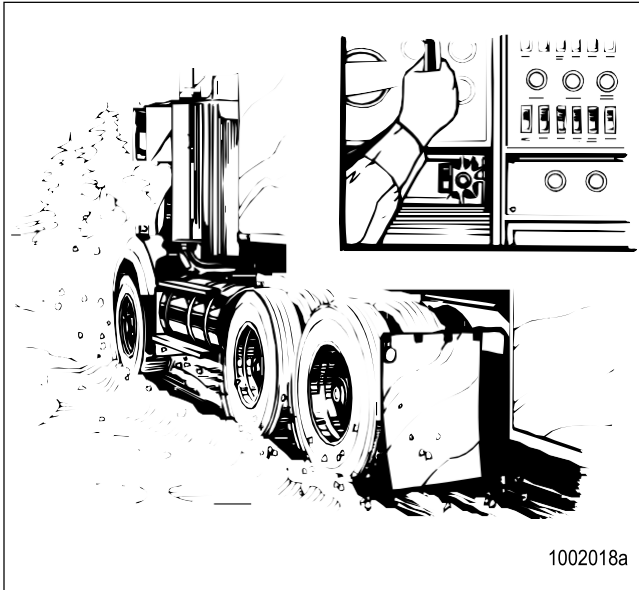


Figure 2.4

RSC uses many of the same components used by ABS and ATC. Additional solenoid valves control the trailer service brakes and depending on the application, the front axle brakes during an RSC event. The solenoid for the trailer braking is a stand-alone valve that is not available as part of the ABS/ATC valve package. Depending on the application, a modulator valve may be located downstream of the solenoid valve. Figure 2.5.

Switch and lamp locations will vary, depending on the vehicle make and model.

Here's how the deep snow and mud feature works.

Driver Action	System Response	Function	
		Active	Not Active
Press deep snow and mud switch	ATC lamp blinks continuously	X	
Press switch again	ATC lamp stops blinking		X

NOTE: Turning off the ignition will also deactivate the deep snow and mud feature.

Roll Stability Control (RSC)

Roll stability control is an option designed to assist drivers in managing the conditions that may result in commercial vehicle rollovers. When RSC senses conditions that may result in a rollover, it reduces engine torque, engages the engine retarder, applies pressure to the drive axle brakes and may modulate the trailer brakes to slow the vehicle down (depending on the application and vehicle configuration, the steer axle brakes may be applied as well). Like ATC, RSC works automatically. The driver does not have to select this feature.

2 Stability and Safety Enhancement Systems: Automatic Traction Control (ATC), Roll Stability Control (RSC), Electronic Stability Control (ESC) and Hill Start Aid (HSA)

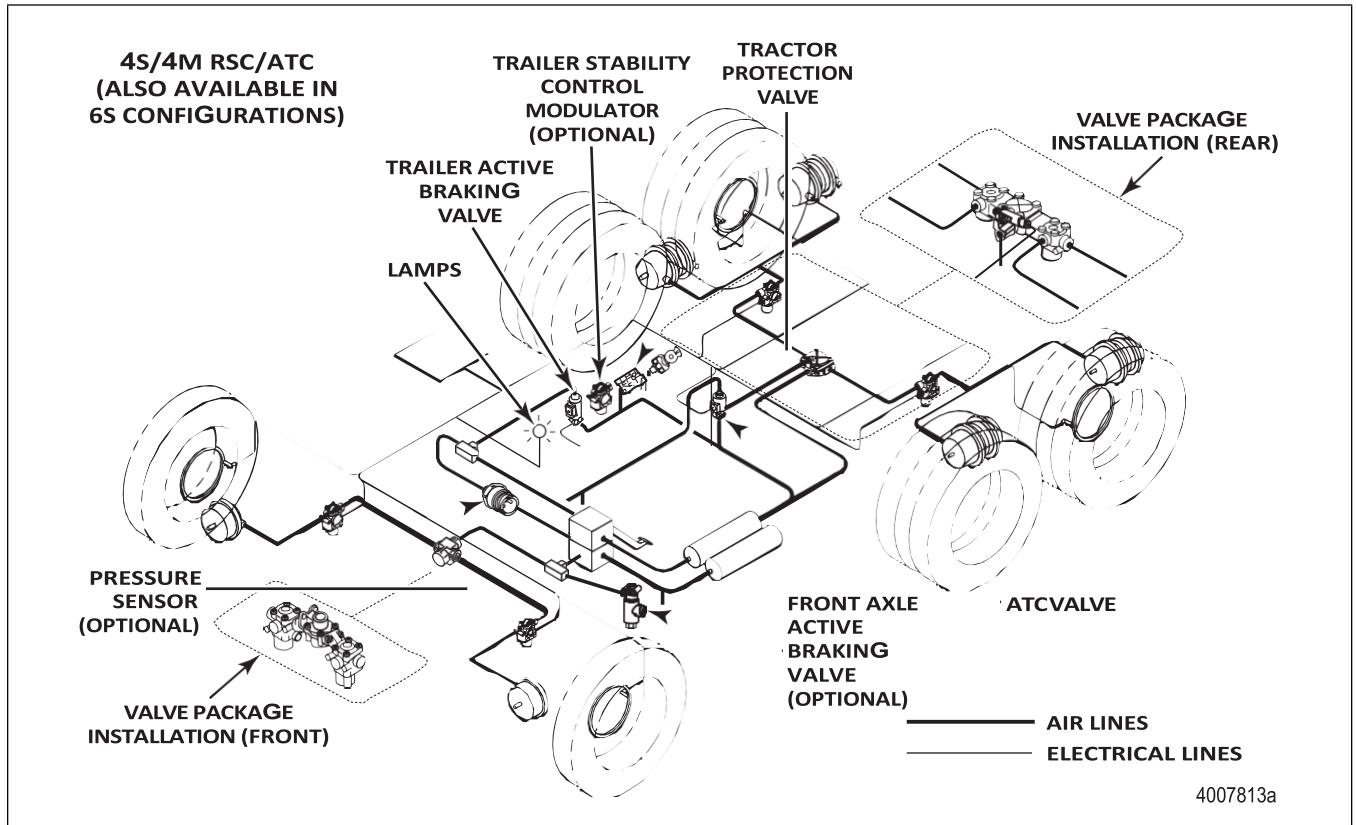


Figure 2.5

ATC and RSC/ESC functions share the same dash indicator lamp, understanding how the ABS and ATC/RSC/ESC lamps work is very important.

- If the vehicle is equipped with ATC, but not RSC/ESC, when the ignition is turned to the ON position, the ABS and ATC lamps will light for approximately three seconds, then both lamps will turn off simultaneously. Figure 2.6.
- If the vehicle is equipped with ATC and RSC/ESC, when the ignition is turned to the ON position, the ABS and ATC/RSC/ESC will both light . . . but the ATC/RSC/ESC lamp will stay lit briefly after the ABS lamp goes out.

2 Stability and Safety Enhancement Systems: Automatic Traction Control (ATC), Roll Stability Control (RSC), Electronic Stability Control (ESC) and Hill Start Aid (HSA)

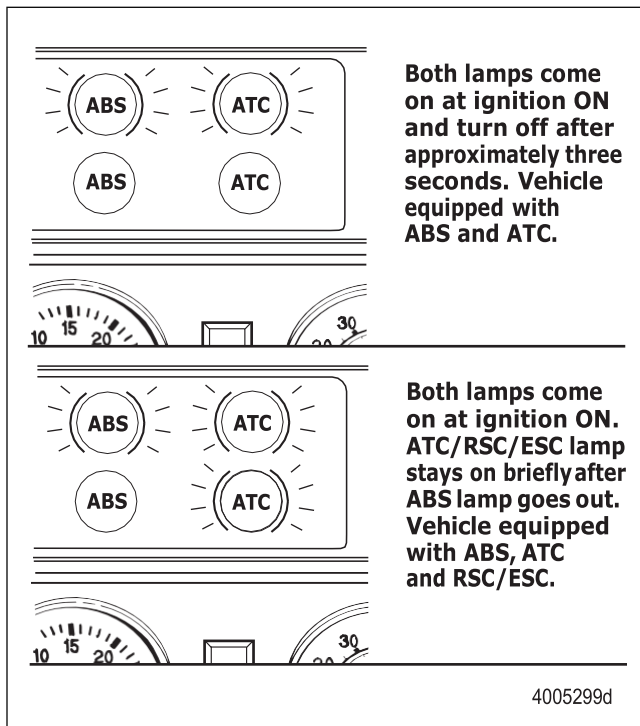


Figure 2.6

NOTE: Active mode means RSC/ESC is installed and will become active if it is needed.

TOOLBOX™ Software can also be used to determine if RSC/ESC is active. Refer to Section 9.

RSC Components

Additional solenoid valves are needed for RSC. These valves control the trailer service brakes and in some applications, the front axle brakes during an RSC event. The solenoid valve for the trailer control is a stand-alone valve. The valve is not part of an ABS valve package. Figure 2.7.

In some applications, a modulator may be located downstream of the solenoid valve to control trailer braking.

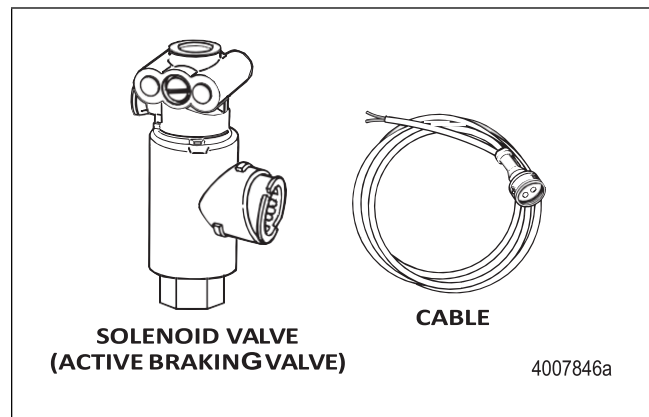


Figure 2.7

Electronic Stability Control (ESC)

Electronic Stability Control (ESC) combines the rollover prevention of Roll Stability Control (RSC) with directional stability in order to keep the vehicle traveling on its intended path by providing spinout and driftout control.

Like RSC, ESC is automatic. It becomes active when the system senses imminent directional or roll instabilities, often before the driver is aware. You will notice a difference in the vehicle when stability control is functioning, but you should continue to drive as normal and provide any additional needed corrections.

You may again notice a reduction in engine torque and additional deceleration from the retarder, if so equipped. You also may notice individual or all brakes applying depending on whether the vehicle is in a roll or directional control event.

ESC is built from the ABS platform and uses many of the same components as ATC and RSC. An additional solenoid valve to control the front axle brakes, a pressure sensor, an ESC module, and a Steering Angle Sensor (SAS) are required in addition to the components necessary for RSC. These components are described in the following section. Figure 2.8.

2 Stability and Safety Enhancement Systems: Automatic Traction Control (ATC), Roll Stability Control (RSC), Electronic Stability Control (ESC) and Hill Start Aid (HSA)

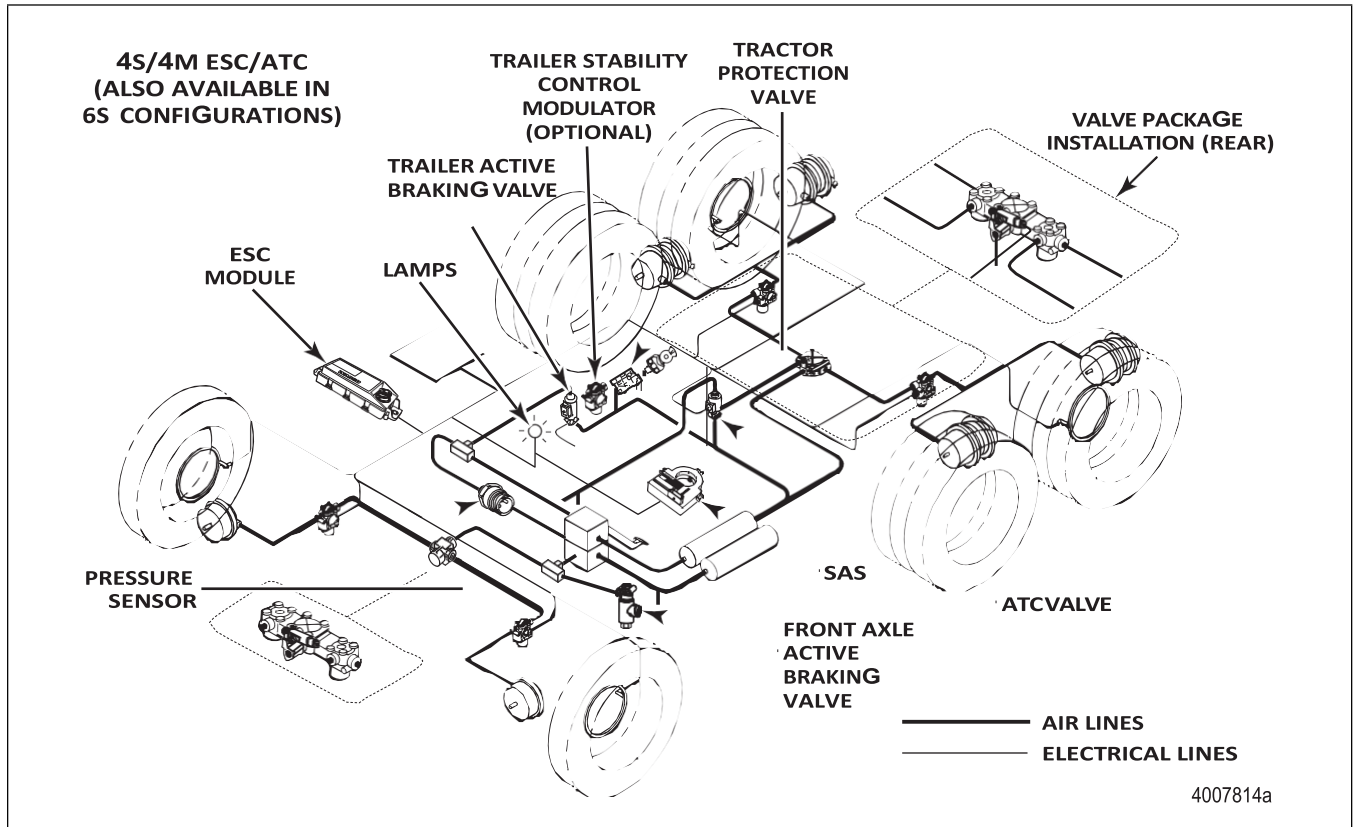


Figure 2.8

ESC Components

The following components are required for ESC in addition to the components required for RSC. Note that for ESC applications on a non-towing vehicle (straight truck), the RSC trailer solenoid valve is not required.

ESC ABS ECU

The ESC ABS ECU is available in both Cab and Frame-mounted versions. The ABS Universal Cab-Mounted ECU with ESC is an upgraded version of the current Universal Cab ECU with a fourth connector containing the necessary inputs/outputs required for full stability control. The ABS Frame-Mounted ECU with ESC is an upgraded version of the current ABS Frame-Mounted ECU with six additional pins on both the X1 and X2 connectors of the ECU. These ECUs support 4S4M, 6S4M and 6S6M vehicle configurations and are compatible with 12V electrical systems. For pinout information, refer to section 6 of this manual.

The ESC ABS ECU contains a parameter setting which is specific to a vehicle configuration validated by Meritor WABCO Engineering. It is imperative that the correct ECU is installed on your vehicle(s) in service. Meritor WABCO or your respective vehicle OEM should be contacted with any questions regarding this.

See below for the cab-mounted version ECU. Figure 2.9.

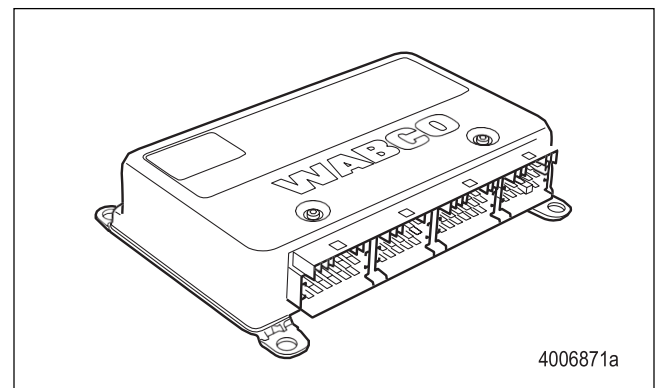


Figure 2.9

2 Stability and Safety Enhancement Systems: Automatic Traction Control (ATC), Roll Stability Control (RSC), Electronic Stability Control (ESC) and Hill Start Aid (HSA)

See below for the frame-mounted version. Figure 2.10.

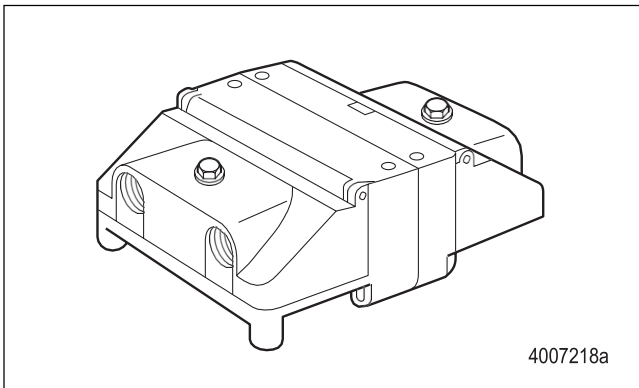


Figure 2.10

Steering Angle Sensor (SAS)

The SAS delivers the driver's steering input (steering wheel position) to the ABS ECU using a dedicated ESC system internal data link. The ABS ECU supplies the sensor with power and ground. The SAS must be calibrated using diagnostic tools (refer to Section 8). The Meritor WABCO SAS is pictured below. Figure 2.11.

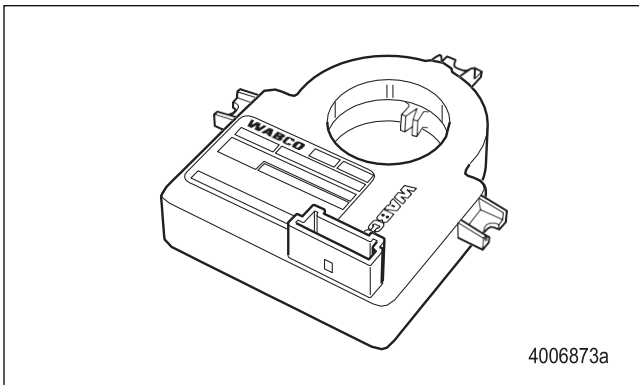


Figure 2.11

ESC Module

The ESC module is part of the ESC system. It measures the vehicle yaw rate as well as vehicle lateral acceleration. The ESC module includes part of the ESC control algorithm. It exchanges data with the ESC ABS ECU via the ESC system internal data link. The ABS ECU supplies the module with power and ground. The ESC module must be activated by diagnostic tools (refer to Section 8).

Figure 2.12.

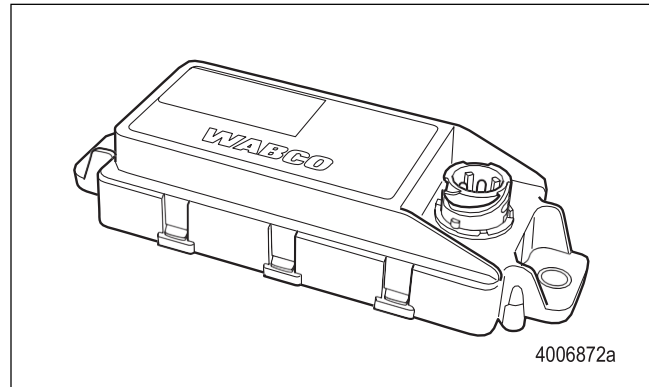


Figure 2.12

Brake Pressure Sensor

The brake pressure sensor provides the system with the driver's brake demand. The sensor can be located in the primary or secondary delivery circuit depending on the application.

Figure 2.13.

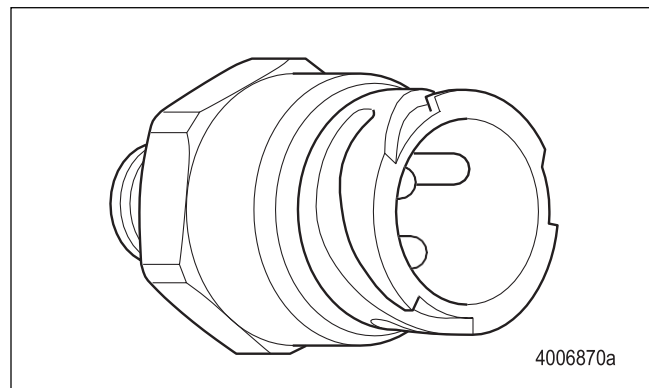


Figure 2.13

Front Axle Brake Valve

For ESC (and in some RSC applications) an additional solenoid valve is used to control steer axle braking during a stability control event. This valve is a 3/2 solenoid valve such as what is used for ATC and RSC/ESC trailer braking. It may either be part of a front axle valve package or may be mounted as a stand-alone valve.

2 Stability and Safety Enhancement Systems: Automatic Traction Control (ATC), Roll Stability Control (RSC), Electronic Stability Control (ESC) and Hill Start Aid (HSA)

Trailer Modulator Valve

In some stability control applications an additional modulator valve (same as what is used for ABS modulation) will be located in the trailer control line downstream of the 3/2 solenoid valve used to control the trailer. This additional modulator valve provides a more tightly controlled pressure to the trailer and will often be used on vehicles equipped with OnGuard Collision Safety systems or on vehicles which pull multiple trailers.

ATC and RSC/ESC functions share the same dash indicator lamp. Understanding how the ABS and ATC/RSC/ESC lamps work is very important.

- If the vehicle is equipped with ATC, but not RSC/ESC, when the ignition is turned to the ON position, the ABS and ATC lamps will light for approximately three seconds, then both lamps will turn off simultaneously. Figure 2.14.
- If the vehicle is equipped with ATC and RSC/ESC, when the ignition is turned to the ON position, the ABS and ATC/RSC/ESC will both light . . . but the ATC/RSC/ESC lamp will stay lit briefly after the ABS lamp goes out.

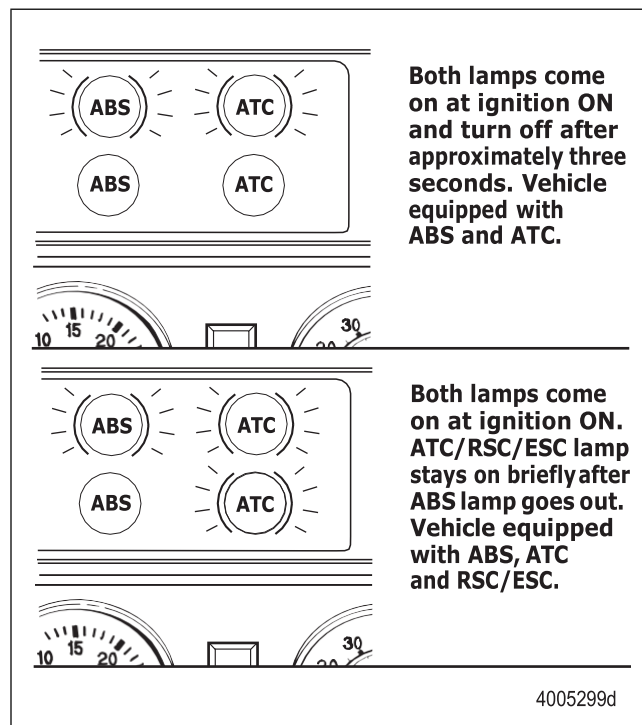


Figure 2.14

NOTE: Active mode means RSC/ESC is installed and will become active if it is needed.

TOOLBOX™ Software can also be used to determine if RSC/ESC is active. Refer to Section 3.

Hill Start Aid

Description

Hill Start Aid (HSA) supports automated manual transmission in reducing/eliminating rolling back of vehicle while launching on grade. Currently, it can only be used with Eaton Ultrashift Plus. Upon request from transmission, HSA holds pressure in the service brakes of all axles of the towing vehicle during vehicle standstill. HSA will hold pressure for a maximum of three seconds following full release of the brake pedal. Communication between transmission and ABS takes place via J1939 data link.

Components

- A. ABS ECU (E4.3 generation and higher) w/Universal E4.4 software.
- B. ATC valve at front axle (similar to Figure 2.7): This valve helps maintain the HSA trapped pressure. Each failure detected on the 3/2 solenoid valve leads to HSA no availability or shut-off. To troubleshoot, please refer to Active Braking Valves (ABV) in Section 3 – Diagnostics, Troubleshooting and Testing.
- C. ATC valve at rear axle (similar to Figure 2.7): This valve, similar to front axle ATC valve, helps to maintain the HSA trapped pressure. Each failure detected on the 3/2 solenoid valve leads to HSA no availability or shut-off. To troubleshoot, please refer to Active Braking Valves (ABV) in Section 3 – Diagnostics, Troubleshooting and Testing.
- D. Pressure sensor (similar to Figure 2.13): A pressure sensor provides the system with the driver's brake demand. The measured pressure is used in case of HSA to set the trapped pressure and/or activate the HSA function. Each failure detected on the pressure sensor leads to HSA no availability or shut-off. To troubleshoot, please refer to Brake Pressure Sensor in Section 3 – Diagnostics, Troubleshooting and Testing. The pressure sensor shall be installed according to the system specification.
- E. HSA switch (dashboard or hard wired).
- F. HSA lamp (hard wired only).

3 Diagnostics, Troubleshooting and Testing

General

Maintenance Information

There is no regularly scheduled maintenance required for the Meritor WABCO ABS or ABS/ATC. However, ABS does not change current vehicle maintenance requirements.

- **Lamp Check:** To ensure the ABS tractor lamp is operating, drivers should check the lamp every time the vehicle is started. When the vehicle is started, the ABS lamp should come on momentarily. If it does not come on, it could mean a burned-out bulb.
- **ABS Wheel Speed Sensors:** Check the wheel speed sensor adjustment and lubricate the sensor and sensor clip whenever wheel-end maintenance is performed. Use only Meritor WABCO-recommended lubricant, as specified in Section 4.

Diagnostics

Use any of the following methods to diagnose E version ABS:

- **TOOLBOX™ Software,** a PC-based ABS diagnostic and testing program that runs in Windows → 2000, NT, XP or Vista. Internet Explorer version 3.02 or higher must be installed. Refer to the information in this section.
- **Blink Codes.** Refer to the information in this section.
- **MPSI Pro-Link → Plus with MPC and Meritor WABCO applications card,** version 2.0 or higher. Refer to the information in this section.
- **OEM Diagnostic Displays.** Refer to the vehicle operator's manual.

Information about TOOLBOX™ Software, MPSI Pro-Link → Plus and blink codes follows. If you have any questions about system diagnostics, please contact ArvinMeritor's Customer Service Center at 866-OnTrac1 (668-7221).

TOOLBOX™ Software Diagnostics

NOTE: For complete instructions for using TOOLBOX™ Software, refer to the User's Manual. The manual is posted on meritorwabco.com/TOOLBOX.

If you have TOOLBOX™ Software installed on your computer, use it to identify system faults. Then, follow the on-screen repair information to make the necessary repairs or replacements.

To display E version ABS faults:

1. Connect the computer to the vehicle:

- Attach the cable from your computer to the J1708 to RS232 converter box.
- Attach the diagnostic cable (Deutsch) to the vehicle. Figure 3.1.

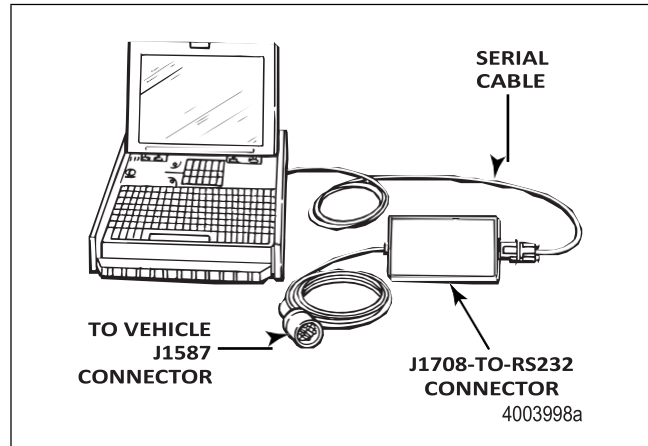


Figure 3.1

2. Select TOOLBOX™ Software from the Desktop or from the Windows Start Menu to display the TOOLBOX™ Main Menu. From the Main Menu, select Tractor ABS. The ABS Main Screen will appear. Figure 3.2.

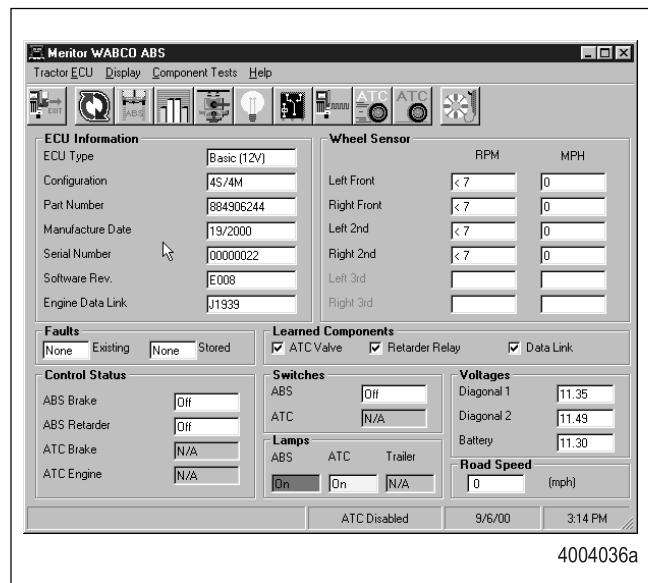


Figure 3.2

3. Select Display for a pull-down menu.
4. From the pull-down menu, select Faults to bring up the Fault Information screen. Figure 3.3.

3 Diagnostics, Troubleshooting and Testing

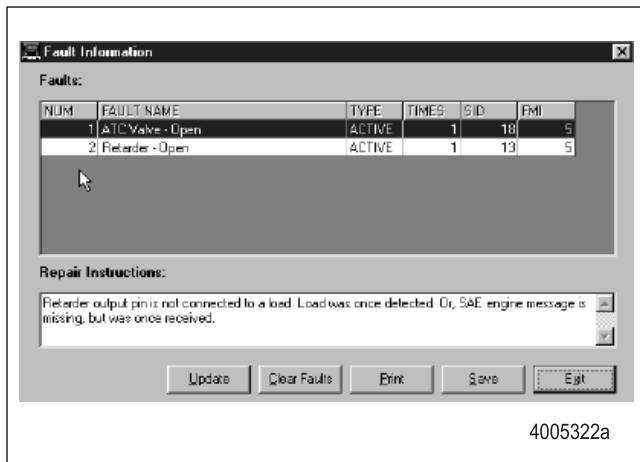


Figure 3.3

5. A description of the fault, the number of times the fault occurred, the system identifier (SID) and the failure mode (FMI) are all displayed in the fault information window. Basic repair instructions for each fault are also provided. Figure 3.3. More detailed information about SID and FMI troubleshooting and repair is provided in the following sections.

For detailed repair instructions, click on the fault to display a troubleshooting information sheet. Bookmark and Thumbnail tabs at the side of the troubleshooting information sheet provide additional information. A sample troubleshooting information sheet appears in the Appendix. This screen also provides a link to the appropriate system schematic.

Faults that may occur after the screen is displayed will not appear until a screen update is requested. Use the update button to refresh the fault information table.

After making the necessary repairs, use the clear faults button to clear the fault. Use the update button to refresh the fault information table and display the new list of faults.

Use the Save or Print button to save or print the fault information data.

Blink Code Diagnostics (Tractor ABS Only)

Definitions

Before using blink code diagnostics, you should be familiar with a few basic terms. If you used previous versions of Meritor WABCO's blink code diagnostics, review these definitions to identify major changes.

ABS Indicator Lamp: This lamp serves two purposes: it alerts drivers to an ABS tractor fault and it is used during diagnostics to display the blink code.

Blink Code: A series of blinks or flashes that describe a particular ABS system fault or condition.

Blink Code Cycle: Two sets of flashes with each set separated by a one-and-one-half second pause. Blink codes are defined in the blink code identification information in this section.

Blink Code Switch: A momentary switch that activates blink code diagnostic capabilities. Switch types and locations vary, depending on the make and model of the vehicle.

Clear: The process of erasing faults from the ECU.

Diagnostics: The process of using blink codes to determine ABS system faults.

Fault: An ABS malfunction detected and stored in memory by the Meritor WABCO ECU. System faults may be Active or Stored.

Active Fault: A condition that currently exists in the ABS system; for example, a sensor circuit malfunction on the left front steering axle. An active fault must be repaired before it can be cleared from memory—and before you can display additional blink code faults.

Stored Fault: There are two types of stored faults:

- A. A repaired active fault that has not been cleared from the ECU.
- B. A fault that occurred but no longer exists. For example, a loose wire that makes intermittent contact. Because stored faults are not currently active, they do not have to be repaired before they can be cleared from memory.

Meritor WABCO recommends you keep a record of these faults for future reference.

System Configuration Code: One digit code displayed during the clear mode. Blink codes for common ABS system configurations are shown in Figure 3.4.

3 Diagnostics, Troubleshooting and Testing

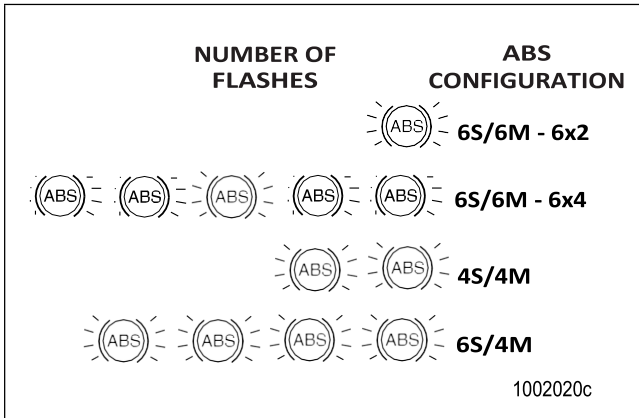


Figure 3.4

Diagnostic Mode

To enter the diagnostic mode, press and hold the blink code switch for one second, then release.

Clear Mode

To erase faults from the ECU, you must be in the clear mode. To enter the clear mode, press and hold the blink code switch for at least three seconds, then release.

If the system displays eight quick flashes followed by a system configuration code, the clear was successful. Stored ABS faults have been cleared from memory.

If you do not receive eight flashes, there are still active faults that must be repaired before they can be cleared.

NOTE: The clear mode is also used to disable the ATC function.

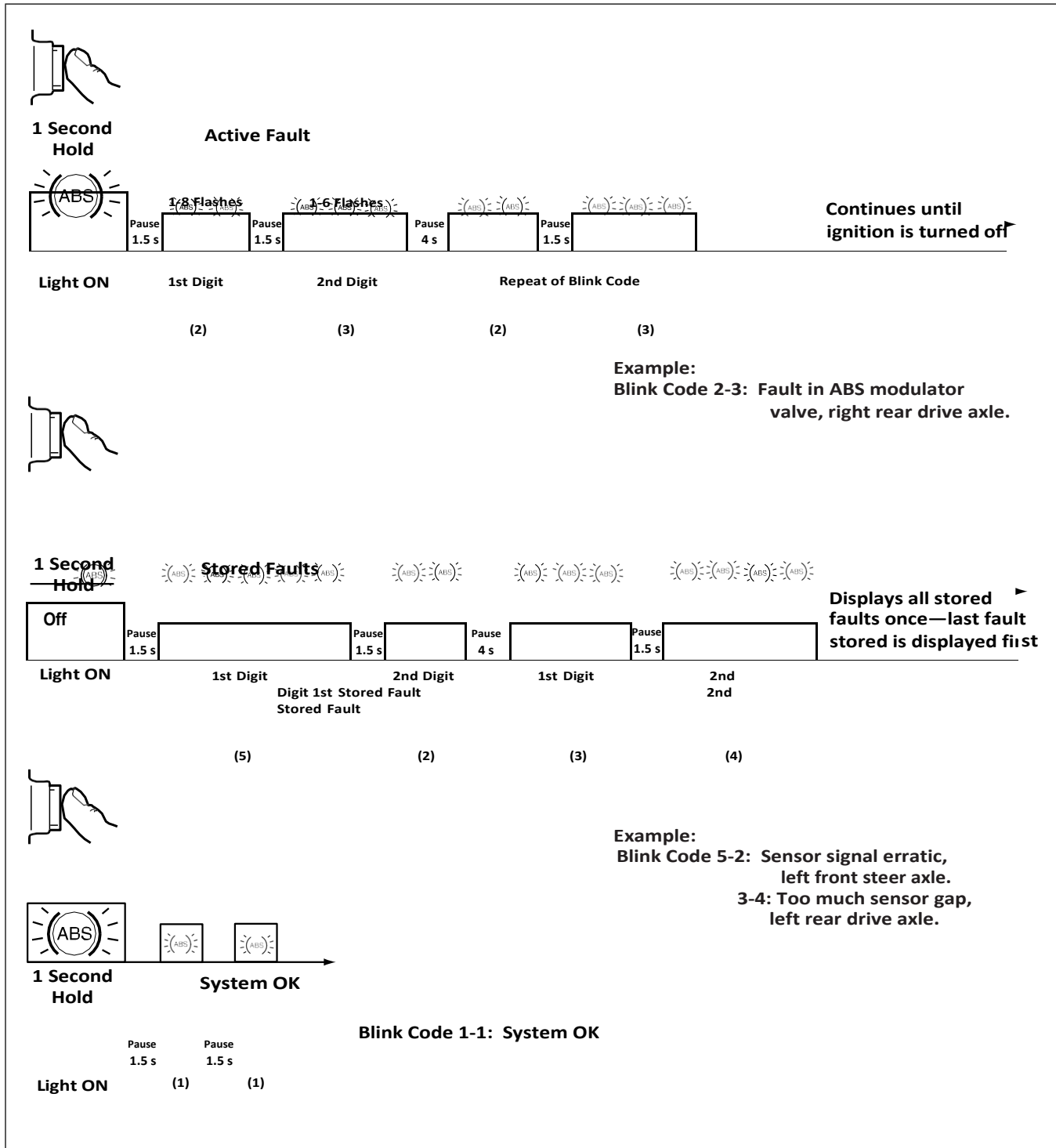
3 Diagnostics, Troubleshooting and Testing

Table C: Troubleshooting with Blink Code Diagnostics

Procedure	System Response	Action
Diagnostics Mode		
<p>Step I.</p> <p>Turn ignition ON.</p>	<p>Possible responses:</p> <p>ABS indicator lamp comes on momentarily then goes out, indicating System OK.</p> <p>ABS indicator lamp does not light, indicating possible wiring fault or burned-out bulb.</p> <p>ABS indicator lamp stays on, indicating:</p> <ul style="list-style-type: none"> • Fault, or faults, in the system. • Sensor fault during last operation. • Faults cleared from ECU, but vehicle not driven. • ECU disconnected. 	<p>No recognizable active faults in the ABS. No action required.</p> <p>Inspect wiring. Inspect bulb. Make necessary repairs.</p> <p>Continue with blink code diagnostics. (Go to Step II.)</p> <p>Continue with blink code diagnostics. (Go to Step II.)</p> <p>Drive vehicle — lamp will go out when vehicle reaches 4 mph (6 km/h).</p> <p>Connect ECU.</p>
<p>Step II.</p> <p>Press and hold Blink Code Switch for one second, then release.</p>	<p>ABS indicator lamp begins flashing two digit blink code(s).</p>	<p>Determine if fault is active or stored:</p> <p>Active Fault: Lamp will repeatedly display one code.</p> <p>Stored Fault: Lamp will display code for each stored fault then stop blinking. Faults will be displayed one time only.</p>
<p>Step III.</p> <p>Count the flashes to determine the blink code.</p>	<p>First Digit: 1-8 flashes, Pause (1-1/2 seconds)</p> <p>Second Digit: 1-6 flashes, Pause (4 seconds)</p>	<p>Find definition for blink code on blink code chart.</p>
<p>Step IV.</p> <p>Turn ignition OFF.</p>	<p>Active Fault</p>	<p>Make the necessary repairs. Repeat Step 1, Step II and Step III until System OK, code (1-1) received.</p>
<p>Repair and record faults.</p>	<p>Stored Fault</p>	<p>Record for future reference.</p> <p>NOTE: Last fault stored is first fault displayed.</p>
Clear Mode		
<p>Step V.</p> <p>Turn ignition ON.</p> <p>Clear Faults from memory: Press and hold blink code switch for at least three seconds, then release.</p>	<p>ABS indicator lamp flashes eight times.</p> <p>Eight flashes not received.</p>	<p>All stored faults successfully cleared.</p> <p>Turn ignition OFF.</p> <p>Active faults still exist, repeat Step I through Step V.</p>

3 Diagnostics, Troubleshooting and Testing

Blink Code Illustrations



S = Seconds

1002021b

Figure 3.5

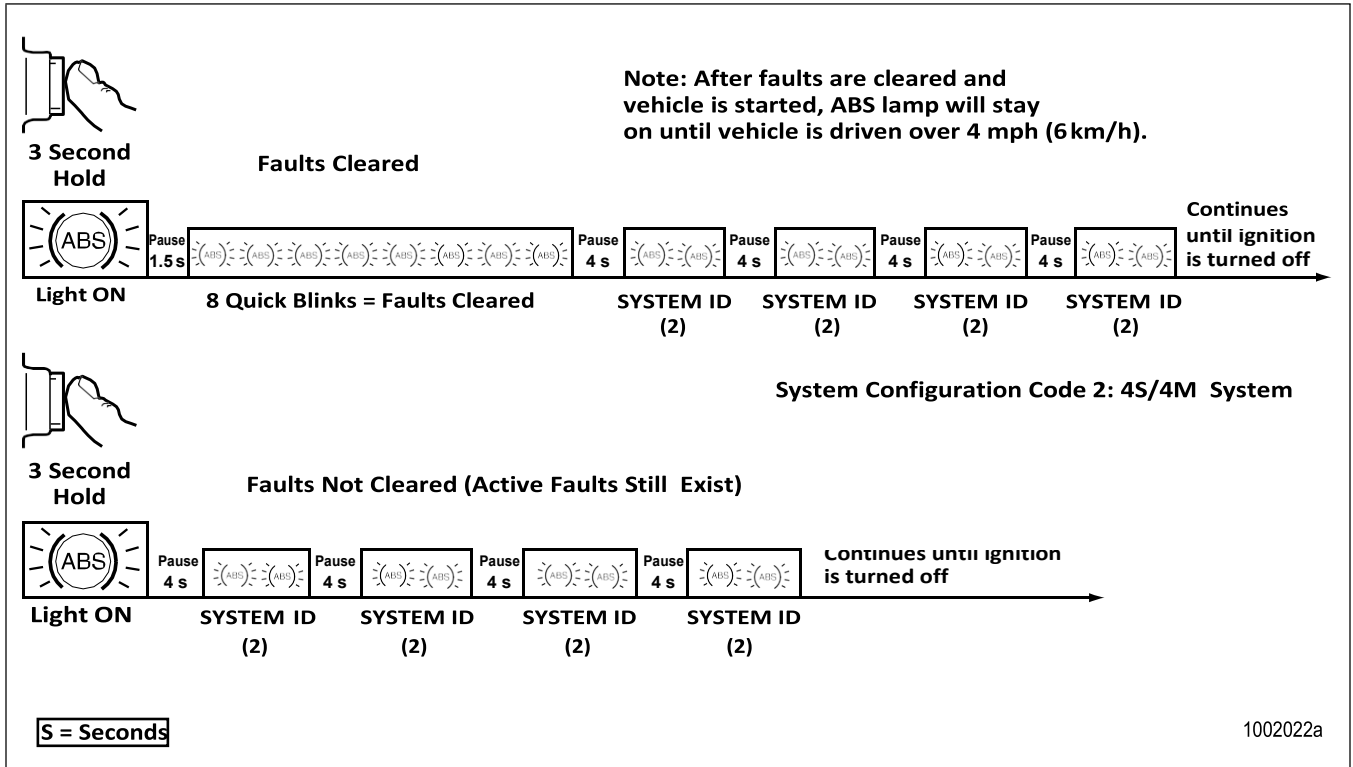


Figure 3.6

3 Diagnostics, Troubleshooting and Testing

Blink Code Conditions

When using blink code diagnostics, the following conditions could occur:

Table D: Blink Code Conditions

Condition	Reason	Action
ABS indicator lamp does not come on at ignition.	Loose or burned-out bulb.	Check bulb. Check connections. Make necessary repairs.
	Voltage not within acceptable range (9.5-14.0 volts) (18-32 for 24V system).	Check connections. Measure voltage. Make necessary repairs.
Can't use blink code diagnostics. ABS indicator lamp will not go off when blink code is activated.	Switch not held for correct length of time: 1 Second—Diagnostics Mode 3 Seconds—Clear All Mode	Repeat procedure, hold switch for correct length of time.
	Incorrect or faulty wiring.	Inspect and repair wiring.
	Fault not erased from ECU after report.	Repeat procedure until System O.K. code received.
Eight flashes not received after blink code switch pressed for at least three seconds, then released.	Active faults still exist.	Identify active faults, then make necessary repairs. Turn ignition OFF, then repeat Blink Code Diagnostics.

Blink Code Identification

Use the following information to identify the blink code:

First Digit (Type of Fault)	Second Digit — Specific Location of Fault
1 No faults	1 No faults
2 ABS modulator valve	1 Right front steer axle (curb side)
3 Too much sensor gap	2 Left front steer axle (driver's side)
4 Sensor short or open	3 Right rear drive axle (curb side)
5 Sensor signal erratic/tire size	4 Left rear drive axle (driver's side)
6 Tooth wheel	5 Right rear/additional axle (curb side)
	6 Left rear/additional axle (driver's side)
7 System function	1 CAN, J1939 or ESC proprietary
	2 ATC valve
	3 Retarder relay (third brake)
	4 ABS indicator lamp
	5 ATC configuration
	6 RSC ESC trailer valve or front axle valve
	7 Brake pressure sensor
	8 Tire pressure monitoring
8 ECU	1 Low power supply
	2 High power supply
	3 Internal fault
	4 System configuration error
	5 Ground
	6 RSC accelerometer/SAE/ESC module

3 Diagnostics, Troubleshooting and Testing

Blink Code Troubleshooting and Repair

Blink Code	Action Required	Reference
2-1, 2-4 2-2, 2-5 2-3, 2-6	Check ABS modulator valve, valve cable and connectors. Verify 4.0-9.0 ohms resistance for 12V ABS modulator valve, 11.0-21.0 ohms resistance for 24V ABS modulator.	Refer to "SID-FMI Troubleshooting and Repair: Modulator Valves" in this section.
3-1, 3-4 3-2, 3-5 3-3, 3-6 3-7	Adjust wheel sensor to touch tooth wheel. Check sensor gap. Check for loose wheel bearings or excessive hub runout. Verify minimum 0.2 volts AC output @ 30 rpm. Check sensor wiring, connectors and sensor.	Refer to "SID-FMI Troubleshooting and Repair: Wheel Speed Sensors" in this section. Refer to "SID-FMI Troubleshooting and Repair: ABS System" in this section.
4-1, 4-4 4-2, 4-5 4-3, 4-6	Check sensor, sensor cable and connectors. Verify 900-2000 ohms resistance.	Refer to "SID-FMI Troubleshooting and Repair: Wheel Speed Sensors" in this section.
5-1, 5-4 5-2, 5-5 5-3, 5-6	Check for tire size mismatch or tooth wheel difference. Check sensor, sensor cable and connector for intermittent contact.	Refer to "SID-FMI Troubleshooting and Repair: Wheel Speed Sensors" and "Tire Size Range" in this section.
6-1, 6-4 6-2, 6-5 6-3, 6-6	Check for damaged tooth wheel.	Refer to "SID-FMI Troubleshooting and Repair: Wheel Speed Sensors" in this section.
7-1*	Check for correct J1939 and ESC (if so equipped) data link connection. Check if fault was caused on dynamometer, see Reference column. Check parameter setting regarding HSA switch and broadcast HSA switch information in EBC 5.	Refer to "SID-FMI Troubleshooting and Repair: J1939 Serial Communications, ESC Module and Steering Angle Sensor" in this section. Refer to "SID-FMI Troubleshooting and Repair: HSA System" in this section.
7-2*	Check ATC valve (also referred to as ABV), valve cables and connectors. Verify 7.0-14.0 ohms resistance (for 12V system), 26.3-49 ohms resistance for 24V system.	Refer to "SID-FMI Troubleshooting and Repair: Active Braking Valves" in this section.
7-3*	Check retarder relay (third brake) connections.	Refer to "SID-FMI Troubleshooting and Repair: Retarder Relay" in this section.
7-6*	Check RSC and Front Axle Active Brake Valves (ABV) and Stability Control Modulator (if so equipped). For ABV, verify 7.0-14.0 ohms resistance for 12V system, 26.3-49 ohms resistance for 24V system. For Stability Control Modulator, verify 4.0-9.0 ohms resistance for 12V system, 11.0-21.0 ohms resistance for 24V system.	Refer to "SID-FMI Troubleshooting and Repair: Active Braking Valves" and "SID-FMI Troubleshooting and Repair: Modulator Valves" in this section.

3 Diagnostics, Troubleshooting and Testing

Blink Code	Action Required	Reference
7-7*	<p>Check Brake Pressure Sensor.</p> <p>Verify sensor is getting 8.0-16.0 volts power and that there is continuity between pressure sensor signal and ground or power.</p> <p>Check Brake Light Switch.</p>	<p>Refer to “SID-FMI Troubleshooting and Repair: Brake Pressure Sensor” in this section.</p> <p>Refer to “SID-FMI Troubleshooting and Repair: Brake Pressure Sensor, Foot Valve Supply Circuit” in this section.</p>
8-1	<p>Check for low voltage.</p> <p>Check vehicle voltage, fuse and supply to ECU (9.0-16.0V for 12V system, 18.0-32.0V for 24V system).</p>	Refer to “SID-FMI Troubleshooting and Repair: Power Supply” in this section.
8-2	<p>Check for high voltage.</p> <p>Check vehicle voltage, fuse and supply to ECU (9.0-16.0V for 12V system, 18.0-32.0V for 24V system).</p>	Refer to “SID-FMI Troubleshooting and Repair: Power Supply” in this section.
8-3	<p>Internal ECU fault.</p> <p>Verify accuracy of blink code.</p>	Contact Meritor WABCO OnTrac.
8-4	<p>Verify all ECU connectors are in place.</p> <p>Verify that correct number of sensors and modulators are connected to the ECU.</p> <p>Contact Meritor WABCO OnTrac to ensure ECU is correct for the application.</p>	Refer to “SID-FMI Troubleshooting and Repair: Internal ABS ECU” in this section.
8-5	Check all ABS, ECU and ABV grounds.	Refer to “SID-FMI Troubleshooting and Repair: Active Braking Valves” and “SID-FMI Troubleshooting and Repair: Power Supply” in this section.
8-6	<p>This blink code is ESC related. Meritor WABCO TOOLBOX™ must be used for system troubleshooting and calibration.</p> <p>Check Steering Angle Sensor and ESC Module calibration, wiring and condition.</p> <p>Contact Meritor WABCO OnTrac to ensure ECU is correct for the application.</p>	Refer to “SID-FMI Troubleshooting and Repair: Steering Angle Sensor” and “SID-FMI Troubleshooting and Repair: ESC Module” in this section.

*If this code continues after all repairs have been made—or if you receive a code for a component that is not installed on the vehicle—it may be necessary to reconfigure the ECU. Refer to the Section 7. TOOLBOX™ Software may also be used to reconfigure the ECU (refer to Section 7). Contact ArvinMeritor’s Customer Service Center at 866-OnTrac1 (668-7221) for additional information or assistance.

Pro-Link→ Plus Diagnostics

NOTE: You must use the Multiple Protocol Cartridge (MPC) and Meritor WABCO applications card, version 2.0 or higher, with E version ECUs. The PLC functions of E version ABS cannot be tested with the Pro-Link→ Plus.

The Pro-Link→ Plus may be used in place of blink code diagnostic procedures.

3 Diagnostics, Troubleshooting and Testing

The Pro-Link[→] Plus screens illustrated appear with E version ECUs. Refer to Maintenance Manual 28, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses, if you are using the Pro-Link[→] Plus with C version ECUs or Maintenance Manual 30, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses, if you are using the

Pro-Link[→] Plus with D version ABS.

Diagnostic Procedure

1. Slide the MPC into the Pro-Link[→] Plus keypad until the connection is tight. Then, insert the Meritor WABCO applications card into the cartridge.
2. Block the wheels, apply the parking brake, and verify that the ignition power is off.
3. Locate the 6-pin diagnostic receptacle in the vehicle cab. Insert the 6-pin connector from the Pro-Link[→] Plus into the receptacle.
4. Turn the ignition to the ON/RUN position. The Pro-Link[→] Plus screen should power up.

If the Pro-Link[→] Plus does not power up, or if the screen indicates NO DATA RECEIVED:

- Check connections.
 - Verify that the cartridge is correctly connected to the Pro-Link[→] Plus keypad.
 - Verify 9.5-14.0 volts (18-32 for 24V systems) DC power and ground at the connector and ABS ECU.
 - Check the fuse panel for a blown fuse.
 - Check for correct wiring in the diagnostic connector.
5. Refer to the Pro-Link[™] Plus manual for complete diagnostic instructions.

The Pro-Link[→] Plus is available from SPX, 800-328-6657.

Pro-Link[→] Plus Screens

This information provides basic screen explanations for the Pro-Link[→] Plus with an MPC and Meritor WABCO application card. For complete operating instructions and test information, refer to the Pro-Link[→] Plus manual.

Fault Information Screens

Existing Faults: Use these screens to identify existing faults. The Pro-Link[→] Plus screen displays a written description of the fault, including the location on the vehicle where each exists. As long as

there is an active (existing) fault in the system, the Pro-Link[→] Plus will not let you clear faults.

Stored Faults: Use these screens to identify faults stored in the ECU memory. Stored faults may be existing faults that have been repaired, or faults that existed for a short time, then corrected themselves. After displaying the stored faults, the Pro-Link[™] Plus lets you erase them from memory. All stored faults are cleared at one time.

Pro-Link[→] Plus Display

Depending upon the ECU being tested, the Pro-Link[→] Plus screen will display certain options or components only when recognized by the ECU. These include:

- ATC, ATC Indicator Lamps, Trailer ABS Indicator Lamp, ATC Valve
- Engine Datalink
- Retarder Relay
- Retarder Datalink

Component Test Screens (Pro-Link[→] Plus)

These screens help you test ABS components. Select this function from the Tractor ABS/ATC menu.

ABS VALVES

ATC

ABS INDICATOR LAMP

ABS TRAILER INDICATOR LAMP

ATC INDICATOR LAMP

ABS/ATC SWITCHES

SENSORS

ENGINE DATALINK

RETARDER RELAY



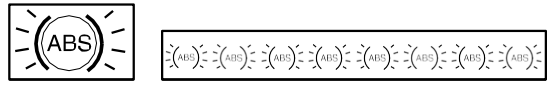
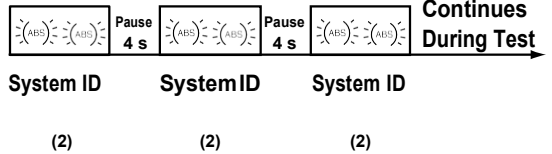
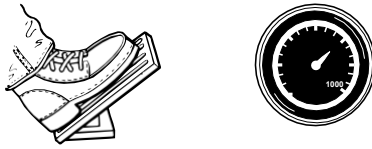
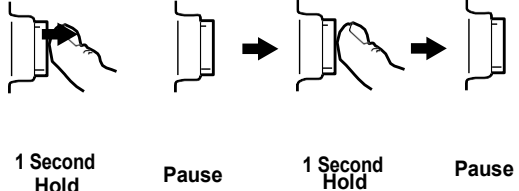

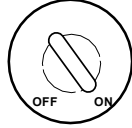
RETARDER DATALINK

VEHICLE VOLTAGES

Select the appropriate function. Each screen has instructions to guide you through the test. Refer to the Pro-Link[→] Plus Manual for complete instructions.

J1939 Datalink Verification — Pro-Link[→] Plus

The Pro-Link[→] Plus diagnostic tool may be used to verify J1939 datalink connection. If you do not have a Pro-Link[→] Plus, you can use the blink code switch to verify this connection.

<p>1. Turn ignition ON. Press blink code switch — hold for three seconds.</p> <p>A. ATC indicator lamp will come on and stay on for the entire test. <i>If the vehicle is not equipped with ATC, the ATC indicator lamp will not come on.</i></p> <p>B. ABS indicator lamp will come on and blink eight times. <i>If the lamp does not blink eight times, there are faults that must be cleared before you continue with this test.</i></p> <p>C. The eight quick flashes will be followed by the system configuration code. A 4S/4M (two blinks) system is identified here. <i>The system configuration code will continue during the entire test.</i></p> <p>2. Activate the J1939 engine torque reduction code, as follows:</p> <p>A. Step on the accelerator. Bring the engine to 1000 rpm. <i>Leave your foot on the accelerator during the entire test.</i></p> <p>B. While the engine is at 1000 rpm, press the blink code switch twice, as follows: Press for one second Release for one second Press for one second Release for one second</p> <p>C. The engine will go to idle for approximately 10 seconds and then return to 1000 rpm.</p> <p>3. Turn ignition OFF. Test complete, engine torque reduction command verified.</p>	<p>1.</p>  <p>A.</p>  <p>B.</p>  <p>8 Quick Blinks = Faults Cleared</p> <p>C.</p>  <p>2.</p> <p>A.</p>  <p>B.</p>  <p>1 Second Hold Pause 1 Second Hold Pause</p> <p>C.</p>  <p>3.</p> 
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3 Diagnostics, Troubleshooting and Testing

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SID-FMI Troubleshooting and Repair

Wheel Speed Sensors

SID	Suspect Component and Location
1	ABS Wheel Speed Sensor, Left Front Steer Axle (Driver's Side)
2	ABS Wheel Speed Sensor, Right Front Steer Axle (Curb Side)
3	ABS Wheel Speed Sensor, Left Rear Second Axle (Driver's Side)
4	ABS Wheel Speed Sensor, Right Rear Second Axle (Curb Side)
5	ABS Wheel Speed Sensor, Left Rear Third Axle (Driver's Side)
6	ABS Wheel Speed Sensor, Right Rear Third Axle (Curb Side)

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
1	Air Gap	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC/ATC Disabled	Sensor air gap is too large, sensor output voltage is too low but is high enough to be read by ECU.	Adjust wheel sensor to touch tooth wheel. Check condition of ABS sensor head. Check for loose wheel bearings or excessive hub runout. Check mounting of ABS tooth wheel and condition of teeth. Check condition and retention of ABS sensor clamping sleeve. Check ABS sensor cable routing and clipping. Turn the wheel and read out amplitudes of sensor signals and compare with required values.
2	Incorrect Tire	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC/ATC Disabled	System has detected a significant difference in the proportion of tire diameter to number of tooth wheel teeth between wheel ends.	Check for tire size mismatch. Check for correct number of ABS tooth wheel teeth. Verify that ECU parameter set is correct for vehicle. Contact Meritor WABCO or OEM.

3 Diagnostics, Troubleshooting and Testing

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
3	Shorted to UBATT	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC/ATC Disabled	Continuity between the sensor leads and battery voltage (short circuit) is detected.	Check sensor, sensor cable and connectors. Verify 900-2000 ohms resistance. Check for continuity between the ABS sensor leads and voltage. Check for corroded or damaged wiring between the ECU and the ABS wheel speed sensor.
4	Shorted to Ground	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC/ATC Disabled	Continuity between the sensor leads and ground (short circuit) is detected.	Check sensor, sensor cable and connectors. Verify 900-2000 ohms resistance. Check for continuity between the ABS sensor leads and ground. Check for corroded or damaged wiring between the ECU and the ABS wheel speed sensor.
5	Open Circuit	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC/ATC Disabled	An open circuit has been detected, i.e. ECU detects a disconnected wheel speed sensor.	Check sensor, sensor cable and connectors. Verify 900-2000 ohms resistance.
6	Short Circuit	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC/ATC Disabled	Continuity between the sensor leads (short circuit) has been detected.	Check sensor, sensor cable and connectors. Verify 900-2000 ohms resistance.
7	Incorrect Pole Wheel	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC/ATC Disabled	Wheel speed signal drops out periodically at speeds higher than 10 kph	Check for damaged tooth wheel or missing teeth.
8	Slip	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC/ATC Disabled	An excessively long wheel slip has been detected.	Adjust wheel sensor to touch tooth wheel. Check sensor gap. Check for loose wheel bearings or excessive hub runout.
9	Wires Mismatched	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC/ATC Disabled	A sensor lead from an incorrect wheel end has been detected.	Check for mismatch fault of another sensor. Correct the harness.

3 Diagnostics, Troubleshooting and Testing

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
10	Speed Drop-Out	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC/ATC Disabled	A temporary loss of the ABS wheel speed signal has been detected.	Adjust wheel speed sensor to touch tooth wheel. Check for loose wheel bearings or excessive hub runout. Check sensor wiring and connectors for intermittent contact. Check condition of ABS sensor head. Check mounting of tooth wheel and condition of teeth. Check condition and retention of ABS sensor clamping sleeve. Check ABS sensor cable routing and clipping. Check for corroded or damaged wiring between the ECU and the ABS wheel speed sensor. Turn the wheel and read out amplitudes of sensor signals and compare with required values.
11	Abnormal Speed (Chatter)	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC/ATC Disabled	Brake drags or chatters. Abnormal vibrations detected which affect sensor signal.	Check sensor wiring and connectors for intermittent contact. Check toothed wheel for damage. Turn the wheel and read out amplitudes of sensor signals and compare with required values.
12	Frequency Too High	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC/ATC Disabled	A non-plausible sensor frequency has been measured.	Check sensor wiring and connectors for intermittent contact. Check if brake at this location is operating correctly, i.e., potentially dragging. Contact Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) if the fault repeats.

ABS Wheel Speed Sensor Testing

Sensor Adjustment

- Push the sensor in until it contacts the tooth wheel.
- Do not pry or push sensors with sharp objects.
- Sensors will self-adjust during wheel rotation.

Electrical Checks

- Take all measurements at the ECU harness connector first to check sensor and harness together. Figure 3.7 and Figure 3.8.
- Measurements should read as below.

Location	Measurement
Between same sensor pins	900-2000 ohm
Sensor leads to voltage or ground	No continuity
Sensor output voltage	At least 0.2 volt AC at 30 rpm

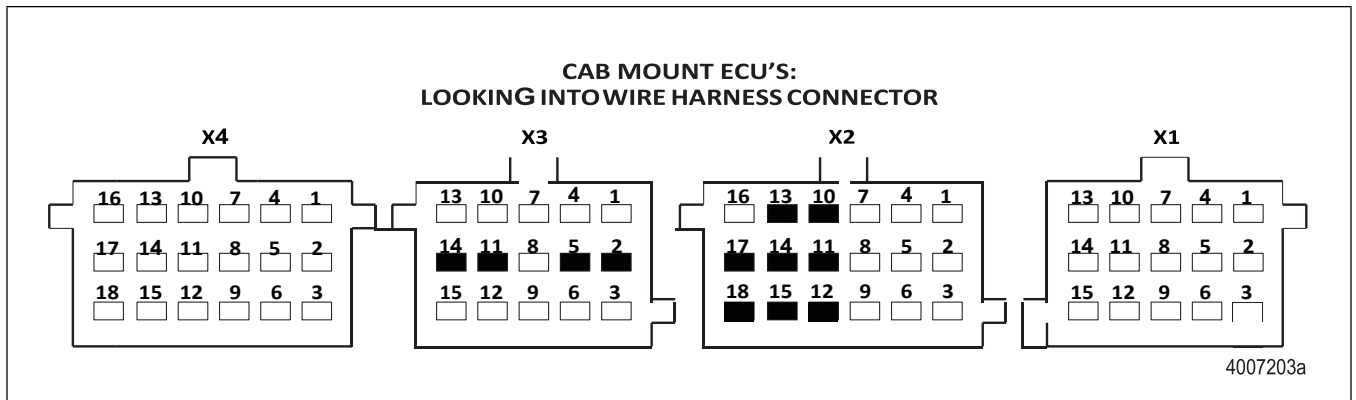


Figure 3.7

3 Diagnostics, Troubleshooting and Testing

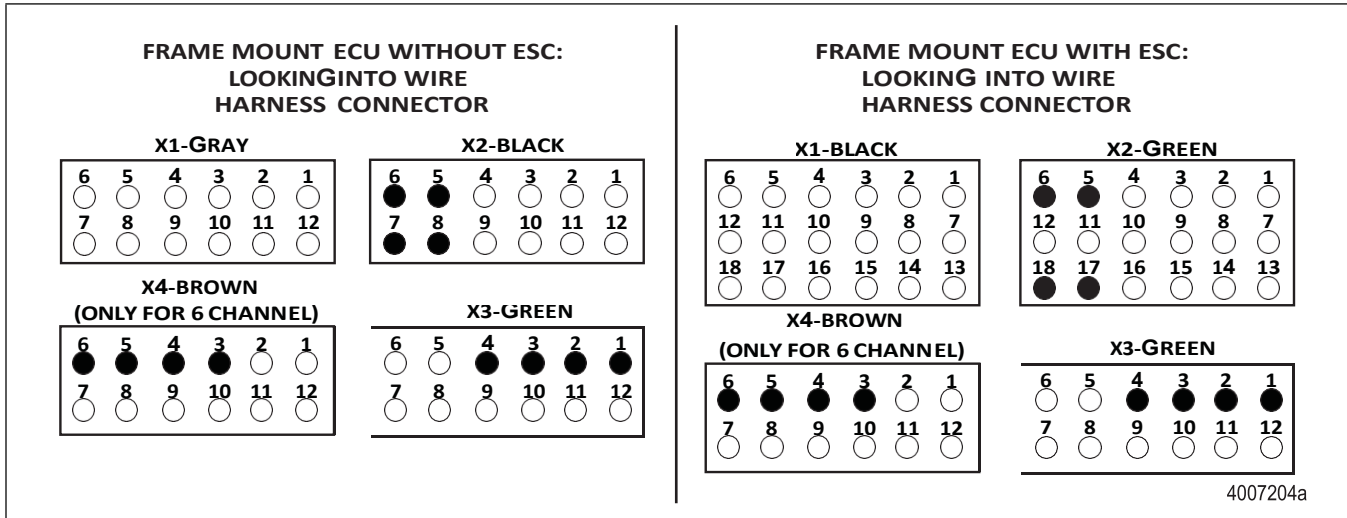


Figure 3.8

ECU	Sensor	Connector	Pins
Cab-Mounted Universal with ESC, Universal or Basic	LF	X2-18 pin	12 and 15
	RF	X2-18 pin	10 and 13
	LR	X2-18 pin	11 and 14
	RR	X2-18 pin	17 and 18
	LR (3rd axle)	X3-15 pin	2 and 5
	RR (3rd axle)	X3-15 pin	11 and 14
Frame-Mounted Non-ESC	LF	X2-Black	7 and 8
	RF	X2-Black	5 and 6
	LR	X3-Green	1 and 2
	RR	X3-Green	3 and 4
	LR (3rd axle)	X4-Brown	3 and 4
	RR (3rd axle)	X4-Brown	5 and 6
Frame-Mounted With ESC	LF	X2-Green	17 and 18
	RF	X2-Green	5 and 6
	LR	X3-Green	1 and 2
	RR	X3-Green	3 and 4
	LR (3rd axle)	X4-Brown	3 and 4
	RR (3rd axle)	X4-Brown	5 and 6

Sensor Testing Available in Meritor WABCO TOOLBOX™ (PC Diagnostics)

In order to compare and test sensor outputs, Meritor WABCO TOOLBOX™ (PC diagnostics) can be used.

Select the wheel speed icon or use the Display drop down menu from the ABS Main screen to display wheel speed data in both numeric and graphical form. This data may be shown in RPM or MPH and in vertical and horizontal graphs. Figure 3.9, Figure 3.10 and Figure 3.11. Select the appearance and style from the Options menu.

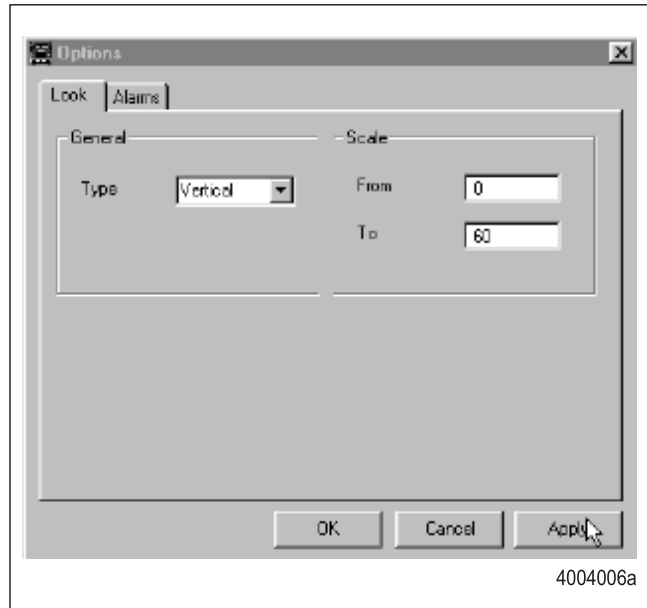


Figure 3.9

3 Diagnostics, Troubleshooting and Testing

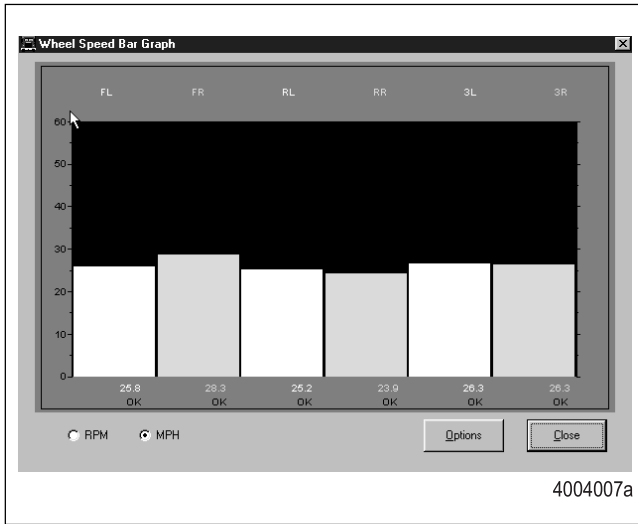


Figure 3.10

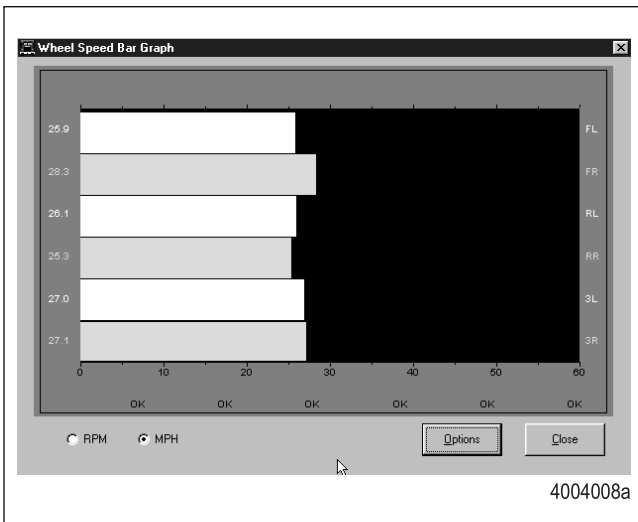


Figure 3.11

3 Diagnostics, Troubleshooting and Testing

Modulator Valves

SID	Suspect Component and Location
7	ABS Modulator, Left Front Steer Axle (Driver's Side)
8	ABS Modulator, Right Front Steer Axle (Curb Side)
9	ABS Modulator, Left Rear Second Axle (Driver's Side)
10	ABS Modulator, Right Rear Second Axle (Curb Side)
11	ABS Modulator, Left Rear Third Axle (Driver's Side)
12	ABS Modulator, Right Rear Third Axle (Curb Side)
19	Stability Control Modulator, Trailer Circuit (Optional)

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
3	Shorted to UBATT	ABS Warning Lamp	ABS Disabled ESC/RSC/ATC Disabled	Continuity between Inlet (IV) or Outlet (OV) and battery supply or another modulator wire (short circuit) is detected.	Verify 4.0-9.0 ohm between IV to common and OV to common for 12V system (11.0-21.0 ohm for 24V system). Check for continuity between Inlet or Outlet and voltage supply or other modulator wires. Check connectors and modulator for corrosion.
5	Open Circuit	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC Disabled	ECU has detected that Inlet (IV), Outlet (OV) or both are not connected.	Verify 4.0-9.0 ohm between IV to common and OV to common for 12V system (11.0-21.0 ohm for 24V system). Check if connectors are fully seated. Check for broken wires or connectors.
6	Shorted to Ground	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC Disabled	Continuity between Inlet (IV) or Outlet (OV) and ground (short circuit) is detected.	Verify 4.0-9.0 ohm between IV to common and OV to common for 12V system (11.0-21.0 ohm for 24V system). Check for continuity between Inlet or Outlet and ground. Check connectors and modulators for corrosion.
7	Shorted to UBATT for SID 19 Only	ABS Warning Lamp	ATC Brake Control Disabled ESC/RSC Disabled	Continuity between Inlet (IV) or Outlet (OV) and battery supply or another modulator wire (short circuit) is detected.	Verify 4.0-9.0 ohm between IV to common and OV to common for 12V system (11.0-21.0 ohm for 24V system). Check for continuity between Inlet or Outlet and voltage supply or other modulator wires. Check connectors and modulators for corrosion.
8	Open Circuit for SID 19 Only	ABS Warning Lamp	ESC/RSC Disabled	ECU has detected that Inlet (IV), Outlet (OV) or both are not connected.	Verify 4.0-9.0 ohm between IV to common and OV to common for 12V system (11.0-21.0 ohm for 24V system). Check if connectors are fully seated. Check for broken wires or connectors.

3 Diagnostics, Troubleshooting and Testing

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
9	Short to Ground for SID 19 Only	ABS Warning Lamp	ESC/RSC Disabled	Continuity between Inlet (IV) or Outlet (OV) and ground (short circuit) is detected.	Verify 4.0-9.0 ohm between IV to common and OV to common for 12V system (11.0-21.0 ohm for 24V system). Check for continuity between Inlet or Outlet and ground. Check connectors and modulators for corrosion.

Modulator Valve Testing

Electrical Checks

- Take measurements at the ECU harness to check the modulator and harness together. Figure 3.14 and Figure 3.15.
- Take measurements at the modulator pins directly to verify the component. Figure 3.12 and Figure 3.13.
- Measurements should read as below. If resistance exceeds 9.0 ohm for 12V system (21.0 ohm for 24V system), clean the electrical contacts at the modulator and retest.

Location	Measurement
IV to Common	4.0-9.0 ohm for 12V system 11.0-21.0 ohm for 24V system
OV to Common	4.0-9.0 ohm for 12V system 11.0-21.0 ohm for 24V system
IV or OV to Voltage Supply or Ground	No continuity

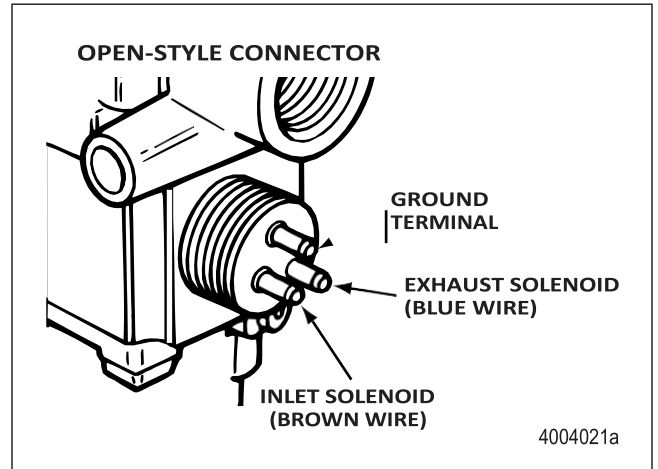


Figure 3.13

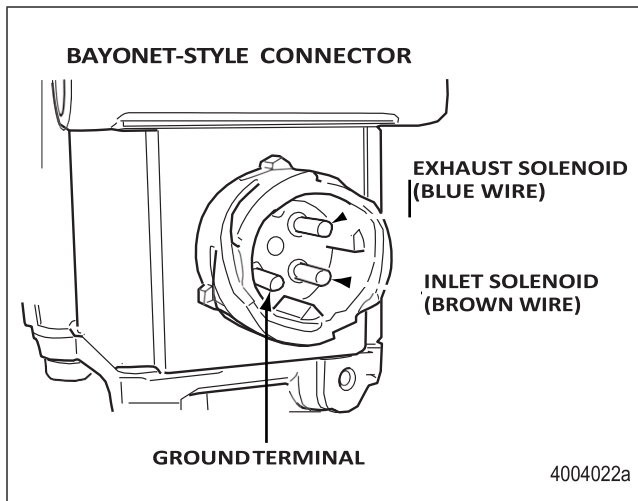


Figure 3.12

3 Diagnostics, Troubleshooting and Testing

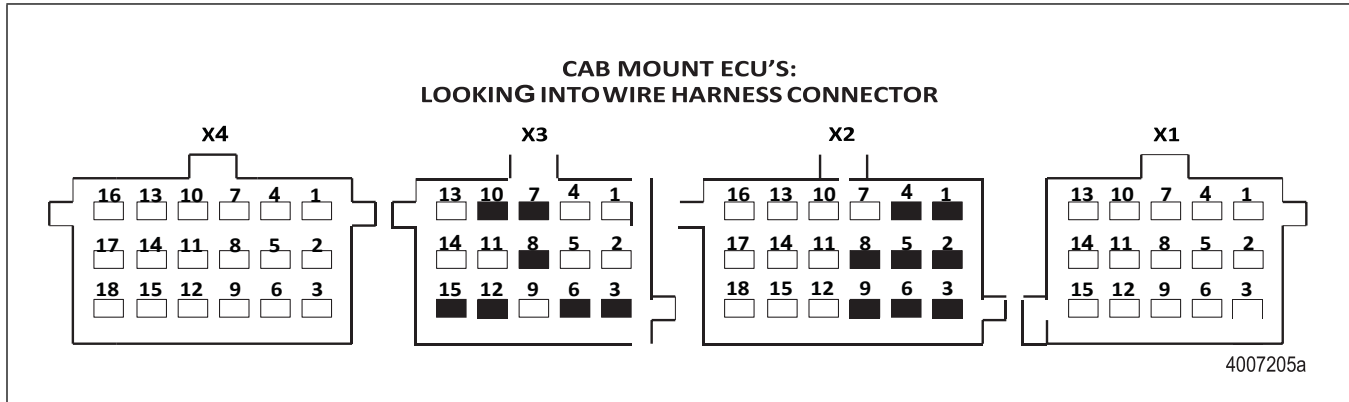


Figure 3.14

ECU	Modulator Circuit	Connector	Pins
Cab-Mounted	LF IV	X2-18 pin	3
Universal with ESC, Universal or Basic (ABS modulators are grounded externally, i.e., common is fed to external ground)	LF OV	X2-18 pin	6
	RF IV	X2-18 pin	1
	RF OV	X2-18 pin	4
	LR IV	X2-18 pin	2
	LR OV	X2-18 pin	5
	RR IV	X2-18 pin	8
	RR OV	X2-18 pin	9
	LR (3rd Axle) IV	X3-15 pin	3
	LR (3rd Axle) OV	X3-15 pin	6
	RR (3rd Axle) IV	X3-15 pin	12
RR (3rd Axle) OV	X3-15 pin	15	
Optional with Stability Control	Trailer IV	X3-15 pin	7
	Trailer OV	X3-15 pin	10
	Trailer Common	X3-15 pin	8

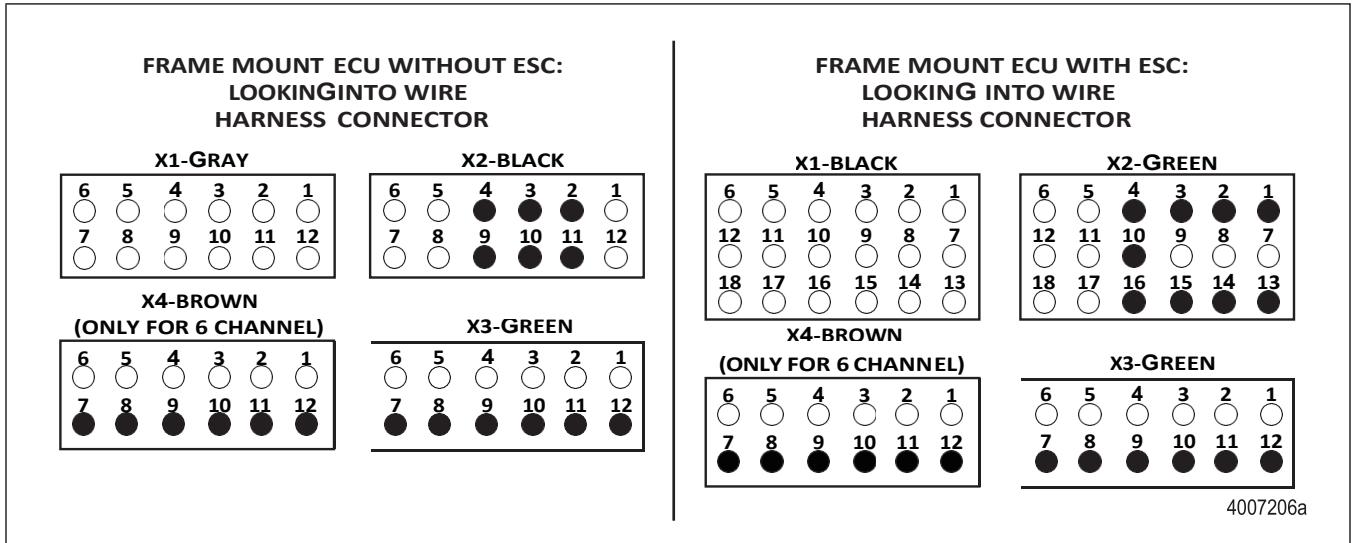


Figure 3.15

ECU	Modulator Circuit	Connector	Pins
Frame-Mounted	LF IV	X2-Black	2
Non-ESC	LF OV	X2-Black	10
	LF Common	X2-Black	11
	RF IV	X2-Black	4
	RF OV	X2-Black	3
	RF Common	X2-Black	9
	LR IV	X3-Green	12
	LR OV	X3-Green	10
	LR Common	X3-Green	11
	RR IV	X3-Green	9
	RR OV	X3-Green	7
	RR Common	X3-Green	8
	LR (3rd Axle) IV	X4-Brown	12
	LR (3rd Axle) OV	X4-Brown	10
	LR (3rd Axle) Common	X4-Brown	11
	RR (3rd Axle) IV	X4-Brown	9
	RR (3rd Axle) OV	X4-Brown	7
RR (3rd Axle) Common	X4-Brown	8	

ECU	Modulator Circuit	Connector	Pins
Frame-Mounted	LF IV	X2-Green	2
With ESC	LF OV	X2-Green	15
	LF Common	X2-Green	14
	RF IV	X2-Green	4
	RF OV	X2-Green	3
	RF Common	X2-Green	16
	LR IV	X3-Green	12
	LR OV	X3-Green	10
	LR Common	X3-Green	11
	RR IV	X3-Green	9
	RR OV	X3-Green	7
	RR Common	X3-Green	8
	LR (3rd Axle) IV	X4-Brown	12
	LR (3rd Axle) OV	X4-Brown	10
	LR (3rd Axle) Common	X4-Brown	11
	RR (3rd Axle) IV	X4-Brown	9
	RR (3rd Axle) OV	X4-Brown	7
RR (3rd Axle) Common	X4-Brown	8	

3 Diagnostics, Troubleshooting and Testing

ECU	Modulator Circuit	Connector	Pins
Optional with Stability Control	Trailer IV	X2-Green	1
	Trailer OV	X2-Green	10
	Trailer Common	X2-Green	13

Modulator Valve Testing Available in Meritor WABCO TOOLBOX™ (PC Diagnostics)

The ABS and ESC modulator valves can be cycled using Meritor WABCO TOOLBOX™.

To cycle the modulator valves, choose the option “Valves” from the “Component Tests” drop down menu. Figure 3.16.

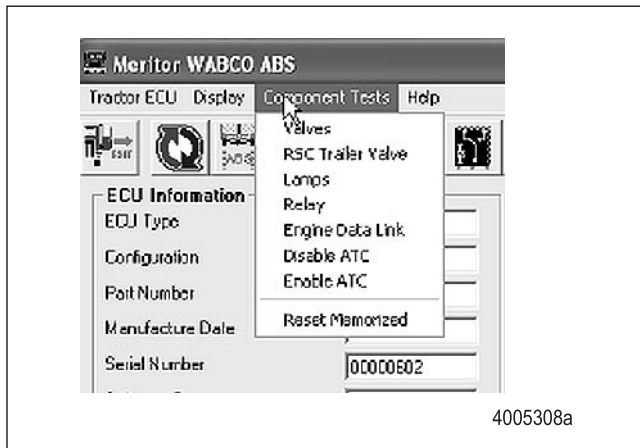


Figure 3.16

The screen in the following figure appears where you can choose to cycle each valve individually or you can choose to cycle all valves in a pre-determined order. Figure 3.17. Then, listen to ensure the correct valve is cycling. This is helpful in verifying correct operation, installation and wiring.

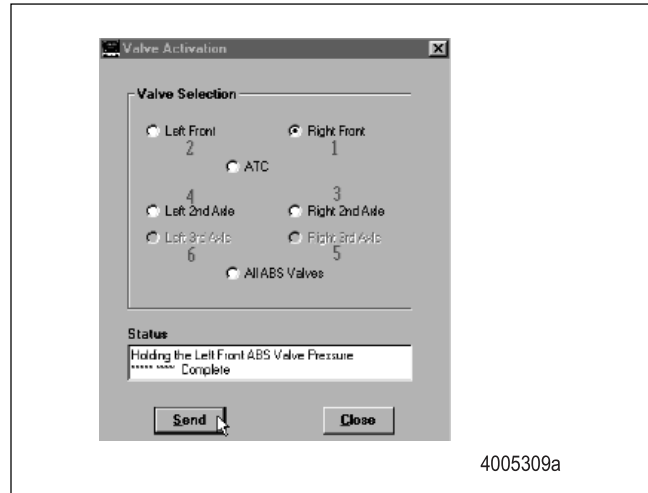


Figure 3.17

In order to test the function of the ESC modulator for the trailer circuit, choose “E4.3 TBV with ABS Valve” from the “Component Tests” drop down menu. Listen to ensure the correct valve is cycling.

Active Braking Valves (ABV)

ABV refers to 3/2 solenoid valves used for active braking during ATC, RSC or ESC.

SID	Suspect Component and Location
15	Active Braking Valve Common (Ground Circuit), Drive Axle, Steer Axle or Trailer Circuit
18	Active Braking Valve Supply, Drive Axle
19	Active Braking Valve Supply, Steer Axle or Trailer Circuit

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
1	Shorted to UBATT for SID 19 Only Specifically for Front Axle ABV	ABS Warning Lamp	ATC Brake Control Disabled ESC/RSC Disabled	Continuity between suspect Active Braking Valve circuit and voltage supply (short circuit) is detected.	Verify 7.0-14.0 ohm between ABV supply and ABV common for 12V system (26.3-49.0 ohm for 24V system). Check for continuity between suspect Active Braking Valve common circuits and voltage supply. Check connectors and modulator for corrosion.
2	Open Circuit for SID 19 Only Specifically for Front Axle ABV	ABS Warning Lamp	ESC/RSC Disabled	ECU has detected that the suspect Active Braking Valve circuit is not detected.	Verify 7.0-14.0 ohm between ABV supply and ABV common for 12V system (26.3-49.0 ohm for 24V system). Check if connectors are fully seated. Check for broken wires or connectors.
3	Shorted to UBATT	ABS Warning Lamp	ABS Disabled (for SID 15 Only) ESC/RSC/ATC Disabled	Continuity between suspect Active Braking Valve circuit and voltage supply (short circuit) is detected.	Verify 7.0-14.0 ohm between ABV supply and ABV common for 12V system (26.3-49.0 ohm for 24V system). Check for continuity between suspect Active Braking Valve common circuits and voltage supply. Check connectors and modulator for corrosion.
4	Short to Ground for SID 19 Only Specifically for Front Axle ABV	ABS Warning Lamp	ESC/RSC Disabled	Continuity between suspect Active Braking Valve circuit and ground is detected.	Verify 7.0-14.0 ohm between ABV supply and ABV common for 12V system (26.3-49.0 ohm for 24V system). Check for continuity between suspect Active Braking Valve circuit and ground. Check connectors and modulator for corrosion.

3 Diagnostics, Troubleshooting and Testing

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
5	High Impedance for SID 15 Open Circuit for SID 18 and 19 (Trailer Circuit Specifically if SID 19)	ABS Warning Lamp	ESC/RSC/ATC Disabled	ECU has detected that the suspect Active Braking Valve circuit is not detected or the circuit has been interrupted.	Verify 7.0-14.0 ohm between ABV supply and ABV common for 12V system (26.3-49.0 ohm for 24V system). Check if connectors are fully seated. Check for broken wires or connectors. If SID 15 FMI 5 repeats after wiring checked and/or repaired, replace ECU.
6	Short to Ground	ABS Warning Lamp	ATC Disabled for SID 15 and 18 ESC/RSC Disabled	Continuity between suspect Active Braking Valve circuit and ground is detected.	Verify 7.0-14.0 ohm between ABV supply and ABV common for 12V system (26.3-49.0 ohm for 24V system). Check for continuity between suspect Active Braking Valve circuit and ground. Check connectors and modulator for corrosion.

Active Braking Valve (ABV) Testing

Electrical Checks

- Take measurements at the ECU harness to check the ABV and harness together. Figure 3.19 and Figure 3.20.
- Take measurements at the ABV pins directly to verify the component. Figure 3.18.
- Measurements should read as below. If resistance exceeds 14.0 ohm for 12V system (49.0 ohm for 24V system), clean the electrical contacts at the solenoid and retest.

Location	Measurement
ABV Supply to ABV Common	7.0-14.0 ohm for 12V system 26.3-49.0 ohm for 24V system
ABV Supply or ABV Common to Voltage Supply or Ground	No continuity

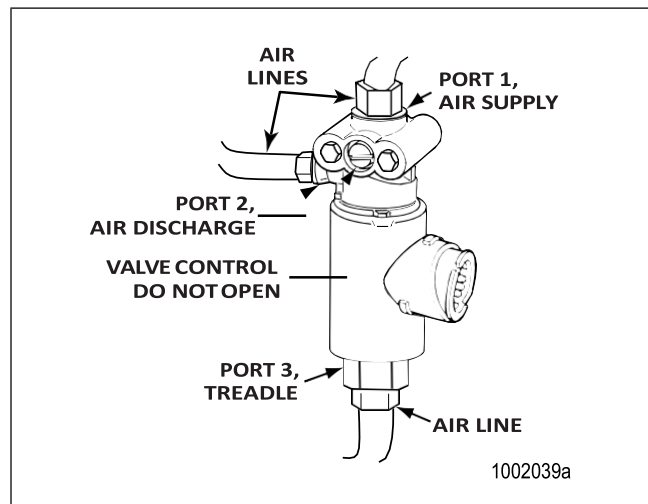


Figure 3.18

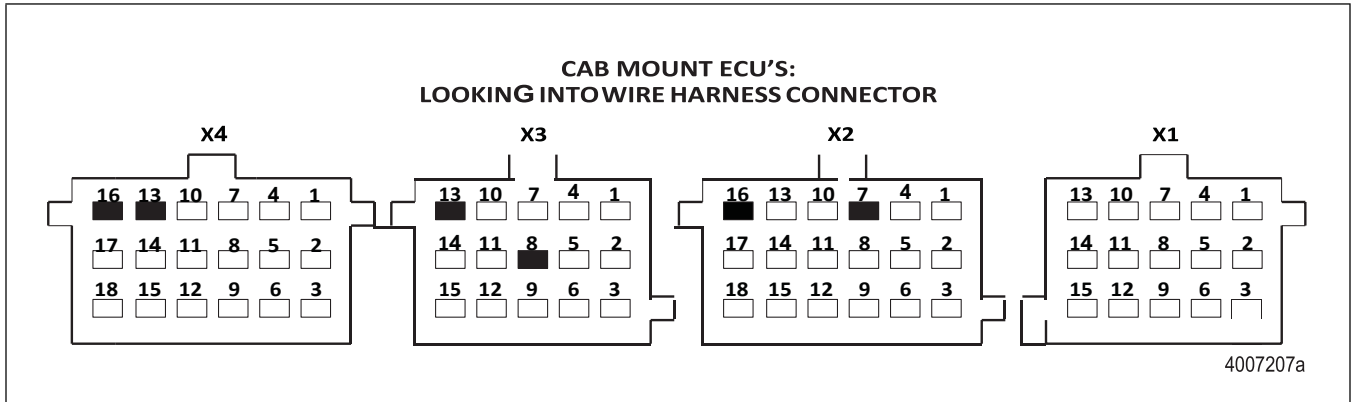


Figure 3.19

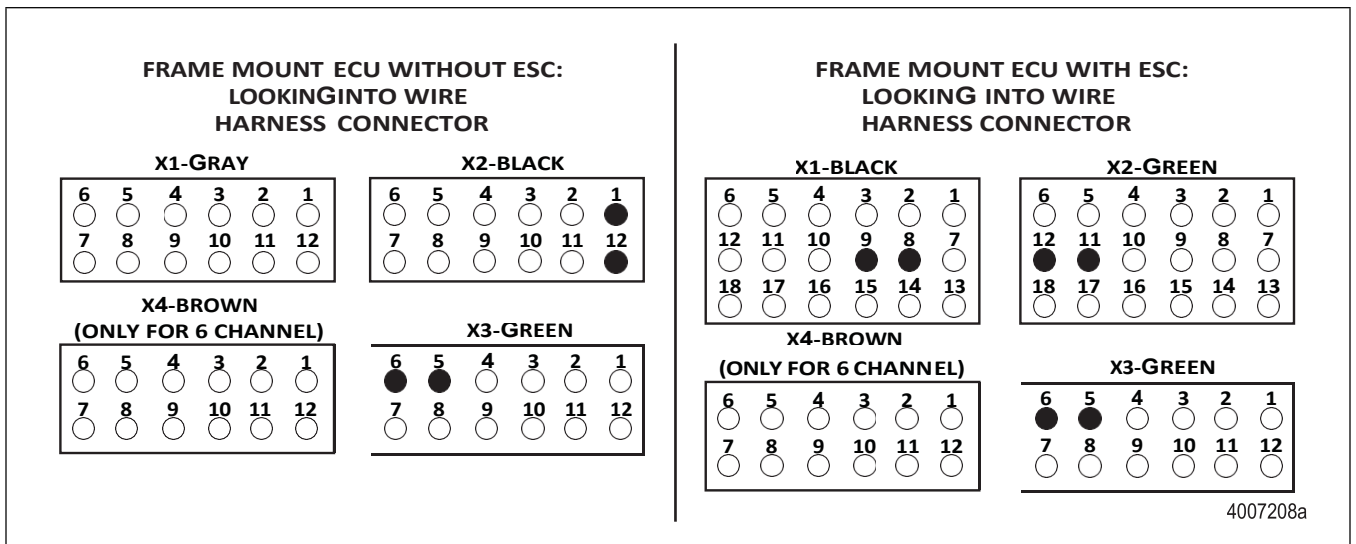


Figure 3.20

ECU	Active Braking Valve Circuit	Connector	Pins
Cab-Mounted Universal with ESC, Universal or Basic	Drive Axle ABV Supply	X2-18 pin	16
	Drive Axle ABV Common	X2-18 pin	7
	Steer Axle ABV Supply	X4-18 pin	16
	Steer Axle ABV Common	X4-18 pin	13
	Trailer ABV Supply	X3-15 pin	13
	Trailer ABV Common	X3-15 pin	8

ECU	Active Braking Valve Circuit	Connector	Pins
Frame-Mounted Non-ESC	Drive Axle ABV Supply	X3-Green	5
	Drive Axle ABV Common	X3-Green	6
	Trailer ABV Supply	X2-Black	1
	Trailer ABV Common	X2-Black	12

3 Diagnostics, Troubleshooting and Testing

ECU	Active Braking Valve Circuit	Connector	Pins
Frame-Mounted With ESC	Drive Axle ABV Supply	X3-Green	5
	Drive Axle ABV Common	X3-Green	6
	Steer Axle ABV Supply	X2-Green	12
	Steer Axle ABV Common	X2-Green	11
	Trailer ABV Supply	X1-Black	9
	Trailer ABV Common	X1-Black	8

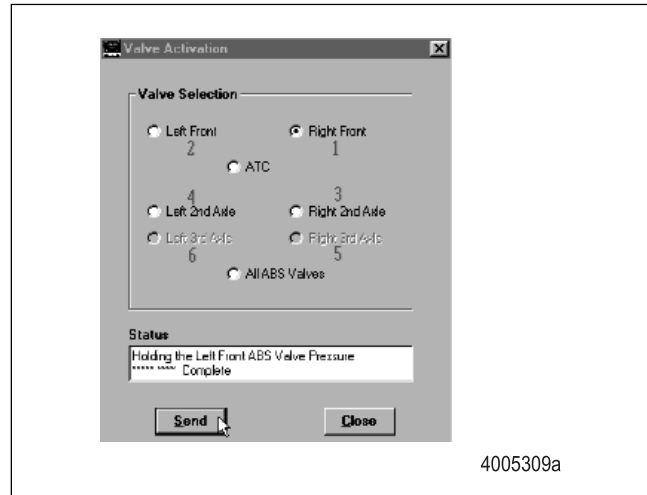


Figure 3.22

ABV Testing Available in Meritor WABCO TOOLBOX™ (PC Diagnostics)

The Active Braking Valves can be cycled using Meritor WABCO TOOLBOX™.

To cycle the ABVs, choose the option “Valves” from the “Component Tests” drop down menu. Figure 3.21.

In order to test the function of the ABV used for Stability Control pressure application to the trailer circuit, choose either “Trailer Brake Valve,” “E4.3 Trailer Brake Valve” or “E4.3 TBV with ABS Valve” (depending on your vehicle configuration) from the “Component Tests” drop down menu. Listen to ensure the correct valve is cycling. If you are unsure which test option to choose, please contact Meritor WABCO OnTrac and have your ECU part number available.

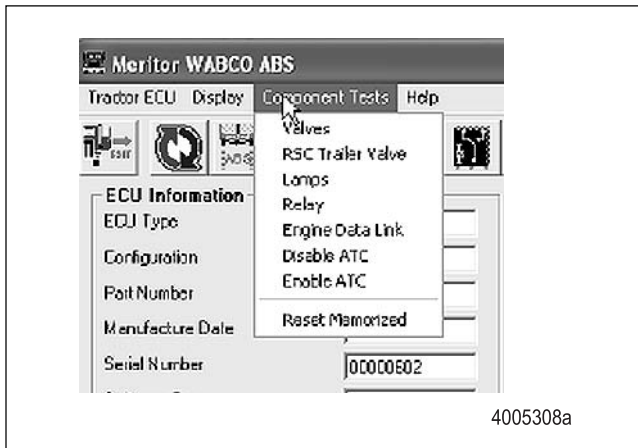


Figure 3.21

The screen in the following figure appears where you can choose to cycle each valve individually. Figure 3.22. Then, listen to ensure the correct valve is cycling. This is helpful in verifying correct operation, installation and wiring.

Power Supply

SID	Suspect Component and Location
14	Supply Voltage, Battery (Could be IGN on Non-ESC Frame ECU)
15	Supply Voltage, Ignition
251	Internal Overvoltage

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
3	Overvoltage for SID 251 Only	ABS Warning Lamp	ABS Disabled ESC/RSC/ATC Disabled	A supply voltage which is too high has been measured by the ECU for more than 5 seconds.	Measure the battery voltage under load. Check the vehicle battery and associated components (alternator). Check the battery and ensure it is correct for the ECU, i.e., ensure a 24V battery is not being used with a 12V ECU. Check for damaged or corroded wiring or connectors.
4	Supply Voltage is too Low for SID 14 or 15 Only	ABS Warning Lamp (while supply voltage is detected as too low)	ABS Disabled ESC/RSC/ATC Disabled	The supply voltage is temporarily too low.	Measure the battery or ignition voltage under load. Check the vehicle battery and associated components (alternator). Check for damaged or corroded wiring or connectors. Check condition of fuses.
5	ECU Central Ground Open Circuit	ABS Warning Lamp	ESC/RSC/ATC Disabled	The ECUs connection to central ground has been interrupted or the resistance measured is too high.	Check for damaged or corroded wiring or connectors.
7	Supply Voltage, Ignition Internal Relay (SID 15 Only)	ABS Warning Lamp	ESC/RSC/ATC Disabled	The internal relay does not open the power line.	Change ECU if fault detection repeats.

Power Supply Testing

Electrical Checks

- Take measurements at the ECU harness. Figure 3.23 and Figure 3.24.
- Measurements should read as below.

Location	Measurement
Supply Voltage, Battery to Ground	9.0-16.0V for 12V system 18.0-32.0V for 24V system
Supply Voltage, Ignition to Ground	9.0-16.0V for 12V system 18.0-32.0V for 24V system

3 Diagnostics, Troubleshooting and Testing

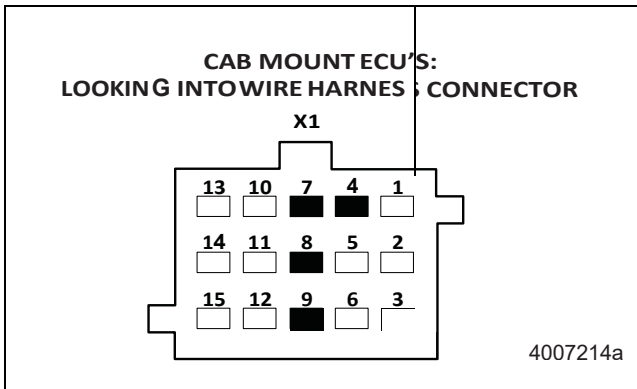


Figure 3.23

ECU	Power Supply Circuit	Connector	Pins
Frame-Mounted With ESC	Supply Voltage, Battery	X1-Black	1
	Supply Voltage, Ignition	X1-Black	2
	Central Ground	X1-Black	13, 14

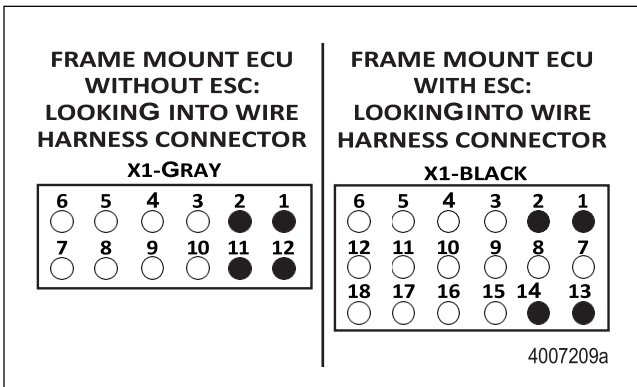


Figure 3.24

ECU	Power Supply Circuit	Connector	Pins
Cab-Mounted Universal with ESC, Universal or Basic	Supply Voltage, Battery	X1-15 pin	8
	Supply Voltage, Ignition	X1-15 pin	7
	Central Ground	X1-15 pin	4, 9
Frame-Mounted Non-ESC	Supply Voltage, Battery (Could be IGN)	X1-Gray	1
	Supply Voltage, Ignition	X1-Gray	2
	Central Ground	X1-Gray	11, 12

Brake Pressure Sensor

SID	Suspect Component and Location
15 or 55	Brake Pressure Sensor, Foot Valve Supply Circuit (could be located in primary or secondary depending on application)

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
3	Shorted to UBATT	ABS Warning Lamp	ESC/RSC Disabled	Continuity between pressure signal circuit and voltage supply (short circuit) is detected.	Check for continuity between pressure sensor signal circuit and voltage supply. Check connectors and pressure sensor for corrosion.
5	Open or Shorted to Ground	ABS Warning Lamp	ESC/RSC Disabled	Continuity between pressure signal circuit and voltage supply (short circuit) or an open circuit is detected.	Check if connectors are fully seated. Check for continuity between pressure sensor signal circuit and ground. Check connectors and pressure sensor for corrosion. Call Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) with part number to ensure ECU is correct for the application.

Brake Pressure Sensor Testing

Electrical Checks

- Take measurements at the pressure sensor harness connector. Figure 3.25, Figure 3.26 and Figure 3.28.
- Measurements should read asbelow.

Location	Measurement
Power Supply to Ground	8.0-16.0V
Pressure Signal to Ground or Power Supply	No continuity

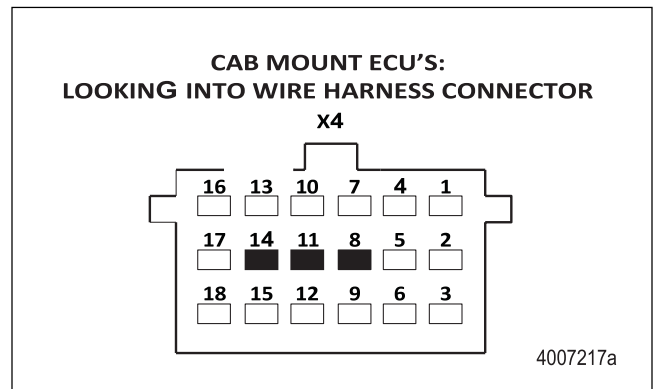


Figure 3.25

3 Diagnostics, Troubleshooting and Testing

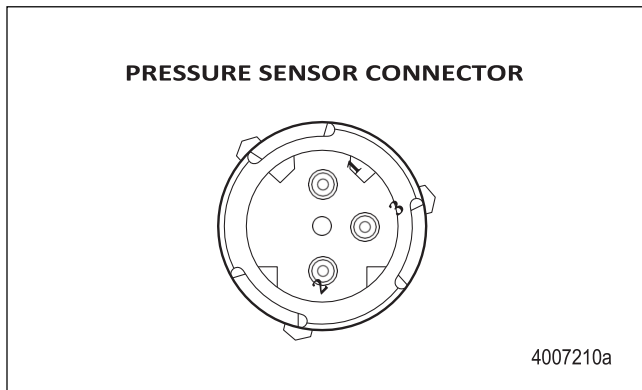


Figure 3.26

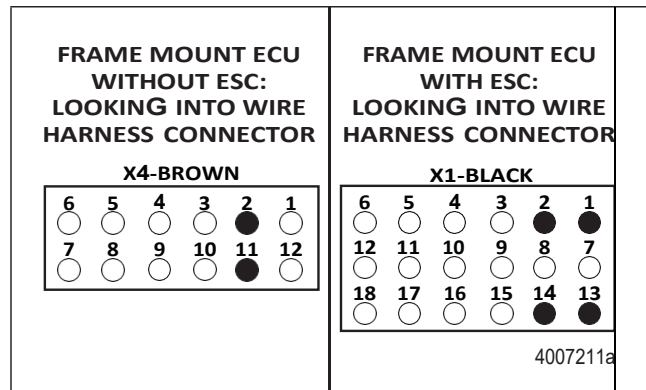


Figure 3.28

Pin	Circuit
1	Power Supply
2	Ground
3	Pressure Signal

Pressure sensor test is available in Meritor WABCO TOOLBOX™ (PC Diagnostics).

Pressure sensor test can be accessed through TOOLBOX™ under Component Tests, Pressure Sensor Test.

- Click Start test and ensure brake pedal position pressure is displayed in the corresponding boxes. Figure 3.27.

ECU	Pressure Sensor Circuit	Connector	Pins
Cab-Mounted	Power Supply	X4-18 pin	8
Universal with ESC or Universal without ESC	Ground	X4-18 pin	11
	Pressure Signal	X4-18 pin	14
Frame-Mounted Non-ESC	Ground	X4-Brown	2
	Pressure Signal	X4-Brown	11
Frame-Mounted With ESC	Ground	X1-Black	10
	Pressure Signal	X1-Black	11

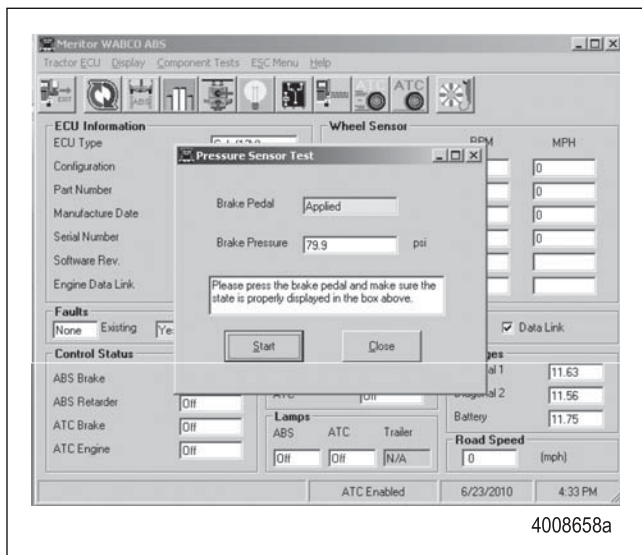


Figure 3.27

3 Diagnostics, Troubleshooting and Testing

ESC Module

SID	Suspect Component and Location
88	ESC Module, Near Fore/Aft Center of Gravity of Vehicle

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
1	ESC Initialization Not Complete	ATC Lamp Blinking	ESC Disabled	The ESC initialization is not complete.	Follow the ESC Initialization (End of Line) Process. Refer to Section 8.
2	ESC System Configuration	ATC Lamp	ESC Disabled	The ESC module is not compatible with the ABS ECU.	Contact Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) or vehicle OEM to check ESC module/ABS ECU combination.
5	ESC CAN Datalink Fault	ATC Lamp	ESC Disabled	Loss of CAN communication between the ESC module and the ABS ECU.	Verify correct wiring, CAN communication and power supply, between the ESC module and the ABS ECU.
9	ESC CAN Datalink	ATC Lamp	ESC Disabled	Data communication between the ESC module and the ABS ECU is missing or incorrect.	Verify correct wiring, CAN communication and power supply, between the ESC module and the ABS ECU. Contact Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) to check parameter setting of ABS ECU and ESC module compatibility.
12	ESC Module Failure	ATC Lamp	ESC Disabled	Yawrate is missing or implausible based on system configuration.	Check mounting of ESC module. Contact Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) to ensure ESC module mounting is in accordance with ABS ECU parameters. Verify correct wiring, CAN communication and power supply, between the ESC module and the ABS ECU.
13	ESC Initialization is Required	ATC Lamp	ESC Disabled	The system has detected that the ABS ECU, ESC module or parameters were exchanged and ESC initialization is required.	Follow the ESC Initialization (End of Line) Process. Refer to Section 8.
14	ESC Module Mounting Fault	ATC Lamp	ESC Disabled	The ESC module mounting is not in accordance with specification.	Check mounting of ESC module. Contact Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) to ensure ESC module mounting is in accordance with ABS ECU parameters. Verify correct wiring, CAN communication and power supply, between the ESC module and the ABS ECU.

3 Diagnostics, Troubleshooting and Testing

SID	Suspect Component and Location
19	SAS and ESC Module Power Supply

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
12	Shorted to Ground	ABS Warning Lamp	ESC/RSC Disabled	Continuity between the power supply circuit for the ESC module/SAS and ground has been detected.	Check for continuity between the ESC component power supply and ground. Check connectors for corrosion or damage.

ESC Module Testing

Electrical Checks

- Take measurements at the ESC module harness connector. Figure 3.29 and Figure 3.30.
- Measurements should read as below.

Location	Measurement
Power Supply to Ground	8.0-16.0V
ESC CAN-High to ESC CAN-Low	Approximately 90 ohm
ESC CAN-High or CAN-LOW to Power or Ground	No continuity

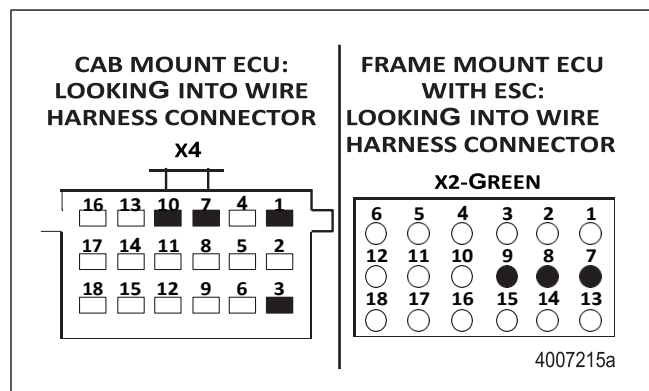


Figure 3.30

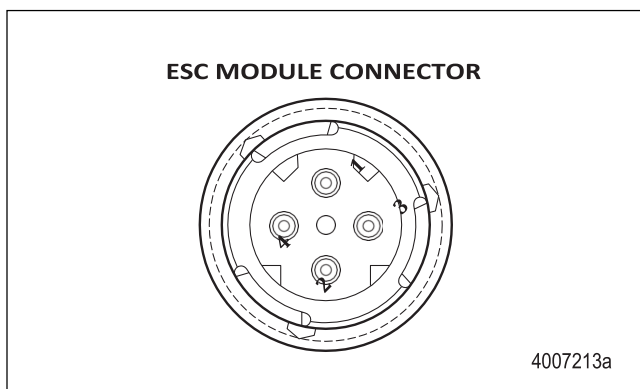


Figure 3.29

ECU	ESC Module Circuit	Connector	Pins
Cab-Mounted Universal with ESC	Power Supply	X4-18 pin	7
	Ground	X4-18 pin	10
	ESC CAN-Low	X4-18 pin	1
	ESC CAN-High	X4-18 pin	3
Frame-Mounted With ESC	Power Supply	X2-Green	9
	Ground	X2-Green	External
	ESC CAN-Low	X2-Green	7
	ESC CAN-High	X2-Green	8

Pin	Circuit
1	Power Supply
2	Ground
3	CAN-High
4	CAN-Low

Additional Checks

- The ESC module contains sensors which measure both lateral acceleration and yaw rate. Thus, it is critical that the module is firmly mounted to the vehicle and that the module is mounted as expected by the ABS ECU.

3 Diagnostics, Troubleshooting and Testing

- The module must be mounted in a manner where the WABCO name on the unit is right-side up. Figure 3.31. The module will always be mounted perpendicular to the frame rails of the vehicle and the connector of the module could be facing the front or rear of the vehicle depending on the OEM's specified mounting. It is critical that the unit be mounted in the exact location and manner as originally installed by the vehicle manufacturer.

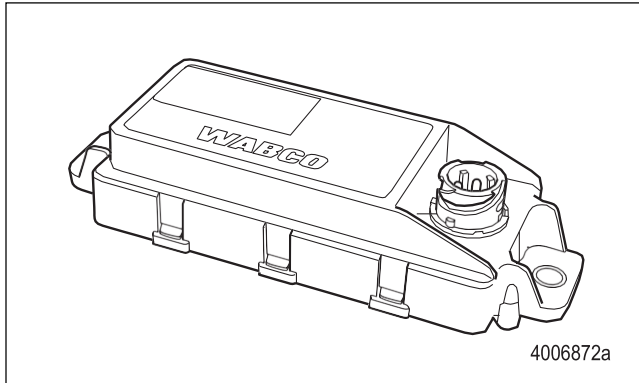


Figure 3.31

3 Diagnostics, Troubleshooting and Testing

Steering Angle Sensor (SAS)

SID	Suspect Component and Location
89	Steering Angle Sensor (SAS), interfaced to steering shaft

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
1	SAS Offset Fault	ATC Lamp	ESC Disabled	The Steering Angle Sensor offset is out of tolerance.	Check installation of the SAS. If work has been performed on the vehicle which affects the steering system or front end alignment, perform SAS Calibration and ESC Initialization. Refer to Section 8.
2	SAS not Plausible	ATC Lamp	ESC Disabled	The ESC module has detected an implausible steering angle compared to the measured yaw rate.	Check mounting of the SAS and ESC module. Contact Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) to ensure that the ECU parameter setting is correct for the vehicle.
7	Steering Ratio Fault	ATC Lamp	ESC Disabled	The calculated steering ratio of the vehicle is not plausible.	Check mounting of the SAS and ESC module. Contact Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) to ensure that the ECU parameter setting is correct for the vehicle. Repeat ESC initialization procedure.
8	SAS Calibration Fault	ATC Lamp	ESC Disabled	The Steering Angle Sensor calibration failed.	Re-perform the SAS calibration process. If the fault persists, replace the SAS.
9	SAS Datalink Fault	ATC Lamp	ESC Disabled	Data communication between the SAS and ABS ECU is missing or incorrect.	Verify correct wiring, CAN communication and power supply, between the SAS and the ABS ECU. Contact Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) to check the parameter setting of ABS ECU and SAS compatibility.
12	SAS Failure	ATC Lamp	ESC Disabled	The Steering Angle Sensor is communicating an internal error to the ABS ECU.	Verify correct wiring, CAN communication and power supply, between the SAS and the ABS ECU. Contact Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) to check the parameter setting of ABS ECU and SAS compatibility.
13	SAS not Calibrated	ATC Lamp	ESC Disabled	The ECU has detected that a new SAS has been installed.	Follow the SAS calibration procedure. Refer to Section 8.
14	SAS Internal Fault	ATC Lamp	ESC Disabled	The Steering Angle Sensor is communicating an internal error to the ABS ECU.	Check the installation and condition of the SAS and steering system.

3 Diagnostics, Troubleshooting and Testing

SID	Suspect Component and Location
19	SAS and ESC Module Power Supply

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
10	Shorted to Plus	ABS Warning Lamp	N.A.	Short circuit to battery supply.	Check and correct wire.
11	Open Circuit	ABS Warning Lamp	N.A.	Open circuit.	Check and correct wire.
12	Shorted to Ground	ABS Warning Lamp	ESC/RSC Disabled	Continuity between the power supply circuit for the ESC module/SAS and ground has been detected.	Check for continuity between the ESC component power supply and ground. Check connectors for corrosion or damage.

Steering Angle Sensor (SAS) Testing

Electrical Checks

- Take measurements at the SAS harness connector. Pins 3 and 4 of the Steering Angle Sensor are internally connected to each other. In the harness which mates to the SAS, one of these two circuits will have a jumper to pin 2 of the SAS. This jumper must be present for correct sensor operation. The other CAN-High circuit which is not jumped to pin 2 of the SAS will be connected to the ECU at the pins specified below. Figure 3.32, Figure 3.33 and Figure 3.34.
- Measurements should read as below.

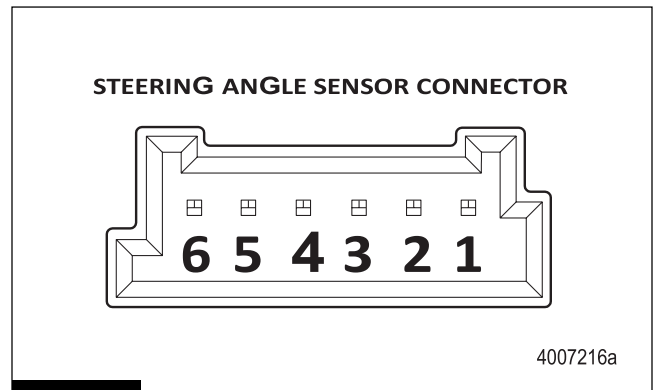


Figure 3.32

Location	Measurement
Power Supply to Ground	8.0-16.0V
ESC CAN-High to ESC CAN-Low	Approximately 90 ohm
ESC CAN-High or CAN-Low to Power or Ground	No continuity

Pin	Circuit
1	CAN-Low
2	Terminating Resistor
3	CAN-High
4	CAN-High
5	Power
6	Ground

3 Diagnostics, Troubleshooting and Testing

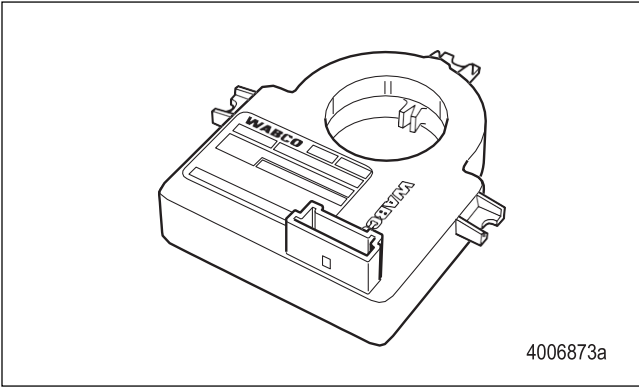


Figure 3.33

- All three mounting tabs of the SAS must be secured to the column assembly by screws. The driving tab of the SAS should be firmly fit into the machined groove in the steering shaft. If the driving tab or the mounting tabs of the sensor appear to be damaged, replace the sensor.

Hill Start Aid (HSA)

HSA can be accessed through TOOLBOX™ Software. Under Component Test, you have the ability to monitor switch status and toggle the lamp. Figure 3.35.

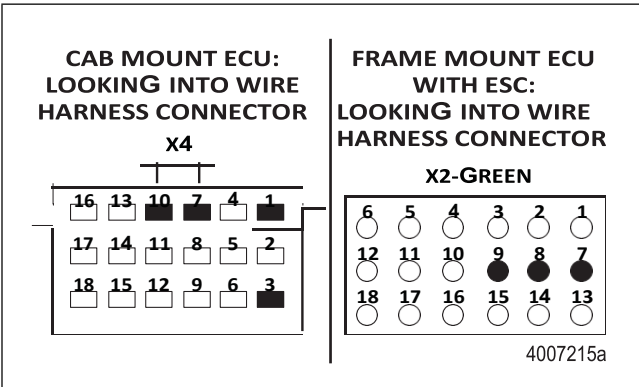


Figure 3.34

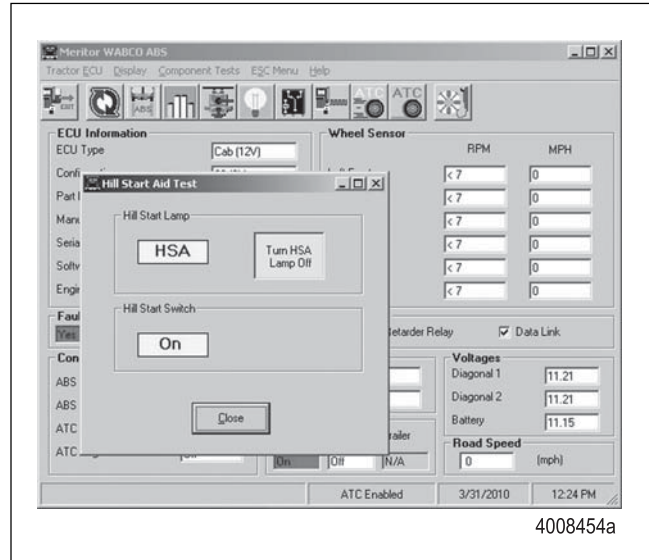


Figure 3.35

ECU	SAS Circuit	Connector	Pins
Cab-Mounted	Power Supply	X4-18 pin	7
	Ground	X4-18 pin	10
	ESC CAN-Low	X4-18 pin	1
Frame-Mounted	ESC CAN-High	X4-18 pin	3
	Power Supply	X2-Green	9
	Ground	X2-Green	External
	ESC CAN-Low	X2-Green	7
With ESC	ESC CAN-High	X2-Green	8

SID	Suspect Component and Location
19	Stability Control Modulator, Trailer Circuit (Optional) OR Active Braking Valve Supply, Steer Axle, Braking Circuit or HSA Lamp or Switch

Additional Checks

- When checking the mounting of the SAS to the column, it is critical that the sensor is mounted in the position originally specified by the vehicle OEM. Failure to do so will result in a fault code.

3 Diagnostics, Troubleshooting and Testing

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
8	HSA Lamp or Switch, RSC Modulator, Open Circuit	Warning Lamp	ESC/RSC Disabled	Output wire is interrupted.	Check wire and connectors.
9	HSA Lamp or Switch, RSC Modulator, Short to Ground	Warning Lamp	ESC/RSC Disabled	Output wire is shorted to ground.	Check wire, connectors and valve.

SID	Suspect Component and Location
94	HSA System

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
2	HSA Active Fault	HSA Warning Lamp	HSA Disabled	The driver remained on the service brake while HSA was active. Driver got a HSA warning message after 80 seconds but did not react. The failure has been displayed after 90 seconds of HSA activation. There was no HSA switch information in the EBCS Message; the HSA switch information is to be received from the CAN Bus according to the HSA switch parameter setting. (Only applicable if instead of a hardwired HSA switch a HSA switch information is provided in EBCS).	The following actions are only applicable if instead of a hardwired HSA switch a HSA switch information is provided in EBCS: <ul style="list-style-type: none"> • Check the parameter setting regarding the HSA switch • Broadcast the HSA switch information in EBCS OR <ul style="list-style-type: none"> • Install a HSA switch • Set the parameter regarding the HSA switch to "Hardwired Switch"

3 Diagnostics, Troubleshooting and Testing

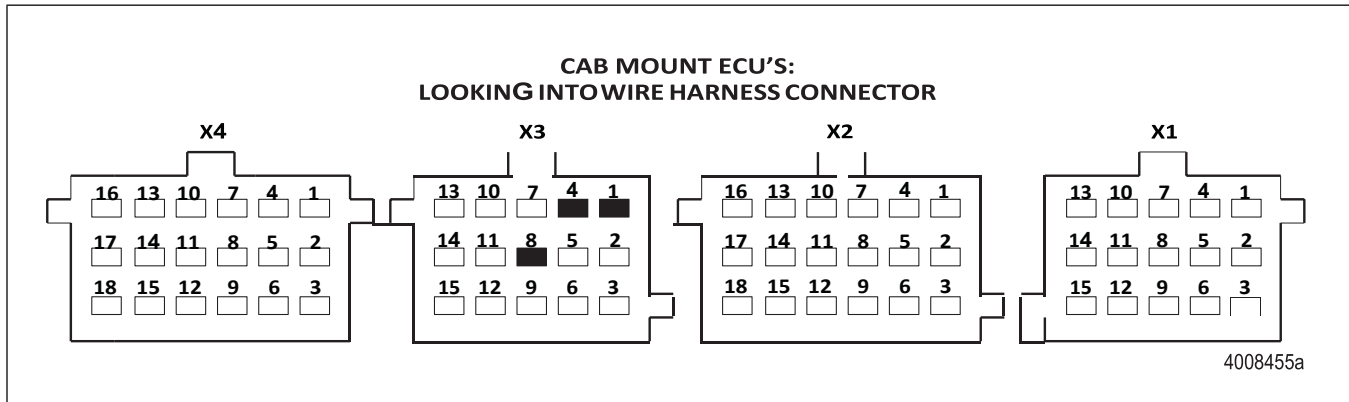


Figure 3.35

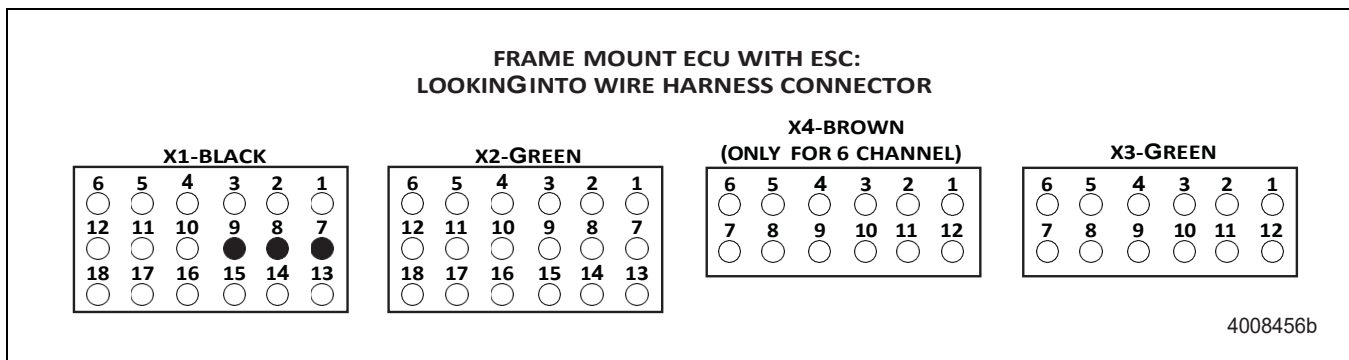


Figure 3.36

ECU	Circuit	Connector	Pins
Cab-Mounted Universal with ESC	HSA Lamp, must be hard wired	X3-15 pin	1
	HSA Switch, can be hard wired or multiplexed	X3-15 pin	4
	Ground	X3-15 pin	8
Frame ECU With ESC	HSA Lamp, must be hard wired	X1-Black	7
	Ground	X1-Black	8
	HSA Switch, can be hard wired or multiplexed	X1-Black	9
	ABV Trailer Control, must be grounded to pin 8		

J1939 Serial Communications

SID	Suspect Component and Location
231	J1939 Data Link

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
5	SAE J1939 Open or Short Circuit	ABS Warning Lamp	ESC/RSC/ATC Disabled J1939 Communication Switched to Inactive	SAE J1939 communication is not possible.	If ABS ECU is only vehicle ECU not communicating, verify J1939 wiring between ABS ECU and J1939 backbone. Resistance should be 60 ohms between J1939 high and low. Verify J1939 low and high are not switched.
6	SAE J1939 No Access	ABS Warning Lamp	ESC/RSC/ATC Disabled If Communication Cannot be Restored After 10 Seconds, J1939 Communication Switched to Inactive	SAE J1939 communication is not possible.	If ABS ECU is only vehicle ECU not communicating, verify J1939 wiring between ABS ECU and J1939 backbone. Resistance should be 60 ohms between J1939 high and low. Verify J1939 low and high are not switched.
9	SAE J1939 Time-Out EEC1	ABS Warning Lamp	ESC/RSC/ATC Disabled	There is either too much time in between EEC1 broadcasts from the engine or the message content is not as expected.	Verify J1939 wiring between engine ECU and vehicle J1939 backbone.
10	SAE J1939 XBR Time-Out	Temporary ABS Warning Lamp	XBR Disabled	The external brake request message (XBR) is expected but is not being received in expected time or not at all.	Verify J1939 wiring between external ECU which is sending request and J1939 backbone. This message is most likely to come from Adaptive Cruise or a Collision Mitigation system such as OnGuard.
12	SAE J1939 Internal Error	ABS Warning Lamp	ABS Disabled ESC/RSC/ATC Disabled	An internal fault related to the CAN controller is detected.	Verify J1939 wiring between ABS ECU and J1939 backbone. If fault repeats, contact Meritor WABCO OnTrac at 866-OnTrac1 (668-7221).
13	XBR Checksum Counter	ABS Warning Lamp	XBR Disabled	The external brake request message (XBR) has been received incorrectly.	Verify J1939 wiring between external ECU which is sending request and J1939 backbone. This message is most likely to come from Adaptive Cruise or a Collision Mitigation system such as OnGuard.

3 Diagnostics, Troubleshooting and Testing

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
14	SAE J1939 ESC1 Time-Out	Temporary ABS Warning Lamp	ESC Disabled	The electronic steering control message (ESC1) is expected but is not being received in expected time or not at all.	Verify J1939 wiring between external ECU which is sending request and J1939 backbone. This message is most likely to come from a steering tag axle controller.

J1939 Serial Communications Testing

Electrical Checks

- If the ABS ECU is the only ECU on the J1939 datalink which cannot communicate, then take measurements at the ABS ECU connector. If other ECUs are not communicating, then troubleshoot the vehicle datalink backbone and contact the vehicle OEM for technical assistance if required. For resistance measurements, the vehicle battery must be disconnected and the ignition must be Off. Figure 3.37 and Figure 3.38.
- Measurements should read as below.

Location	Measurement
J1939 High to J1939 Low	Approximately 60 ohm
J1939 High or J1939 Low to Ground or Power Supply	No continuity

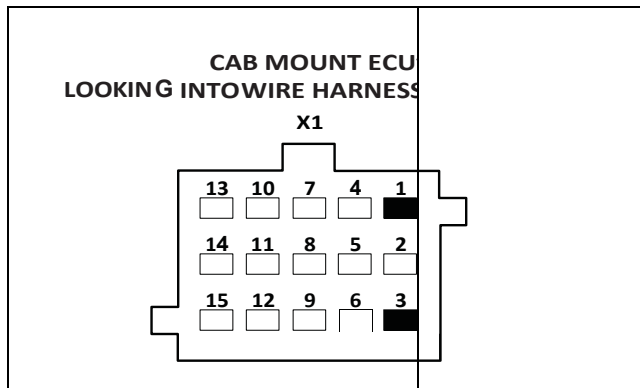


Figure 3.37

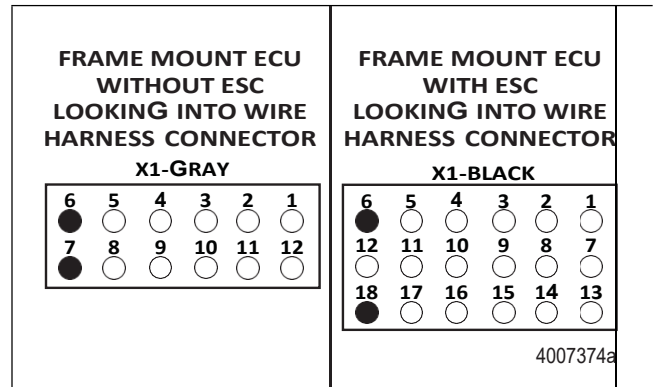


Figure 3.38

ECU	J1939 Datalink Circuit	Connector	Pins
Cab-Mounted	J1939 High	X1-15 pin	3
All	J1939 Low	X1-15 pin	1
Frame-Mounted	J1939 High	X1-Gray	7
Without ESC	J1939 Low	X1-Gray	6
Frame-Mounted	J1939 High	X1-Black	18
With ESC	J1939 Low	X1-Black	6

Internal ABS ECU

SID	Suspect Component and Location
22	ABS System

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
14	ABS Complete Shut-off	Warning Lamp	Complete Shut-Off	The number of stored wheel speed sensor failures is checked. To avoid that, the degree of sensor pole stud failures for instance, progress because of lack of maintenance response, ignorance of repair instructions (warning lamp ignorance), that critical driving situations due to ABS faulty controls arise, special measures are undertaken dependent on the number of wheel sensor failures, collective error count stored in the EEPROM (without electrical failure).	Check sensor wiring, connectors and sensor.

SID	Suspect Component and Location
253	ABSECU (Consult OEM Manual for Location)

3 Diagnostics, Troubleshooting and Testing

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
2	ABS System Configuration EEPROM Wheel Parameter Incorrect	ABS Warning Lamp	ABS Disabled ESC/RSC/ATC Disabled	The ECU memorized system is not in accordance with the harness. There are loads detected at outputs which should be open circuits. Wheel parameters (number of toner ring teeth or tire size) are out of tolerance.	Check number of sensors and modulators and correct wiring and compare to ECU type. Call Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) with part number to ensure ECU is correct for the application.
12	EEPROM Checksum	ABS Warning Lamp	ABS Disabled ESC/RSC/ATC Disabled	There is an incorrect checksum in the EEPROM. A diagnostic tool may have been disconnected during active diagnosis.	Reset ECU by cycling the ignition or by using the reset option in TOOLBOX™. If fault persists, contact Meritor WABCO OnTrac at 866-OnTrac1 (668-7221).
13	ABS System Fault	ABS Warning Lamp	ABS Disabled ESC/RSC/ATC Disabled	The ECU memorized system is not in accordance with the harness.	Check number of sensors and modulators and correct wiring and compare to ECU type. Call Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) with part number to ensure ECU is correct for the application.
14	EEPROM ESC Parameter Incorrect	ATC Lamp	ESC Disabled	The stability control parameters set in the ECU are not in accordance with what is detected or learned on the vehicle.	Call Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) with part number to ensure ECU is correct for the application.

SID	Suspect Component and Location
254	ABSECU (Consult OEM manual for location)

3 Diagnostics, Troubleshooting and Testing

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
5	No Loads Detected	ABS Warning Lamp	ABS Disabled ESC/RSC/ATC Disabled Fault is not Memorized	The ECU detects that no modulators are connected. This is a common fault during end of line testing or programming if only the X1 connector is connected.	Check harness to ensure that modulators are connected and check fuses.
8	Excessive Slip	ABS Warning Lamp	ABS Disabled ESC/RSC/ATC Disabled	One axle is detected to be rotating much faster than another. This fault is common on dynotesters if the detection is not disabled via diagnostic command. It is also possible that there are excessive sensor air gaps on multiple wheel ends.	Use the "Disable ATC" diagnostic command when the vehicle is on a dynotester. Check for excessive ABS sensor gap on multiple wheel ends.
9	Excessive Modulator Activation Time	ABS Warning Lamp	ABS Wheel Disabled ESC/RSC Disabled ATC Disabled if Fault on Driven Wheel	An ABS modulator was activated for an abnormally long time.	Check subject ABS tooth wheel for damage or corrosion. If fault repeats, contact Meritor WABCO OnTrac at 866-OnTrac1 (668-7221).
12	Internal Error	ABS Warning Lamp	ABS Disabled ESC/RSC/ATC Disabled	There are multiple causes. Valves may have been activated too long during diagnostic testing.	Reset ECU by cycling the ignition or by using the reset option in TOOLBOX™. If fault persists, contact Meritor WABCO OnTrac at 866-OnTrac1 (668-7221).
13	Accelerometer Out of Range	ABS Warning Lamp	RSC Disabled	The measured lateral acceleration by the ECU is out of range.	Verify that the ECU is mounted firmly and per OEM specification. Call Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) with part number to ensure ECU is correct for the application.
14	ECU Mounting, Accelerometer Not Plausible	ABS Warning Lamp	RSC Disabled	The measured lateral acceleration is not plausible or the learned off-set is too high. ECU may be mounted incorrectly.	Verify that the ECU is mounted firmly and per OEM specification. Call Meritor WABCO OnTrac at 866-OnTrac1 (668-7221) with part number to ensure ECU is correct for the application.

3 Diagnostics, Troubleshooting and Testing

Retarder Relay

SID	Suspect Component and Location
13	Retarder Relay

FMI	Fault Description	Fault Indication	System Reaction	Cause	Repair Information
3	Shorted to UBATT	ABS Warning Lamp	Hardwired Retarder Control is Disabled	Continuity between the retarder relay output and the battery supply has been detected.	Check for continuity between the retarder relay output and voltage supply. Check connectors and retarder relay for corrosion or damage.
5	Open Circuit	ABS Warning Lamp	Hardwired Retarder Control is Disabled	ECU has detected that the retarder relay is not connected but was previously learned.	Check if connections are fully seated. Check for broken wires or connectors. If hardwired retarder control is not installed on the vehicle but this fault is present, the operator should perform "Reset Memorized Components" TOOLBOX™ procedure.
6	Shorted to Ground	ABS Warning Lamp	Hardwired Retarder Control is Disabled	Continuity between the retarder relay output and ground has been detected.	Check for continuity between the retarder relay output and ground. Check connectors and retarder relay for corrosion or damage.

Retarder Relay Testing

Electrical Checks

- Take measurements at the ECU harness connector.
- Measurements should read as below.

ECU	J1939 Datalink Circuit	Connector	Pins
Cab-Mounted Universal with ESC, Universal or Basic	Retarder Relay Output	X1-15 pin	14
Frame-Mounted Non ESC	Retarder Relay Output	X1 Gray	5
Frame-Mounted With ESC	Retarder Relay Output	X1-Black	5

Additional Checks

- If fault code 13 SID-5 FMI "Retarder Relay Open Circuit" is active and the vehicle does not require a hardwired control of the retarder, it is possible that the retarder relay was learned either during diagnostic testing or while the ECU was installed on a different vehicle. In this case, the "Reset Memorized" command described in Section 7 can be used.
- The function of the retarder relay can also be verified using Meritor WABCO TOOLBOX™. Under the "Component Tests" drop down menu, select the "Relay" option. The following screen will appear. Figure 3.39. This is helpful in verifying the correct operation, installation and wiring of the unit under test.

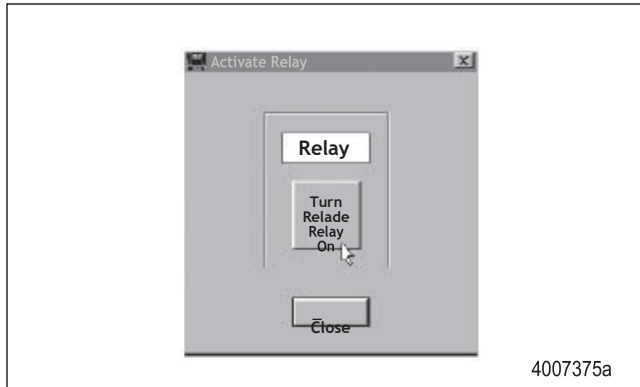


Figure 3.39

Tire Size Range Testing

ABS

For correct ABS/ATC operation with the standard ECU, front and rear tire sizes must be within $\pm 14\%$ of each other. When this tire size range is exceeded without electronically modifying the ECU, the system performance can be affected and the indicator lamp can illuminate.

Calculate the tire size with the following equation:

$$\% \text{ Difference} = \left\{ \frac{\text{RPM Steer}}{\text{RPM Drive}} - 1 \right\} \times 100$$

RPM — tire revolutions per mile

RSC

RSC requires that the steer axle tire size range be within $\pm 5\%$ of a pre-set value.

Call Meritor WABCO at 866-OnTrac1 (668-7221) if you plan a tire size range greater than those specified.

ESC

ESC requires that the steer axle tire size range be within $\pm 3\%$ of a pre-set value.

Call Meritor WABCO at 866-OnTrac1 (668-7221) if you plan a tire size range greater than those specified.

Dynamometer Testing Vehicles with ATC

⚠ WARNING

The automatic traction control (ATC) function must be disabled before any type of dynamometer testing is conducted on the vehicle. If the ATC is not disabled, the vehicle ATC may actuate and cause the vehicle to move forward without warning to the operator. If the vehicle moves forward unexpectedly, the vehicle may cause damage or injuries to individuals who are in the path of the vehicle.

⚠ CAUTION

Do not cycle the vehicle ignition while the vehicle is on a dynamometer. Cycling the vehicle ignition will enable the ATC.

Vehicles with ATC must have the ATC disabled to test the vehicle on a dynamometer. To disable the ATC, use one of the following methods:

1. Blink Code Switch

Press and hold the blink code switch for at least three seconds. Refer to the blink code diagnostics information in this section for a description of how the blink code display will appear.

- Once the system configuration code begins, ATC has been disabled.
- The ATC lamp comes on and stays on while ATC is disabled.
- ATC will remain disabled until the vehicle ignition is cycled.
- After testing, ATC will automatically reactivate the first time the vehicle ignition is cycled.

2. Remove Power

Remove the ABS circuit breaker/fuse or remove the ECU power connector to disable the ABS and ATC.

- After testing, re-install the circuit breaker/fuse and the ATC will automatically reactivate the first time the vehicle power is applied to the ECU.

3. TOOLBOX™ Software

At the ABS Main Menu, select the *Disable ATC* icon or use the pull down menu to send the command to the ECU to disable the ATC. Refer to the TOOLBOX™ Software Owner's Manual for complete instructions for using TOOLBOX™.

- ATC will remain disabled until the enable command is sent or the vehicle ignition is cycled.

3 Diagnostics, Troubleshooting and Testing

- After testing, ATC will automatically reactivate the first time the vehicle ignition is cycled.

4. MPSI Pro-Link[→] Plus

Refer to the MPSI Pro-Link[→] Plus Owner's Manual for instructions.

- ATC will remain disabled until the enable command is sent or the vehicle ignition is cycled.
- After testing, ATC will automatically reactivate the first time the vehicle ignition is cycled.

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Release all air from the air systems before you remove any components. Pressurized air can cause serious personal injury.

⚠ CAUTION

When welding on an ABS- or ABS/ATC-equipped vehicle is necessary, disconnect the power connector from the ECU to prevent damage to the electrical system and ABS/ATC components.

Component Removal and Installation

Wheel Speed Sensors

Sensor Lubricant Specification

Meritor WABCO specifications call for a sensor lubricant with the following characteristics:

Lubricant must be mineral oil-based and contain molydisulfide. It should have excellent anti-corrosion and adhesion characteristics, and be capable of continuous function in a temperature range of -40° to 300°F (-40° to 150°C).

Lubricants approved for use on Meritor WABCO sensors and spring clips are as follows. Figure 4.1.

- Mobilith SHC-220 (Mobil)
- TEK 662 (Roy Dean Products)
- Staburags NBU 30 PTM (Kluber Lubrication)
- Valvoline EP 633

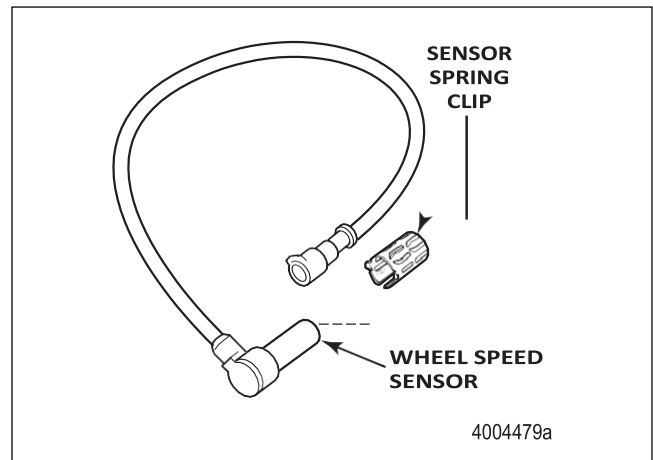


Figure 4.1

Wheel Speed Sensor Removal — Front Axle

NOTE: When replacing the wheel speed sensor, the sensor spring clip must also be replaced.

To remove the sensor from the front axle:

⚠ WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

1. Place blocks under the rear tires to stop the vehicle from moving. Apply the parking brake.
2. If necessary, raise the front tires off the ground. Place safety stands under the axle.
3. Disconnect the fasteners that hold the sensor cable to other components.
4. Disconnect the sensor cable from the chassis harness.
5. Remove the sensor from the sensor holder. Use a twisting motion if necessary. Do not pull on the cable. Figure 4.2.

4 Component Replacement

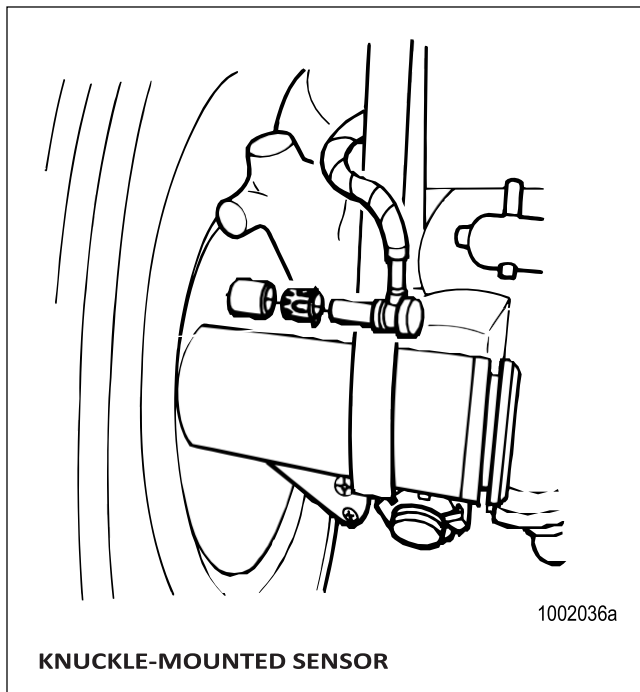


Figure 4.2

6. Remove the sensor spring clip.

Wheel Speed Sensor Installation — Front Axle

To replace the sensor in the front axle:

1. Connect the sensor cable to the chassis harness.
2. Install the fasteners used to hold the sensor cable in place.
3. Apply a Meritor WABCO recommended lubricant to the sensor spring clip and sensor.
4. Install the sensor spring clip. Make sure the spring clip tabs are on the inboard side of the vehicle.
5. Push the sensor spring clip into the bushing in the steering knuckle until the clip stops.
6. Push the sensor completely into the sensor spring clip until it contacts the tooth wheel.

NOTE: After installation, there should be no gap between the sensor and the tooth wheel. During normal operation, a gap of up to 0.04-inch (1.016 mm) is allowable.

7. Remove the blocks and safety stands.

Wheel Speed Sensor Removal — Rear Axle

NOTE: When replacing the wheel speed sensor, the sensor spring clip must also be replaced.

To remove the sensor from the rear axle:

⚠ WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

1. Place blocks under the front tires to stop the vehicle from moving.
2. Raise the rear tire off the ground. Place safety stands under the axle.
3. Release the parking brake and back off the slack adjuster to release the brake shoes.
4. Remove the wheel and tire assembly from the axle.
5. Remove the brake drum.
6. Remove the sensor from the mounting block in the axle housing. Use a twisting motion if necessary. Do not pull on the cable.
7. Remove the sensor spring clip from the mounting block.
8. Disconnect the fasteners that hold the sensor cable and the hose clamp to other components.
9. Disconnect the sensor cable from the chassis harness.

Wheel Speed Sensor Installation — Rear Axle

1. Apply a Meritor WABCO recommended lubricant to the sensor spring clip and sensor.
2. Install the sensor spring clip. Verify that the spring clip tabs are on the inboard side of the vehicle.
3. Push the sensor spring clip into the mounting block until it stops.

NOTE: After installation, there should be no gap between the sensor and the tooth wheel. During normal operation, a gap of up to 0.04-inch (1.016 mm) is allowable.

4 Component Replacement

4. Push the sensor completely into the sensor spring clip until it contacts the tooth wheel. Figure 4.3.

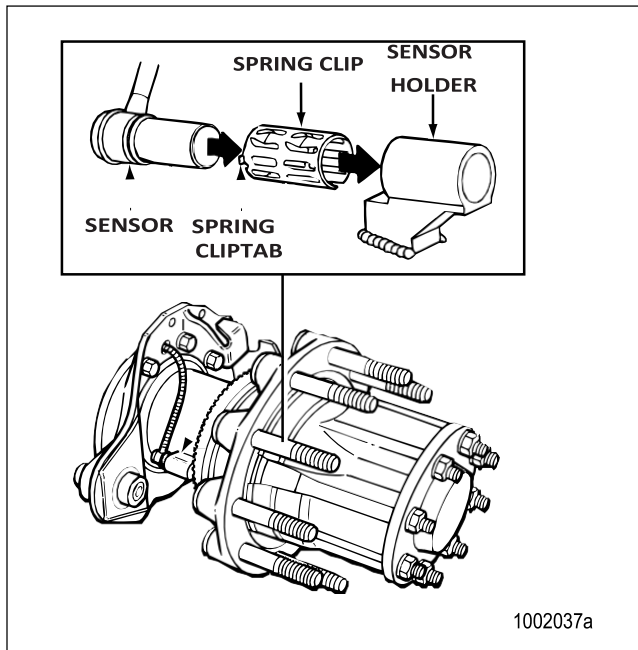


Figure 4.3

5. Insert the sensor cable through the hole in the spider and axle housing flange. Route the cable to the frame rail. Be sure to route the cable in a way that will prevent pinching or chafing and will allow sufficient movement for suspension travel.
6. Connect the sensor cable to the chassis harness.
7. Install the fasteners that hold the sensor cable in place.
8. Install the brake drum on the wheel hub.
9. Complete the installation per the vehicle manufacturer's manual.

ABS Modulator Valve

Removal

1. Turn the ignition switch to the OFF position. Apply the parking brake.

⚠ WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

2. Place blocks under the front and rear tires to stop the vehicle from moving.
3. If necessary, raise the vehicle off the ground and place safety stands under the axle.
4. Disconnect the wiring connector from the ABS valve.
5. Disconnect the air lines from Ports 1 (air supply) and 2 (air discharge) of the ABS valve. Figure 4.4.

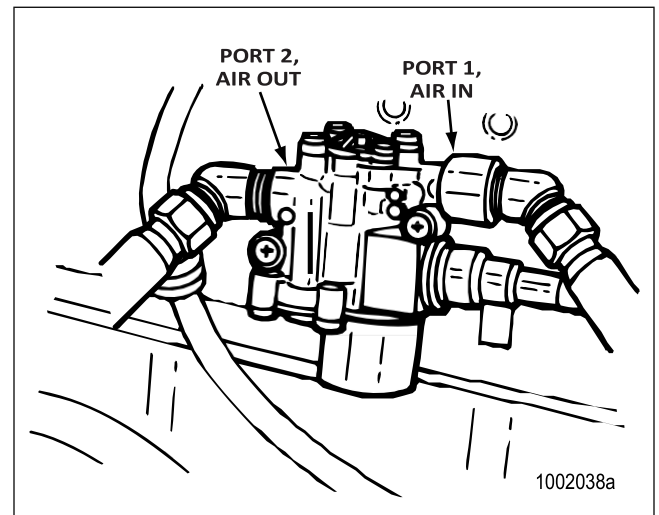


Figure 4.4

6. Remove the two mounting capscrews and nuts.
7. Remove the ABS valve.

Installation

⚠ CAUTION

Moisture can affect the performance of all ABS/ATC systems, as well as the standard braking system. Moisture in air lines can cause air lines to freeze in cold weather.

1. Install the ABS valve with two mounting capscrews and nuts. Tighten the capscrews per the manufacturer's recommendation.
2. Connect the line to the brake chambers to Port 2 of the ABS valve. Connect the air supply line to Port 1 of the ABS valve.
3. Connect the wiring connector to the ABS valve. Hand tighten only.
4. Remove the blocks and stands.
5. Test the installation.

4 Component Replacement

Checking the Installation

1. Apply the brakes. Listen for leaks at the modulator valve.
2. Turn the ignition on and listen to the modulator valve cycle. If the valve fails to cycle, check the electrical cable connection. Make repairs as needed.
3. Drive the vehicle. Verify that the ABS indicator lamp operates correctly.

ATC Valve

Removal

1. Turn the ignition switch to the OFF position. Apply the parking brake.

WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

2. Place blocks under the front and rear tires to stop the vehicle from moving.
3. If necessary, raise the vehicle off the ground. Place safety stands under the axle.
4. Relieve line pressure by bleeding the air from the appropriate supply tank.
5. Disconnect the wiring from the ATC valve.
6. Disconnect the air lines from Port 1 (air supply), Port 2 (air discharge) and Port 3 (treadle) of the ATC valve. Figure 4.5.

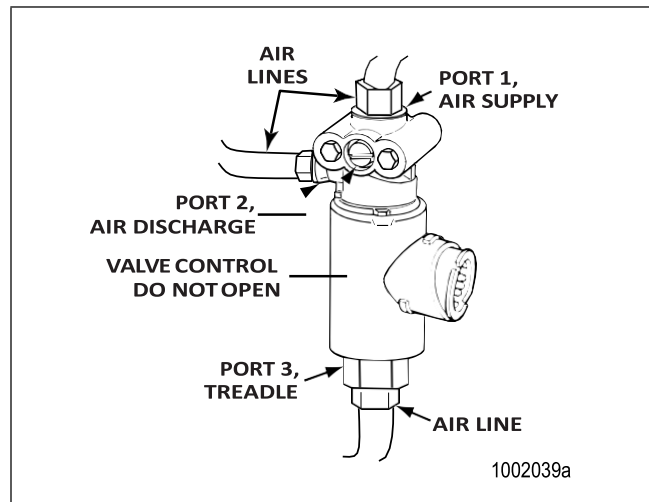


Figure 4.5

7. Remove the two mounting capscrews and nuts. Remove the ATC valve.

Installation

1. Install the ATC valve with two mounting capscrews and nuts. Tighten the capscrews per the manufacturer's recommendation.
2. Connect the air supply, discharge and treadle lines to Ports 1, 2 and 3 of the ATC valve.
3. Connect the harness connector to the ATC valve. Hand tighten only.
4. Remove the blocks and stands.
5. Test the installation.

Checking the Installation

To test the ATC valve:

1. Start the vehicle.
2. Fully charge the reservoirs with air. Shut off the vehicle.
3. Apply the brakes.
4. Listen for air leaks at the ATC valve.
5. Release the brakes.
6. Activate the ATC valve using the MPSI tool.
7. Disconnect the MPSI tool.
8. Drive the vehicle. Verify that the ATC indicator lamp operates correctly.

Trailer Active Braking Valve

Removal

1. Turn the ignition switch to the OFF position. Apply the parking brake.
2. Place blocks under the front and rear tires to stop the vehicle from moving.
3. If necessary, raise the vehicle off the ground. Place safety stands under the axle.
4. Relieve line pressure by bleeding the air from the appropriate supply tank.
5. Disconnect the wiring from the trailer active braking valve (solenoid valve).
6. Disconnect the air lines from Port 1 (air supply), Port 2 (air discharge) and Port 3 (treadle) of the solenoid valve. Figure 4.6.

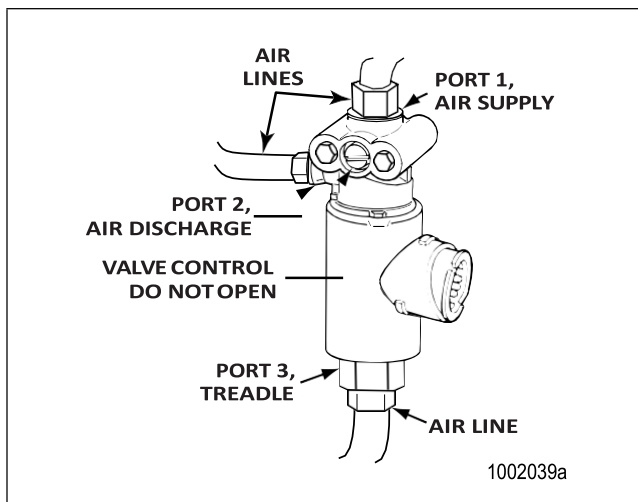


Figure 4.6

7. Remove the two mounting capscrews and nuts. Remove the solenoid valve.

Installation

1. Install the solenoid valve with two mounting capscrews and nuts.
Tighten the capscrews per the manufacturer's recommendation. Do not exceed 15 ft-lb (20 N•m). @
2. Connect the air supply, discharge and treadle lines to Ports 1, 2 and 3 of the solenoid valve.

3. Connect the harness connector to the solenoid valve. Hand tighten only.
4. Remove the blocks and stands.
5. Test the installation.

Checking the Installation

To test the trailer active braking valve (solenoid valve):

1. Connect the blue glad hand to a 50 cu. in. (819 cu. cm) air tank.
2. Start the vehicle.
3. Fully charge the reservoirs with air. Shut off the vehicle.
4. Activate the solenoid valve using TOOLBOX™ Software.
5. Listen for air leaks at the solenoid valve.
6. Make necessary repairs.
7. Turn the ignition on. Verify that the ATC/Stability Control indicator lamp operates correctly.

ABS Valve Packages

Removal and Installation — Complete Package

1. Place blocks under tires to stop the vehicle from moving.
2. If necessary, raise the tires off the ground.
3. Drain the air from all system air tanks.
4. Remove all the air lines and connections from the ABS valve package. Figure 4.7 and Figure 4.8.

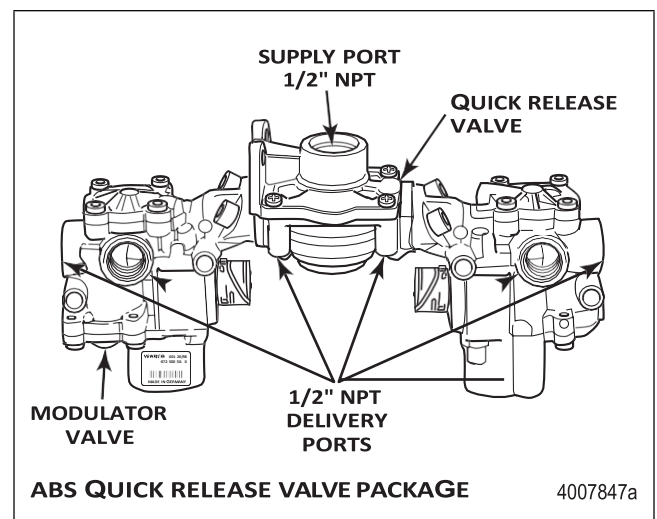


Figure 4.7

4 Component Replacement

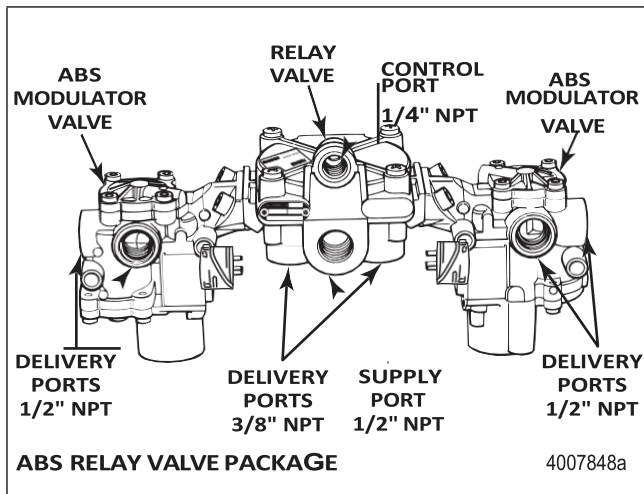


Figure 4.8

5. Remove the mounting bolts from the valve package. Remove the valve package from the vehicle.
6. Replace the ABS valve package: Tighten the bolts to the vehicle manufacturer's recommendation. Remove the blocks and safety stands as necessary.
7. Test the installation.

Removal and Installation — Component Valves

1. Remove the ABS valve package from the vehicle. Figure 4.9.

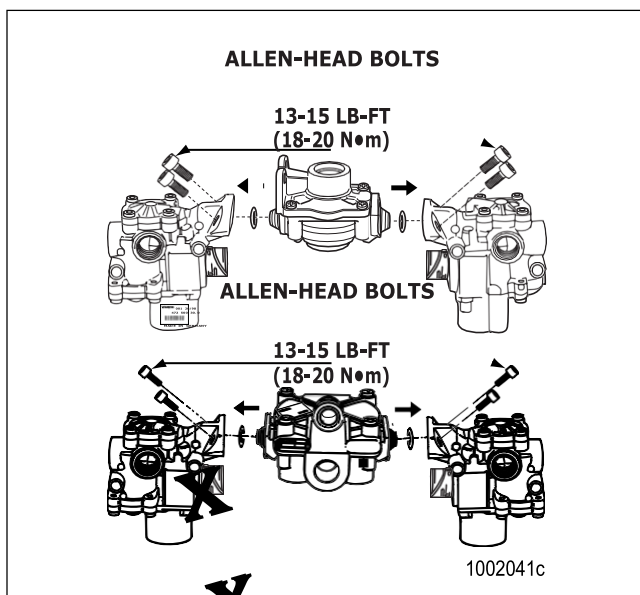


Figure 4.9

2. Use a 6 mm Allen wrench to loosen and remove the Allen-head bolts.
3. Carefully separate the ABS modulator valve(s) from the relay or quick release valve.
4. Remove and discard old O-rings. Lubricate replacement O-rings with the grease provided.
5. Plug any unused ports on the replacement valve(s).
6. Attach the ABS modulator valve(s) to the relay or quick release valve. Use a 6 mm Allen wrench to tighten the Allen-head bolts to 13-15 lb-ft (18-20 N•m).
7. Replace the ABS valve package: Tighten the bolts to the vehicle manufacturer's recommendation. Remove the blocks and safety stands as necessary.
8. Check the valves for leaks:
 - Modulator valve(s). Refer to the procedure for checking the modulator valve installation in this section.
 - Relay or quick release valve. Refer to the procedure for checking the quick release or relay valve installation in this section.

Active Braking Valve on the ABS Valve Package

Removal

NOTE: If there is enough room to work, it is not necessary to remove the valve package from the vehicle before replacing the active braking valve (solenoid valve). If the valve package must be removed, follow the instructions for removing and replacing the ABS Valve Package that appear in this section of the manual.

When installing the new active braking valve (solenoid valve) on the valve package, you must use the new O-rings, seals, mounting bolts and lubricant included with the replacement kit.

1. Turn the ignition switch to the OFF position. Apply the parking brake.
2. Place blocks under the front and rear tires to stop the vehicle from moving.
3. If necessary, raise the vehicle off the ground. Place safety stands under the axle.
4. Relieve line pressure by bleeding the air from the appropriate supply tank.

4 Component Replacement

5. Disconnect the wiring from the solenoid valve.
6. Disconnect the supply air line from the adapter and the treadle air line from the solenoid valve.
7. Use a 5 mm Allen wrench to remove the two screws that hold the adapter piece to the relay valve portion of the valve package.

Use a 6 mm Allen wrench to remove the two mounting bolts that hold the solenoid valve to the adapter piece. Remove the solenoid valve from the adapter piece. Remove the solenoid valve.

Remove the adapter piece, seal and O-rings from the valve package. Figure 4.10.

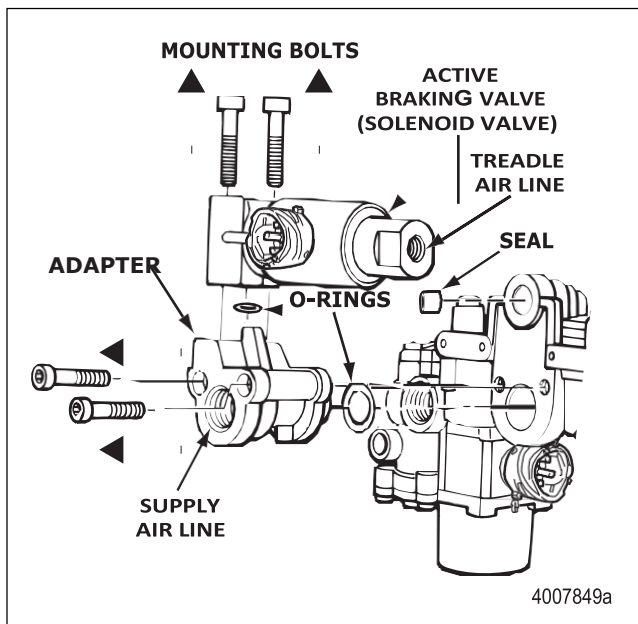


Figure 4.10

Installation

1. Clean and lubricate the small adapter piece O-ring. Install the O-ring on the adapter piece.

Use the two new M8 Allen-head bolts to attach the solenoid valve to the adapter piece. Use a 6 mm Allen-head tool to tighten to 13-15 lb-ft (18-20 N•m). Figure 4.11. @

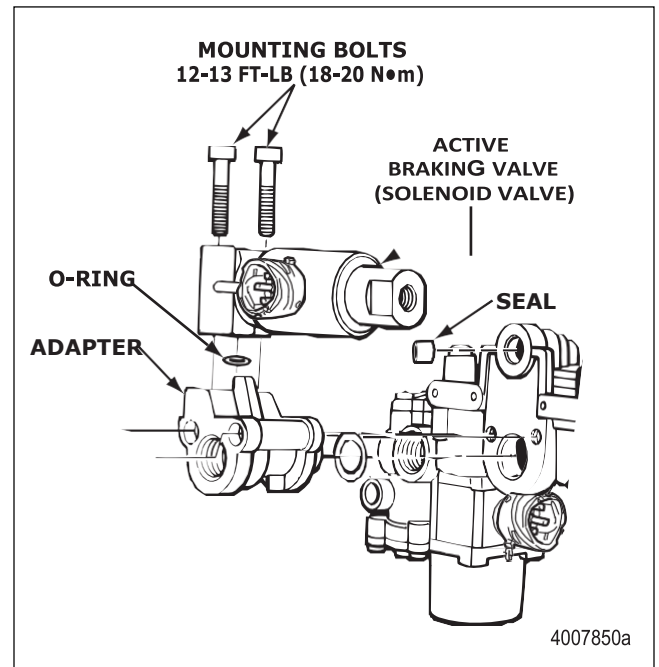


Figure 4.11

2. Lubricate the replacement seal and install it in Port 2 of the solenoid valve.

Lubricate the large replacement O-ring and install it in the groove of the relay valve supply port. Figure 4.12.

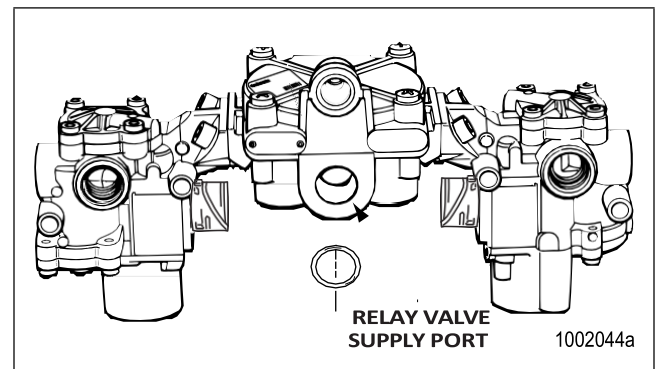


Figure 4.12

NOTE: Use Meritor WABCO-recommended lubricant.

3. Use the two M6 Allen-head bolts to attach the adapter to the relay valve. Use a 5 mm Allen-head tool to tighten to 4-5 lb-ft (6-8 N•m). Figure 4.13. @

4 Component Replacement

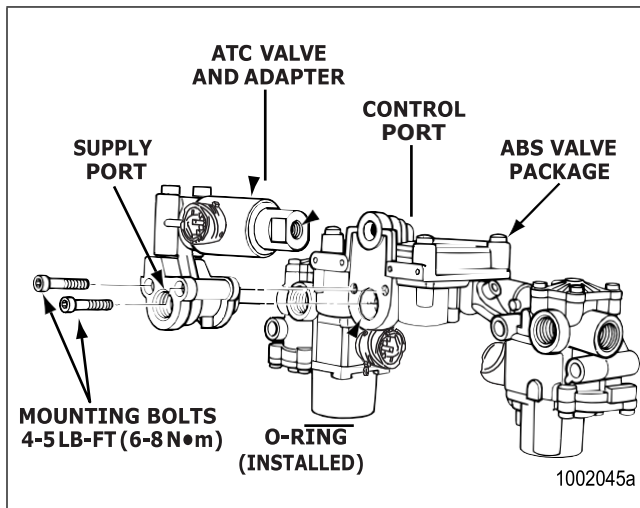


Figure 4.13

4. Connect the supply air line to the supply port on the adapter. Connect the treadle air line to the control port on the solenoid valve. Place a wrench on the adapter to prevent the control port from twisting. Tighten the fitting to 15 ft-lb (20 N•m). Do not overtighten. @
5. Attach the wiring connector to the solenoid valve. Hand tighten only.
6. Remove the blocks and stands.
7. Test the installation.

Checking the Installation

1. Start the vehicle.
2. Fully charge the reservoirs with air. Shut off the vehicle.
3. Apply the brakes.
4. Listen for air leaks at all valves.
5. Drive the vehicle. Verify that the ABS indicator lamp operates correctly.

Electronic Stability System (ESC) Component Replacement

ESC ECU

Removal

1. Turn the ignition switch to the OFF position. Apply the parking brake.

2. Place blocks under the front and rear tires to prevent the vehicle from moving.
3. Disconnect the wiring harness connectors from the ESC ECU.
4. Remove the mounting hardware. Remove the ESC ECU.

Installation

1. Install the ESC ECU using the manufacturer's mounting hardware. Tighten the hardware per the manufacturer's recommendation.
2. Install the wiring harness connectors to the ESC ECU.
3. Remove the blocks.
4. Test the installation.

Testing the Installation

To test the ECU installation, the system must be calibrated:

1. Follow the ESC End of Line Calibration Procedure described in this manual.
2. When the ESC End of Line Calibration Procedure is completed, the ABS and ATC/ESC lamps should come on and go back off when ignition power is turned on. The ATC/ESC lamp may remain on briefly after the ABS lamp goes off.
3. There should not be any active faults displayed in the ECU memory.

Front Axle Active Braking Valve (Solenoid Valve)

Removal

1. Turn the ignition switch to the OFF position. Apply the parking brake.

⚠ WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

2. Place blocks under the front and rear tires to prevent the vehicle from moving.
3. If necessary, raise the vehicle off the ground and place safety stands under the vehicle.
4. Relieve line pressure by bleeding the air from the appropriate supply tank.

4 Component Replacement

5. Disconnect the wiring harness connector from the front axle active braking valve (solenoid valve).
6. Disconnect the air line from Port 1 (Air Supply), Port 2 (Air Discharge) and Port 3 (Treadle) of the front axle active braking valve (solenoid valve). Figure 4.14.

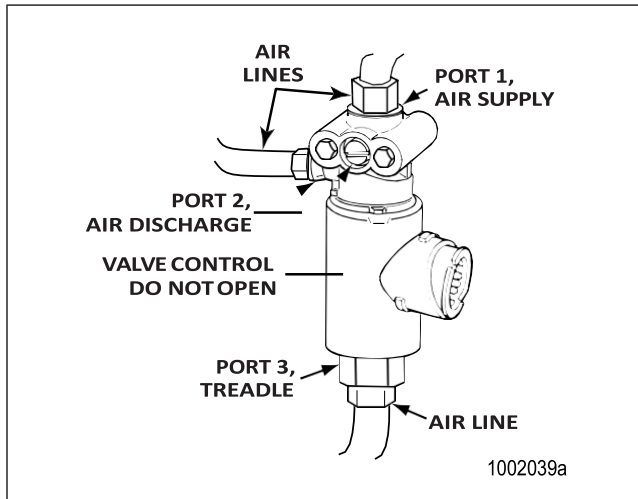


Figure 4.14

7. Remove the two mounting capscrews and nuts. Remove the solenoid valve.

Installation

1. Install the solenoid valve with the two capscrews and nuts. Tighten the capscrews per the manufacturer's recommendation.
2. Connect the air supply, discharge and treadle lines to Ports 1, 2 and 3 of the solenoid valve.
3. Connect the wiring harness connector to the ESC valve. Hand tighten only.
4. Remove the stands and blocks.
5. Test the installation.

Testing the Installation

To test the solenoid valve:

1. Turn the ignition on and verify that the ATC/Stability Control lamp operates correctly.
2. Start the vehicle.
3. Fully charge the reservoirs with air. Shut off the vehicle.
4. Apply the brakes and check for air leaks at the solenoid valve.

5. Activate the solenoid valve using the TOOLBOX™ software.
6. Verify that the front brakes apply.

Steering Angle Sensor (SAS) — Meritor WABCO Only

Removal

1. Center the steering wheel with the front wheels positioned straight ahead.
2. Turn the ignition switch to the OFF position. Apply the parking brake.
3. Place blocks under the front and rear tires to prevent the vehicle from moving.
4. Locate the SAS on the steering column shaft, either near the universal joint on the bottom of the column or under the steering wheel near the top of the column.

⚠ WARNING

If equipped, disable the supplemental restraint system (air bag) to avoid serious personal injury. Refer to the vehicle manufacturer's service publication for further information.

5. If the SAS is located at the top of the steering column, remove the vehicle steering wheel using the recommended steering wheel puller.
6. The SAS is attached by three screws to the steering column with the center tab located in the grooved steering column shaft. Figure 4.15.

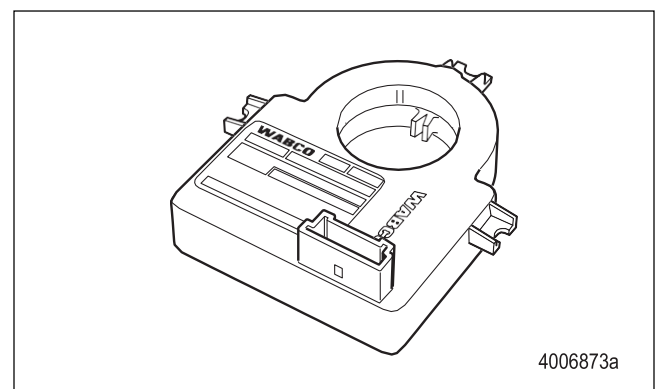


Figure 4.15

7. Disconnect the wiring harness connector from the SAS. (Note the position of the connector either facing up or down.)
8. Remove the attaching screws and slide the SAS off of the steering column shaft.

4 Component Replacement

Installation

CAUTION

If the SAS is not installed in the correct orientation, it will not function correctly and may become damaged.

1. Apply a small amount of the supplied grease to the tab in the center of the SAS and to the machined groove on the steering shaft.
2. Install the SAS with the connector facing the same direction as the original. Place the SAS over the steering column shaft and slide it into place with the SAS tab placed in the groove that is machined on the steering column shaft.
3. Using the new furnished screws, replace the attaching screws and tighten to a maximum of 22 in-lb (2.5 N•m). @
4. Install the SAS wiring harness connector by pushing the connector together until the small tab snaps into place.
5. Install the steering wheel and tighten per the manufacturer's recommendation.
6. Remove the blocks.
7. Test the installation.

Testing the Installation

To test the SAS installation, the system must be calibrated.

1. Follow the ESC End of Line Calibration Procedure described in this manual.
2. When the ESC End of Line Calibration Procedure is completed, the ABS and ATC/ESC lamps should come on and go back off when ignition power is turned on. The ATC/ESC lamp may remain on briefly after the ABS lamp goes off.
3. There should not be any active faults displayed in the ECU memory.

ESC Module

Removal

1. Turn the ignition switch to the OFF position. Apply the parking brake.

WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

2. Place blocks under the front and rear tires to prevent the vehicle from moving.
3. If necessary, raise the vehicle off the ground and place safety stands under the vehicle.
4. Disconnect the wiring harness connector from the ESC module. Figure 4.16.

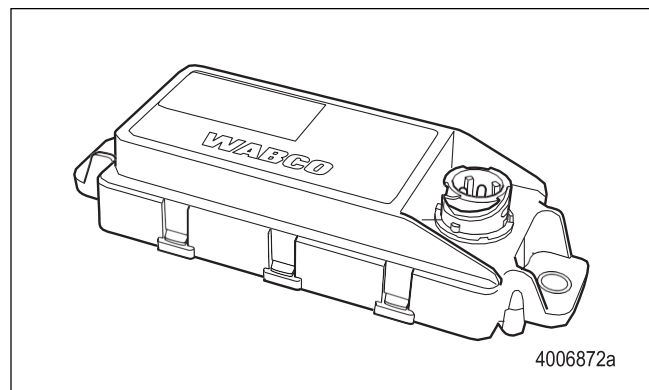


Figure 4.16

5. Remove the two mounting capscrews and nuts. Remove the ESC module.

Installation

NOTE: It is important that the module is aligned correctly and the tab on the ESC mounting surface fits into the appropriate hole.

1. Install the ESC module with the two capscrews and nuts. Tighten the capscrews per the manufacturer's recommendation.
2. Connect the wiring harness connector to the ESC module. Hand tighten only.
3. Remove the stands and blocks.
4. Test the installation.

Test the Installation

To test the ESC module installation, the system must be calibrated.

1. Follow the ESC End of Line Calibration Procedure described in this manual.
2. When the ESC End of Line Calibration Procedure is completed, the ABS and ATC/ESC lamps should come on and go back off when ignition power is turned on. The ATC/ESC lamp may remain on briefly after the ABS lamp goes off.
3. There should not be any active faults displayed in the ECU memory.

Brake Pressure Sensor

Removal

1. Turn the ignition switch to the OFF position. Apply the parking brake.

WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

2. Place blocks under the front and rear tires to prevent the vehicle from moving.
3. If necessary, raise the vehicle off the ground and place safety stands under the vehicle.
4. Relieve line pressure by bleeding the air from the appropriate supply tank.
5. Disconnect the wiring harness connector from the brake pressure sensor. Figure 4.17.

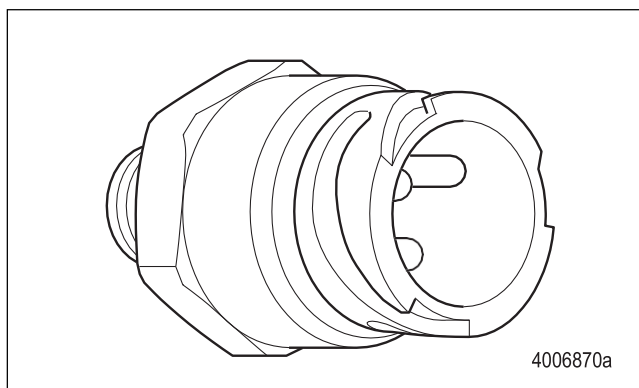


Figure 4.17

6. Disconnect the air line or unscrew the brake pressure sensor from the air line fitting.

7. Remove the brake pressure sensor.

Installation

1. Connect the brake pressure sensor to the air line or attach the sensor to the air line fitting.
2. Connect the wiring harness connector to the brake pressure sensor. Hand tighten only.
3. Remove the stands and blocks.
4. Test the installation.

Testing the Installation

To test the brake pressure sensor:

1. Turn the ignition on and verify that the ATC/ESC lamp operates correctly.
2. Start the vehicle and fully charge the reservoirs with air. Shut off the vehicle.
3. Apply the brakes and check for air leaks at the brake pressure sensor.

5 Appendix I — System Configurations

ABS Configurations

Refer to Figure 5.1, Figure 5.2, Figure 5.3, Figure 5.4, Figure 5.5, Figure 5.6 and Figure 5.7 for system configuration layouts.

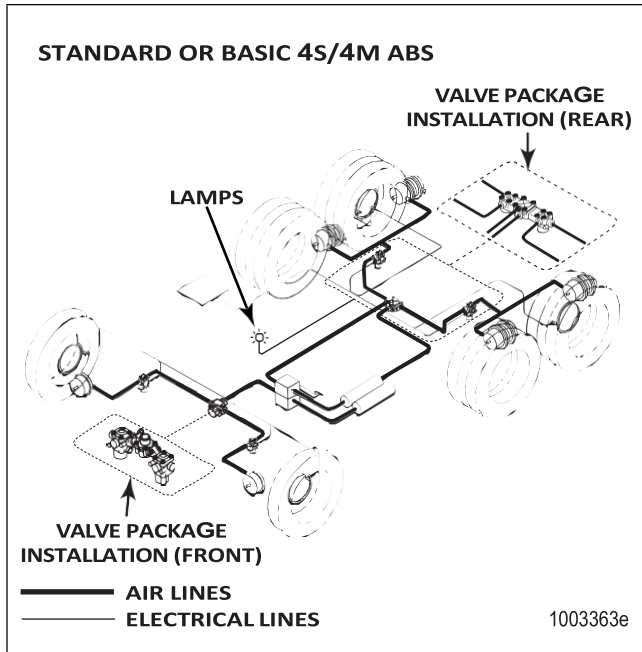


Figure 5.1

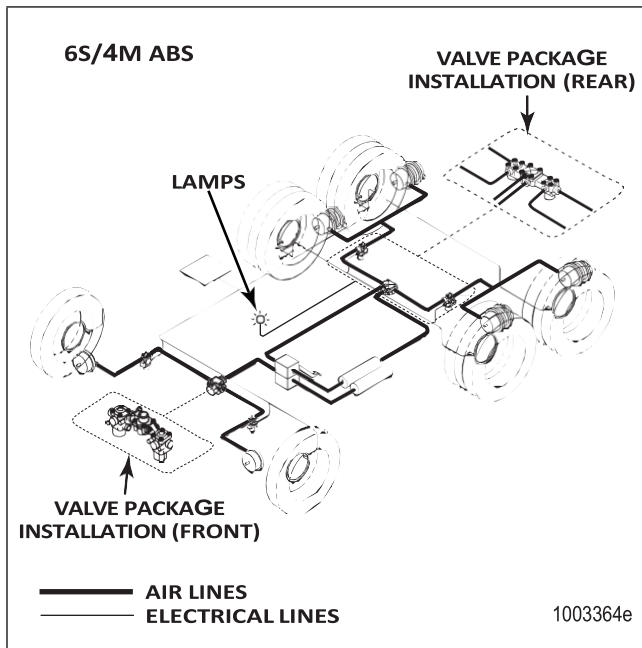


Figure 5.2

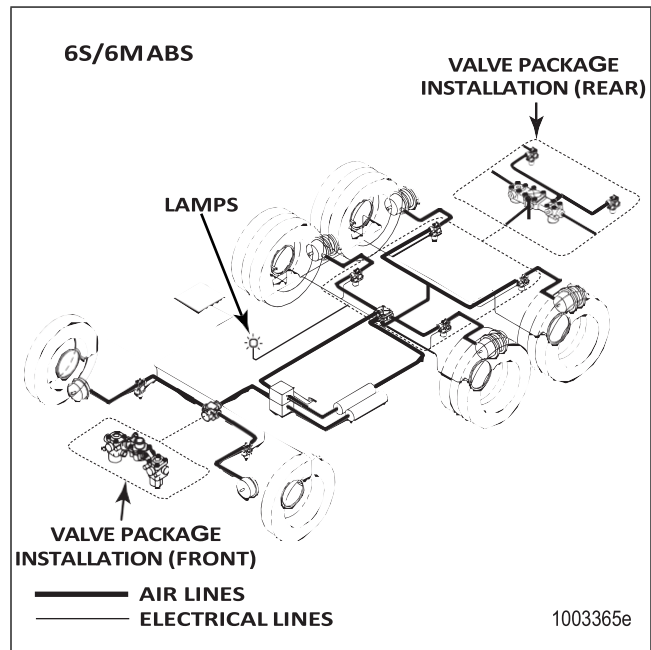


Figure 5.3

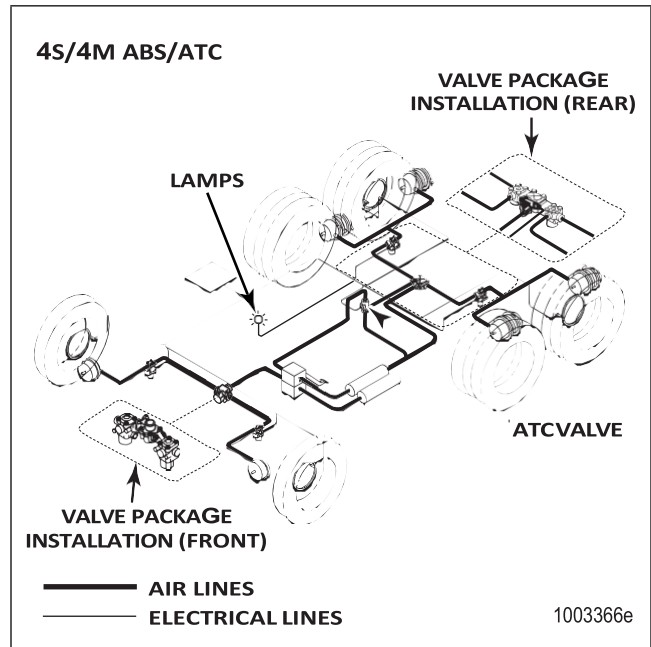


Figure 5.4

5 Appendix I — System Configurations

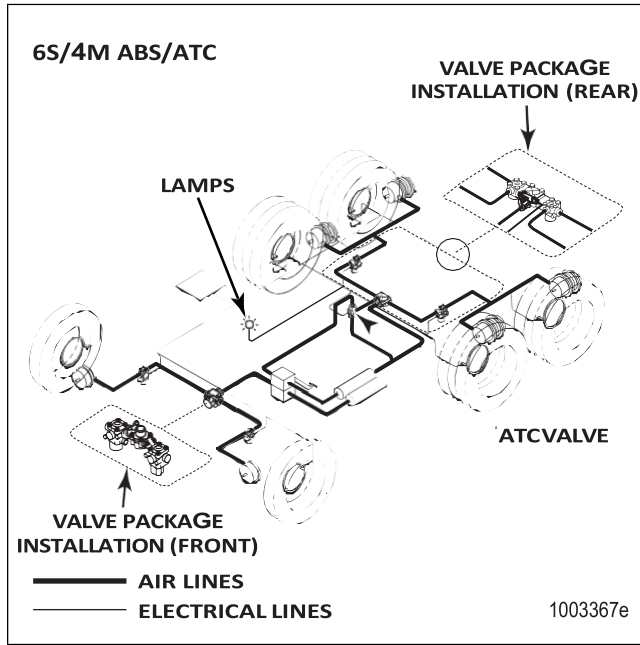


Figure 5.5

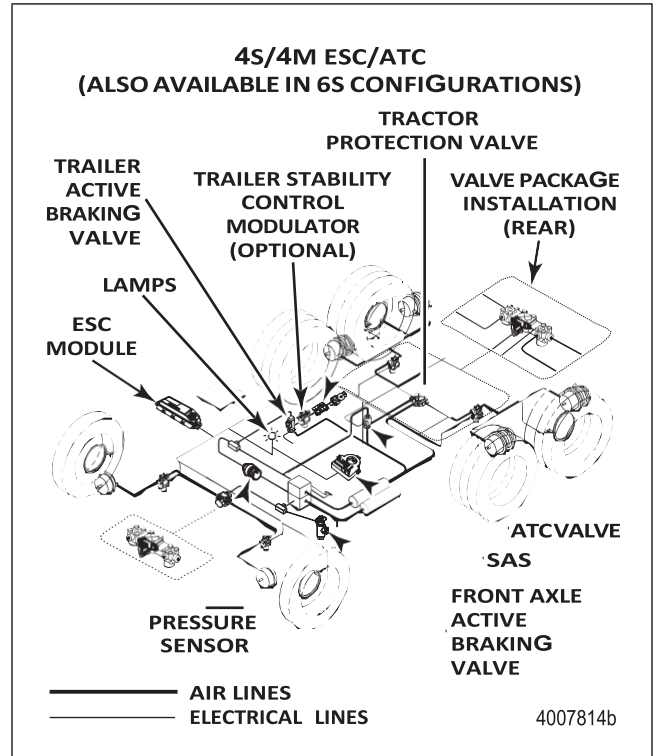


Figure 5.7

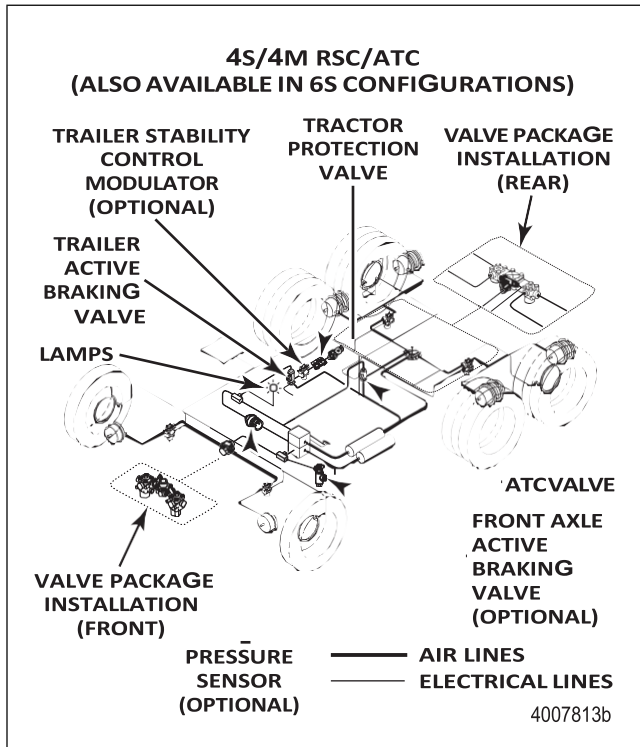


Figure 5.6

6 Appendix II — Wiring Diagrams

ECU Connector Pin Assignments

Refer to Figure 6.1, Figure 6.2, Figure 6.3, Figure 6.4, Figure 6.5, Figure 6.6, Figure 6.7, Figure 6.8, Figure 6.9, Figure 6.10, Figure 6.11, Figure 6.12, Figure 6.13 and Figure 6.14 for ECU wiring diagrams.

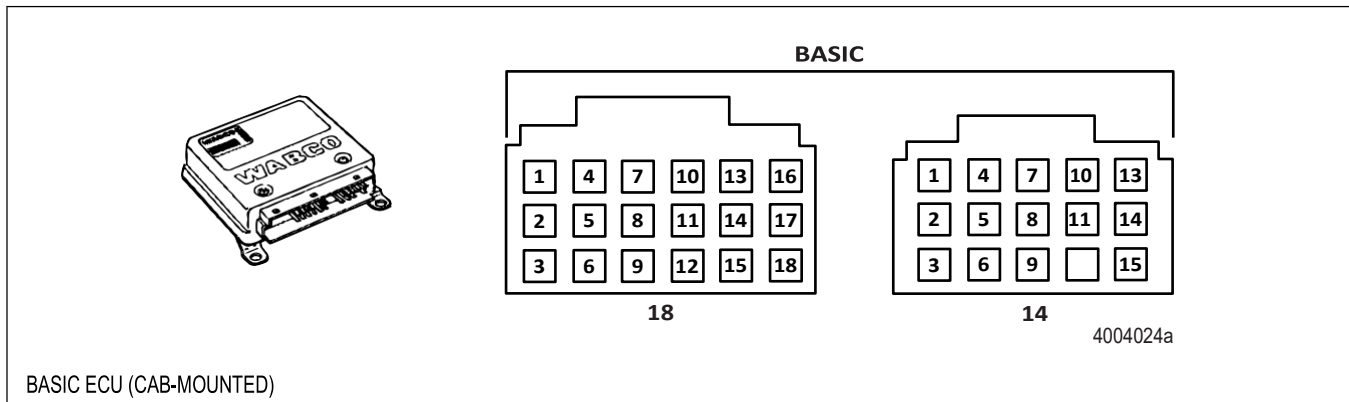


Figure 6.1

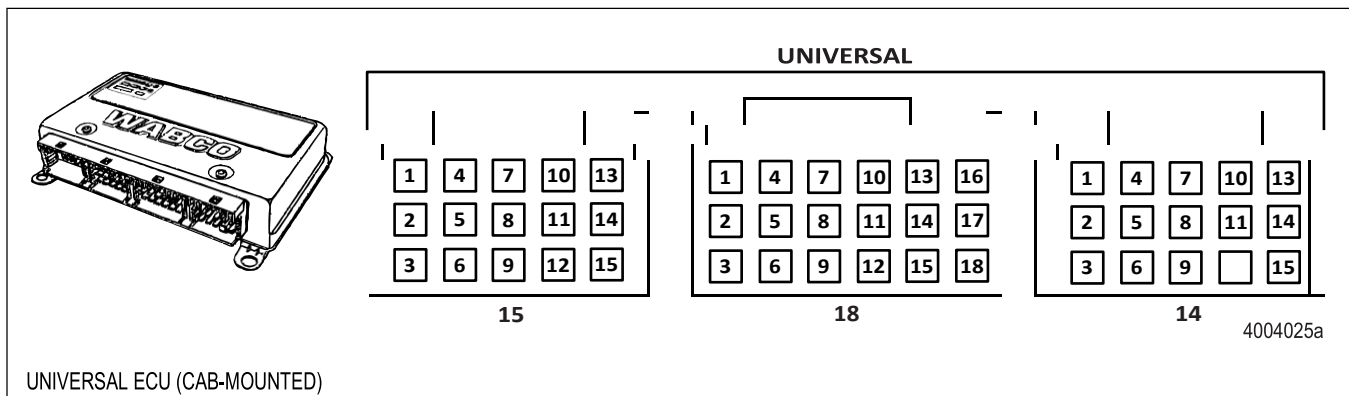


Figure 6.2

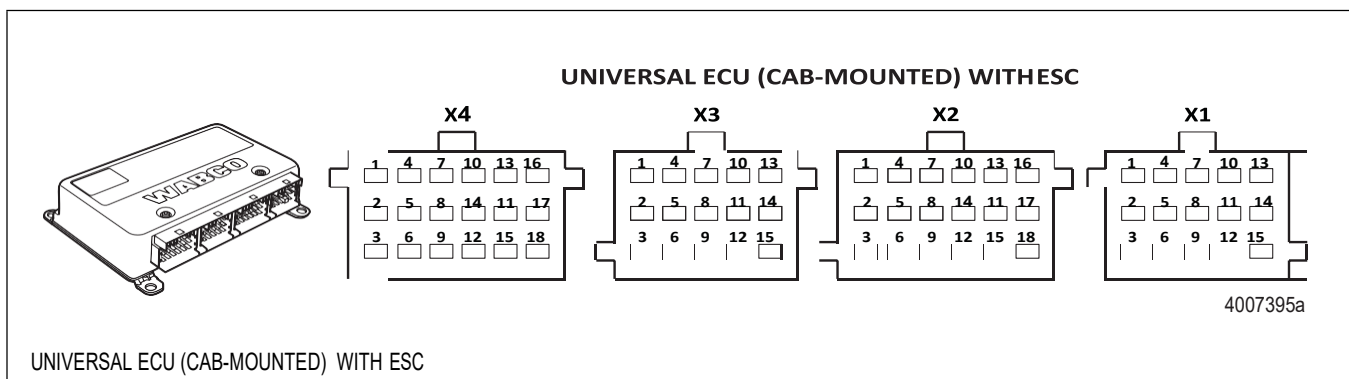


Figure 6.3

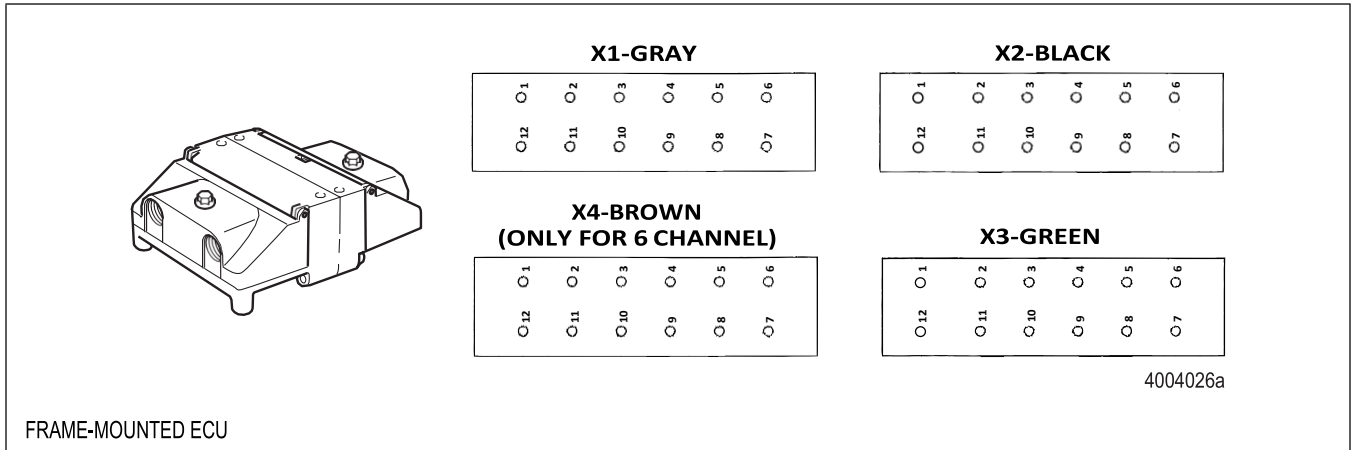


Figure 6.4

ECU (Frame-mounted) with ESC

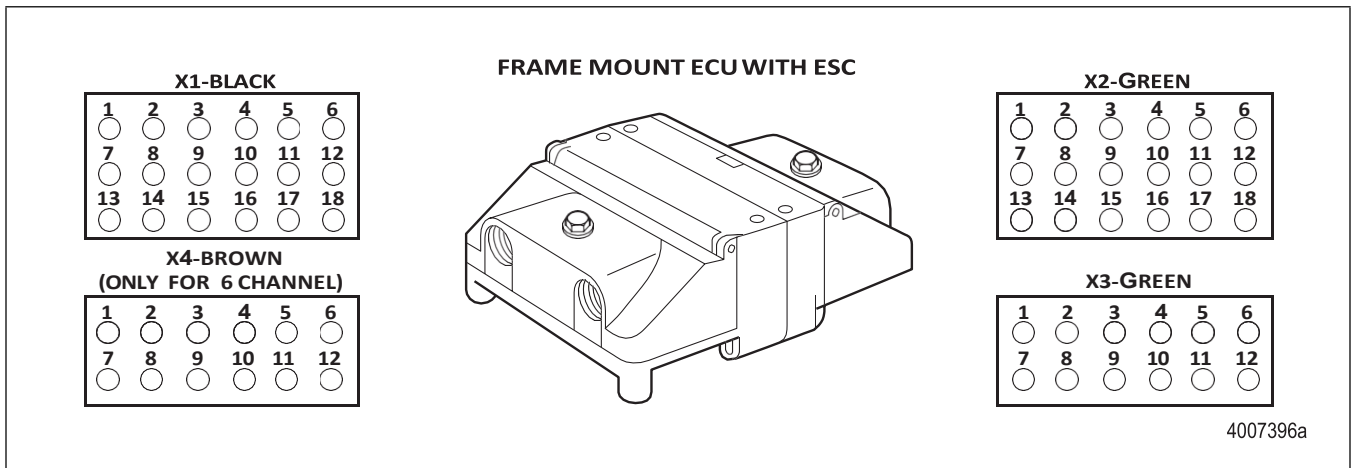
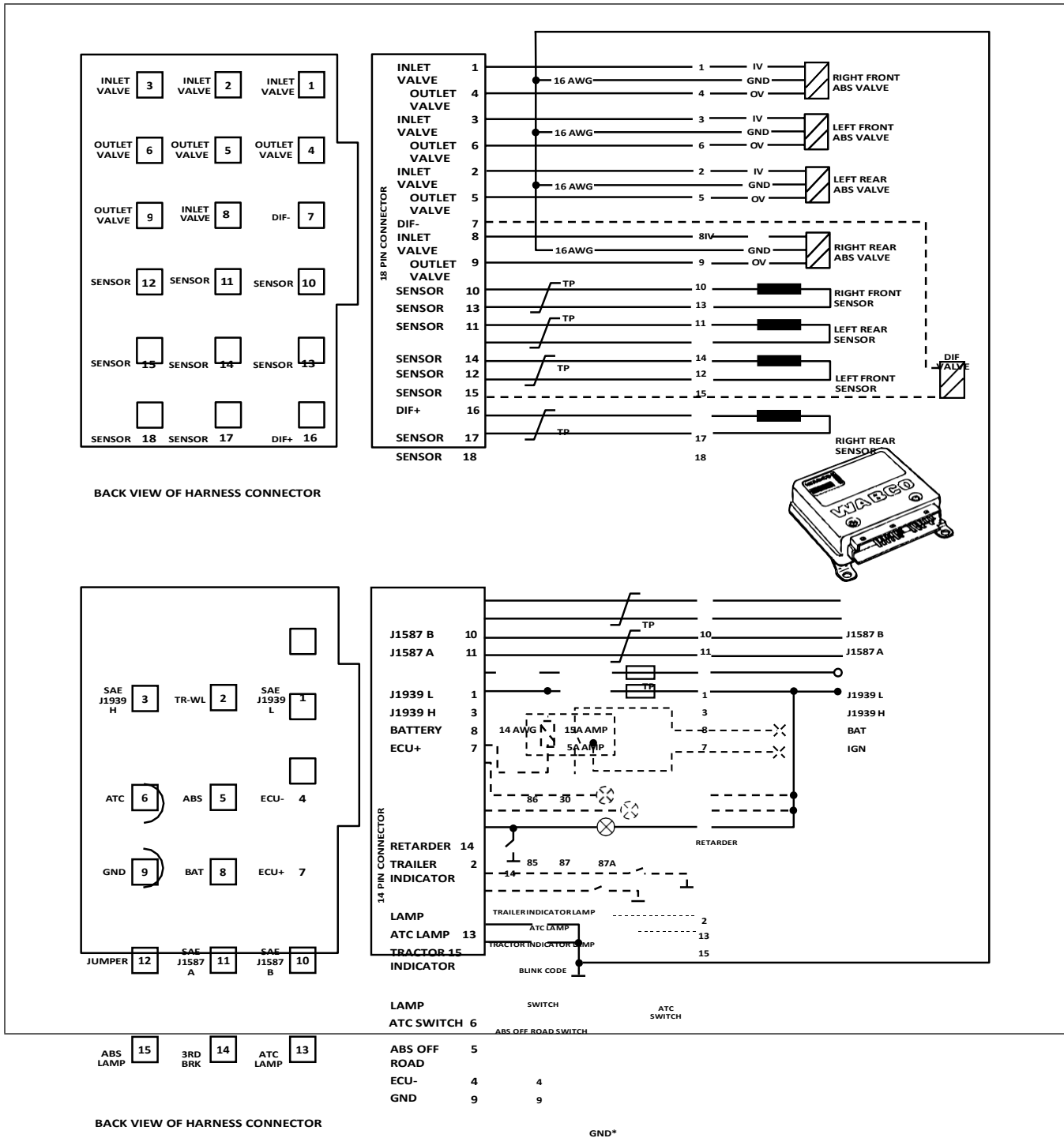


Figure 6.5

6 Appendix II—Wiring Diagrams

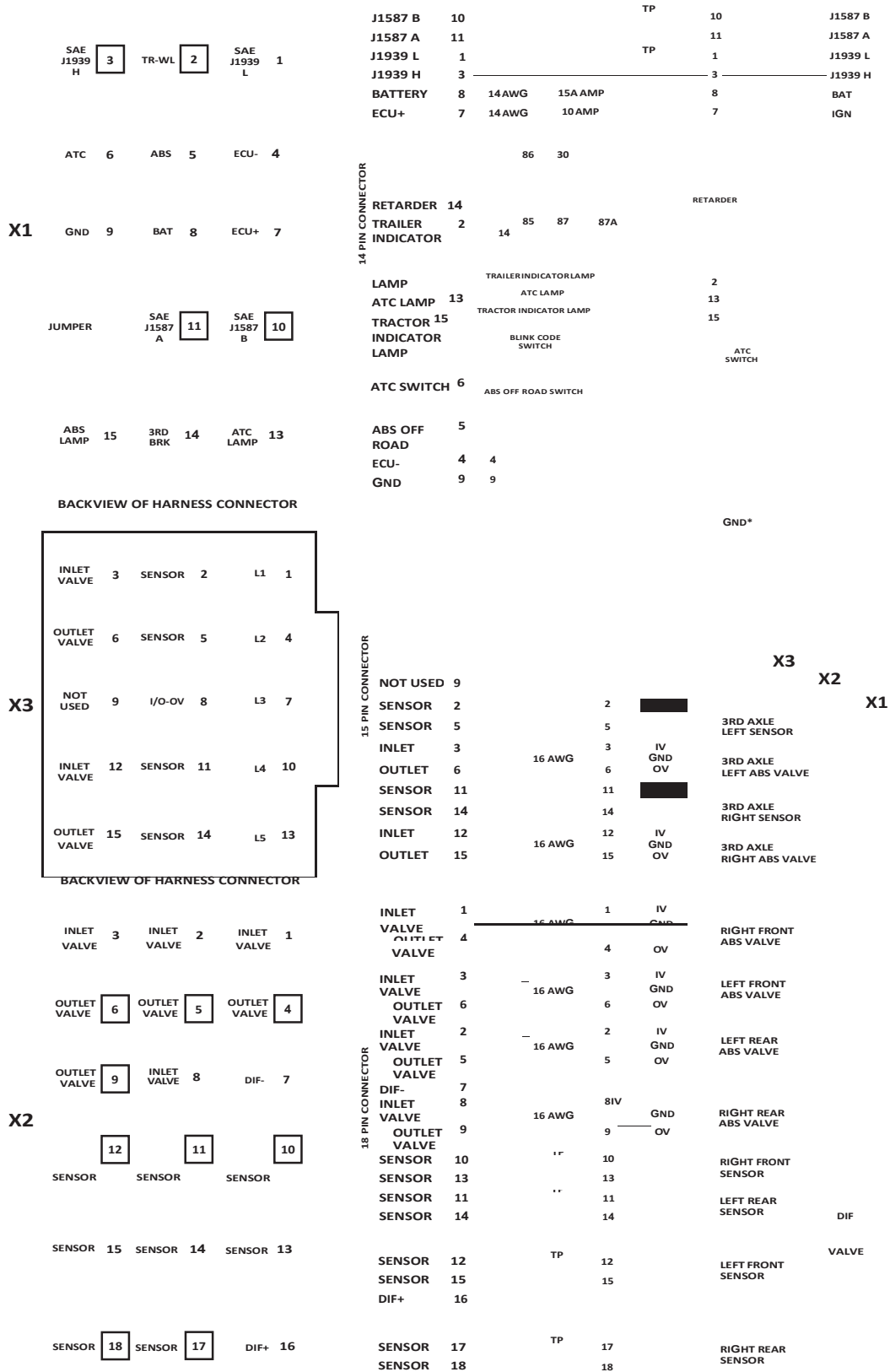
Basic ECU (Cab-mounted)



*All connected to a common star ground.

Figure 6.6

6S/6M Universal ECU (Cab-mounted)

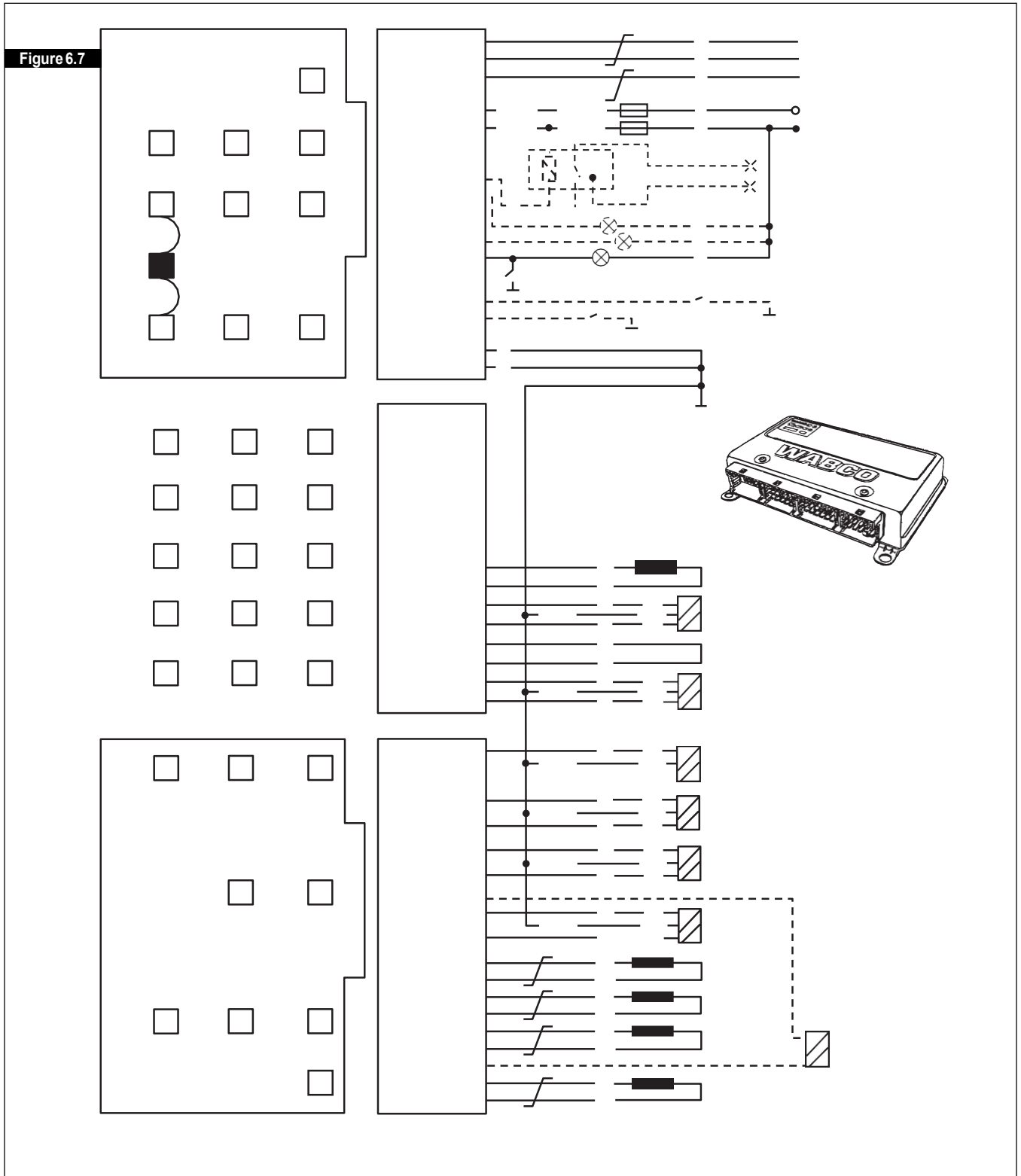


6 Appendix II—Wiring Diagrams

4004030f

BACKVIEW OF HARNESS CONNECTOR

Figure 6.7



6 Appendix II—Wiring Diagrams

GND

9 9

BACKVIEW OF HARNESS CONNECTOR

GND*

Momentary Switch

----- **Optional Equipment**

Twisted Pair = TP

All unmarked wires should be 16 or 18 AWG.

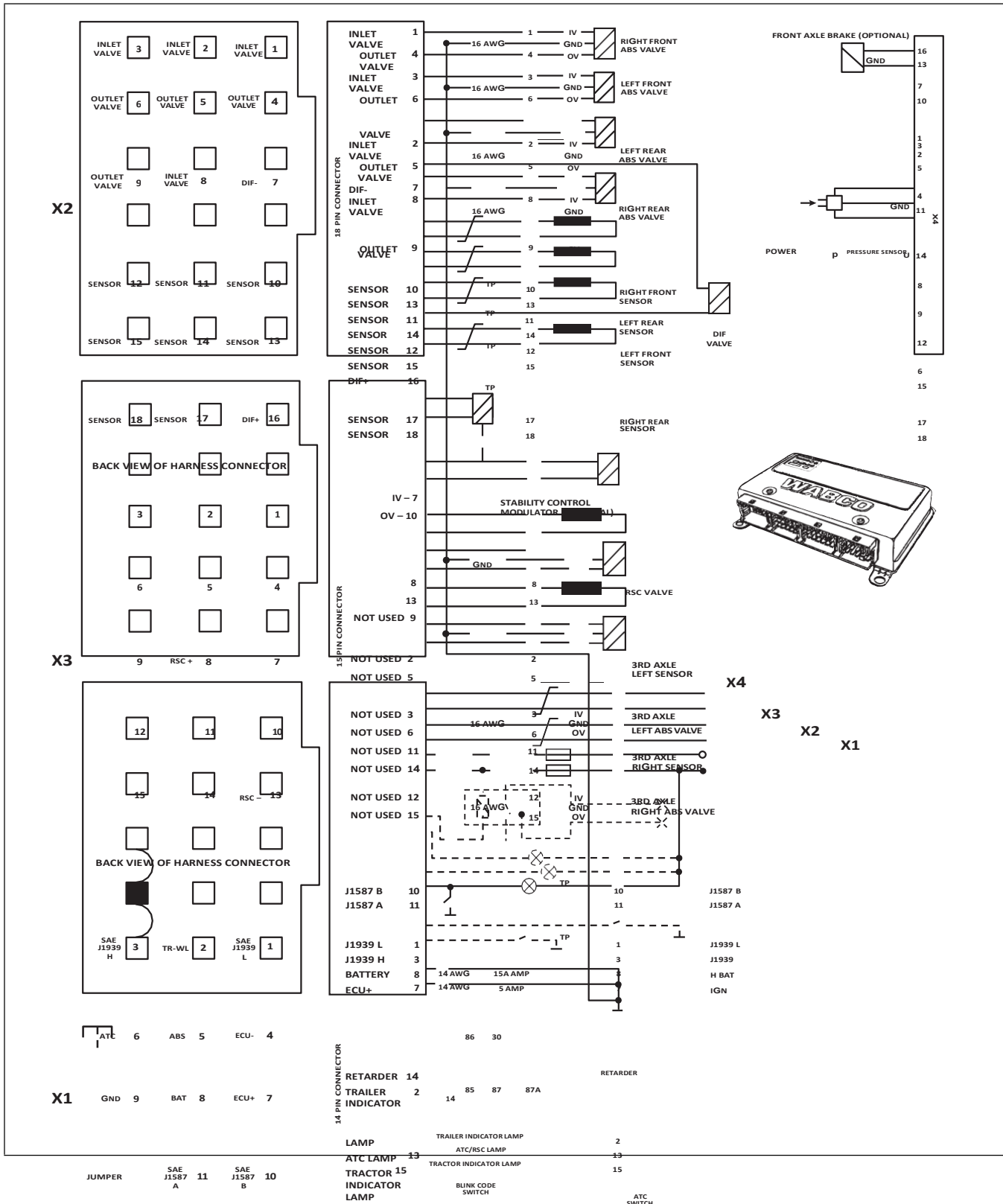
All fuses should be blade type.

***All connected to a common star ground.**

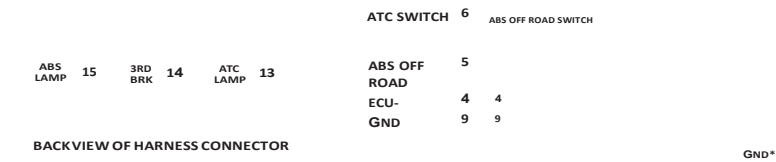
4004030g

Figure 6.8

6S/6M Universal ECU (Cab-mounted) with RSC with Front Axle Brake (6S/4M and 4S/4M Configurations are also available)



6 Appendix II—Wiring Diagrams



Momentary Switch

----- Optional Equipment

Twisted Pair = TP

All unmarked wires should be 16 or 18 AWG.

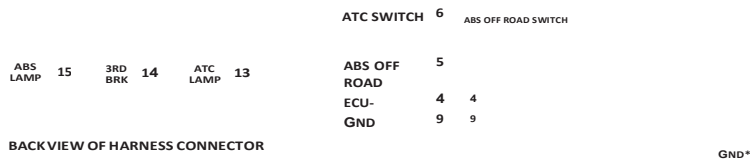
All fuses should be blade type.

*All connected to a common star ground.

4004030h

Figure 6.9

6 Appendix II—Wiring Diagrams



Momentary Switch

----- **Optional Equipment**

Twisted Pair = TP

All unmarked wires should be 16 or 18 AWG.

All fuses should be blade type.

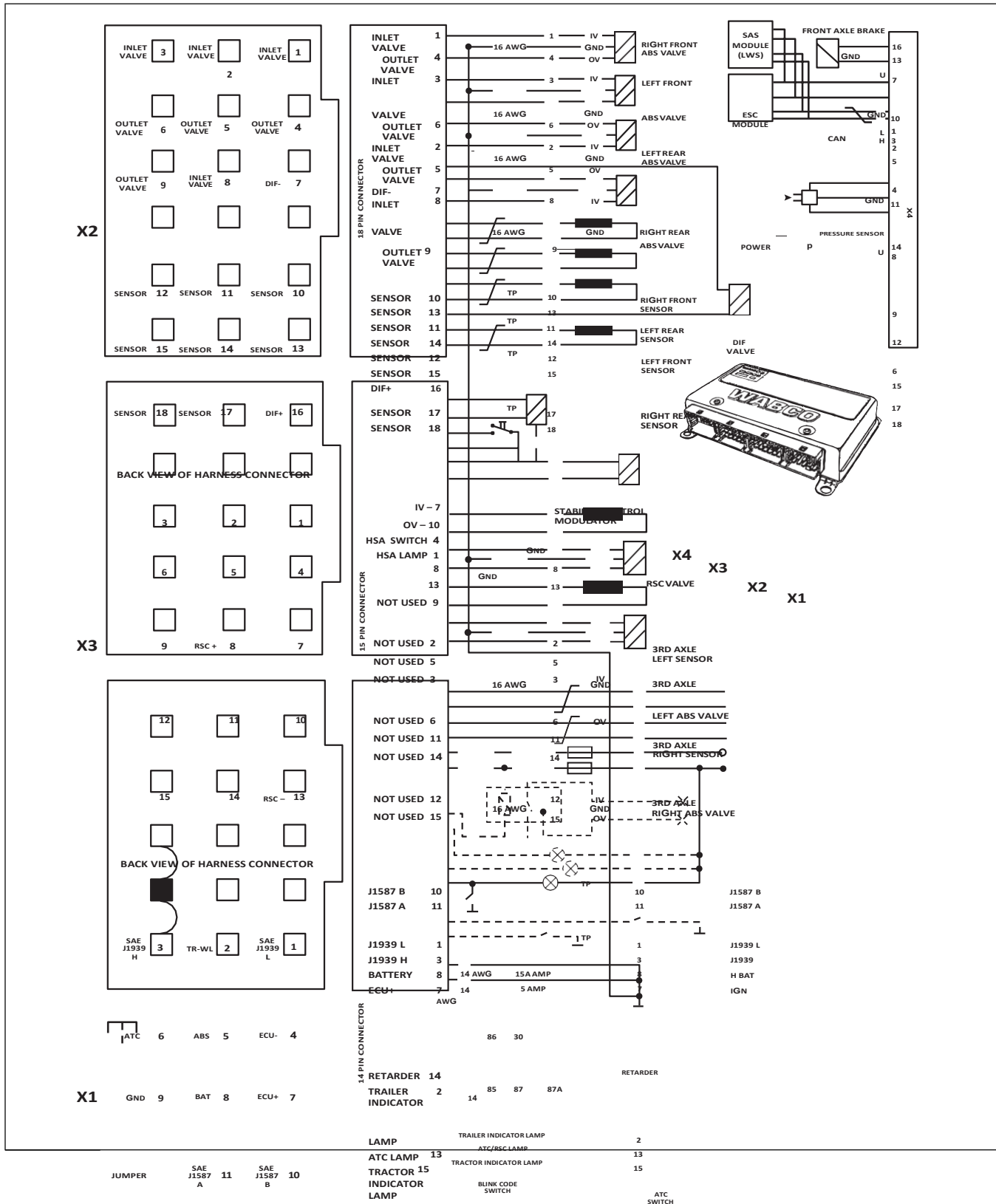
***All connected to a common star ground.**

4007397a

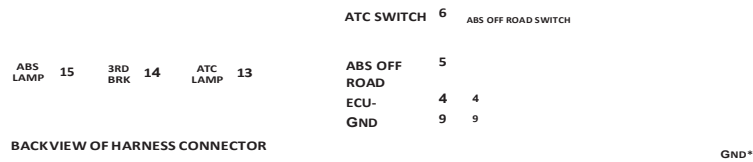
Figure 6.10

6 Appendix II—Wiring Diagrams

Hill Start Aid (HSA) for 6S/6M Universal ECU (Cab-mounted) with ESC (6S/4M and 4S/4M Configurations are also available)



6 Appendix II—Wiring Diagrams



Momentary Switch

----- Optional Equipment

Twisted Pair = TP

All unmarked wires should be 16 or 18 AWG.

All fuses should be blade type.

*All connected to a common star ground.

4008457a

Figure 6.11

Frame-mounted ECU

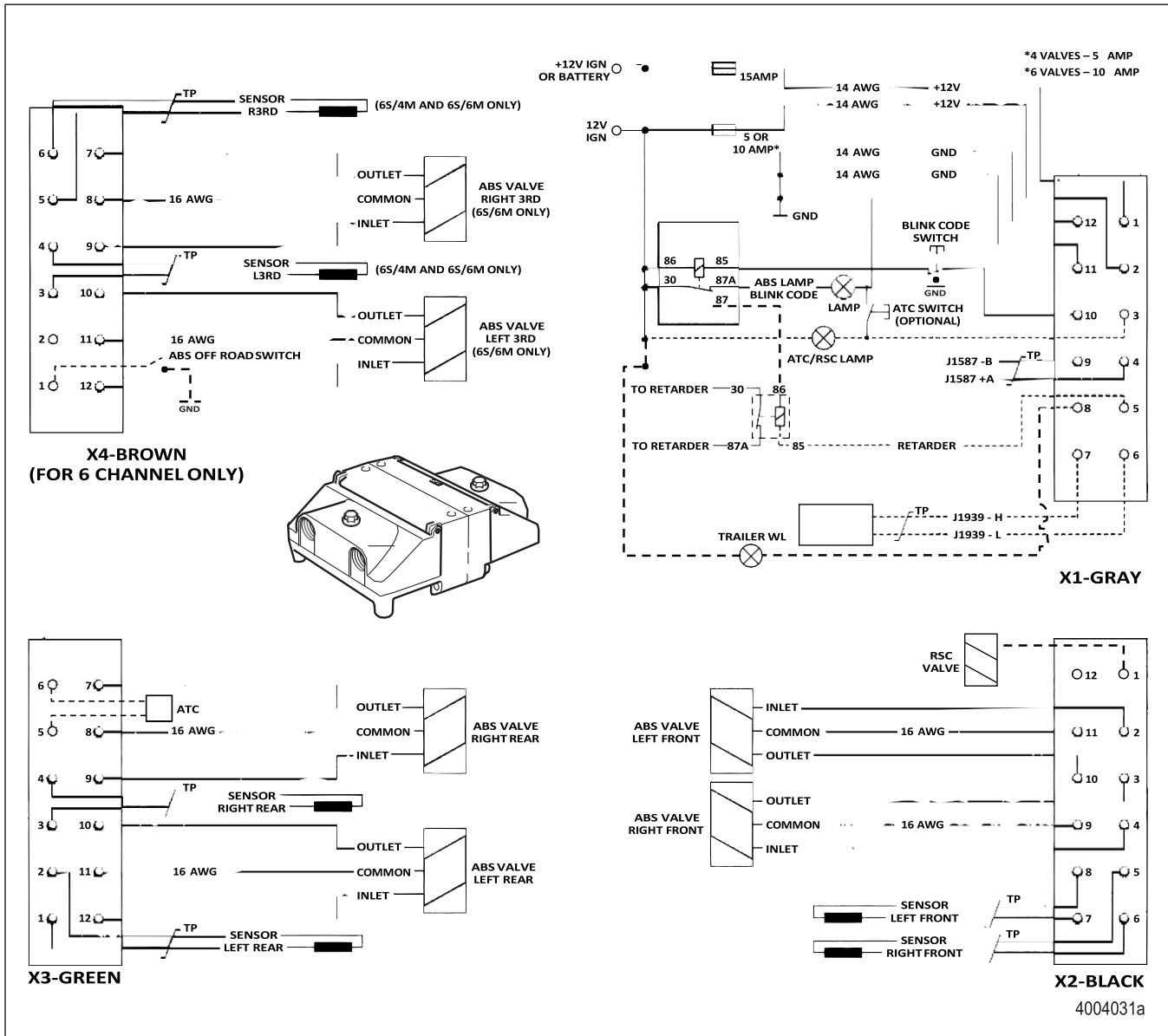


Figure 6.12

6 Appendix II — Wiring Diagrams

6S/6M Frame-mounted ECU with ESC (6S/4M and 4S/4M Configurations are also available)

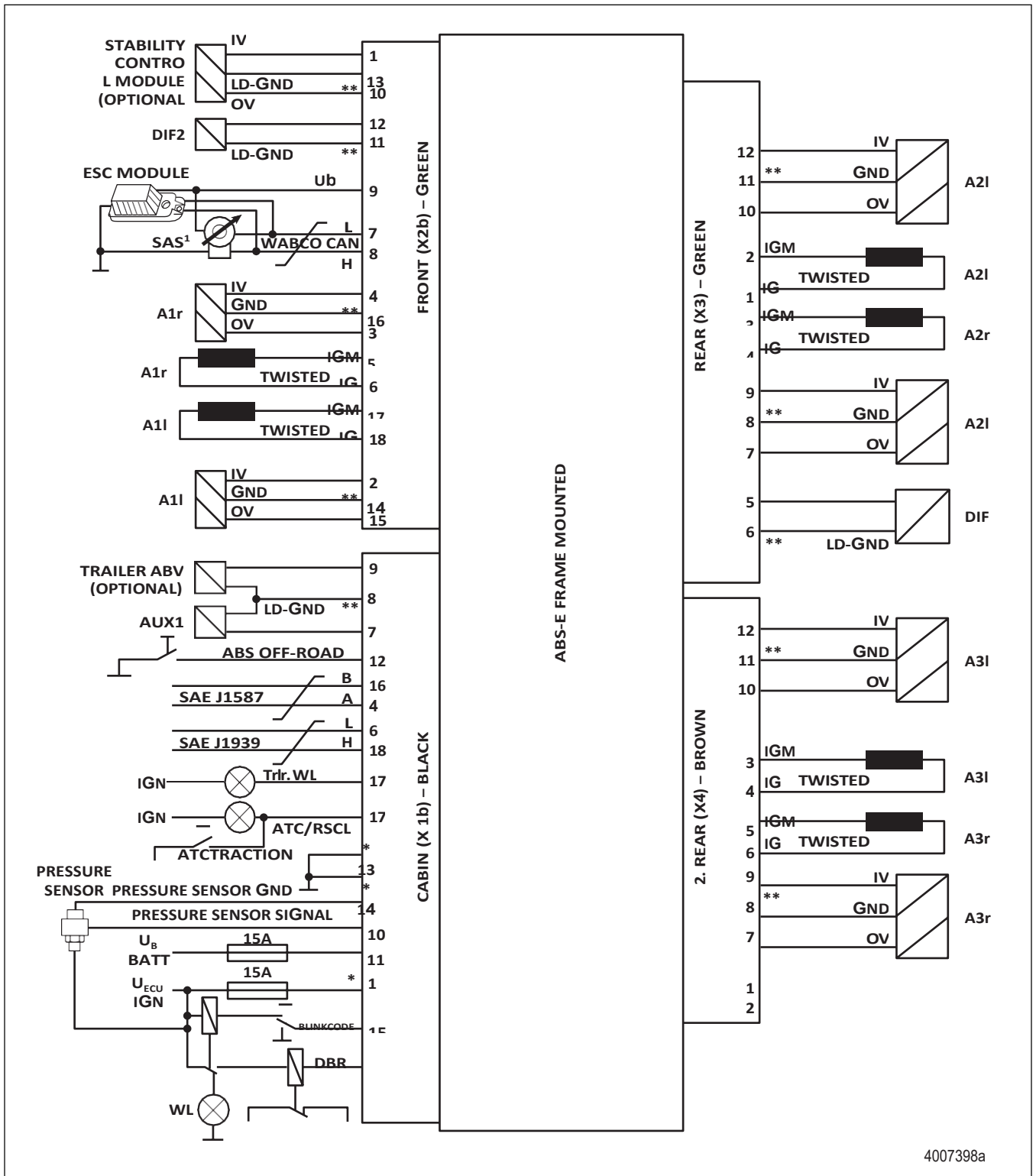
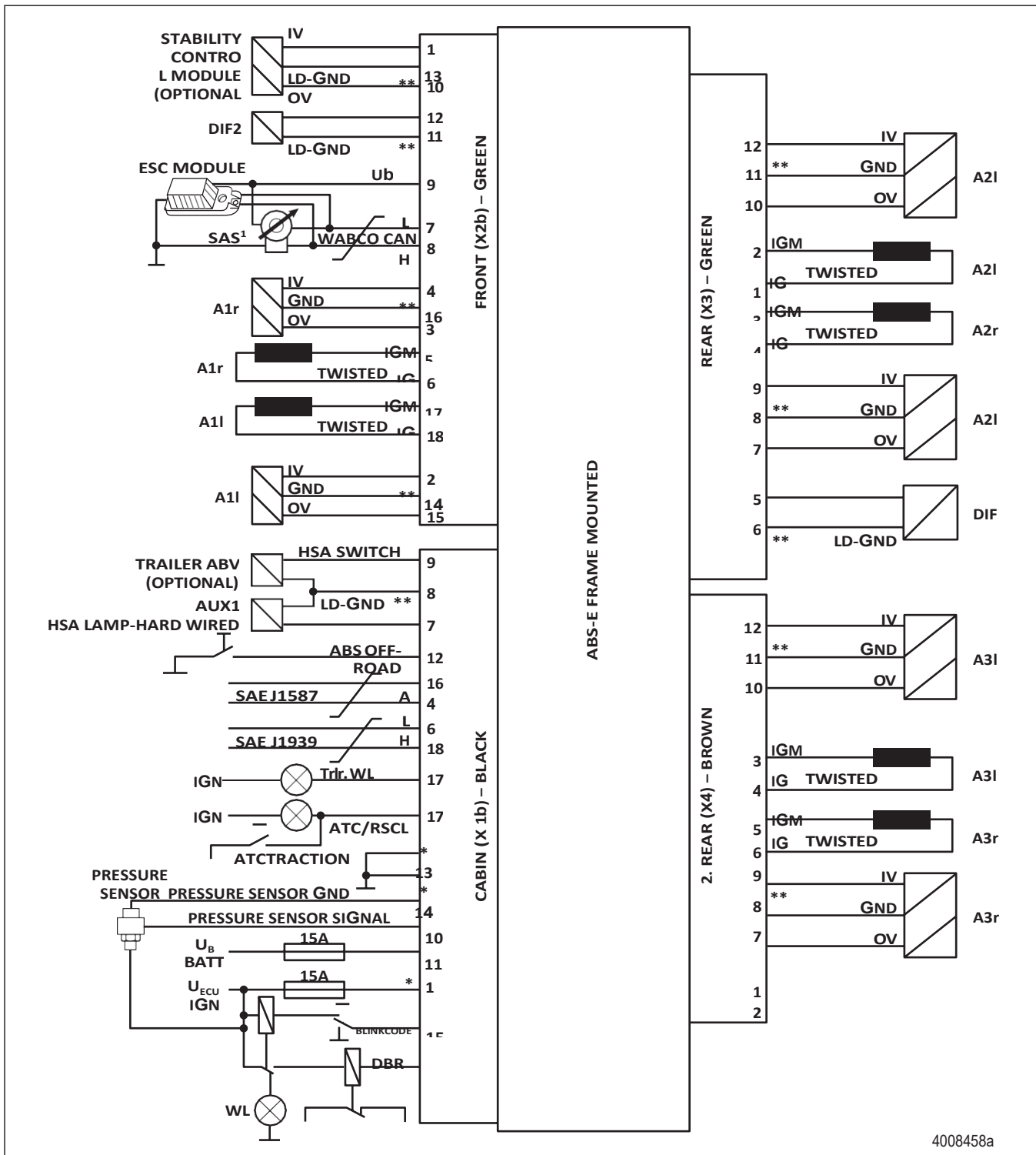


Figure 6.13

4007398a

Hill Start Aid (HSA) for 6S/6M Frame-mounted ECU with ESC (6S/4M, 4S/4M and HSA without ESC are also available)



4008458a

Figure 6.14

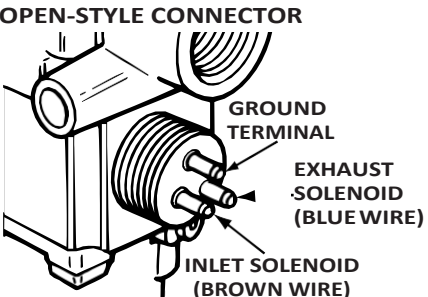
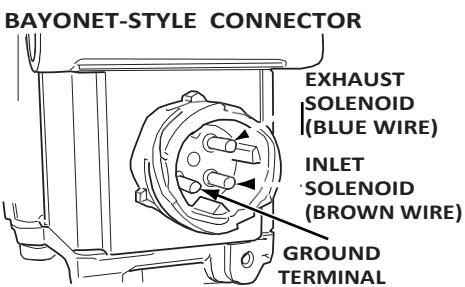
7 Appendix III — Additional ABS Information

Troubleshooting

Meritor WABCO ABS Valve Package

This troubleshooting information is a reference tool to help identify possible malfunctions of the ABS modulator or relay valves. It does not take the place of diagnostic tests or other service instructions.

Condition	Possible Cause	Recommended Action
Air constantly leaks from exhaust port of relay valve.	Internal relay valve problem.	Replace the relay valve.
Air leaks from exhaust port of ABS modulator valve or relay valve when parking brake is released.	Parking brake problem. OR Anti-compound 2-way check valve problem.	Service the appropriate component. <ul style="list-style-type: none">• Refer to manufacturer's service manual for instructions.
Rear service brakes releasing slowly (brakes dragging).	Kinked air line. Dirt buildup inside relay valve.	Inspect/repair lines, brakes. If the condition is not corrected: <ul style="list-style-type: none">• Replace the relay valve.

Condition	Possible Cause	Recommended Action
<p>Valves don't cycle at power-up.</p> <p>OR</p> <p>Indicator lamp comes on (blink code or diagnostic tool indicates electrical problem with ABS valve).</p>	<p>Broken wire.</p> <p>OR</p> <p>Loose or broken terminal connection.</p> <p>Corroded connector pins.</p> <p>OR</p> <p>Problem with solenoid.</p>	<p>Check the wires and connections.</p> <ul style="list-style-type: none"> • Make repairs as needed. <p>If condition is not corrected: Measure resistance across each valve solenoid coil terminal and ground on the ABS modulator valve to ensure 4.0 to 8.0 ohms (11-21 for 24V system).</p> <ul style="list-style-type: none"> • If greater than 8.0 ohms or 21 ohms for 24V system, clean the valve and repeat the measurement. <ul style="list-style-type: none"> — If cleaning does not solve the problem, replace the ABS modulator valve. • If less than 4.0 ohms (11 for 24V system), replace the ABS modulator valve.
 <p>OPEN-STYLE CONNECTOR</p> <p>GROUND TERMINAL</p> <p>EXHAUST SOLENOID (BLUE WIRE)</p> <p>INLET SOLENOID (BROWN WIRE)</p>		
4004032a		
 <p>BAYONET-STYLE CONNECTOR</p> <p>EXHAUST SOLENOID (BLUE WIRE)</p> <p>INLET SOLENOID (BROWN WIRE)</p> <p>GROUND TERMINAL</p>		
4004033a		
<p>ABS valve package damaged.</p>	<p>Road hazards.</p> <p>OR</p> <p>Vehicle damage.</p>	<p>Replace the complete ABS valve package or individual component as required.</p>

Reconfiguration Procedure

How to Reconfigure an ECU (E Version)

Before reconfiguring the ECU, contact ArvinMeritor's Customer Service Center at 866-OnTrac1 (668-7221) for additional information.

E version ECUs memorize the following components if they are connected at power-up:

- ATC valve
- Retarder relay
- Datalink SAE J1939

NOTE: The ATC valve and Datalink SAE J1939 are required for RSC/ESC. The RSC/ESC ECUs cannot be reconfigured to remove these components. Only the retarder relay is memorized or cleared.

Once these components have been memorized, the ECU will look for them at each power-up. If a memorized component is not present, the ECU will record a fault. For example, if an ATC valve is memorized, but is not present at the next power-up, the ECU records a fault. This can occur if an ECU is moved from one truck to another and one or more of the memorized components are not available on the new truck. If this occurs, use TOOLBOX™ Software to reconfigure the ECU. If you do not have TOOLBOX™ Software, follow the manual reconfiguration instructions in this section.

TOOLBOX™ Software

NOTE: For complete instructions for using TOOLBOX™ Software, refer to the TOOLBOX™ User's Manual, TP-99102.

To reconfigure the ECU with TOOLBOX™ Software, use the *Reset Memorized* command.

Select *Reset Memorized* from the pull down menu to tell the ECU to reset the memorized or “learned” components. Figure 7.1 and Figure 7.2.

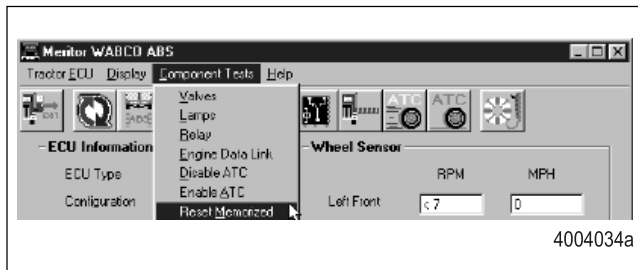


Figure 7.1



Figure 7.2

Manual Reconfiguration

Refer to Table E and Figure 7.3 for information on manual reconfiguration.

7 Appendix III — Additional ABS Information

Table E:

Action	Result	Reason
1. Turn the ignition ON. 2. Press and hold the blink switch for at least three seconds. NOTE: Do not hold this switch longer than seven seconds.	The ABS lamp displays the ABS system configuration code: <ul style="list-style-type: none"> • One blink: 6S/6M • Two blinks: 4S/4M • Four blinks: 6S/4M NOTE: The ABS lamp may display eight quick flashes before the system configuration code begins.	Stored faults cleared, no active faults present. Continue with reconfiguration. NOTE: The reconfiguration procedure cannot be conducted if there are active faults present. These must be repaired before proceeding with the reconfiguration.
Observe the ABS and ATC lamps.	The ATC lamp comes on and stays on. The ABS lamp will continuously blink the system configuration code.	A complete ATC system — including an ATC lamp — is installed. If not, the ATC lamp will not come on. ECU reconfiguring the system. The ECU checks the following components and reprograms itself based on the new system: <ul style="list-style-type: none"> • ATC valve AND/OR • Retarder relay AND/OR • Datalink J1939
While the configuration code is flashing, press the blink code switch three times (one second each, with a one second pause between each). Turn the ignition OFF.	The ABS lamp displays four quick flashes, followed by a continuous display of the system configuration code. NOTE: The system configuration code continues until ignition is turned OFF.	Successfully reconfigured.

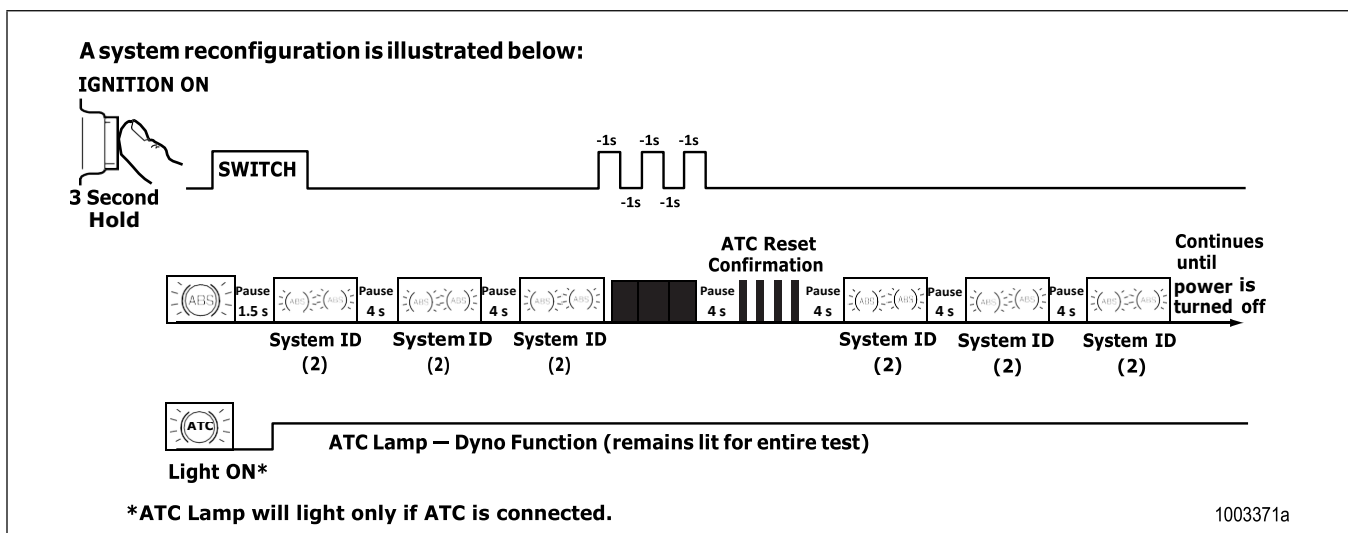


Figure 7.3

ESC End of Line Calibration Procedure

This procedure is performed as part of the final assembly of the vehicle at the manufacturing site. Also, this procedure must be performed in the field by a trained technician if components are replaced such as the Steering Angle Sensor (SAS), the Electronic Stability Control (ESC) module or the ESC Electronic Control Unit (ECU). This calibration should also be performed when a major steering repair or replacement has taken place.

The process consists of two operations. The first one is the SAS Calibration, followed by the ESC Initialization. The status of the ESC End of Line (EOL) procedure can be verified using one of the following allowed faults.

- SAS not calibrated — SID 89, FMI 13
- ESC initialization required — SID 88, FMI 13
- ESC initialization not completed — SID 88, FMI 1

NOTE: To prevent incorrect activations, SAS Calibration and ESC Initialization must be done separately. It is necessary to perform the SAS calibration prior to the ESC initialization.

For any questions or assistance, please contact the Meritor WABCO OnTrac customer service center at 866-OnTrac1 (668-7221) or visit www.meritorwabco.com for further details.

⚠ CAUTION

Additional faults must not be active. Any other faults must be resolved before one of the main menu items is available.

SAS Calibration

NOTE: The SAS Calibration must be done after a front wheel alignment has been performed.

To access the Meritor WABCO TOOLBOX™ Software, from the desktop screen, double click on the Meritor WABCO PC Diagnostics (TOOLBOX™) icon. Figure 8.1.

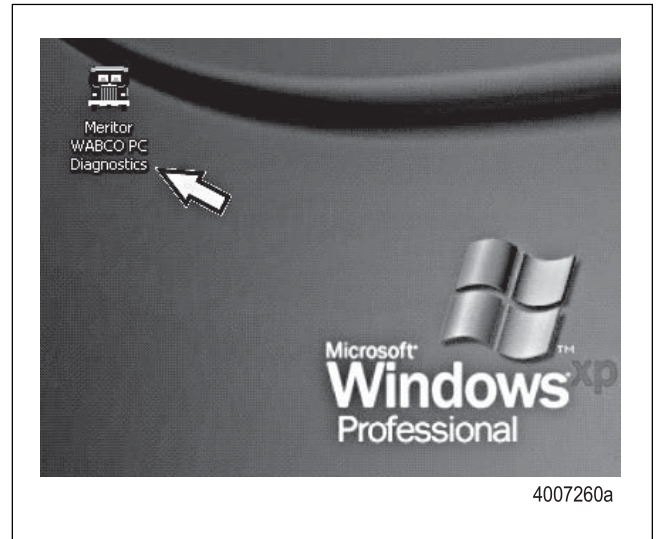


Figure 8.1

From the message box that appears, click on the Pneumatic ABS button. Figure 8.2.

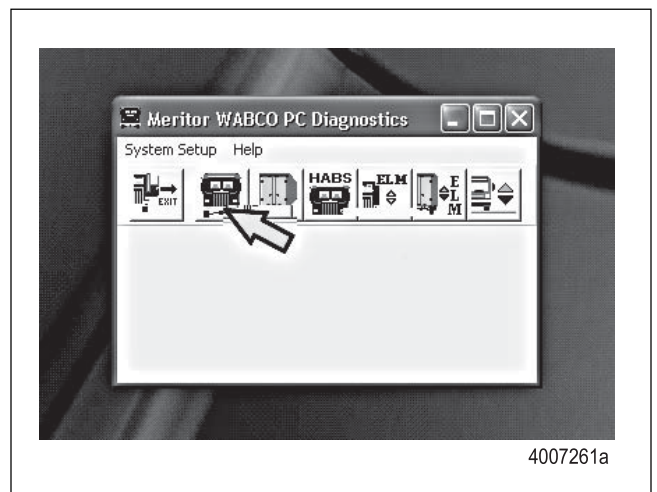


Figure 8.2

To verify the status of the ESC EOL, from the initial screen, double click on the Faults box. Figure 8.3.

8 Appendix IV — ESC Calibrations

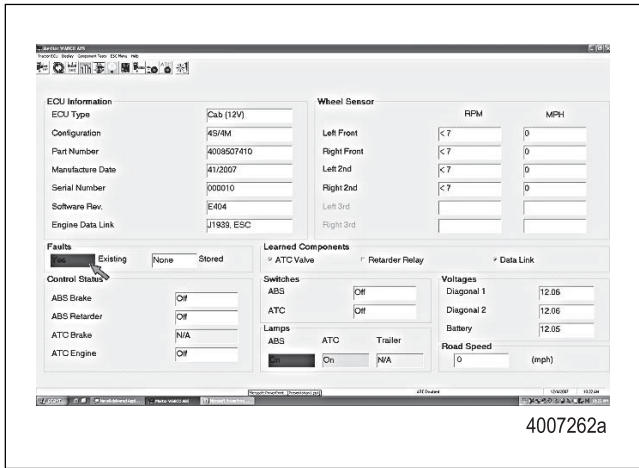


Figure 8.3

This message shows the Steering Angle Sensor code SID 89, FMI 13. Figure 8.4.

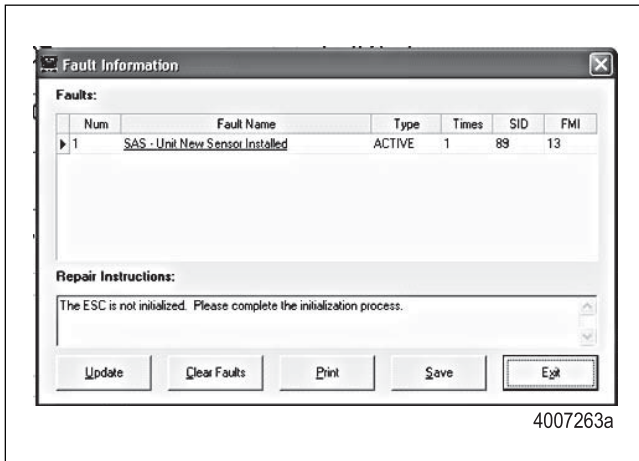


Figure 8.4

To access the ESC EOL, from the bar menu at the initial screen, click on the "ESC Menu" button. A drop box will illuminate. Select the option "End of Line." Figure 8.5.

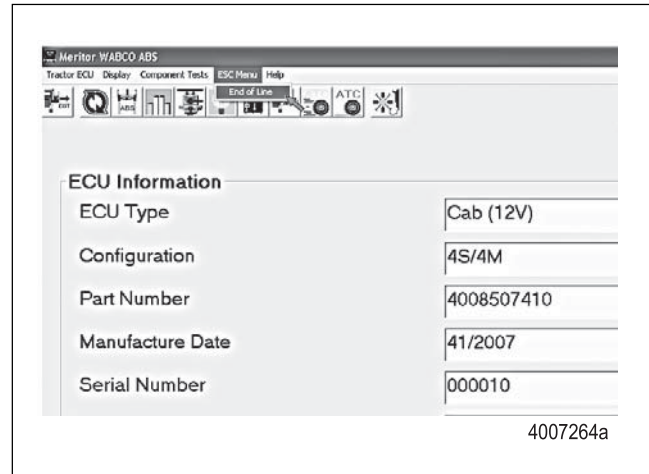


Figure 8.5

In the message box that appears, click the "SAS Calibration" button. Figure 8.6.

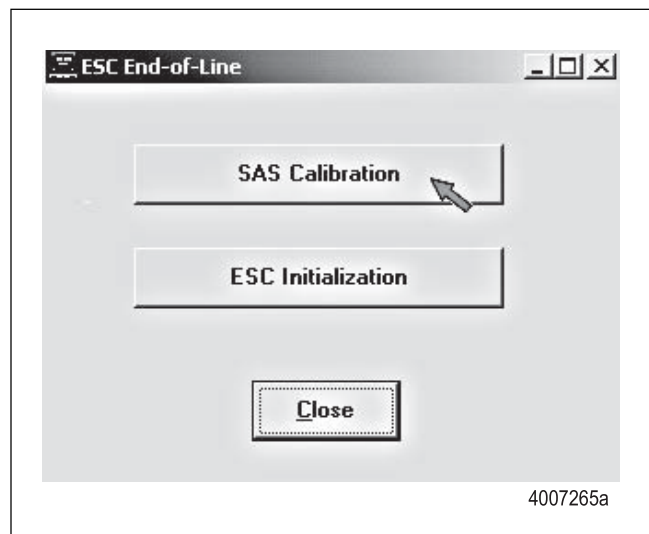


Figure 8.6

Follow the instructions in the message box that appears. Figure 8.7.

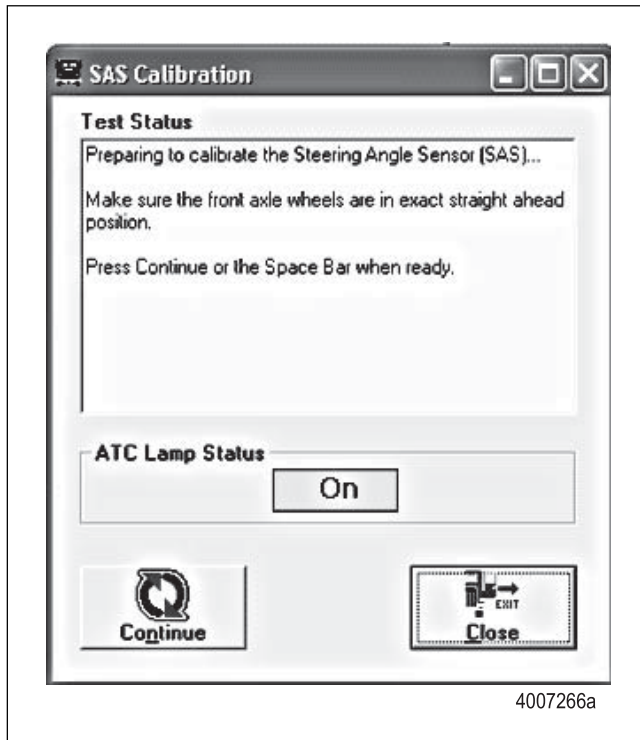


Figure 8.7

The message will let you know when the SAS has been calibrated. Once the SAS is calibrated, press the “Close” button or the space bar to continue. Figure 8.8.

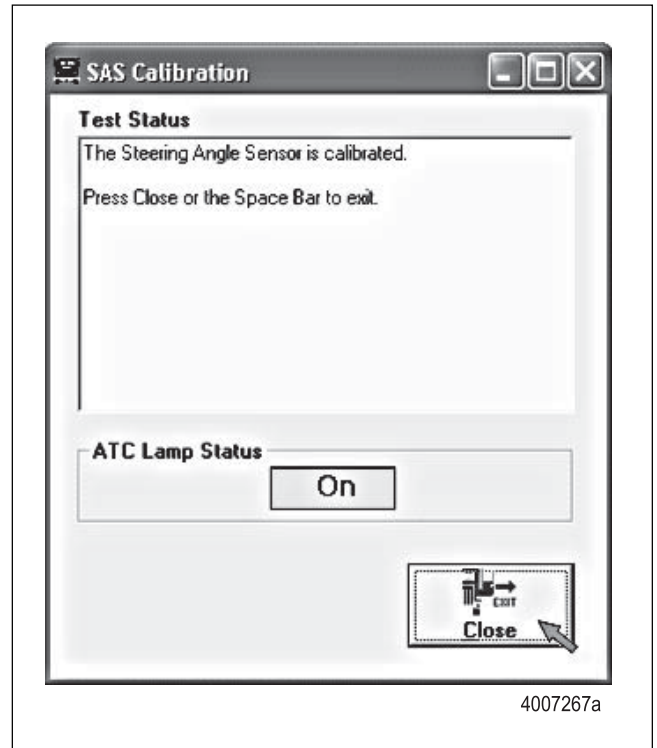


Figure 8.8

The SAS calibration is now completed.

ESC Initialization

To verify the status of the ESC Initialization, from the initial screen, double click on the “Faults” box. Figure 8.9.

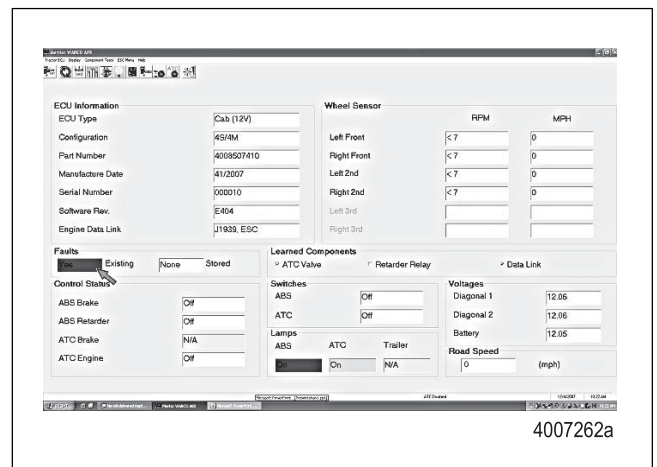


Figure 8.9

The message that appears shows the ESC Initialization Not Complete code SID 88, FMI 1. Figure 8.10.

8 Appendix IV — ESC Calibrations

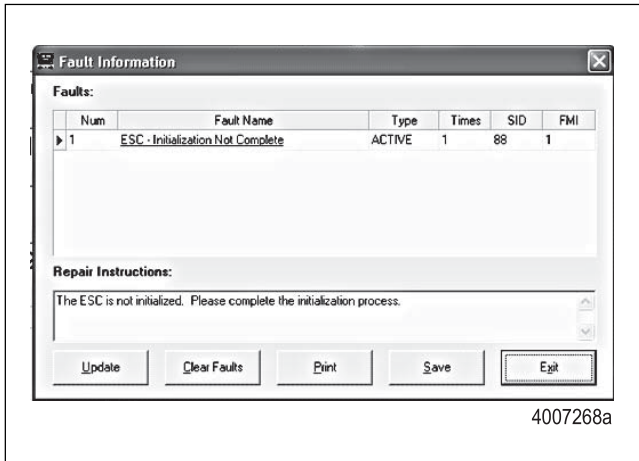


Figure 8.10

From the bar menu at the initial screen, click on the “ESC Menu” button. Select the option “End of Line.” Figure 8.11.

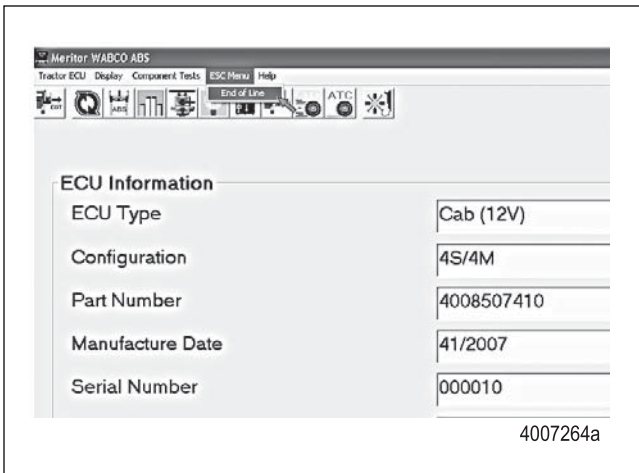


Figure 8.11

This time, click on the “ESC Initialization” button. Figure 8.12.

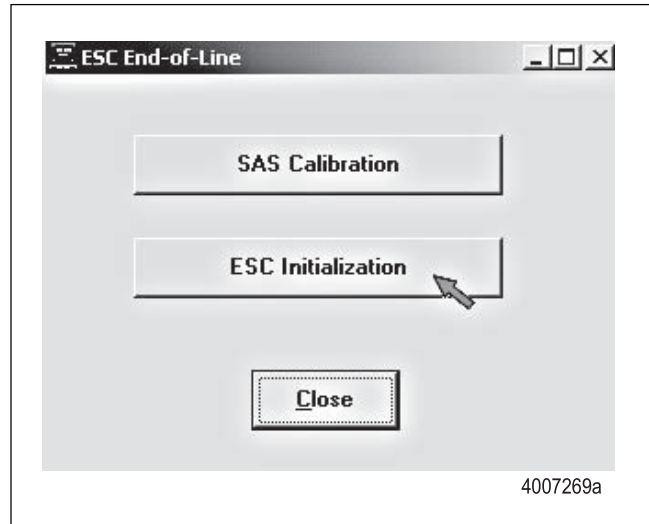


Figure 8.12

Check the message box that appears. Press the space bar or click the “Continue” button when ready to proceed. Figure 8.13.

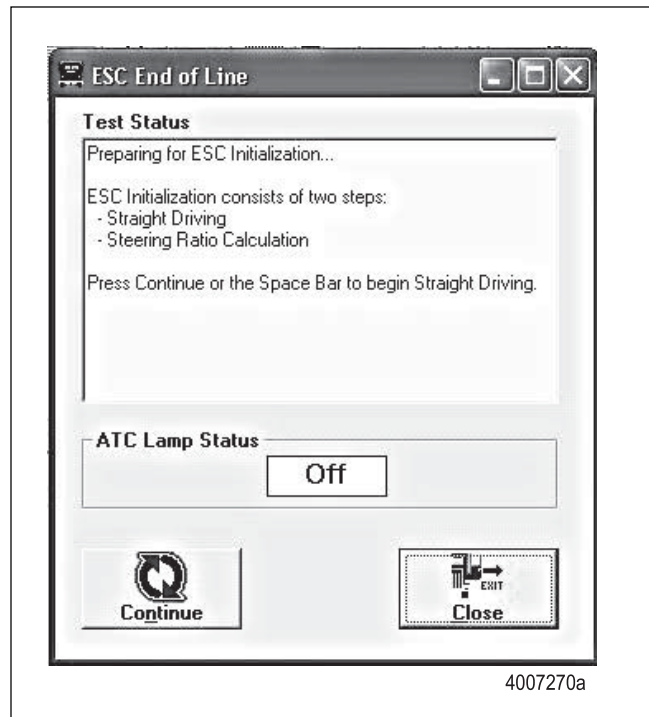


Figure 8.13

Carefully follow the instructions that are in the message box. Figure 8.14. The ESC Initialization procedure requires that the vehicle be driven to complete.

- The ATC lamp will start blinking when the 15 mph speed has been reached.
- When the Straight Driving Adjustment is completed after about 800 feet, the ATC lamp will stop blinking and will be ON solid.

NOTE: The Straight Driving Adjustment can be done in segments as the ECU will accumulate the information until the 800 feet is reached, but must be done within the same ignition cycle.

Click the “Continue” button.

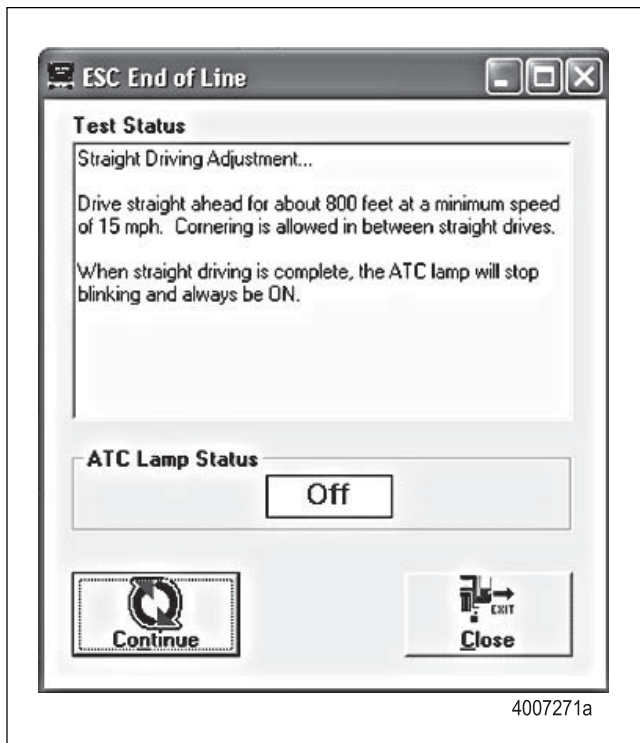


Figure 8.14

This message will appear after the Straight Driving Adjustment is completed. Figure 8.15. Carefully read the message for the Calculation of Steering Ratio and follow the instructions. Click the “Continue” button and start driving the vehicle in a circle with the steering wheel rotated 360 degrees in one direction.

NOTE: The circle driving (Calculation of Steering Ratio) can be done in segments as the ECU will accumulate the information until the desired distance is reached, but must be done within the same ignition cycle. The calibration requires driving in both directions with the steering wheel rotated 360 degrees.

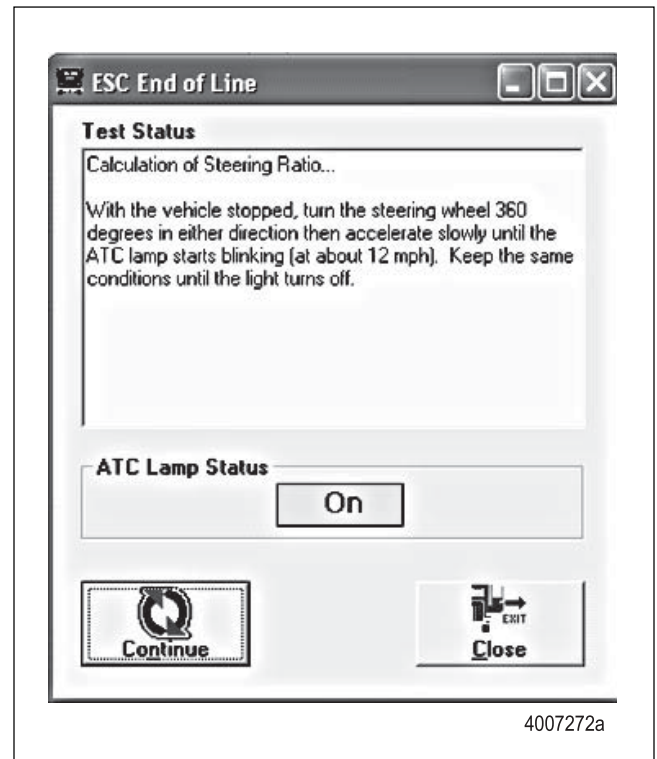


Figure 8.15

Read this message box carefully. Figure 8.16. The ATC lamp will start blinking when the required conditions are met. Keep driving until the ATC lamp turns off. Stop the vehicle and click the “Continue” button.

8 Appendix IV — ESC Calibrations

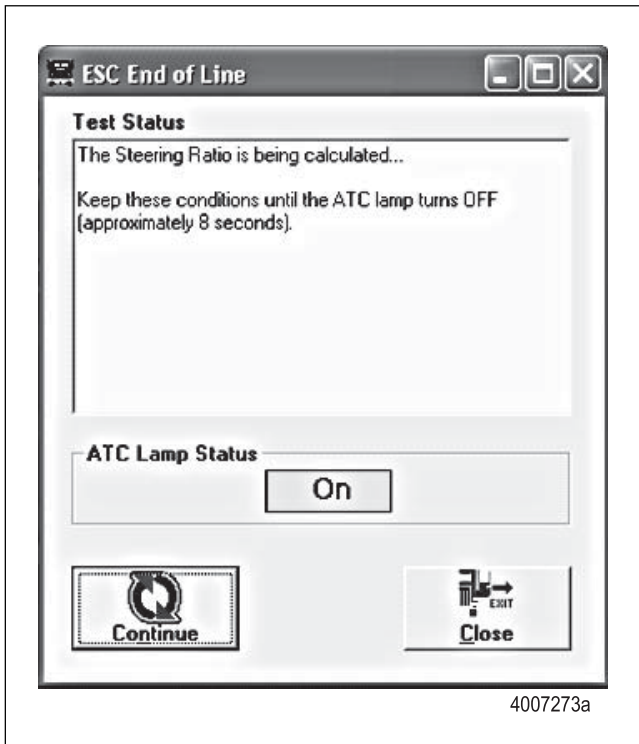


Figure 8.16

Turn the steering wheel 360 degrees in the opposite direction and repeat the driving conditions. Again, the ATC lamp will start blinking when the required conditions are met. Keep driving until the lamp turns off. Figure 8.17. Click the "Continue" button.

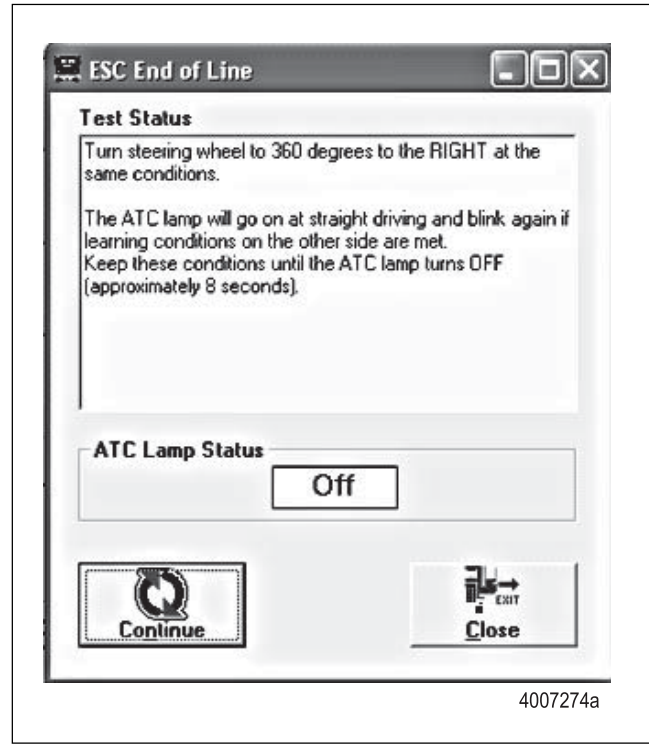


Figure 8.17

A message box (ESC End of Line Data) with the Steering Ratios and Steering Angle Offset values will appear. Click the "Close" button. Figure 8.18.

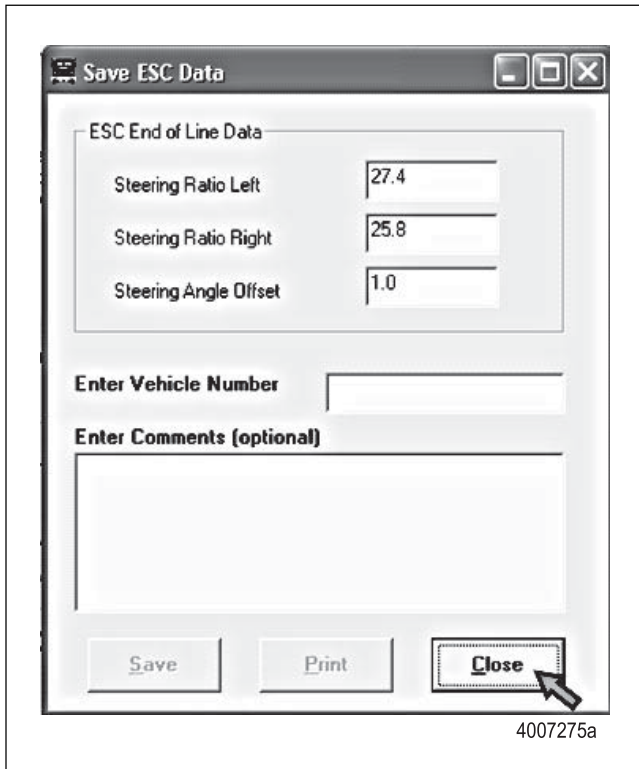


Figure 8.18

Read the message box and carefully follow the instructions. Click the “Close” button and cycle the ignition. Figure 8.19.

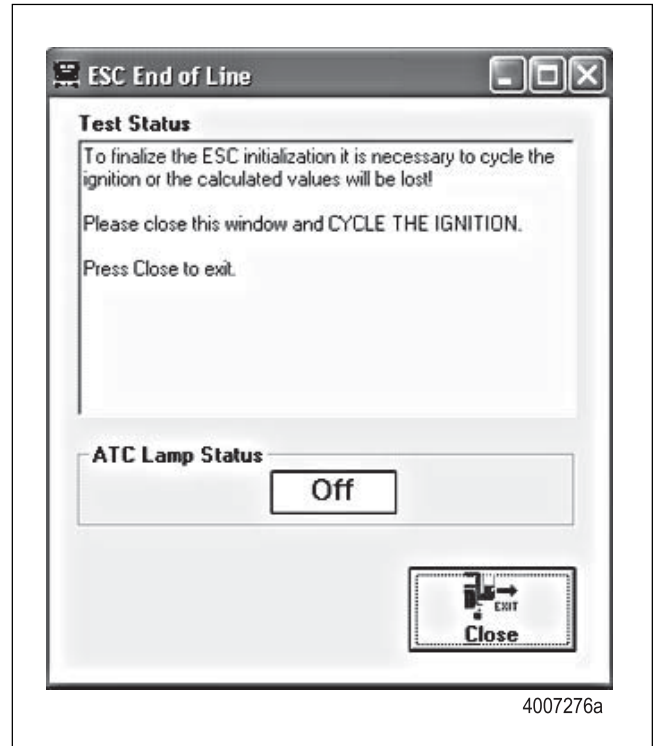


Figure 8.19

When the ignition is turned back ON, check that no active or stored faults are logged in the ECU and that the ABS and ATC/ESC warning lamps are OFF. Figure 8.20.

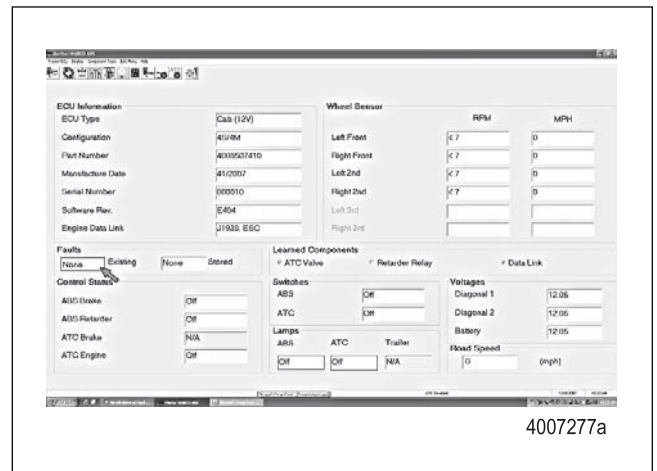


Figure 8.20

The ESC EOL Initialization procedure is completed.

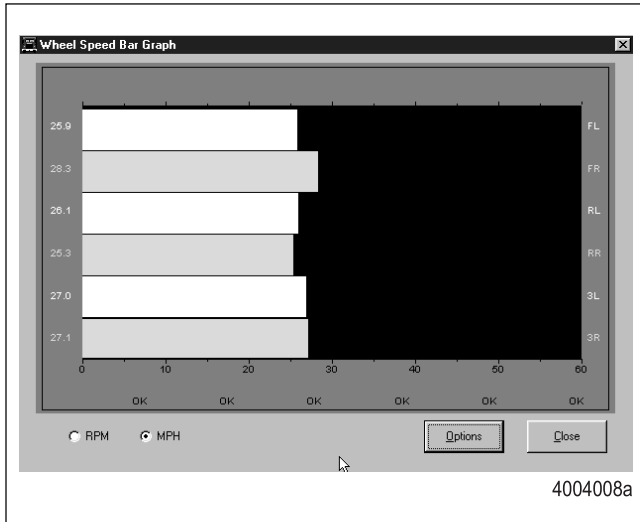


Figure 9.4

Memorized Data

Select *Memorized Components* from the Display menu.

NOTE: Use Display/Memorized Components to view data.

Figure 9.5. To clear a memorized component, use the Memorized Components function that appears on the Component Tests Menu.

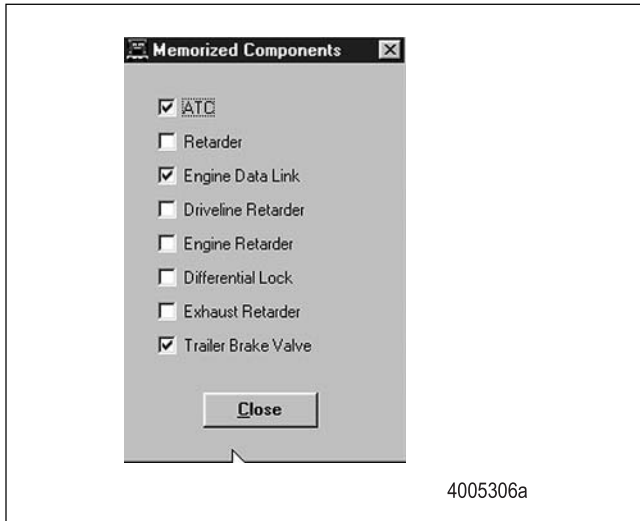


Figure 9.5

NOTE: Trailer Brake Valve = RSC Valve

RSC Data

Select *RSC Data* from the pull down menu for RSC status information. Figure 9.6.

For RSC Control Status:

NA — RSC is not an option

OFF — RSC is installed but is not currently active

For Accelerometersensor:

Acceptable range is 2.21-2.78 volts.

A red background in this field indicates voltage is outside of the acceptable range.

A green background in this field indicates voltage is within the acceptable range.

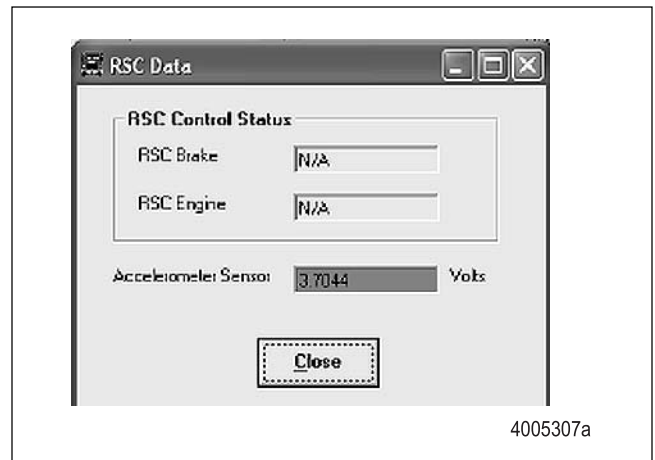


Figure 9.6

NOTE: Trailer Brake Valve = RSC Valve

Component Tests

Select *Component Tests* from the Tractor ABS Main Screen. A pull down menu will appear. Figure 9.7.

9 Appendix V—TOOLBOX™ Software and Pro-Link® Plus

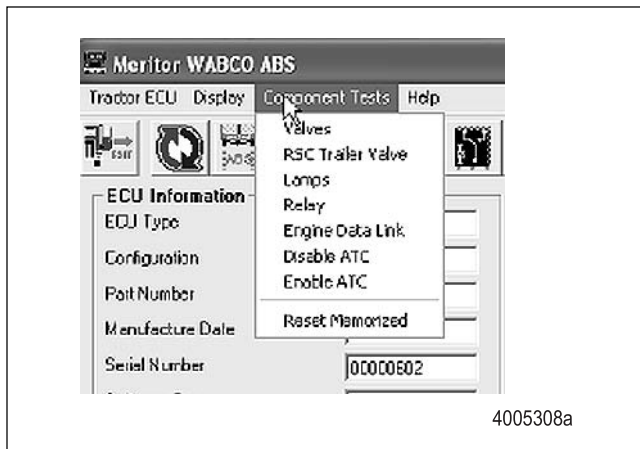


Figure 9.7

NOTE: Components for test may also be selected from the icons on the Tractor ABS Main Screen.

Select *Valves* from the pull down menu to select and cycle individual ABS modulator valves. Then, listen to ensure the correct valve is cycling. This is also helpful in verifying correct operation, installation and wiring. Figure 9.8.

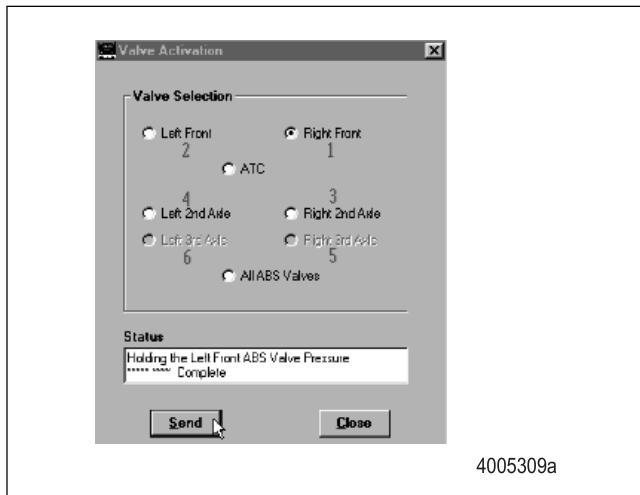


Figure 9.8

Select *all valves* from the menu to cycle all available ABS valves in the order shown below.

Verification of the ATC valve is also available from this menu.

RSC Trailer Valve

Select *RSC Trailer Valve* from the pull down menu to cycle the RSC trailer valve.

Do not activate the service brake while testing the RSC trailer valve. Figure 9.9.

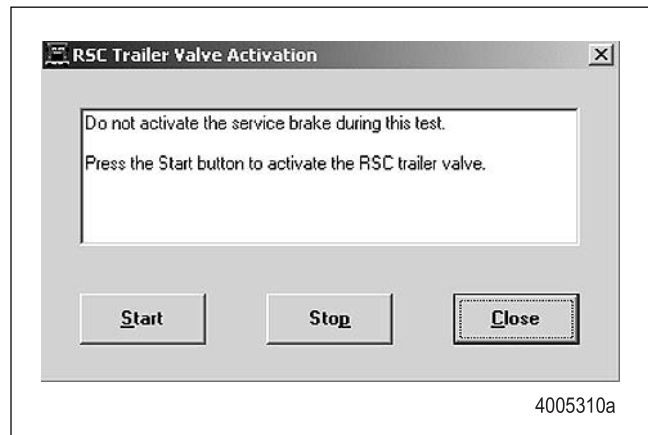


Figure 9.9

Press Start to begin the test. Figure 9.10.

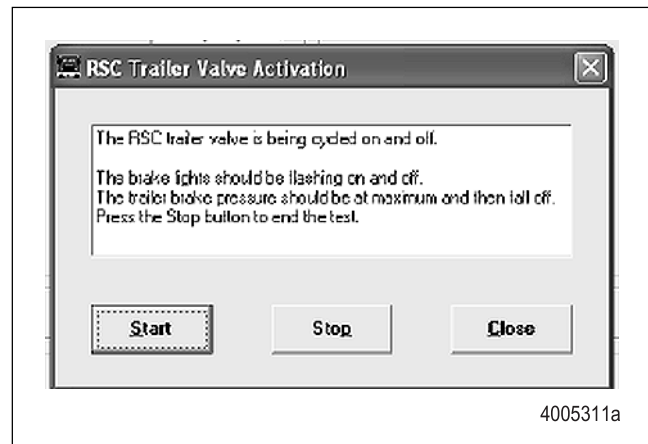


Figure 9.10

Lamps

Select *Lamps* from the pull down menu to turn the tractor ABS, trailer ABS or ATC (wheel spin) indicator lamps on or off. Figure 9.11.

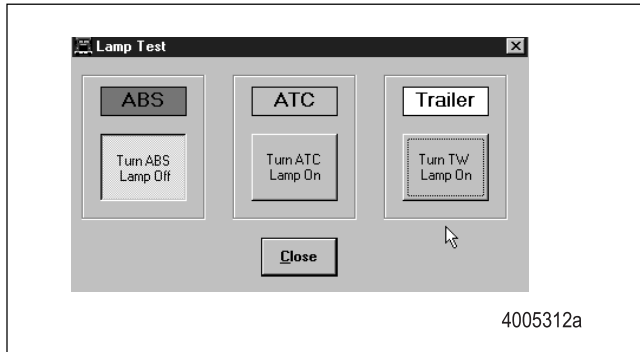


Figure 9.11

This is helpful in verifying correct operation, installation and wiring of the lamps to the ECU.

Relay

Select *Relay* from the pull down menu to turn the Retarder Relay on or off. Figure 9.12.

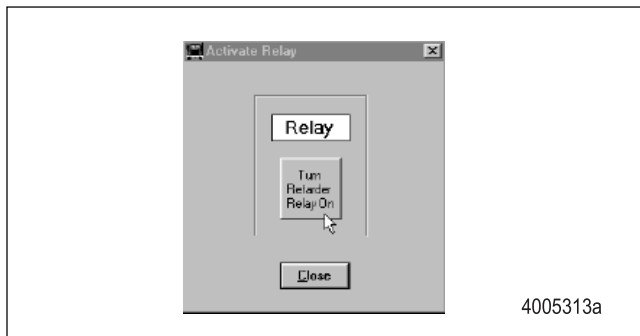


Figure 9.12

This is helpful in verifying correct operation, installation and wiring of the unit under test.

Select *Engine Data Link* from the pull down menu to send a “limit engine torque” command to the engine or a “disable retarder” command to the retarder. Figure 9.13.

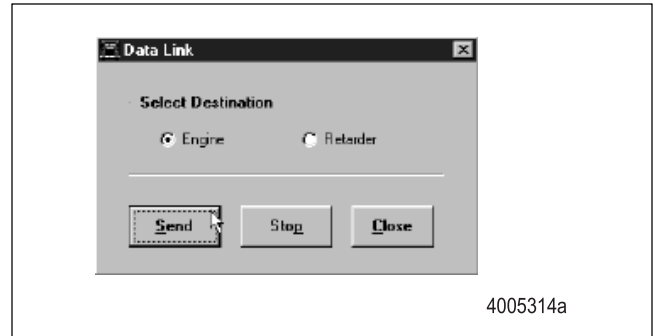


Figure 9.13

Select *Disable ATC* from the pull down menu to send a command to the ECU to disable automatic traction control. ATC will remain disabled until the enable command is sent or the vehicle ignition is cycled. The status bar on the Main Screen reflects the current state of the ATC function, either Enabled, Disabled or N/A (not available).

Using the Disable ATC command is useful and essential for dynamometer testing. Figure 9.14.

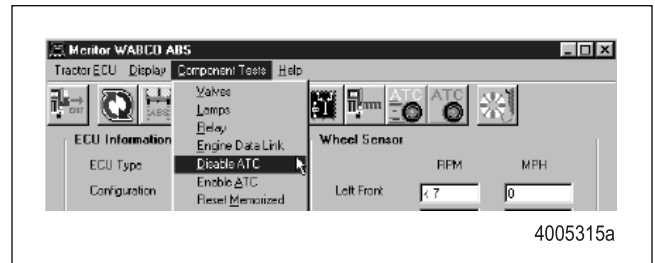


Figure 9.14

Enable ATC

Select *Enable ATC* from the pull down menu to send a command to the ECU to enable automatic traction control. This is the normal state of the ECU. The status bar on the Main Screen reflects the current state of the ATC function, either Enabled, Disabled or N/A (not available). Figure 9.15.

9 Appendix V—TOOLBOX™ Software and Pro-Link® Plus

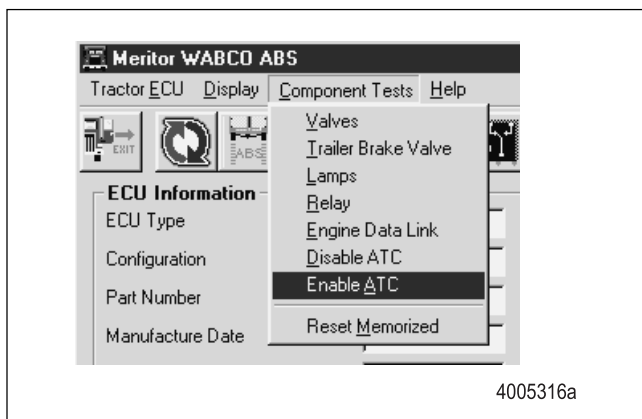


Figure 9.15

Reset Memorized

Select *Reset Memorized* from the pull down menu to tell the ECU to reset the memorized or “learned” components.

The ECU has the ability to learn the following components: ATC valve, engine datalink and retarder relay. Once any of these have been detected, the ECU expects to see them each time the ECU is powered on. If they are not seen, the ECU records a fault.

There are times when an ECU is moved to another vehicle — or during diagnostic testing — you may want the ECU to disregard these learned components. Use the *Reset Memorized* command for this purpose.

Pro-Link[→] Plus Display

With some ECUs, the Pro-Link[→] Plus will display system information — components or options supported by the ECU. Access these screens through System Setup (main ABS menu).

The following screens illustrate:

- A 4S/4M ABS/ATC system
- Where the ECU has not recognized a retarder relay
- Where the ECU has recognized a J1939 datalink
- The ECU is capable of supporting ABS and ATC switches.

NOTE: Yes indicates the ECU is capable of supporting these options. These may or may not be installed on the vehicle.

TRACTOR ABS/ATC	
SYSTEM INFORMATION	
SENSORS	4
MODULATORS	4

ATC VALVE	YES
RETARDER RELAY	NO
J1939	YES
ABS SWITCH	YES
ATC SWITCH	YES

Component Test Screens

These screens help you test ABS components. Select this function from the Tractor ABS/ATC menu.

- ABS VALVES
- ATC
- ABS INDICATOR LAMP
- ATC INDICATOR LAMP
- ABS/ATC SWITCHES
- SENSORS
- ENGINE DATALINK
- RETARDER RELAY
- RETARDER DATALINK
- VEHICLE VOLTAGES

Select the appropriate function. Each screen has instructions to guide you through the test. Refer to the Pro-Link[→] Plus Manual for complete instructions.

Component Tests and Functions (Pro-Link[→] Plus)

These screens help you test ABS components. Select this function from the Tractor ABS/ATC menu.

TRACTOR COMP TESTS
— SELECTIONS —
↑ VEHICLE VOLTAGES ↓

9 Appendix V—TOOLBOX™ Software and Pro-Link® Plus

Select the appropriate function. Each screen has instructions to guide you through the test. Refer to the Pro-Link® Plus Manual for complete instructions.

The following definitions explain the function of each test.

Table F: Definitions

Component Test	Function
Vehicle Voltages	Monitors the voltage signals powering the ECU.
ABS Valves	Cycles the valves, one at a time. With brake pedal applied, you should hear four short air exhausts, then one long air pressure hold. A menu selection lets you choose from four or six valves. This test is used to verify valve locations and correct wiring. NOTE: The treadle must be applied to pressurize the brake chambers.
ATC	Checks the ATC valve. You will hear a click as the valve cycles. NOTE: TOOLBOX™ Software or the Pro-Link® Plus may be used to shut off ATC for dynamometer testing.
ABS Tractor Lamp	Monitors the commanded (on/off) states of the ABS tractor lamp. Follow the screen prompts (1 On, 2 Off) to change the status of the lamp on the instrument panel.
ABS Trailer Lamp	Monitors the commanded (on/off) states of the ABS trailer lamp. Follow the screen prompts (1 On, 2 Off) to change the status of the lamp on the instrument panel.
ATC Tractor Lamp	Monitors the commanded (on/off) states of the ATC tractor lamp. Follow the screen prompts (1 On, 2 Off) to change the status of the lamp on the instrument panel.
ABS/ATC Switches	Checks the status of ABS and ATC/Deep Snow and Mud switches on the instrument panel.
Sensors	Monitors the input to the ECU from the wheel. Vehicle must be stationary and wheels must be rotated during this test.
Engine Datalink	Checks wiring connections and response between the engine and the ECU.
Retarder Relay	Activates the relay to verify function (a click will be heard). This test also checks wiring connections.
Retarder Datalink	Checks wiring connections and retarder response between the retarder and the ECU.

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Inc.

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Appendix C

MERITOR WABCO

System Saver Series Single Cartridge Air Dryers

Maintenance Manual 34
Revised 11-02

System Saver Series

- **1000**
- **1200E, P, U**
- **1800E, P, U**

MERITOR WABCO

System Saver Series Single Cartridge Air Dryers

**Maintenance Manual 34
Revised 11-02**

System Saver Series

- 1000
- 1200E, P, U
- 1800E, P, U

Before You Begin

This manual provides instructions for Meritor WABCO's System Saver Series single cartridge air dryers. Before you begin procedures:

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Caution and Warning safety alerts that precede instructions or procedures you will perform. These alerts help to avoid damage to components, serious personal injury, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Access Product and Service Information on our Web Site

Enter meritorwabco.com in your browser's address box for quick access to our web site. At our home page, click on literature to access our publications.




meritorwabco.com

To Order Information by Phone

Call ArvinMeritor's Customer Service Center at 800-535-5560 to order the following item.

- Drivetrain Plus™ by ArvinMeritor Technical Electronic Library on CD. Features product and service information on most Meritor, ZF Meritor and Meritor WABCO products. \$20. Order TP-9853.

Safety Alerts, Torque Symbol and Notes

 WARNING	A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury.
 CAUTION	A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components.
 NOTE	A torque symbol alerts you to tighten fasteners to a specified torque value.
NOTE	A Note provides information or suggestions that help you correctly service a component.

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Air Dryer Components..... 4
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Component Replacement Guide 35

System Overview

Maintenance Manual 34 contains troubleshooting steps and service information for the Meritor WABCO System Saver Series (1000, 1200 and 1800) single cartridge air dryers.

NOTE: If you have a System Saver TWIN air dryer, use Maintenance Manual 35.

Air Dryer Documentation

TP-92116, Installing the Meritor WABCO System Saver Series Air Dryer, provides complete installation instructions.

PB-96134 contains a complete listing of air dryer replacement parts.

TP-97101 is a troubleshooting guide. There is also a poster-sized troubleshooting guide, TP-9772, available.

TP-9672, Air Dryer Application Guide, provides an in-depth look at System Saver Series air dryer applications.

T-20102V, Air System Troubleshooting video Stopping With Air and T-97105V, System Saver 1200 videotapes are also available.

To order literature, contact ArvinMeritor's Customer Service Center, 800-535-5560.

Air Dryer Identification

Alphabetical designations of the System Saver Series family of air dryers have specific meanings:

- P Indicates an external purge tank is used for desiccant regeneration
- U Indicates discharge line — unloaded compressor
- E Indicates a Holset style compressor function
- G Indicates integral governor for air compressor control
- UP Indicates discharge line — unloaded compressor (with external purge tank)

System Saver 1200/1800: System regeneration valve assembly on side of dryer

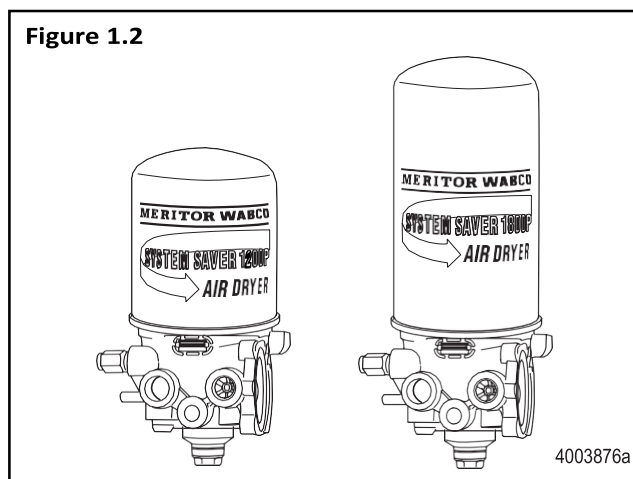
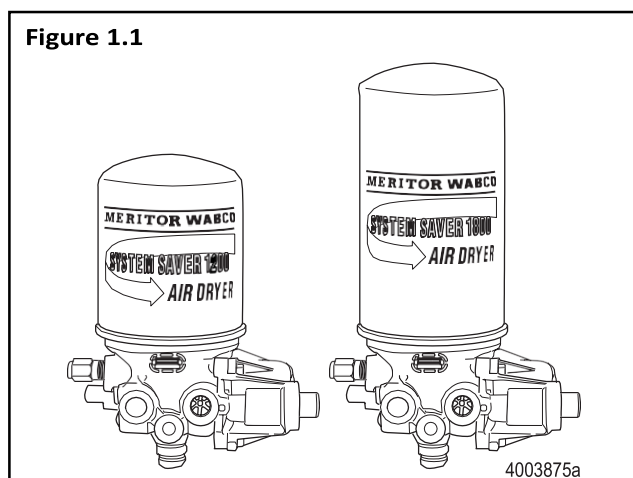
System Saver 1200E: Tubing and banjo fitting at front of dryer

System Saver 1200P/1800P: Uses dedicated purge tank. Port 22 drilled and tapped.

System Saver 1200U/1800U: Small regeneration hole visible in back of Port 1 when fitting is removed. No spring in turbo cut-off valve assembly.

System Saver 1200UP/1800UP: Port 22 drilled and tapped. Small regeneration hole visible at back of Port 1 when fitting is removed. No spring in turbo cut-off valve assembly. Dedicated purge tank.

The air dryer base is the same for both the 1200 and 1800 Series air dryers, however the 1800 Series canister is 3.2 inches taller than the 1200. This larger canister contains 50% more desiccant, which makes the 1800 ideal for applications calling for frequent starts, stops and long compressor cycles. System Saver 1200 and System Saver 1800 Series air dryers are illustrated in **Figure 1.1**. System Saver 1200P and System Saver 1800P, which are used with a dedicated purge tank, are illustrated in **Figure 1.2**.



Section 1 Introduction

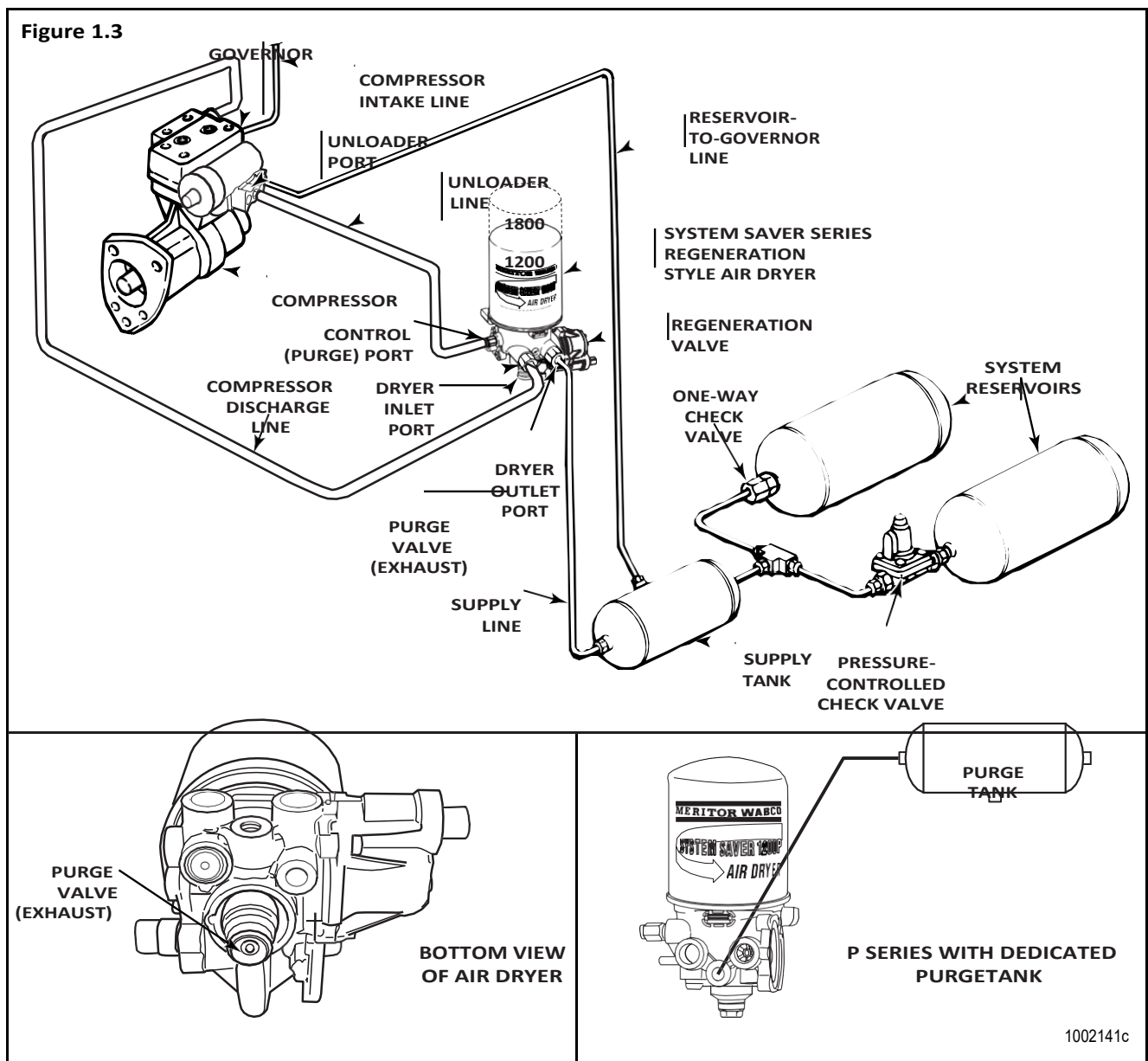
MERITOR WABCO

How the Air Dryer Works

During system pressure build-up, compressed air passes into the air dryer where the filter system removes contaminants and passes the air into the drying stage.

Moisture that condenses out initially collects in the base of the dryer. Moisture-laden air passes through the desiccant bed in the air dryer cartridge and is dried. When the compressor unloads, the water is expelled and dried air flows back through the dryer, drying the desiccant for the next cycle.

A typical Meritor WABCO System Saver 1200 or 1800 Series air dryer installation is illustrated in **Figure 1.3**. Illustrations for Combo Tank installations appear in Appendix III, Special Applications.



Air Dryer Cycle

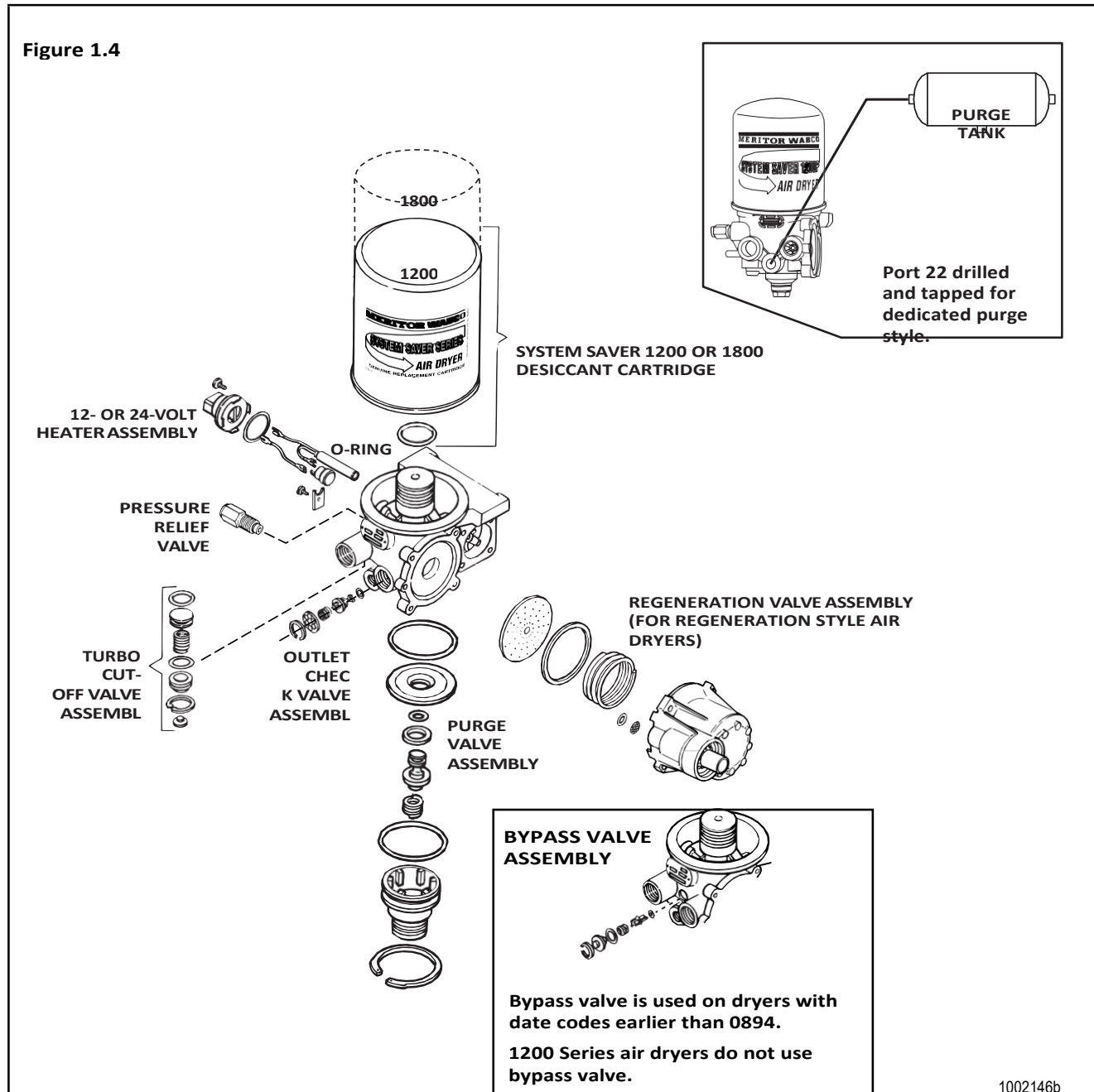
A single cartridge air dryer cycle is illustrated below.

<p>The governor turns the compressor on when supply tank pressure drops below cut-in pressure (approximately 100 psi).</p>	<p>1002142a</p>
<p>Compressed air passes into the air dryer at the inlet port:</p> <ul style="list-style-type: none"> Moisture-laden air and contaminants pass through the desiccant. Moisture is retained by desiccant; moisture also collects in the base of the dryer. 	<p>1002143a</p>
<p>The governor turns the compressor off when system reaches cut-out pressure (approximately 120 psi).</p>	<p>1002145a</p>
<p>When the compressor unloads, the purge valve opens:</p> <ul style="list-style-type: none"> Dryer purges, expels water collected in dryer base. Regeneration valve opens: <ul style="list-style-type: none"> Dry system air flows back through the dryer. 10 psi taken from supply and secondary tanks. Back flow dries desiccant, preparing it for the next cycle. 	<p>1002144a</p>

Air Dryer Components

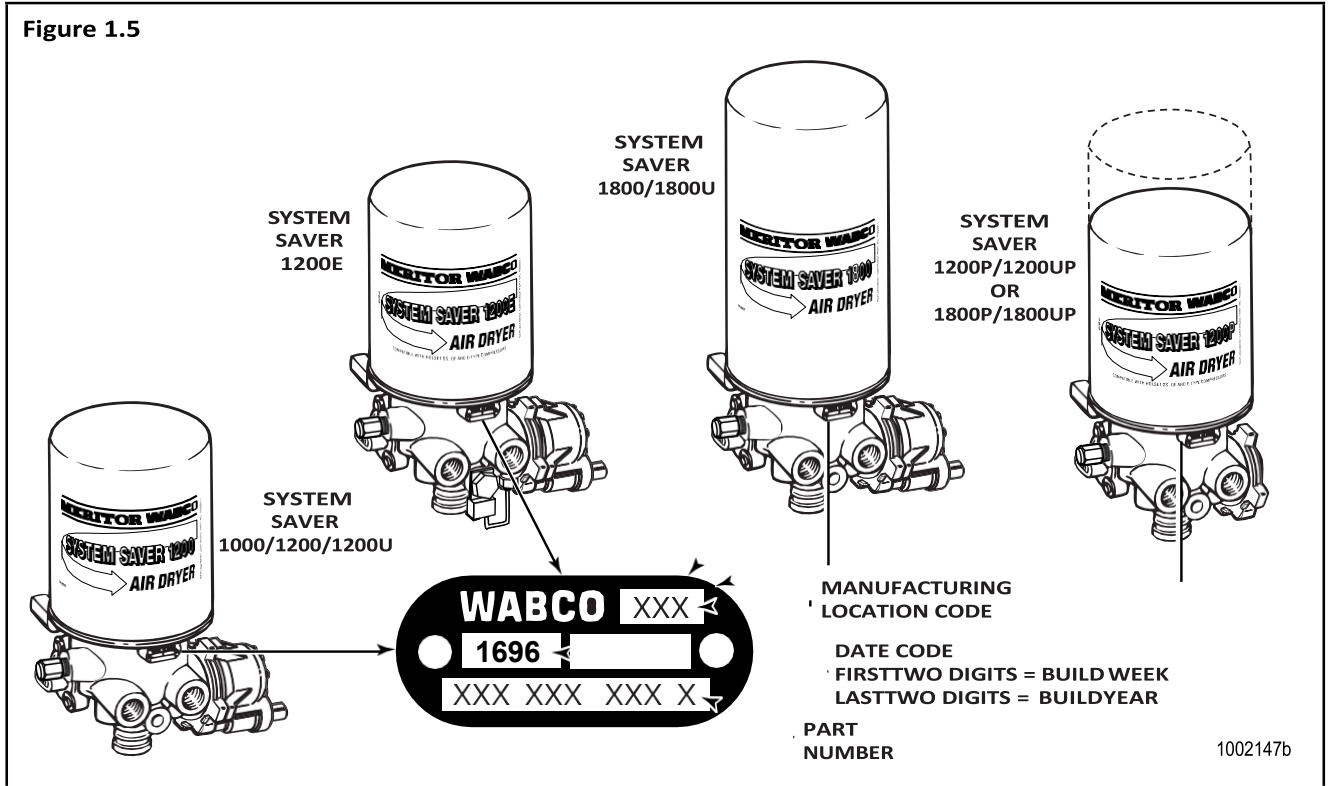
Meritor WABCO single cartridge air dryers contain replaceable component parts. Air dryer components are illustrated in **Figure 1.4**. Refer to Section 3 for instructions.

NOTE: For information about System Saver E air dryers and components, refer to Appendix I and Appendix II. For special applications, refer to Appendix III.



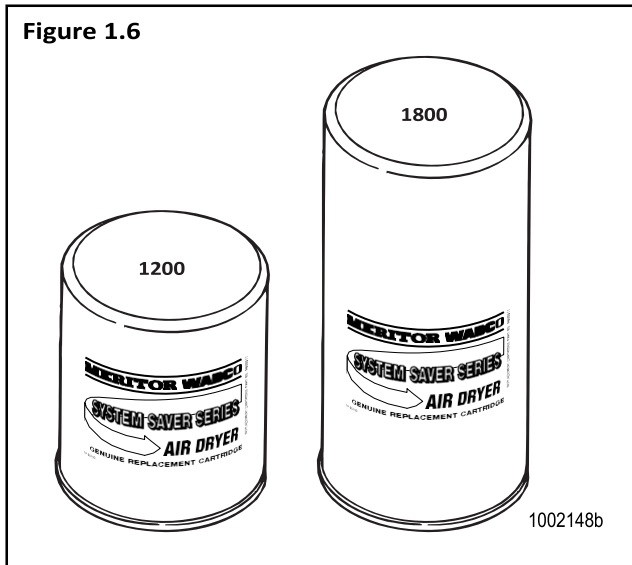
Dryer Identification

The identification tag on the face of the dryer provides important information about the air dryer — information you will need when servicing or replacing components. **Figure 1.5.**



Description of Components

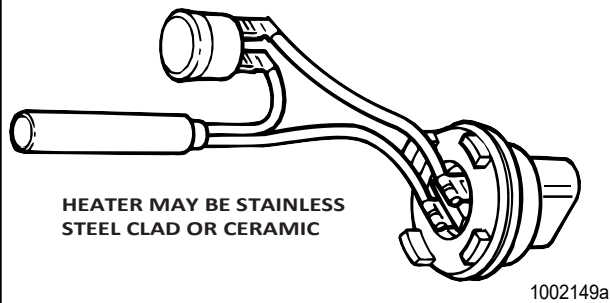
Replacement components for single canister air dryers are described below.



Desiccant Cartridge: A cylindrical steel housing containing the filter elements and desiccant needed to filter and dry system air.

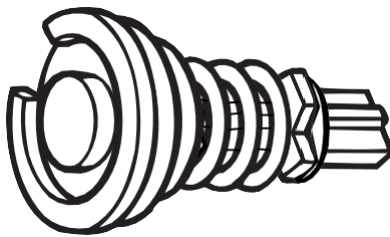
Spin-on/spin-off design allows quick and easy maintenance. The System Saver 1800 Series cartridge is 3.2-inches taller than the 1200 Series cartridge. **Figure 1.6.**

Figure 1.7



Heater: Located in the air dryer base, the heater prevents water that collects in the air dryer from freezing. It consists of a cylindrical resistive-type heating element and a small circular thermostat. Heater is available for 12- and 24-volt air dryers. **Figure 1.7.**

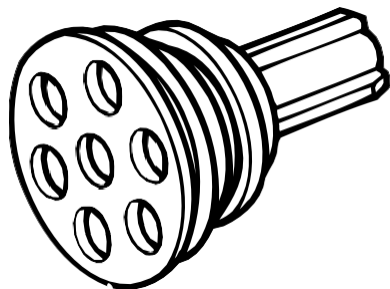
Figure 1.8



Bypass Valve: A valve located between the inlet and outlet ports of the dryer. It allows air to flow into the dryer and go directly to the outlet port, bypassing the desiccant cartridge. The 1200, 1200E Series and 1000 Series with date codes later than 0894 do not use a bypass valve. **Figure 1.8.**

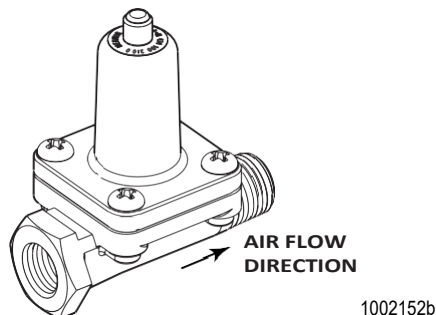
For 1000 Series dryers with date code 0894 or earlier.

Figure 1.9

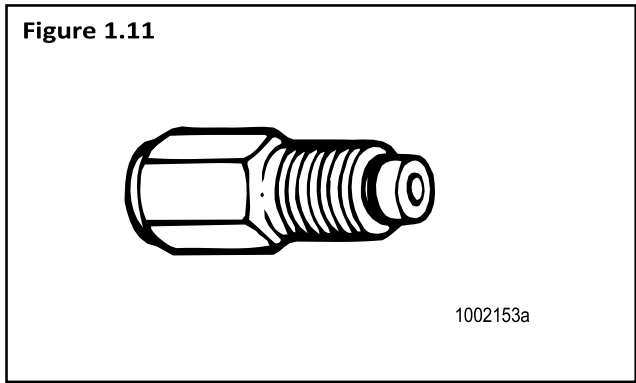


Outlet Check Valve: A valve located in the outlet port (port 21) of the air dryer. It prevents air from flowing back through the air dryer and escaping out the purge valve during a compressor unload cycle. **Figure 1.9.**

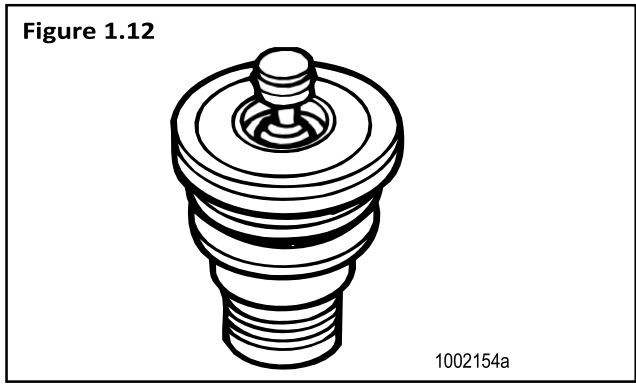
Figure 1.10



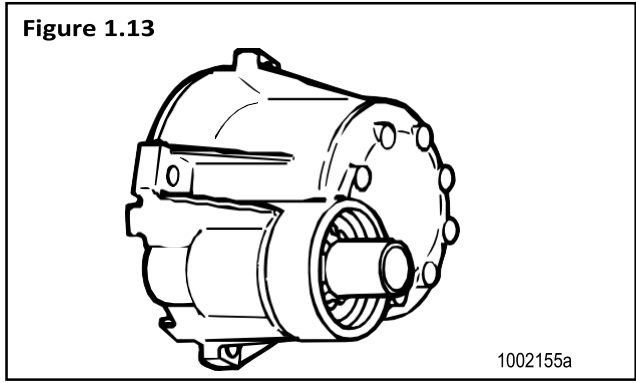
Pressure-Controlled Check Valve (PCCV): Used with System Saver Series regeneration style air dryers. The PCCV is usually mounted on the secondary air tank in place of an inlet check valve. It lets air backflow from the secondary tank to the supply tank as long as system pressure remains between the normal cut-in and cut-out range of the governor. It allows additional air volume for generation during the air dryer purge cycle. Not used with "P" style air dryers. **Figure 1.10.**



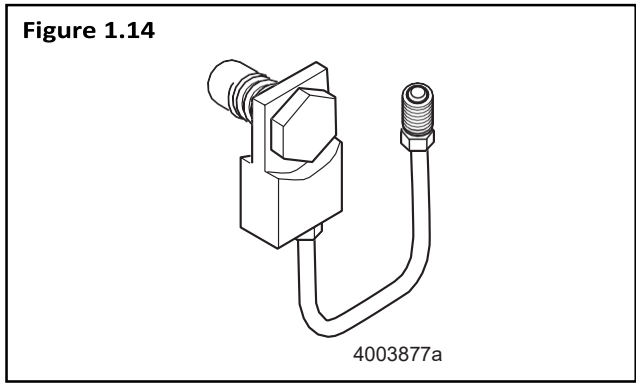
Pressure Relief Valve: A valve that protects the air dryer from over-pressurization. On dryers with date codes earlier than 2295, it is installed in the inlet port of the dryer (port 1) using a Street-Tee fitting. On dryers with date codes later than 2295, the pressure relief valve is attached directly to the air dryer. **Figure 1.11.**



Purge Valve: A valve located on the bottom of the air dryer base that remains open during a compressor unload cycle. It allows collected moisture, condensation, and contamination to be expelled from the air dryer during a purge cycle. **Figure 1.12.**

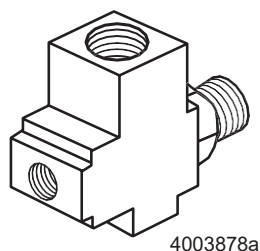


Regeneration Valve: The valve that controls regeneration of the desiccant. It allows air from the supply and secondary tanks to bypass the outlet check valve. The air expands and backflushes moisture off of the desiccant, then out through the dryer's purge valve. **Figure 1.13.**
Not used with "P" style dryers.



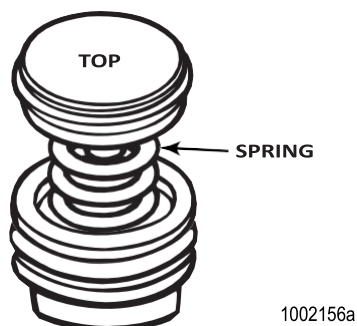
ECON Valve Replacement Part: This valve is used on System Saver Series 1200E single cartridge air dryers used with Holset E-type compressors.

Figure 1.15



ECON Valve: This valve must be installed if System Saver 1000 or 1200 Series air dryers NOT DESIGNATED E are used with Holset E-type compressors. This valve is not required on System Saver 1200 E air dryers.

Figure 1.16

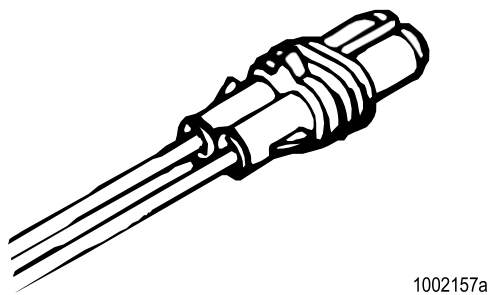


Turbo Cut-off Valve: A valve located in the inlet port of the air dryer. It closes the path between the air compressor and the air dryer purge valve during compressor unload. This prevents a loss of turbocharger boost pressure during a compressor unload cycle, thereby maintaining boost pressure for maximum engine horsepower. **Figure 1.14.**

There is no spring in the turbo cut-off valve assemblies used on U Series air dryers.

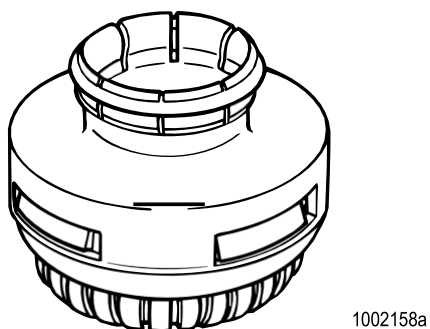
The System Saver E Series air dryers use a special turbo cut-off valve. Refer to the air dryer parts book PB-96134 for part number information.

Figure 1.17



Heater Power Harness: Twelve-inch cable with Metri-Pack plug provides electrical connection to air dryer heating unit. **Figure 1.17.**

Figure 1.18



Purge Silencer: Optional part for all Meritor WABCO air dryers. It is used to reduce the noise level of an air dryer purge. **Figure 1.18.**

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

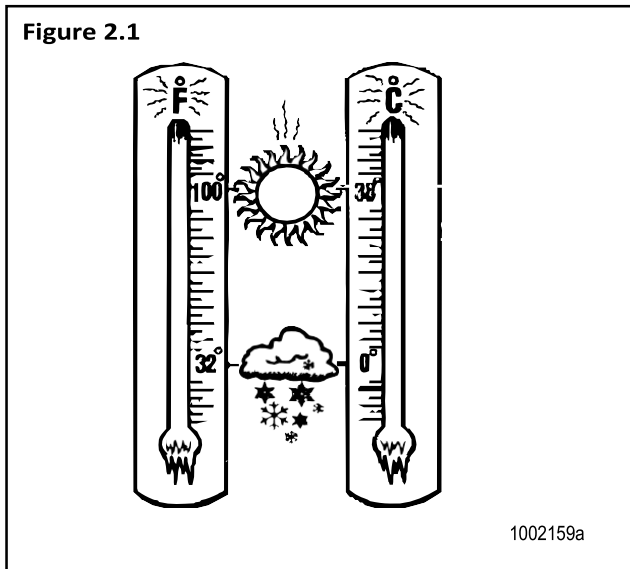
Routine Maintenance

To keep your Meritor WABCO air dryer operating efficiently, the following routine maintenance is recommended.

Interval	Required Action
Weekly.	Ensure dryer purges when compressor unloads.
Weekly, or as recommended by the manufacturer.	Drain purge tank (dedicated purge tank dryers).
Weekly, or as recommended by the manufacturer, whichever is most frequent.	Check for moisture in the system by opening the drain cock slowly.
<ul style="list-style-type: none"> • Every 2-3 years, or more often depending on usage, vocation, and condition of compressor. • Whenever compressor is rebuilt. 	Replace the desiccant cartridge.

Maintenance Tips

The Meritor WABCO air dryer will provide years of reliable service, even under adverse operating conditions. To provide additional protection against the harmful effects of extreme heat or cold, here are a few helpful tips.



Dedicated Purge Tank

Optimum mounting location for the dedicated purge tank is **ABOVE** the air dryer.

Extreme Heat

Make sure the compressor discharge line is long enough to keep inlet air below 175°F (80°C). (Refer to Operating Environment Requirements in Appendix II.)

Extreme Cold

Make sure the air dryer heater is in good working order by running a heater resistance test. Refer to Heater Resistance in this section.

Check the line from the governor to port 4 of the dryer for oil and/or water. Keep this line clean to help prevent freezing.

Meritor WABCO air dryer components are installed in the air dryer at the factory and are designed to last for the life of the dryer. Under some operating conditions, however, a replacement may be required. Refer to Section 3 for replacement guide instructions.

Section 2 Troubleshooting & Testing

MERITOR WABCO

Troubleshooting

Conditions you may experience, and suggested solutions, appear in the following System Saver Series Air Dryer Troubleshooting table.

NOTE: The exploded view of the System Saver single canister air dryer in Section 1 illustrates the location of components in the dryer.

Condition	Possible Cause	Conditions May Occur In:		Solution
		Regeneration Style Air Dryers	Dedicated Purge Tank Air Dryers	
Dryer leaks from purge valve during compressor loaded cycle. The leak may cause excessive compressor cycling or prevent the system from building air pressure.	<p>Purge valve frozen open (cold weather operation).</p> <p>Debris under purge valve seat, such as particles from fittings or air inlet line.</p> <p>Purge valve washer installed upside-down.</p> <p>Wrong air line connected to dryer port 4 (unloader port).</p> <p>Purge valve snap ring not fully seated in groove.</p>	Yes	Yes	<p>Check heater. Repair/replace if necessary. Make sure governor to dryer port 4 line is free of water/oil.</p> <p>Remove and inspect purge valve and clean water/oil from top of piston.</p> <p>Disassemble and clean purge valve.</p> <p>Remove cartridge and clean dryer sump area.</p> <p>Ensure lip on aluminum washer faces DOWN, away from dryer.</p> <p>Verify correct air line installation and correct as needed.</p> <p>Seat snap ring fully into groove.</p>
Slight leak from purge valve. After several hours, the supply tank may be empty.	Outlet check valve not seating or regeneration valve not shutting off regeneration airflow.	Yes	No	Remove, inspect, and clean outlet check valve and regeneration valve diaphragm. Replace if worn or damaged.
Regeneration cycle too long (more than 30 seconds), accompanied by loss of pressure in the supply tank.	Outlet check valve not seating.	Yes	Yes	Inspect and replace outlet check valve as needed.
	Regeneration valve not shutting off regeneration airflow.	Yes	No	Replace regeneration valve.
Regeneration cycle too short (less than 10 seconds).	High air system demands during compressor unloaded cycle.	Yes	Yes	Increase air system capacity or reduce air demands.
	Pressure-controlled check valve not installed in system or not working properly.	Yes	No	Check and replace pressure-controlled check valve as needed.
	One-way check valve installed in system reservoir instead of, or with, pressure-controlled check valve.	Yes	No	Remove one-way check valve. Make sure pressure-controlled check valve is installed correctly.
	Regeneration valve not working.	Yes	No	Remove regeneration valve and clean oil from diaphragm. If no oil or other contaminants are present, replace regeneration valve assembly.
	Air governor not working properly.	Yes	Yes	Inspect per manufacturer's instructions and repair/replace as needed.
Water in purge tank	Block in purge tank line.	N/A	Yes	Clear blockage. Replace desiccant cartridge.

Condition	Possible Cause	Conditions May Occur In:		Solution
		Regeneration Style Air Dryers	Dedicated Purge Tank Air Dryers	
No regeneration cycle. No airflow from purge valve after initial purge blast (dryer decompression).	Air dryer not connected to supply tank or connections reversed at dryer.	Yes	No	Verify proper dryer installation per system diagram.
	Regeneration valve not working.	Yes	No	Replace regeneration valve.
	One-way check valve installed in supply tank.	Yes	No	Remove one-way check valve.
	Alcohol evaporator installed between dryer and supply tank.	Yes	No	Install bypass line around evaporator or remove evaporator from system.
	Blocked line/pinched line from purge tank.	No	Yes	Clear/repair line.
Air dryer does not purge when compressor unloads (no blast of air from purge valve).	Air line between governor and air dryer port 4 kinked or plugged.	Yes	Yes	Repair air line.
	Purge valve stuck closed.	Yes	Yes	Replace purge valve.
	Air governor not working properly.	Yes	Yes	Inspect air governor. Repair/replace per manufacturer's instructions.
	Cut-out pressure never achieved by air compressor.	Yes	Yes	Check for air leaks in system and repair as needed. If no leaks in system, check compressor output. Repair/replace per manufacturer's instructions.
Air dryer purges too often, perhaps as frequently as every 15 seconds, accompanied by excessive cycling of the compressor.	Leak in line between governor and dryer port 4.	Yes	No	Repair air line.
	Leak in line between supply tank and governor.	Yes	Yes	Repair air line.
	Excessive air system leaks.	Yes	Yes	Repair leaks.
	Excessive air system demands.	Yes	Yes	Increase air system capacity or reduce air demand.
	Outlet check valve not seating.	Yes	Yes	Inspect and replace outlet check valve as needed.
	Regeneration valve not shutting off properly.	Yes	No	Replace regeneration valve.
	Air governor has less than 16 psi range.	Yes	Yes	Replace air governor.
Leaking air compressor unloader(s).	Yes	Yes	Inspect compressor. Repair/replace per manufacturer's instructions.	
Air flows out of purge valve entire time compressor is unloaded.	Turbo cut-off valve not sealing. NOTE: With U Series air dryers the compressor unloads through the dryer, so a steady flow of air is normal.	Yes	No	Replace turbo cut-off valve.
Rapid "spitting" of air from purge valve in small amounts. Frequency varies with engine speed.	Holset E-type compressor used, but no Econ valve installed.	Yes	Yes	Install Econ valve to provide make-up air to compressor.
	Compressor not completely unloading when cut-out pressure is reached.	Yes	Yes	Inspect compressor. Repair/replace per manufacturer's instructions.
Air leak at turbo cut-off valve vent. Hole burned in piston.	Temperature of air coming into dryer is too high — not enough cooling takes place before dryer inlet.	Yes	Yes	Move dryer farther from compressor. Add additional compressor discharge line before air dryer. Add cooling coil or heat exchanger before air dryer. NOTE: Inlet air temperature must not exceed 175°F (80°C).

Section 2 Troubleshooting & Testing

MERITOR WABCO

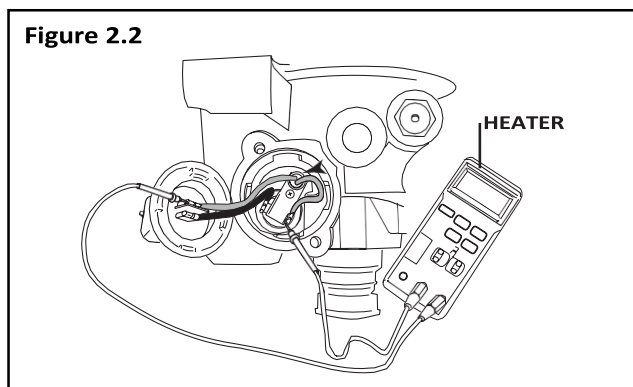
Condition	Possible Cause	Conditions May Occur In:		Solution
		Regeneration Style Air Dryers	Dedicated Purge Tank Air Dryers	
Air leak at turbo cut-off valve vent.	Lip seal installed upside-down on piston. Lip must face UP (towards dryer).	Yes	Yes	Install lip seal correctly.
	Valve bore worn excessively.	Yes	Yes	Inspect valve bore for wear. If a new turbo cut-off valve does not seal in a clean, lubricated bore, replace the air dryer.
Air dryer frozen (water collecting in base of dryer is freezing).	No electrical power to heater connector.	Yes	Yes	Check for a blown fuse. Repair heater circuit.
	Low voltage to heater connector.	Yes	Yes	NOTE: There must be power to the heater connector the entire time the vehicle's ignition is ON .
	Heater assembly not working.	Yes	Yes	Repair cause of low voltage, such as poor electrical ground, bad connections, corroded wire splices, etc.
	Wrong voltage air dryer used; i.e., 12-volt air dryer used in a 24-volt system.	Yes	Yes	Replace heater assembly. Replace with correct voltage air dryer.
No air pressure build-up in system.	Air dryer not plumbed correctly (connections reversed).	Yes	Yes	Ensure compressor discharge line is plumbed to air dryer port 1, and air dryer port 21 is connected to vehicle's supply tank.
	Wrong air line connected to dryer port 4.	Yes	Yes	Ensure dryer port 4 line is connected to the "UNL" port of the air governor.
	Air governor not working properly.	Yes	Yes	Inspect governor per manufacturer's instructions. Repair or replace as needed.
	Air system leaks, such as compressor discharge line, air dryer, reservoirs, brake or suspension valves, etc.	Yes	Yes	Locate leak(s) and repair.
	Air dryer leaks from purge valve.	Yes	Yes	Refer to purge valve conditions listed in this chart.
Water in tanks; often following aftermarket installation or when dryer is a replacement for a competitive brand.	Pressure-controlled check valve not installed in correct tank or not installed at all.	Yes	No	Install pressure-controlled check valve in secondary tank.
	Pressure-controlled check valve properly installed, but one-way check valve not removed.	Yes	No	Remove one-way check valve so that only the pressure-controlled check valve is installed between the secondary tank and supply tank.
Water, oil, or sludge in air system tanks.	Desiccant contaminated with oil.	Yes	Yes	Replace desiccant. Inspect compressor per manufacturer's instructions.
Water in system tanks, everything else checks out okay.	Dryer not suitable for application.	Yes	Yes	Review application guidelines. For assistance, call ArvinMeritor's Customer Service Center at 800-535-5560.

System Tests

Heater Resistance

To avoid damaging components, Meritor WABCO recommends performing this resistance check with the heater in place.

1. Set volt-ohmmeter to ohms.
2. Disconnect vehicle harness at the heater.
3. Remove the two screws holding the external components in place.
4. With wires connected and properly secured, touch one probe to each heater element lead.



5. Measure the resistance. Acceptable resistance is:

- 12 Volt: 1.0-2.0 ohms
- 24 Volt: 5.0-7.0 ohms

If resistance is less than 1.0 ohm for a 12-volt or 5.0 ohms for a 24-volt system, replace the heater.

6. Reinstall components and vehicle harness.

Leak Test

1. Drain air from all system tanks.
2. Close reservoir draincocks.
3. Start the vehicle. Allow air system pressure to build while engine idles.
4. When the system reaches cut-out pressure there will be a purge, or strong blast of air, followed by a mild flow which will last 10-25 seconds.
5. Shut off the engine.

6. Apply a soap solution to each connection that contains pressurized air. Check the connections to see if soap solution bubbles.

No Soap Bubbles: Connections are sealed properly.

Soap Bubbles Appear: Connections are NOT sealed properly.

To repair improperly sealed connections:

1. Drain all reservoirs.
2. Remove leaking connection.
3. Inspect the connectors and ports for damaged threads or cracks. Replace if necessary.
4. Apply pipe sealant to the connection.

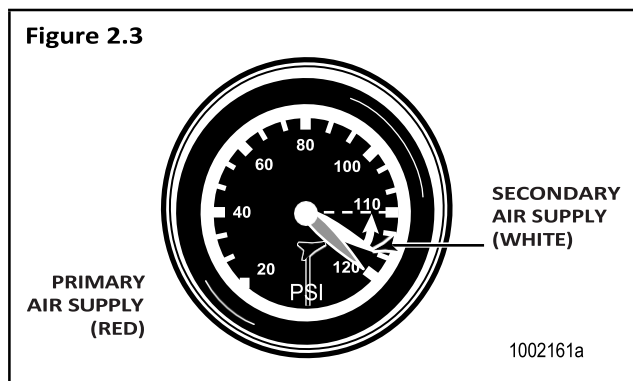
NOTE: Repeat leak test until all connections are sealed.

Air Pressure Checks

NOTE: When checking air pressure during these tests, do not rely on cab air gauges for accurate readings. Install a calibrated air gauge (accurate to within 1 psi) in the secondary air tank for making determinations about the continued use or replacement of equipment.

Operational Test for System Saver Series Air Dryers — Regeneration and Purge Style

1. Check compressor loaded and unloaded cycle.
When the compressor is in the **loaded cycle**, air pressure will build to approximately 120 psi (cut-out pressure). When the compressor reaches the **unloaded cycle**, the air dryer will purge, initiating regeneration of the air dryer.



Section 2 Troubleshooting & Testing

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2. During the regeneration cycle, which lasts from 10-25 seconds, supply and secondary tanks will drop approximately 10 psi in pressure. Check the secondary air gauge on the vehicle dash panel to **verify this drop**.

NOTE: A 10 psi drop in pressure in the secondary air system is normal for Meritor WABCO System Saver Series regeneration style air dryers. There should be no visible pressure drop for P Series dryers. If there is a visible pressure drop (P Series dryer), perform a check valve leak test on the system check valves.

Step 3 applies to regeneration style air dryers only.

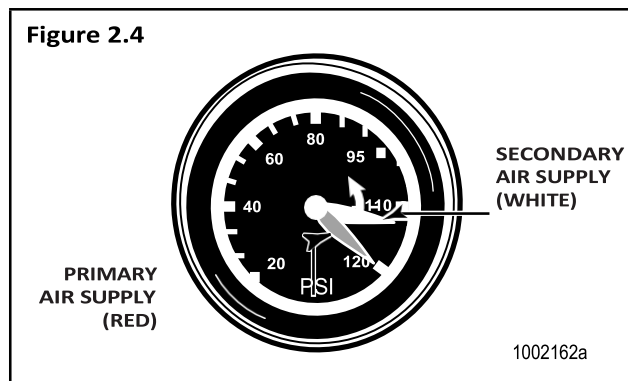
3. If there is no drop in pressure, one of the following conditions may apply:
 - Pressure-controlled check valve not installed, or installed on wrong air tank.
 - Pressure-controlled check valve installed to a one-way check valve, instead of **in place** of a one-way check valve.
 - There is another check valve located between the air dryer and the secondary air tank, usually at the supply tank.
 - Secondary air gauge not plumbed to the secondary air system. Use a calibrated air gauge in the secondary tank to check air pressure.
 - Make the necessary installation changes or repairs and repeat the operational test.
 - If the secondary pressure drops 25 psi or more during the regeneration cycle — and there are no other air-operated components using air during this cycle — there are air leaks or other air system problems.
 - Identify and repair all air leaks and air system problems.
 - Clean the Regeneration and Outlet Check valves.
 - Disconnect the compressor line from the air dryer (Dryer Port 4). Check the compressor and governor per the manufacturer's recommendation.

Pressure-Controlled Check Valve Test — Regeneration Style Only

1. Turn off the engine after the air system reaches cut-out pressure (approximately 120 psi) and the air compressor has unloaded.

2. Drain the supply tank down to 80 psi or lower.
3. Check the secondary tank air gauge. It should read 95 ± 5 psi.

NOTE: A drop from 120 to 95 ± 5 psi during this test is normal for vehicles equipped with the System Saver Series air dryer and a pressure-controlled check valve.



4. If the secondary tank air gauge reading is less than 90 psi:
 - Pressure-controlled check valve may be installed backwards (arrow on valve must point toward host reservoir). Make necessary corrections and retest.
 - Check for leaks in the secondary air system. Identify and repair any leaks.
5. If the secondary tank air gauge reading does not change — or the reading does not drop below 100 psi:
 - Pressure-controlled check valve not installed, or installed on wrong air tank.
 - Pressure-controlled check valve installed **TO** a one-way check valve, rather than **IN PLACE OF** a one-way check valve.
 - There is another check valve located between the air dryer and the secondary air tank, usually at the supply tank.
 - Secondary air gauge not plumbed to the secondary air system. Use a calibrated air gauge in the secondary tank to check air pressure.
 - Make the necessary installation changes or repairs and repeat the operational test.



WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Remove all pressure from the air system before you disconnect any component, including the desiccant cartridge. Pressurized air can cause serious personal injury.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Serious personal injury can result.

Replacement Requirements

Before replacing any air dryer component, make sure the air compressor and air governor are working properly. Repair or replace these parts, if necessary. Check the entire air system for leaks, and repair as necessary. When draining air tanks before servicing the air dryer, check for water and/or oil that may have accumulated in the tanks. Water and/or oil in the air tanks could indicate a problem with the dryer or compressor.

Replacement Requirements		
Component	When to Replace	Why
Desiccant Cartridge	Every two to three years.	Preventative maintenance.
	When compressor is replaced.	Contaminated cartridge.
	Water in supply tank.	Saturated or contaminated cartridge, high duty cycle (wrong application of air dryer).
Bypass Valve (dryers with date codes earlier than 0894)	Valve leaking, inlet to outlet.	Cut O-ring, bad seat.
Heater Assembly	Water collecting in air dryer is freezing — electrical power to dryer is O.K.	Heater assembly not working (internal short or open circuit).
Outlet Check Valve	Air continues to flow from purge valve after purge cycle, but stops flowing when the compressor load cycle begins.	Valve is stuck in the open position, or not functioning properly.
	No pressure build-up in system, everything else is O.K.	Valve is stuck in closed position.
Purge Valve	No purge cycle when compressor unloads — normal pressure at dryer control port 4 (governor port).	Valve is stuck in the closed position, or not functioning properly.
	Air flows from purge valve during compressor's load cycle — no pressure at dryer control port.	Valve is stuck in the open position, or not functioning properly.
Turbo Cut-Off Valve	Air flows from purge valve during compressor unload cycle after purge cycle, and flow is noticeably stronger at high engine RPM, especially under load.	Turbo cut-off valve leaking.
	No pressure build-up in system — high compressor discharge line pressure.	Valve stuck in closed position.
Regeneration Valve	Regeneration cycle continues after compressor begins, and secondary tank pressure drops 15 psi or more.	Regeneration valve allowing too much air to come back into cartridge.
	Purge cycle is too short (5 seconds or less) — pressure-controlled check valve is O.K., no leak in governor control line.	Regeneration valve not allowing enough air to come back into cartridge.
	Air dryer purges — but no regeneration, no check valve between air dryer and supply tank, and purge valve has not closed.	Regeneration valve not allowing any air to come back into cartridge.
Pressure-Controlled Check Valve	Regeneration cycle too short; may result in water in tank.	Valve checks (stops airflow) too high.

Section 3 Installing Replacement Parts

MERITOR WABCO

NOTE: When replacing air dryer components, use only Meritor WABCO replacement parts.

The exploded view of the air dryer in Section 1 shows the location of the various air dryer components.

Component Replacement



WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Remove all pressure from the air system before you disconnect any component, including the desiccant cartridge. Pressurized air can cause serious personal injury.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.

Desiccant Cartridge

1. Replacement kit contains one cartridge and one O-ring. **Figure 3.1.**

NOTE: Replacement cartridges are marked "System Saver Series."

2. Loosen and remove the old cartridge. Use strap wrench if necessary.
3. Remove and discard O-ring from dryer base.
4. Inspect and clean seal seat. Repair any minor damage.

NOTE: If seats are damaged so badly that a tight seal cannot be maintained, replace the air dryer.

5. Lubricate and install new O-ring on stem.
6. Lubricate cartridge seal.
7. Thread replacement cartridge onto the base until the seal touches the base. Then, tighten the cartridge **ONE** additional turn. **DO NOT OVERTIGHTEN.** **Figure 3.2.**

Figure 3.2

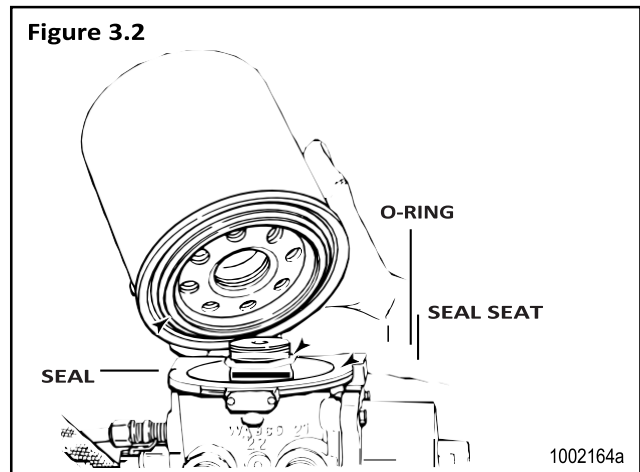
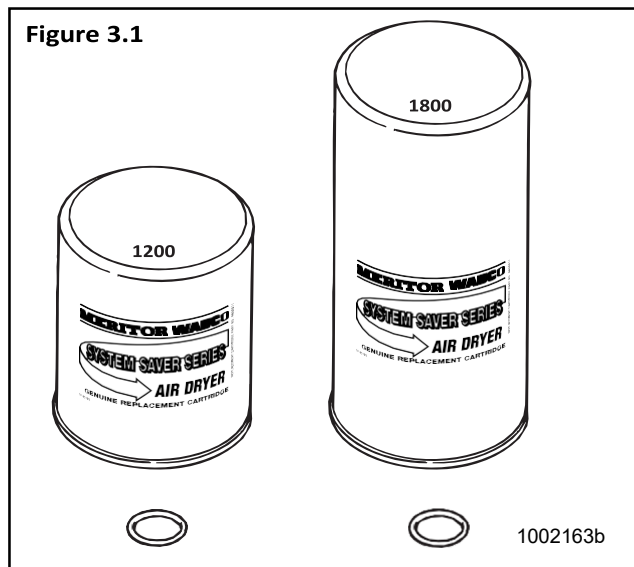


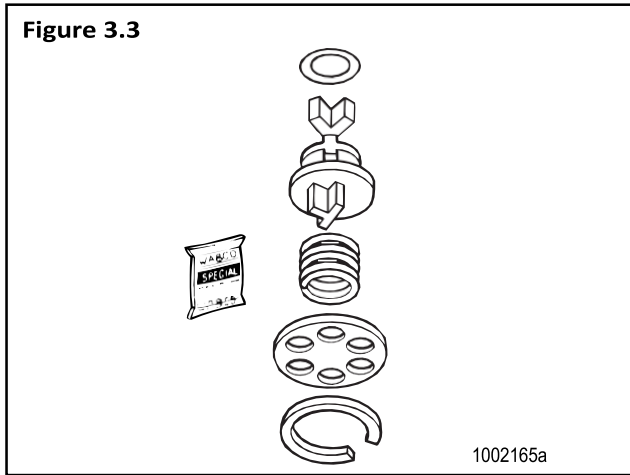
Figure 3.1



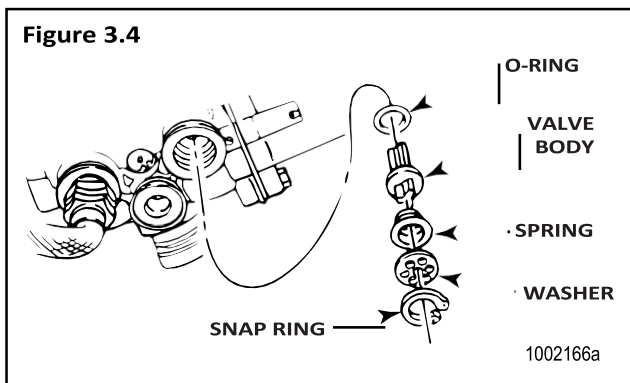
Outlet Check Valve Assembly

1. Review **Figure 3.3** to make sure you have all of the parts required to replace the outlet check valve.

Use the grease included with the replacement kit to lubricate the O-ring seal.



2. Remove the snap ring, washer, spring, valve body and O-ring.
3. Clean and inspect the valve bore. If the bore is damaged so that a tight seal cannot be maintained, replace the air dryer.
4. Install the new O-ring on the valve body. **Figure 3.4.**

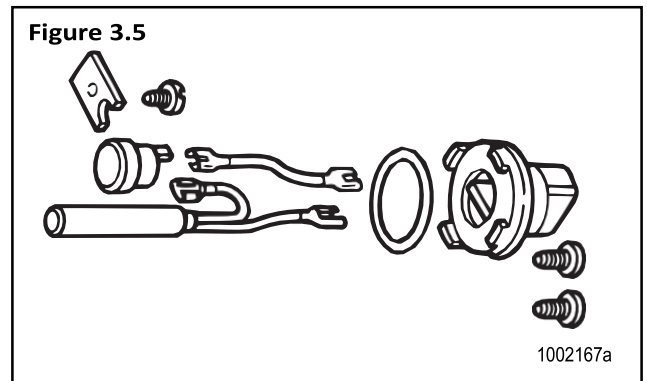


5. Apply a thin layer of grease to the valve bore and the O-ring.
6. Install the new valve body with its long end in the bore.

7. Install the new spring with its small end around the “Y”-shaped fins on the valve body.
8. Install the new washer and the new snap ring to hold the components in place.

Heater Assembly

1. Review **Figure 3.5** to make sure you have all of the parts required to replace the heater assembly.



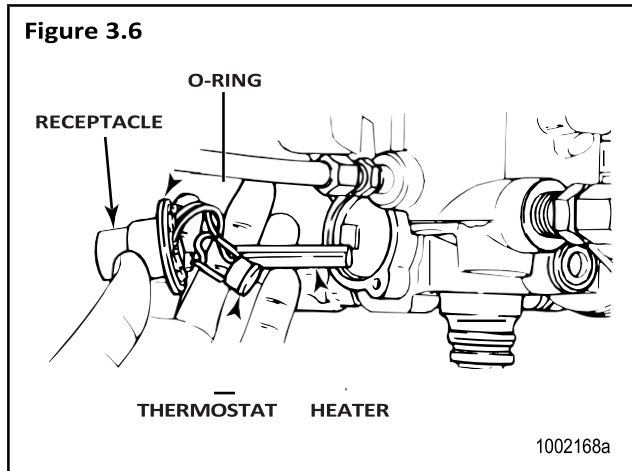
2. Disconnect the plug.
3. Remove the screws, receptacle and O-ring from the base to access the retainer screw.
4. Remove the retainer screw and then remove the entire heater assembly.
5. Install the new element and thermostat in their cavities.

Section 3 Installing Replacement Parts

MERITOR WABCO

NOTE: For dryers with date codes of 0894 or earlier, follow the special instructions in the replacement kit to complete the installation.

6. Install the new retainer and screw to hold the element and the thermostat in place.
7. Install the new O-ring and receptacle and fasten them in place with the screws.
Figure 3.6.



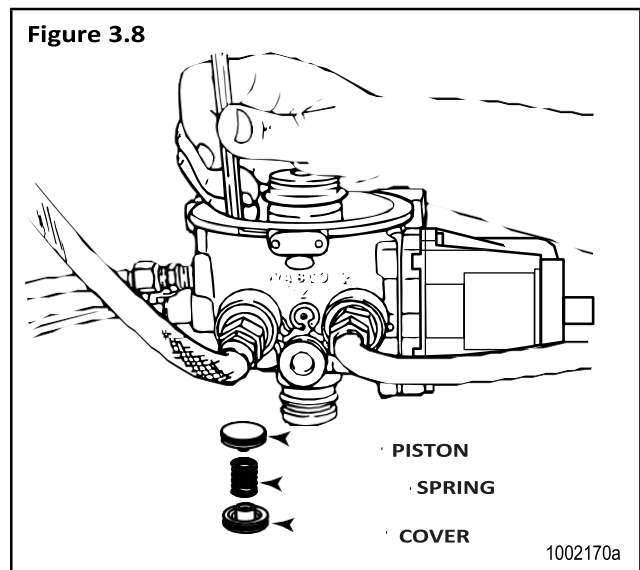
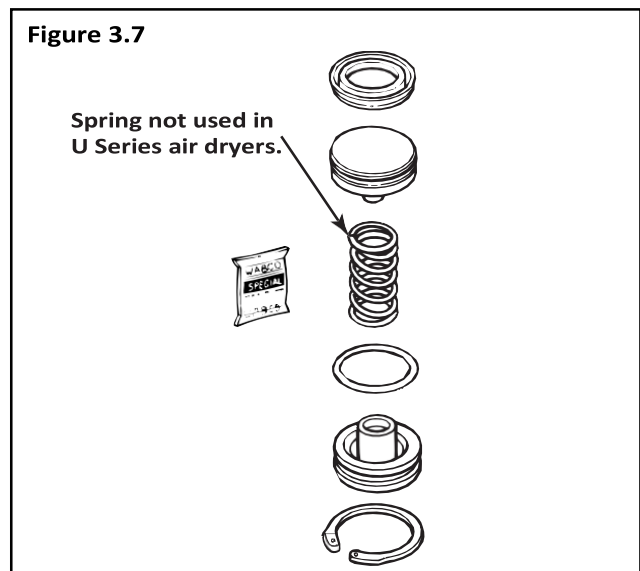
Turbo Cut-Off Valve Assembly

NOTE: E Series air dryers use a different turbo cut-off valve assembly. Refer to PB-96134 for information.

1. Review **Figure 3.7** to make sure you have all of the parts required to replace the turbo cut-off valve.

Use the grease included with the replacement kit to lubricate O-rings and seals.

2. Remove the snap ring. The cover and spring may fall out of the bore when the snap ring is removed.
3. Remove the desiccant cartridge as described above. Use a wooden stick to push the piston, spring and cover out of the bore. **Figure 3.8.**
4. Clean and inspect the valve bore. If the bore is damaged so that a tight seal cannot be maintained, replace the air dryer. **Figure 3.8.**
5. Install new lip seal on piston. Seal lip must face up (toward top of piston).




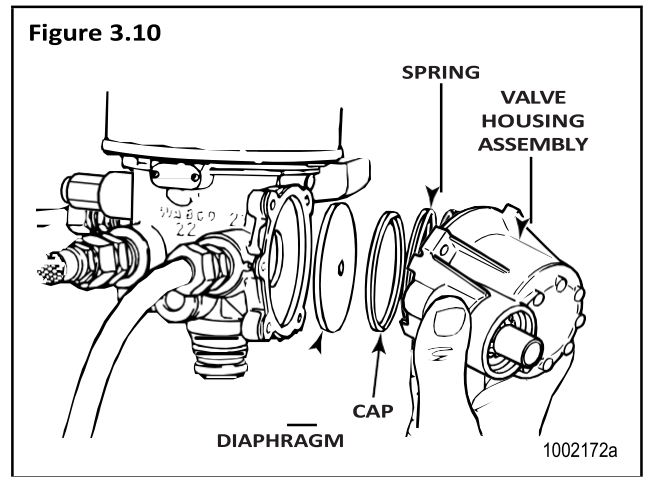
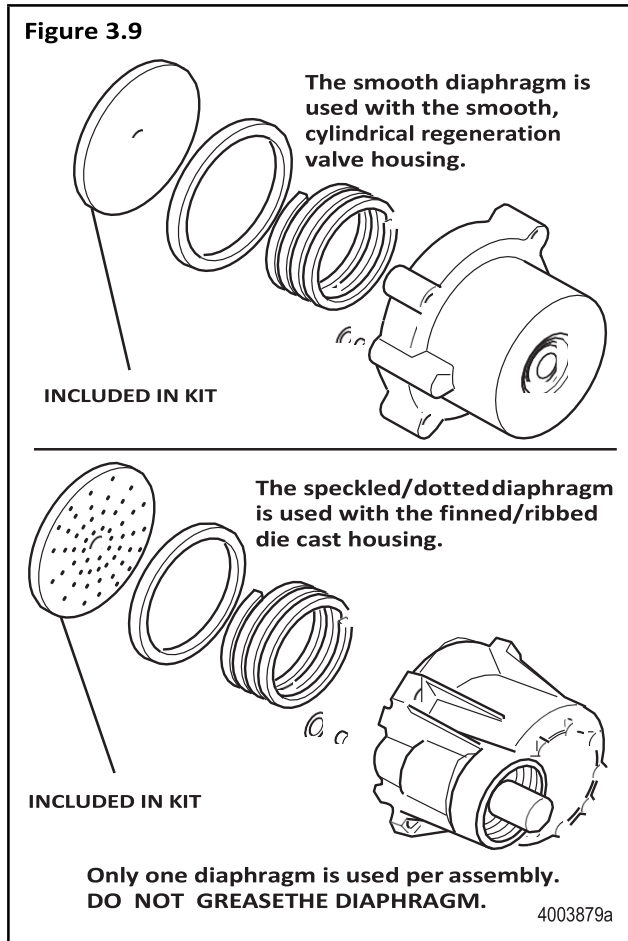
6. Install new O-ring on cover.
7. Apply a thin layer of grease to the valve bore and the O-rings.
8. Install the new piston with flat side toward dryer.
9. Install the new spring, cover and snap ring to hold the components in place.
10. Install plug.
11. Replace the desiccant dryer.

Regeneration Valve Assembly

The regeneration valve assembly kit contains two different diaphragms to service the regeneration valve assembly for System Saver 1000, 1200 or 1800 air dryers. Use the correct diaphragm for the style of regeneration valve housing as indicated in the sketches below. Use of the incorrect part will result in unsatisfactory purging of the desiccant cartridge and may result in excess water in the air system.

1. Review **Figure 3.9** to make sure you have all of the parts required to replace the regeneration valve. Use the grease included with the replacement kit to lubricate O-rings and seals.
2. Remove the four mounting bolts and the valve housing assembly. When you remove the housing, the spring and cap will fall out.
3. Remove the rubber diaphragm.

4. Clean and inspect the diaphragm lip groove. If the groove is damaged so that a tight seal cannot be maintained, replace the air dryer.
5. Install the new diaphragm with its lip in the groove. **DO NOT GREASE THE DIAPHRAGM.**
6. Install the new spring and cap with the cap lip facing out. Install the valve housing assembly with the new lubricated O-ring and filter over the orifice. Install the new mounting bolts and tighten to 53 lb-in (6 N•m). **Figure 3.10.** 



Section 3 Installing Replacement Parts

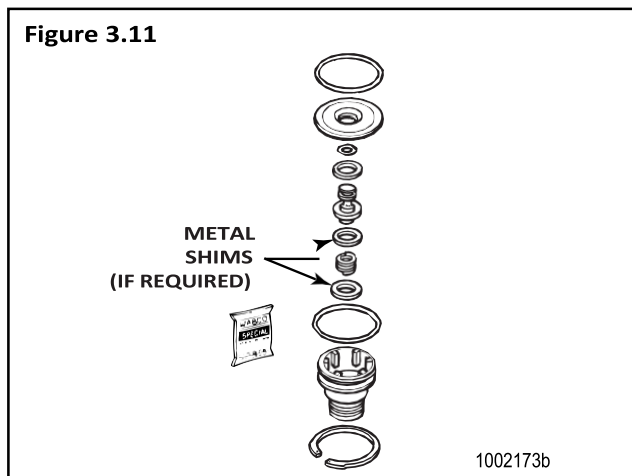
MERITOR WABCO

Purge Valve Assembly

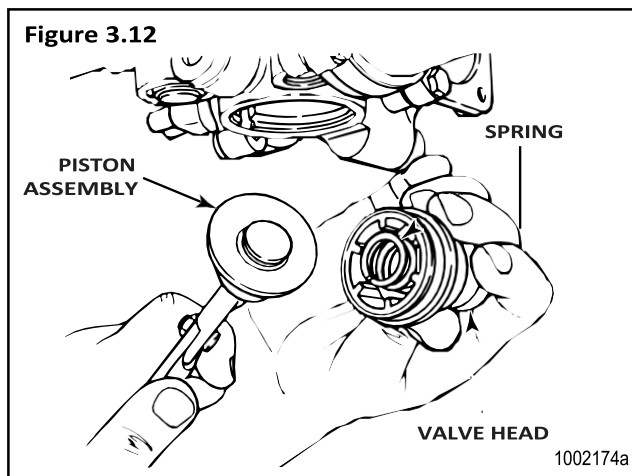
1. Review **Figure 3.11** to make sure you have all of the parts required to replace the purge valve.

Use the grease included with the replacement kit to lubricate O-rings and seals. **Do not grease the rubber seat.**

If shims are included in the replacement kit, they must be installed above and below the spring. If they are not included, they are not needed.

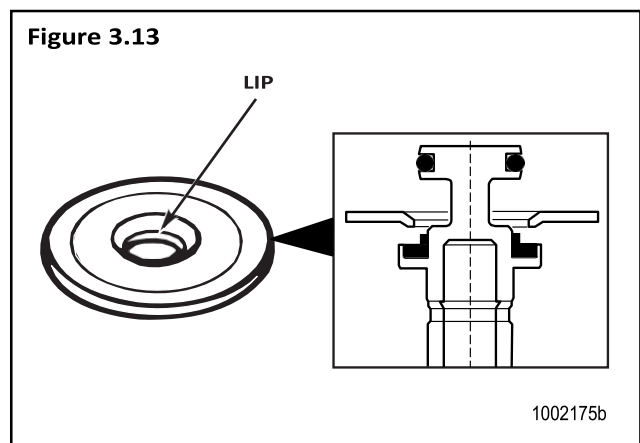


2. Remove the snap ring, valve head and spring.
3. Remove the piston assembly from the base. **Figure 3.12.**

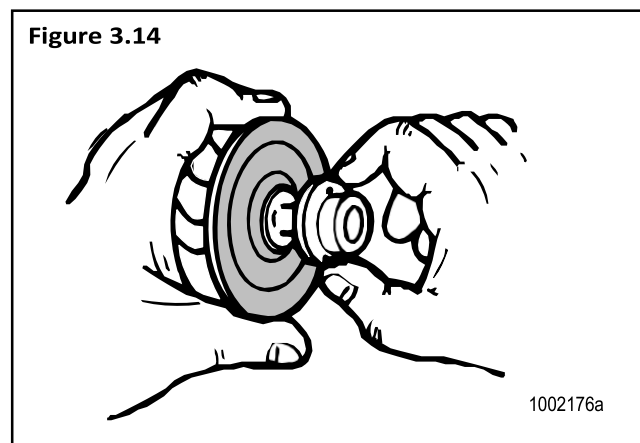


4. Remove washer and O-rings from the base.
5. Clean and inspect the valve bore. If the bore is damaged so that a tight seal cannot be maintained, replace the air dryer.
6. Apply a thin layer of grease to the valve bore and to all O-rings (use the grease included with replacement kit).
7. Install new washer and O-ring in dryer base and on valve head.
8. Assemble piston assembly:
 - Install O-ring in groove on piston head.
 - Install piston seat in groove on piston base.
 - Install washer on piston.

NOTE: Lip on washer must face piston seat. **Figure 3.13.**



9. Install washer on piston assembly. **Figure 3.14.**



10. Install spring in valve head; fit valve head assembly into bore.

NOTE: If shims are included in the replacement kit, they must be installed above and below the spring. If they are not included, they are not needed.

11. Install snap ring to hold the valve head in place.

NOTE: Make sure snap ring is fully seated or assembly will leak from the purge valve.

Pressure-Controlled Check Valve (PCCV)

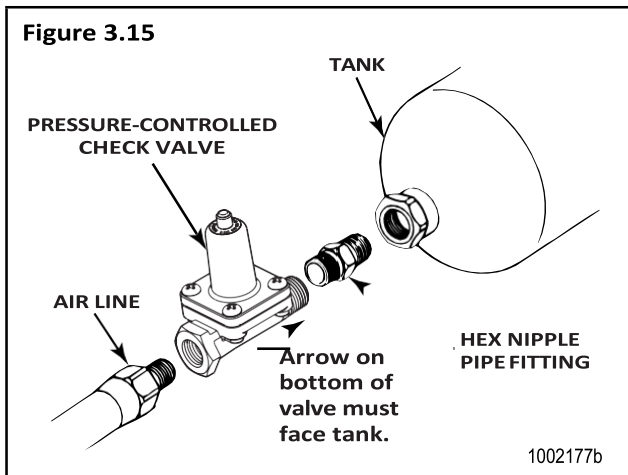


WARNING

Remove all air pressure from the tank before you remove the pressure-controlled check valve. Pressurized air can cause serious personal injury.

1. Before replacing, look at the arrow on this valve. You must install the valve so that the arrow faces the tank on which it is installed. **Figure 3.15.**

NOTE: New style valves have the hex nipple pipe fitting installed.



2. Disconnect the air line from the pressure-controlled check valve and remove the valve from the tank and hex nipple pipe fitting.

3. Install the new valve.
 - Whatever orientation (up or down) the valve is in when it is tight is acceptable, as long as the arrow is pointing in the right direction.
4. Apply pipe sealant to the fittings and connect the air line to the PC check valve.
5. Test the installation for proper operation. (Refer to Testing the Meritor WABCO System Saver Series Air Dryer in this section.)

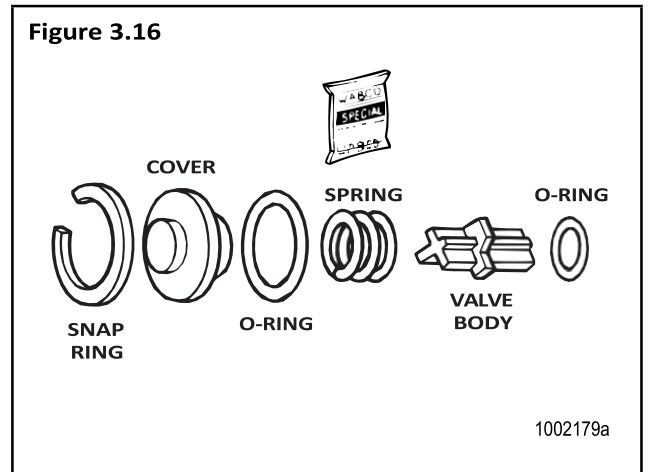
Bypass Valve



NOTE: Used only on dryers with date codes of 0894 or earlier.

1. Review **Figure 3.16** to make sure you have all of the parts required to replace the bypass valve.

Use the grease included with the replacement kit to lubricate O-rings and seals.



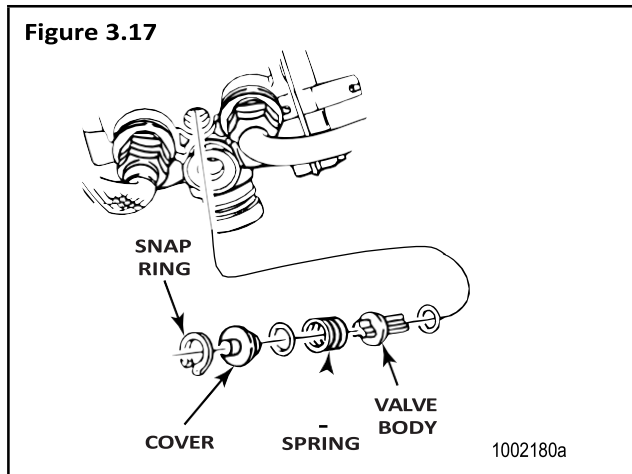
2. Remove the snap ring, cover, spring and valve body.
3. Clean and inspect the valve bore. If the bore is damaged so that a tight seal cannot be maintained, then replace the air dryer.

Section 3 Installing Replacement Parts

MERITOR WABCO

4. Install the new O-rings on the new valve body and cover.
5. Apply a thin layer of grease to the valve bore and the O-rings.
6. Install the new valve body with its long end in the bore. **Figure 3.17.**
7. Install the new spring so it fits around the "Y"-shaped fins on the valve body.
8. Install the new cover and the new snap ring to hold the components in place.

Figure 3.17

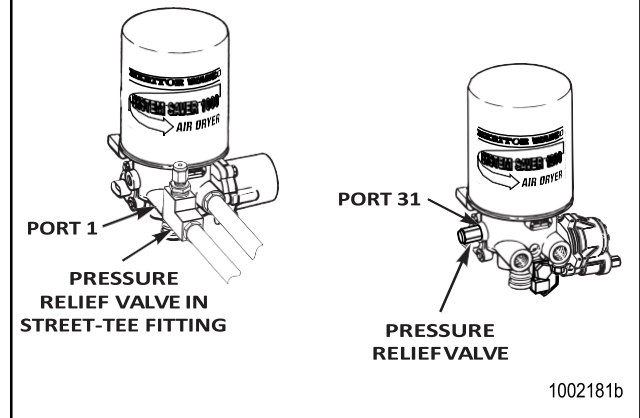


Pressure Relief Valve

NOTE: If you plan to replace the Street-Tee fitting, refer to TP-9557, Pressure Relief Valve Installation, for instructions. This publication is available from Meritor WABCO, 800-535-5560.

1. Remove the old valve from the dryer.
If your dryer uses a bypass valve (date code of 2295 or earlier), the pressure relief valve will be installed with a Street-Tee fitting at the front (Port 1) of the dryer. On dryers with date codes later than 2295, the pressure relief valve is located at the side of the dryer (Port 31). **Figure 3.18.**
2. Unscrew and remove the old pressure relief valve. **Figure 3.18.**

Figure 3.18



! WARNING

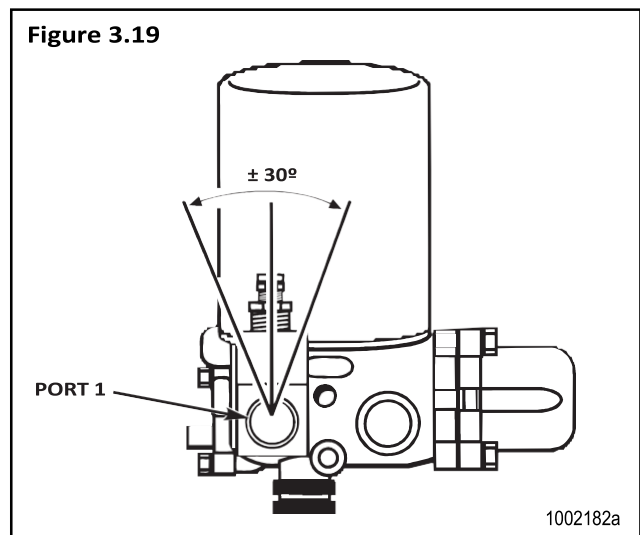
For Street-Tee installations, install the pressure relief valve in the UP position, or within 30° of vertical. **Figure 3.19.** If not installed in the correct position, serious personal injury and damage can result.

3. Screw the replacement valve into the Street-Tee fitting or the dryer base, depending on the model air dryer you have.

Do not exceed torque of 30 lb-ft (40.8 N•m) for 3/8-inch thread, or 65 lb-ft (88.4 N•m) for 1/2-inch thread. **T**

NOTE: The threads on the replacement pressure relief valve provided by Meritor WABCO are coated with sealant. They do not require any additional sealant.

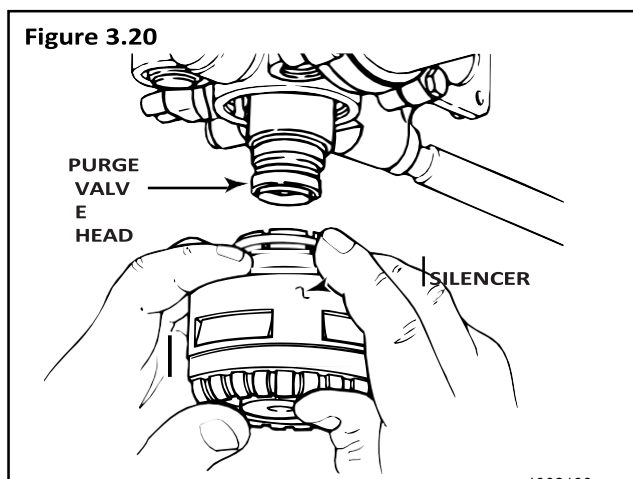
Figure 3.19



Purge Silencer (Muffler)

NOTE: This is an optional part designed to reduce dryer purge noise level.

1. Remove retainer ring. Remove old silencer from purge valve head. **Do not damage** purge valve head.
2. Clean purge valve head.
3. Install replacement silencer firmly onto purge valve head until fully seated. Secure with retainer ring. **Figure 3.20.**

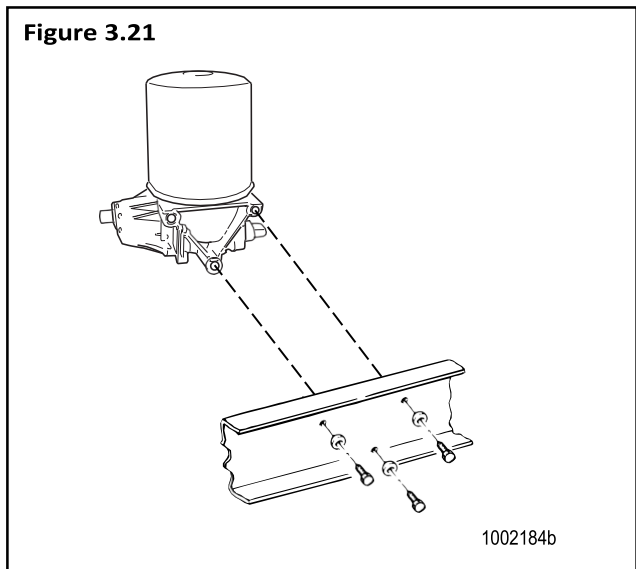


Air Dryer Assembly

NOTE: This procedure is for removing and replacing a unit. For instructions on an initial installation, refer to TP-92116, Installing the Meritor WABCO System Saver Air Dryer.

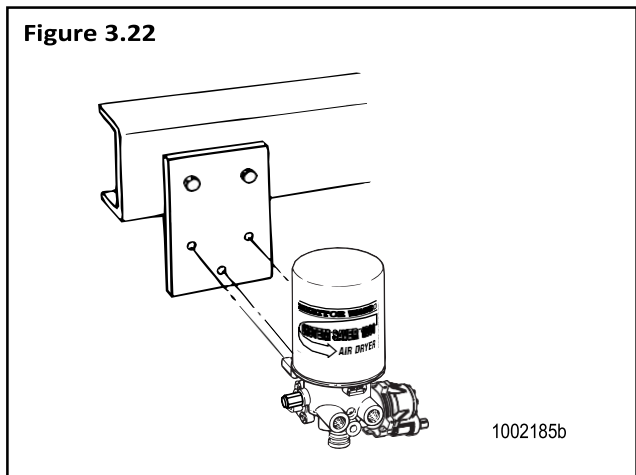
1. Drain all pressure from the air system. Disconnect all air lines.
Use markers to label the lines for proper reinstallation.
2. Disconnect the heater electrical plug from the heater receptacle.
3. Remove the three mounting bolts. Remove the air dryer from its mounting location. **Figure 3.21.**

Figure 3.21



4. Attach the new unit to the frame or mounting bracket with new mounting capscrews and washers. Tighten the capscrews to 22 to 30 lb-ft (30-40 N•m). **Figure 3.22.**

Figure 3.22



5. Connect heater electrical plug to heater receptacle.
6. Reconnect all system air lines.
7. Test the installation for proper operation. (Refer to Testing the Meritor WABCO System Saver Series Air Dryer which follows.)

Testing the Meritor WABCO System Saver Series Air Dryer

1. Turn off the engine after the air system reaches cut-out pressure (approximately 120 psi) and the air compressor has unloaded.
2. Drain the primary air tank(s) down to 80 psi or lower.
3. Check the secondary tank air gauge. It should read 95 ± 5 psi. This drop from cut-out pressure to 95 ± 5 psi for this particular test is normal for vehicles equipped with any Meritor WABCO single cartridge air dryer and the pressure-controlled check valve.
4. If the secondary tank air gauge reading is less than 90 psi, check to see if the pressure-controlled check valve is installed backwards. If so, install correctly and re-test. If not, check for air leaks in the secondary air system. If no significant air leaks are found, then replace the valve and re-test.
5. If the secondary tank air gauge reading does not change, or the reading does not fall below 100 psi, then check for one of the possibilities listed above in Step 4. If none of those possibilities is found, then the pressure-controlled check valve may be shutting off at 100 psi or higher. Replace the valve and retest.

NOTE: When checking air pressures during these procedures, do not rely on cab air gauges for accurate readings. Install a calibrated air gauge (accurate to within 1 psi) in the secondary air tank for making determinations about the continued use or replacement of any equipment.

Basic Air System/Air Dryer Terms

Air Compressor	A device that pumps air to and builds air pressure in an air system.
Air Dryer	A device that cools, filters, and dries the air delivered by an air compressor.
Air Governor	A device that controls the operation of the air compressor by constantly monitoring air pressure in the supply tank of the air system. The air governor initiates the compressor load cycle when “cut-in” pressure is realized, and initiates the compressor unload cycle when the “cut-out” pressure is reached. The air governor also controls the air dryer by sending an air signal (at the beginning of the compressor unload cycle) to the control port of the air dryer, initiating the purge cycle. When this air signal is removed by the governor (at the beginning of the compressor load cycle), the purge valve closes and the drying cycle begins.
Compressor Load Cycle	The time during which the air compressor is building air pressure in an air system.
Compressor Unload Cycle	The time during which the air compressor is idling and is not building air pressure in an air system.
Cut-In Pressure	The pressure level in the air system supply tank which triggers the compressor load cycle.
Cut-Out Pressure	The pressure level in the air system supply tank which triggers the compressor unload cycle.
Dedicated Purge Tank	A separate air tank used exclusively for holding air used in an air drying cycle. This tank eliminates the need for a regeneration valve. Optimum mounting location for the dedicated purge tank is ABOVE the air dryer.
Desiccant	A granular substance that has a high affinity for water and is used to retain moisture from the air stream flowing through the air dryer cartridge.
Discharge Line — Unloaded Compressor	An unloader or air discharge line used to dump unused air to atmosphere once system has reached cut-out pressure.
Drying Cycle	The time during which the air dryer cools, filters, and removes moisture from the air delivered by the air compressor. The drying cycle begins and ends the same as the compressor load cycle.
Purge	The initial blast of air (decompression) from the air dryer purge valve at the beginning of the unload cycle of the air compressor.
Purge Cycle	The time during which the air dryer is undergoing purge and regeneration. This cycle starts at the beginning of the compressor unload cycle and normally ends well before the beginning of the compressor load cycle.
Regeneration	The mild backflow of air through the air dryer and out the purge valve that begins immediately after the purge and lasts normally 10 to 25 seconds. This backflow of air from the air system and through the air dryer removes moisture from the desiccant cartridge and readies the air dryer for the next compressor load cycle.



WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

General Requirements

NOTE: For complete installation and operating requirements, refer to TP-9672, Air Dryer Application Guidelines.

- Compressor discharge line should have a continual downhill run to the air dryer. There should be no water traps (low points or kinks) in the line before or after the dryer.
- Mount air dryer so that there is no direct splash or spray from a wheel.
- For maximum operating efficiency, mount dedicated purge tank ABOVE the air dryer.
- Keep air dryer at least 12 inches from any heat-producing sources like exhaust manifolds or pipes, transmissions, etc.
- Make sure there are no valves or other devices in the dryer-to-supply-tank line to prohibit or restrict the flow of air back from the supply tank to the air dryer.
- Feed purge valve by a direct line from the air governor.

Operating Environment Requirements

Operating Parameter	Requirement
Temperature (ambient operating range)	-40°F to 175°F (-40°C to 80°C)
Electrical Power (for heater and solenoid/timer power)	12 or 24 volts available
Thermostat Range (On/Off temp)	45°F, 86°F (7°C, 30°C)

Discharge Line:

- Diameter from compressor to air dryer
1/2-inch i.d. minimum
- Length from compressor to air dryer
Determined by temperature of air at the inlet port of the air dryer. At normal vehicle operating temperature, length must be sufficient to keep temperature **BELOW 175°F (80°C)**.
- **Recommendations for discharge lines:**
 - **21 cfm and under:** To minimize the likelihood of a discharge line blockage during cold climate operation, it is recommended that for discharge lines exceeding 9 feet in length, a minimum of 3 feet of 1/2-inch thick closed-cell polyethylene pipe insulation be used at the connection to the air dryer.
 - **Over 21 cfm:** 10 feet/20 feet — use copper pipe or stainless steel braided teflon tubing for minimum of first 10 feet.

System Saver Series Installation Criteria

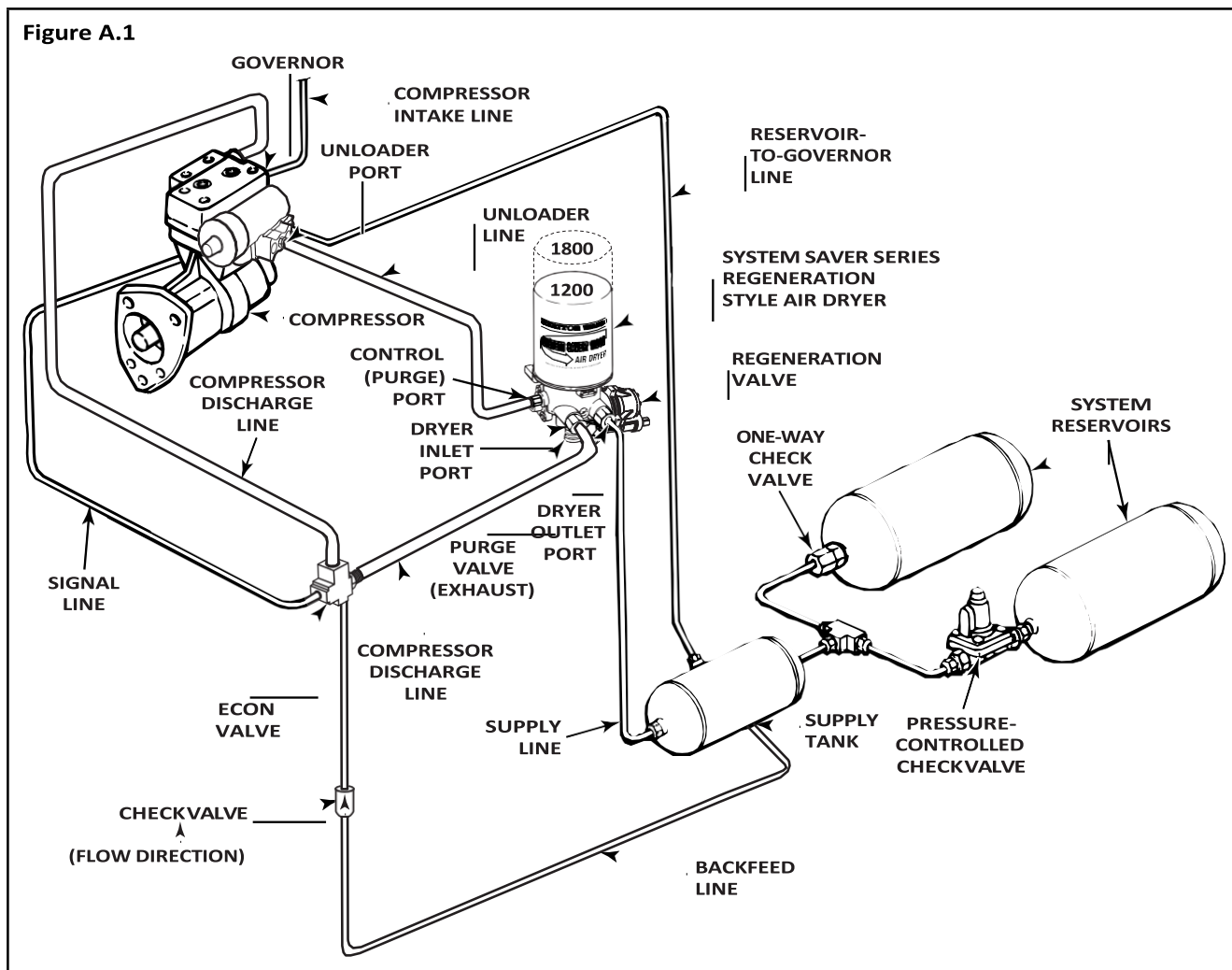
Operating Parameters		Requirements
Pressure requirements	Maximum pressure	140 psi
	Minimum governor cut-out pressure	115 psi
	Governor range	15 to 25 psi (cut-out — cut-in)
Flow capacity	Compressor rating	25 cfm maximum
Compressor on-time	Normal running	2 minutes maximum
	Occasional (three times per day maximum)	7 minutes
Compressor unloaded time	Minimum for purge cycle	20 seconds
Maximum duty cycle	Compressor on-time ÷ total running time	30%
Discharge line	Temperature at inlet port determines required length and diameter.	To minimize the likelihood of a discharge line blockage during cold climate operation, it is recommended that for discharge lines exceeding 9 feet in length, a minimum of 3 feet of 1/2-inch thick closed-cell polyethylene pipe insulation be used at the connection to the air dryer.

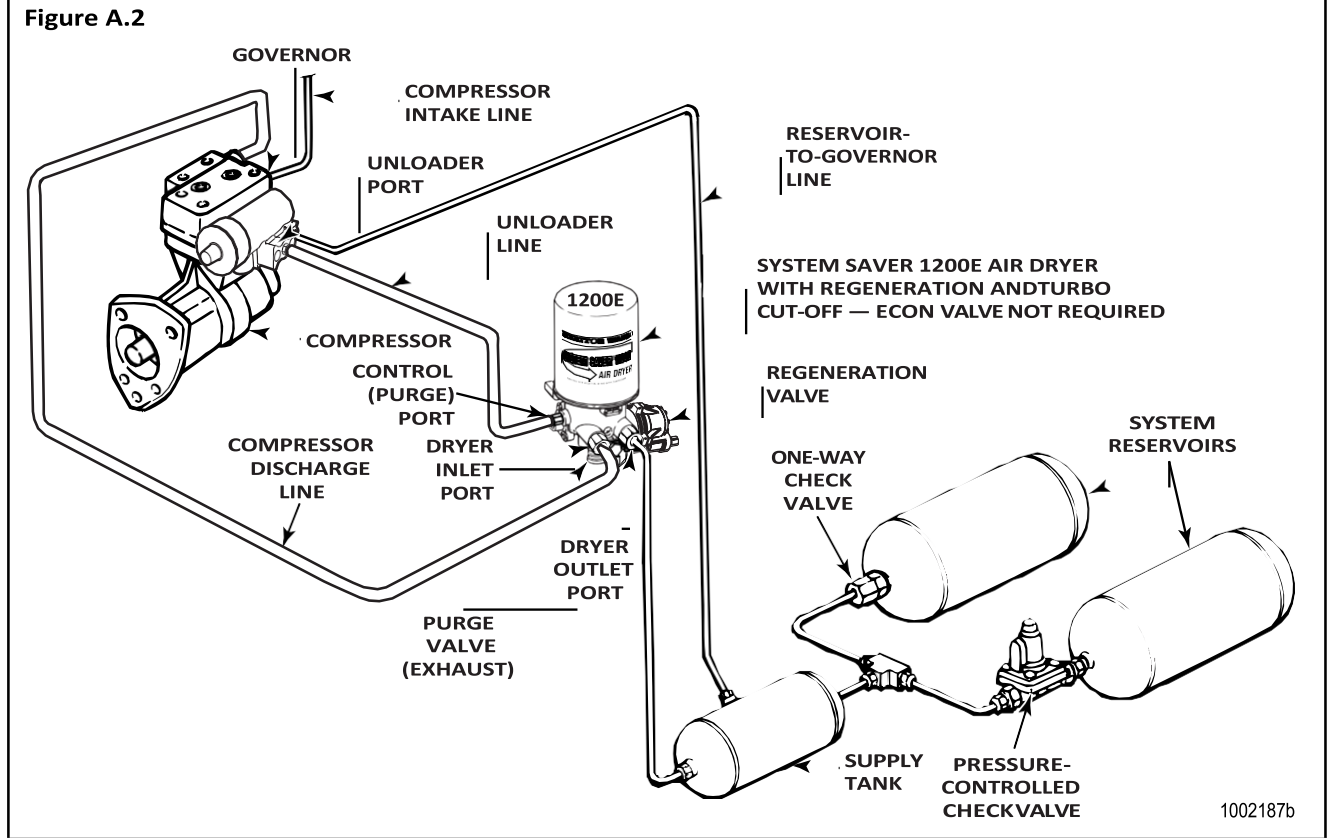
Holset E-Type Compressor Systems

When a System Saver Series air dryer is used with a Holset E-type compressor system, an external Econ valve is used. **Figure A.1.**

On the 1200E Series, an integral Econ function eliminates the need for the external Econ valve. **Figure A.2.**

If you are currently using a System Saver Series air dryer WITHOUT an Econ valve, and your application requires one, Meritor WABCO recommends installing the System Saver 1200E.



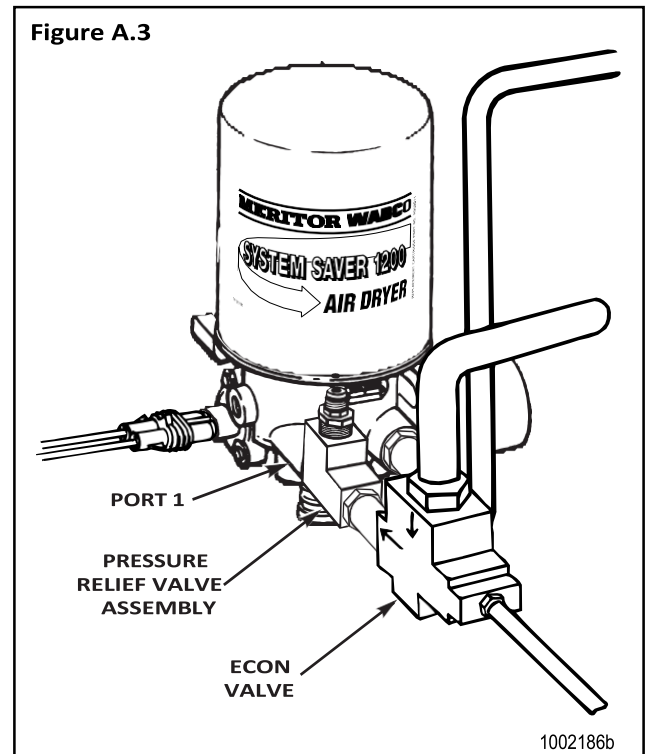


ECON Valve

Meritor WABCO recommends the ECON valve be mounted in the air system away from the dryer. This helps prevent dryer freeze-up. Refer to the vehicle manufacturer’s manual for installation instructions.

To replace an ECON valve that is mounted directly to the air dryer, follow these instructions.

1. Unscrew and remove all of the lines from the Econ valve at the air dryer inlet port.
Figure A.3.



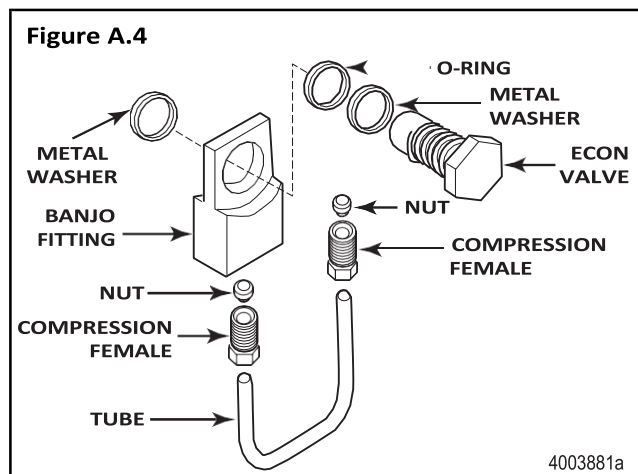
Appendix III Special Applications

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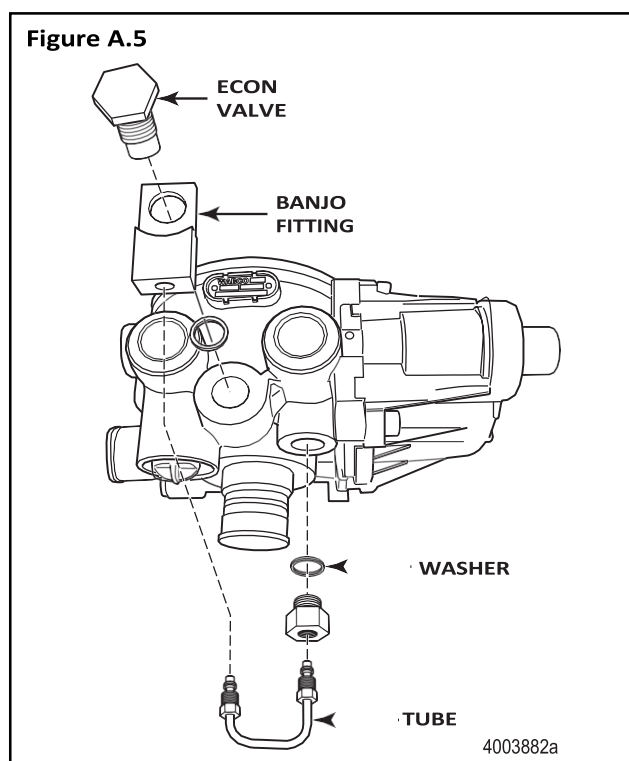
2. Unscrew and remove the Econ valve from the air dryer inlet port No. 1. Save fitting for reinstallation.
3. Install the replacement Econ valve.
 - Apply a good quality teflon paste pipe sealant, like Loctite® PST 567, on male threads of the replacement Econ valve.
4. Reconnect the lines to the Econ valve at air dryer inlet port (Port 1).

To replace the Econ valve assembly on Meritor WABCO System Saver 1200E air dryers, follow these instructions.

1. Remove the Econ valve assembly.
 - A. Using a flare wrench, loosen the compression nuts on each end of the U-shaped tube. **Figures A.4 and A.5.**



- B. Loosen and remove the restricted-flow nut on the air dryer.
- C. Remove the metal washer.
- D. Using a wrench, loosen and remove the Econ valve from the banjo fitting.
- E. Remove the banjo fitting and metal washer.
- F. Clean the valve surface area thoroughly before replacement.



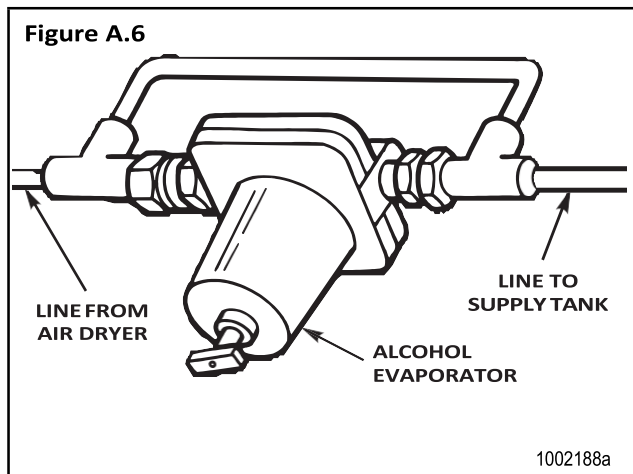
2. Install the replacement Econ valve assembly.
 - A. Install the metal washer on the restricted-flow nut.
 - B. Install the restricted-flow nut on the air dryer.
 - C. Position the metal washer and banjo fitting on the Econ valve port.
 - D. Loosely fit the U-shaped tube into the banjo fitting and restricted-flow nut. Make sure the tube is fully seated.
 - E. Install and hand-tighten the compression nuts on each end of the U-shaped tube.
 - F. Lubricate and install the O-ring on the Econ valve.
 - G. Install the Econ valve into the banjo fitting.
 - H. Torque the Econ valve and all nuts to specifications.

Alcohol Evaporator

Check the vehicle's air system for an alcohol evaporator.

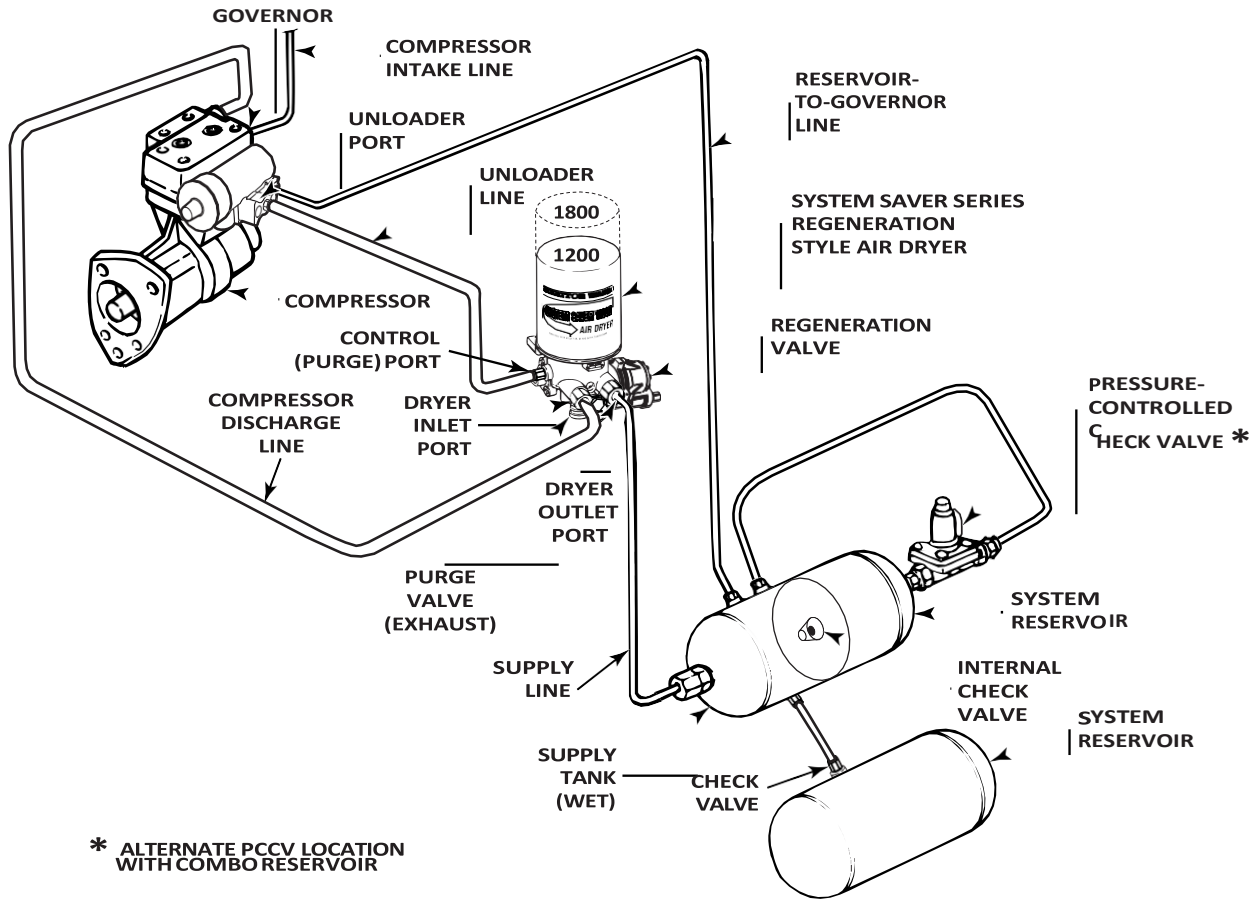
NOTE: Typically, an alcohol evaporator will be installed in the line between the air dryer and the supply (wet) tank. Common installations are on the truck's firewall, on a frame rail and behind the cab. However, an alcohol evaporator can also be found at other locations.

1. Check the vehicle's air system to determine if an alcohol evaporator is installed.
2. If an alcohol evaporator is installed in the air system, check for a bypass line connected to the evaporator. **Figure A.6.**



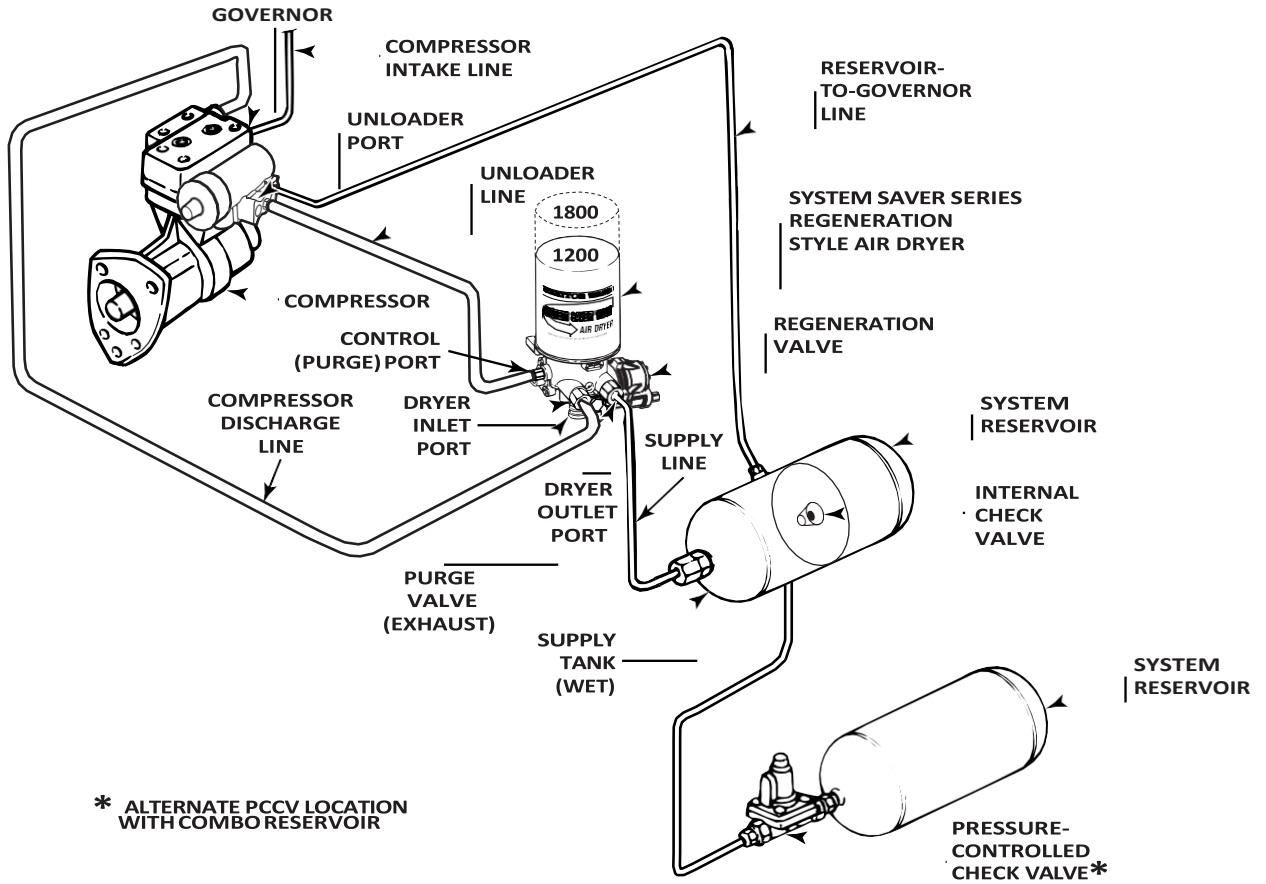
3. If a bypass line is connected to the evaporator; check to see if a check valve is installed in the bypass line. If check valve is installed:
 - Remove the check valve from the bypass line,
 - Remove the bypass line and
 - Replace the bypass line with 1/4-inch nylon line.

Combo Tank Installation for Regeneration-Style Air Dryers



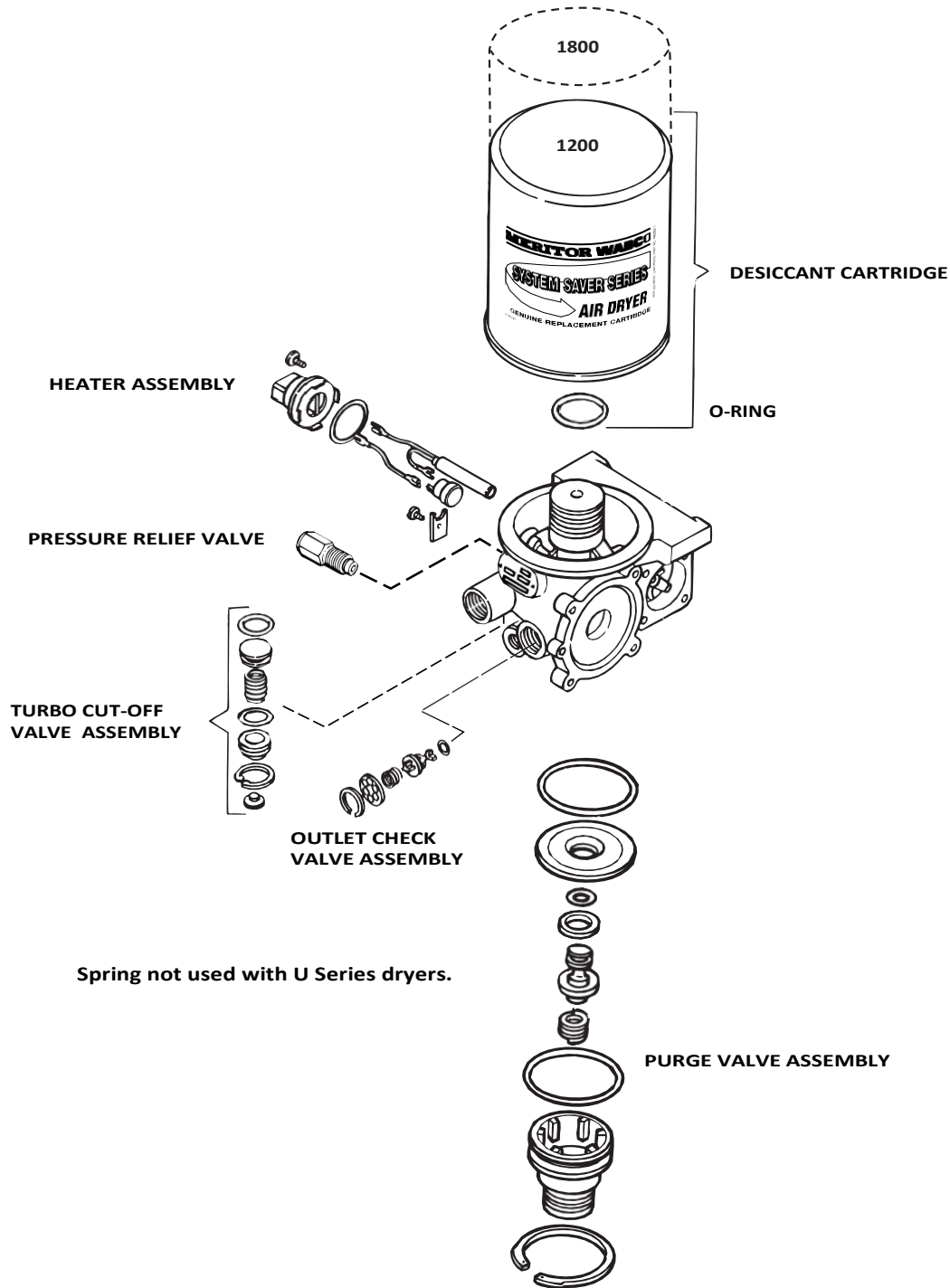
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Combo Tank Installation for Regeneration-Style Air Dryers



4003884a

Meritor WABCO System Saver Series Single Cartridge Air Dryer
Component Replacement Guide — Dedicated Purge



4003885a

**Meritor WABCO System Saver Series Single Cartridge Air Dryer
Component Replacement Guide**

HEATER ASSEMBLY

- Disconnect plug.
- Remove old assembly.
- Install replacement element and thermostat.
 - Install retainer and screw to secure.
- Install replacement O-ring and receptacle.
 - Fasten in place with screws.

PRESSURE RELIEF VALVE

- Unscrew and remove old valve.
- Screw replacement valve into dryer or Street-Tee fitting.
- Do not exceed recommended torque. Refer to Pressure Relief Valve in Section 3.

TURBO CUT-OFF

VALVE ASSEMBLY*

- Remove snap ring.
- Remove desiccant cartridge.
- Use a wooden stick to

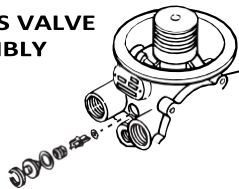
push piston, spring and cover out of the bore.

- Clean bore (if bore is badly damaged, replace the air dryer).
- Install replacement assembly.
- Replace desiccant cartridge.

OUTLET CHECK VALVE ASSEMBLY

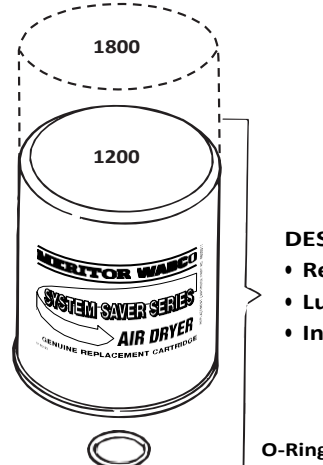
- Remove old assembly.
- Clean valve bore.
- Install replacement O-ring in bore. Then, grease O-ring and bore.

BYPASS VALVE ASSEMBLY



Bypass valve is used on dryers with date codes earlier than 0894.

1200 Series air dryers do not use bypass valve.



DESICCANT CARTRIDGE

- Remove old cartridge.
- Lube and install O-ring.
- Install replacement cartridge.

Do not grease diaphragm.

REGENERATION VALVE ASSEMBLY — REGENERATION STYLE DRYERS ONLY

- Remove old assembly and diaphragm.
- Clean diaphragm lip groove. Install replacement diaphragm and assembly.

SHIMS (IF REQUIRED)

PURGE VALVE ASSEMBLY

- Remove old assembly.
- Clean valve bore.
- Grease valve bore.
- Install replacement assembly.

NOTE: If shims are included in the replacement kit, install one above and one below the spring.

* E Series dryers use a different style turbo cut-off valve (Refer to Parts Book PB-96134).

** Spring not used with U Series dryers.

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Appendix D

ALLISON TRANSMISSION

SHIFT SELECTOR OPERATION AND CODE MANUAL



DRIVING **TRANSMISSION TECHNOLOGY™**



P.O. Box 894, Speed Code 462-470-PF3
Indianapolis, Indiana 46206-0894
www.allisontransmission.com

SA3360EN (2008/05) Litho in U.S.A.
ISO/QS 9000 and ISO 14001 Certified

Instructions for reading oil level and diagnostic codes for
3000/4000 SERIES ALLISON TRANSMISSIONS

The Allison Advantage

Your Allison Automatic is fully electronically controlled. The Allison electronic controls package oversees the operation of the transmission, controlling transmission upshifts and downshifts, and providing important information on the operation of your drive system.

Through readouts on your shift selector, you will be able to monitor transmission oil levels and read diagnostic codes. This brochure will help you understand shift selector readouts, and enjoy long, trouble-free operation of your Allison Automatic.

Shift Selector Models

Use the following information to determine which section of this brochure is applicable to your shift selector. Detailed oil level and diagnostic code readout information for your specific shift selector can be found on the pages as shown below.

If your vehicle has a shift selector that has a:

- *Double-digit display and was released after July 2008, equipped with MY09 prognostics, see the section for **MY09 Shift Selectors**.*
- *Double-digit display and was released after July 2008, not equipped with prognostics, see the section for **4th Generation Electronic Controls**.*
- *Double digit-display and was released prior to July 2008, see the section for **4th Generation Electronic Controls**.*
- *Single-digit display, see the section for **3rd Generation Electronic Controls**.*

MY09 Shift Selectors	4-11
4th generation Electronic Controls Shift Selectors	12-17
3rd generation Electronic Controls Shift Selectors	18-23

Checking Fluid Levels

The transmission fluid cools, lubricates and transmits hydraulic power, so it is important the proper fluid level be maintained at all times. If the fluid level is too low, the converter and clutches do not receive an adequate supply of fluids. If the fluid level is too high, the fluid can aerate causing the transmission to shift erratically or overheat.

Diagnostics

The electronic control system of your Allison Automatic is programmed to automatically alert and inform the operator of a problem with the transmission system. When the Transmission Control Module (TCM) detects a problem condition, the TCM:

- Restricts shifting
- Illuminates the CHECK TRANS* light on the instrument panel
- Registers a diagnostic code

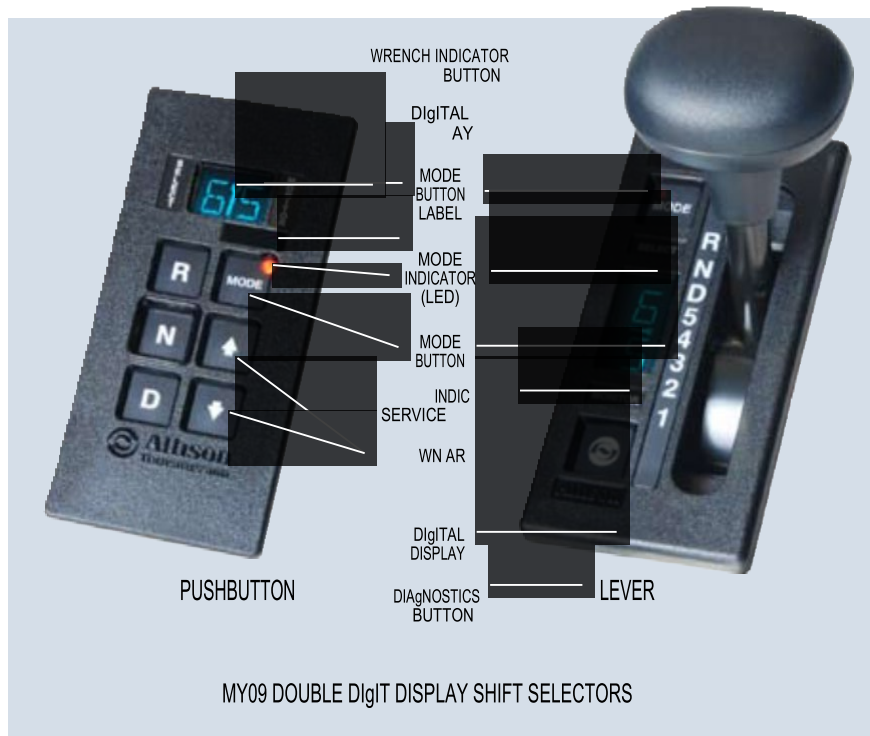
Continued illumination of the CHECK TRANS light during vehicle operation (other than start-up) indicates that the TCM has signaled a diagnostic code.

* For some problems, diagnostic codes may be registered without the TCM activating the CHECK TRANS light. Your Allison Transmission authorized service outlet should be consulted whenever there is a transmission-related concern. They have the equipment to check for diagnostic codes and to correct problems which arise.

The Best Keeps Improving

As the world leader in medium- and heavy-duty commercial transmissions, Allison Transmission continues its ongoing improvement initiative with the introduction of new prognostic features for MY09 Allison 3000 and 4000 Series models, available July 2008.

MY09 prognostics monitor various operating parameters to determine and alert when a specific maintenance function is required. MY09 prognostics feature Oil Life Monitor, Filter Life Monitor and Transmission Health Monitor. At this time, Allison Approved TES 295 transmission fluid is required to engage MY09 prognostics.



OEM's may supply shift selectors for some vehicles equipped with MY09 prognostics. If your Allison-equipped vehicle's shift selector is different from those shown above, contact your OEM for further details.

MY09 Prognostic Functions

When service is due for Allison 3000 and 4000 Series models, a WRENCHICON on the shift selector's digital display alerts the operator.



OIL LIFE MONITOR

When fluid is due for a change: The WRENCHICON is illuminated and stays on for two minutes after the DRIVE RANGE is selected.



FILTER LIFE MONITOR

When the filter(s) is due for a change: The WRENCHICON flashes on and off for two minutes after the DRIVE RANGE is selected.



TRANSMISSION HEALTH MONITOR

When clutch maintenance is due: The WRENCHICON comes on and stays on in all ranges.



Accessing Prognostics via Allison Shift Selector

When you are alerted via the WRENCH ICON on the shift selector that service is due, you can check the status of all three prognostics by toggling through the shift selector display as follows. *Be sure to park the vehicle on a level surface, shift to N (Neutral) and apply the parking brake before accessing prognostics through the shift selector.*

OIL LIFE MONITOR

Using a *pushbutton shift selector* simultaneously press the UP and DOWN arrows two times.



Using a *lever shift selector* press the DIAGNOSTICS button two times.



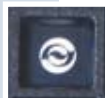
“OM” appears followed by a “%”, which represents the amount of oil life remaining before a fluid change is required.

FILTER LIFE MONITOR

Using a *pushbutton shift selector* simultaneously press the UP and DOWN arrows three times.



Using a *lever shift selector* press the DIAGNOSTICS button three times.



“FM” appears followed by either OK or LO. OK means filters do not need to be changed and LO means filters need to be changed.

TRANSMISSION HEALTH MONITOR

Using a *pushbutton shift selector* simultaneously press the UP and DOWN arrows four times.



Using a *lever shift selector* press the DIAGNOSTICS button four times.



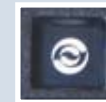
6

Checking Fluid Levels on MY09 Shift Selectors

Use the following procedure to display oil level information.

To enter oil level display mode:

1. Park the vehicle on a level surface, shift to N (Neutral) and apply the parking brake.
2. Using a *pushbutton shift selector*, simultaneously press the UP and DOWN arrows one time.



Using a *lever shift selector*, press the DIAGNOSTICS button one time.

3. The fluid level reading may be delayed until the following conditions are met:

- Engine is at idle.
- The fluid temperature is between 60°C (140°F) and 104°C (220°F).
- Transmission is in N (Neutral).
- The vehicle has been stationary for approximately two minutes to allow the fluid to settle.
- The engine is at idle (below 1000 rpm – not "fast" idle).

DELAYED FLUID LEVEL CHECK

The indication of a delayed fluid level check for *pushbutton and lever selectors* is a flashing display and a numerical countdown.



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K
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means no clutch
maintenance is required
and LO means clutch
maintenance
is required.

4. The shift selector displays the oil level data as follows:

- **CORRECT FLUID LEVEL** – “OL” is displayed (“OL” represents “Fluid (Oil) Level Check Mode”), followed by “OK.” The “OK” display indicates the fluid is within the correct fluid level zone. The sensor display and the transmission dipstick may not agree exactly because the oil level sensor compensates for fluid temperature.



- **LOW FLUID LEVEL** – “OL” is displayed (“OL” represents “Fluid (Oil) Level Check Mode”) followed by “LO” (“LO” represents “Low Oil Level”) and the number of quarts the transmission fluid is low.

Example: OL LO 02 “2” indicates that 2 additional quarts of fluid will bring the fluid level within the middle of the “OK” zone.



- **HIGH FLUID LEVEL** – “OL” is displayed (“OL” represents “Fluid (Oil) Level Check Mode”) followed by “HI” (“HI” represents “High Oil Level”) and the number of quarts the transmission fluid is overfilled.

Example: OL HI 01 “1” indicates 1 quart of fluid above the full transmission level.



- **INVALID FORDISPLAY** – If any of the previous conditions are not met, the shift selector will display “OL” (“OL” represents “Fluid (Oil) Level Check Mode”) followed by “--” and a numerical display. The numerical display is a fault code and indicates conditions are not proper to receive the fluid level information, or that there is a system malfunction.

The fault codes that may be encountered are shown below:

DISPLAY FAULT CODE	FLUID LEVEL FAULT CODE DESCRIPTION
OL, --, 0X*	Setting time too short
OL, --, 50 or, EL	Engine speed too low
OL, --, 59 or, EH	Engine speed too high
OL, --, 65 or, SN	Neutral must be selected
OL, --, 70 or, TL	Sump fluid temperature too low
OL, --, 79 or, TH	Sump fluid temperature too high
OL, --, 89 or, SH	Output speed high
OL, --, 95 or, FL	Oil level sensor failed**

*A number between 8 and 1 that flashes during countdown period.

**Report sensor failure display to a distributor or dealer in your area.

CAUTION: A low or high fluid level can cause overheating and irregular shift patterns. Incorrect fluid level can damage the transmission.

To exit the oil level display mode:

- *Pushbutton selector:* Press any range button.
- *Lever selector:* Press the DIAGNOSTICS button one time.



MODE BUTTON

On motorhomes and general delivery trucks, Allison Automatics can offer primary and secondary shift schedule modes to enhance performance or fuel economy. The vehicle always starts in the primary mode (light off). You can switch to the secondary mode (light on) by pushing the MODE button.



Displaying Active Diagnostic Codes

To enter the diagnostic mode:

1. Bring the vehicle to a complete stop. Apply the parking brake.
2. Using a *pushbutton shift selector*, simultaneously press the UP and DOWN arrows five times.

Using a *lever shift selector*, press the DIAGNOSTICS button five times.



To read the digital display codes:

Diagnostic codes will appear two characters at a time on a *pushbutton* or *lever selector*.

When the diagnostic mode is entered, the first code (position d1) is displayed as follows:

Example Code: P0722

Displayed as: d1, P, 07, 22



The Code Position (d1) is the first item displayed, followed by the Diagnostic Trouble Code (DTC),** P, 07, 22. Each item is displayed for about one second. The display cycles continuously until the next code list position is accessed by pressing the MODE button.

For a detailed list of Diagnostic Transmission Codes for MY09 shift selectors, see pages 30 through 33.

To clear diagnostic codes:

Press and hold the MODE button for 10 seconds to clear both active and inactive codes.

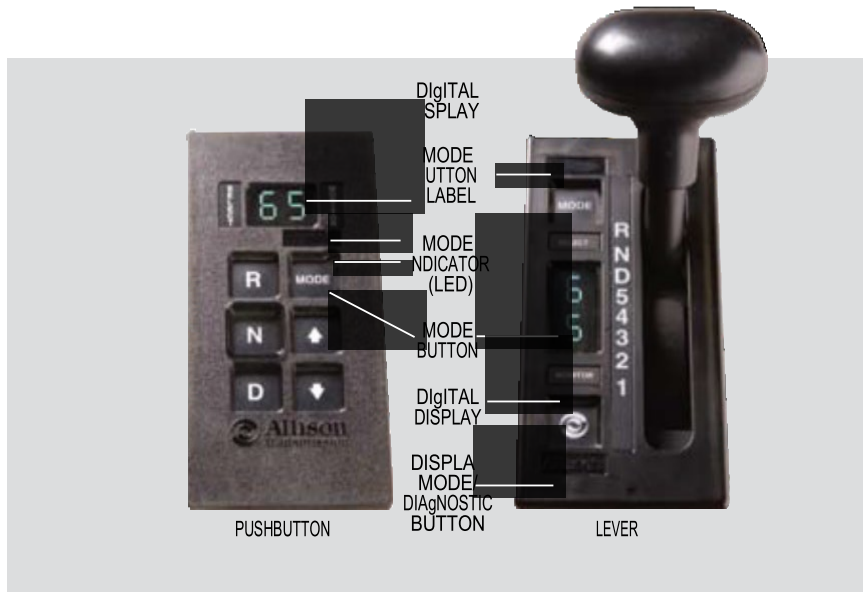


Be sure to record all codes displayed before they are cleared. This is essential for troubleshooting. Begin operating as normal.

Drive the vehicle and check for code recurrence. If codes continue to recur, bring the vehicle to an authorized Allison Transmission service outlet to diagnose and repair the problem causing the codes.

** Diagnostic Trouble Code (DTC) – The diagnostic trouble code number referring to the general condition or area of fault detected by the TCM.

4th generation Electronic Controls Shift Selectors



Vehicle manufacturers may choose different types of shift selectors for their vehicles. The shift selector in your Allison-equipped vehicle will be similar to the pushbutton or lever style shown above.

Checking Fluid Levels

Use the following procedure to display oil level information.

To enter the oil level display mode:

1. Park the vehicle on a level surface, shift to N (Neutral) and apply the parking brake.
2. Using a *pushbutton selector*, simultaneously press the UP and DOWN arrow buttons one time.



Using a *lever selector*, press the DISPLAY MODE/DIAGNOSTIC button one time.

3. The fluid level reading may be delayed until the following conditions are met:
 - Engine is at idle.
 - The fluid temperature is between 60°C (140°F) and 104°C (220°F).
 - Transmission is in N (Neutral).
 - The vehicle has been stationary for approximately two minutes to allow the fluid to settle.
 - The engine is at idle (below 1000 rpm – not "fast" idle).

DELAYED FLUID LEVEL CHECK

The indication of a delayed fluid level check for *pushbutton and lever selectors* is a flashing display and a numerical countdown in the SELECT/MONITOR window display.



4. The shift selector displays the oil level data as follows:

- **CORRECT FLUID LEVEL** – “OL” is displayed (“OL” represents “Fluid (Oil) Level Check Mode”), followed by “OK.” The “OK” display indicates the fluid is within the correct fluid level zone. The sensor display and the transmission dipstick may not agree exactly because the oil level sensor compensates for fluid temperature.



- **LOW FLUID LEVEL** – “OL” is displayed (“OL” represents “Fluid (Oil) Level Check Mode”) followed by “LO” (“LO” represents “Low Oil Level”) and the number of quarts the transmission fluid is low.

Example: OL LO 02 “2” indicates that 2 additional quarts of fluid will bring the fluid level within the middle of the “OK” zone.



- **HIGH FLUID LEVEL** – “OL” is displayed (“OL” represents “Fluid (Oil) Level Check Mode”) followed by “HI” (“HI” represents “High Oil Level”) and the number of quarts the transmission fluid is overfilled.

Example: OL HI 1 “1” indicates 1 quart of fluid above the full transmission level.



- **INVALID FOR DISPLAY** – If any of the previous conditions are not met, the shift selector will display “OL” (“OL” represents “Fluid (Oil) Level Check Mode”) followed by “— —” and a numerical display. The numerical display is a fault code and indicates conditions are not proper to receive the fluid level information, or that there is a system malfunction.

The fault codes that may be encountered are shown on page 9.

CAUTION: *A low or high fluid level can cause overheating and irregular shift patterns. Incorrect fluid level can damage the transmission.*

To exit the oil level display mode:

DOUBLE DIGIT DISPLAY

- *Pushbutton selector:* Press any range button.
- *Lever selector:* Press the DIAGNOSTICS button one time.



MODE BUTTON

On motorhomes and general delivery trucks, Allison Automatics can offer primary and secondary shift schedule modes to enhance performance or fuel economy. The vehicle always starts in the primary mode (light off). You can switch to the secondary mode (light on) by pushing the MODE button.



Displaying Active Diagnostic Codes

To enter the diagnostic mode:

1. Bring the vehicle to a complete stop. Apply the parking brake.
2. Using a *pushbutton shift selector*, simultaneously press the UP and DOWN arrows two times.

Using a *lever shift selector*, press the DISPLAY MODE/DIAGNOSTIC button two times..



To read the digital display codes:

Diagnostic codes will appear two characters at a time on a *pushbutton* or *lever selector*.

When the diagnostic mode is entered, the first code (position d1) is displayed as follows:

Example Code: PO722

Displayed as: d1, P, 07, 22



The Code Position (d1) is the first item displayed, followed by the Diagnostic Trouble Code (DTC), ** P, 07, 22. Each item is displayed for about one second. The display cycles continuously until the next code list position is accessed by pressing the MODE button.

To clear diagnostic codes:

Press and hold the MODE button for 10 seconds to clear both active and inactive codes.



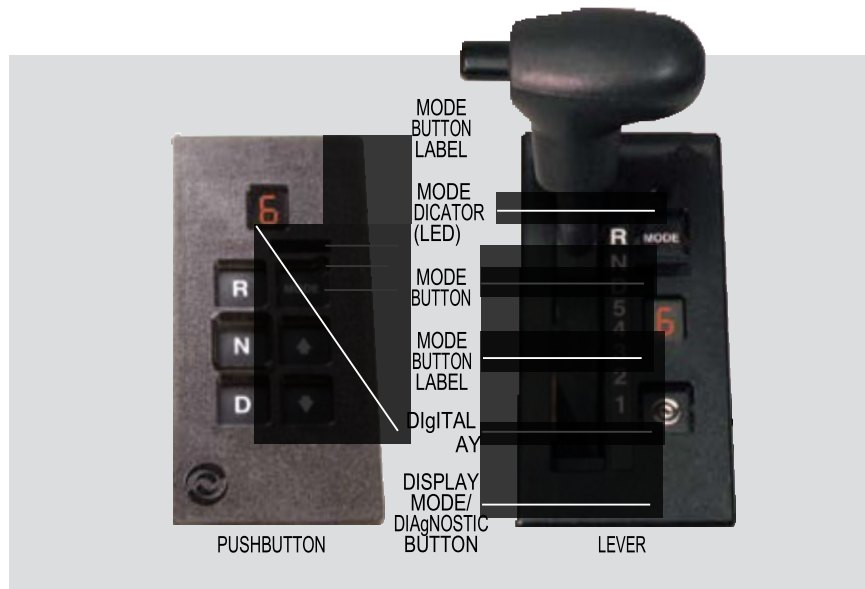
Be sure to record all codes displayed before they are cleared. This is essential for troubleshooting. Begin operating as normal.

Drive the vehicle and check for code recurrence. If codes continue to recur, bring the vehicle to an authorized Allison Transmission service outlet to diagnose and repair the problem causing the codes.

For a detailed list of Diagnostic Transmission Codes for 4th Generation Shift Selectors, see pages 30 through 33.

**** Diagnostic Trouble Code (DTC) – The diagnostic trouble code number referring to the general condition or area of fault detected by the TCM.**

3rd generation Electronic Controls Shift Selectors



SINGLE DIGIT DISPLAY SHIFT SELECTORS

Vehicle manufacturers may choose different types of shift selectors for their vehicles. The shift selector in your Allison-equipped vehicle will be similar to one of the pushbutton or lever styles as shown above.

Checking Fluid Levels

Use the following procedure to display oil level information.

To enter the oil level display mode:

1. Park the vehicle on a level surface, shift to N (Neutral) and apply the parking brake.
2. Using a *pushbutton shift selector*, simultaneously press the UP and DOWN arrow buttons one time.



Using a *lever shift selector*, press the DISPLAY MODE/DIAGNOSTIC button one time.

3. The fluid level reading may be delayed until the following conditions are met:
 - Engine is at idle.
 - The fluid temperature is between 60°C (140°F) and 104°C (220°F).
 - Transmission is in N (Neutral).
 - The vehicle has been stationary for approximately two minutes to allow the fluid to settle.
 - The engine is at idle (below 1000 rpm – not "fast" idle).

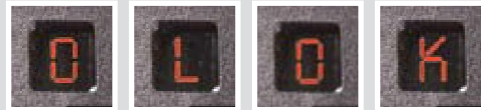
DELAYED FLUID LEVEL CHECK

A delayed fluid level check for *pushbutton and lever selectors* is indicated by a “-” in the display window followed by a numerical countdown.



4. The shift selector displays the oil level data as follows:

- **CORRECT FLUID LEVEL** – “OL” is displayed (“OL” represents “Fluid (Oil) Level Check Mode”), followed by “OK.” The “OK” display indicates the fluid is within the correct fluid level zone. The sensor display and the transmission dipstick may not agree exactly because the oil level sensor compensates for fluid temperature.



- **LOW FLUID LEVEL** – “OL” is displayed (“OL” represents “Fluid (Oil) Level Check Mode”) followed by “LO” (“LO” represents “Low Oil Level”) and the number of quarts the transmission fluid is low.

Example: OL LO 2 “2” indicates that 2 additional quarts of fluid will bring the fluid level within the middle of the “OK” zone.



- **HIGH FLUID LEVEL** – “OL” is displayed (“OL” represents “Fluid (Oil) Level Check Mode”) followed by “HI” (“HI” represents “High Oil Level”) and the number of quarts the transmission fluid is overfilled.

Example: OL HI 1 “1” indicates 1 quart of fluid above the full transmission level.



- **INVALID FOR DISPLAY** – If any of the above conditions are not met, the shift selector will display “OL” (“OL” represents “Fluid (Oil) Level Check Mode”) followed by “-” and a numerical display. The numerical display is a fault code and indicates conditions are not proper to receive the fluid level information, or that there is a system malfunction.

The fault codes that may be encountered are shown below:

DISPLAY FAULT CODE	FLUID LEVEL FAULT CODE DESCRIPTION
O, L, -, 0, X*	Setting time too short
O, L, -, 5, 0	Engine speed too low
O, L, -, 5, 9	Engine speed too high
O, L, -, 6, 5	Neutral must be selected
O, L, -, 7, 0	Sump fluid temperature too low
O, L, -, 7, 9	Sump fluid temperature too high
O, L, -, 8, 9	Output speed high
O, L, -, 9, 5	Oil level sensor failed**

*A number between 8 and 1 that flashes during countdown period.

**Report sensor failure display to a distributor or dealer in your area.

CAUTION: A low or high fluid level can cause overheating and irregular shift patterns. Incorrect fluid level can damage the transmission.

To exit the oil level display mode:

SINGLE DIGIT DISPLAY

- **Pushbutton selector:**
Press the NEUTRAL button or simultaneously press the UP and DOWN arrows two times.
- **Lever selector:**
Press the DISPLAY MODE/DIAGNOSTIC button two times or momentarily move the shift selector to any range and back to neutral.



MODE BUTTON

On motorhomes and general delivery trucks, Allison Automatics can offer primary and secondary shift schedule modes to enhance performance or fuel economy. The vehicle always starts in the primary mode (light off). You can switch to the secondary mode (light on) by pushing the MODE button.



Displaying Active Diagnostic Codes

To enter the diagnostic mode:

1. Bring the vehicle to a complete stop. Apply the parking brake.
2. Using a *pushbutton shift selector*, simultaneously press the UP and DOWN arrows two times.

Using a *lever shift selector*, press the DISPLAY MODE/DIAGNOSTIC button two times.



To read the digital display codes:

Diagnostic codes will appear one digit at a time on a *lever or pushbutton selector*.

When the diagnostic mode is entered, the first code (position d1) is displayed as follows:

Example Code: 13 12



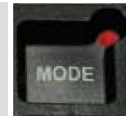
Code Position: d1 – indicates that this is the first diagnostic code listed in the TCM memory.

Main Code: 13 - (two digits displayed one at a time) is listed first and provides the general condition or area of a fault detected by the TCM.

Sub Code: 12 - (two digits displayed one at a time) is listed second and provides specific areas or conditions within the main code that caused the fault. This subcode indicates the problem is caused by low voltage.

To clear diagnostic codes:

Press and hold the MODE button for approximately three seconds until the MODE INDICATOR (LED) flashes. Release the MODE button and active indicators will not be illuminated. To clear inactive codes, press and hold the MODE button for 10 seconds. Some codes are self-clearing and others require ignition cycles to clear.



Be sure to record all codes displayed before they are cleared. This is essential for troubleshooting. Begin operating as normal.

Drive the vehicle and check for code recurrence. If codes continue to recur, bring the vehicle to an authorized Allison Transmission service outlet to diagnose and repair the problem causing the codes.

For a detailed list of Diagnostic Transmission Codes for 3rd Generation Shift Selectors, see pages 24 through 29.

Diagnostic Transmission Codes

MAIN CODE	SUB CODE	CODE DESCRIPTION
34	16	REAL TIME BLOCK CHECKSUM
	17	CUSTOMER MODIFIABLE CONSTANTS CHECKSUM
35	00	POWER INTERRUPTION
	16	REAL TIME WRITE INTERRUPTION
36	00	HARDWARE/SOFTWARE NOT COMPATIBLE
	01	TID NOT COMPATIBLE W/HARDWARE/SOFTWARE
	02	TID DID NOT COMPLETE
42	12	A SOLENOID SHORTED TO BATTERY
	13	B SOLENOID SHORTED TO BATTERY
	14	C SOLENOID SHORTED TO BATTERY
	15	D SOLENOID SHORTED TO BATTERY
	16	E SOLENOID SHORTED TO BATTERY
	21	F SOLENOID SHORTED TO BATTERY
	22	g SOLENOID SHORTED TO BATTERY
	23	H SOLENOID SHORTED TO BATTERY
	24	J SOLENOID SHORTED TO BATTERY
	26	N SOLENOID SHORTED TO BATTERY
44	12	A SOLENOID SHORTED TO gROUND
	13	B SOLENOID SHORTED TO gROUND
	14	C SOLENOID SHORTED TO gROUND
	15	D SOLENOID SHORTED TO gROUND
	16	E SOLENOID SHORTED TO gROUND
	21	F SOLENOID SHORTED TO gROUND
	22	g SOLENOID SHORTED TO gROUND
	23	H SOLENOID SHORTED TO gROUND
	24	J SOLENOID SHORTED TO gROUND
	26	N SOLENOID SHORTED TO gROUND
45	12	A SOLENOID CIRCUIT OPEN
	13	B SOLENOID CIRCUIT OPEN
	14	C SOLENOID CIRCUIT OPEN
	15	D SOLENOID CIRCUIT OPEN
	16	E SOLENOID CIRCUIT OPEN
	21	F SOLENOID CIRCUIT OPEN
	22	g SOLENOID CIRCUIT OPEN
	23	H SOLENOID CIRCUIT OPEN
	24	J SOLENOID CIRCUIT OPEN
	26	N SOLENOID CIRCUIT OPEN

Diagnostic Transmission Codes

MAIN CODE	SUB CODE	CODE DESCRIPTION
13	12	ECU INPUT VOLTAGE LOW
	13	ECU INPUT VOLTAGE MEDIUM LOW
	23	ECU INPUT VOLTAGE HIGH
14	12	OIL LEVEL SENSOR, FAILED LOW
	23	OIL LEVEL SENSOR, FAILED HIGH
21	12	THROTTLE POSITION SENSOR, FAILED LOW
	23	THROTTLE POSITION SENSOR, FAILED HIGH
22	14	ENGINE SPEED SENSOR
	15	TURBINE SPEED SENSOR
	16	OUTPUT SPEED SENSOR
23	12	PRIMARY SHIFT SELECTOR FAULT
	13	PRIMARY SHIFT SELECTOR MODE FAULT
	14	SECONDARY SHIFT SELECTOR FAULT
	15	SECONDARY SHIFT SELECTOR MODE FAULT
	16	SHIFT SELECTOR DISPLAY LINE FAULT
24	12	SUMP FLUID TEMPERATURE, COLD
	23	SUMP FLUID TEMPERATURE, HOT
25	00	OUTPUT SPEED SENSOR @ 0 RPM, LOW
	11	OUTPUT SPEED SENSOR @ 0 RPM, 1ST
	22	OUTPUT SPEED SENSOR @ 0 RPM, 2ND
	33	OUTPUT SPEED SENSOR @ 0 RPM, 3RD
	44	OUTPUT SPEED SENSOR @ 0 RPM, 4TH
	55	OUTPUT SPEED SENSOR @ 0 RPM, 5TH
	66	OUTPUT SPEED SENSOR @ 0 RPM, 6TH
	77	OUTPUT SPEED SENSOR @ 0 RPM, REVERSE
26	00	THROTTLE SOURCE NOT DETECTED
	11	ENGINE COOLANT SOURCE NOT DETECTED
32	00	C3 PRESSURE SWITCH OPEN IN LOW
	33	C3 PRESSURE SWITCH OPEN IN 3RD
	55	C3 PRESSURE SWITCH OPEN IN 5TH
	77	C3 PRESSURE SWITCH OPEN IN REVERSE
33	12	SUMP OIL TEMPERATURE SENSOR, FAILED LOW
	23	SUMP OIL TEMPERATURE SENSOR, FAILED HIGH
34	12	CALIBRATION COMPATIBILITY WRONG
	13	CALIBRATION BLOCK CHECKSUM
	14	POWER OFF BLOCK CHECKSUM
	15	DIAGNOSE QUEUE BLOCK CHECKSUM

Diagnostic Transmission Codes

MAIN CODE	SUB CODE	CODE DESCRIPTION
46	21	F SOLENOID CIRCUIT OVERCURRENT
	26	N & H SOLENOID CIRCUIT OVERCURRENT
	27	A-HI SOLENOID CIRCUIT OVERCURRENT
51	01	OFFgOINg RATIO TEST, LOW TO 1
	10	OFFgOINg RATIO TEST, 1 TO LOW
	12	OFFgOINg RATIO TEST, 1 TO 2
	21	OFFgOINg RATIO TEST, 2 TO 1
	23	OFFgOINg RATIO TEST, 2 TO 3
	24	OFFgOINg RATIO TEST, 2 TO 4
	35	OFFgOINg RATIO TEST, 3 TO 5
	42	OFFgOINg RATIO TEST, 4 TO 2
	43	OFFgOINg RATIO TEST, 4 TO 3
	45	OFFgOINg RATIO TEST, 4 TO 5
	46	OFFgOINg RATIO TEST, 4 TO 6
	53	OFFgOINg RATIO TEST, 5 TO 3
	64	OFFgOINg RATIO TEST, 6 TO 4
	65	OFFgOINg RATIO TEST, 6 TO 5
	XY	OFFgOINg RATIO TEST, X TO Y
52	01	OFFgOINg C3PS TEST, LOW TO 1
	08	OFFgOINg C3PS TEST, LOW TO N1
	32	OFFgOINg C3PS TEST, 3 TO 2
	34	OFFgOINg C3PS TEST, 3 TO 4
	54	OFFgOINg C3PS TEST, 5 TO 4
	56	OFFgOINg C3PS TEST, 5 TO 6
	71	OFFgOINg C3PS TEST, REVERSE TO 1
	72	OFFgOINg C3PS TEST, REVERSE TO 2
	78	OFFgOINg C3PS TEST, REVERSE TO N1
	99	OFFgOINg C3PS TEST, N3 TO N2
XY	OFFgOINg C3PS TEST, X TO Y	
53	08	OFFgOINg SPEED TEST, LOW TO N1
	09	OFFgOINg SPEED TEST, L TO NNC
	18	OFFgOINg SPEED TEST, 1 TO N1
	19	OFFgOINg SPEED TEST, 1 TO RELS
	28	OFFgOINg SPEED TEST, 2 TO N1
	29	OFFgOINg SPEED TEST, 2 TO N2
	38	OFFgOINg SPEED TEST, 3 TO N1
	39	OFFgOINg SPEED TEST, 3 TO N3

Diagnostic Transmission Codes

MAIN CODE	SUB CODE	CODE DESCRIPTION
53	48	OFFgOINg SPEED TEST, 4 TO N1
	49	OFFgOINg SPEED TEST, 4 TO N3
	58	OFFgOINg SPEED TEST, 5 TO N1
	59	OFFgOINg SPEED TEST, 5 TO N3
	68	OFFgOINg SPEED TEST, 6 TO N1
	69	OFFgOINg SPEED TEST, 6 TO N4
	78	OFFgOINg SPEED TEST, REVERSE TO N1
	99	OFFgOINg SPEED TEST, N2 TO N3 OR N3 TO N2
	XY	OFFgOINg SPEED TEST, X TO Y
	54	01
07		ONCOMINg RATIO TEST, LOW TO REVERSE
10		ONCOMINg RATIO TEST, 1 TO LOW
12		ONCOMINg RATIO TEST, 1 TO 2
17		ONCOMINg RATIO TEST, 1 TO REVERSE
21		ONCOMINg RATIO TEST, 2 TO 1
23		ONCOMINg RATIO TEST, 2 TO 3
24		ONCOMINg RATIO TEST, 2 TO 4
27		ONCOMINg RATIO TEST, 2 TO REVERSE
32		ONCOMINg RATIO TEST, 3 TO 2
34		ONCOMINg RATIO TEST, 3 TO 4
35		ONCOMINg RATIO TEST, 3 TO 5
42		ONCOMINg RATIO TEST, 4 TO 2
43		ONCOMINg RATIO TEST, 4 TO 3
45		ONCOMINg RATIO TEST, 4 TO 5
46		ONCOMINg RATIO TEST, 4 TO 6
53		ONCOMINg RATIO TEST, 5 TO 3
54		ONCOMINg RATIO TEST, 5 TO 4
56		ONCOMINg RATIO TEST, 5 TO 6
64		ONCOMINg RATIO TEST, 6 TO 4
65		ONCOMINg RATIO TEST, 6 TO 5
70		ONCOMINg RATIO TEST, REV. TO LOW
71		ONCOMINg RATIO TEST, REVERSE TO 1
72	ONCOMINg RATIO TEST, REVERSE TO 2	
80	ONCOMINg RATIO TEST, N1 TO LOW	
81	ONCOMINg RATIO TEST, N1 TO 1	
82	ONCOMINg RATIO TEST, N1 TO 2	
83	ONCOMINg RATIO TEST, N1 TO 3	

Diagnostic Transmission Codes

MAIN CODE	SUB CODE	CODE DESCRIPTION
63	41	PUMP/PACK AND NEUTRAL gENERAL PURPOSE INPUT
	47	RELS INPUT, FAILED ON
64	12	RETARDER MODULATION SENSOR, FAILED LOW
	23	RETARDER MODULATION SENSOR, FAILED HlgH
65	00	ENgINE RATINg TOO HlgH
	11	ENgINE NOT RESPONDINg TO LRTP TORQUE REDUCTION
	12	ENgINE NOT RESPONDINg TO DEFAULT TRANSMISSION TORQUE LIMIT
66	00	SERIAL COMMUNICATION INTERFACE FAULT
	11	S. C. I. ENgINE COOLANT SOURCE FAULT
	22	J1939 RETARDER REQUEST FAULT
	33	J1939 DRIVER DEMAND TORQUE FAULT
	34	ENgINE NOT RESPONDINg TO J1939 SEM CONTROL
69	27	A-HlgH SWITCH INOPERATIVE IN ECU
	28	F-HlgH SWITCH INOPERATIVE IN ECU
	29	N & H-HlgH SWITCH INOPERATIVE IN ECU
	33	COMPUTER OPERATING PROPERLY TIMEOUT IN ECU
	34	ECU WRITE TIMEOUT
	35	ECU CHECKSUM TEST
	36	RAM SELF TEST IN ECU
	39	COMMUNICATION CHIP ADDRESSINg ERROR
	41	I/O ASIC ADDRESSINg TEST IN ECU
	42	SPI OUTPUT FAILURE
	43	SPI INPUT FAILURE
70	12	MINOR LOOP OVERRUN IN SOFTWARE
	13	ILLEgAL WRITE TO ADDRESS \$0000
	14	MAJOR LOOP OVERRUN IN SOFTWARE

Diagnostic Transmission Codes

MAIN CODE	SUB CODE	CODE DESCRIPTION
54	85	ONCOMINg RATIO TEST, N1 TO 5
	86	ONCOMINg RATIO TEST, N1 TO 6
	87	ONCOMINg RATIO TEST, N1 TO REVERSE
	92	ONCOMINg RATIO TEST, N2 TO 2
	93	ONCOMINg RATIO TEST, N3 TO 3
	95	ONCOMINg RATIO TEST, N3 TO 5
	96	ONCOMINg RATIO TEST, N4 TO 6
	XY	ONCOMINg RATIO TEST, X TO Y
55	07	ONCOMINg C3PS TEST, LOW TO REVERSE
	17	ONCOMINg C3PS TEST, 1 TO REVERSE
	27	ONCOMINg C3PS TEST, 2 TO REVERSE
	87	ONCOMINg C3PS TEST, N1 TO REVERSE
	97	ONCOMINg C3PS TEST, NVL TO REVERSE
	XY	ONCOMINg C3PS TEST, X TO Y
56	00	LOW RANgE VERIFICATION TEST
	11	1ST RANgE VERIFICATION TEST
	22	2ND RANgE VERIFICATION TEST
	33	3RD RANgE VERIFICATION TEST
	44	4TH RANgE VERIFICATION TEST
	55	5TH RANgE VERIFICATION TEST
	66	6TH RANgE VERIFICATION TEST
	77	REVERSE RANgE VERIFICATION TEST
57	11	1ST RANgE VERIFICATION C3PS TEST
	22	2ND RANgE VERIFICATION C3PS TEST
	44	4TH RANgE VERIFICATION C3PS TEST
	66	6TH RANgE VERIFICATION C3PS TEST
	88	N1 RANgE VERIFICATION C3PS TEST
	99	N2 OR N4 RANgE VERIFICATION C3PS TEST
61	00	RETARDER OIL TEMPERATURE, HOT
62	12	RETARDER TEMP. SENSOR, FAILED LOW
	23	RETARDER TEMP. SENSOR, FAILED HlgH
	32	ENgINE COOLANT TEMP. SENSOR, FAILED LOW
	33	ENgINE COOLANT TEMP. SENSOR, FAILED HlgH
63	00	INPUT FUNCTION FAULT
	26	KICKDOWN INPUT, FAILED ON
	40	SERVICE BRAKE STATUS INPUT, FAILED ON

Diagnostic Transmission Codes

DIAGNOSTIC CODE	CODE DESCRIPTION
C1312	RETARDER REQUEST SENSOR, FAILED LOW
C1313	RETARDER REQUEST SENSOR, FAILED HIGH
P0122	PEDAL POSITION SENSOR, LOW VOLTAGE
P0123	PEDAL POSITION SENSOR, HIGH VOLTAGE
P0218	TRANSMISSION FLUID OVER TEMPERATURE
P0602	TCM NOT PROGRAMMED
P0610	TCM VEHICLE OPTIONS (TRANSID) ERROR
P0613	TCM PROCESSOR
P0614	TORQUE CONTROL DATA MISMATCH—ECM/TCM
P0634	TCM INTERNAL TEMPERATURE TOO HIGH
P063E	AUTO CONFIGURATION THROTTLE INPUT NOT PRESENT
P063F	AUTO CONFIGURATION ENGINE COOLANT TEMP INPUT NOT PRESENT
P0658	ACTUATOR SUPPLY VOLTAGE 1 (HSD1), LOW
P0659	ACTUATOR SUPPLY VOLTAGE 1 (HSD1), HIGH
P0701	TRANSMISSION CONTROL SYSTEM PERFORMANCE
P0702	TRANSMISSION CONTROL SYSTEM ELECTRICAL (TRANSID)
P0703	BRAKE SWITCH CIRCUIT MALFUNCTION
P0708	TRANSMISSION RANGE SENSOR, HIGH
P070C	TRANSMISSION FLUID LEVEL SENSOR, LOW
P070D	TRANSMISSION FLUID LEVEL SENSOR, HIGH
P0711	TRANSMISSION FLUID TEMPERATURE SENSOR PERFORMANCE
P0712	TRANSMISSION FLUID TEMPERATURE SENSOR, LOW
P0713	TRANSMISSION FLUID TEMPERATURE SENSOR, HIGH
P0716	TURBINE SPEED SENSOR PERFORMANCE
P0717	TURBINE SPEED SENSOR, NO SIGNAL
P0719	BRAKE SWITCH ABS, INPUT LOW
P071A	RELS INPUT, FAILED ON
P071D	GENERAL PURPOSE FAULT
P0721	OUTPUT SPEED SENSOR PERFORMANCE
P0722	OUTPUT SPEED SENSOR, NO SIGNAL
P0726	ENGINE SPEED SENSOR PERFORMANCE
P0727	ENGINE SPEED SENSOR, NO SIGNAL

Diagnostic Transmission Codes

DIAGNOSTIC CODE	CODE DESCRIPTION
P0729	INCORRECT 6TH GEAR RATIO
P0731	INCORRECT 1ST GEAR RATIO
P0732	INCORRECT 2ND GEAR RATIO
P0733	INCORRECT 3RD GEAR RATIO
P0734	INCORRECT 4TH GEAR RATIO
P0735	INCORRECT 5TH GEAR RATIO
P0736	INCORRECT REVERSE GEAR RATIO
P0741	TORQUE CONVERTER CLUTCH SYSTEM, STUCK OFF
P0776	PRESSURE CONTROL SOLENOID 2, STUCK OFF
P0777	PRESSURE CONTROL SOLENOID 2, STUCK ON
P0796	PRESSURE CONTROL SOLENOID 3, STUCK OFF
P0797	PRESSURE CONTROL SOLENOID 3, STUCK ON
P0842	TRANSMISSION PRESSURE SWITCH 1, LOW
P0843	TRANSMISSION PRESSURE SWITCH 1, HIGH
P088A	DETERIORATED FILTER
P088B	VERY DETERIORATED FILTER
P0880	TCM POWER INPUT SIGNAL
P0881	TCM POWER INPUT SIGNAL PERFORMANCE
P0882	TCM POWER INPUT SIGNAL, LOW
P0883	TCM POWER INPUT SIGNAL, HIGH
P0894	TRANSMISSION COMPONENT SLIPPING
P0897	TRANSMISSION FLUID AT LIMIT
P0960	PRESSURE CONTROL SOLENOID MAIN MOD CONTROL, OPEN
P0962	PRESSURE CONTROL SOLENOID MAIN MOD CONTROL, LOW
P0963	PRESSURE CONTROL SOLENOID MAIN MOD CONTROL, HIGH
P0964	PRESSURE CONTROL SOLENOID 2 CONTROL, OPEN
P0966	PRESSURE CONTROL SOLENOID 2 CONTROL, LOW
P0967	PRESSURE CONTROL SOLENOID 2 CONTROL, HIGH
P0968	PRESSURE CONTROL SOLENOID 3 CONTROL, OPEN
P0970	PRESSURE CONTROL SOLENOID 3 CONTROL, LOW
P0971	PRESSURE CONTROL SOLENOID 3 CONTROL, HIGH
P0973	SHIFT SOLENOID 1 CONTROL, LOW

Notes

DIAGNOSTIC CODE	CODE DESCRIPTION
P0974	SHIFT SOLENOID 1 CONTROL, HIGH
P0975	SHIFT SOLENOID 2 CONTROL, OPEN
P0976	SHIFT SOLENOID 2 CONTROL, LOW
P0977	SHIFT SOLENOID 2 CONTROL, HIGH
P0989	RETARDER PRESSURE SENSOR, FAILED LOW
P0990	RETARDER PRESSURE SENSOR, FAILED HIGH
P1739	INCORRECT LOW GEAR RATIO
P1891	THROTTLE POSITION SENSOR PWM SIGNAL, LOW
P1892	THROTTLE POSITION SENSOR PWM SIGNAL, HIGH
P2184	ENGINE COOLANT TEMPERATURE SENSOR, LOW
P2185	ENGINE COOLANT TEMPERATURE SENSOR, HIGH
P2637	TORQUE MANAGEMENT FEEDBACK SIGNAL (SEM)
P2641	TORQUE MANAGEMENT FEEDBACK SIGNAL (LRTP)
P2670	ACTUATOR SUPPLY VOLTAGE 2 (HSD2), LOW
P2671	ACTUATOR SUPPLY VOLTAGE 2 (HSD2), HIGH
P2685	ACTUATOR SUPPLY VOLTAGE 3 (HSD3), LOW
P2686	ACTUATOR SUPPLY VOLTAGE 3 (HSD3), HIGH
P2714	PRESSURE CONTROL SOLENOID 4, STUCK OFF
P2715	PRESSURE CONTROL SOLENOID 4, STUCK ON
P2718	PRESSURE CONTROL SOLENOID 4 CONTROL, OPEN
P2720	PRESSURE CONTROL SOLENOID 4 CONTROL, LOW
P2721	PRESSURE CONTROL SOLENOID 4 CONTROL, HIGH
P2723	PRESSURE CONTROL SOLENOID 1, STUCK OFF
P2724	PRESSURE CONTROL SOLENOID 1, STUCK ON
P2727	PRESSURE CONTROL SOLENOID 1 CONTROL, OPEN
P2729	PRESSURE CONTROL SOLENOID 1 CONTROL, LOW
P2730	PRESSURE CONTROL SOLENOID 1 CONTROL, HIGH
P2736	PRESSURE CONTROL SOLENOID 5 CONTROL, OPEN
P2738	PRESSURE CONTROL SOLENOID 5 CONTROL, LOW
P2739	PRESSURE CONTROL SOLENOID 5 CONTROL, HIGH
P2740	RETARDER OIL TEMPERATURE, HOT
P2742	RETARDER OIL TEMPERATURE SENSOR, LOW
P2743	RETARDER OIL TEMPERATURE SENSOR, HIGH
P2761	TCC PCS CONTROL, OPEN
P2763	TCC PCS CONTROL, HIGH

DIAGNOSTIC CODE	CODE DESCRIPTION
P2764	TCC PCS CONTROL, LOW
P278A	KICKDOWN INPUT, FAILED ON
P2789	CLUTCH ADAPTIVE LEARNING AT LIMIT
P2793	GEAR SHIFT DIRECTION
P2808	PRESSURE CONTROL SOLENOID 6, STUCK OFF
P2809	PRESSURE CONTROL SOLENOID 6, STUCK ON
P2812	PRESSURE CONTROL SOLENOID 6 CONTROL, OPEN
P2814	PRESSURE CONTROL SOLENOID 6 CONTROL, LOW
P2815	PRESSURE CONTROL SOLENOID 6 CONTROL, HIGH
U0001	HIGH SPEED CAN BUS RESET COUNTER OVERRUN (IESCAN)
U0010	CAN BUS RESET COUNTER OVERRUN
U0100	LOST COMMUNICATION WITH ECM/PCM (J1587)
U0103	LOST COMMUNICATION WITH GEAR SHIFT MODULE (SHIFT SELECTOR) 1
U0115	LOST COMMUNICATION WITH ECM
U0291	LOST COMMUNICATION WITH GEAR SHIFT MODULE (SHIFT SELECTOR) 2
U0304	INCOMPATIBLE GEAR SHIFT MODULE 1 (SHIFT SELECTOR ID)
U0333	INCOMPATIBLE GEAR SHIFT MODULE 2 (SHIFT SELECTOR ID)
U0404	INVALID DATA RECEIVED FROM GEAR SHIFT MODULE (SHIFT SELECTOR) 1
U0592	INVALID DATA RECEIVED FROM GEAR SHIFT MODULE (SHIFT SELECTOR) 2



Appendix E

**RIDEWELL
SUSPENSIONS**

**THE ENGINEERED SUSPENSION
COMPANY**

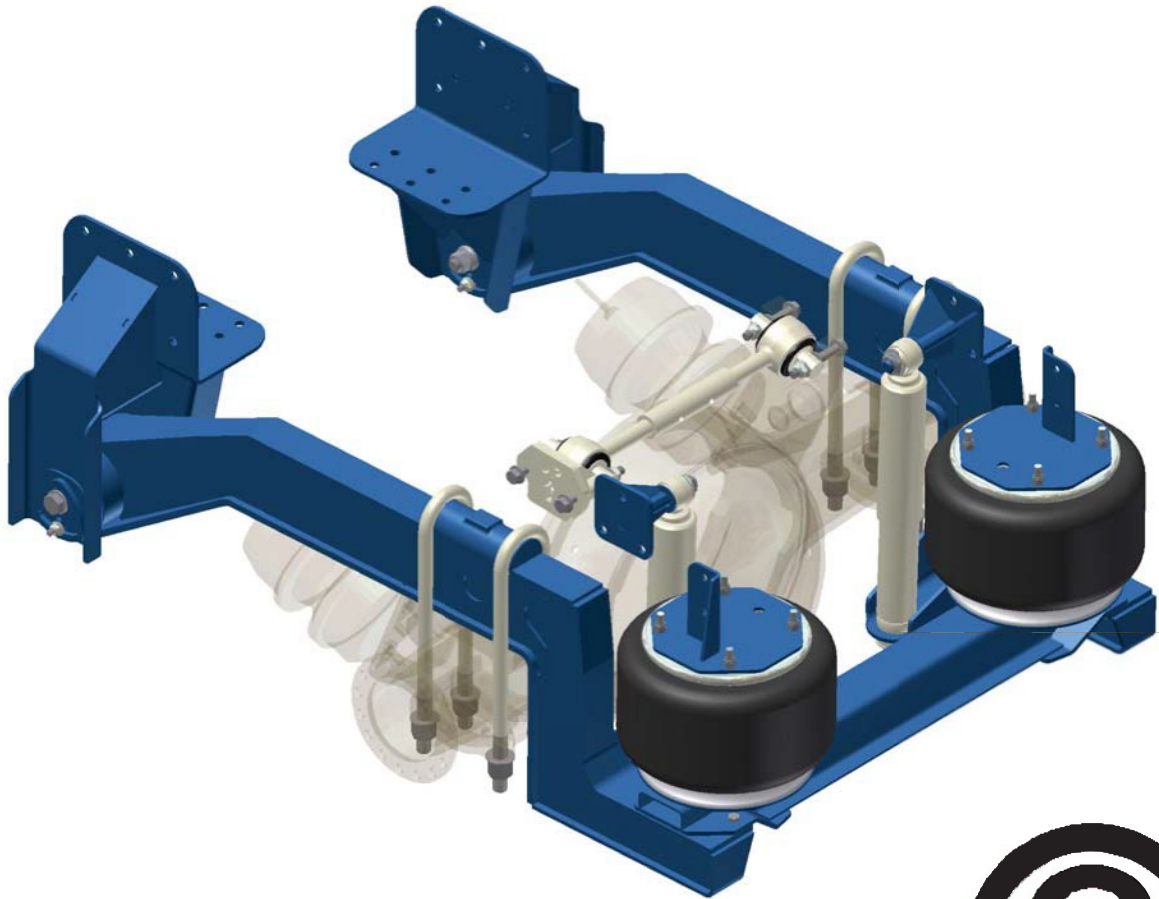
RAD-241 OWNER'S MANUAL

RIDEWELL SUSPENSIONS

The Engineered Suspension Company

RAD-241

Owner's Manual



www.ridewellcorp.com

P.O. Box 4586 • Springfield, MO 65808 • 417.833.4565 • 417.833.4560 (fax)



Suspension Identification:

Ridewell Suspensions are identified by a metal tag attached to the left-hand hanger that indicates part number, revision level, & serial number. Consult your vehicle manufacturer for your correct mounting height.

Parts:

For optimum suspension performance, order only Ridewell parts. Replacement parts for RAD-241 are shown on page 8 of this manual.

Sales, Service & Warranty:

If you need assistance regarding this product, please contact us and we will be glad to help you.

Mailing Address

Ridewell Corporation
P.O. Box 4586
Springfield, MO 65808

Shipping Address

Ridewell Corporation
3715 East Farm Rd. 94
Springfield, MO 65803

Phones, Fax, E-mail

800.641.4122, 417.833.4565
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Alignment

There are two types of alignment mechanisms used on the RAD-241 suspension - eccentric bolt and Speed-Set™. The eccentric bolt uses a 1 ¼” nut, while the Speed-Set™ mechanism uses a 7/8” fastener.

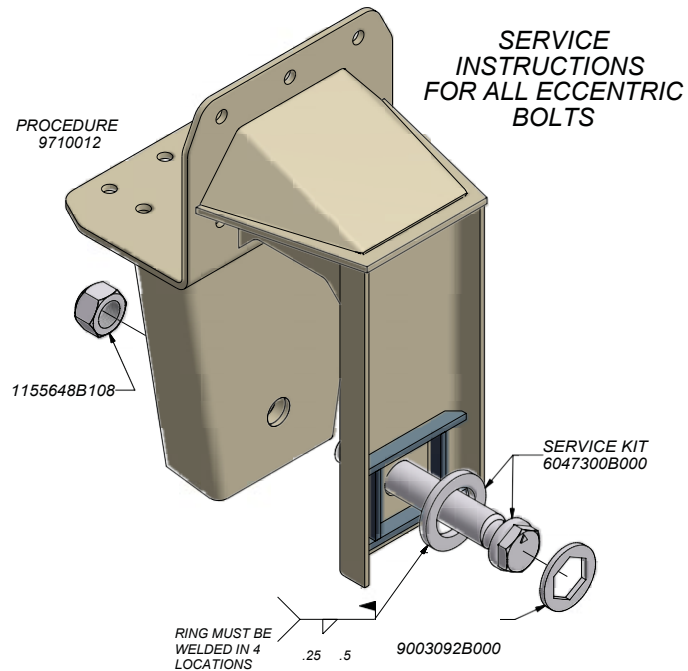
Eccentric Bolt: Axles may be re-aligned by rotating the eccentric pivot bolt. An arrow at the 12 o'clock position indicates the neutral position. Rotation of this bolt to 9 or 3 o'clock will move the axle a total of ¼” per side.

1. Remove the nut on the eccentric bolt and discard.
2. Remove the anti-turn washer covering the nut of the eccentric bolt assembly. Use a grinder to remove the tack welds.
3. To align the axle, turn the arrow the direction of required movement.
4. Re-install anti-turn washers and tack weld in two locations.
5. Install a new 1 ¼” locknut and torque to 750 ft-lbs.

Service Notes:

Service kit 6047300B000 replaces eccentric bolt assembly 5007300B000.

Weld receiver ring 9090005 into “picture frame” of hanger.
Install eccentric bolt 1137694B000 as normal with arrow mark at 12 o'clock.



Speed-Set™: The alignment is accomplished by rotating the alignment plates. The neutral position is indicated by the arrow in the 6 o'clock position. Rotating the alignment plates forward or rearward moves the axle a total of ½” per side.

1. Loosen the pivot nut and the alignment plate nuts.
2. With a ½ drive ratchet, rotate the pivot plates in the desired direction. The pivot plates on either side of a hanger must be rotated equal amounts or loss of pivot bolt torque may occur.
3. Torque the 7/8” pivot nut to 520 ft-lbs.
4. Torque the adjuster plate nuts to 60 ft-lbs.



Bushings

Inspection: Bushings should remain centered in the eye and hanger and should not exhibit excessive movement. Excessive tire wear on the rear axle may warrant bushing replacement.

Replacement:

Clamp-in bushing:

1. Raise and secure the vehicle frame and exhaust the air from the air springs.
2. Remove the tires.
3. Remove the anti-turn washer (if installed) from 1 ¼" nut. Remove nut.
4. Remove anti-turn washer from eccentric bolt. Use a grinder to remove tack welds. Turn the eccentric bolt arrow to the 12 o'clock position and remove the eccentric bolt.
5. Use a grinder to remove vertical welds that join the clamping plate to the frame hanger in two places. Tap out the eccentric bolt/clamping plate assembly and all the beam to drop from the frame hanger.
6. Remove the 5/8" fasteners from the bushing clamp and remove the bushing.
7. Install a new bushing and insert new clamp fasteners. Torque the clamp fasteners to 100 ft-lbs. Ensure that the bushing has remained centered in the eye during the assembly process.
8. Reassemble the beams to the hangers with new eccentric bolts in the 12 o'clock position.
9. Follow the alignment procedure in this manual as needed. Re-install the anti-turn washers and tack weld them into place. Torque the locknut on the eccentric bolt to 750 ft-lbs.
10. Weld the clamp plate into place in the previous locations.

Press-in bushing:

1. Raise and secure the vehicle frame and exhaust the air from the air springs.
2. Remove the tires.
3. Remove the pivot bolt and rotate the beams down and out of the hangers. Removal of the alignment plate fasteners is not necessary.
4. With a hydraulic press, press out the bushings and press in new ones. If a portable press is not available, the beams will have to be removed from the axle.
5. Reassemble the hanger and beam with new pivot bolts. Re-alignment should not be necessary unless the alignment plate fasteners have been removed. Torque the pivot bolt



Fasteners

Inspection: See Chart A for proper fastener torque values.

Fastener Size	Location	Torque (ft-lbs.)
½" 13NC	Air Spring Bottom	50
½" 13NC	Air Spring Top	25
½" 13NC	Cross-Channel	60
½" 13NC*	Alignment Plate	60
⅞" 9NC*	Bushing Pivot Bolt	520
1 ¼" 7NC*	Bushing Pivot Bolt	750
1" 14NC	U-Bolt	500
⅝" 11NC*	Bushing Clamp	100
⅝" 11NC*	Transverse T-Rod	210
1" 8NC	Shock Absorber Nut	1.75" bushing width
⅞" 14NF*	U-Bolt	425

Ride Height

Inspection: The RAD-241 suspension is designed to accommodate a specific vehicle ride height. Ride Height is measured from the bottom of frame to the center of the axle and is controlled by the height control valve(s). Operating outside the designed ride height of the suspension may cause problems such as poor ride quality and driveline noise and wear. To determine the correct ride height of your suspension, contact the vehicle manufacturer or Ridewell Suspensions.

Service: The ride height should be measured when the vehicle is on level ground. The ride height of the suspension can be adjusted by the height control valve. Refer to your height control valve installation instructions for further information.



Shock Absorbers

The RAD-241 suspension is designed with premium adjustable Koni shock absorbers and can be adjusted to improve ride and handling or to compensate for wear.

Rebound Adjustment Procedures:

1. Remove the shock absorber from the vehicle and hold it vertically with the lower eye or pin attached in a vise. Use clamp plates to prevent damage.
2. Fully collapse the shock absorber, at the same time turning the dust cap or piston rod slowly to the left (counterclockwise), until it is felt that the cams of the adjustment nut engage in the recesses of the foot valve assembly.
3. Some shock absorbers include a bumprubber concealed under the dust cover and it must be removed prior to adjusting.
4. The damper may have already been adjusted. Therefore, check whether the shock absorber is in the adjustment position by keeping it collapsed and gently turning it further to the left counting at the same time half turns until a stop is felt. Stop turning then and do not use force.
5. Keeping the shock absorber collapsed, make 1 half turn (180 degrees) to the right (clockwise). In case of prior adjustment, add the number of half turns previously found. The total range is approximately 5 half turns.
6. Pull the shock absorber out vertically without turning for at least 1 centimeter to disengage the adjusting mechanism. The dust cap or piston rod may now be turned freely.

Adjusting direction:

Clockwise = Firmer

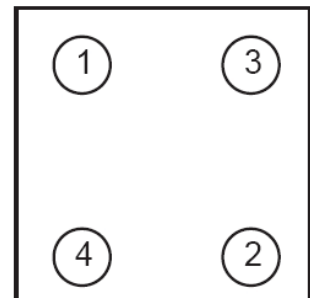
Counterclockwise = Softer

Transverse Torque Rod

Inspection: The transverse torque rod is essential to the proper lateral location of the axle. The length of the rod must be such that the beams and u-bolts of the suspension are equal distances from the chassis frame rails. Shims are provided at the chassis end of the rod for adjustability. A transverse torque rod with the improper length may cause the u-bolts to wear on the chassis and will cause the bushings to wear prematurely.

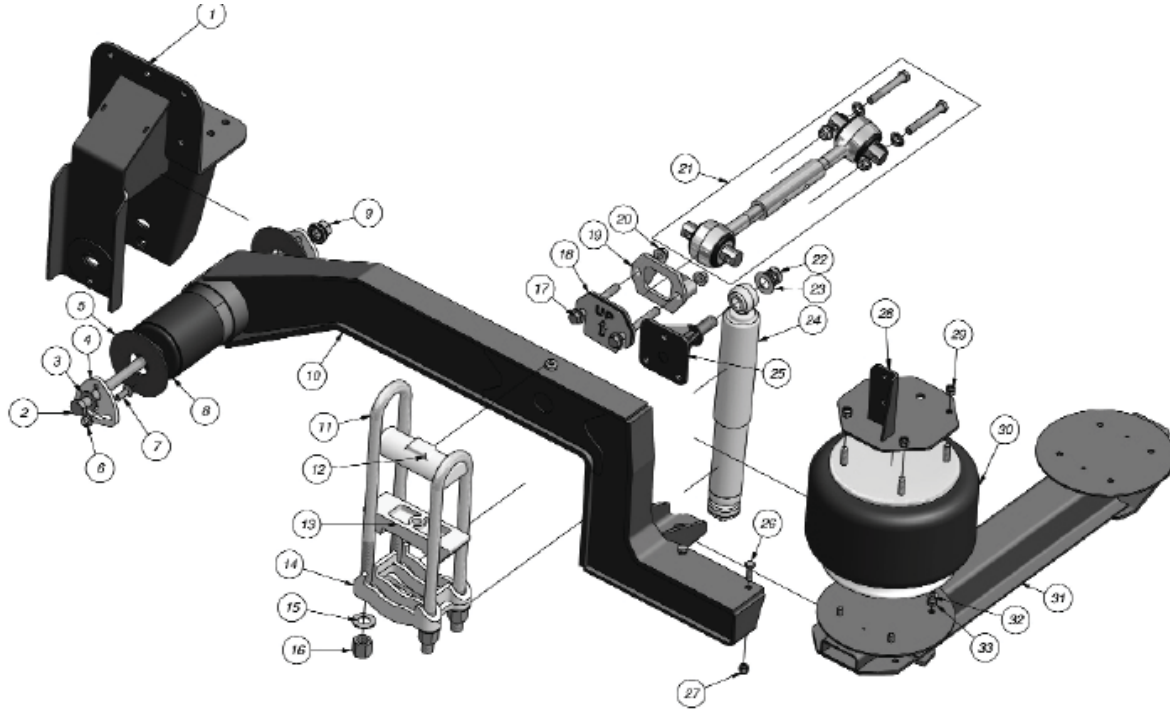
U-Bolts

U-bolts must be retightened after the first 6,000 miles and every 36,000 miles thereafter. If U-bolts must be removed for any reason while servicing the vehicle, they must be retightened in a criss-cross pattern as shown. Do not overtighten.





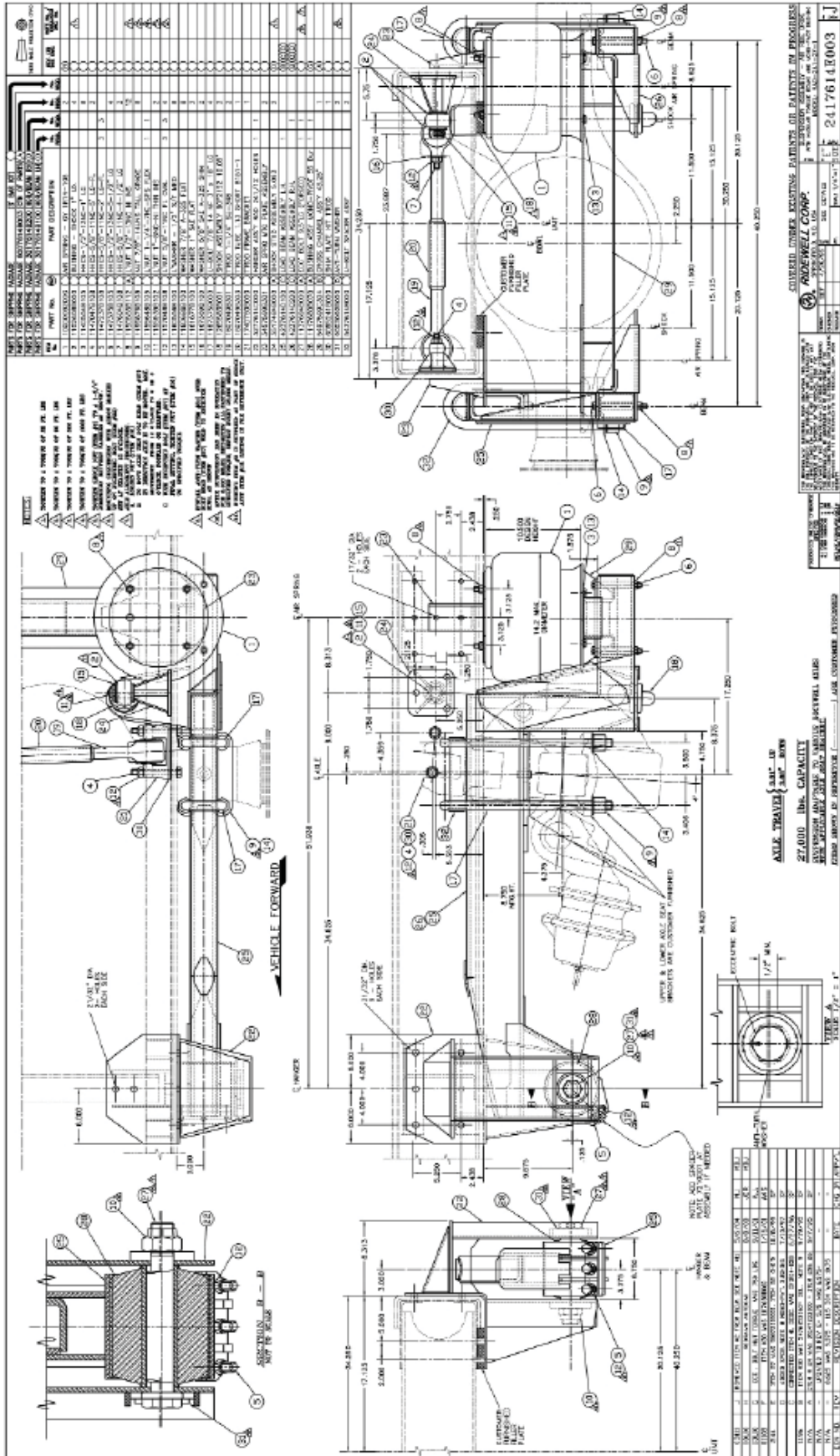
Parts Illustrations



RAD-241 PARTS LIST

ITEM	PART NO	DESCRIPTION	SUSPENSION NUMBER AND QTY			
			2410010	2410012	2410013	2410014
1	3270002	HANGER ASSEMBLY-LH/RH	2			2
	3270003	HANGER ASSEMBLY-LH/RH		2	2	
2	1140054	HHCS 7/8" 14NF 10"L GR8 P&O	2	2	2	2
3	1160868B100	WASHER 7/8" A-325 FLAT	2	2	2	2
4	5340018	ADJUSTER PLATE ASSEMBLY	4	4	4	4
5	1167680B000	WASHER-UHMW 6.25X2.125X.188	4	4	4	4
6	1150012	L'NUT 1/2" 13NC FLANGED GR G	4	4	4	4
7	1130012	BOLT, CARRIAGE 1/2 13NC 1.50LG	4	4	4	4
8	1110060	BUSH 60 DURO .906 ID	2	2	2	2
9	1150028	L'NUT 7/8" 14NF GR8 SECURELOK	2	2	2	2
	5970310	BUSH/BEAM LH ASM	1			1
	5970311	BUSH/BEAM RH ASM	1			1
	5970314	BUSH/BEAM LH ASM		1	1	
	5970315	BUSH/BEAM RH ASM		1	1	
11	1187676B302	UB 1" 14UNS 3"x19"L	4	4	4	4
12	1740004	U-BOLT TOP PLATE	2	2	2	2
13	a	UPPER AXLE SEAT BRACKET	2	2	2	2
14	a	LOWER AXLE SEAT BRACKET	2	2	2	2
15	1161480B100	WASHER 1" A-325 FLAT	8	8	8	8
16	1154790B108	NUT 1" 14UNS TALL GRADE 8	8	8	8	8
17	1140030	HHCS 5/8" 11NC 5-1/2"L FLN GR8	2	2	2	2
18	6095241B000	SHIM PLATE KIT-T'ROD	1	1	1	1
19	1740760B000	TRO ROD FRAME BRKT 22186-000	1	1	1	1
20	1157048B108	L'NUT 5/8" 11NC OVAL FLANGED	4	4	4	4
21	a	TRANSVERSE TORQUE ROD	1	1	1	1
22	1155939B102	L'NUT 1" 8NC THIN NYL INSERT	2	2	2	2
23	1161677B100	WASHER 1" SAE FLAT	2	2	2	2
24	1265583B001	SHOCK ASY 90F2152 10.08" KONI	2	2	2	2
25	3517484B000	SHOCK STUD ASSY 5.063	2	2	2	2
26	1147051B108	HHCS 1/2" 13NC 1-1/2LG	4	4	4	4
27	1158152B105	L'NUT 1/2" 13NC TOP LOCK	4	4	4	4
28	3457599B301	A S MTG PLT ASY	2	2	2	2
29	1150555B112	L'NUT 1/2" 13NC NYL INSERT	8	8	8	8
30	1000009200G	A/SPG 1R14-108 /1T19F-5 #9200	2	2	2	2
	5490012	A.S. CROSS CHNL ASM	1			
	5490018	A.S. CROSS CHNL ASM		1		
	5490019	A.S. CROSS CHNL ASM			1	
	5490020	A.S. CROSS CHNL ASM				1
32	1180556B100	L'WASHER 1/2" S/T MED	8	8	8	8
33	1140554B105	HHCS 1/2" 13NC 1"L	8	8	8	8

Notes: a - Contact Ridewell Suspensions or the vehicle manufacturer for more information.



NO.	PART NO.	PART DESCRIPTION	QTY.	UNIT
1	1120000001	SHOCK - 40" HGT. 1/2"	4	EA.
2	1120000002	SHOCK - 40" HGT. 1/2"	4	EA.
3	1120000003	SHOCK - 40" HGT. 1/2"	4	EA.
4	1120000004	SHOCK - 40" HGT. 1/2"	4	EA.
5	1120000005	SHOCK - 40" HGT. 1/2"	4	EA.
6	1120000006	SHOCK - 40" HGT. 1/2"	4	EA.
7	1120000007	SHOCK - 40" HGT. 1/2"	4	EA.
8	1120000008	SHOCK - 40" HGT. 1/2"	4	EA.
9	1120000009	SHOCK - 40" HGT. 1/2"	4	EA.
10	1120000010	SHOCK - 40" HGT. 1/2"	4	EA.
11	1120000011	SHOCK - 40" HGT. 1/2"	4	EA.
12	1120000012	SHOCK - 40" HGT. 1/2"	4	EA.
13	1120000013	SHOCK - 40" HGT. 1/2"	4	EA.
14	1120000014	SHOCK - 40" HGT. 1/2"	4	EA.
15	1120000015	SHOCK - 40" HGT. 1/2"	4	EA.
16	1120000016	SHOCK - 40" HGT. 1/2"	4	EA.
17	1120000017	SHOCK - 40" HGT. 1/2"	4	EA.
18	1120000018	SHOCK - 40" HGT. 1/2"	4	EA.
19	1120000019	SHOCK - 40" HGT. 1/2"	4	EA.
20	1120000020	SHOCK - 40" HGT. 1/2"	4	EA.
21	1120000021	SHOCK - 40" HGT. 1/2"	4	EA.
22	1120000022	SHOCK - 40" HGT. 1/2"	4	EA.
23	1120000023	SHOCK - 40" HGT. 1/2"	4	EA.
24	1120000024	SHOCK - 40" HGT. 1/2"	4	EA.
25	1120000025	SHOCK - 40" HGT. 1/2"	4	EA.
26	1120000026	SHOCK - 40" HGT. 1/2"	4	EA.
27	1120000027	SHOCK - 40" HGT. 1/2"	4	EA.
28	1120000028	SHOCK - 40" HGT. 1/2"	4	EA.
29	1120000029	SHOCK - 40" HGT. 1/2"	4	EA.
30	1120000030	SHOCK - 40" HGT. 1/2"	4	EA.
31	1120000031	SHOCK - 40" HGT. 1/2"	4	EA.
32	1120000032	SHOCK - 40" HGT. 1/2"	4	EA.
33	1120000033	SHOCK - 40" HGT. 1/2"	4	EA.
34	1120000034	SHOCK - 40" HGT. 1/2"	4	EA.
35	1120000035	SHOCK - 40" HGT. 1/2"	4	EA.
36	1120000036	SHOCK - 40" HGT. 1/2"	4	EA.
37	1120000037	SHOCK - 40" HGT. 1/2"	4	EA.
38	1120000038	SHOCK - 40" HGT. 1/2"	4	EA.
39	1120000039	SHOCK - 40" HGT. 1/2"	4	EA.
40	1120000040	SHOCK - 40" HGT. 1/2"	4	EA.
41	1120000041	SHOCK - 40" HGT. 1/2"	4	EA.
42	1120000042	SHOCK - 40" HGT. 1/2"	4	EA.
43	1120000043	SHOCK - 40" HGT. 1/2"	4	EA.
44	1120000044	SHOCK - 40" HGT. 1/2"	4	EA.
45	1120000045	SHOCK - 40" HGT. 1/2"	4	EA.
46	1120000046	SHOCK - 40" HGT. 1/2"	4	EA.
47	1120000047	SHOCK - 40" HGT. 1/2"	4	EA.
48	1120000048	SHOCK - 40" HGT. 1/2"	4	EA.
49	1120000049	SHOCK - 40" HGT. 1/2"	4	EA.
50	1120000050	SHOCK - 40" HGT. 1/2"	4	EA.

CONTROL TUBES EXISTING PATENTS OR PATENTS IN PROGRESS
 TRADE MARKS OF OTHER MANUFACTURERS
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 2417614E003



Service Intervals

	Every 1,000 miles	First 6,000 miles of operation	Every 12,000 miles	Every 36,000 miles	Every 100,000 miles
Bushings	I				
Air Springs	I				
Structure	I				
Ride Height	I				
U-Bolts		T		T	
Fastener Torque		T		T	

I = Inspect, L = Lubricate, T = Tighten, R = Replace

Warranty

Ridewell Suspensions warrants the suspension systems manufactured by it to be free from defects in material and workmanship, under proper use, installation, application, and maintenance for period of 3 years with no mileage limit after delivery to the original purchaser. The responsibility of Ridewell Suspensions under this warranty is limited to making good at the company factory by repair or replacement of any part or parts which it manufactures.

Written permission for any claim return must be first obtained from Authorized Ridewell personnel. All returns must have transportation charges prepaid by the customer and accompanied with a complete written explanation of claimed defects and the circumstances of operational failure. On all component parts not manufactured by Ridewell, their warranty is to the extent that the manufacturer of such parts warrant them to Ridewell Suspensions. This is the only authorized warranty and is in lieu of all other expressed or implied warranties or representations, including any implied warranties of merchantability or fitness, or of any obligations on the part of Ridewell Suspensions. In no event will Ridewell be liable for business interruptions, loss of profits, personal injury, cost of delay, or for other special, indirect, incidental or consequential losses, costs or damages.

Subject to all of the above conditions, if repair or replacement of any defective part is made by Ridewell Suspensions, Ridewell will return the repaired or replaced part to the original purchaser with transportation charges prepaid.

- 1 - 12 months 100% Parts & Labor
- 13 - 24 months 100% Parts & 50% Labor
- 25 - 36 months 50% Parts Only



Appendix F



Frequently Asked Questions

Fire and Emergency Vehicle Emissions Derate Exemption Customer FAQ

Cummins Inc. Rev. 4.24.13



Frequently Asked Questions

Fire and Emergency Vehicle Emissions Derate Exemption Customer FAQ

What is Cummins response to the Direct Final Rule (DFR) issued by EPA providing relief to emergency vehicles?

Background:

There has been concern from fire and emergency vehicle users that aftertreatment systems hamper their ability to complete missions (via engine derates and shutdowns) and cause undue hardship for this market. In May 2012 the EPA released a regulatory announcement outlining a voluntary program that provides engine manufacturers flexibility to provide relief to emergency vehicles such as ambulances and fire trucks so they would no longer face vehicle speed or engine power disruptions related to their diesel emissions control systems. Once this announcement was published to the Federal Register, the general public was allowed to submit comments within a 60 day window. Since no adverse comments were submitted to the EPA in that 60 day timeframe, the EPA issued a Direct Final Rule (DFR) on August 7, 2012

The DFR provides relief to emergency vehicles by allowing engine manufacturers to prevent the engine from loss of vehicle speed, engine power (torque) due to abnormal conditions of the emission control system or by preventing those abnormal conditions from occurring during emergency response. Examples include:

- Excessive exhaust backpressure from an overloaded Diesel Particulate Filter (DPF)
- Engines with Selective Catalytic Reduction (SCR) running out of Diesel Exhaust Fluid (DEF)

Key Message: We agree that under no condition should an emergency vehicle be shut down due to an emissions fault.

Cummins cares about its Customers

- Cummins is committed to the emergency vehicle market, which we've been in for over 70 years
- Cummins offers on-site support to customers.

- We support data based approaches and solutions and have reached out to customers inviting them to help be part of the solution by providing additional data on specific instances of real-world operational and maintenance issues.

Cummins has been and continues to actively work with the industry to address the DFR

- We have worked to be in alignment with the US Environmental Protection Agency (EPA), Engine Manufacturers Association (EMA), Fire Apparatus Manufacturers Association (FAMA).
- We have reached out to various fire service organizations (CFSI - Congressional Fire Services Institute, IAFC - International Assn of Fire Chiefs, FDSOA - Fire Dept Safety Officer's Assn, SEAFCA - Southeastern Assn of Fire Chiefs, WFCFA - Western Fire Chief's Assn), groups, and congressional offices to understand concerns and provide educational information.

Cummins has been and continues to reach out to educate on how the Cummins DPF System operates

- DPF aftertreatment systems introduced additional complexity; many and perhaps all issues can be resolved through customer understanding of how to operate and maintain the engine and aftertreatment system.
- Our engines are operating as designed and approved by EPA.
- Cummins emergency rated engines are specially designed to not shutdown or derate due to DPF loading.
- The Cummins Aftertreatment System does not affect engine and pumping performance - as long as it is properly maintained.

What is meant by ‘Inducement’ or ‘derate’ and what does it mean to me as a customer?

“Inducement” is an Environmental Protection Agency (EPA) term aimed at keeping engines which utilize Selective Catalytic Reduction (SCR) aftertreatment operating properly. An ‘inducement’ may also be referred to as an engine derate. There are three primary events that could initiate an inducement/derate: (1) Low Diesel Exhaust Fluid (DEF) level, (2) Incorrect fluid in DEF tank, and (3) SCR Faults. The driver will recognize this as a performance penalty initiated by the Electronic Control Module (ECM), resulting in a loss of vehicle speed or engine power (torque).

It is important to note that there are ample driver / operator reminders and warnings to prevent the activation of an inducement. For example, drivers will see dash lamps to remind them to add DEF and are alerted if there is incorrect fluid in the DEF tank. Some fire truck builders offer DEF level gauges on pump panels as available options.

What flexibilities are included in the Direct Final Rule issued by EPA on August 7, 2012?

Vehicle speed and engine power (torque) derates can be suspended during emergency operation. Examples include excessive exhaust back pressure from an overloaded diesel particulate filter (DPF) and running out of Diesel Exhaust Fluid (DEF).

Provision is included for both future product and modifying engines already in the field.

It is important to note that this is a voluntary program and each engine manufacturer had to submit their solutions to EPA for approval of any changes before going into production.

What is not included in the Direct Final Rule issued by EPA on August 7, 2012?

OEMs must still install aftertreatment systems for emissions control. The aftertreatment system devices and associated equipment will remain unchanged moving forward.

The belief that aftertreatment systems will be removed from fire and emergency vehicles is a common misconception within the industry.

What is Cummins position on the DFR issued by the EPA?

Cummins publically supported the DFR as stated when it was published on August 7, 2012. We have identified our solution and implemented changes to our engine software to ensure that the emissions control system does not disrupt an emergency mission.

What is Cummins solution?

Cummins has developed a new engine software specific to fire and emergency vehicle calibrations that will be incorporated into our EPA 2013 engines. This new calibration eliminates all emissions related vehicle speed or engine power (torque) derates. This includes derates associated with low level Diesel Exhaust Fluid (DEF), incorrect DEF and SCR faults that some customers may experience on EPA 2010 engines.

What engines for 2013 will include the emissions derate exemption calibration?

All EPA 2013 ISB6.7 and ISL9 EV rated engines include the new calibration that eliminates all emissions related vehicle speed and engine torque derates. Some EPA 2013 ISX12 and ISX15 engines for fire and emergency vehicles built in early 2013 may require an electronic calibration update to eliminate emissions related derates.

How do I know if my 2013 engine has the new emergency vehicle calibration update?

If you have an EPA 2013 ISB6.7 or ISL9 EV rated engine you have the new calibration already. Some ISX12 and ISX15 engines built in early 2013 may not include the new calibration and will require a calibration update that can be performed at a Cummins authorized service location. Customers can contact Cummins Care at 1-800-DIESELS™ (1-800-343-7357) with their Engine Serial Number (ESN) to determine what calibration was in the engine when it left the factory and if they are eligible for an update at no additional charge

Will all of the warning lamps still exist with the new emergency vehicle calibration?

Yes, The Diesel Exhaust Fluid (DEF) lamp, High Exhaust System Temperature (HEST) lamp and all other warning lamps will still continue to function as specified for emergency vehicle applications. The engine and aftertreatment system will still need appropriate and timely maintenance – including passive and/or active aftertreatment regenerations – as specified in the Operations and Maintenance Manual.

There is one exception to note: The new 2013 emergency vehicle calibration will eliminate the red stop engine lamp illuminating in conjunction with the DEF lamp and check engine lamp to signify critically low DEF levels.

For more information on EPA 2013 emergency vehicle warning lamps and emissions derate information please see the “EPA 2013 Driver Tips For Fire and Emergency Vehicles” brochure (Bulletin 4971424). (<http://cumminsengines.com/assets/pdf/4971424.pdf>)

Didn't the initial SCR “inducement” on EPA 2010 engines cause a derate in emergency vehicles?

Yes, however, this was changed in July-2011 through an agreement with FAMA and the EPA. A calibration update was made in July-2011 that changed the inducement/derate for SCR (low level DEF and incorrect DEF) from engine power (torque) to vehicle speed. The July-2011 calibration change is “backwards compatible” and can be obtained from any Cummins authorized service location.

For more information on EPA 2010 emergency vehicle engine derates and engines produced from January 2010 – December 2012, please see the “Driver Tips for Fire and Emergency Vehicles” brochure (Bulletin 4971316). (<http://cumminsengines.com/assets/pdf/4971316.pdf>)

Can I upfit my engine built prior to 2013 with this new calibration?

Yes, service calibrations for engines built prior to 2013 that utilize different emissions derate logic (as outlined below) are available at Cummins authorized service locations.

Is this new 2013 calibration update available at no charge for engines built prior to 2013?

No, if you have an engine built prior to 2013 you can request to have the new 2013 calibration update at a Cummins authorized service location but this will be installed at your expense.

Do I need a new engine dataplate if I receive the 2013 calibration update?

If your engine was built between Jan 1, 2010 and July 8, 2011 and you have not received the calibration update introduced on July 8, 2011 that changes the SCR inducement from an engine power (torque) derate to a vehicle speed derate you will need to obtain a new engine dataplate signifying that the engine is designed for use in fire and emergency vehicles only.

Due to the change in SCR inducements and to meet EPA requirements an engine dataplate is required signifying that the engine is designed for use in fire and emergency vehicles only.

What are the inducements/derates for Cummins engines in fire and emergency vehicles built since Jan 1, 2010?

The following table shows the inducements for EPA 2010 engines (including engines built between Jan 1 2010 and July 8, 2011), EPA 2010 engines that include the July-2011 calibration (changing the inducement from engine power/torque to vehicle speed) as well as EPA 2013 engines. Note, as discussed above, that there is a new emergency vehicle calibration for 2013 that will eliminate emissions related inducements/derates.

EPA 2010 Engines <u>BUILT BEFORE July 8, 2011</u> That have not received the Emergency Vehicle electronic calibration update		EPA 2010 Engines <u>BUILD ON/AFTER July 8, 2011</u> That have not received the Emergency Vehicle electronic calibration update		EPA 2013 Engines *Heavy Duty Exception	
DEF Tank Level	Inducement	DEF Tank Level	Inducement	DEF Tank Level	Inducement
> 10%	None	> 10%	None	> 10%	None
10%	None	10%	None	10%	None
5%	None	5%	Vehicle Speed Limited to 55 mph (pumping is still enabled)	5%	None
2.5%	25% Torque Derate				
0%	40% Torque Derate (ramped in at 1% per minute)	0%	Vehicle Speed Limited to 55 mph (pumping is still enabled)	0%	None
0%	40% Torque Derate & Vehicle Speed Limited to 5 mph And after the engine has been intentionally shut down or in the idle position for 1 hour	0%	Vehicle Speed Limited to 25 mph (pumping may be limited after key-off) And after the engine has been intentionally shut down	0%	None And after the engine has been intentionally shut down

- The first two columns illustrate the inducements that apply to EPA 2010 engines in all on-highway applications. The first two columns will also apply to emergency vehicles calibrated engines that were built before July 8, 2011 and that have not received any optional calibration available after that date only.
- The second two columns illustrate revisions made to the inducements for EPA 2010 emergency vehicle calibrated engines that were built on/after July 8, 2011 or for engines built before July 8, 2011 that have received any optional calibration upfit.
- The third two columns illustrate that there are no SCR emissions related inducements for EPA 2013 engines with the new emergency vehicle calibration for 2013. *Note: as mentioned earlier, Some EPA 2013 ISX12 and ISX15 EV engines built in early 2013 may require an electronic calibration update to eliminate emissions related derates.



Appendix G

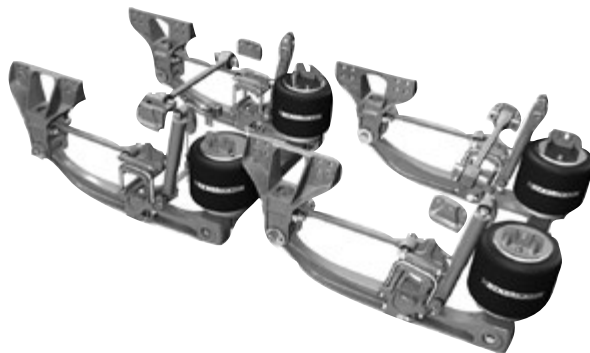
HENDRICKSON

The World Rides On US

TECHNICAL PROCEDURE

PRIMAAX® EX / FIREMAAX® EX

PRIMAAX® / FIREMAAX® SERIES



H TECHNICAL PROCEDURE

PRIMAAX® EX • FIREMAAX® EX PRIMAAX® • FIREMAAX® Rear Air Suspension

SUBJECT: Pre-delivery & Preventive Maintenance
LIT NO: 17730-266
DATE: January 2021 **REVISION:** D

IMPORTANT

INTRODUCTION

Following appropriate inspection procedures is important to help ensure the suspension system and component parts are properly maintained for efficient operation and service life. Hendrickson recommends the PRIMAAX® EX • FIREMAAX® EX | PRIMAAX® • FIREMAAX® heavy-duty rear suspension be inspected at pre-delivery, the first 1,000 miles of service and regular preventive maintenance intervals. Off-highway and severe service operating conditions require more frequent inspections than on-highway service operations.

This inspection procedure helps maintenance personnel to determine if a component replacement is required. In particular, inspection procedures for the pivot and D-pin bushings are detailed later in this document.

Refer to the following Hendrickson Technical Procedure publications as applicable for complete PRIMAAX EX • FIREMAAX EX | PRIMAAX • FIREMAAX suspension inspection procedures, important safety notices, preventive maintenance details, and component replacement, available online at www.hendrickson-intl.com.

- 17730-238
- 17730-254 (Volvo)
- 17730-263 (Kenworth)
- 17730-279 (Mack)
- 17730-283 (International Truck)
- 17730-284 (Caterpillar)
- 17730-329 (Mack HDT)
- 17730-329 (Mack HDT)

SAFETY REMINDER

All applicable warnings and cautions should be read carefully to help prevent personal injury and to assure that proper methods are used. Improper maintenance, service or repair may damage the vehicle, cause personal injury, render the vehicle unsafe in operation, or void manufacturer's warranty.

Failure to follow the applicable safety precautions can result in personal injury and/or property damage. Carefully read and understand all safety related information within the applicable Hendrickson publications, on all decals, and in all such materials provided by the vehicle manufacturer before operating the vehicle, or conducting any maintenance, service or repair.

WARNING

LOAD CAPACITY

ADHERE TO THE PUBLISHED CAPACITY RATINGS FOR THE SUSPENSION. ADD-ON AXLE ATTACHMENTS AND OTHER LOAD TRANSFERRING DEVICES, SUCH AS LIFTABLE AXLES, CAN INCREASE THE SUSPENSION LOAD ABOVE ITS RATED AND APPROVED CAPACITIES, WHICH CAN RESULT IN COMPONENT DAMAGE AND ADVERSE VEHICLE HANDLING, PERSONAL INJURY OR PROPERTY DAMAGE.

CAUTION

A TECHNICIAN USING A SERVICE PROCEDURE OR TOOL WHICH HAS NOT BEEN RECOMMENDED BY HENDRICKSON MUST FIRST SATISFY HIMSELF THAT NEITHER HIS SAFETY NOR THE VEHICLE'S SAFETY WILL BE JEOPARDIZED BY THE METHOD OR TOOL SELECTED. INDIVIDUALS DEVIATING IN ANY MANNER FROM THE INSTRUCTIONS PROVIDED WILL ASSUME ALL RISKS OF CONSEQUENTIAL PERSONAL INJURY OR DAMAGE TO EQUIPMENT INVOLVED.



ALWAYS WEAR PROPER EYE PROTECTION AND OTHER REQUIRED PERSONAL PROTECTIVE EQUIPMENT TO HELP PREVENT PERSONAL INJURY WHEN PERFORMING VEHICLE MAINTENANCE, REPAIR OR SERVICE.

AREAS OF INSPECTION

NOTE

Torque values shown in this publication apply only if Hendrickson supplied fasteners are used. If non Hendrickson fasteners are used, follow the torque specification listed in the vehicle manufacturer's service manual.

The inspection must include the following components:

- Air springs
- Air supply and fittings
- All fasteners
- Bushings: D-pin • Pivot
- Clamp group: Top pad, U-bolts and locknuts
- Frame hanger bracket
- Height control valve and air lines
- QUIK-ALIGN connections
- S-cam support tube bracket (if equipped)
- Shock absorbers
- Tire wear
- Transverse and longitudinal torque rods
- U-Beam assembly: Cross tube, Support beam, End cap (enhanced or detachable)

■ Signifies performance critical components.

HENDRICKSON RECOMMENDED INSPECTION INTERVALS

	PRE-DELIVERY INSPECTION	FIRST IN-SERVICE INSPECTION	PREVENTIVE MAINTENANCE
Visually inspect for proper installation, assembly, and function. Check for all of the following and replace components as necessary:			OFF-HIGHWAY Every 6 Months/1,200 Hours or 25,000 miles/ 40,000 km, whichever comes first ON-HIGHWAY Every 12 Months or 50,000 miles, whichever comes first
<ul style="list-style-type: none"> • Signs of unusual movement, loose or missing components • Signs of abrasive or adverse contact with other components • Damaged, or cracked parts • Improper suspension function or alignment 			
Visually inspect the overall condition of and for any signs of damage to:	Within the first 500 miles (500 km)	Within the first 1,000 miles (1,600 km) or 100 Hours	Every 12 Months / 2400 Hours
<ul style="list-style-type: none"> • U-Beam assembly • Air springs and air lines 			
Inspect fasteners for proper torque as recommended in this publication and as detailed in the *applicable Hendrickson publications:			
<ul style="list-style-type: none"> • QUIK-ALIGN fasteners and torque rod to top pad fasteners, see Figure 1 • Clamp group U-bolt fasteners, see Figure 2 • DO NOT re-torque integrated end cap, see Figure 3 			
Verify the lateral alignment of the drive axles are within the vehicle manufacturer's tolerances			
Verify ride height, refer to the Ride Height procedure in the *applicable Hendrickson publications.			

See vehicle manufacturer's applicable publications for other preventive maintenance requirements.

*Refer to the applicable Hendrickson PRIMAAX EX • FIREMAAX EX | PRIMAAX • FIREMAAX Technical Publication for your vehicle.

NOTE

Figures 1 through 3 illustrate PRIMAAX EX • FIREMAAX EX suspension basic connections, refer to the appropriate PRIMAAX EX • FIREMAAX EX Hendrickson Technical Publication for your vehicle.



FIGURE 1

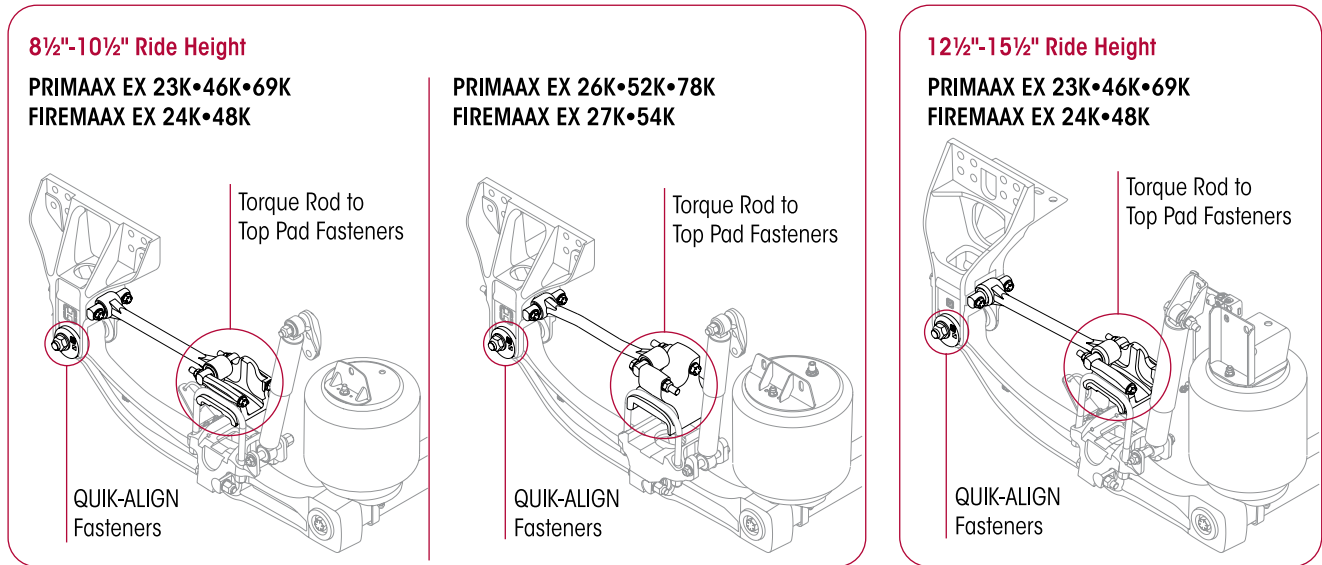


FIGURE 2

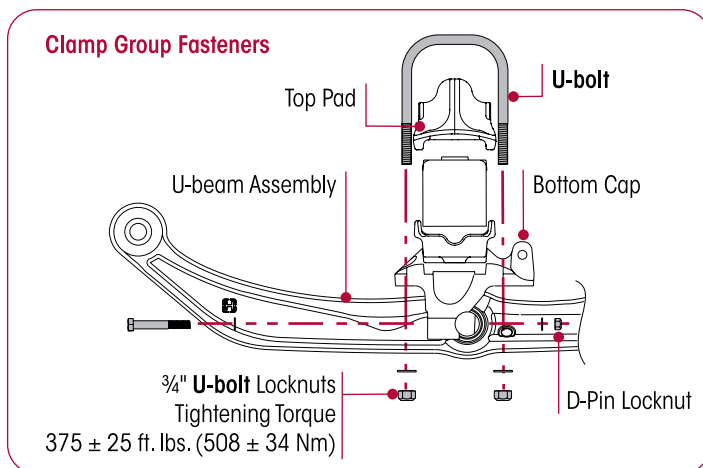
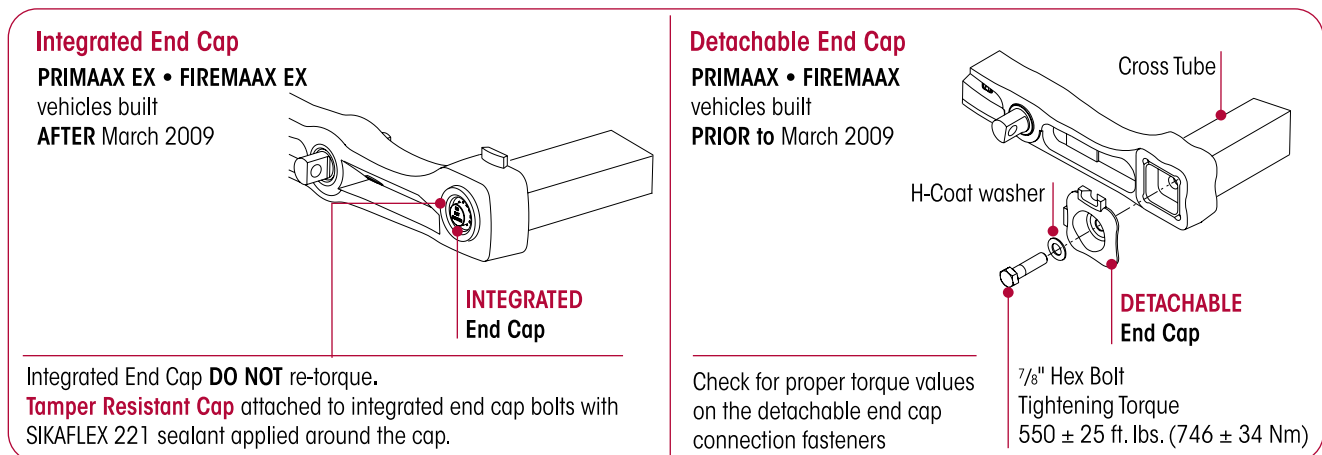


FIGURE 3



WARNING

PIVOT BUSHING

THE PIVOT AND D-PIN BUSHINGS ARE CRITICAL COMPONENTS OF THE PRIMAAX EX • FIREMAAX EX • PRIMAAX • FIREMAAX SUSPENSIONS. IF ANY SUCH COMPONENTS APPEAR DAMAGED OR WORN THE COMPONENT MUST BE REPLACED. FAILURE TO REPLACE SUCH WORN OR DAMAGED COMPONENTS CAN RESULT IN THE DEFORMATION OF PARTS, LOSS OF CLAMP FORCE, BOLT FAILURE, LOSS OF THE AXLE'S ALIGNMENT, ADVERSE VEHICLE HANDLING, PROPERTY DAMAGE, OR PERSONAL INJURY.

The two types of pivot bushing inspections are visual and physical. The pivot bushing can be **visually** inspected by looking at the outer rubber flange(s) of the bushing. If the visual inspection warrants a **physical** inspection, it can be conducted in which disassembly is required.

VISUAL INSPECTION

If the pivot bushing rubber flange(s) are intact and there are no signs of **metal to metal** contact, the bushing does not require replacement.

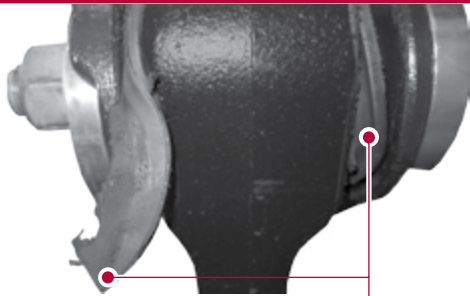
- The support beam is designed with the pivot bushing centered in the support beam end hub. If the pivot bushing is not centered in the end hub, it is an indication that the pivot bushing could be worn and a pivot bushing physical inspection is required.
- If the pivot bushing shows signs of torn, separated or disconnected rubber, see Figures 4 and 5, this could be a result of axle misalignment. If this condition is evident, a pivot bushing physical inspection is required.
- If the outer rubber flange(s) is missing, or there are shards of rubber visible, (see Figure 6) this could be a result of axle misalignment. If this condition is evident, pivot bushing replacement is required.

FIGURE 4

FIGURE 5

FIGURE 6

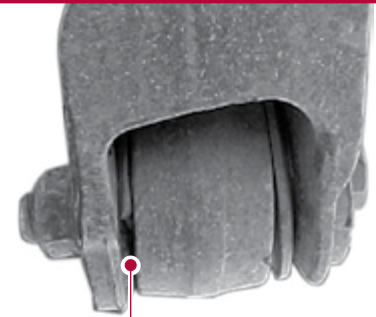
VISUAL INSPECTION – Torn, Disconnected or Missing Rubber Flange



Torn Rubber



Disconnected Rubber Flange



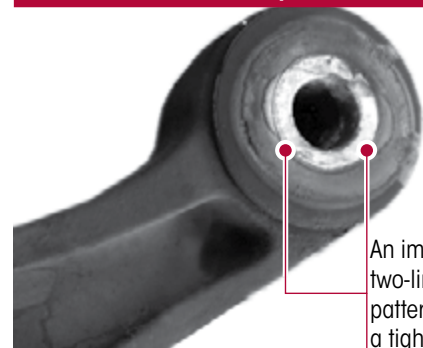
Missing Rubber Flange

PHYSICAL INSPECTION

1. Remove the U-Beam assembly, per the appropriate PRIMAAX EX • FIREMAAX EX | PRIMAAX • FIREMAAX Technical Procedure for your vehicle.
2. After removal, inspect the pivot bushing connection, examine the pivot bushing inner metal area.
3. No replacement is needed if the bushing exhibits a tight joint, see Figure 7. An imprinted two-line wear pattern on the bushing inner metal indicates the pivot bushing is securely clamped in the frame hanger.

FIGURE 7

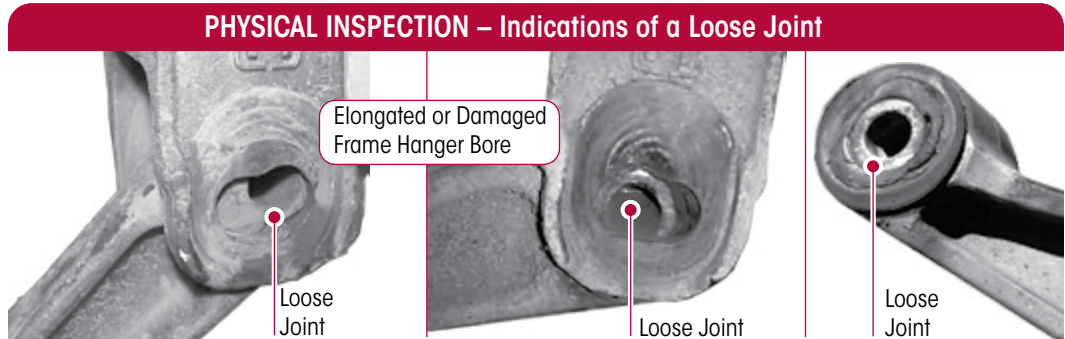
GOOD JOINT – No Replacement Needed



An imprinted two-line wear pattern exhibits a tight joint

4. Inspect pivot bushing and frame hanger, replacement is necessary if any indications of the following are apparent, see Figure 8:
 - Signs of rust, distorted, separated or torn rubber, elongated or damaged bore. This could be a result of axle misalignment or loose fasteners.

FIGURE 8



5. Inspect the frame hanger legs and the QUIK-ALIGN collars. If any of the following are present, the pivot bushing and one (1) or more of the mating components may require replacement:
 - Evidence of wear marks on the inside of the frame hanger legs indicating metal to metal contact or movement
 - The snout of the QUIK-ALIGN concentric or eccentric collar is elongated or damaged
6. Check the suspension alignment and adjust if necessary, refer to appropriate PRIMAAX EX • FIREMAAX EX | PRIMAAX • FIREMAAX Technical Publication for your vehicle.

D-PIN BUSHING

VISUAL INSPECTION

It is not necessary to disassemble the D-pin connection to perform a D-pin visual inspection. The D-pin bushing is designed with a layer of rubber in the bushing, it is acceptable to see a bead of rubber protruding from the bushing, see Figure 9.

D-pin bushing **REQUIRE** replacement only if:

- Metal to metal contact wear marks on the D-pin outer metal are evident, see Figure 10
- D-pin outer metal is distorted, see Figure 10

FIGURE 9

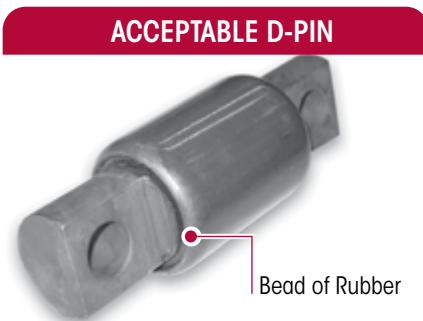
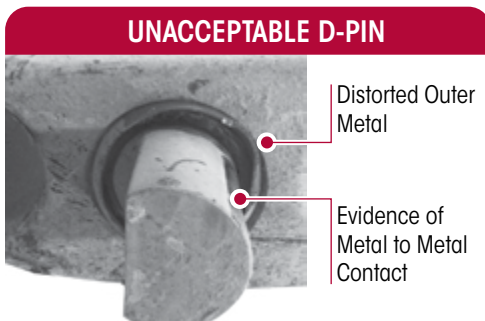


FIGURE 10



Refer to D-pin Component Replacement Section in the appropriate PRIMAAX EX • FIREMAAX EX | PRIMAAX • FIREMAAX Technical Procedure for your vehicle.



Hendrickson technical and parts support contact information:



Toll-free U.S. and Canada
1.866.755.5968
Outside U.S. and Canada
1.630.910.2800



Parts Identification
truckparts@hendrickson-intl.com
Technical Support
techservices@hendrickson-intl.com



1.630.910.2899



Additional Hendrickson
Product Information
www.hendrickson-intl.com

Actual product performance may vary depending upon vehicle configuration, operation, service and other factors. All applications must comply with applicable Hendrickson specifications and must be approved by the respective vehicle manufacturer with the vehicle in its original, as-built configuration. Contact Hendrickson for additional details regarding specifications, applications, capacities, and operation, service and maintenance instructions.

Call Hendrickson at **1.866.755.5968** (toll-free) or **1.630.910.2800** for additional information.



www.hendrickson-intl.com

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17730-266 Rev D 01-21

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Printed in United States of America



Appendix H

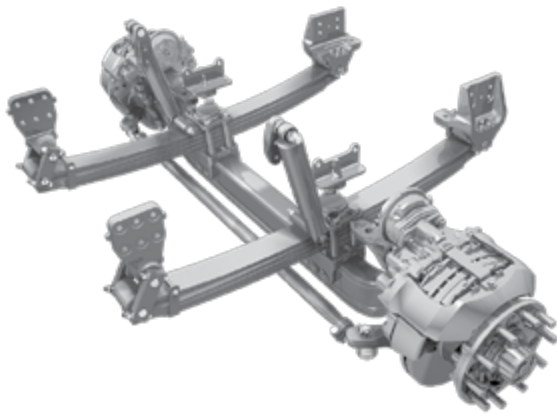
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The World Rides On US

TECHNICAL PROCEDURE

STEERTEK NXT High Capacity

Steer Axle System for Fire and Rescue Vehicles



H TECHNICAL PROCEDURE

STEERTEK NXT High Capacity Steer Axle System for Fire and Rescue Vehicles

SUBJECT: Service Instructions

LIT NO: 17730-311

DATE: April 2019

REVISION: B

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SECTION 1 Introduction

This publication is intended to acquaint and assist maintenance personnel in the preventive maintenance, service, repair and rebuild of the Hendrickson STEERTEK NXT High Capacity Steer Axle System for applicable Fire and Rescue Vehicles.

NOTE

Use only Hendrickson Genuine parts for servicing this suspension system.

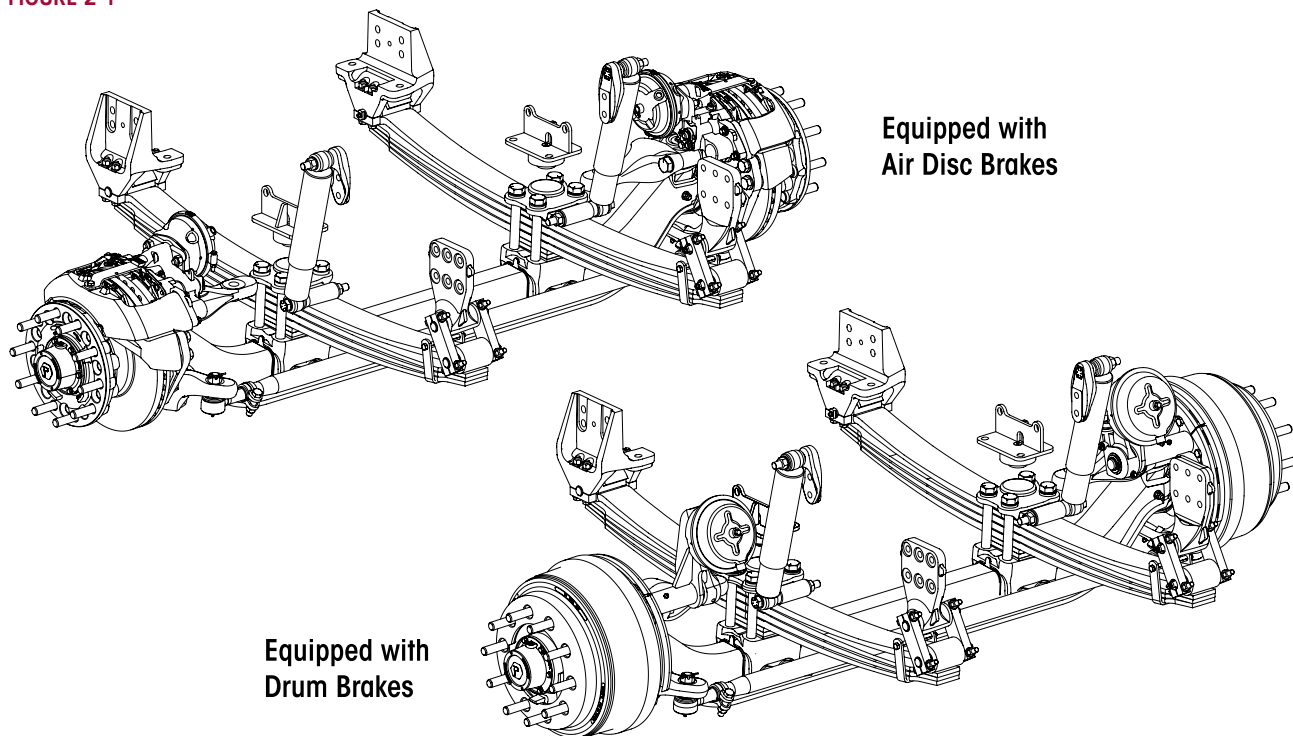
It is important to read and understand the entire Technical Procedure publication prior to performing any maintenance, service, repair, or rebuild of the product. The information in this publication contains parts lists, safety information, product specifications, features, proper maintenance, service, repair and rebuild instructions for STEERTEK NXT High Capacity Steer Axle System.

Hendrickson reserves the right to make changes and improvements to its products and publications at any time. Contact Hendrickson Tech Services for information on the latest version of this manual at 1-866-755-5968 (toll-free U.S. and Canada), 1-630-910-2800 (outside U.S. and Canada) or e-mail: techservices@hendrickson-intl.com.

The latest revision of this publication is available online at www.hendrickson-intl.com.

SECTION 2 Product Description

FIGURE 2-1





Hendrickson's STEERTEK NXT High Capacity Steer Axle System — STEERTEK NXT High Capacity is the durable and lightweight alternative to forged I-beam axles. Optimized performance and integrated with Hendrickson spring and elastomer technology, STEERTEK NXT achieves complete suspension and axle system efficiency. The unique design provides up to 40 pounds of weight savings compared to traditional forged I-beam axles. Continuous beam architecture minimizes stress points for added durability. STEERTEK NXT High Capacity is rated for 100% off-highway use.

Multiple Axle Configurations — deep or standard drop, wide or narrow track, flexible spring seat centers and multiple steering arm and tie rod arm configurations.

Brake Compatibility — Compatible with drum 16.5" x 6" or air disc brakes with up to brakes and 315 to 445 mm tires.

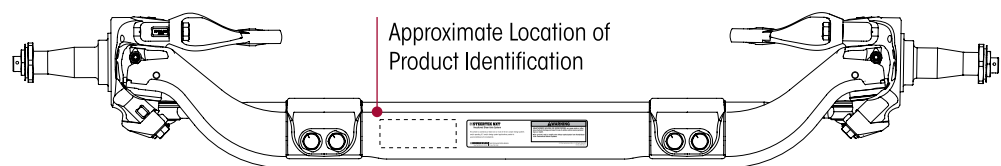
Knuckle Assembly — Removable kingpin design helps reduced maintenance. Premium kingpin bushings and seals provide enhanced protection from the elements to improve bushing life

Leaf Spring Assembly — The lightweight durable design provides excellent stability, ride and handling.

TECHNICAL NOTES

1. STEERTEK NXT high-capacity system is approved for 100% OFF-highway usage. Other applications must be pre-approved by both Hendrickson and vehicle manufacturer. The system has a 18,000 to 24,000 pound capacity with load ratings up to 24,000 pound in certain applications. System capacity represents maximum loads on tires at ground level.
2. The STEERTEK NXT system is available with 70.89" Intersections (KPI).
3. The STEERTEK NXT system offers 3.74" axle beam drop height. Axle beam drop is measured from the kingpin intersection to the top of the axle.
4. This system is anti-lock braking system (ABS) ready. This system is compatible with industry standard wheel ends and brakes.
5. The STEERTEK NXT system product identification is etched on the front of the axle beam providing the following information, see Figure 2-2:
 - **Axle part number:** Identifies the features of the axle beam.
 - **Axle assembly number:** Identifies the complete assembly, which includes the steering knuckles and bracket assemblies.

FIGURE 2-2





SECTION 3 Important Safety Notice

Proper maintenance, service and repair is important to the reliable operation of the suspension. The procedures recommended by Hendrickson and described in this technical publication are methods of performing such maintenance, service and repair.

The warnings and cautions should be read carefully to help prevent personal injury and to assure that proper methods are used. Improper maintenance, service or repair may damage the vehicle, cause personal injury, render the vehicle unsafe in operation, or void manufacturer's warranty.

Failure to follow the safety precautions in this manual can result in personal injury and / or property damage. Carefully read and understand all safety related information within this publication, on all decals and all such materials provided by the vehicle manufacturer before conducting any maintenance, service or repair.

■ EXPLANATION OF SIGNAL WORDS

Hazard "Signal Words" (Danger-Warning-Caution) appear in various locations throughout this publication. Information accented by one of these signal words must be observed to help minimize the risk of personal injury to service personnel, or possibility of improper service methods which may damage the vehicle or render it unsafe.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

Additional 'Notes' or 'Service Hints' are utilized to emphasize areas of procedural importance and provide suggestions for ease of repair. The following definitions indicate the use of these signal words as they appear throughout the publication.



INDICATES AN IMMINENTLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, WILL RESULT IN SERIOUS INJURY OR DEATH.



INDICATES A POTENTIAL HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, CAN RESULT IN SERIOUS INJURY OR DEATH.



INDICATES A POTENTIAL HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, MAY RESULT IN MINOR OR MODERATE INJURY, OR PROPERTY DAMAGE.

NOTE

An operating procedure, practice condition, etc., which is essential to emphasize.

SERVICE HINT

A helpful suggestion, which will make the servicing being performed a little easier and / or faster.

Also note that particular service operations may require the use of special tools designed for specific purposes. These special tools can be found in the Special Tools Section of this publication.



The torque symbol alerts you to tighten fasteners to a specified torque value. Refer to Torque Specifications Section of this publication.



■ SAFETY PRECAUTIONS

WARNING

FASTENERS

DISCARD USED FASTENERS. ALWAYS USE NEW FASTENERS TO COMPLETE A REPAIR. FAILURE TO DO SO COULD RESULT IN FAILURE OF THE PART, OR MATING COMPONENTS, LOSS OF VEHICLE CONTROL, PERSONAL INJURY, OR PROPERTY DAMAGE.

LOOSE OR OVER TORQUED FASTENERS CAN CAUSE COMPONENT DAMAGE, LOSS OF VEHICLE CONTROL, PROPERTY DAMAGE, OR SEVERE PERSONAL INJURY. MAINTAIN CORRECT TORQUE VALUE AT ALL TIMES. CHECK TORQUE VALUES ON A REGULAR BASIS AS SPECIFIED, USING A TORQUE WRENCH THAT IS REGULARLY CALIBRATED. TORQUE VALUES SPECIFIED IN THIS TECHNICAL PUBLICATION ARE FOR HENDRICKSON SUPPLIED FASTENERS ONLY. IF NON-HENDRICKSON FASTENERS ARE USED, FOLLOW TORQUE SPECIFICATION LISTED IN THE VEHICLE MANUFACTURER'S SERVICE MANUAL.

WARNING

LOAD CAPACITY

ADHERE TO THE PUBLISHED CAPACITY RATINGS FOR THE SUSPENSIONS. ADD-ON AXLE ATTACHMENTS (I.E. SLIDING FIFTH WHEELS) AND OTHER LOAD TRANSFERRING DEVICES CAN INCREASE THE SUSPENSION LOAD ABOVE THE RATED AND APPROVED CAPACITIES WHICH COULD RESULT IN FAILURE AND LOSS OF VEHICLE CONTROL, POSSIBLY CAUSING PERSONAL INJURY OR PROPERTY DAMAGE.

WARNING

REPAIR OR RECONDITIONING

THE REPAIR OR RECONDITIONING OF SUSPENSION OR AXLE COMPONENTS IS NOT ALLOWED AS SHOWN ON LABEL IN FIGURE 3-1. ANY AXLE COMPONENTS FOUND TO BE DAMAGED OR OUT OF SPECIFICATIONS MUST BE REPLACED. ALL MAJOR HENDRICKSON COMPONENTS ARE HEAT TREATED AND TEMPERED. THE COMPONENTS CANNOT BE BENT, WELDED, HEATED, OR REPAIRED WITHOUT REDUCING THE STRENGTH OR LIFE OF THE COMPONENT. FAILURE TO FOLLOW THESE GUIDELINES CAN CAUSE LOSS OF VEHICLE CONTROL, POSSIBLE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE AND WILL VOID APPLICABLE WARRANTIES.

WARNING

SUPPORT THE VEHICLE PRIOR TO SERVICING

PLACE THE VEHICLE ON A LEVEL FLOOR AND CHOCK THE WHEELS TO HELP PREVENT THE VEHICLE FROM MOVING. NEVER WORK UNDER A RAISED VEHICLE SUPPORTED ONLY BY A FLOOR JACK. ALWAYS SUPPORT A RAISED VEHICLE WITH SAFETY STANDS. BLOCK THE WHEELS AND MAKE SURE THE UNIT WILL NOT ROLL BEFORE RELEASING BRAKES. A JACK CAN SLIP OR FALL OVER. SERIOUS PERSONAL INJURY CAN RESULT.

WARNING

MODIFYING COMPONENTS

DO NOT MODIFY OR REWORK PARTS WITHOUT AUTHORIZATION FROM HENDRICKSON. DO NOT SUBSTITUTE REPLACEMENT COMPONENTS NOT AUTHORIZED BY HENDRICKSON. USE OF MODIFIED, REWORKED, SUBSTITUTE OR REPLACEMENT PARTS NOT AUTHORIZED BY HENDRICKSON MAY NOT MEET HENDRICKSON'S SPECIFICATIONS, AND CAN RESULT IN FAILURE OF THE PART, LOSS OF VEHICLE CONTROL, POSSIBLE PERSONAL INJURY OR PROPERTY DAMAGE, AND WILL VOID ANY APPLICABLE WARRANTIES. USE ONLY HENDRICKSON AUTHORIZED REPLACEMENT PARTS.

WARNING

SHOCK ABSORBERS

THE SHOCK ABSORBERS ARE A REQUIRED COMPONENT WHETHER SUPPLIED BY HENDRICKSON OR THE VEHICLE MANUFACTURER. HENDRICKSON IS NOT RESPONSIBLE FOR COMPONENTS SUPPLIED BY THE VEHICLE MANUFACTURER. FOR ASSISTANCE WITH INSPECTION, MAINTENANCE AND REBUILD INSTRUCTIONS, SEE VEHICLE MANUFACTURER.

WARNING

PERSONNEL PROTECTIVE EQUIPMENT

ALWAYS WEAR PROPER EYE PROTECTION AND OTHER REQUIRED PERSONAL PROTECTIVE EQUIPMENT TO HELP PREVENT PERSONAL INJURY WHEN PERFORMING VEHICLE MAINTENANCE, REPAIR OR SERVICE.



WARNING

AXLE CAMBER

UNAUTHORIZED WELDING OR MODIFICATIONS CAN CAUSE CRACKS OR OTHER AXLE STRUCTURAL DAMAGE AND RESULT IN LOSS OF VEHICLE CONTROL, SEVERE PERSONAL INJURY OR DEATH. DO NOT BEND, WELD OR MODIFY AXLE WITHOUT AUTHORIZATION FROM HENDRICKSON TRUCK COMMERCIAL VEHICLE SYSTEMS.

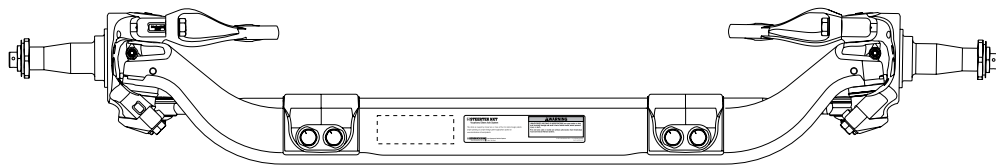
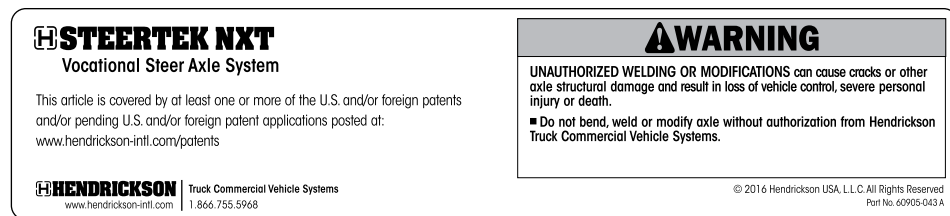
AXLE CAMBER IS NOT ADJUSTABLE. DO NOT CHANGE THE AXLE CAMBER ANGLE OR BEND THE AXLE BEAM, SEE FIGURE 3-1. BENDING THE AXLE BEAM TO CHANGE THE CAMBER ANGLE CAN DAMAGE THE AXLE AND REDUCE AXLE STRENGTH, WILL VOID HENDRICKSON'S WARRANTY AND CAN CAUSE LOSS OF VEHICLE CONTROL, POSSIBLY CAUSING PERSONAL INJURY OR PROPERTY DAMAGE.

WARNING

IMPROPER JACKING METHOD

IMPROPER JACKING METHOD CAN CAUSE STRUCTURAL DAMAGE AND RESULT IN LOSS OF VEHICLE CONTROL, SEVERE PERSONAL INJURY OR DEATH. DO NOT USE AXLE BEAM OUTBOARD OF AXLE SEATS. REFER TO VEHICLE MANUFACTURER FOR PROPER JACKING INSTRUCTIONS, SEE FIGURE 3-1.

FIGURE 3-1



WARNING

DAMAGED AXLE COMPONENTS

IF A VEHICLE EQUIPPED WITH A STEERTEK NXT SYSTEM IS INVOLVED IN A CRASH, THE AXLE STEER KNUCKLES MUST BE DISASSEMBLED AND A THOROUGH INSPECTION OF THE AXLE MUST BE PERFORMED NOTING THE CONDITION OF THE AXLE BEAM, KINGPINS, AND KNUCKLE ASSEMBLIES, INCLUDING THE AREAS OF AXLE TO KINGPIN INTERFACE, FOR ANY DAMAGE, GAPS, KINGPIN MOVEMENT OR PLAY. IF ANY COMPONENT APPEARS DAMAGED, OR THE KINGPINS APPEAR TO CONTAIN ANY DAMAGE, GAPS, MOVEMENT OR PLAY, THE COMPLETE AXLE ASSEMBLY MUST BE REPLACED.

IN ADDITION, IN THE EVENT A CRASH RESULTS IN EXCESSIVE SIDE LOAD DAMAGE TO ADJACENT PARTS, SUCH AS A BENT WHEEL, HUB, OR SPINDLE, IT IS STRONGLY RECOMMENDED TO REPLACE SUCH ADJACENT PARTS AND THE COMPLETE AXLE ASSEMBLY.

CONTACT HENDRICKSON TECH SERVICES WITH ANY QUESTIONS. FAILURE TO REPLACE ANY DAMAGED COMPONENTS CAN CAUSE LOSS OF VEHICLE CONTROL, POSSIBLE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE AND WILL VOID ANY APPLICABLE WARRANTIES.

CAUTION

PROCEDURES AND TOOLS

A MECHANIC USING A SERVICE PROCEDURE OR TOOL WHICH HAS NOT BEEN RECOMMENDED BY HENDRICKSON MUST FIRST SATISFY HIMSELF THAT NEITHER HIS SAFETY NOR THE VEHICLE'S SAFETY WILL BE JEOPARDIZED BY THE METHOD OR TOOL SELECTED. INDIVIDUALS DEVIATING IN ANY MANNER FROM THE INSTRUCTIONS PROVIDED ASSUME ALL RISKS OF POTENTIAL PERSONAL INJURY OR DAMAGE TO EQUIPMENT INVOLVED.



WARNING

OFF-ROADWAY TOWING

WHEN A VEHICLE IS DISABLED AND EQUIPPED WITH A STEERTEK NXT SYSTEM, CARE MUST BE TAKEN TO ENSURE THERE IS NO DAMAGE TO THE SUSPENSION OR AXLE WHEN TOWING THE VEHICLE. THE USE OF TOW STRAPS ARE NECESSARY TO TOW A DISABLED VEHICLE FROM A REPAIR FACILITY PARKING LOT INTO THE SHOP BAY. THE TOW STRAPS SHOULD BE CONNECTED TO THE TOW HOOKS PROVIDED BY THE VEHICLE MANUFACTURER AT THE FRONT OF THE BUMPER. IF THE USE OF TOW HOOKS IS NOT AN OPTION, THEN TOW STRAPS MAY BE WRAPPED AROUND THE FRONT STEERTEK NXT SYSTEM, (SEE FIGURE 3-2) IN A MANNER THAT IS ACCEPTABLE FOR TOWING THE VEHICLE FROM A REPAIR FACILITY PARKING LOT INTO THE SHOP BAY. DO NOT USE A TOW CHAIN AROUND THE FRONT STEERTEK NXT SYSTEM TO TOW THE VEHICLE, DOING SO WILL DAMAGE THE AXLE AND VOID ANY APPLICABLE WARRANTY, (SEE FIGURE 3-2). FOR DETAILED INSTRUCTIONS FOR ON-HIGHWAY TOWING, SEE TOWING PROCEDURE SECTION OF THIS PUBLICATION.

FIGURE 3-2



WARNING

TORCH / WELDING

DO NOT USE A CUTTING TORCH TO REMOVE ANY FASTENERS. THE USE OF HEAT ON SUSPENSION COMPONENTS WILL ADVERSELY AFFECT THE STRENGTH OF THESE PARTS. A COMPONENT DAMAGED IN THIS MANNER CAN RESULT IN THE LOSS OF VEHICLE CONTROL AND POSSIBLE PERSONAL INJURY OR PROPERTY DAMAGE.

EXERCISE EXTREME CARE WHEN HANDLING OR PERFORMING MAINTENANCE IN THE AREA OF THE LEAF SPRING ASSEMBLY AND AXLE. DO NOT CONNECT ARC WELDING GROUND LINE TO THE LEAF SPRING ASSEMBLY OR AXLE. DO NOT STRIKE AN ARC WITH THE ELECTRODE ON THE LEAF SPRING ASSEMBLY OR AXLE. DO NOT USE HEAT NEAR THE LEAF SPRING ASSEMBLY OR AXLE. DO NOT NICK OR GOUGE THE LEAF SPRING ASSEMBLY OR AXLE. SUCH IMPROPER ACTIONS CAN DAMAGE THE LEAF SPRING ASSEMBLY OR THE AXLE, AND CAN CAUSE LOSS OF VEHICLE CONTROL AND POSSIBLE PERSONAL INJURY OR PROPERTY DAMAGE.

WARNING

PARTS CLEANING

SOLVENT CLEANERS CAN BE FLAMMABLE, POISONOUS AND CAUSE BURNS. TO HELP AVOID SERIOUS PERSONAL INJURY, CAREFULLY FOLLOW THE MANUFACTURER'S PRODUCT INSTRUCTIONS AND GUIDELINES AND THE FOLLOWING PROCEDURE:

1. WEAR PROPER EYE PROTECTION
2. WEAR CLOTHING THAT PROTECTS YOUR SKIN
3. WORK IN A WELL VENTILATED AREA
4. DO NOT USE GASOLINE, OR SOLVENTS THAT CONTAIN GASOLINE. GASOLINE CAN EXPLODE
5. HOT SOLUTION TANKS OR ALKALINE SOLUTIONS MUST BE USED CORRECTLY. FOLLOW THE MANUFACTURER'S RECOMMENDED INSTRUCTIONS AND GUIDELINES CAREFULLY TO HELP PREVENT PERSONAL ACCIDENT OR INJURY

DO NOT USE HOT SOLUTION TANKS OR WATER AND ALKALINE SOLUTIONS TO CLEAN GROUND OR POLISHED PARTS. DOING SO WILL CAUSE DAMAGE TO THE PARTS AND VOID ANY APPLICABLE WARRANTY.

SECTION 4 Parts List

Refer to the specific parts list for your vehicle available online at <https://www.hendrickson-intl.com/resources/literature/parts-lists/sp-306-steertek-nxt-high-capacity-for-sutphen-vehicles>

NOTE Additional brake component part and service information is referenced in the Parts List.

FIGURE 4-1



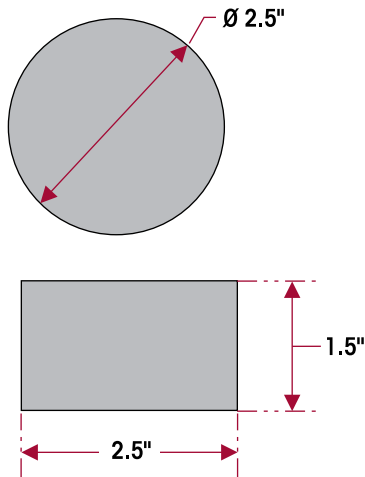


SECTION 5 Special Tools

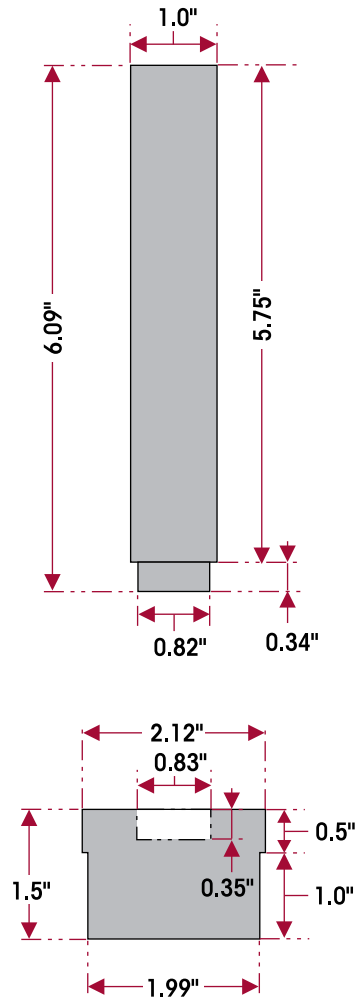
SHOP MADE TOOLS

These shop made tools are designed to install and remove kingpin bushings. Bushing tools are made from cold rolled steel or equivalent. Drawings are for reference only. Hendrickson does not supply these.

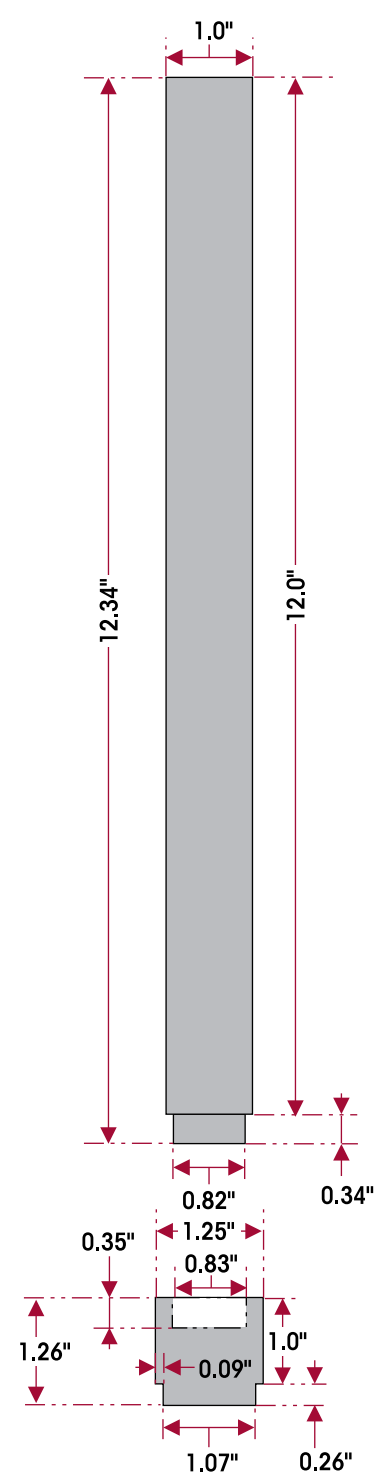
KINGPIN BUSHING / SEAL DRIVER



KINGPIN BUSHING AND SEAL INSTALLER / REMOVER



AXLE COLLAR DRIVER



KINGPIN BUSHING TOOL – ADJUSTABLE STRAIGHT FLUTE REAMER

The dimension of cutting diameter must facilitate a range of **2.00"-2.01"**



SECTION 6

Towing Procedures

ON-HIGHWAY AND ON-ROADWAY

Hendrickson recommends that a vehicle equipped with a STEERTEK NXT steer axle and suspension system be towed by the following methods (listed in order of preference) for ON-HIGHWAY or ON-ROADWAY applications.

- **METHOD 1** — Wheel lift, the ideal towing procedure
- **METHOD 2** — Towing the vehicle from the rear
- **METHOD 3** — Conventional axle fork

Please read, understand and comply with any additional towing instructions and safety precautions that may be provided by the vehicle manufacturer.

Hendrickson will not be responsible for any damage to the axle, suspension or other vehicle components resulting from any towing method or fixture not authorized by Hendrickson.

Please contact Hendrickson Tech Services at 1-866-755-5968 or send e-mail to: techservices@hendrickson-intl.com with any questions regarding proper towing procedures for vehicles equipped with a STEERTEK NXT system.

METHOD 1 — WHEEL LIFT

This method provides the greatest ease for towing the vehicle. Lifting at the tires helps reduce the risk of possible damage to the axle, suspension, and engine components during towing operations, see Figure 6-1.

FIGURE 6-1



METHOD 2 — TOWING VEHICLE FROM THE REAR

This method is preferred when the proper equipment is not available to perform the wheel lift method and is necessary for wreckers not equipped with an under lift system.



METHOD 3 — AXLE FORK LIFT

This is an alternative method for towing the vehicle, but requires standard tow forks and designated lift points.

NOTE

When lifting a vehicle with an under lift boom, care must be taken not to damage the engine's oil pan. Vehicles equipped with a front fairing may require removal of the front fairing prior to towing to prevent component damage.

- Ensure there is sufficient clearance between the oil pan and the boom.
 - Release the tractor brakes.
 - Install safety straps prior to towing the vehicle, it is preferred to use nylon safety straps. Chains have a tendency to bind and may cause damage to the axle.
1. Use a tow fork with a minimum of 4.5" opening, 2" shank, see Figure 6-2.
 2. Install the fork in the boom properly.
 3. The proper tow fork location is centered between the locknuts on the axle seats, see Figure 6-3.

FIGURES 6-2



FIGURE 6-3



OFF-ROADWAY TOWING

WARNING

WHEN A VEHICLE IS DISABLED AND EQUIPPED WITH A STEERTEK NXT SYSTEM, CARE MUST BE TAKEN TO ENSURE THERE IS NO DAMAGE TO THE SUSPENSION OR AXLE WHEN TOWING THE VEHICLE. THE USE OF TOW STRAPS ARE NECESSARY TO TOW A DISABLED VEHICLE FROM A REPAIR FACILITY PARKING LOT INTO THE SHOP BAY. THE TOW STRAPS SHOULD BE CONNECTED TO THE TOW HOOKS PROVIDED BY THE VEHICLE MANUFACTURER AT THE FRONT OF THE BUMPER. IF THE USE OF TOW HOOKS IS NOT AN OPTION, THEN TOW STRAPS MAY BE WRAPPED AROUND THE FRONT STEERTEK NXT SYSTEM, (SEE FIGURE 6-4) IN A MANNER THAT IS ACCEPTABLE FOR TOWING THE VEHICLE FROM A REPAIR FACILITY PARKING LOT INTO THE SHOP BAY. DO NOT USE A TOW CHAIN AROUND THE FRONT STEERTEK NXT SYSTEM TO TOW THE VEHICLE, DOING SO WILL DAMAGE THE AXLE AND VOID ANY APPLICABLE WARRANTY, (SEE FIGURE 6-4).

- NYLON STRAPS OR CHAINS ARE NOT RECOMMENDED FOR ON-HIGHWAY OR ON-ROADWAY TOWING.

FIGURE 6-4





SECTION 7

Preventive Maintenance

The STEERTEK NXT High Capacity steer axle system is low maintenance system. Following appropriate inspection procedure is important to help ensure the proper maintenance and operation of the STEERTEK NXT High Capacity steer axle system and component parts function to their highest efficiency. Look and replace any bent, cracked, worn or damaged parts.

HENDRICKSON RECOMMENDED PREVENTIVE MAINTENANCE INTERVALS

- **The first 1,000 miles**
- **Vocational** – every 25,000 miles (40,000 kilometers) or 6 months, whichever comes first

COMPONENT INSPECTION

- **Axle seat** — Check torque. Inspect axle seats for cracks or damage. Inspect axle seat liners, check for any missing liner material. If liner material is missing disassemble clamp group and replace liners, see Component Replacement Section of this publication.
- **Clamp group** — Check torque on clamp group mounting hardware. Refer to the Clamp Group Re-Torque Interval in this section.
- **Fasteners** — Look for any loose or damaged fasteners on the entire suspension. Make sure all fasteners are tightened to the specified torque. Refer to Torque Specifications Section of this publication if fasteners are supplied by Hendrickson, non-Hendrickson fasteners, refer to the vehicle manufacturer. Use a calibrated torque wrench to check torque in a tightening direction. As soon as the fastener starts to move, record the torque. Correct the torque if necessary. Replace any worn or damaged fasteners.
- **Front and rear spring hangers** — Check for cracks or loose mounting hardware. Replace if necessary, see Component Replacement Section of this publication for replacement procedure.
- **Shackle bracket** — Look for any signs of excessive wear to shackle and shackle bracket.
- **Shock absorber** — Look for any signs of dents or leakage. Refer to the Shock Absorber Inspection in this section.
- **Steel leaf spring** — Look for cracks. Replace if cracked or broken. Check the front bushings for any wear or deterioration. Replace leaf spring assembly if any of the previous conditions are observed. See the Component Replacement Section of this publication for replacement procedure.
- **Operation** — All steering components must move freely through the full range of motion from axle stop to axle stop.
- **Steering pivot points** — Check for looseness at all pivot points. Inspect and lubricate all pivot points. Refer to the STEERTEK NXT High Capacity Greasing and Lubrication Specifications Table 7-1, in this section.
- **STEERTEK NXT High Capacity axle and Tie Rods** — Inspect for any cracks or dents on the axle, and also refer to the Tie Rod Ends Inspection and Lubrication Section in this publication. Replace as necessary.
- **Tire wear** — Inspect tires for wear patterns that may indicate suspension damage or misalignment. See Tire Inspection in this section.
- **Wear and damage** — Inspect all parts of suspension for wear and damage. Look for bent or cracked parts. Replace all worn or damaged parts.

See vehicle manufacturer's applicable publications for other preventive maintenance requirements.



LUBRICATION INTERVALS

For vehicles equipped with the STEERTEK NXT High Capacity steer axle system, regular lubrication intervals should be followed to help prevent premature wear to the kingpin bushings and tie rod ends, see Lubrication Specification Table 7-1 below.

NOTE The recommended service lubrication interval is a guideline, the vehicle may require increased lubrication interval depending on severity of operation.

TABLE 7-1

STEERTEK NXT High Capacity — Greasing and Lubrication Specifications				
Component	Greasing Interval	Grease	NLGI Grade	Outside Temperature
Kingpin Bushings	Maximum of 10,000 miles (16,100 kilometers) or 90 days, whichever comes first.	Multipurpose Grease	2	Refer to the lubricant manufacturer's specifications for the temperature service limits applicable to your area.
Tie Rod Ends				
Drag Link	See Vehicle Manufacturer			
Threaded Pin	Every 3 months	Lithium Base Grease	2	

NOTE: Lubrication greases acceptable for use on the STEERTEK NXT will carry a designation of NLGI #2 EP and rated GC-LB or equivalent.

KINGPIN LUBRICATION

1. Place vehicle on the ground.
2. Prior to greasing the kingpins on the vehicle, the suspension must be in a loaded condition.
3. Clean off all the grease zerks and grease gun tip with a clean shop towel prior to lubrication.
4. Lubricate the kingpins through the grease zerks on the top and bottom of the steering knuckle, see Lubrication Specification Table 7-1 above.
5. Force the required lubricant into the upper and lower kingpin grease zerks, (Figure 7-1) until new lubricant flows out from the upper kingpin connection and steering knuckle and the thrust bearing purge location, see Figures 7-1 and 7-2.

NOTE Greasing at the lower zerk should purge grease from the thrust bearing shell. The left and right side of the STEERTEK NXT High Capacity steer axle system have steel roller thrust bearings.

FIGURE 7-1

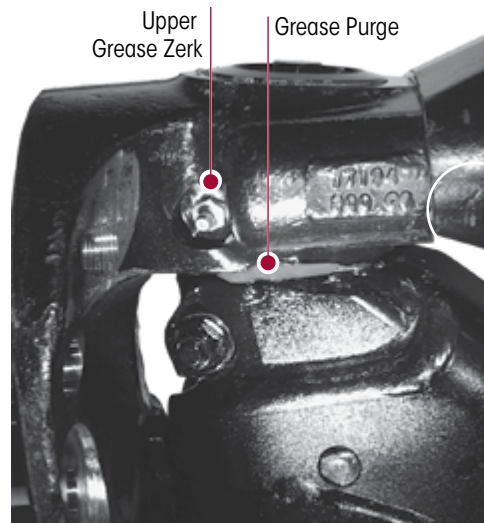
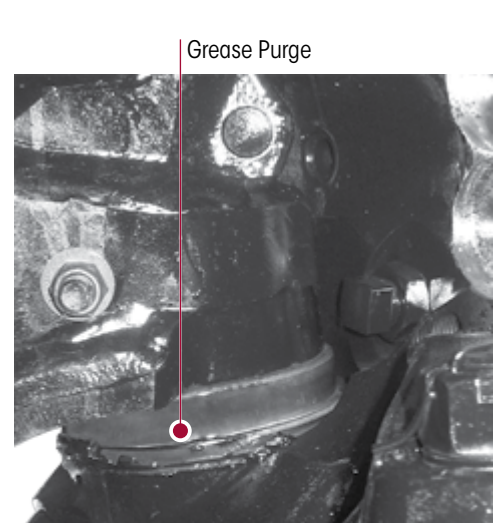


FIGURE 7-2



TIE ROD END LUBRICATION

LUBRICATION PROCEDURE

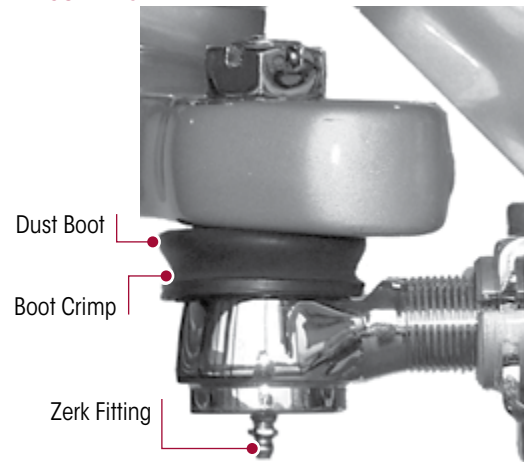
1. Turn the vehicle wheels straight ahead.
2. Wipe the grease zerk and grease gun tip with clean shop towels.
3. Wipe the seal / boot clean with shop towels.
4. Attach a grease gun to the grease zerk. Either a hand or pneumatic grease gun is acceptable. If air operated grease gun is used, system air pressure should not exceed 150 psi (1035 kPa).

CAUTION

EXCEEDING THE MAXIMUM AIR PRESSURE TO THE GREASE ZERK CAN CAUSE DAMAGE TO THE DUST BOOT AND COMPONENT FAILURE.

5. Dirt, water, and discolored old grease should flow from the relief vents or purge holes near the boot crimp or bellows area, see Figure 7-3. Continue to purge grease until fresh grease flows from the purge area.
6. If the tie rod end is designed for lube service and it will not accept grease proceed as follows:
 - a. Remove the grease zerk
 - b. Inspect the threaded grease zerk hole in the tie rod end and remove any obstructions
 - c. Install a new grease zerk
 - d. Continue the lubrication procedure
 - e. If the tie rod end will not accept grease following this procedure it will be necessary to replace the tie rod end, (see Tie Rod End replacement in the Component Replacement Section of this publication)
7. Apply grease until all the old grease is purged from the boot and fresh grease is coming out.

FIGURE 7-3



TIE ROD ENDS

INSPECTION

Before beginning this inspection procedure, the entire system must be unloaded (i.e., the front end of the vehicle must be raised and supported with safety stands).

CAUTION

DO NOT GREASE THE TIE ROD ASSEMBLY BEFORE PERFORMING THE INSPECTION. DOING SO CAN INHIBIT EFFORTS TO DETERMINE ACTUAL WEAR.

CAUTION

REPLACE THE ENTIRE TIE ROD END IF THE BOOT IS TORN OR MISSING, FAILURE TO DO SO CAN CAUSE PREMATURE WEAR OF THE TIE ROD END.

1. Block rear wheels of vehicle. Using the bottom of the axle beam or the frame rails, raise the front end off the ground and support with stands.
2. With the engine off, turn the wheels from full left to full right and then return to the straight-ahead position.
3. Check that the boots are in place and completely installed over the tie rod ends.
4. Check for cracking or tears in the boots. Also check the boot seals for damage. Replace the entire tie rod end if the boot is damaged.



WARNING

THE COTTER PIN MUST BE INSTALLED CORRECTLY THROUGH THE TIE ROD END WITH THE CASTLE NUT TIGHTENED TO THE PROPER TORQUE SPECIFICATION IN ORDER TO SECURELY ATTACH THE TIE ROD. LOSS OF THE COTTER PIN CAN CAUSE THE TIE ROD END NUT TO BECOME LOOSE AND ADVERSELY AFFECT VEHICLE STEERING AND POSSIBLY RESULT IN TOTAL LOSS OF STEERING CONTROL.

5. Check that the tie rod end nut is installed and secured with a cotter pin. If the cotter pin is missing, check the nut torque specification and then install a new cotter pin. Always tighten the castle nut to specified torque when setting the cotter pin. **DO NOT** back off the nut to insert cotter pin.

WARNING

IT IS CRITICAL TO CHECK THE 5/8" TIE ROD CLAMP BOLT HEAD LOCATION TO VERIFY THE CLAMP FASTENERS HAVE SUFFICIENT CLEARANCE AWAY FROM THE LOWER SHOCK ABSORBER MOUNT AT FULL WHEEL CUT. THE FASTENERS MUST NOT CONTACT THE LOWER SHOCK ABSORBER MOUNT. FAILURE TO DO SO CAN CAUSE ONE OR MORE COMPONENTS TO FAIL CAUSING LOSS OF VEHICLE CONTROL AND POSSIBLE PERSONAL INJURY OR PROPERTY DAMAGE.

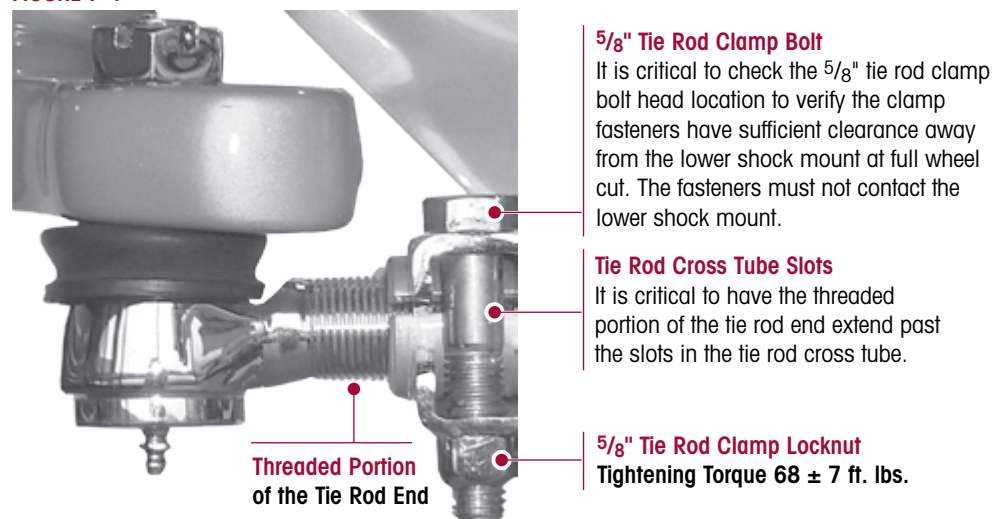
6. Verify the 5/8" tie rod clamp bolt head does not contact the lower shock absorber mount at full wheel cut, see Figure 7-4.

WARNING

THE THREADED PORTION OF THE TIE ROD END MUST EXTEND PAST THE SLOTS INTO THE TIE ROD CROSS TUBE, SEE FIGURE 7-4. FAILURE TO DO SO CAN CAUSE COMPONENT DAMAGE, LOSS OF VEHICLE CONTROL AND POSSIBLE PERSONAL INJURY OR PROPERTY DAMAGE.

7. Check that the tie rod end is threaded correctly into the cross tube and is engaged deeper than the end of the cross tube slot. The tie rod end must be visible the entire length of the cross tube slot, see Figure 7-4.

FIGURE 7-4



8. Check that grease zerks are installed. Replace a damaged grease zerk with a new one.

CAUTION

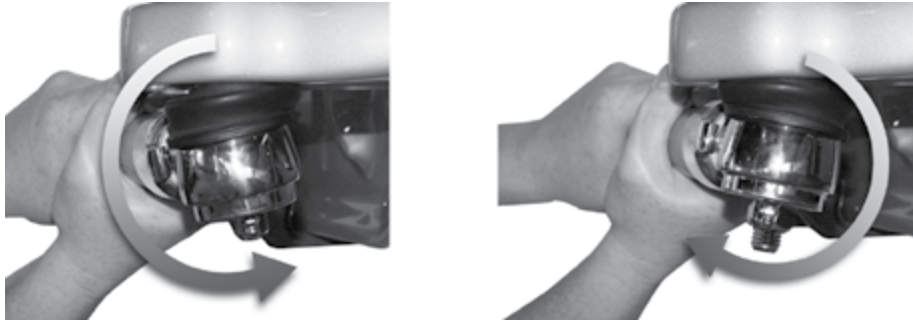
DO NOT USE THE FOLLOWING ITEMS OR METHODS TO CHECK FOR MOVEMENT OF THE TIE ROD ASSEMBLY, WHICH CAN CAUSE DAMAGE TO COMPONENTS:

- A CROW BAR, PICKLE FORK OR 2 X 4.
- ANYTHING OTHER THAN HANDS USED TO GRASP AND ROTATE THE CROSS TUBE ASSEMBLY (CAN RESULT IN DAMAGE TO THE CROSS TUBE).
- EXCESSIVE PRESSURE OR FORCE APPLIED TO THE TIE ROD ENDS OR THE JOINTS OF THE ASSEMBLY.

9. By hand or using a pipe wrench, with jaw protectors to avoid gouging the cross tube, rotate the cross tube toward the front of the vehicle and then toward the rear. After rotating, center the cross tube. If the cross tube will not rotate in either direction, replace both tie rod ends, see Figure 7-5.



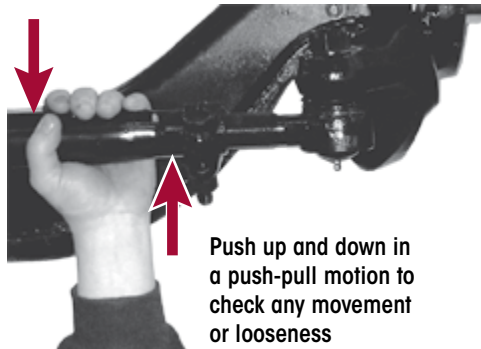
FIGURE 7-5



10. Position yourself directly below the tie rod end. Using both hands, grab the assembly end as close to the tie rod end as possible (no more than 6" or 152.4 mm). Apply hand pressure with reasonable human effort vertically up and down in a push-pull motion several times (using approximately 50-100 pounds of force). Check for any movement or looseness at both tie rod end locations, see Figure 7-6.

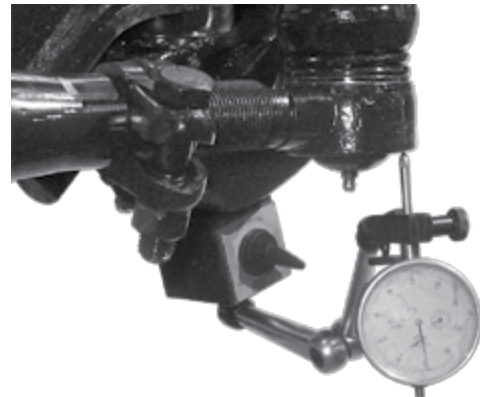
11. If there is any movement in the tie rod assembly, install a magnetic based dial indicator on the tie rod arm, see Figure 7-7.

FIGURE 7-6



Push up and down in a push-pull motion to check any movement or looseness

FIGURE 7-7



12. Set the dial indicator to zero.

13. Apply hand pressure with reasonable human effort vertically up and down in a push-pull motion several times (using approximately 50-100 pounds of force). Observe the reading on the dial indicator.

14. If the reading is more than 0.060", replace both tie rod ends at the next service interval.

15. If a tie rod end exhibits ≥ 0.125 " of movement by hand, the vehicle should be removed immediately from use and the tie rod end be replaced.

NOTE

According to the Commercial Vehicle Safety Alliance (CVSA), the "out of service" criteria for front steer axle tie rod assemblies on any commercial vehicle is: Any motion other than rotational between any linkage member and its attachment point of more than $\frac{1}{8}$ " (3 mm) measured with hand pressure only. (393.209(d)), (published in the North American Standard Out-of-Service Criteria Handbook, April 1, 2006.)



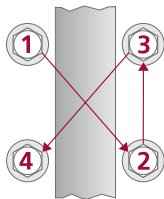
CLAMP GROUP RE-TORQUE INTERVAL

1. Clamp group hex bolts and axle collar hex cap bolts must be torqued to specification at preparation for delivery.
2. Clamp group hex bolts and axle collar hex cap bolts must be re-torqued at 1,000 miles.
3. Thereafter follow the 6 month / 50,000 mile visual inspection and annual re-torque interval.

WARNING

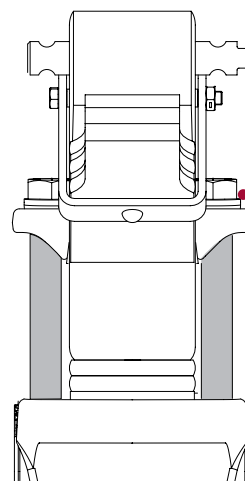
ENSURE CLAMP GROUP IS ALIGNED PROPERLY PRIOR TO TIGHTENING HARDWARE. FAILURE TO DO SO CAN CAUSE LOSS OF VEHICLE CONTROL, PROPERTY DAMAGE OR PERSONAL INJURY.

FIGURE 7-9



4. Ensure that the clamp group is properly aligned and the hex bolts are seated in the axle seat, and the top pad is centered on the leaf spring, see Figure 7-8.
5. Check for the signs of component or bolt movement.
6. If signs of movement are present, disassemble the clamp group fasteners, check for component wear or damage and replace as necessary, then install new clamp group fasteners and repeat Steps 4 through 5.
7. Tighten the clamp group hex bolts evenly in 100 foot pounds increments to 600 ± 20 foot pounds torque in the proper pattern to achieve uniform bolt tension, see Figure 7-9.

FIGURE 7-8



IMPORTANT NOTE
Ensure that Clamp Group Assembly is properly aligned

1" Clamp Group Hex Bolt
Tightening Torque at the Bolt Head
 600 ± 20 ft. lbs.

STEERING KNUCKLE

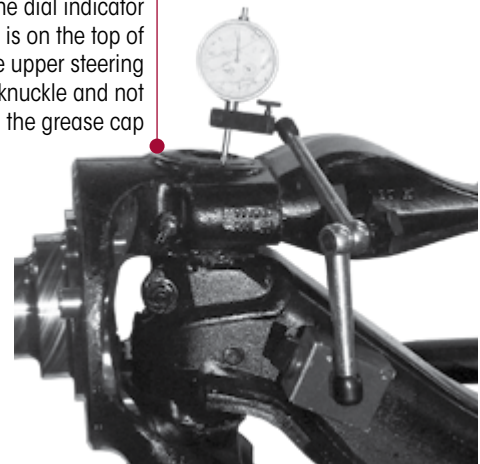
CHECKING VERTICAL END PLAY (UP AND DOWN MOVEMENT)

The operating specification for vertical end play on the steering knuckle is 0.008" to 0.030".


FIGURE 7-10

1. Chock the rear tires to help prevent the vehicle from moving.
2. Set the parking brakes.
3. Use a jack to raise the vehicle until both tires are 1" off the ground.
4. Place a dial indicator on each side of the axle as follows:
 - a. Index the wheels slightly (left or right).
 - b. Place the magnetic dial indicator base on the axle, see Figure 7-10.
 - c. Place the tip of the dial indicator on the top of the upper steering knuckle (not on the grease cap).
5. Set the dial indicator to "0" (zero).
6. Lower the jack.

Ensure the tip of the dial indicator is on the top of the upper steering knuckle and not on the grease cap





7. If vertical end play is greater than 0.030", or below 0.008" an adjustment of the upper knuckle is necessary. If the vertical end play is:
 - **Greater than 0.030"**, add shims until the proper vertical end play is achieved.
 - **Less than 0.008"**, remove shims until the proper vertical end play is achieved.
8. Retighten the kingpin draw keys to  188 ± 12 foot pounds torque.

KINGPIN BUSHING WEAR

CHECKING STEERING KNUCKLE LATERAL MOVEMENT

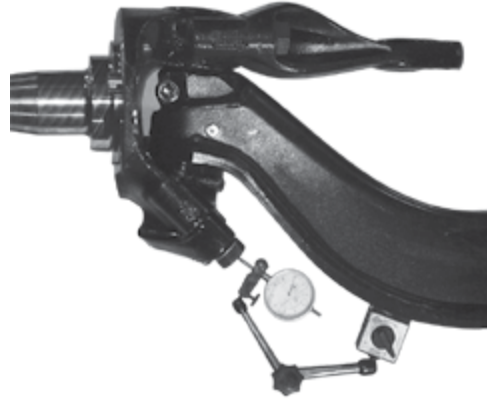
NOTE

If one (1) bushing is worn or damaged, it is mandatory to replace both the upper and lower bushings on that knuckle assembly.

FIGURE 7-11
CHECKING UPPER KINGPIN BUSHING



FIGURE 7-12
CHECKING LOWER KINGPIN BUSHING



1. Chock the wheels to help prevent the vehicle from moving. Set the parking brake.
2. Use a jack to raise the vehicle until the wheels are off the ground. Support the vehicle with safety stands.
3. **CHECKING THE UPPER KINGPIN BUSHING.** Install the base of a dial indicator onto the axle beam and place the tip against the steering knuckle, see Figure 7-11.
4. Set the dial indicator to "0" zero.
5. Move the top of the tire in and out by applying reasonable constant pressure and then release, see Figure 7-13.
6. Check the reading on the dial indicator. If the dial indicator moves more than 0.015", the upper bushing is worn or damaged. Replace both bushings. Refer to the Kingpin Bushing replacement procedure in the Component Replacement Section of this publication.
7. **CHECKING THE LOWER KINGPIN BUSHING.** Install a dial indicator so that the base is on the axle and the indicator tip is against the inside of the bottom of the knuckle, see Figure 7-12.
8. Set the dial indicator to "0" zero.
9. Move the bottom of the tire in and out. If the dial indicator moves more than 0.015", the lower bushing is worn or damaged. Replace both kingpin bushings. Refer to the Component Replacement Section of this publication.

FIGURE 7-13





SHOCK ABSORBER

NOTE

It is not necessary to replace shock absorbers in pairs if only one (1) shock absorber requires replacement.

Hendrickson offers a long service life, premium shock absorber for use on STEERTEK NXT High Capacity suspensions. If shock absorber replacement is necessary, Hendrickson recommends that original Hendrickson shock absorbers be replaced with identical Hendrickson Genuine parts for servicing. Failure to do so will affect the suspension performance, durability, and will void the warranty.

Inspection of the shock absorber can be performed by doing a heat test, and a visual inspection. For instructions on shock absorber replacement see the Component Replacement Section of this publication.

FIGURE 7-14



HEAT TEST

1. Drive the vehicle at moderate speeds on rough road for minimum of fifteen minutes.



WARNING

DO NOT GRAB THE SHOCK ABSORBER AS IT COULD POSSIBLY BE HOT AND CAUSE PERSONAL INJURY.

2. Use an infrared thermometer to check the temperature of the shock absorber. This can also be performed by carefully touching the shock absorber body below the dust cover. Touch the frame to get an ambient reference, see Figure 7-14. A warm shock absorber is acceptable, a cold shock absorber should be replaced.
3. To inspect for an internal failure, remove and shake the suspected shock absorber. Listen for the sound of metal parts rattling inside. Rattling of metal parts can indicate that the shock absorber has an internal failure.

VISUAL INSPECTION

Look for any of the potential problems shown in Figure 7-15 when doing a visual inspection. Inspect the shock absorbers fully extended. Replace as necessary.

FIGURE 7-15

SHOCK ABSORBER VISUAL INSPECTION - UNACCEPTABLE CONDITIONS



Damaged upper or lower mount



Damaged upper or lower bushing



Damaged dust cover and / or shock body



Bent or dented shock absorber



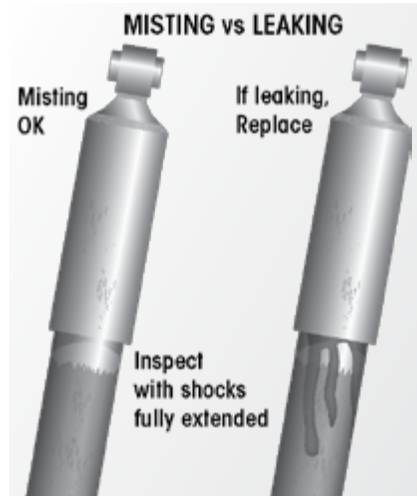
Improper installation
Example: washer (if equipped installed backwards)

LEAKING VS. MISTING VISUAL INSPECTION

The inspection must not be conducted after driving in wet weather or a vehicle wash. The shock absorber needs to be free from water. Many shock absorbers are often misdiagnosed as failures. Misting is the process whereby very small amounts of shock absorber fluid evaporate at a high operating temperature through the upper seal of the shock absorber. When the “mist” reaches the cooler outside air, it condenses and forms a film on the outside of the shock absorber body. Misting is perfectly normal and necessary function of the shock absorber. The fluid which evaporates through the seal area helps to lubricate and prolong the life of the seal.

FIGURE 7-16

A shock absorber that is truly leaking and needs to be replaced will show signs of fluid leaking in streams from the upper seal. These streams can easily be seen when the shock absorber is fully extended, underneath the main body (dust cover) of the shock absorber. Look for these potential problems when doing a visual inspection. Inspect the shock absorbers fully extended. Replace as necessary.



NOTE

The STEERTEK NXT High Capacity steer axle system is equipped with a premium seal on the shock absorber, however this seal will allow for misting to appear on the shock absorber body (misting is not a leak and is considered acceptable).

Inspect the shock absorber fully extended. **A shock absorber that is truly leaking** will show signs of fluid **leaking in streams from the upper seal**. These streams can easily be seen, underneath the main body (dust cover) of the shock absorber. Replace as necessary.

TIRE INSPECTION

The leading causes of tire wear are the following, in order of importance:

1. Tire Pressure
2. Toe Setting
3. Thrust Angle
4. Camber

The following tire Inspection guidelines are based upon Technology & Maintenance Council (TMC) recommended practices. Any issues regarding irregular tire wear where Hendrickson is asked for assistance will require tire and alignment maintenance records, reference TMC’s literature numbers RP 219A, RP 230, or RP 642.

Tire wear is normally the best indicator of vehicle alignment condition. If tires are wearing too rapidly or irregularly, alignment corrections may be needed. The tire wear patterns described below can help isolate specific alignment problems.

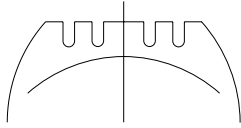
The most common conditions of concern are:

- Overall Fast Wear (Miles per 32nd)
- Feather Wear
- Rapid Shoulder Wear (One Shoulder Only)
- One-Sided Wear
- Diagonal Wear
- Cupping



FIGURE 7-17

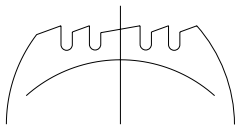
OVERALL FAST WEAR (Miles per 32nd)



Overall Fast Wear — Fast wear can be described as exhibiting a good, but accelerated wear pattern. It is typically caused by operating conditions, such as mountainous terrain, frequency and severity of turning, abrasive road surfaces in combination with vehicle configurations and their attributes—such as power steering, heavy axle loads, high wheel cuts, setback axles, short wheel base tractors, long wheel base straight trucks. To correct this problem, consult with vehicle and tire manufacturers when specifying equipment or replacing tires. For more information, see TMC RP 219A publication, page 11. For information on how to accurately measure and record tire rates, see TMC RP 230 publication.

FIGURE 7-18

FEATHER WEAR



Feather wear — Tread ribs or blocks worn so that one side is higher than the other resulting in step-offs across the tread face. Generally, ribs or blocks exhibit this wear. To spot this problem, do the following:

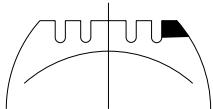
With one hand flat on the tread of the tire and a firm down pressure, slide your hand across the tread of the tire. In one direction, the tire will feel smooth and in the opposite direction there will be a sharp edge to the tread. Typical causes of feather wear include: excessive side force scrubbing, resulting from conditions of misalignment such as excessive toe, drive axle misalignment, worn, missing or damaged suspension components, bent tie rods or other chassis misalignment.

To correct this problem, tires can be rotated to another axle for maximum utilization of remaining tread. Additionally, diagnose the vehicle itself and correct misalignment condition as required. If steer tire feathers are in opposite directions, an improper toe condition is most likely the cause. For more information, see TMC RP 219A publication, page 5.

If feather wear on both steer tires is in the same direction, drive axle or other chassis misalignment is indicated. If one steer tire shows feather wear and the other steer tire has normal wear, a combination of toe and drive axle or chassis misalignment is indicated.

FIGURE 7-19

RAPID SHOULDER WEAR (One Shoulder Only)



Rapid Shoulder Wear (One Shoulder Only) — Is defined as a tire worn on the edge of one shoulder, sometimes extending to inner ribs. It can progress to diagonal wipeout. For more information, see TMC RP 219A publication, page 22.

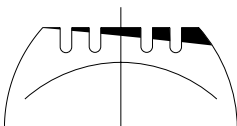
This wear condition is usually caused by excessive toe or excessive camber. These conditions can be created by a misaligned or bent axle and can also be caused by loose or worn wheel bearings.

To correct this type of rapid shoulder wear:

- *Tires* – Change direction of rotation of tire. If shoulder wear is severe, remove and retread.
- *Vehicle* – Diagnose misalignment and / or mechanical condition and correct.

FIGURE 7-20

ONE-SIDED WEAR



One-sided wear — Is excessive wear on one side of tire extending from the shoulder towards the center of the tread. For more information, see TMC RP 219A, page 26.

One-sided wear is usually caused by improper alignment, worn kingpins, loose wheel bearings, excessive camber, excessive axle loads, non-parallel axles, or non-uniform tire and wheel assembly caused by improper bead seating or bent wheel.

To correct one-sided wear:

- *Tires* – Depending on severity, rotate tires to another axle position or, if worn to minimum tread depths, submit for possible retreading.
- *Vehicle* – Diagnose mechanical problem and correct.



Diagonal Wear — Can be described as localized flat spots worn diagonally across the tread at approximately 25-35° angles, often repeating around the tread circumference. For more information, see TMC RP 219A publication, page 20.

Diagonal wear is usually caused by bad wheel bearings, toe out, mis-mounting of tire and wheel assembly to axle, and mismatched duals for size and / or inflation pressures. It may start as brake skid. Diagonal wear is aggravated by high speed empty or light load hauls.

FIGURE 7-21
DIAGONAL WEAR

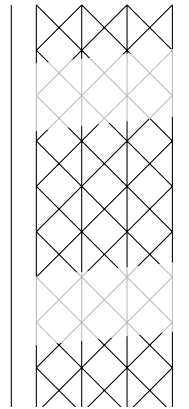
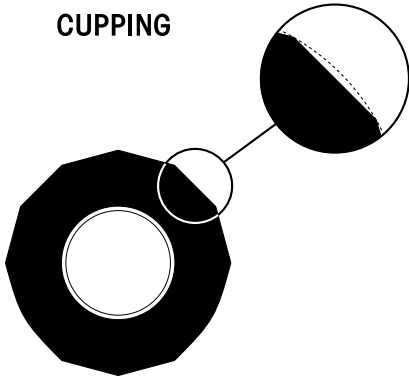


FIGURE 7-22
CUPPING



Cupping — Localized, dished out areas of fast wear creating a scalloped appearance around the tire. Cupping, which appears around the tire on the shoulder ribs, may also progress to adjoining ribs, see TMC RP 219A publication, page 7.

Cupping is usually a result of moderate-to-severe imbalance, improper rim / wheel mounting, excessive wheel end play or other assembly non-uniformity. It can also be due to lack of shock absorber control on some suspension types.

To solve cupping problems:

- *Tires* – Correct mismount or balance problem. If ride complaints arise, steer tires may be rotated to drive or trailer axle.
- *Vehicle* – Diagnose component imbalance condition, i.e., wheel, rim, hub, brake, drum. Correct as necessary.

To correct diagonal wear, reverse direction of rotation of the tire. If wear is excessive, true tire. If the source of trouble is the vehicle, diagnose cause and correct as needed.

WHEEL BEARING END PLAY INSPECTION

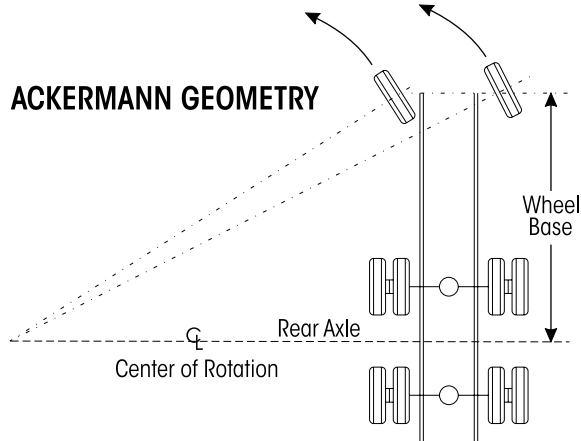
Refer to Meritor for wheel bearing end play inspection and wheel bearing adjustment procedures.



SECTION 8 Alignment & Adjustments

ALIGNMENT DEFINITIONS

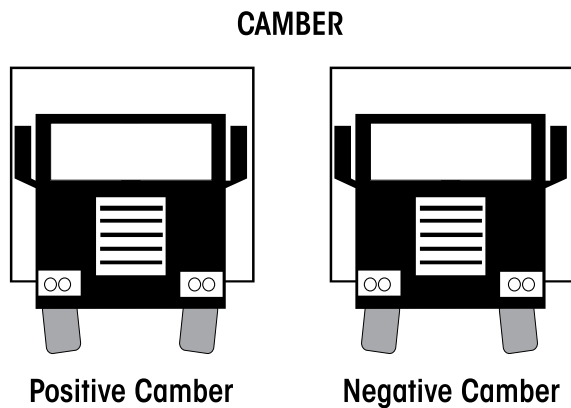
FIGURE 8-1



Ackermann steering geometry — The geometry of the four bar linkage consisting of the front axle, two knuckle assemblies, and tie rod assembly is designed to provide free rolling of front tire in a turn. Ackermann geometry is dependent upon the steering axle track-width and wheelbase of the vehicle. Improper geometry results in wheel scrub in turns which generally appears as toe wear on the tire, usually more wear on one side of the vehicle than the other due to the operational route of the vehicle.

Bump steer (feedback) — The feedback felt through the steering linkage to the steering wheel when a steer axle tire hits a bump in the road. This occurs because the axle-end of the drag link and the axle attachment point of the spring do not travel in parallel circular arcs as the suspension moves up and down. This condition can also be caused by trapped air in the power steering system.

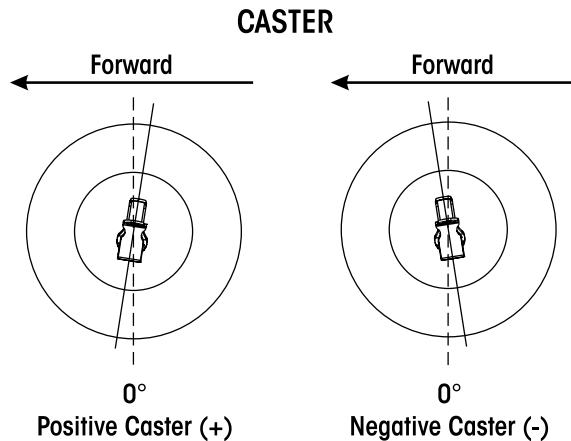
FIGURE 8-2



Camber — The angle formed by the inward or outward tilt of the wheel reference to a vertical line. Camber is positive when the wheel is tilted outward at the top and is negative when the wheel is tilted inward at the top.

Excessive positive camber may cause smooth wear on the outer half of the tire tread. Excessive negative camber may cause wear on the inner half of the tread. Static-unloaded camber angles are built into the axle to put the loaded tire perpendicular to the road.

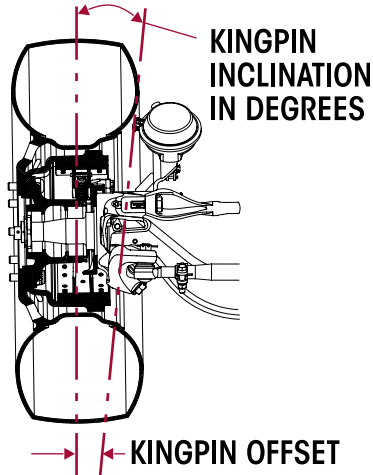
FIGURE 8-3



Caster — The forward or rearward tilt of the steering axle kingpin in reference to a vertical line. The angle is measured in degrees. Caster is positive when the top of the steering axis is tilted rearward and is negative when the tilt is forward. Proper caster is important for directional stability and returnability. Too much positive caster can cause shimmy, excessive steering effort and is normally a vehicle performance and handling consideration. Uneven positive caster may create a steering pull toward the side with the lower caster. This attribute may be used to compensate for crowned roads.



FIGURE 8-4

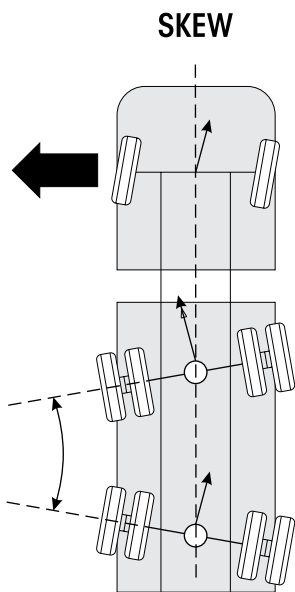


Kingpin inclination (KPI) — The inward tilt of the kingpin from the vertical. This front suspension parameter has a pronounced effect on steering effort and returnability. As the front wheels are turned around an inclined kingpin, the front of the truck is lifted. This lifting of the vehicle is experienced as steering effort when the turn is executed and exhibits itself as recovery force when the steering wheel is released.

Kingpin offset — The distance between the center of the tire patch and intersection of the kingpin axis with the ground. This parameter of front-end geometry is important in vehicles without power steering and has a major effect on static steering. If there is no kingpin offset, the tires must scrub around the center of the pin patch when turned in a static condition, resulting in higher static steering efforts.

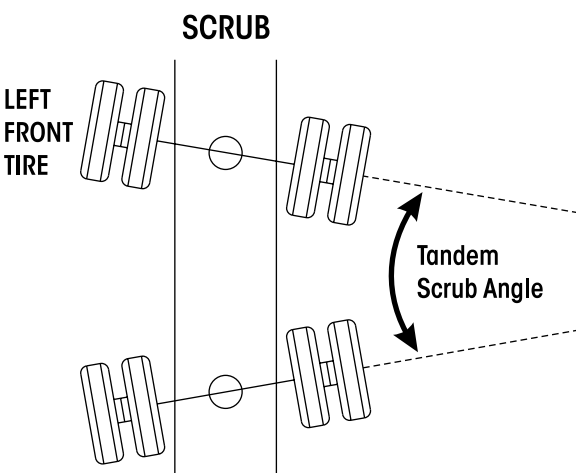
Steering arm — The component that connects the drag link to the axle knuckle assembly.

FIGURE 8-5



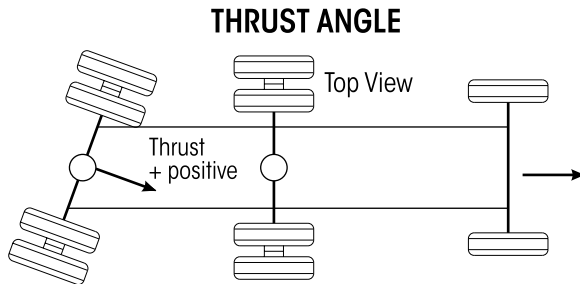
Scrub, skew, tram angle or parallelism — The angle formed by two thrust or tracking lines of a tandem (or multiple) axle vehicle. As indicated by the term "parallelism", the ideal condition is when the two thrust lines form a 0° angle, or are parallel to each other. Positive skew or tram is when the distance between the right axle ends is less than the distance between the left.

FIGURE 8-6



Any scrub angle other than 0° will cause the tandem axles to work against each other. The steer axle must be turned to offset the "push" of the tandem axles to keep the vehicle moving straight ahead. This causes every tire on the vehicle to "scrub". Tire wear from tandem scrubbing occurs at the leading edge of the steer tires in a pattern called "inside / outside" wear, that is, the inside edge of the left steer tire and the outside edge of the right steer tire will exhibit irregular wear for example. Additional tire wear may occur on all tandem axle tires.

FIGURE 8-7



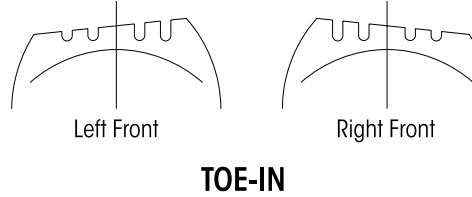
Thrust angle, tracking, or square — The angle formed by the center-line of the vehicle frame (geometric center-line) and the direction that an axle points. As indicated by the term "square", the ideal value for the angle is 0° or when the axle center-line is at 90° or perpendicular to the geometric center-line. Thrust or tracking to the right is positive, and to the left is negative.

A steering correction is required to offset the effect of the thrust angles and keeps the vehicle traveling in a straight line. It results in a lateral offset between the steer and drive axle tires commonly referred to as "dog tracking."

Tie rod arm (Ackermann-arm, cross tube arm) — The component that transmits steering forces between left and right axle knuckle assemblies through the cross tube assembly.

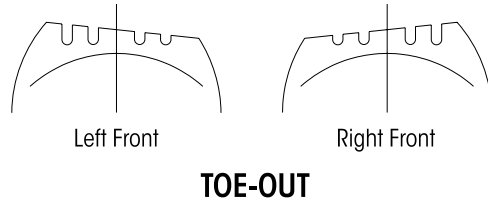


FIGURE 8-8



Toe-in — Is when the horizontal line intersects in front of the wheels, or the wheels are closer together in front than in the back. Toe-in is commonly designated as positive, toe-out as negative. Excessive toe-in wears the outside edge of the tires. Steer axle toe is adjustable to reduce wear to the leading edge of the tire and also to avoid road wander. Toe is adjusted in a static, unloaded condition so that the tires will run in a straight line under a dynamic, loaded condition.

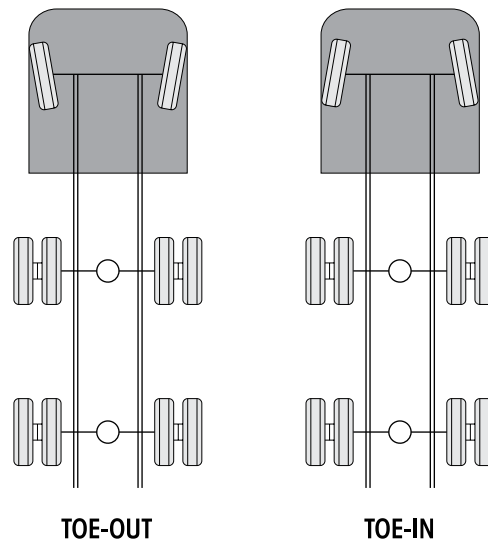
FIGURE 8-9



Toe-out — Is when the horizontal lines intersect behind the wheels, or the wheels are closer together in back than in front. Toe-in is commonly designated as positive, toe-out as negative. Excessive toe-out wears the inside edge of the tires. Steer axle toe is adjustable to reduce wear to the leading edge of the tire and also to avoid road wander. Toe is adjusted in a static, unloaded condition so that the tires will run in a straight line under a dynamic, loaded condition.

FIGURE 8-10

TOTAL TOE



Toe-out on turns — (See Ackermann Geometry). Excessive turning angles such as those encountered in pickup and delivery operations may contribute to premature tire wear. Be advised that the greater turning angles, the more that toe and camber change. If you have any doubt regarding the optimum turning angles for your operation, contact the vehicle's manufacturer, axle OEM, tire OEM and alignment equipment manufacturer for advice.

Total toe — The angle formed by two horizontal lines through the planes of two wheels. Steer axle toe is adjustable to reduce wear to the leading edge of the tire and also to avoid road wander. Toe is adjusted in a static, unloaded condition so that the tires will run in a straight line under a dynamic, loaded condition.

INSPECTION PRIOR TO ALIGNMENT

WHEELS AND TIRES

Examine the following items:

- Tires are inflated to the manufacturer's specified tire pressure.
- Steer axle tires are the same size and type.
- Lug nuts are tightened to manufacturer's specified torque.
- Wheels are balanced.
- Wheels and tires are free of excessive wear and damage.
- Wheel bearing end play is within OEM specification.

FRONT SUSPENSION

Inspect the following:

- All fasteners are installed and tightened to the specified torque. See Torque Specification Section of this publication.
- Leaf springs are free of wear or damage.



- Shock absorbers are free of wear and damage.
- Vehicle ride height for both the front and rear are within specification. Follow manufacturer's guidelines (if equipped).
- Front and rear spring mounts are free of wear or damage.

INSPECT TIE ROD ENDS

Perform Tie Rod Inspection procedure; refer to the Preventive Maintenance Section of this publication.

REAR AXLE AND REAR SUSPENSION

The rear axle can cause front tire wear. If the outer edge of one front tire is worn and the inner edge of the other front tire is worn, check the following:

- Make sure the rear axle (especially a tandem axle) is correctly aligned. Refer to the procedure dictated by the vehicle or suspension manufacturer.
- All fasteners including U-bolts (if applicable) are installed and tightened to the specified torque.
- The leaf springs are not worn or damaged.
- The bushings in the leaf springs are not worn or damaged.
- The torque rods (if used) are correctly adjusted (if adjustable).
- The frame is not bent or twisted.
- Refer to any additional recommendations and specifications from the manufacturer of vehicle on rear axles and suspensions. Reference The Technology & Maintenance Council (TMC) Guidelines for Total Vehicle Alignment.

FRONT WHEEL ALIGNMENT

Hendrickson recommends technicians review The Technology & Maintenance Council's publication (TMC) "Guidelines for Total Vehicle Alignment" (TMC RP 642).

Check total (front and rear) vehicle wheel alignment when any of the following occurs:

- Every 80,000 to 100,000 miles, or 12-18 months (normal maintenance).
- When the vehicle does not steer correctly.
- To correct a tire wear condition.

For rear wheel alignment specifications and adjustments refer to the vehicle manufacturer.

The front wheel alignment specifications can be found in the Alignment Specifications Section of this publication. There are two types of front wheel alignment:

1. **Minor alignment** – a minor front wheel alignment is done **for all** normal maintenance conditions, see below.
2. **Major alignment** – a major alignment is done when uneven or excessive tire wear is evident, or response at the steering wheel is sluggish, or the need for major wheel alignment check and adjustment is required, see below.

MINOR FRONT WHEEL ALIGNMENT

Perform the minor front wheel alignment in the following sequence:

1. Inspect all systems that affect wheel alignment. Refer to the Inspection Prior to Alignment in this section.
2. Check the wheel bearing end play.
3. Check and adjust toe.
4. Check and adjust the vehicle ride height as specified in the Preventive Maintenance Section of this publication.



MAJOR FRONT WHEEL ALIGNMENT

Be certain to follow wheel alignment inspection intervals as specified by the original equipment manufacturer. Before performing a major front wheel alignment, it is recommended that alignment equipment calibration be checked to ensure proper vehicle alignment.

Major wheel alignment is accomplished in the following sequence of operation:

1. Inspect all the systems that influence the wheel alignment. Refer to the Inspection Prior to Alignment in this section.
2. Check and adjust the maximum turn angle, refer to the Steering Stop Adjustment Procedure in this section, see Figures 8-11 and 8-12.

FIGURE 8-11



FIGURE 8-12



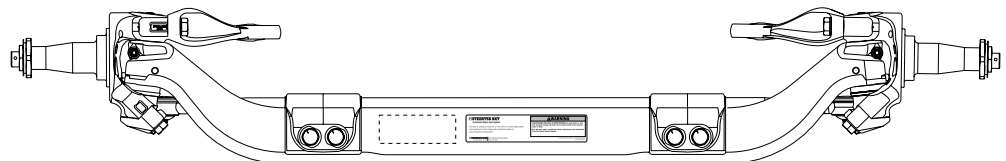
3. If the vehicle is equipped with power steering, check the pressure relief in the power steering system and reset if necessary. Refer to the vehicle manufacturer regarding the subject: Adjusting the Pressure Relief in the Power Steering System.
4. Check the turning angle. Refer to the original equipment manufacturer specifications.
5. Check the kingpin (or steering axis) inclination. Refer to Kingpin Inclination under Alignment Definitions in this section.

WARNING

AXLE CAMBER IS NOT ADJUSTABLE. DO NOT CHANGE THE AXLE CAMBER ANGLE OR BEND THE AXLE BEAM. BENDING THE AXLE BEAM TO CHANGE THE CAMBER ANGLE CAN DAMAGE THE AXLE AND REDUCE AXLE STRENGTH, AND WILL VOID HENDRICKSON'S WARRANTY. A BENT AXLE BEAM CAN CAUSE LOSS OF VEHICLE CONTROL, POSSIBLY CAUSING PERSONAL INJURY OR PROPERTY DAMAGE, SEE FIGURE 8-13.

FIGURE 8-13

<p>STEERTEK NXT Vocational Steer Axle System</p>	<p>WARNING</p> <p>UNAUTHORIZED WELDING OR MODIFICATIONS can cause cracks or other axle structural damage and result in loss of vehicle control, severe personal injury or death.</p> <p>■ Do not bend, weld or modify axle without authorization from Hendrickson Truck Commercial Vehicle Systems.</p>
<p>This article is covered by at least one or more of the U.S. and/or foreign patents and/or pending U.S. and/or foreign patent applications posted at: www.hendrickson-intl.com/patents</p>	<p>© 2016 Hendrickson USA, L.L.C. All Rights Reserved Part No. 60905-043 A</p>
<p> HENDRICKSON Truck Commercial Vehicle Systems www.hendrickson-intl.com 1.866.755.5968</p>	



6. Check camber angle. **DO NOT** attempt to adjust camber. Refer to "Camber" under the Alignment Definitions in this section.
7. It is necessary to verify that all ride heights (front and rear) are within specifications prior to checking caster to get an accurate caster reading.
8. Check and adjust caster angle. Refer to Caster Angle under Alignment Definitions in this section.

NOTE The use of two (2) different angle caster shims will not change cross caster. Cross caster is the difference between the caster readings for left and right side of the vehicle.

9. Check and adjust toe-in, refer to "Toe Setting" in this section.

STEERING STOP

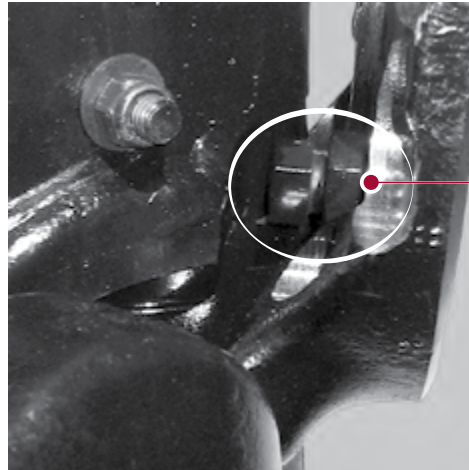
ADJUSTMENT PROCEDURE

When the axle or steering knuckle is replaced, the steering stop adjustment must be checked.

The steering stop adjustment procedure is as follows:

1. Drive truck onto turntables and chock the rear wheels.
2. Measure the wheel cut. The wheel cut is determined by steering the tires. Wheel cut is measured at the inside wheel only, therefore the tires must be turned to the full lock position for each right hand and left hand direction. Refer to the vehicle manufacturer for exact specifications.
3. Increase the wheel cut by loosening the jam nuts and screw the axle stops in clockwise.
4. Tighten the jam nuts.

FIGURE 8-14



Ensure the sides of square head axle stops are set parallel to the axle beam

NOTE It is very important that the sides of the square head axle stops are set parallel to the axle beam to ensure a good contact point on the axle, see Figure 8-14.

5. Decrease the wheel cut by loosening the jam nuts and screw the axle stops out counter-clockwise.
6. Tighten the jam nuts to 50 ± 10 foot pounds torque.
7. Measure the wheel cut and check for any interference with related steering components.

WARNING

ALWAYS CHECK / RESET THE STEERING GEAR BOX POPPETS WHEN THE WHEEL CUT IS DECREASED. FOLLOW MANUFACTURER'S GUIDELINES FOR THE GEAR BOX POPPET RESETTING PROCEDURE. FAILURE TO DO SO CAN RESULT IN PREMATURE FAILURE OF THE AXLE OR STEERING KNUCKLE. THIS CONDITION CAN CAUSE LOSS OF VEHICLE CONTROL, PERSONAL INJURY OR PROPERTY DAMAGE AND VOID ANY APPLICABLE WARRANTY.



TOE SETTING

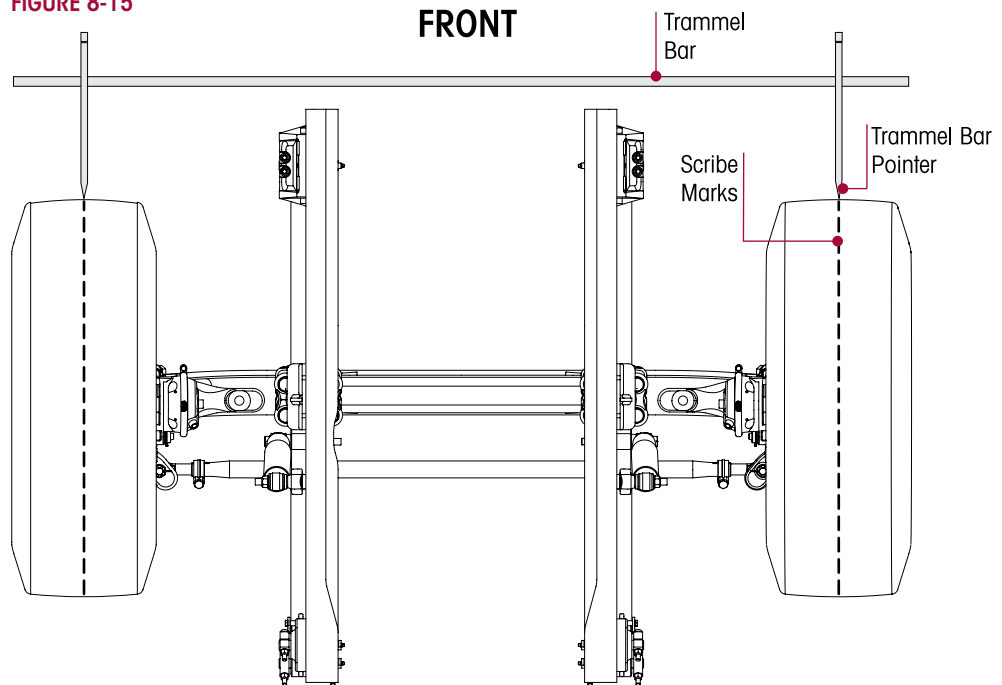
1. Place the vehicle on a level floor with the wheels in a straight ahead position.
2. Raise the vehicle and support the front axle with jack stands.
3. Use paint and mark the center area of tread on both steer axle tires around the complete outer diameter of the tires.
4. Scribe a line through both steer axle tires in the painted area around the complete outer diameter of the tires.
5. Raise the vehicle and remove the jack stands.
6. Set the vehicle on the ground.

NOTE

DO NOT measure toe-in with the front axle off the ground. The weight of the vehicle must be on the front axle when toe-in is measured.

7. Use a trammel bar and measure the distance between the scribe marks at the rear of the steer axle tires. Record the measurement.
8. Install the trammel bar and measure the distance between the scribe marks at the front of the steer axle tires. Record the measurement, see Figure 8-15.

FIGURE 8-15



NOTE

When setting up the trammel bar the pointers should be level with the spindles at the front and rear of the steer axle tires.

9. To calculate the toe setting subtract the front measurement from the rear measurement, the difference between the two will equal the toe-in / toe-out measurement.

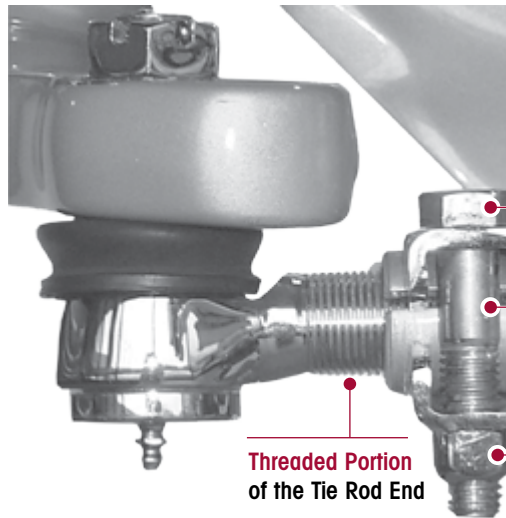
WARNING

THE THREADED PORTION OF THE TIE ROD END MUST EXTEND PAST THE SLOTS INTO THE TIE ROD CROSS TUBE. SEE FIGURE 8-16. FAILURE TO DO SO CAN CAUSE COMPONENT TO FAIL CAUSING LOSS OF VEHICLE CONTROL AND POSSIBLE PERSONAL INJURY OR PROPERTY DAMAGE.

10. If the toe measurement is not within the specifications of $\frac{1}{16}'' \pm \frac{1}{32}''$ ($0.060'' \pm 0.030''$), it will be necessary to adjust the toe setting. Refer to the following procedure.
 - a. Loosen the tie rod cross tube clamp bolts and locknuts.
 - b. Turn the tie rod cross tube until the specified toe-in distance is achieved.
 - c. Tighten the bolt and locknut on the tie rod cross tube to $\boxed{68} \pm 7$ foot pounds torque.



FIGURE 8-16

**5/8" Tie Rod Clamp Bolt**

It is critical to check the 5/8" tie rod clamp bolt head location to verify the clamp fasteners have sufficient clearance away from the lower shock mount at full wheel cut. The fasteners must not contact the lower shock mount.

Tie Rod Cross Tube Slots

It is critical to have the threaded portion of the tie rod end extend past the slots in the tie rod cross tube.

5/8" Tie Rod Clamp Locknut

Tightening Torque 68 ± 7 ft. lbs.

**Threaded Portion
of the Tie Rod End**

WARNING

IT IS CRITICAL TO CHECK THE 5/8" TIE ROD CLAMP BOLT HEAD LOCATION TO VERIFY THE CLAMP FASTENERS HAVE SUFFICIENT CLEARANCE AWAY FROM THE LOWER SHOCK ABSORBER MOUNT AT FULL WHEEL CUT. THE FASTENERS MUST NOT CONTACT THE LOWER SHOCK ABSORBER MOUNT. FAILURE TO DO SO CAN CAUSE ONE OR MORE COMPONENTS TO FAIL CAUSING LOSS OF VEHICLE CONTROL AND POSSIBLE PERSONAL INJURY OR PROPERTY DAMAGE.

11. Verify the 5/8" tie rod clamp bolt head does not contact the lower shock absorber mount at full wheel cut, see Figure 8-16.
12. Repeat Steps 1-10 until the correct toe setting is achieved.



SECTION 9 Component Replacement

FASTENERS

Hendrickson recommends that when servicing the vehicle to replace the removed fasteners with new equivalent fasteners. Maintain correct torque values at all times. Check torque values as specified, see Hendrickson's Torque Specifications Section of this publication. If non-Hendrickson fasteners are used follow torque specifications listed in the vehicle manufacturer's service manual.

SHOCK ABSORBERS

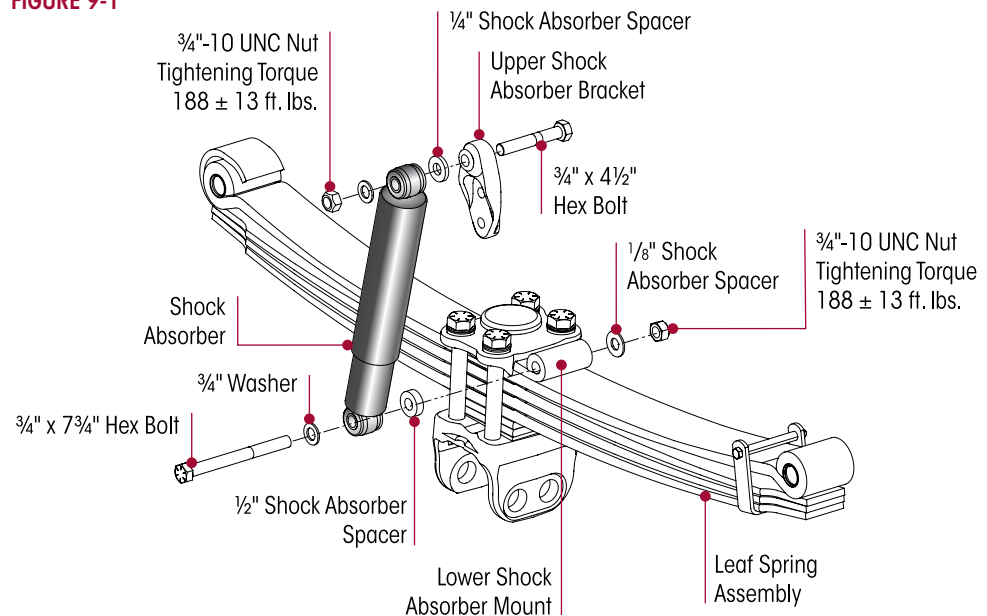
NOTE

It is not necessary to replace the shock absorbers in pairs if only one (1) shock absorber requires replacement.

DISASSEMBLY

1. Place the vehicle on a level floor.
2. Chock the wheels.
3. Remove the lower mounting bolts, fasteners, and spacer.
4. Remove the upper mounting bolts and fasteners.
5. Slide out the shock absorber.
6. Inspect the shock absorber mounting brackets and hardware for damage or wear, replace as necessary.

FIGURE 9-1



ASSEMBLY

1. Install the upper inboard shock absorber spacer, shock absorber and fasteners into the upper shock absorber bracket, see Figure 9-1. Snug fasteners, **DO NOT** tighten at this time.
2. Install the lower bolt from the outboard side of the leaf spring shock absorber mount and attach the washer, outboard spacer, inboard spacer and locknut, see Figure 9-1.
3. Tighten the upper and lower shock absorber eye locknuts to 188 ± 13 foot pounds torque.
4. Remove the wheel chocks.

FRONT LEAF SPRING FRAME HANGER

DISASSEMBLY

1. Place the vehicle on level floor.
2. Chock the wheels.
3. Raise the frame and support the vehicle with frame stands.
4. Support the front axle with a floor jack.
5. Remove the lower shock absorber mounting fasteners.

SERVICE HINT

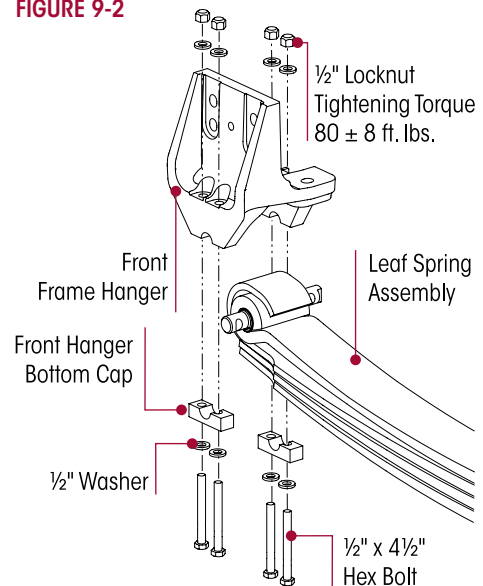
A floor jack may be required to support the axle.

6. Loosen or remove the bottom cap fasteners from the opposite side frame hanger / spring pin connection.
7. Remove the bottom cap and fasteners from the hanger being replaced, see Figure 9-2.
8. Lower the floor jack until the spring eye / spring pin clears the front frame hanger legs.
9. Remove the frame mounting fasteners from the hanger per manufacturer's guidelines.
10. Remove the hanger from the vehicle.

ASSEMBLY

1. Install the new hanger on the frame.
2. Install new frame fasteners per manufacturer's guidelines.
3. Raise the axle into the front hanger.
4. Install the front hanger bottom cap and fasteners.
5. Tighten the 1/2" locknut to 80 ± 8 foot pounds torque.
6. Install the lower shock absorber mounting fasteners to 188 ± 13 foot pounds torque.
7. Remove the frame stands and lower frame.
8. Remove the wheel chocks.

FIGURE 9-2



LEAF SPRING AND CLAMP GROUP ASSEMBLY

You will need:

- Axle Collar Driver, refer to the Special Tools Section of this Publication.

DISASSEMBLY

1. Place the vehicle on a level floor.
2. Chock the wheels.
3. Raise the vehicle and support the vehicle with frame stands.
4. Suspend the front axle to remove the load from leaf spring assembly.
5. Remove the tires for greater access.
6. Support the axle with a floor jack.
7. Remove the lower shock absorber mounting fasteners and discard.
8. Loosen the front hanger bottom cap fasteners on both leaf springs, see Figure 9-3, **DO NOT** remove at this time.



9. Remove the lower rear shackles fasteners from both leaf springs assemblies, see Figure 9-3.
10. Partially remove the axle collar bolts with a couple of threads engaged.
11. Strike the bolt heads with a hammer to dislodge and drive out the rear collars.
12. Install the collar bushing driver from the rear of the axle, see Figure 9-5.

FIGURE 9-3

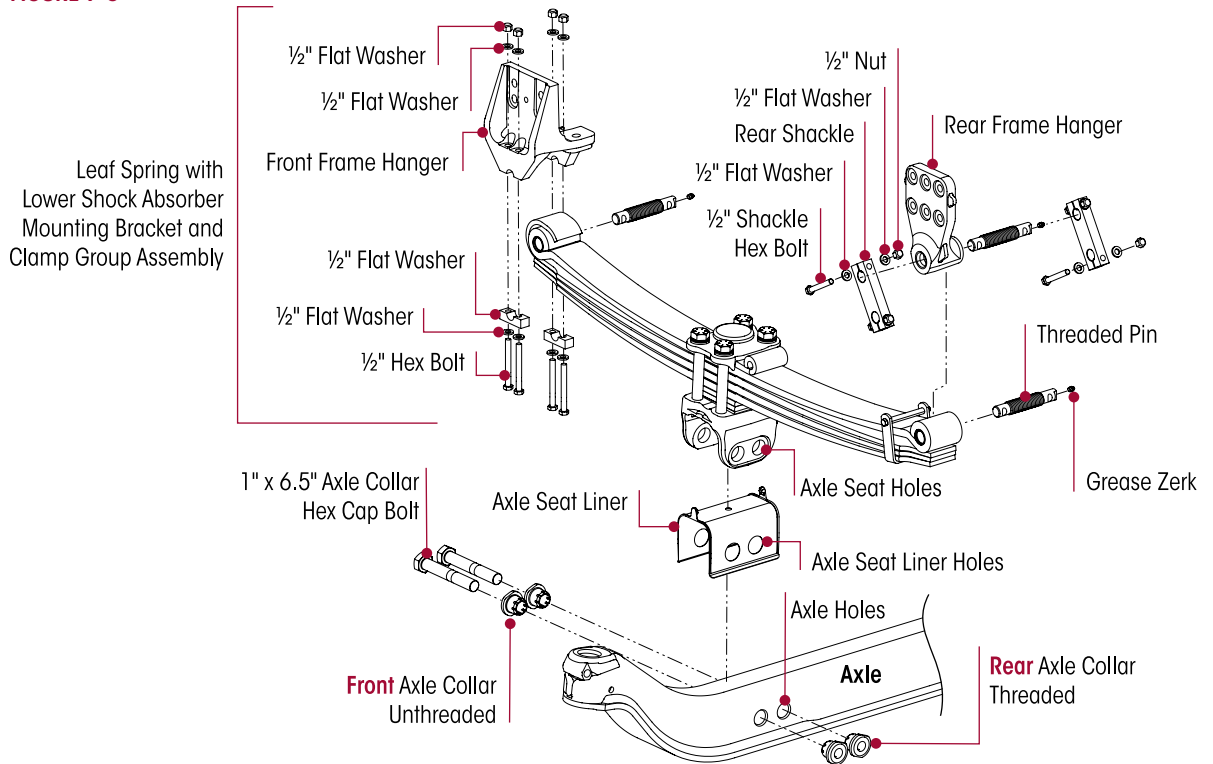


FIGURE 9-4

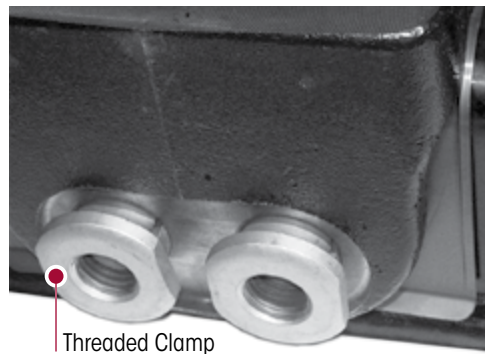


FIGURE 9-5

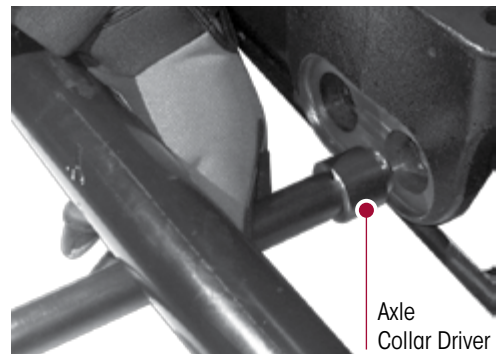
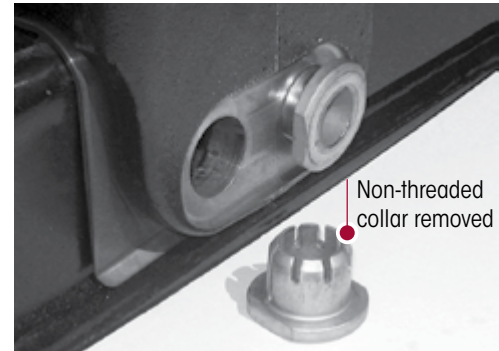


FIGURE 9-6



FIGURE 9-7





13. Strike the bushing driver to dislodge and drive out the front axle collars, Figure 9-6, until the front bushing collars are clear from the axle, see Figure 9-7.
14. Lower the axle until there is enough clearance to remove the leaf spring assembly from the axle.
15. Remove the hanger bottom cap fasteners and bottom caps on the leaf spring being removed.
16. Remove the leaf spring and clamp group assembly from the axle.

ASSEMBLY

WARNING

WHEN PLACING THE LEAF SPRING AND CLAMP GROUP ASSEMBLY IN A VISE IT IS NECESSARY TO PROTECT THE MACHINED SURFACES FROM GOUGES OR MARRING BY USING BRASS JAWS (SOFT JAWS) SEE FIGURE 9-8. FAILURE TO DO SO CAN CAUSE PREMATURE PART DAMAGE, DAMAGE TO THE LEAF SPRING AND CLAMP GROUP ASSEMBLY, LOSS OF WARRANTY, LOSS OF VEHICLE CONTROL, CAUSING PERSONAL INJURY OR PROPERTY DAMAGE.

SERVICE HINT

It is acceptable to mount the leaf spring and clamp group components in a soft jaw vise when performing the tightening procedure.

1. Secure the leaf spring and clamp group assembly in a suitable holding device, such as a vice with brass jaws (soft jaws), see Figure 9-8.

FIGURE 9-8

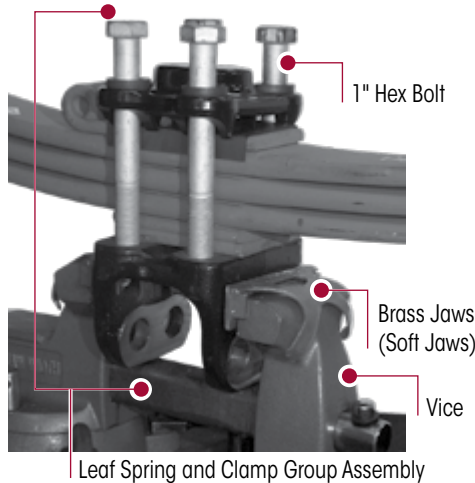


FIGURE 9-9

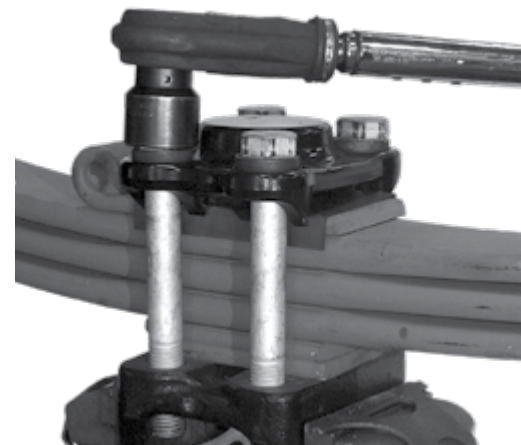


FIGURE 9-10

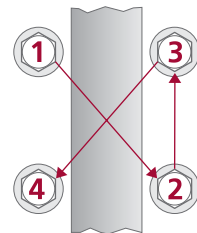
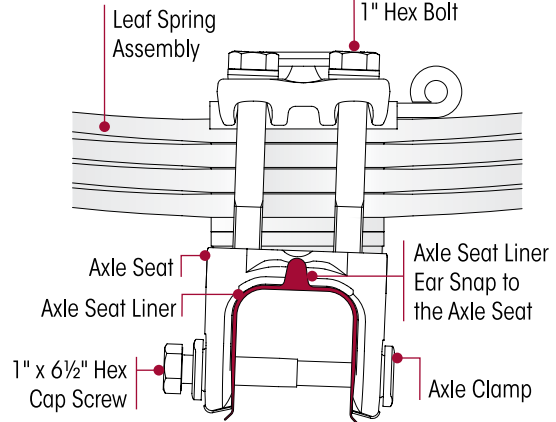


FIGURE 9-11



2. Ensure the clamp group hex bolts are tightened to 600 ± 20 foot pounds torque in the proper pattern to achieve uniform bolt tension, see Figures 9-10 and 9-11.
3. Install the new axle seat liner under the axle seat (liner ear snap to side of axle seat), see Figure 9-11.

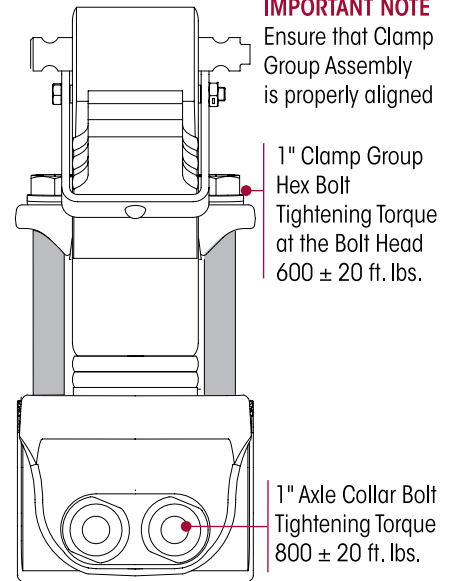
WARNING

THE WEIGHT OF THE LEAF SPRING AND CLAMP GROUP ASSEMBLY IS APPROXIMATELY 230 POUNDS. CARE SHOULD BE TAKEN AT REMOVAL AND INSTALLATION TO PREVENT PERSONAL INJURY OR DAMAGE TO COMPONENTS.



4. Install the new leaf spring and clamp group assembly (approximate weight 230 pounds) on the axle. Ensure the axle seat liner holes are lined up with the axle seat and axle holes, see Figures 9-3.
5. Install the non-threaded collar at the front of the axle and the threaded collars at the rear of the axle going into the axle seat, axle seat liner and axle. Tap into place with a mallet.
6. Install the new axle collar fasteners with the bolt head located on the front side of the axle.
7. Tighten both sides, left and right of the axle collar bolts in four stages, stage one 100 foot pounds, stage two 350 foot pounds, stage three 700 foot pounds and the fourth and final 800 ± 20 foot pounds torque, see Figure 9-12.
8. Install the axle assembly into the front hanger and rear shackle assembly.
9. Install the spring hanger clamps, front hanger bottom cap and fasteners. Tighten fasteners to 80 ± 8 foot pounds torque.
10. Install the rear shackles and fasteners and tighten fasteners to 80 ± 8 foot pounds torque.
11. Raise the axle and the leaf spring clamp group assembly.
12. Install the lower shock absorber hex bolt locknuts and tighten to 188 ± 13 foot pounds torque.
13. Raise the vehicle.
14. Remove the frame supports and load the front axle with the vehicle weight.
15. Install tires per the vehicle manufacturer's specifications.
16. Remove the wheel chocks.

FIGURE 9-12



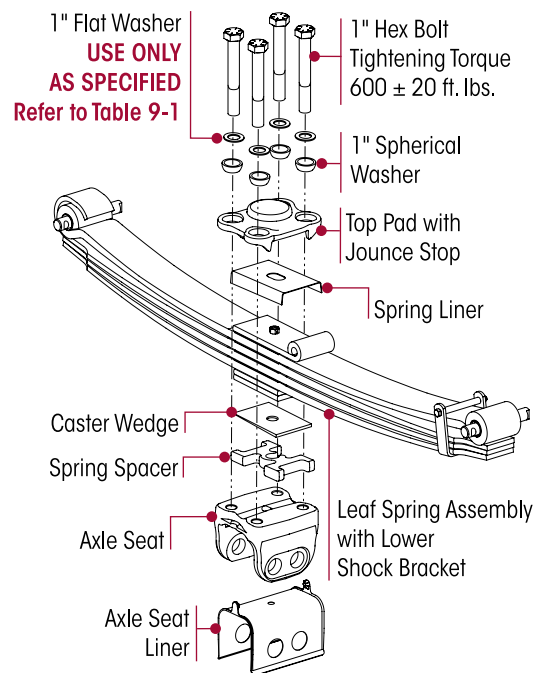
CLAMP GROUP COMPONENTS

The clamp group instructions can be used to replace the different components in the clamp group, such as the leaf spring, axle seat or top pad.

DISASSEMBLY

1. Remove the Leaf Spring and Clamp Group Assembly per instructions in this section.
2. Prior to removal of hex bolts, refer to Table 9-1 to determine if hex bolts are equipped with washers or not to aid in assembly.
3. Remove and discard the four (4) 1" hex bolts.
4. Remove the top pad.
5. Remove and discard all plastic leaf spring liners.
6. Remove the leaf spring assembly and leaf spring spacer.

FIGURE 9-13





7. Prior to removal of caster wedge, note the location and orientation, see Figure 9-13. Remove the caster wedge.
8. Prior to removal of spring spacer, note the location and orientation, see Figure 9-13. Remove the spring spacer.
9. Inspect all clamp group components for any damage, replace as necessary.

ASSEMBLY

1. Install caster wedge in same location and orientation as removed, see Figure 9-13.
2. Install the leaf spring onto the spring spacer.
3. Install new spring liner onto leaf spring assembly.
4. Install the top pad on top of leaf spring liner.



USE 1" FLAT WASHERS (PART NO. 22962-051) ONLY AS SPECIFIED IN TABLE 9-1 (LEAF SPRING AND CLAMP GROUP ASSEMBLY). THE TABLE LISTS DIFFERENT CONFIGURATIONS FOR THIS ASSEMBLY. FOR CERTAIN CONFIGURATIONS THE CLAMP GROUP REQUIRES THE USE OF 1" FLAT WASHERS (PART NO. 22962-051) WITH THE SPECIFIED 1" HEX BOLT LENGTH, BUT NOT IN OTHER CONFIGURATION SPECIFICATIONS IN TABLE 9-1 CAN RESULT IN IMPROPER CLAMP FORCE IN THE LEAF SPRING AND CLAMP GROUP ASSEMBLY, IMPROPER SEATING AND COMPONENT DAMAGE, WHICH CAN CAUSE LOSS OF VEHICLE CONTROL, ADVERSE VEHICLE HANDLING, PROPERTY DAMAGE AND PERSONAL INJURY.

5. Install the hex bolts and washers as noted prior to disassembly (refer to Table 9-1) into the holes on the top pad, see Figure 9-13, and hand tighten. **DO NOT** tighten to torque at this time.

TABLE 9-1

***Leaf Spring Assembly and Components**

Capacity	Ride Height	Leaf Spring & Clamp Group Assembly	Clamp Group Service Kit	Leaf Spring Assembly	1" Hex Bolt		1" Flat Washer (USE ONLY AS SPECIFIED)	Spring Spacer	
					Length	Part No.		Thickness	Part No.
ROSENBAUER									
18K	8"	80141-101	34013-278	82378-000	7"	64107-002	Not Required	---	---
	9.82"	80141-102	34013-256		9"	64107-003	22962-051	1"	79814-000
20K	8"	80141-201	34013-278	82379-000	7"	64107-002	Not Required	---	---
	9.5"	80141-202	34013-279		8.5"	64107-006	Not Required	1"	79814-000
24K	8"	80141-001	34013-254	82380-000	7.5"	64107-000	22962-051	---	---
	9"	80141-002	34013-255		8.5"	64107-006	22962-051	1"	79814-000
KME									
20K	10"	80888-001	34013-312	82532-000	9"	64107-003	Not Required	---	---
	11"	80888-002	34013-313		10"	64107-008	Not Required	1"	79814-000
22K	10"	80888-101	34013-312	82533-000	9"	64107-003	Not Required	---	---
	11"	80888-102	34013-313		10"	64107-008	Not Required	1"	79814-000
24K	10"	80888-201	34013-314	82534-000	9.5"	64107-007	22962-051	---	---
	11"	80888-202	34013-315		10.5"	64107-009	22962-051	1"	79814-000

NOTE: *Refer to the specific Hendrickson Parts List publication for your vehicle available online at www.hendrickson-intl.com.

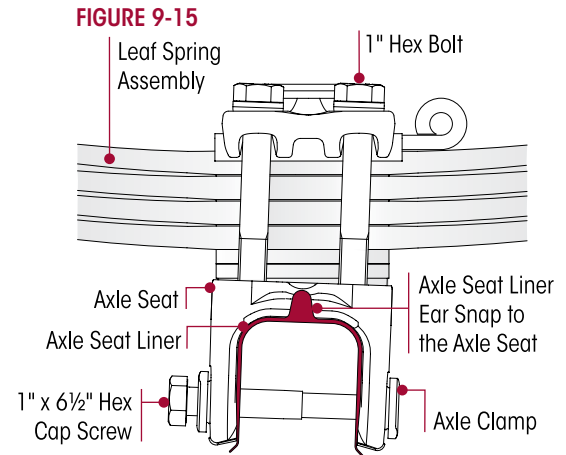
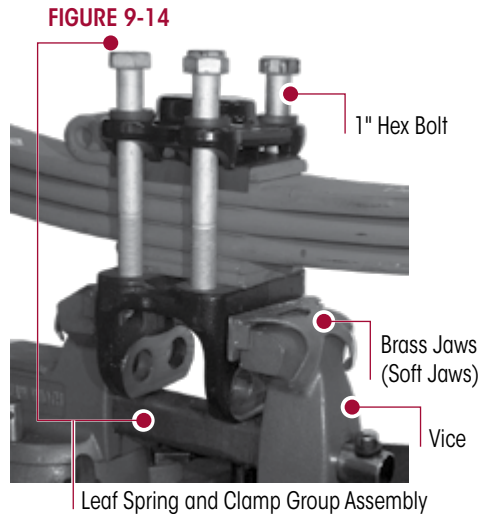


WARNING

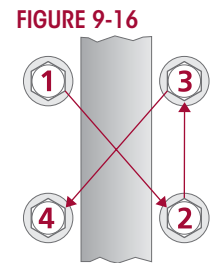
WHEN PLACING THE LEAF SPRING AND CLAMP GROUP ASSEMBLY IN A VISE IT IS NECESSARY TO PROTECT THE MACHINED SURFACES FROM GOUGES OR MARRING BY USING BRASS JAWS (SOFT JAWS) SEE FIGURE 9-14. FAILURE TO DO SO CAN CAUSE PREMATURE PART DAMAGE, DAMAGE TO THE LEAF SPRING AND CLAMP GROUP ASSEMBLY, LOSS OF WARRANTY, LOSS OF VEHICLE CONTROL, CAUSING PERSONAL INJURY OR PROPERTY DAMAGE.

SERVICE HINT

It is acceptable to mount the leaf spring and clamp group components in a soft jaw vise when performing the tightening procedure.



- Secure the leaf spring and clamp group assembly in a suitable holding device, such as a soft jaw vise, see Figure 9-14.
- Tighten the clamp assembly hex bolts evenly in 100 foot pounds increments to 600 ± 20 foot pounds torque in the proper pattern to achieve uniform bolt tension, see Figure 9-16.
- Install the new axle seat liner under the axle seat (liner tabs snap to the sides of axle seat), see Figure 9-15.



WARNING

THE WEIGHT OF THE LEAF SPRING AND CLAMP GROUP ASSEMBLY IS APPROXIMATELY 230 POUNDS. CARE SHOULD BE TAKEN AT REMOVAL AND INSTALLATION TO PREVENT PERSONAL INJURY OR DAMAGE TO COMPONENTS.

- Install the new leaf spring and clamp group assembly (approximate weight 230 pounds) on the axle per the Leaf Spring and Clamp Group Assembly instructions in this section.

STEERTEK NXT HIGH CAPACITY AXLE

AXLE REMOVAL

- Place the vehicle on level floor.
- Chock the wheels.

WARNING

DO NOT USE A TORCH ON AXLE COLLAR FASTENERS OR ANY OTHER PART OF THE STEERTEK NXT HIGH CAPACITY STEER AXLE SYSTEM. THE USE OF A TORCH CAN CAUSE DAMAGE TO CERTAIN STEERTEK NXT COMPONENTS THAT CAN RESULT IN THE LOSS OF VEHICLE CONTROL AND POSSIBLE PERSONAL INJURY OR PROPERTY DAMAGE.

- Raise the frame.
- Support the vehicle with frame stands and suspend the front axle with the shock absorbers attached.
- Remove the front wheels, hubs, brake shoes, ABS sensors, and backing plate assembly.

6. Disconnect the drag link from the steering arm.
7. Support the axle with a suitable jack.

WARNING

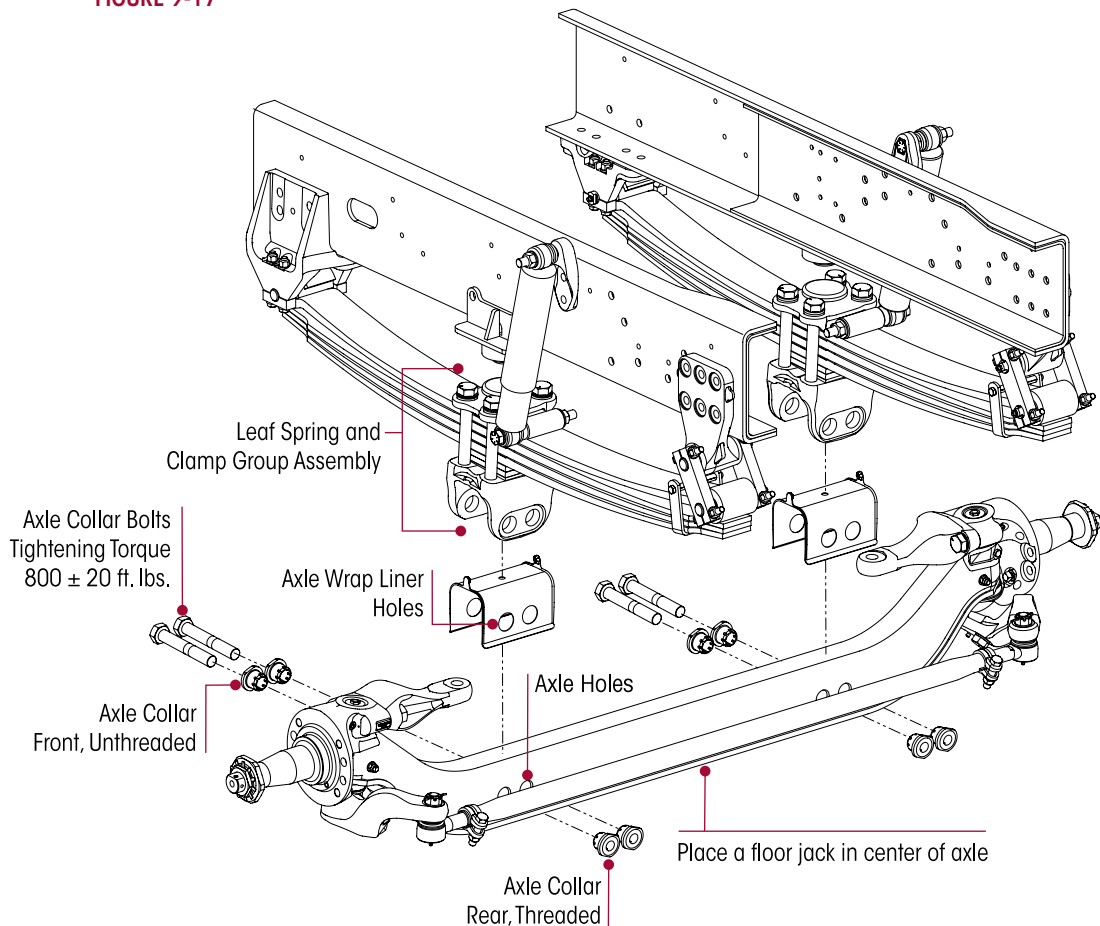
DO NOT REPAIR OR RECONDITION SUSPENSION OR AXLE COMPONENTS FOUND TO BE DAMAGED OR OUT OF SPECIFICATIONS. ALL SUCH DAMAGED OR OUT OF SPECIFICATION COMPONENTS MUST BE REPLACED. ALL MAJOR HENDRICKSON COMPONENTS ARE HEAT TREATED AND TEMPERED. STEERTEK NXT COMPONENTS CANNOT BE BENT, WELDED, HEATED, OR REPAIRED WITHOUT REDUCING THE STRENGTH OR LIFE OF THE COMPONENT. FAILURE TO FOLLOW THESE GUIDELINES CAN CAUSE LOSS OF VEHICLE CONTROL, AND POSSIBLE PERSONAL INJURY OR DEATH OR PROPERTY DAMAGE AND WILL VOID APPLICABLE WARRANTIES.

8. Remove the 1" axle collar bolts and clamps, refer Leaf Spring and Clamp Group Disassembly.
9. Lower the axle and remove from the vehicle.

AXLE INSTALLATION

1. Place the new axle on a floor jack and position the axle under the vehicle, see Figure 9-17.
2. Install the new axle seat liner under the axle seat (liner ear snap to the side of the axle seat).
3. Raise the axle into position.
4. Ensure the axle seat liner holes are lined up with the axle seat and axle holes, see Figure 9-17.
5. Install the new axle collar fasteners with the bolt head located on the front side of the axle.

FIGURE 9-17



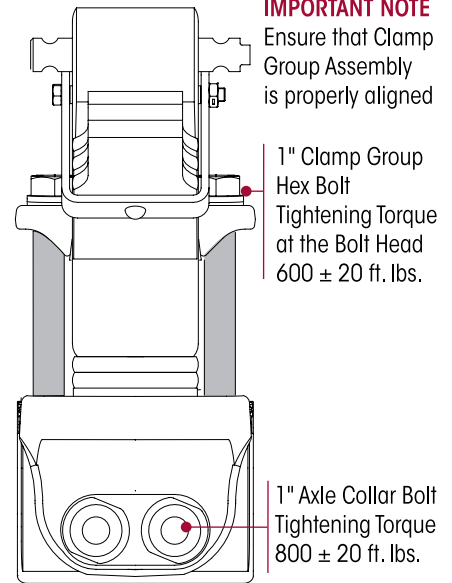


- Tighten both sides, left and right of the axle collar bolts in four stages, stage one 100 foot pounds, stage two 350 foot pounds, stage three 700 foot pounds and the fourth and final 800 ± 20 foot pounds torque, see Figure 9-18.

- Install the steering knuckles, refer to the Steering Knuckle Assembly instructions in this section.
- Install the tie rod assembly in the tie rod arms.
- Install the $\frac{7}{8}$ " hardened washers on the tie rod arm and the castle nuts. Tighten the castle nuts to 185 foot pounds, then rotate until the first castle slot lines up with the cotter pin bore in the tie rod end. **DO NOT** back off nut for cotter pin installation.
- Install the tie rod end cotter pin.
- Connect the drag link in the steering arm.
- Install the castle nut on the drag link taper stud. Tighten the castle nut to 185 foot pounds, then rotate until the first castle slot lines up with the cotter pin bore in the drag link. **DO NOT** back off nut for cotter pin installation.

- Install the drag link cotter pin.
- Install the brake backing plate assemblies and ABS sensor and torque all fasteners per manufacturer's specifications.
- Install the brakes, hubs, and wheels per the vehicle manufacturer's guidelines.
- Raise the vehicle and remove the frame supports.
- Lower the vehicle and load the front axle with the truck's weight. Remove the floor jack.
- Remove the wheel chocks.
- Fill the hubs with the proper lubricant, (see manufacturer's guidelines for recommended lubrication), if required.
- Grease the front steering components as per lubrication guidelines in the Preventive Maintenance Section of this publication.

FIGURE 9-18



STEERING KNUCKLE

DISASSEMBLY

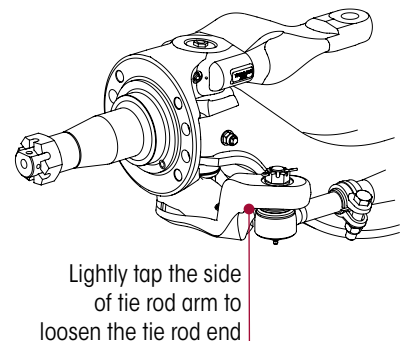
- Place the vehicle on level floor.
- Chock the wheels.
- Support the vehicle with jack stands on the axle.
- Remove the wheel and hub assembly.
- Remove the brake components from steering knuckle.

SERVICE HINT

Lightly tap the side of the tie rod arm with a mallet to separate the tie rod end from the tie rod arm, see Figure 9-19.

- Disconnect the tie rod assembly from the tie rod arms, see Figure 9-19.
- Remove the tie rod assembly.

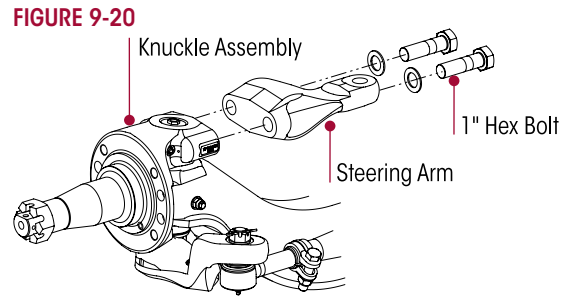
FIGURE 9-19





STEERING ARM DISASSEMBLY

1. Remove the two steering-arm-to-knuckle hex bolts from the knuckle assembly. Figure 9-20.
2. Remove the steering arm from the knuckle. If necessary, use a leather or plastic mallet to tap the outside of the arm and separate the arm from the knuckle.
3. Remove the steering arm.
4. Inspect the steering arm for cracks or damage, replace as necessary.



TIE ROD ARM DISASSEMBLY

WARNING

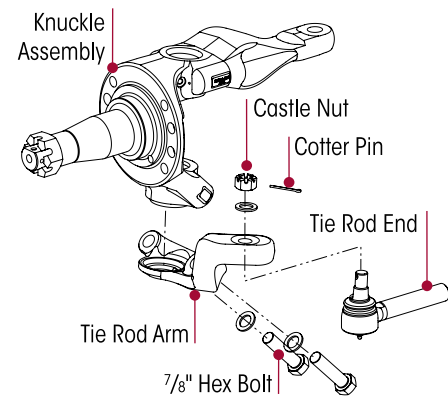
SUPPORT THE TIE ROD ASSEMBLY DURING MAINTENANCE AND SERVICE TO PREVENT SERIOUS PERSONAL INJURY AND DAMAGE TO COMPONENTS.

CAUTION

DO NOT HEAT THE TIE ROD ARM TO REMOVE THE TIE ROD ASSEMBLY. HEATING THE TIE ROD ARM WILL SOFTEN PARTS AND DAMAGE TO COMPONENTS WILL RESULT.

1. Remove and discard tie rod arm 7/8" fasteners.
2. Remove the tie rod arms, see Figure 9-21.

FIGURE 9-21



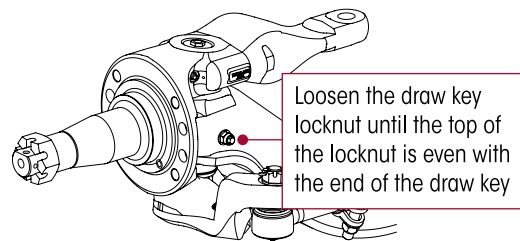
GREASE CAP, DRAW KEY AND KINGPIN DISASSEMBLY

You will need:

- Brass drift and hammer
- Heavy-duty King Pin Press that can generate 46,000 pounds of force and will accommodate kingpins size of 2" to 2 5/32"

1. Remove the top grease cap.
2. Remove the draw keys.
 - a. Loosen the threaded draw key locknut until the top of the locknut is even with the end of the draw key, see Figure 9-22.
 - b. Use a brass drift and a hammer to hit the end of the draw key.
 - c. Remove the nut from the draw key. Remove the draw key from the knuckle.
3. If you are not replacing the bushings, use the following procedure to prevent damaging the bushings during kingpin removal.
 - a. Use a brass drift and a hammer to remove the kingpins from the knuckle. Figure 9-23.
 - b. Remove any flaring on the drift that touches the bushings.
 - c. Wrap tape to a thickness of 1/16" (1.5 mm) onto the end of the drift.

FIGURE 9-22



WARNING

DO NOT HEAT THE AXLE TO REMOVE THE KINGPIN. HEATING THE AXLE WILL DAMAGE THE AXLE AND STEERING KNUCKLE COMPONENTS. FAILURE TO DO SO CAN CAUSE, LOSS OF WARRANTY, LOSS OF VEHICLE CONTROL CAUSING PERSONAL INJURY OR PROPERTY DAMAGE.



4. If the kingpin is difficult to remove, use a hydraulic kingpin press to remove the kingpin.

FIGURE 9-23

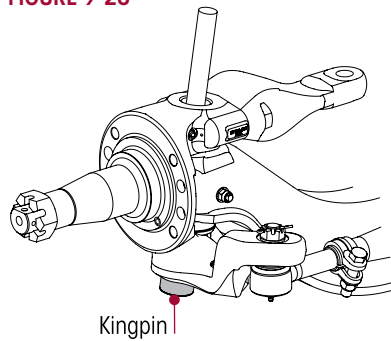
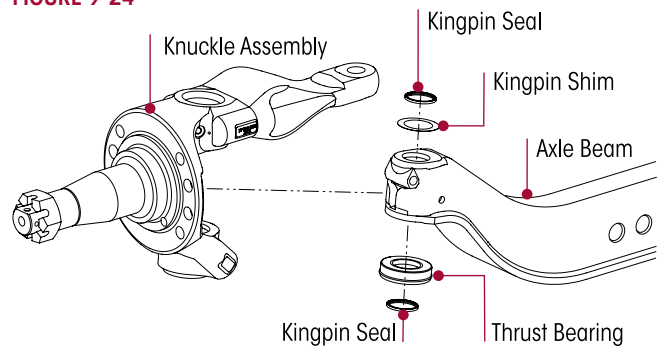


FIGURE 9-24



5. Remove the knuckle from the axle beam.

WARNING

WEAR GLOVES WHEN YOU REMOVE OR INSTALL SHIMS. SHIMS HAVE SHARP EDGES THAT CAN CAUSE SERIOUS PERSONAL INJURY.

6. While wearing gloves, remove the shims, the thrust bearing and the seal from the beam and / or steering knuckle. Figure 9-24.

7. Inspect the parts, refer to the Preventive Maintenance Section of this publication.

KINGPIN BUSHING

You will need:

- Impact wrench
- Adjustable straight flute reamer with a cutting diameter must facilitate a range of 2.0" to 2.01"

Refer to the Special Tools Section of this publication for the following shop made tools:

- Kingpin Bushing / Seal Driver
- Kingpin Bushing and Seal Installer / Remover Tools

FIGURE 9-25



FIGURE 9-26



FIGURE 9-27



REMOVAL

1. Place the steering knuckle on a workbench squarely supported.
2. Place the kingpin bushing and seal installer / remover tools in the steering knuckle / kingpin bore, see Figure 9-25.
3. Use a hammer and drive out the kingpin bushing, see Figure 9-26.
4. Rotate the knuckle over and repeat Steps 1-3 to remove the other kingpin bushing.
5. Clean the knuckle kingpin bores with a rotary wire wheel and inspect for reassembly, see Figure 9-27.

STEERING KNUCKLE BORE MEASUREMENT

Complete the following steering knuckle bore inspection and the measurement instructions prior to installing the kingpin bushing.

1. Measure the upper knuckle bore inside diameter at two locations. Always use an inside micrometer or a telescoping gauge when taking a knuckle bore measurement. Some out-of-roundness at the top and bottom of the bore edges is acceptable. Steering knuckle bore diameter is 1.938" ± 0.003".
2. Measure the upper and lower bore in two positions and at two locations. The two positions must be 90° opposed from each other, see Figures 9-28 through 9-30. If the average measurement is more than the knuckle bore maximum diameter specification, replace the knuckle.

FIGURE 9-28



FIGURE 9-29

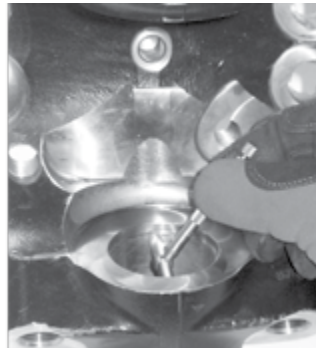


FIGURE 9-30



INSTALLATION

1. Install kingpin bushings from the axle side of the steering knuckle.
2. Place the new kingpin bushing into the steering knuckle bore so the seam **DOES NOT** align with the grease channel, see Figures 9-31 and 9-32.

FIGURE 9-31



FIGURE 9-32





3. Use the kingpin bushing driver to install the kingpin bushing into the **steering knuckle bore**, see Figure 9-33. Continue installation until the kingpin bushing is flush with the machined surface of the steering knuckle.
4. Remove the kingpin bushing / seal driver.
5. Install the kingpin bushing and seal installer / remover tools.
6. Continue driving the kingpin bushing into the steering knuckle until it is flush with the bottom of kingpin seal bore, see Figures 9-34 and 9-35.
7. Repeat steps for the remaining kingpin bushing.
8. Ream the bushings, see Kingpin Bushing Reaming in this section.

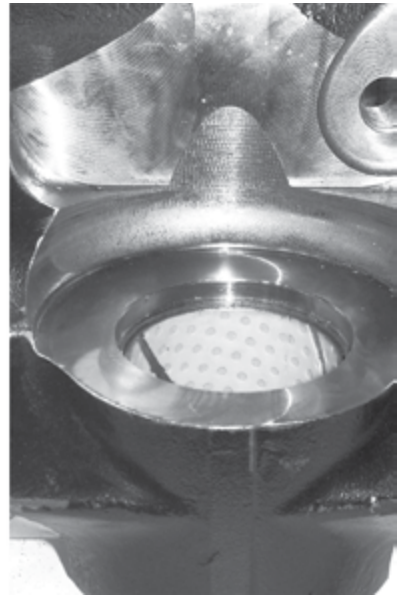
FIGURE 9-33



FIGURE 9-34



FIGURE 9-35



KINGPIN PREPARATION AND MEASUREMENT

- Cleaning Ground and Polished Parts
 - Use a cleaning solvent to clean ground or polished parts and surfaces. **DO NOT USE GASOLINE.**
 - **DO NOT** clean ground or polished parts in a hot solution tank or with water, steam, or alkaline solutions. These solutions will cause corrosion of the parts.

DRYING THE CLEANED PARTS

- Parts must be dried immediately after cleaning. Dry the parts with clean paper towels, clean rags, or compressed air. **DO NOT** dry bearings by spinning with compressed air. Damage to the bearings will result.

PREVENTING CORROSION ON CLEANED PARTS

- Apply a light coating of oil to all cleaned and dried parts that are going to be reused. **DO NOT** apply oil to the brake lining or the brake drums. If parts are to be stored, apply an effective rust inhibitor to all surfaces.



TO HELP PREVENT SERIOUS EYE INJURY, ALWAYS WEAR PROPER EYE PROTECTION WHEN YOU PERFORM VEHICLE MAINTENANCE OR SERVICE



WARNING

SOLVENT CLEANERS CAN BE FLAMMABLE, POISONOUS AND CAUSE BURNS. TO HELP AVOID SERIOUS PERSONAL INJURY, CAREFULLY FOLLOW THE MANUFACTURER'S PRODUCT INSTRUCTIONS AND GUIDELINES AND THE FOLLOWING PROCEDURES:

- WEAR PROPER EYE PROTECTION.
- WEAR CLOTHING THAT PROTECTS YOUR SKIN.
- WORK IN A WELL VENTILATED AREA.
- DO NOT USE GASOLINE, SOLVENTS OR OTHER MATERIALS THAT CONTAIN GASOLINE THAT CAN EXPLODE.
- HOT SOLUTION TANKS OR ALKALINE SOLUTIONS MUST BE USED CORRECTLY. FOLLOW THE MANUFACTURER'S RECOMMENDED INSTRUCTIONS AND GUIDELINES CAREFULLY TO HELP PREVENT PERSONAL ACCIDENT OR INJURY.

CAUTION

DO NOT USE HOT SOLUTION TANKS OR WATER AND ALKALINE SOLUTIONS TO CLEAN GROUND OR POLISHED PARTS. DAMAGE TO THE PARTS WILL RESULT.

1. Inspect the kingpin for wear or damage. Use a micrometer and measure the kingpin. If the kingpin has less than 2.0" diameter, replacement is necessary, see Figure 9-36.
2. Set up the adjustable straight flute reamer to match kingpin dimension, see Figure 9-37. The dimension of cutting diameter must facilitate a range of 2.0" to 2.001".

Kingpin minimum dimension is 2.0"

FIGURE 9-36

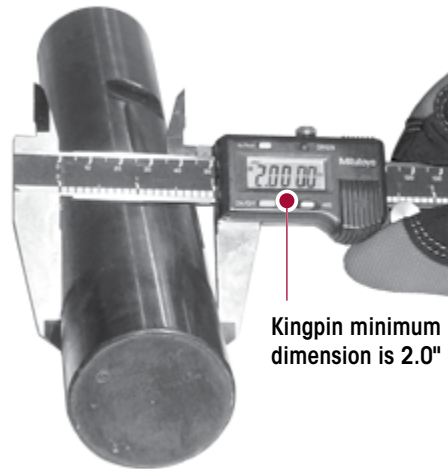
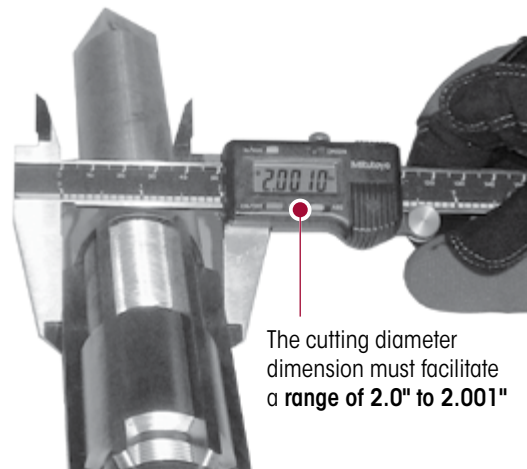


FIGURE 9-37



KINGPIN BUSHING REAMING

WARNING

WHEN INSTALLING STEERING KNUCKLE COMPONENTS IN A VISE IT IS NECESSARY TO PROTECT THE MACHINED SURFACES FROM GOUGES OR MARRING BY USING BRASS JAWS, SEE FIGURE 9-38. FAILURE TO DO SO CAN CAUSE PREMATURE PART DAMAGE, DAMAGE TO THE STEERING KNUCKLE COMPONENTS, LOSS OF WARRANTY, LOSS OF VEHICLE CONTROL, CAUSING PERSONAL INJURY OR PROPERTY DAMAGE.

WARNING

PRIOR TO INSTALLATION ENSURE THAT ALL RESIDUAL LOCTITE® MATERIAL IS REMOVED FROM THE MOUNTING BOLTS AND THE THREAD BORES IN THE UPPER STEERING KNUCKLES, AND NEW LOCTITE 277 OR EQUIVALENT IS APPLIED TO HELP ENSURE THAT THE BOLTS SUSTAIN THE PROPER TORQUE REQUIREMENT. FAILURE TO DO SO CAN CAUSE LOSS OF VEHICLE CONTROL RESULTING IN PERSONAL INJURY OR PROPERTY DAMAGE.

NOTE

Bushing size is to be 0.001" larger than the kingpin size.

1. Place the knuckle in a vise with brass jaws (soft jaws), see Figure 9-38.
2. Install the pilot in the lower kingpin bore.



CAUTION

REAM THE KINGPIN BUSHINGS WITH AN ADJUSTABLE STRAIGHT FLUTE REAMER. (SEE SPECIAL TOOLS SECTION OF THIS PUBLICATION) DO NOT HONE OR BURNISH THE KINGPIN BUSHINGS. HONING OR BURNISHING WILL DAMAGE THE BUSHINGS AND VOID ANY APPLICABLE WARRANTY.

3. Install the adjustable straight flute reamer into the pilot.
4. Slide the adjustable straight flute reamer into the upper bushing and into the pilot until the reamer blades touch the bushing.
5. Rotate the adjustable straight flute reamer with a light **DOWNWARD** pressure. **DO NOT** apply too much force. Rotate the reamer smoothly, see Figure 9-39.

FIGURE 9-38

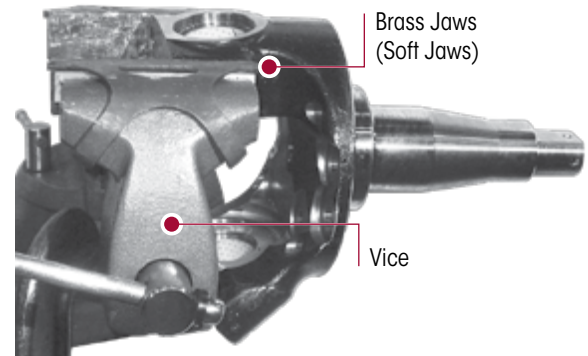


FIGURE 9-39

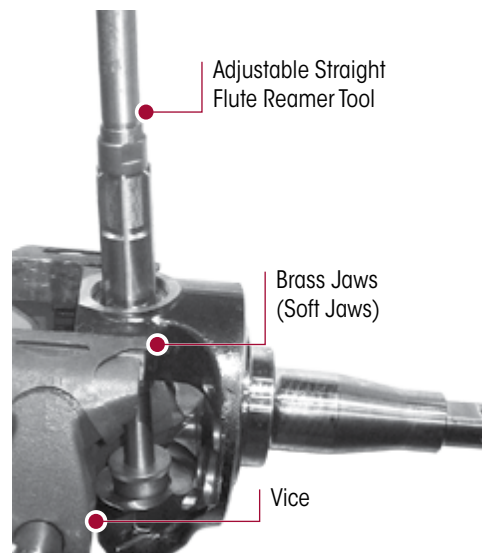
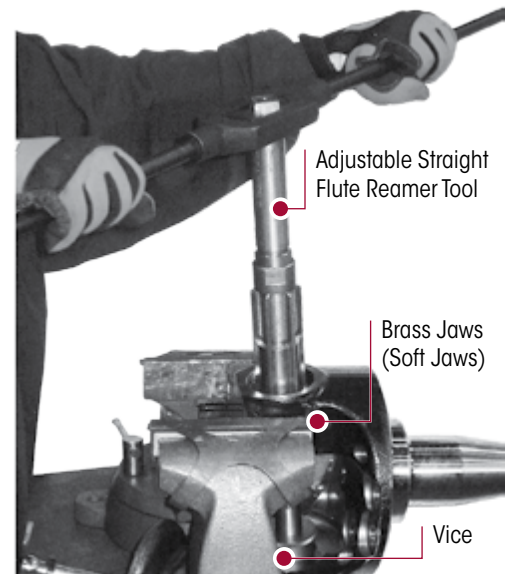


FIGURE 9-40



6. Turn the knuckle over in the vise and repeat Steps 2-5 for the other kingpin bushing, see Figures 9-39 and 9-40.

SERVICE HINT

If the adjustable straight flute reamer must be removed through the bushing. Rotate the tool in the opposite cutting direction.

7. Clean all material from the bushings.
8. Lightly lubricate the new the kingpin with penetrating oil and slide into the steering knuckle bore to ensure the kingpin fits properly into the kingpin bushings.

KINGPIN SEAL INSTALLATION

1. Place the steering knuckle assembly on a suitable workbench.
2. Lay the kingpin seal into the bore of the steering knuckle. Ensure the lip of the kingpin seal faces toward the axle, see Figure 9-41.
3. Use the kingpin bushing / seal driver tool and drive the kingpin seal firmly into the steering knuckle assembly with a hammer.
4. Use a kingpin bushing and seal installer / remover tools with a hammer until it bottoms out in the kingpin bore, see Figure 9-42.



FIGURE 9-41

Ensure the lip of the Kingpin Seal is facing **towards** the axle.



FIGURE 9-42

Kingpin seal bottoms out in the kingpin bore



STEERING KNUCKLE INSTALLATION

FIGURE 9-43

1. Clean the kingpin bores of the axle beam.
2. Install the thrust bearing assembly on the inner steering knuckle. The seal must face **UPWARD** toward the beam. The top inner diameter will contact the bottom of the axle beam, see Figures 9-43 and 9-44.

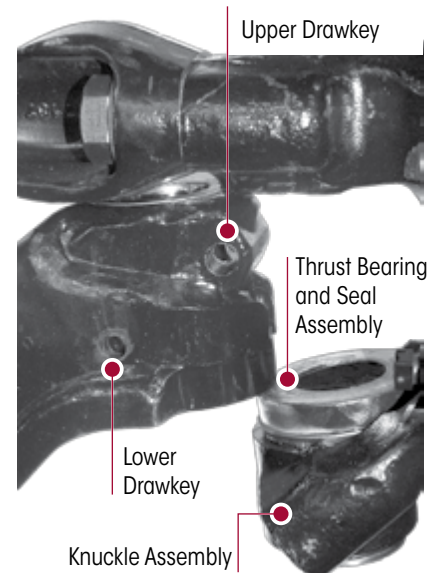


WARNING

WEAR GLOVES WHEN YOU INSTALL THE SHIMS. SHIMS HAVE SHARP EDGES THAT CAN CAUSE SERIOUS PERSONAL INJURY.

3. Place the knuckle onto the axle beam, see Figure 9-44.
4. Place a pry bar between the steering arm boss and the axle beam. Lift the knuckle and slide the shim pack between the top of the beam and the steering knuckle, see Figure 9-45.
5. Align all the steering knuckle components within the kingpin bore. If the bores are not aligned, the components will be damaged during kingpin installation.
6. Remove the pry bar.
7. Apply the multi-purpose grease onto the bottom half of the kingpin prior to kingpin installation onto the steering knuckle.

FIGURE 9-44



CAUTION

VERIFY THAT THE DRAW KEY IS INSTALLED COMPLETELY OR THE LOCKNUT IS TIGHTENED TO 35 ± 5 FOOT POUNDS TORQUE. IF NOT INSTALLED CORRECTLY, THE KINGPIN AND THE AXLE BEAM WILL BE DAMAGED.

8. Install the kingpin into the top of the knuckle and through the area where the shims are located, see Figures 9-46 and 9-47. **DO NOT** force the kingpin through the upper kingpin bushing. Ensure the word **TOP** is facing up, see Figure 9-48.



FIGURE 9-45

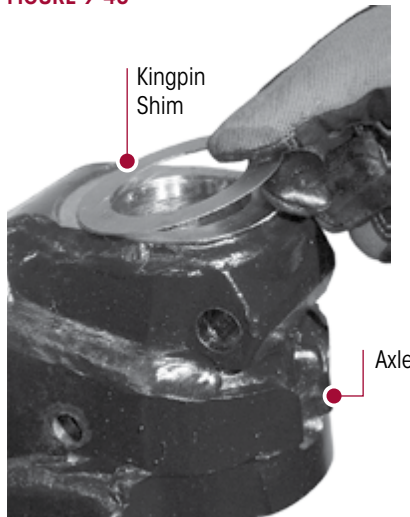


FIGURE 9-46

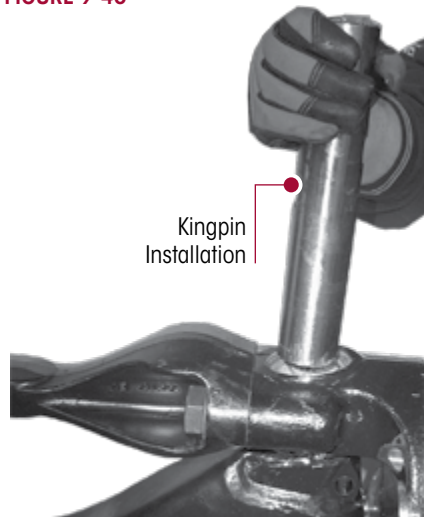
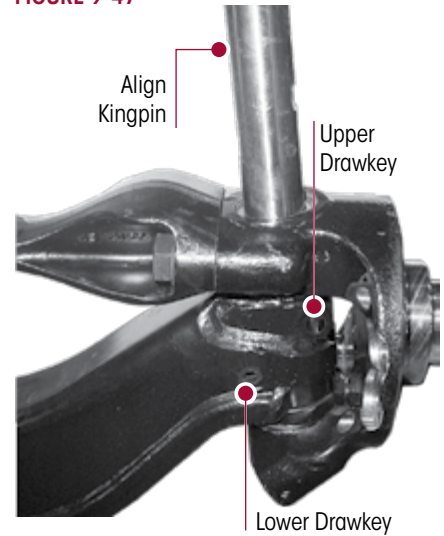


FIGURE 9-47



9. Rotate the kingpin and slide in until the two draw key slots align with the axle draw key bores, see Figure 9-49 and 9-50.
10. If required, use a hammer and a brass drift to apply direct force to the kingpin for seating into the lower steering knuckle bore, see Figure 9-49.
11. Seat the upper draw key into the front of the axle beam, see Figure 9-50.
12. Seat the lower draw key into the back of the axle beam by striking it with a hammer and drift, see Figure 9-49. The draw keys must align with the slots of the kingpin.
13. Install draw key locknuts, Snug, **DO NOT** tighten torque until after the steering knuckle vertical end play procedure is completed.

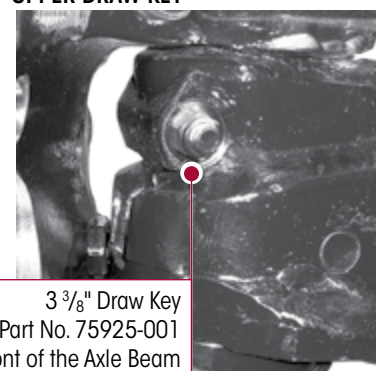
FIGURE 9-48



FIGURE 9-49
LOWER DRAW KEY



FIGURE 9-50
UPPER DRAW KEY



MEASURE STEERING KNUCKLE VERTICAL END PLAY

1. Turn the knuckle to the straight-ahead position.
2. Attach a dial indicator to the axle. Place the tip onto the top of the steering knuckle.
3. Set the dial indicator to **zero**, see Figure 9-51.



4. Use one of the following methods to measure the vertical clearance.
 - Place a pry bar between the knuckle and the top of the axle center. Pry the knuckle up and measure the vertical end play.
 - Place a block of wood and a hydraulic jack under the bottom of the knuckle. Raise the knuckle until the pointer on the dial indicator stops, see Figure 9-51.
5. Record dial indicator reading.
 - If the knuckle binds or **zero** end play is measured, remove shims from the shim pack.
 - If the reading is more than the correct specification shown in Table 9-2, add shims to the shim pack.

FIGURE 9-51

Ensure the tip of the dial indicator is on the top of the upper steering knuckle and not on the grease cap

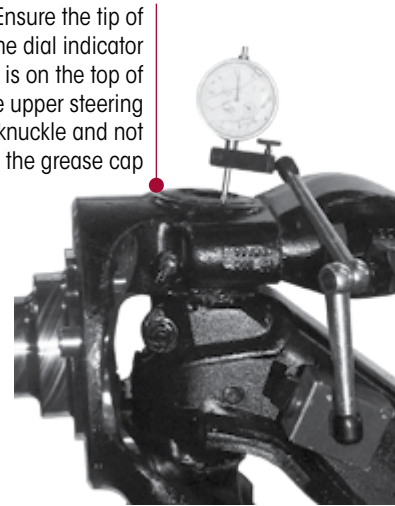


TABLE 9-2

END PLAY SPECIFICATIONS

New or Rebuilt Axles:	0.001-0.010 inch (0.025-0.254 mm)
In-service Axles:	0.001-0.030 inch (0.025-0.762 mm)

6. Tighten upper and lower draw key locknuts to $\boxed{35} \pm 5$ foot pounds torque.

GREASE CAP INSTALLATION



TAKE CARE WHEN YOU USE LOCTITE ADHESIVE TO AVOID SERIOUS PERSONAL INJURY. READ THE MANUFACTURER'S INSTRUCTIONS BEFORE USING THIS PRODUCT. FOLLOW THE INSTRUCTIONS CAREFULLY TO PREVENT IRRITATION TO THE EYES AND SKIN. IF LOCTITE® ADHESIVE MATERIAL GETS INTO YOU EYES, FOLLOW THE MANUFACTURER'S EMERGENCY PROCEDURES. HAVE YOUR EYES CHECKED BY A PHYSICIAN AS SOON AS POSSIBLE.

NOTE

If reusing a grease cap, ensure to apply the Loctite Straight Thread Sealant™ (STS) all around the threads (apply to a minimum of 3 threads), see Figure 9-52.

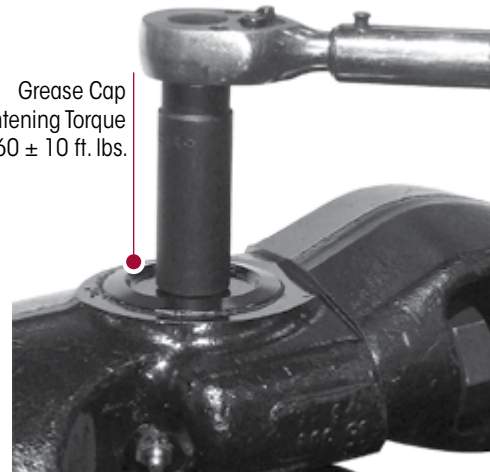
FIGURE 9-52

Apply Loctite STS to a minimum of three grease cap threads



FIGURE 9-53

Grease Cap Tightening Torque 60 ± 10 ft. lbs.



1. Ensure Loctite STS is applied to a minimum of three grease cap threads (note: new grease caps have Loctite STS pre-applied).
2. Install the threaded grease caps onto the top of the knuckle.



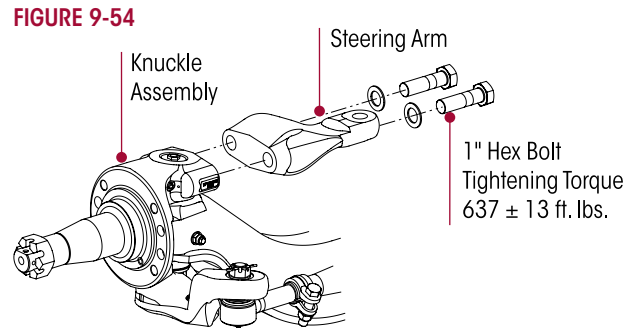
3. Tighten the grease caps to 60 ± 10 foot pounds, see Figure 9-53.
4. Remove the bottle jack and continue assembling the wheel ends.

STEERING ARM INSTALLATION

WARNING

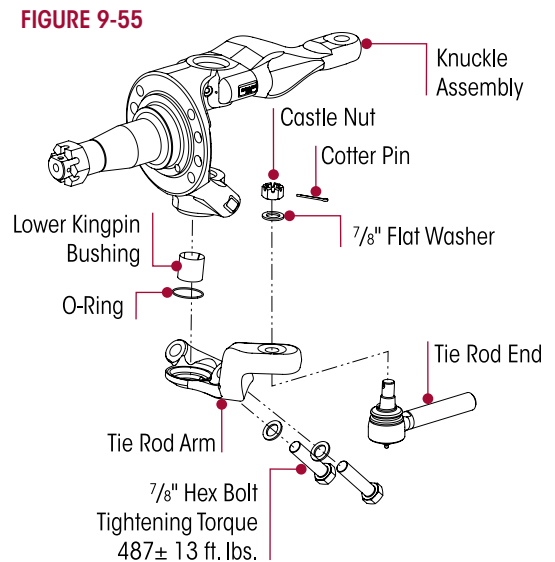
TAKE CARE WHEN YOU USE LOCTITE ADHESIVE TO AVOID SERIOUS PERSONAL INJURY. READ THE MANUFACTURER'S INSTRUCTIONS BEFORE USING THIS PRODUCT. FOLLOW THE INSTRUCTIONS CAREFULLY TO PREVENT IRRITATION TO THE EYES AND SKIN. IF LOCTITE ADHESIVE MATERIAL GETS INTO YOU EYES, FOLLOW THE MANUFACTURER'S EMERGENCY PROCEDURES. HAVE YOUR EYES CHECKED BY A PHYSICIAN AS SOON AS POSSIBLE.

1. Use a tap to remove old Loctite adhesive from the internal threads of the knuckle.
2. Use new steering arm hex bolts and apply Loctite 680 adhesive. Ensure to cover at least half of the thread area.
3. Insert the hex bolts through the steering arm. Hand-start the bolts into the knuckle assembly, see Figure 9-54.
4. Tighten the steering arm hex bolts to 637 ± 13 foot pounds torque.



TIE ROD ARM INSTALLATION

1. Install new O-ring on the bottom of the steering knuckle.
2. Use a tap to remove old Loctite adhesive from the internal threads of the knuckle.
3. Use new tie rod arm hex bolts and apply Loctite 680 adhesive. Ensure to cover at least half of the thread area.
4. Lubricate O-ring with grease and install tie rod arm on the bottom of the steering knuckle.
5. Insert the tie rod arm hex bolts through the tie rod arm and into the steering knuckle. Hand-start the bolts into the knuckle assembly, see Figure 9-55.
6. Tighten the tie rod arm bolts to 487 ± 13 foot pounds torque.
7. Install brake torque plate.



IMPORTANT NOTE

It is critical to apply Loctite to the three (3) brake torque plate bolts to ensure that these bolts sustain the proper torque requirement of steering knuckle assembly.

8. Apply Loctite Red 262 to the torque plate bolts prior to installation into the torque plate.
9. Tighten torque plate bolts to 400 ± 50 foot pounds torque.
10. Install the tie rod end into the tie rod arm, see Figure 9-55.
11. Tighten the castle nuts to 185 foot pounds torque then rotate the castle nut to the next castle slot and install cotter pin, see Figure 9-55.



12. Install the drag link into the steering arm and tighten to the vehicle manufacturer's specifications.
13. Install wheel ends and tires.
14. Remove jack and safety stands.
15. Grease steering knuckles with the vehicle on the floor.
16. Remove the wheel chocks.

TIE ROD ENDS AND CROSS TUBE

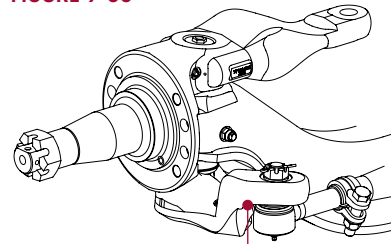
NOTE:

Hendrickson supplies different tie rod configurations. Prior to ordering, locate the part number on the tie rod tube, for additional information see Technical Bulletin SEU-0223 or contact Hendrickson Tech Services.

DISASSEMBLY

1. Chock the wheels.
2. Position the steer axle tires straight ahead.
3. Remove the cotter pin and castle nut.
4. Lightly tap the side of the tie rod arm to loosen the tie rod end from the tie rod arm, see Figure 9-56.
5. Repeat to Steps 3 and 4 to remove the other tie rod end.
6. Remove the cross tube and tie rod ends from the vehicle.

FIGURE 9-56



Lightly tap the side of tie rod arm to loosen the tie rod end

7. Mount the cross tube in a soft jaw vice.
8. Remove the hardware from the clamp on the cross tube.
9. Count the exposed threads on the tie rod end being replaced.
10. Remove the tie rod end from the cross tube.

WARNING

DO NOT HEAT THE CROSS TUBE WITH A TORCH TO FACILITATE THE REMOVAL OF THE TIE ROD END. THE USE OF SUCH HEAT CAN ADVERSELY AFFECT THE STRENGTH OF THE CROSS TUBE. A COMPONENT DAMAGED IN THIS MANNER WILL RESULT IN LOSS OF WARRANTY, AND CAN RESULT IN THE AND LOSS OF VEHICLE CONTROL, AND POSSIBLE PERSONAL INJURY OR PROPERTY DAMAGE.

11. If the opposing tie rod end is being replaced repeat Steps 8 through 10.
12. Inspect the cross tube for dents, cracks, or thread damage. Replace the cross tube if needed.

ASSEMBLY

1. Lubricate the new tie rod end threads with Anti-Seize.

NOTE

When installing the cross tube the thread direction of the tie rod ends are as follows:

- A right hand threaded tie rod end will be installed into the right side tie rod arm.
- A left hand threaded tie rod end will be installed into the left side tie rod Arm.

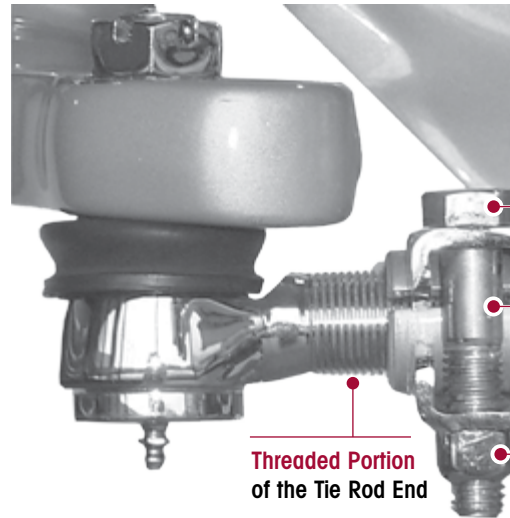
2. Install the new tie rod end into the cross tube, leaving the same amount of threads exposed that were counted on the failed tie rod end prior to removal.

WARNING

THE THREADED PORTION OF THE TIE ROD END MUST EXTEND PAST THE SLOTS INTO THE TIE ROD CROSS TUBE, SEE FIGURE 9-57. FAILURE TO DO SO CAN CAUSE COMPONENT DAMAGE, LOSS OF VEHICLE CONTROL AND POSSIBLE PERSONAL INJURY OR PROPERTY DAMAGE.



FIGURE 9-57



5/8" Tie Rod Clamp Bolt

It is critical to check the 5/8" tie rod clamp bolt head location to verify the clamp fasteners have sufficient clearance away from the lower shock mount at full wheel cut. The fasteners must not contact the lower shock mount.

Tie Rod Cross Tube Slots

It is critical to have the threaded portion of the tie rod end extend past the slots in the tie rod cross tube.

Threaded Portion of the Tie Rod End

5/8" Tie Rod Clamp Locknut

Tightening Torque 68 ± 7 ft. lbs.

WARNING

IT IS CRITICAL TO CHECK THE 5/8" TIE ROD CLAMP BOLT HEAD LOCATION TO VERIFY THE CLAMP FASTENERS HAVE SUFFICIENT CLEARANCE AWAY FROM THE LOWER SHOCK ABSORBER MOUNT AT FULL WHEEL CUT. THE FASTENERS MUST NOT CONTACT THE LOWER SHOCK ABSORBER MOUNT. FAILURE TO DO SO CAN CAUSE ONE OR MORE COMPONENTS TO FAIL CAUSING LOSS OF VEHICLE CONTROL AND POSSIBLE PERSONAL INJURY OR PROPERTY DAMAGE.

3. Replace the opposing tie rod end if necessary by repeating Steps 1 and 2.

WARNING

DO NOT HEAT THE CROSS TUBE WITH A TORCH TO ROTATE THE CROSS TUBE IN THE TIE ROD END. THE USE OF SUCH HEAT CAN ADVERSELY AFFECT THE STRENGTH OF THE CROSS TUBE. A COMPONENT DAMAGED IN THIS MANNER WILL RESULT IN LOSS OF WARRANTY, AND CAN RESULT IN THE LOSS OF VEHICLE CONTROL, AND POSSIBLE PERSONAL INJURY OR PROPERTY DAMAGE.

4. It is critical that the cross tube rotate in the opposing tie rod end, even if it is not replaced.
5. Install the tie rod end into the tie rod arm.
6. Tighten the castle nuts to 185 foot pounds, torque then rotate the castle nut to the next castle slot and install cotter pin.
7. Grease the tie rod ends. Refer to the Lubrication Table 7-1 for required lubricant in the Preventive Maintenance Section of this publication.
8. Set the toe, refer to the Toe Adjustment Procedure in the Alignment & Adjustments Section of this publication.

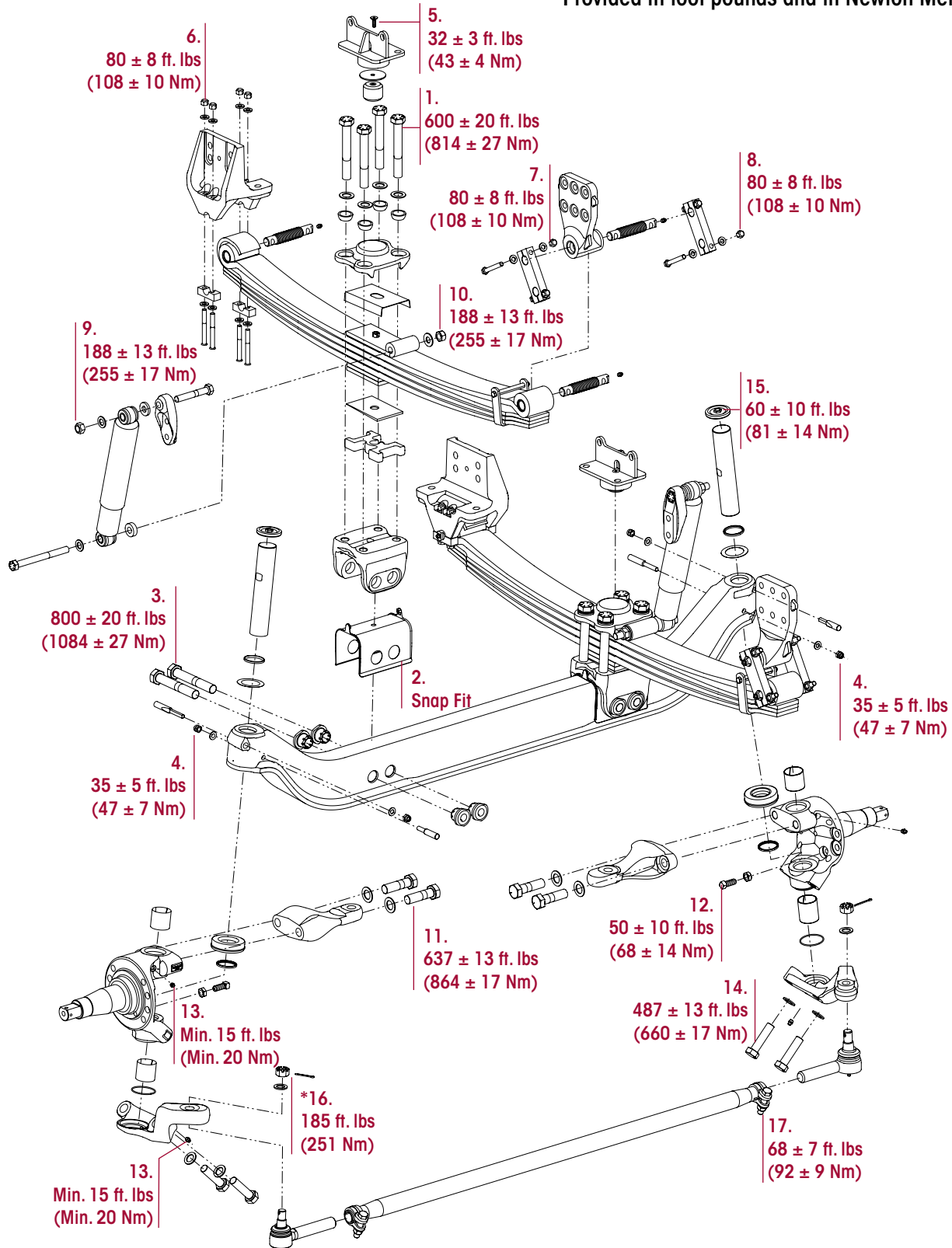
AIR DISC BRAKES • DRUM BRAKES ASSEMBLY

Brake components are not supplied by Hendrickson for aftermarket service purposes. For more information and assistance with service, maintenance and rebuild instructions on these components, refer to specific Parts List for your suspension system, see Parts List Section of this publication.



SECTION 10 Torque Specifications

HENDRICKSON RECOMMENDED TORQUE VALUES
Provided in foot pounds and in Newton Meters





STEERTEK NXT High Capacity for Fire and Rescue Vehicles

HENDRICKSON RECOMMENDED TORQUE SPECIFICATIONS					
NO.	COMPONENT	FASTENER		TORQUE VALUE	
		QUANTITY	SIZE	Foot Pounds	Newton Meters
	Frame fasteners are furnished and installed by the vehicle manufacturer. Vehicle manufacturer may use an equivalent HUCK fastener at frame mount.				
	WARNING: ENSURE CLAMP GROUP IS ALIGNED PROPERLY PRIOR TO TIGHTENING HARDWARE. FAILURE TO DO SO CAN CAUSE LOSS OF VEHICLE CONTROL, PROPERTY DAMAGE OR PERSONAL INJURY.				
1	Clamp Group Hex Bolt	8	1"-8 UNC	600 ± 20	814 ± 27
2	Axle Seat Liner	2		Snap Fit	Snap Fit
3	Axle Collar at the Bolt Head	4	1"-8 UNC	800 ± 20	1084 ± 27
4	Kingpin Draw Key Nut	4	7/8"-14 UNC	35 ± 5	47 ± 7
5	Jounce Stop	2	M10	32 ± 3	43 ± 4
6	Front Frame Hanger to Leaf Spring Assembly	8	1/2"-20 UNC	80 ± 8	108 ± 10
7	Rear Shackle to Rear Frame Hanger	4	1/2"-20 UNC	80 ± 8	108 ± 10
8	Rear Shackle to Leaf Spring Assembly	4	1/2"-20 UNC	80 ± 8	108 ± 10
9	Upper Shock Absorber	2	3/4"-10 UNC	188 ± 13	255 ± 17
10	Lower Shock Absorber	2	3/4"-10 UNC	188 ± 13	255 ± 17
11	Knuckle Assembly to Steering Arm	4	1"-14 UNF	637 ± 13	864 ± 17
12	Knuckle / Axle Wheel Stop Bolt	2	5/8" Jam Nut	50 ± 10	68 ± 14
13	Grease Zerk	4		Minimum of 15	Minimum of 20
14	Knuckle Assembly to Tie Rod Arm	4	7/8"-14 UNF	487 ± 13	660 ± 17
15	Grease Cap	2	1/2"	60 ± 10	81 ± 14
16	Tie Rod Ends to Tie Rod Arms	2	7/8" Castle Nut	*185	*251
17	Tie Rod Tube to Tie Rod Ends	2	5/8"	68 ± 7	92 ± 9
<p>• All hardware 1/4" and greater is Grade 8 with no additional lubrication.</p> <p>NOTE: Torque values shown in this publication apply only if Hendrickson supplied fasteners are used. If non Hendrickson fasteners are used, follow the torque specification listed in the vehicle manufacturer's service manual.</p> <p>* Tighten to 185 foot pounds torque, advance castle nut to the next hex face to install cotter pin. DO NOT back off nut for cotter pin installation.</p>					

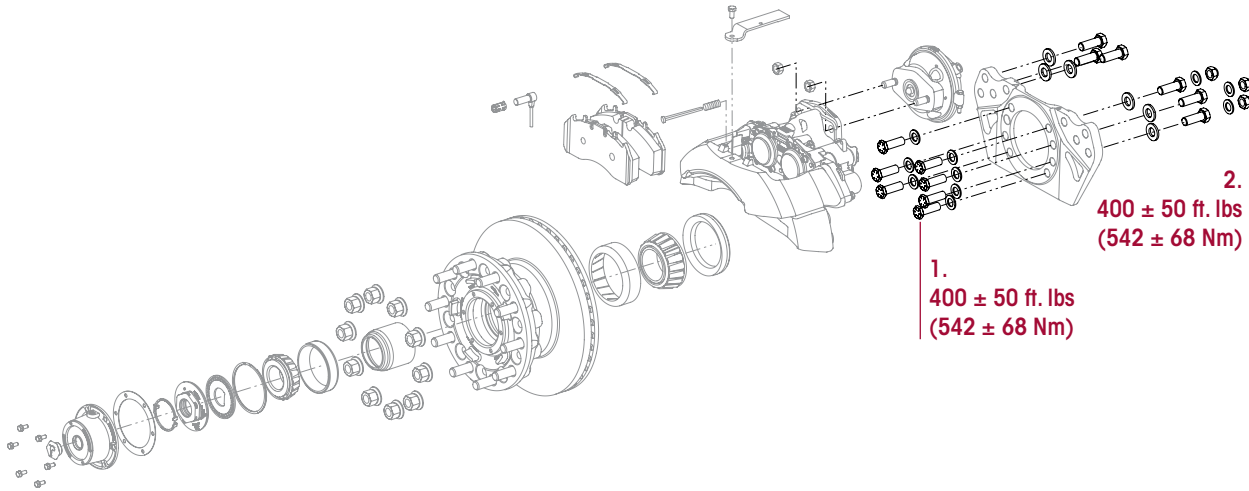
Additional brake component part and service information is referenced in the Parts List. Refer to the specific parts list for your vehicle available online at www.hendrickson-intl.com/Truck/Fire-Rescue/STEERTEK-NXT-Fire



HENDRICKSON RECOMMENDED TORQUE VALUES
 Provided in foot pounds and in Newton Meters

HENDRICKSON RECOMMENDED TORQUE SPECIFICATIONS

Air Disc Brakes



NO.	COMPONENT	FASTENER		*TORQUE VALUE	
		QUANTITY	SIZE	Foot Pounds	Newton Meters
1.	Torque Plate Hex Bolts to Knuckle	8	3/4"	400 ± 50	542 ± 68
2.	Torque Plate Hex Nuts	6	3/4"	400 ± 50	542 ± 68

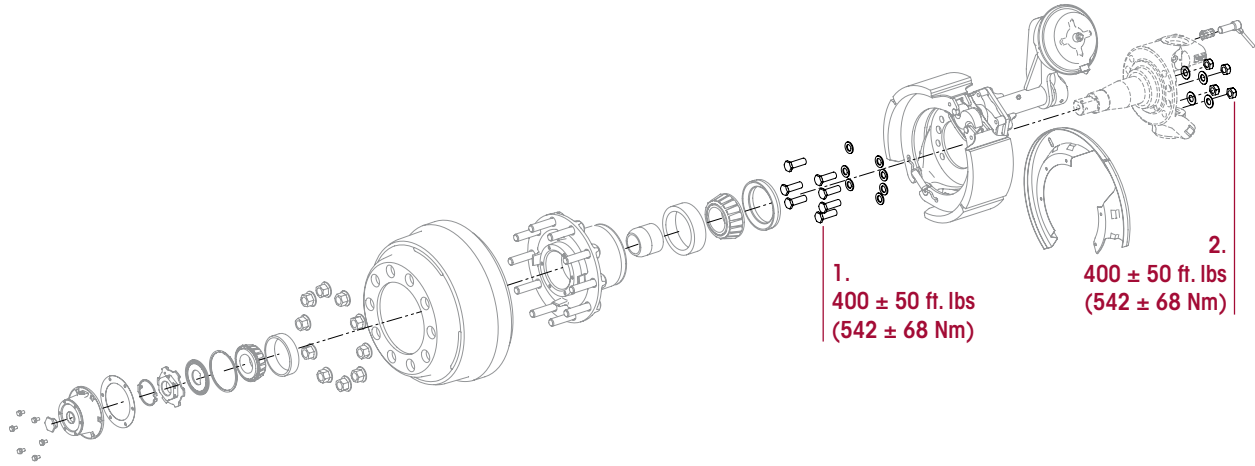
NOTE: For fasteners not supplied by Hendrickson, follow the torque specification listed in the vehicle manufacturer's or the component manufacturer's service manual. Refer to the Parts List publication for your specific vehicle available online at www.hendrickson-intl.com.



HENDRICKSON RECOMMENDED TORQUE VALUES Provided in foot pounds and in Newton Meters

HENDRICKSON RECOMMENDED TORQUE SPECIFICATIONS

Drum Brakes



NO.	COMPONENT	FASTENER		*TORQUE VALUE	
		QUANTITY	SIZE	Foot Pounds	Newton Meters
1.	Torque Plate Hex Bolts to Knuckle	8	¾"	400 ± 50	542 ± 68
2.	Torque Plate Hex Nuts	6	¾"	400 ± 50	542 ± 68

NOTE: For fasteners not supplied by Hendrickson, follow the torque specification listed in the vehicle manufacturer's or the component manufacturer's service manual. Refer to the Parts List publication for your specific vehicle available online at www.hendrickson-infl.com.



SECTION 11 Troubleshooting Guide

STEERTEK NXT High Capacity for Fire and Rescue Vehicles

STEERTEK NXT TROUBLESHOOTING GUIDE		
CONDITION	POSSIBLE CAUSE	CORRECTION
Worn or damaged kingpins and kingpin bushings	Dirt in system– contaminated lubricant	Polish and inspect kingpin, replace bushing and seals, then follow specified lubrication procedures
	Incorrect lubricant	Lubricate axle with specified lubricant
	Axle not lubricated at scheduled frequency	Lubricant axle at scheduled frequency
	Incorrect lubrication procedures	Use correct lubrication procedures
	Lubrication interval not compatible with operating conditions	Change lubrication interval to match operating conditions
	Worn or missing seals	Replace worn or missing seals
Vibration or shimmy of front axle during operation	Caster out of specification	Adjust caster to specification
	Wheels and / or tires out of balance	Balance or replace wheels and / or tires
	Worn shock absorbers	Replace shock absorbers
	Wheel bearing adjustment	Check wheel bearing end play to the vehicle manufacturer’s specifications.
Excessive wear on tires or uneven tire tread wear	Tires have incorrect air pressure	Adjust tire pressure to manufacturer’s specification
	Tires out of balance	Balance or replace tires
	Incorrect axle alignment	Align axles
	Incorrect toe setting	Adjust toe-in to manufacturer’s specification
	Incorrect steering arm geometry	Repair steering system as necessary
	Excessive wheel bearing end play	Check specified wheel nut torque, replace worn or damaged wheel bearings
	Worn suspension components or kingpins	Replace components and / or kingpins
	Wheel bearing adjustment	Check wheel bearing end play to the vehicle manufacturer’s specifications
Vehicle is hard to steer	Low pressure in the power steering system	Repair power steering system
	Steering linkage needs lubrication	Lubricate steering linkage
	Steering knuckles are binding	Check vertical end play
	Incorrect steering arm geometry	Repair steering system as necessary
	Caster out of specification	Adjust caster to specification
	Tie rod ends hard to move	Replace tie rod ends
	Worn thrust bearing	Replace thrust bearing



SECTION 12 Alignment Specifications

STEERTEK NXT High Capacity for Fire and Rescue Vehicles

FRONT SUSPENSION ALIGNMENT SPECIFICATIONS			
CAMBER ¹	DESIGN SPECIFICATION	RANGE	
		MINIMUM	MAXIMUM
LEFT	0.0°±1.0°	-1.0°	+1.0°
RIGHT	-0.25°±1.0°	-1.25°	+0.75°
CROSS	0.0°	—	+2.0°
CAMBER NOTES:			
<ol style="list-style-type: none"> The camber angle is not adjustable. DO NOT bend axle or otherwise try to adjust camber. If found out of specification, notify Hendrickson Tech Services for further information. 			
CASTER ^{1,2}	DESIGN SPECIFICATION	RANGE	
		MINIMUM	MAXIMUM
LEFT	3.75°±1.0°	+2.75°	+4.75°
RIGHT	3.75°±1.0°	+2.75°	+4.75°
CROSS ³	0.0°	—	+1.5°
CASTER NOTES:			
<ol style="list-style-type: none"> Caster is determined with the vehicle at specified ride height for air suspension or at rated load for mechanical suspension systems. It is critical that the vehicle front and rear ride height is within specifications prior to performing a caster measurement or adjustment. See Hendrickson ride height specifications and procedure. In most cases actual vehicle caster is defined with the frame rails at zero slope. Refer to the vehicle manufacturer's specifications for correct frame rail slope. (Both the alignment surface and the vehicle's frame rails should be level during execution of alignment procedures). For vehicles with a positive frame rake (higher in rear) add the frame slope (in degrees) to the caster reading to determine true vehicle caster. The Cross caster angle is not adjustable – DO NOT bend axle or otherwise try to adjust cross caster. If found out of specifications notify Hendrickson Tech Services for further information. Changes to caster can be attained by using caster shims as provided by the vehicle manufacturer or chassis and body manufacturer. Caster shims must match, side to side, to reduce uneven loading to the suspension components. The use of two (2) different angle caster shims will not correct cross caster. Example of caster adjustment: 4.5° RH/5° Left Hand would require one (1), 1.0 shim on each side to increase caster and achieve 5.50° Right Hand/6.00° Left Hand, which is in specification. DO NOT attempt to use uneven shims. 			
Hendrickson recommends the following TMC² practices:			
TOTAL TOE ²	DESIGN SPECIFICATION ¹	RANGE	
		MINIMUM	MAXIMUM
	1/16" ± 1/32" (0.06" ± 0.03")	1/32" (0.03")	3/32" (0.09")
TOE-IN NOTES:			
<ol style="list-style-type: none"> Toe-in is to be set and adjusted in the normal vehicle unladed configuration. Actual vehicle curb weight on the ground. Toe should be checked at the tires front and rear tread center, at a distance above ground equal to the tire's rolling radius. In most instances total toe is set by the vehicle manufacturer or body builder. Consult the vehicle manufacturer for specifications. 			



SECTION 13

Reference Material

This technical publication covers Hendrickson Truck Suspension's recommended procedures for our parts / products. Other components play a major role in overall performance and Hendrickson recommends you follow the specific vehicle manufacturer's recommendation for care and maintenance. Some recommended procedures have been developed by The Technology & Maintenance Council (TMC) and Hendrickson supports these recommendations. We have compiled a list of these below.

TMC

To obtain copies of the following RP's, video's, or charts, contact TMC at:

TMC/ATA
2200 Mill Road
Alexandria, VA 22314

Phone: 703-838-1763
website: tmc.truckline.com
online ordering: www.truckline.com/store

Important References

TMC RP 214B	Tire/Wheel End Balance and Runout
TMC RP 216	Radial Tire Conditions Analysis Guide
TMC RP 219A	Radial Tire Wear Conditions and Causes
TMC RP 222A	User's Guide To Wheels and Rims
TMC RP 230	Tire Test Procedures for Tread wear, Serviceability, and Fuel Economy
TMC RP 514	Pre-Alignment Inspection
TMC RP 618	Wheel Bearing Adjustment Procedure
TMC RP 620B	Front End Alignment Steering Geometry
TMC RP 708A	Trailer Axle Alignment
TMC RP 642	Guidelines For Total Vehicle Alignment
TMC RP 644	Wheel End Conditions Analysis Guide
TMC RP 645	Tie Rod End Inspection and Maintenance Procedure

Video's

TMC T0326	Wheel End Maintenance
TMC T0372	Tire Pre-Trip Inspection Guidelines

Other

TMC T0400	Wheel bearing Adjustment Procedure Wall Chart
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Actual product performance may vary depending upon vehicle configuration, operation, service and other factors.
All applications must comply with applicable Hendrickson specifications and must be approved by the respective vehicle manufacturer with the vehicle in its original, as-built configuration.
Contact Hendrickson for additional details regarding specifications, applications, capacities, and operation, service and maintenance instructions.

*Call Hendrickson at **1.866.755.5968** (toll-free) or **1.630.910.2800** for additional information.*



www.hendrickson-intl.com

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