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July 2005 edition

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FOREWORD

This manual has been developed to provide the owner and operator with service information for the Workhorse Motor Home Chassis. This manual was also designed to familiarize you with your motor home chassis normal operation and usage. Major components and systems are described, and maintenance and inspection procedures given. In addition, providing information for proper maintenance of the motor home chassis, some inspection and diagnostic procedures are included to help detect and identify common conditions that may occur.

This Manual includes the latest information at the time of its printing. Workhorse Custom Chassis reserves the right to make changes to this product after its printing, without further notice.

CUSTOMER AND ROADSIDE ASSISTANCE

Workhorse provides customer and roadside assistance during the New Workhorse Limited Warranty. We have developed one toll free number for customer concerns and roadside assistance **1-877-W-HORSE-1 (1-877-946-7731)**.



Customers with chassis concerns or questions can contact our experienced staff at the listed toll free number. Our experienced staff will assist in resolving all product and service related concerns. They can also be used to locate the nearest Workhorse Custom Chassis Customer Care Center or maintenance facility. Our Customer Care Centers are also listed on our web site, www.workhorse.com/rvs/dealer.asp.

Roadside Service is available through the same customer assistance number. Our roadside assistance is included during the base warranty of 3 years or 36,000 miles, whichever comes first. Our roadside service includes:

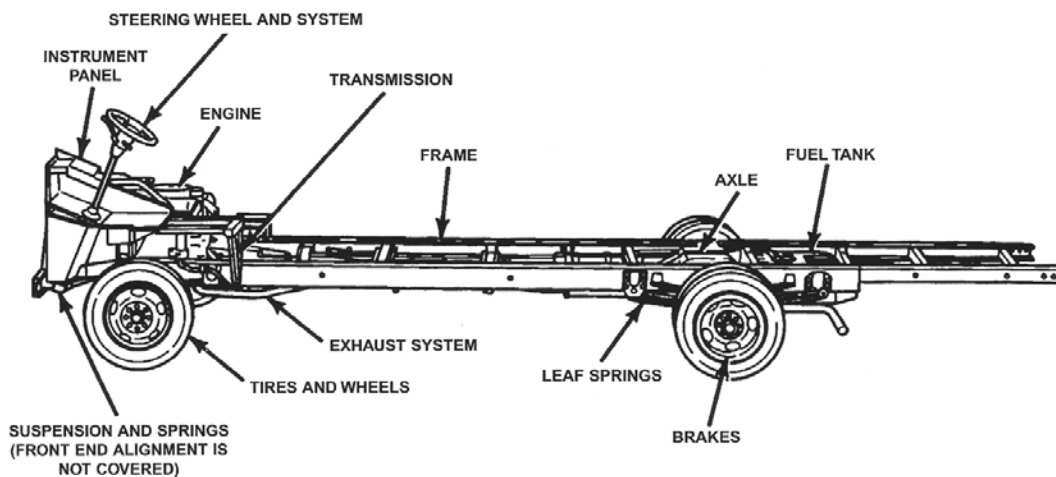
- 24 hours a day, 7 days a week roadside and customer assistance.
- Towing to a Workhorse Custom Chassis Customer Care Center or qualified RV service facility through a nation wide towing network.
- Other emergency services include tire change, jump starts, ignition key replacement and fuel delivery.
- Winching services are also included if vehicle is within 25 feet of legal roadway.

Refer to the Warranty and Owner Assistance Information manual and/or the Owner's Manual for further details.

WORKHORSE CUSTOM CHASSIS LIMITED WARRANTY

BASIC CHASSIS COVERAGE

New Workhorse Custom Chassis are covered for 3 years or 36,000 miles, whichever comes first. This covers the complete chassis as delivered to the body manufacturer including engine, transmission, suspension, axle, etc. (see example below). The Allison™ 1000MH and 2100MH 5 or 6-speed transmissions (W Series chassis with 20,700 GVWR or higher) are covered by a 5 year - 200,000 mile warranty, whichever comes first, beginning April 6, 2005 VIN 409091. Prior to this date and after January 2, 2004 the Allison™ transmission warranty was for 2 years or 80,000 miles. The LCT1000 used in W Series chassis beginning in 2001 model year to January 1, 2004 were covered by a 3 year unlimited mileage warranty. The Allison™ warranty is administered by Allison™ and performed by certified Allison™ repair facilities. You can contact Allison™ Worldwide Assistance at: (317) 242-3538, for more detailed warranty information. The New Workhorse Limited Warranty covers repairs to correct any defects related to materials or workmanship occurring during the warranty coverage period. Needed repairs will be performed using new or remanufactured parts.



Roadside assistance is also included in basic chassis coverage. Roadside assistance will arrange towing to the nearest Workhorse Custom Chassis Dealer or qualified repair facility if vehicle cannot be driven because of a warranty defect within the base warranty period. Please refer to Customer and Roadside Assistance, in this manual, and/or your Warranty and Owner Assistance Manual or Owner's Manual for further details.

DIESEL ENGINES

Workhorse Custom Chassis offered an optional diesel engine in the P Series chassis from 1999-2003. The 6.5L Diesel engine is covered for 5 years or 100,000 miles, whichever comes first. A \$100 deductible is applicable per visit after the expiration of the base warranty that is 3 years or 36,000 miles, whichever comes first.

EMISSIONS CONTROL SYSTEM WARRANTIES

Emissions Defect Warranty relates to defects in materials and workmanship to components designed, equipped and built so as to conform at the time of sale with applicable regulations of the Federal Environmental Protection Agency (EPA). A detailed emission warranty parts list is provide in the Warranty and Owner Assistance Information Manual and/or the Owner's Manual.

The Heavy Duty Emission Defect Warranty is for 5 years or 50,000 miles, whichever occurs first, on all gasoline chassis greater than 8,500 lbs. GVWR and on diesel chassis up to 19,500 lbs. GVWR. Chassis with diesel engines greater then 19,500 lbs. GVWR are

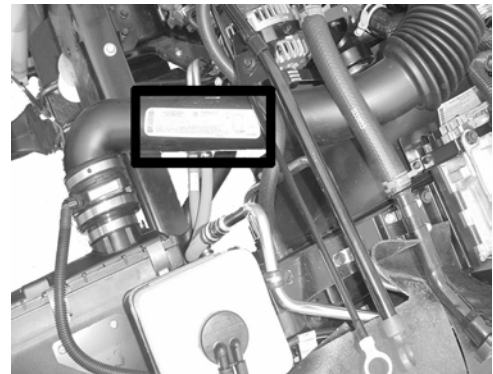
covered for 5 year or 100,000 miles, whichever occurs first.

Emission Control Systems Warranties*									
Coverage	2 YRS/ 24,000 MI	3 YRS/ 36,000 MI	3 YRS/ 50,000 MI	5 YRS/ 50,000 MI	5 YRS/ 100,000 MI	7 YRS/ 70,000 MI	8 YRS/ 80,000 MI	Chassis Life	
Federal									
• Gasoline Engines Heavy Duty Emission Control									
• 6.5L Diesel Engine									
California									
• Gasoline Engines									
- Medium Duty Emission Control System									
- Specified components									
- Heavy Duty Emissions Control System									
• Heavy Duty Diesel Engines									
Noise Emissions									
• Applicable to chassis over 10,000 lbs. GVWR only									

Defects in materials or workmanship of emission warranted parts continue to be covered under the 6.5L Diesel engine subject to a \$100 deductible charge.

Refer to Warranty and Owner Assistance Information manual and/or the Owner's Manual for specific warranty coverage for vehicles registered in California.

Emissions Performance Warranty relates to states or local jurisdictions that have established periodic vehicle Inspection and Maintenance (I/M) programs. In some jurisdictions, the I/M program requires the verification of the emission certification label. The black rectangle box in the adjacent picture shows a top view of the location of the certification label on all Workhorse RV Chassis.



If an EPA approved I/M program is required in your area, you may also be eligible for Emissions Performance Warranty coverage when the following three conditions are met:

- The vehicle has been maintained and operated in accordance with the instructions for proper maintenance and use set forth in the Owner's Manual.
- The vehicle fails an EPA-approved I/M test during the emission warranty period.
- The failure results, or will result, in the owner of the vehicle having to bear a penalty of other sanctions (including the denial of the right to use the vehicle) under local, state or federal law.

If all these conditions are met, Workhorse Custom Chassis warrants that your dealer will replace, repair, or adjust to Workhorse Custom Chassis specifications, at no charge to you, any of the emission warranty parts list that is provided in the Warranty and Owner Assistance Information Manual and/or the Owner's Manual.

DELAYED WARRANTY START AND CHASSIS IDENTIFICATION

POINTS TO NOTE REGARDING DELAYED WARRANTY

Workhorse offers a warranty extension to compensate for reasonable time and mileage while the motor home chassis is at the Body Company, during delivery, and in the dealer inventory. This extension is referred to as Delayed Warranty Start and applies to new motor homes chassis only, dealer demos excluded. The maximum extension of the delayed warranty start is the lesser of 24 months or 6,000 miles from the original date sold to the body manufacturer. The date sold is normally within a few days of the build date. The chassis build date along with the VIN is found on the label shown in the adjacent picture.



Typical Label Location

The selling Recreational Vehicle Dealer is responsible to notify Workhorse Custom Chassis when a new motor home is sold to its first retail owner. This notification is through a form that is included with the Workhorse box build information which is shipped to each body builder. This form is known as the Delayed Warranty Start Form. Once this form is received from the selling dealer and is within the limits of eligibility, Workhorse updates our warranty systems to reflect the date and mileage the vehicle placed in service (i.e. sold to first retail owner). If the Delayed Warranty Start Form was not completed on purchase of the vehicle and the vehicle was purchased within the extension period, Workhorse will review all requests to update the Delayed Warranty Start date and mileage. Included in the bulletin section of this manual is a Delayed Warranty Start Form that can be completed by the owner and submitted to Workhorse for consideration along with documentation showing vehicle sold as new.

SERVICE PARTS IDENTIFICATION LABEL

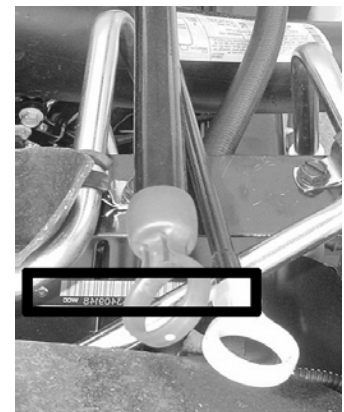
The Service Parts Identification Label, SPID, is provided with all Workhorse chassis. The body manufacturer installs this label on an inner body panel. Typically, the label can be found on the inner wall left of the driver's seat. This label lists vehicle identification number, wheelbase, and all production options or special equipment on the chassis when it was shipped from the factory. This label is a great resource when order any parts for the chassis.

VEHICLE IDENTIFICATION NUMBER (VIN)

The VIN is the legal identification of the chassis. On the Workhorse Chassis the VIN plate is located on top of the radiator core support, although it may be moved by the body manufacturer. The adjacent picture shows the standard location of the VIN plate. On page 7 is a numbering system chart to assist in deciphering the VIN number.

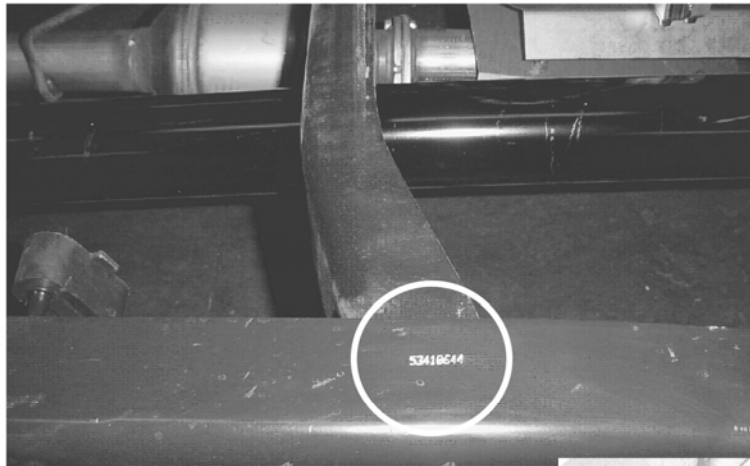
Workhorse vs. Chevrolet VINs

- First three characters of a Chevrolet Motor home Chassis VIN are "1GB".
- First three characters of a Workhorse Custom Chassis VIN are "5B4".

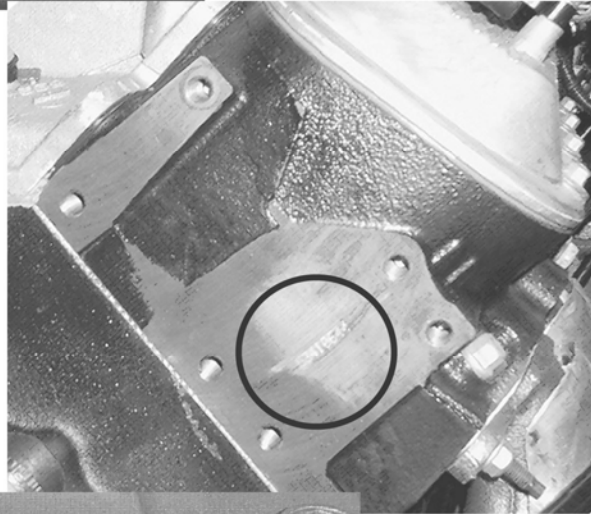


VIN Identification Plate

The VIN number is also located in other places on your motor home chassis. Refer to the following pictures for a few of those locations.



**RH FRAME RAIL
BEHIND TRANSMISSION**



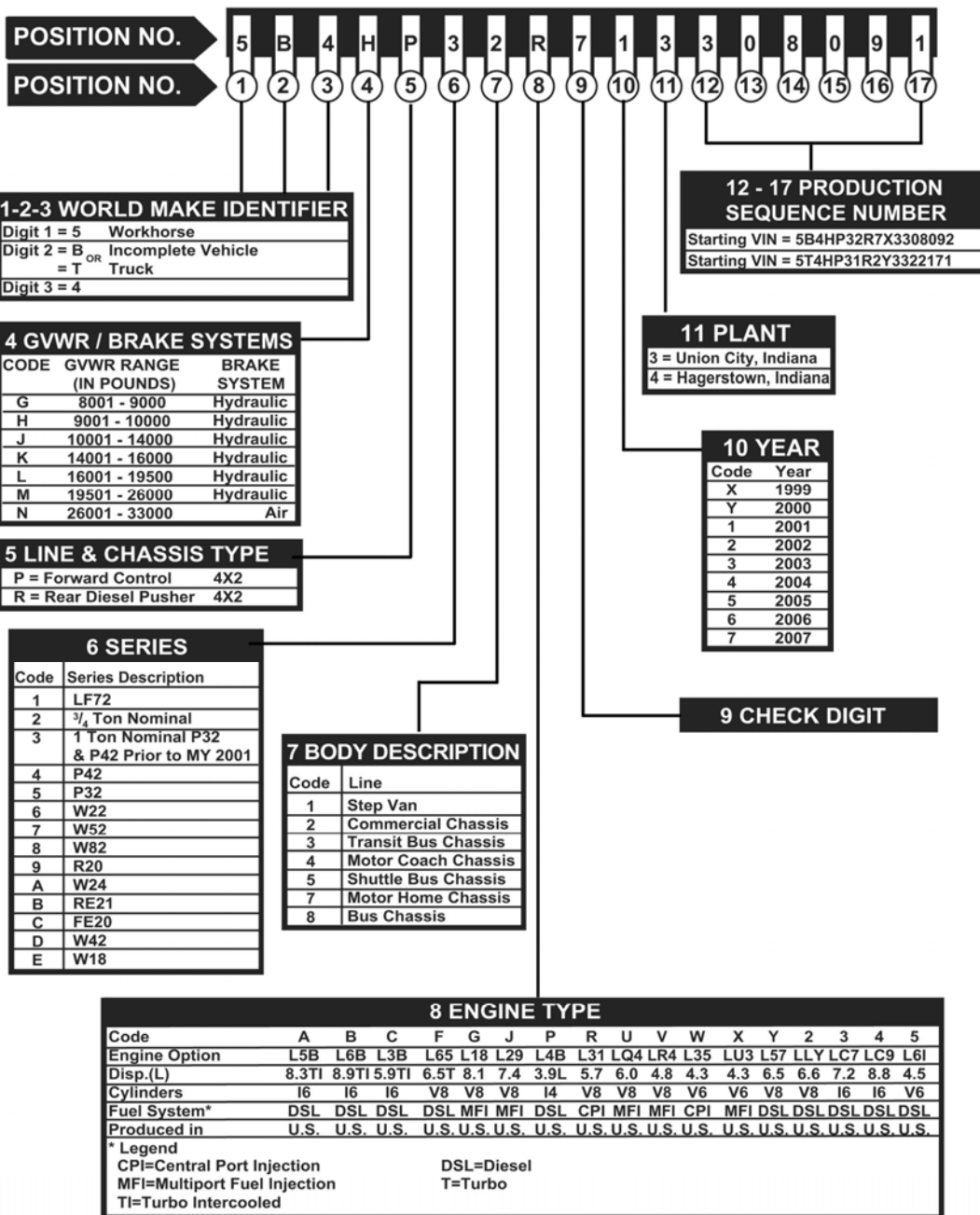
**REAR OF RH
CYLINDER HEAD**



**TOP OF
TRANSMISSION CASE**



WORKHORSE 2006 MOTOR HOME CHASSIS, COMMERCIAL/BUS CHASSIS, AND INTEGRATED VEHICLE VEHICLE IDENTIFICATION NUMBERING SYSTEM



WEIGHT LABELS, TERMS AND DEFINITIONS

Most body manufacturers now include weight labels that list the actual weight as well as capacities of your motor home in various stages of loading. Although some manufacturers have provided this information for a number of years, these labels have become more common since September of 2000 when RVIA (Recreational Vehicle Industry Association) members were required to install a standard weight label. These weight labels include various terms and show your motor home in various loaded conditions indicating the approximate carrying capacity(s) of your motor home. This label is generally found on the backside of a cabinet or closet door.

GVWR - *Gross Vehicle Weight Rating*: The maximum weight the chassis was designed to carry including cargo, fluids, and passengers. This does not include the weight of any item being towed but does include the tongue weight of towed item.

GAWR - *Gross Axle Weight Rating*: The maximum amount of weight on a single axle. This is measured between the ground and all the tires on a single axle.

GCWR - *Gross Combination Weight Rating*: The maximum amount of combined weight of the chassis including cargo, fluids and passengers as well as any item that is being towed (trailer, boat, vehicle, etc.).

UVW - *Unloaded Vehicle Weight*: The weight of the vehicle as it leaves the body manufacturers factory with full fuel (5.6 pounds per gallon-gas, 6.8 pounds per gallon-diesel), engine oil, and coolant. This does not include dealer-installed options.

NCC - *Net Carrying Capacity*: The maximum weight of all personal belongings, food, fresh water, LP gas, dealer installed accessories, people, etc. that can be carried by the vehicle. This is usually calculated by subtracting the UVW from the GVWR. On RVIA labels this has been replaced by CCC (Cargo Carrying Capacity).

SCWR - *Sleeping Capacity Weight Rating*: The manufacturers designated sleeping positions of the motor home. This rating is calculated by multiplying the number of sleeping positions by 154 pounds (70kg) and is utilized in calculating the CCC.

CCC - *Cargo Carrying Capacity*: This rating is the remaining weight the vehicle can carry with full fresh water, full water heater, full LP tank and the SCWR. This rating is calculated by adding the fresh water capacity times 8.3 pounds (3.8kg) per gallon, LP capacity times 4.5 pounds (2kg) per gallon, the SCWR and the UVW then subtracting the sum from the GVWR. This does not take into account dealer installed options.

These labels give a great estimate of the actual vehicle weight and its carrying capacity but they cannot substitute for getting the vehicle weighed. The weights listed are mostly calculations and can be based on approximate base weights. Most of these labels do not give individual weights on each tire nor do they account for dealer-installed options such as awnings, satellite dishes, washer/dryers, etc.

TOWING CAPACITIES

The term "GCWR", gross combination weight rating, is a new term to be learned when the motor home operator decides to enter into the "world of towing." GCWR refers to the maximum combined weight of the motor home with all its contents plus the weight of the trailer, car, boat, or whatever is being towed. The GCWR for Workhorse Chassis vary based on the model year and GVWR of the chassis. Please refer to the following section "1999-2006 Workhorse Recreational Vehicle Chassis," to determine your GCWR, you must know the GVWR and model year, or refer to the MVSS label in your motor home.

To calculate a WCC Motor Home Chassis towing capacity it is a simple calculation. Take the GCWR and subtract the "actual motor home weight," which must be equal or be less than the GVWR, the difference will equal the towing capacity (i.e. **GCWR – Actual weight of motor home = Maximum towing capacity**). Actual motor home weight refers to the motor home loaded for travel including fuel, water, propane, food, clothing, kitchen utensils, passengers etc. Below is an example of how to calculate your towing capacity once you have loaded and weighed your motor home.

Example: A 2006 Workhorse chassis with a 22,000 lb. GVWR has a GCWR of 26,000 lbs. The completed motor home fully loaded, including passengers, water, LP, etc., weighs 21,000 lbs. (actual weight). Subtract actual weight of 21,000 lbs. from the GCWR of 26,000 lbs., equaling 5,000 lbs. towing capacity. The same vehicle loaded to the maximum GVWR, 22,000 lbs., would have a towing capacity of 4,000 lbs., 26,000 GCWR subtract 22,000 (actual loaded weight) equaling 4000 lbs.

Note: To help avoid personal injury due to poor braking action, adequate trailer brakes are required on trailers or vehicles over 1000 pounds loaded weight.

CAUTION:

Workhorse Custom Chassis does not provide the receiver hitches that are normally included on motor homes. If ratings are listed on the hitch, this is typically the rating of the hitch not necessarily the actual towing capacity of the vehicle, make adjustment when required.

NOTICE:

Improper wiring to towed unit can cause chassis and towed unit electrical problems. Towed unit wiring is often added and is often spliced into Workhorse Chassis wiring. Towed unit electrical requirements above 6 amps that is spliced into chassis wiring can overload the chassis turn signal and/or 4 way flasher switch resulting in switch continued failure. There are market kits that use relays such that the operating current does not go through the turn signal or 4-way flasher switch. These relay kits are recommended in place of cutting into chassis wiring.

TOWING ACCESSORY PROVIDERS

Following is a list of manufacturers producing vehicle tow bars and/or braking systems. This was provided for motor home owner's convenience, Workhorse Custom Chassis has not approved nor are we able to recommend a manufacturer of these accessories.

- Automatic Equipment Mfg. Co. (402) 385-3051; www.aemfg.com
- Demco (Dethmers Mfg. Co.) (800) 543-3626; www.demco-products.com
- Master Concepts Inc. (800) 470-2287; www.brakebuddy.com
- Night Shift Auto Inc. (800) 933-3372; www.readybrake.com
- Remco (Recreational Equipment Mfg. Corp.) (800) 228-2481; www.remco-towing.com
- Roadmaster (800) 669-9690; www.roadmasterinc.com
- SMI Marketing Inc. (800) 893-3763; www.smibrake.com
- Tow Brake International LTD. (800) 927-6778; www.towbrake.com
- U.S. Gear Corp. (800) 874-3271; www.usgear.com
- Blue Ox Products (888) 425-5382; www.blueox.us

Towing World www.towingworld.com tow bars, towed vehicle braking systems and towable vehicle information).

2006 -1999 WORKHORSE RECREATIONAL VEHICLE CHASSIS

MOTOR HOME CHASSIS SPECIFICATIONS

Workhorse has offered a variety of Gross Vehicle Weight Rating (GVWR), axle rating and configurations, as well as wheelbases. The following charts detail these offerings by chassis model year.

GVWR	FRONT GAWR	REAR GAWR	GCWR	WHEEL TRACK	WHEELBASES	SERIES
All weight ratings pounds				Front-Inches	Inches	
2006 Model Year						
16,000	6,500	10,500	22,000*	83.54	158.5, 178, 190, 208, 228	W16
18,000	7,000	12,000	22,000*	83.54	158.5, 178, 190, 208, 228	W18
20,700 <i>Optional</i>	7,500	13,500 <i>14,500</i>	26,000	82.56	190, 208, 228	W20
22,000 <i>Optional</i>	8,000 <i>8,500</i>	14,500 <i>15,000</i>	26,000	82.56	208, 228, 242	W22
24,000	9,000	15,500	30,000	82.56	208, 228, 242	W24
2005 Model Year						
15,000	6,000	10,000	19,000	82.95	158.8, 178, 190, 208	P
17,000	6,000	11,000	22,000	82.95	178, 190, 208, 228	P
18,000	6,000	12,000	22,000	82.95	178, 190, 208, 228	P
20,700 <i>Optional</i>	7,500	13,500 <i>14,500</i>	26,000	82.56	190, 208, 228	W20
22,000 <i>Optional</i>	8,000 <i>8,500</i>	14,500 <i>15,000</i>	26,000	82.56	208, 228, 242	W22
24,000	9,000	15,500	30,000	82.56	208, 228, 242	W24
2004 Model Year						
14,800	5,500	10,000	19,000	69.7	158.8, 178, 190, 208	P
15,000	6,000	10,000	19,000	82.95	158.8, 178, 190, 208	P
17,000	6,000	11,000	22,000	82.95	178, 190, 208, 228	P
18,000	6,000	12,000	22,000	82.95	178, 190, 208, 228	P
20,700 <i>Optional</i>	7,500	13,500 <i>14,500</i>	26,000	82.56	190, 208, 228	W20
22,000 <i>Optional</i>	8,000 <i>8,500</i>	14,500 <i>15,000</i>	26,000	82.56	208, 228, 242	W22
24,000	9,000	15,500	30,000	82.56	208, 228, 242	W24

* W16 and W18 chassis equipped with the 6.0L engine have a GCWR of 20,000 lb.

BOLD indicates new model or option introductions

GVWR	FRONT GAWR	REAR GAWR	GCWR	WHEEL TRACK	WHEELBASES	SERIES
All weight ratings pounds				Front-Inches	Inches	
2003 Model Year						
12,300	4,880	7,500	19,000	69.7	158.8	P
14,800	5,500	10,000	19,000	69.7	158.8, 178, 190, 208	P
15,000	6,000	10,000	19,000	82.95	158.8, 178, 190, 208	P
17,000	6,000	11,000	22,000	82.95	178, 190, 208, 228	P
18,000	6,000	12,000	22,000	82.95	178, 190, 208, 228	P
20,700 <i>Optional</i>	7,500	13,500 <i>14,500</i>	26,000	82.56	190, 208, 228	W20
22,000 <i>Optional</i>	8,000 <i>8,500</i>	14,500 <i>15,000</i>	26,000	82.56	208, 228, 242	W22
2002 Model Year						
12,300	4,880	7,500	19,000	69.7	158.8	P
14,800	5,500	10,000	19,000	69.7	158.8, 178, 190, 208	P
15,000	6,000	10,000	19,000	82.95	158.8, 178, 190, 208	P
17,000	6,000	11,000	21,000	82.95	178, 190, 208, 228	P
18,000	6,000	12,000	21,000	82.95	178, 190, 208, 228	P
20,700 <i>Optional</i>	7,500	13,500 <i>14,500</i>	26,000	82.56	208, 228	W20
22,000 <i>Optional</i>	8,000 <i>8,500</i>	14,500	26,000	82.56	208, 228	W22
2001 Model Year						
12,300	4,880	7,500	19,000	69.7	158.8	P
14,800	5,500	10,000	19,000	69.7	158.8, 178, 190, 208	P
15,000	6,000	10,000	19,000	82.95	158.8, 178, 190, 208	P
17,000	6,000	11,000	21,000	82.95	178, 190, 208, 228	P
18,000	6,000	12,000	21,000	82.95	178, 190, 208, 228	P
20,700 <i>Optional</i>	7,500	13,500 <i>14,500</i>	26,000	82.56	208, 228	W20
22,000	8,000	14,500	26,000	82.56	208, 228	W22
2000 Model Year						
12,300	4,880	7,500	19,000	69.7	158.8	P
14,800	5,500	10,000	19,000	69.7	158.8, 178, 190, 208	P
15,000	6,000	10,000	19,000	82.95	158.8, 178, 190, 208	P
16,500	5,500	11,000	21,000	69.7	178, 190, 208, 228	P
17,000	6,000	11,000	21,000	82.95	178, 190, 208, 228	P
18,000	6,000	12,000	21,000	82.95	178, 190, 208, 228	P
1999 Model Year						
12,300	4,880	7,500	19,000	69.7	158.8	P
14,800	5,500	10,000	19,000	69.7	158.8, 178, 190, 208	P
16,500	5,500	11,000	21,000	69.7	158.8, 178, 190, 208, 228	P

BOLD indicates new model or option introductions

ENGINE AND TRANSMISSION SPECIFICATIONS

Workhorse has offered a variety of engines and transmissions based on the chassis configuration and model year. Below is a chart detailing these offerings by chassis and model year.

MODEL YEAR	SERIES / GVWR (in lbs.)	ENGINE OFFERED	ENGINE RATINGS	TRANSMISSION OFFERED	GEARS
2006	W16 / W18 16,000/18,000	8.1L Vortec 496 cid	340 horsepower @ 4200 rpm 455 ft-lb torque @ 3200 rpm	GM 4L85E	4
2006 optional	W16 16,000	6.0L Vortec 364 cid	300 horsepower @ 4400 rpm 360 ft-lb torque @ 4000 rpm	GM 4L80E	4
2006 optional	W18 18,000	6.0L Vortec 364 cid	300 horsepower @ 4400 rpm 360 ft-lb torque @ 4000 rpm	GM 4L85E	4
2006	W20 / W22 20,700/22,000	8.1L Vortec 496 cid	340 horsepower @ 4200 rpm 455 ft-lb torque @ 3200 rpm	Allison™ 1000	6
2006	W24 24,000	8.1L Vortec 496 cid	340 horsepower @ 4200 rpm 455 ft-lb torque @ 3200 rpm	Allison™ 2100	6
2005	P Series 15,000–18,000	8.1L Vortec 496 cid	340 horsepower @ 4200 rpm 455 ft-lb torque @ 3200 rpm	GM 4L85E	4
2005-2001	W20 / W22 20,700/22,000	8.1L Vortec 496 cid	340 horsepower @ 4200 rpm 455 ft-lb torque @ 3200 rpm	Allison™ 1000	5
2005-2004	W24 24,000	8.1L Vortec 496 cid	340 horsepower @ 4200 rpm 455 ft-lb torque @ 3200 rpm	Allison™ 2100	5
2004	P Series 14,800–18,000	8.1L Vortec 496 cid	340 horsepower @ 4200 rpm 455 ft-lb torque @ 3200 rpm	GM 4L85E	4
2003	P Series 12,300–18,000	8.1L Vortec 496 cid	340 horsepower @ 4200 rpm 455 ft-lb torque @ 3200 rpm	GM 4L85E	4
2003-2002 optional	P Series 12,300–18,000	6.5L Turbo Diesel	195 horsepower @ 3400 rpm 430 ft-lb torque @ 1800 rpm	GM 4L80E	4
2002-2001	P Series 12,300–18,000	8.1L Vortec 496 cid	340 horsepower @ 4200 rpm 455 ft-lb torque @ 3200 rpm	GM 4L80E	4
2002-2001 optional	P Series 12,300–14,800	5.7L Vortec 350 cid	235 horsepower @ 4000 rpm 325 ft-lb torque @ 2800 rpm	GM 4L80E	4
2001-2000 optional	P Series 12,300–18,000	6.5L Turbo Diesel	190 horsepower @ 3400 rpm 385 ft-lb torque @ 1700 rpm	GM 4L80E	4
2000	P Series 12,300– 18,000	7.4L Vortec 454 cid	290 horsepower @ 4000 rpm 410 ft-lb torque @ 3200 rpm	GM 4L80E	4
1999	P Series 12,300–16,500	7.4L Vortec 454 cid	290 horsepower @ 4000 rpm 410 ft-lb torque @ 3200 rpm	GM 4L80E	4
1999 optional	P Series 12,300–16,500	6.5L Turbo Diesel	190 horsepower @ 3400 rpm 385 ft-lb torque @ 1700 rpm	GM 4L80E	4

BOLD indicates new model and/or option introductions

RV WEIGHTS AND LOADING

ABOUT RV WEIGHTS

A discussion of recreational vehicle weight ratings, how they are determined, and how exceeding these figures can affect the operation of the vehicle.

By C. JAY HAYNOR, F15585 (JAN, 1992)

Technical Editor

Recently, Paul, a friend of mine who owns a large auto parts warehouse, was talking with me about one of his delivery trucks. The truck was a 1986 model with a gross vehicle weight rating (GVWR) of 11,000 pounds. The same chassis is used by motor home manufactures to build Class C coaches. The truck gave excellent service for eight months. Not too long after that, however, all of the drive-shaft universal joints wore out, and multiple disc brake pad and rear brake shoe replacements were necessary. These and other repairs were causing Paul some concern. He noted that the front tires were cupped severely, and rear tires had sidewall cracks. Paul's question to me was, "Why?"

When I talked with a few of the employees, they confirmed my suspicions. It seems that one of the salesmen was selling to a new account and used this truck to deliver some of the "parts." The "parts" included pallets of oil, transmission fluid, and batteries. The truck was overloaded and equally important, subjected to poor weight distribution. The load on the rear tires was excessive, thereby cracking the sidewalls on the rear tires. The excessive rear load also lowered the rear of the truck, thereby raising the front. Because of that, the front tires made less contact with the road, and cupping resulted. This reminded me of pictures I once saw of a Federal Express airplane that was so heavily loaded in the rear that the front of the plane actually lifted well off the ground. The truck instance, though not as dramatic, was an example of the same type of overload condition. And many of the other mechanical difficulties that the truck began to experience could be attributed to overloading.

If the major components of a chassis including; engine, transmission, brakes, axles, tires, and frame are components that are overloaded; their life expectancy diminishes rapidly.

In the "good old days" weight ratings were more guidelines than rigid "to the ounce" specifications. Then, along came the energy crunches of the 1970's. As a result, fuel economy and production costs became critical. Automobile manufactures and RV manufactures found that one of the fastest and easiest ways to increase fuel economy and to reduce production costs was to lighten the vehicles wherever they safely could. Today, more than ever before, it is of the utmost importance that we pay more attention to technical definitions and weights as they relate to our homes on wheels.

One of the organizations involved in establishing definitions that motor home manufacturers and chassis builders' use is the Recreation Vehicle Industry Association (RVIA). The weight issue is equally important to consumers. So, let's consider some of the definitions that we coach owners should understand before taking the next step, which is actually weighing our motor home's.

Two definitions exist for the term chassis as it applies to motor homes. In the case of a Class A motor home, the chassis consists of the frame, running gear, steering, and suspension system. In the case of a Class C or micro-mini-motor home, the chassis include the same components as does a Class A motor home chassis plus a cab.

From the definitions above, we can clearly see that the chassis is separate from the body or coach in a Class A motor home and separate from the motor home body in a Class C coach. It is the chassis manufacturer that determines the weight ratings and load specifications. The only exception would be if the chassis were modified and recertified by the company performing the modification. This would be indicated on a label positioned near the original label on the coach. The location of these labels varies from vehicle to vehicle.

Gross vehicle weight rating (GVWR) is the weight specified by the chassis manufacturer as the maximum loaded weight of the vehicle (including driver and passengers). Sometimes a tag axle-a non-powered rear axle-is added to a chassis. This usually is done to increase the GVWR of the chassis, and as previously mentioned it becomes the responsibility of that party to post and certify the new GVWR. The addition of axles does not increase GCW.

Gross axle weight rating (GAWR) is specified by the chassis manufacturer as the load carrying capacity of a single-axle system as measured at the tire-ground interface (in other words, at the place where the tire meets the ground). It is important to note that the GAWR is limited to the lowest individual rating of the tires, the wheels, the springs, or the axle-in other words, whichever component is the weakest link in the chain. Therefore, changing from load range D to load range E or F tires may or may not increase the GAWR, since this rating could be dependent upon other (weaker) components. The GAWR assumes that the weight is evenly distributed over the axle with 50 percent on the right side and 50 percent on the left side-not 70/30, for instance. In other words, in the case of an axle with GAWR of 6,000 pounds, the load distribution should be 3,000 pounds on one side and 3,000 pounds on the other.

Axle weight is both the amount of weight carried by a single axle and the amount of weight transmitted to the highway by one axle.

Shipping weight is the average weight of a specific vehicle as it leaves the assembly plant, including grease and oil plus regular production options but without any primary mover engine fuel (gasoline or diesel fuel).

Empty weight is defined as the shipping weight of a specific vehicle plus the maximum weight of primary mover engine fuel (gasoline or diesel fuel).

Curb weight is the weight of the vehicle empty (without payload and driver) but including engine fuel, coolant, engine oil, tools, spare tire, and all other standard equipment. It is determined without water in the tanks or water heater, and with empty LP-gas containers. (Note: This definition, while accepted within the RV industry, may differ from definitions utilized by governmental regulatory agencies).

Wet weight is the empty weight of a specific vehicle with the fresh water tanks, water heater, and LP-gas containers full with wastewater holding tanks empty. This weight is particular significant to motor home owners, because when you subtract this figure from the gross vehicle weight rating, you have a fairly accurate indication of the amount of weight that can be added to the vehicle, including driver and passengers, clothing, food, etc.

Payload is a term commonly used in the trucking industry. In the RV industry, the term carrying capacity also is used. Carrying capacity is defined as the average weight that can be added to a specific vehicle without exceeding the GVWR. Carrying capacity can be computed by subtracting the empty weight of the vehicle from the GVWR figure. The addition of any other equipment or cargo and passengers adds to the vehicle from the GVWR figure. The addition of any other equipment or cargo and passengers adds to the vehicle weight and subtracts from the allowable carrying capacity. It is important to remember that the limiting factor in this rating could be the axles, springs, tires, transmission parking pawl, or any other equipment.

Center of gravity is the point where the weight of the chassis and/or body and payload is concentrated and if suspended at that point would balance front-to-rear and side-to-side. Cornering, acceleration and other forces are considered as acting on a vehicle's center of gravity. Thus, it has a great influence on body lean and other handling characteristics. Even if all of the weights fall within the specifications, if they are not distributed properly, the coach could still suffer from excessive body lean or substandard handling characteristics. It should be noted that the center of gravity of a basement model coach would be higher than that of a traditionally designed motor home.

Weight distribution is the arrangement of body and payload weight on a vehicle's chassis. It has a very definite bearing on the life of the tires, axles, springs, frame, and other parts. The fact that the total weight of the vehicle does not exceed the recommended maximum GVWR does not insure that the coach is not overloaded. Overloading can be due to improperly positioning heavy materials so that the load is centered over one rear tire or so far forward on the body that the front axle and tires are overloaded. An understanding of the proper methods of load placement will enable coach owners to prevent an overload condition. It should be noted also that the limiting factor is the weight rating, not the cubic foot capacity of the storage compartments. Some motor home owners may be under the space; it must be acceptable for them to fill each nook and cranny to capacity. This isn't always the case, however. By providing varied and ample storage space, motor coach manufacturers are attempting to meet a multitude of needs.

Weighing your coach. Of course, the only way to be sure to avoid an overload condition is to weigh the coach. To do so accurately, the coach owner needs to find a scale that has a level area on the side, and to develop an excellent rapport with the person doing the weighing. The level side area is very important, because it will be necessary to have 50 percent of the left and right sides of the coach off the scale during some of the weighing. If the side area is not level, side weights will be incorrect. Suitable scales might be found at stops, sand and gravel pit operations, and moving companies.

I would suggest that you make a photocopy of the coach weighing worksheet that accompanies this article and use it as a reference at the scale. Weigh the coach at an off time, since the entire process can take up to one-half hour. Before weighing the coach, load it as you normally would for travel, including food, clothing, fuel, water, propane, etc. This is not the time to be conservative!

The worksheet divides the coach into four sections. This is done by finding the halfway point between the front and rear tires (axles) and the halfway point between the front tires and then the halfway point between the rear tires. Do not simply use the distance between the front and rear of the coach body; be sure to use the axles as a reference point. Use tape to make the side-

to-side halfway points on the front bumper and on the rear bumper to make the reference points easily visible. Do the same for the front-to-rear halfway points by applying tape to the side of the coach. Drive the coach onto the scale to the point that the front-to-rear tape pieces indicate that one-half of wheelbase is on the scale and one-half is off. Referring to the worksheet, this will be weight number W1.

Next, drive the entire motor home onto the scale. This will be weight number W2. Then drive off the scale so that the side tape stripe indicates that the rear half of the chassis remains on. This will be weight W3. I emphasize that it is important that one-half of the chassis, not the coach, rests on the scale during weighing.

Weight number W1 should not exceed the GAWR for the front axle. Weight number W2 should not exceed the total GVWR. Weight number W3 should not exceed the rear axle GAWR.

Now comes the time when rapport with the scale attendant and patience come in handy. To make these weights more meaningful, use the side-to-side and front-to-rear tape pieces to divide the chassis up into quarters and then weigh each section: front left, weight zone W4; rear left, weight zone W6; front right, weight zone W5; and finally rear right, weight zone W7. The weights for zone W4 and zone W5 should be about equal, as should the weights for zones W6 and W7. If this is not the case, try to move items inside the coach to bring the weights close.

When you compare the total weight of the two front quarters to the total axle weight, the figures probably will not be exactly equal, but they should be close. The same applies to the rear axle. It is also possible that the front and rear GAWR when totaled will be more than the GVWR. This is because the limiting factor may be something such as the transmission parking pawl, braking capacity or another component.

Since tire manufacturers determine pressure recommendations for each individual tire based on the weight that a particular tire is carrying, these quartered weights are very important. Use the front and rear axle weights on the work sheet to determine the proper air pressure by the consulting the tire manufacturer's manual, which should be available at any tire store.

One last word of caution: start with the weight you would normally carry when traveling. If the weight places the vehicle over GVWR, remove some weight and weigh the coach again. The importance of weight and weight distribution in terms of safety and your motor home's overall health cannot be overemphasized.

Another term with which motor home owners should be familiar is gross combination weight rating (GCWR), which is the value specified by the chassis manufacturer as the maximum allowable total loaded weight of the tow vehicle and trailer combination. For our purposes the tow vehicle is the motor home, and the trailer ordinarily is a towed car. To determine what size car can be towed safely behind a motor home, subtract the actual motor home weight, which must be less than the GVWR, from the GCWR. Normally this weight will be approximately 3,000 pounds, in which case the towed car combination (including trailer, dolly or tow bar) should not exceed 3,000 pounds. Weigh the tow car as you normally tow it, and if you find that it is overloaded, remove any weight necessary to bring it into specifications.

I hope this short discussion of motor home weights will motivate you to weigh your coach and make any necessary adjustments.

COACH WEIGHING WORKSHEET

WEIGH IN ORDER USING THE "W" NUMBERS	RATING	ACTUAL	DIFFERENCE	W4 LEFT FRONT ZONE W4	W5 RIGHT FRONT ZONE W5
	GAWR	WEIGHT	+ OR -		
W1	FRONT	_____	_____	_____ WEIGHT	_____ WEIGHT
W2	REAR	_____	_____		
W3	TOTAL GVWR	_____	_____	_____ PSI TIRE CHART	_____ PSI TIRE CHART
NOTES: Coach should be loaded normally Including passengers				W6 LEFT REAR ZONE W6 _____ WEIGHT _____ PSI TIRE CHART	W7 RIGHT REAR ZONE W7 _____ WEIGHT _____ PSI TIRE CHART

PROPER LOADING

Workhorse suggests weighing your motor home before loading to verify front axle, rear axle and side-to-side weights. Once armed with this information you will be able to load your motor home within specifications of the chassis and possibly correct for any side-to-side weight differences. After loading we suggest to weigh your motor home again to verify you're within specifications and the weight is properly distributed throughout the coach. For details on the how to weigh your motor home refer to RV Weights & Loading section, "About RV Weights".

After verifying correct weight distribution of your fully loaded motor home we suggest the vehicle wheel alignment is checked and adjusted if required. Although your motor home is aligned at our assembly plant and again at the body manufacturer's assembly plant, the alignment can be affected by normal loading of your belongings. Please refer to the wheel alignment and tire inflation sections prior to having your chassis aligned for addition information regarding proper alignment specifications, tire pressure and air bags (air bags on P Series only).

LOADING CONDITIONS AND CORRECTIONS

Unusual load conditions can affect the ride and handling of the vehicle. If unusual loading is apparent, it will usually become visible in the form of a lean and/or low suspension, or through poor handling characteristics. A detailed explanation of how to check the distribution of weight and the effects of improper loading can be found in the front of this section, RV Weights and Loading “About RV Weights”.

The importance of a near equal axle-to-frame side-to-side measurement and weights cannot be overstressed. As well as uniformed weight distribution front to rear. Workhorse Custom Chassis recommends that the front axle be loaded **at least** the same percentage of capacity as the rear. For example, if the rear is loaded at 90 percent of rated capacity, the front should be loaded to a minimum of 90 percent of its capacity. A lower percentage of the weight distribution can cause unloading of the front suspension resulting in handling and braking concerns. Even with the preferred weight distribution it is not recommended to have large amounts of weight at the extreme front, rear or top of the vehicle. A motor home with an un-uniformed weight distribution will directly affect desirable vehicle handling and an acceptable front-end alignment. If there is more weight toward one side of the motor home, at the extreme rear or the front, repositioning of the load is required to obtain a more uniform weight distribution.

If your motor home is within the GAWR but heavier on one side having a tendency to lean and weight cannot be shifted due to vehicle build, adjustments may be able to be made. The addition of a spacer block of sufficient thickness to equalize the left /right axle-to-frame measurement could be installed. Spacer blocks are positioned between the rear axle spring seat and spring pack, never install spacer blocks in the front axle. Spacer blocks are not sold as WCC parts but can generally be fabricated at local repair facility. Installation of a spacer block and/or spring leaf is not covered by the WCC New Vehicle Warranty and can resolve a lean/sag but may not correct a handling concern.

Note: The addition of a spacer block/shim can correct for a body lean and retain similar ride quality, while the addition of a spring leaf tends to reduce the ride quality. The addition of a spring leaf on chassis with Stabil-Ride spring system should never be considered. These types of adjustments should only be considered if the side-to-side weight variation is less than 600 lbs., if the variation is higher it is recommended to adjust the weight. Take care when making any adjustment to the leaf springs to ensure axle positioning pins and axle U-Bolts are also adjusted/replaced if needed.

CAUTION: In making any adjustments, motor home owners should be cautioned in the use of certain after-market suspension devices. These devices are merchandised as leveling devices to raise the “sagging” of the vehicle that may be caused by an overloading situation or a weight distribution problem. Verify the root cause of your concern prior to the installation of additional suspension components. Also, some of these aftermarket devices can severely limit the wheel travel that was designed into the suspension. Limiting the wheel travel may cause undue stress on other components of the suspension causing premature wear or failure.

FRONT SUSPENSION AND AXLE

Workhorse Custom Chassis incorporates two unique suspension systems on our chassis depending on its platform or "Series." Each suspension system was specifically designed to provide the best in class ride and handling for its application.

W SERIES

The W Series chassis have a solid front axle design with our Stabil-Ride leaf spring suspension system. A solid axle, also referred to as an I-beam, has both front wheels mounted on the ends of a solid axle/beam.

Workhorse utilizes a special type of solid axle, the mono-beam double drop front axle that allows extra clearances for components, such as the engine. The front axle assembly is attached at each side of the axle to a leaf spring pack by U-bolts. The spring eyes, located at the ends of the spring pack, are attached to the frame at the front hangers through rubber bushings. The rear ends of the springs are attached to the frame by the use of shackles that allow the spring to "change in length" while the vehicle is in motion. Ride control is provided by two identical double-acting shock absorbers mounted

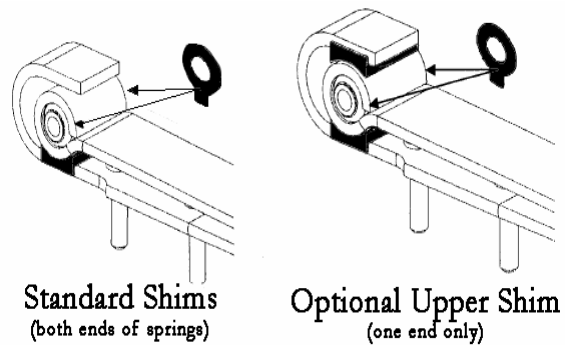


between the frame and brackets mounted to the axle. Body roll is controlled by a stabilizer (anti-sway) tube that connects the axle indirectly to the frame. The deflection of the main springs are slowed and controlled by an auxiliary elastomer springs positioned between the frame and the axle. The auxiliary springs are multi stage autothane units that do not require maintenance or adjustment. Workhorse currently offers our Stabil-Ride front suspension in 6,500 lb., 7,000 lb., 7,500 lb., 8,000 lb., 8,500 lb., and 9,000 lb. GAWR.

W SERIES MAINTENANCE AND INSPECTIONS

Since the front springs and shock absorbers use rubber bushings in the mounts, no lubrication is required. However, inspect the suspension periodically for worn or damaged components such as weak or broken spring leaves, leaking shock absorbers, worn or missing spring inserts, and loose or broken mounting bolts.

The W16 through W24 chassis utilize a two-leaf, parabolic taper, constant rate, spring pack, which simply is a low friction style two leaf spring pack to enhanced ride quality. This low friction spring design the springs only touch in a few key areas. These areas have Teflon inserts (shims) to inhibit squeaks and pops that can occur with any spring design. Inspect these key areas, see adjacent diagram, to ensure the inserts are in good condition. If standard inserts are intact and a noise is believed to be originating from the springs, contact the local Workhorse Service Center for inspection.

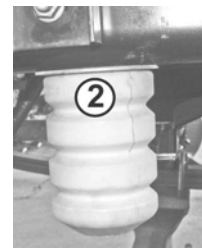
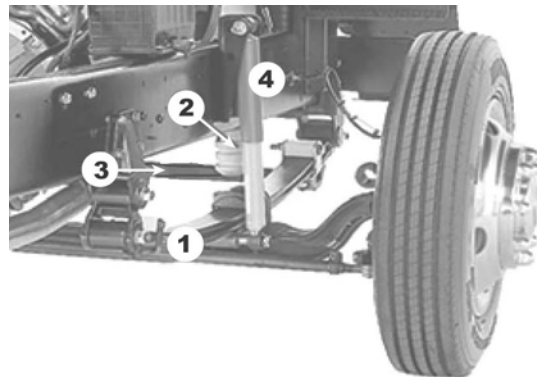


Stabil-Ride Springs (W16-W24)

The U-bolts attaching the front axle to the leaf springs should be checked and retightened to the specified torque after the first 500 miles of operation. Recheck the U-bolt torque each 10,000 miles thereafter. The torque specification for the U-bolt nuts is 140 lb. ft. (190 N•m) for the W Series chassis - 15/16 socket required.

W SERIES FRONT LEAF SPRINGS, STABILIZERS AND SHOCKS

The W Series chassis utilize the Stabil-Ride leaf spring suspension system. This system has a two-leaf parabolic taper constant rate spring pack, see adjacent picture #1. The spring pack has a low friction design that includes Teflon inserts at the friction points (front and rear of the spring pack). The deflection of the main springs is slowed and controlled by an auxiliary elastomer spring positioned between the frame and the axle, see adjacent picture #2. This "Like-Air" auxiliary spring is a multi stage autothane unit that does not require maintenance or adjustment. Workhorse utilizes three "Like Air" auxiliary springs depending on the GAWR. The 6,500 lb., 7,000 lb., 7,500 lb. and 8,000 lb. front suspension utilize a white auxiliary spring 5.196" tall, Workhorse part no. W0000431. The 8,500 lb. front suspension utilizes a gray auxiliary spring 5.196" tall, Workhorse part no. W0002592. The 9,000 lb. front suspension utilizes a white auxiliary spring 3.622" tall, Workhorse part no. W0002002. All Stabil-Ride front suspensions came standard with custom tuned 46mm Monroe shocks, until late production 2004 model year. Starting late production 2004 model year, a running change to custom tuned Bilstein shocks began and continues to be standard equipment, see above picture #4. An integral 2.5" rectangular stabilizer tube with steel-to-steel connection for immediate responsiveness was standard beginning on September 2, 2003, stabilizer assembly Workhorse part no. W0005643. Prior to this date a 2.0" integral rectangular stabilizer was utilized. The stabilizer is attached to the front of each leaf springs running laterally between them and provides stabilization through the torsional resistance of the rectangular tube, see above picture #3.



A kit is available that includes the 2.5" stabilizer tube and Bilstein shocks (front and rear) for units build prior to September 2, 2003, Workhorse part no. W8001341.

W SERIES STABIL AIR™ SUSPENSION KIT

Workhorse has a Stabil-Air™ aftermarket air suspension kit available for installation on your W20, W22 and W24 chassis. Stabil-Air™ is a fully integrated air suspension system with all components artfully combined to deliver the ride and handling you would expect in more complex and more expensive air suspension systems.

Using advanced design principles and thorough testing, Stabil-Air™ was custom-engineered and to perform with only the key components necessary to provide the best ride and handling: new-technology parabolic springs, outboard-mounted air bags, patented integral stabilizer bar, and unique overload protection auxiliary spring. Also, new Koni shocks, specifically tuned to work with this air suspension, are included in the kit.

In addition, Stabil-Air™ comes with two new features: driver selectable heights and Horizon Leveling logic. Horizon Leveling is the combination of Stabil-Air™ and Firestone IntelliRide™ that makes it possible to easily level your motor home at campsites and in parking lots with the push of a button - without using house jacks! Visit the Workhorse website at www.workhorse.com for more information.

P SERIES (MODEL YEARS 1999-2005)

The P Series chassis have a coil spring independent front suspension system. The control arms are unequal length, short (upper)/long (lower). The coil springs are located between the lower control arms and the cross member; thus the lower control arms are the load-carrying members. Double acting shock absorbers are also attached to the lower control arms and connect to the frame. All P Series Workhorse RV chassis are equipped with air bag cylinders to provide an adjustable front suspension for ride quality and load-carrying capacity. These air cylinders are positioned in the center of the coil springs and can be adjusted by valves located on the bottom of each bag. Workhorse offers two versions of this independent front suspension design, the standard track and the wide track. Both have the same basic design as described above but are offered in different track widths and carrying capacities.

The standard track independent front suspension measures 69.7" front track width (measured at the center of front tires). The standard track front suspension has a 4,880 lb. GAWR on the 12,300 lb. GVWR chassis or a 5,500 lb. GAWR on the 14,800 lb. and 16,500 lb. GVWR chassis. In the 2000 model year the wide track independent front suspension was introduced and measures 82.95" front wheel track (measured at the center of the front tires). The wide track suspension has a 6,000 lb. GAWR and was standard on our 15,000 lb., 17,000 lb. and 18,000 lb. GVWR chassis.



P SERIES GENERAL MAINTENANCE AND INSPECTION

The front suspensions must be lubricated periodically in accordance with the maintenance schedule. Lubrication grease fitting locations are indicated in the lubrication section of this manual and in the Owner's Manual. The suspension should be inspected during lubrication for signs of damage or wear. Inspect all bushings, joints, linkage and tires for signs of abnormal wear or movement. The shock absorbers should also be inspected for sign of leakage or physical damage that would indicate a need for replacement.

P SERIES FRONT SHOCKS AND STABILIZERS

The P Series standard track front suspensions use heavy-duty 35mm hydraulic shocks and a 1¼" diameter front stabilizer bar. The standard track front suspension is on all 12,300 lb., 14,800 lb., and 16,500 lb. GVWR chassis. The P Series wide track front suspensions use Bilstein high-pressurized gas charged shocks with a 1.81" working diameter piston. A 1⅝" diameter front stabilizer bar with polyurethane bushings is standard on all wide track suspensions. The wide track front suspension is on all 15,000 lb., 17,000 lb., and 18,000 lb. GVWR chassis. The stabilizer bar is supported by bushings and stamped steel bracket with two bolts attaching to the frame and the lower control arm on both the wide track and standard track suspensions. The stabilizer bracket bolts require 24 lb. ft. torque for proper clamping. Inspect periodically for looseness.

P SERIES FRONT COIL SPRINGS AND AIR BAG CYLINDER

The air bag cylinders should be inspected periodically for signs of deterioration, damage or leaks. To verify possible leaks with the air bag removed from the vehicle, inflate the bag and submerge it in water and check for air bubbles. The standard track suspension system, 4,880 lb. or 5,500 lb. GAWR, utilizes an Airlift Heavy Duty Bag, Workhorse part no. W8803508. The wide track suspension system, 6,000 lb. GAWR, utilized a high-pressure air cylinder from its introduction in Nov. 1999 to Aug. 14, 2001, Workhorse part no. W0001111. Beginning on August 15, 2001 a new coil spring, Workhorse part no. W0000991, was integrated along with the Airlift Heavy Duty Bag, Workhorse part no. W88035508, on all wide track 6,000 lb. GAWR suspensions. The new coil spring originally was blue in color for ease of identification during the change then returned to the standard black starting in the production week of December 1, 2003. Regardless of the spring color the new coil spring is approximately 12% stiffer than the previous spring and is a direct replacement for all P32 chassis. Inflation pressures in either air bag cylinder should be maintained at 50 PSI minimum to avoid chafing. Maximum pressure for the Airlift bag used on the 4,880 lb., 5,500 lb. and the 6000 lb. post Aug. 15, 2001 GAWR suspensions is 90 PSI. The high-pressure air cylinder use from Nov. 1999 to Aug. 15, 2001 on the wide track 6000 lb. GAWR suspensions has a maximum of 110 PSI. Air bag cylinder pressures will vary depending on load and preferred ride quality. Workhorse suggests initially setting the cylinders at 50-60 PSI for the 4,880 lb. axle and 80-90 PSI for the 5,500 lb. and 6,000 lb. axles. Finally air bag pressure should be adjusted for personal comfort and load within outlined recommendations. The general rule is higher inflation pressure firmer the ride quality.

Note: From the factory, Workhorse only supplies air cylinders on the front suspension; any rear air cylinders are aftermarket or installed by the body manufacturer.

Service Tip - For units that appear to have a low front ride height due to operating at near front suspension capacity or if air bag cylinders have been run below minimum recommended pressure:

1. Jack up the motor home by the middle of the front cross member and allow the wheels to hang.
2. Remove the air from the air bag and re-inflate the air bag to the proper pressure.
3. Lower the unit and bleed off air (as necessary) to maintain proper air bag pressure.

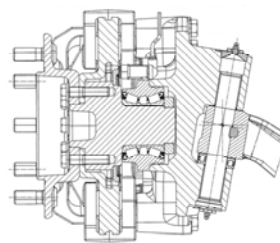
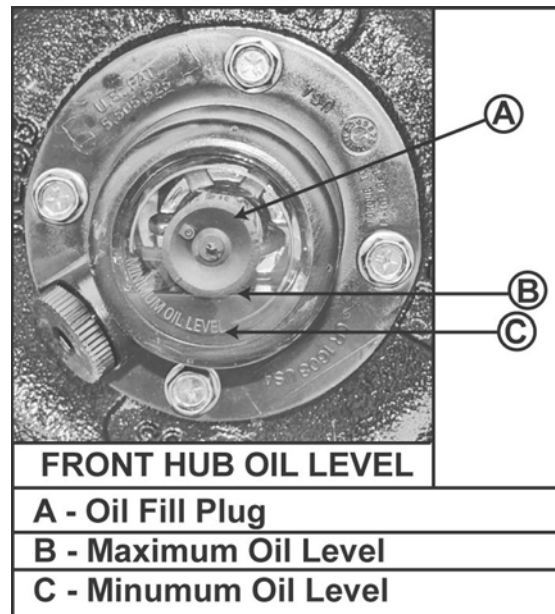
This may provide some ride height improvement as the air bag tends to stretch lengthwise slightly with this procedure.

FRONT WHEEL BEARINGS

The W Series chassis utilize two different front hub bearing systems. The W20, W22, and W24 chassis utilize an oil lubricated front hub bearing system. The oil level in the front hubs can be checked by simply looking into the sight glass on the front wheel hubs. The sight glass is located in the center of the hub and is marked with a full level on the glass. If oil is low, remove the cap located in the center of the hub adjacent to the sight glass taking care to not allow any dirt or water in the oil and the fill is pointed upward. Once filled to the proper level drive a short distance and check oil level again, you may require addition oil as flows through the system. The condition of the fluid must also be inspected during tire rotation or once if per year, if fluid is contaminated (i.e. dirt or water in the oil) the fluid must be changed and inner hub assembly cleaned.

The W16 and W18 chassis utilize spindle-less hub system with uni-pack bearings. This front hub bearing system does not require adjustment, maintenance, inspection or lubrication.

The P Series chassis utilize packed grease front hub bearing lubrication system. This system uses a high temperature wheel bearing grease, see "Recommended Fluids and Lubricants" in the Owner's Manual or in the back of this guide, for lubrication specifications. Under normal usage these bearings should be clean, inspected and repacked with grease every 30,000 miles or during brake relining, whichever occurs first. In a severe duty application this interval should be every 15,000 miles or during brake relining, whichever occurs first.



STEERING

The steering system consists of the steering linkage, steering gear, steering pump, hoses, and the steering column and wheel. Rotation of the steering wheel rotates the input shaft (wormshaft) on the steering gear, which transfers motion to the output shaft of the steering gear. The output shaft controls direction of the front wheels through a series of arms and levers referred to as the steering linkage.

W Series steering linkage is located on the outboard side of the left (driver's side) frame rail and to the rear of the mono-beam axle. Steering effort is transmitted to left-hand and right-hand adjustable tie rods through low mounted steering arms on the steering knuckles. The left (driver side) steering arm is connected through the steering knuckle to the intermediate arm at the top of the steering knuckle. The intermediate steering arm is connected to pitman arm through the drag link with left-hand and right-hand adjustable tie rods.

The pitman arm is connected to the output shaft of the steering gear. The steering angle or wheel cut on the 7,500 lb. and 8,000 lb. front axles is 45 degrees, on all chassis built to August 28, 2002. The optional 8,500 lb. front axle and all W Series chassis built after August 28, 2002 will have a wheel cut angle of 47 degrees. Starting January 6, 2004 all W Series chassis wheel cut increased to 50 degrees.



P Series steering linkage is located forward of the front cross member. Steering effort is transmitted to left-hand and right-hand adjustable tie rods through a relay rod. The relay rod is connected to the idlers suspended by steering supports (bell cranks). The right idler is connected to the steering stabilizer shock. The left idler is connected to the pitman arm by the intermediate shaft. The pitman arm is connected to the output shaft of the steering gear.

Depending on the year and chassis series we have offered a number of different steering wheels. The standard steering wheel on the W20, W22 and W24's was a molded light truck style 16" wheel, until October 1, 2004 production, when the previously optional 18" leather wrapped diesel style steering wheel became standard. The W16 and W18 come standard with a 15" molded style steering wheel. If desired the standard molded steering wheel on any of the W Series chassis can be exchanged for the larger 18" leather wrapped wheel. The exchange requires the replacement of the steering wheel, Workhorse part no. W0001967, and the horn button, Workhorse part no. W0002440. The P Series also came standard with a molded style steering wheel but an optional 16.5" leather wrapped steering wheel was made available in later years. If desired the standard molded steering wheel can be exchanged on the P Series chassis for the larger leather wrapped wheel. The exchange requires the replacement of the steering wheel, Workhorse part no W0004602, and the horn button, Workhorse part no. W0002440.

MAINTENANCE AND INSPECTION

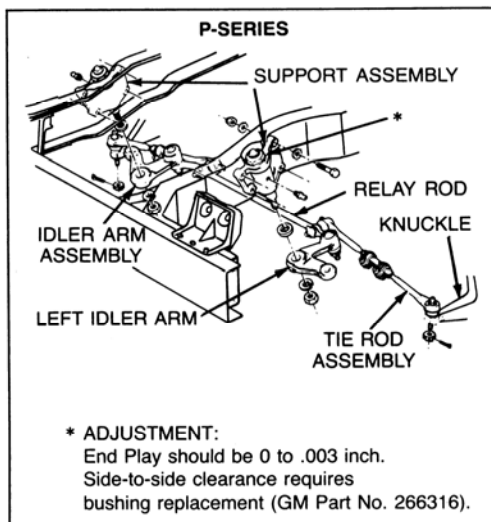
The steering linkage under normal conditions should be lubricated with any water-resistant EP-type chassis lubricate every 3,000 miles or three months, whichever occurs first. Inspect linkage for looseness and/or damage during lubrication. Inspect all joints, grease boots on tie rods, adjusting sleeves, steering supports/bell cranks (if equipped) and linkage for physical damage, wear or movement. All grease fitting locations are shown in the lubrication section of this manual and your Owner's Manual. If grease boots on the tie rods ends or drag links are torn, cracked or show signs of aging, the boots and/or should be replaced. Boots on the W20, W22 and W24 chassis are available without replacing the tie rods/drag links, Workhorse part no. W8003032 (kit including two boots).

Power steering inspection should include fluid level/condition, belt condition, and a check for leaks from the pump, hoses, and steering gear. Other factors that can affect power steering effectiveness are loose components, loose pump pulley and/or excess front axle weight.

STEERING SUPPORTS (BELL CRANKS) P SERIES ONLY

The steering support or bell crank, as also referred, provides support and movement of the steering linkage for the P Series chassis. There are two steering supports on the P Series chassis and are located on the outside of the frame forward of the front suspension. The steering supports should be greased and inspected for correct adjustment as part of your normal steering linkage lubrication

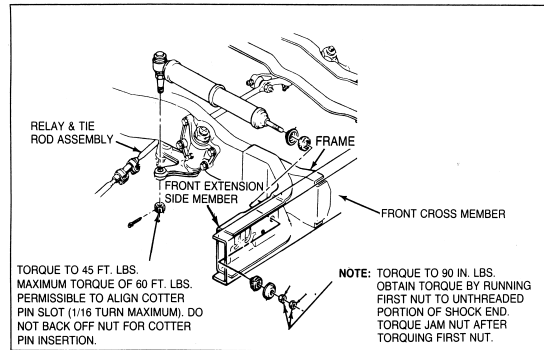
The fit of the shafts in the steering linkage support assembly should be tight with endplay (up and down movement) not exceeding .003 in. If the endplay exceeds .003 inch in either assembly, adjust it to within .000-.003 inch. To adjust, loosen the large lock nut, torque cap to 25 ft. lbs. and then loosen 1/16th of a turn and tighten lock nut. If there is lateral (side to side) play, replace bushing with Workhorse part no. 00266316 in the affected assembly.



STEERING SUPPORT PART BREAK DOWN	
Part Description	Part No.
Nut	00219758
Lock Washer	00131046
Seal	03786454
Fitting	09411017
Service Assembly	15712329
Housing w/ Bushing	15728066
Shaft	03768940
Nut	15728043
Protector	15728065
Thrust Washer	03768946
Bushing	00266316

STEERING DAMPENER P SERIES ONLY

Steering dampener is located on right side of chassis between the idler arm and front cross member (see adjacent figure). Early failure can result from rust formation on the dampeners' shaft after extended vehicle storage. Inspect shaft for rust before moving vehicle after extended storage, remove rust from rod when necessary. Periodic inspection for fluid leakage is recommended; replace dampener shock if leakage is detected. Workhorse uses a heavy-duty hydraulic steering dampener shock on all 12,300 lb., 14,800 lb., and 16,500 lb. GVWR chassis. The 15,000 lb., 17,000 lb., and 18,000 lb. GVWR chassis come standard with Bilstein high-pressurized gas charged steering dampener shock.

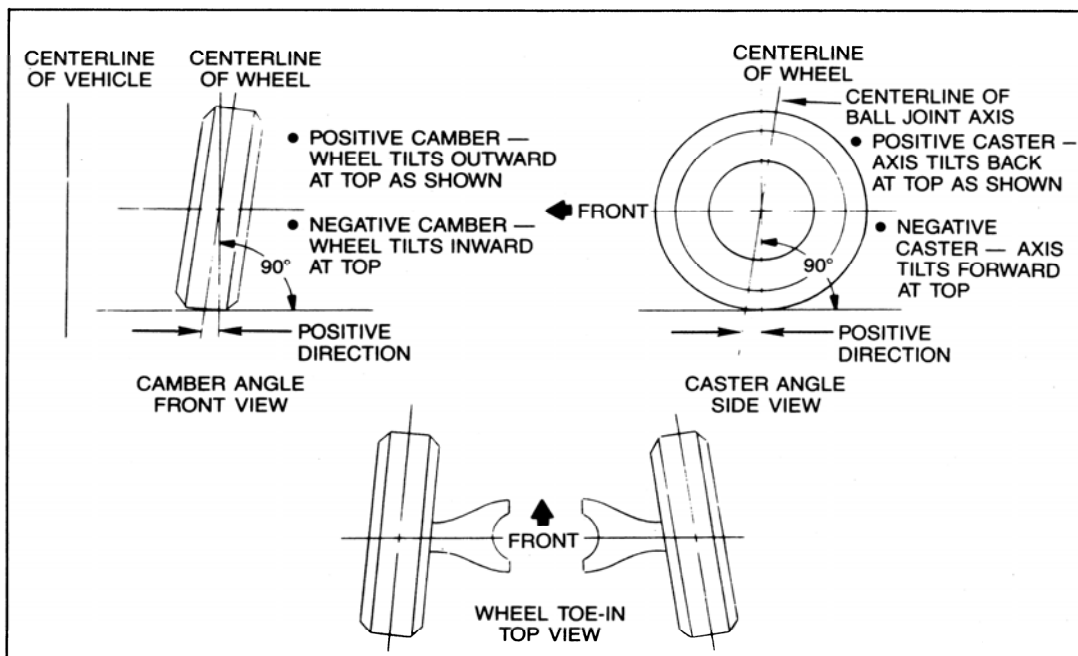


FRONT END ALIGNMENT

GENERAL DESCRIPTION

The term "front alignment" refers to the angular relationships between the front wheels, the front suspension attaching parts and the ground.

The pointing in or "toe-in" of the front wheels, the tilt of the front wheels from vertical or "camber" (when viewed from the front of the vehicle), and the tilt of the suspension members from vertical or "caster" (when viewed from the side of the vehicle), are all involved in front alignment. See diagram below.



W SERIES MAINTENANCE AND INSPECTION

There are several factors that can affect front alignment. These factors include tire inflation, the condition of wheel bearings, and the condition of steering and suspension components. These are the basis for the following checks that can indicate problems that should be corrected.

1. Check all tires for proper inflation pressures and approximately the same tread wear.
2. Check front wheel bearings for looseness.
3. Check for looseness in steering knuckle (king pin), tie rod ends and steering gear.
4. Check for excessive run-out of wheels and tires.
5. Check for a difference in the ride height between right and left sides of the vehicle.
6. Note: Excessive or unevenly distributed loads also affect ride height and alignment. This should be taken into consideration when making the check.
7. Check for steering gear looseness at frame.
8. Check for improperly operating shock absorbers. There may be evidence of a leaking shock(s).
9. Check for worn or missing spring tip inserts, spring clamp inserts and spring eyelet bushings.
10. Check for loose or missing stabilizer bar attachments.
11. Steering and vibration complaints are not always the result of improper alignment. An additional item to be checked is the possibility of tire lead due to worn or improperly manufactured tires. "Lead" is the deviation of the vehicle from a straight path, on a level road, without hand pressure on the steering wheel. Tire balance should also be checked.

Wheel Alignment Specifications W Series

Operation	Specification	Side to Side Tolerance
Caster	Not Adjustable	Not Adjustable
Camber	Not Adjustable	Not Adjustable
Toe	0.06 +/-0.02 degrees 0.03 +/- 0.01 inches	Toe-in equal

Application	Specification	
	English	Metric
Steering Linkage Tie Rod Adjuster Retaining Nut	18	25

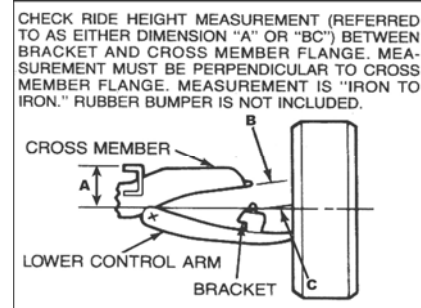
Note: The caster and camber wheel angles are designed into the front axle of all W Series chassis. If it is determined that adjustments are required please contact Workhorse for the proper service procedure. It is not recommended to bend the axle assembly.

Note: Workhorse aligns all chassis prior to being delivered to the body manufacturer. The body manufacturer must realign chassis after the body has been completed. **It is recommended to have the alignment checked after the vehicle is loaded for normal travel.**

P SERIES MAINTENANCE AND INSPECTION

There are several factors that can affect front alignment. These factors include tire inflation, air cylinder pressures, the condition of wheel bearings, and the condition of steering and suspension components. These are the basis for the following checks that can indicate problems that should be corrected.

1. Check all tires for proper inflation pressures and approximately the same tread wear.
2. Check front wheel bearings for looseness.
3. Check for looseness of ball joints, tie rod ends and steering relay rods and damper.
4. Check for excessive run-out of wheels and tires.
5. Check for a difference in the ride height between right and left sides of the vehicle.



Note: Excessive or unevenly distributed loads also affect ride height and alignment. This should be taken into consideration when making the check. Also, if the motor home is equipped with air bag cylinders, it is important that the cylinders be inflated to the proper pressure for the load being carried, in order to maintain adequate ride height.

1. Check for steering gear looseness at frame.
2. Check for improperly operating shock absorbers and evidence of a leaking shock (s).
3. Check for loose control arms.
4. Check for loose or missing stabilizer bar attachments.
5. Steering and vibration complaints are not always the result of improper alignment. An additional item to be checked is the possibility of tire lead due to worn or improperly manufactured tires. "Lead" is the deviation of the vehicle from a straight path, on a level road, without hand pressure on the steering wheel. Tire balance should also be checked.

Wheel Alignment Specifications P Series

Caster adjusting for Dimension "A"/"BC"

Inches	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/4	4 1/2	4 3/4	5
Caster Angle (Degrees)			5 1/2	5 1/4	5 STD.	4 3/4	4 1/2	4	3 3/4	3 1/2	3 1/4	3	3
Side to Side Tolerance	0.50 degrees												

Operation	Camber	Toe
Specification	0.25 +/- 0.50 degrees	0.06 +/- 0.02 degrees 0.03 +/- 0.01 inches
Side to Side Tolerance	0.50 degrees	Toe-In equal

Application	Specification	
	English	Metric
Steering Linkage Tie Rod Adjuster Retaining Nut	18	25
Upper Control Arm Bolt	140	190

Note: Workhorse aligned all chassis prior to being delivered to the body manufacturer. The body manufacturer must realign chassis after the body has been completed. **It is recommended to have the alignment checked after the vehicle is loaded for normal travel, air bag cylinders adjusted and at normal operating temperature.**

REAR SUSPENSION

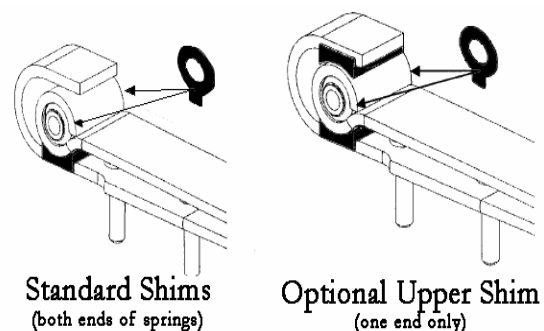
The rear axle assembly is attached at each side of the axle to a leaf spring pack by U-bolts. The spring eyes, located at the ends of the spring packs, are attached to the frame at the front hangers through rubber bushings. The rear ends of the springs are attached to the frame by the use of shackles that allow the spring to “change in length” while the vehicle is in motion. Ride control is provided by two identical double-acting shock absorbers, angle mounted, between the frame and brackets mounted to the axle. Body roll is controlled by a stabilizer (anti-sway) bar/tube system connects the axle and the frame either directly or indirectly. Workhorse has offered a various rear GAWR depending on the GVWR of the chassis.

- 12,300 lb. GVWR chassis has a 7,500 lb. GAWR.
- 14,800 lb. and 15,000 lb. GVWR chassis has a 10,000 lb. GAWR.
- 16,000 lb. GVWR gas a 10,500 lb. GAWR
- 16,500 lb. and 17,000 lb. GVWR chassis has an 11,000 lb. GAWR.
- 18,000 lb. GVWR chassis has a 12,000 lb. GAWR.
- 20,700 lb. GVWR chassis is available with a 13,500 lb. or optional 14,500 lb. GAWR.
- 22,000 lb. GVWR chassis has a 14,500 lb. GAWR or an optional 15,000 lb. GAWR.
- 24,000 lb. GVWR chassis has a 15,500 lb. GAWR.

MAINTENANCE AND INSPECTIONS

Since the rear springs and shock absorbers use rubber bushings in the mounts, no lubrication is required. However, inspect the suspension periodically for worn or damaged components such as weak or broken spring leaves, leaking shock absorbers, worn or missing spring inserts, and loose or broken mounting bolts.

The W16 through W24 chassis utilize a two leaf parabolic taper constant rate spring pack, which simply is a low friction style two leaf spring pack to enhanced ride quality. This low friction spring design the springs only touch in a few key areas. These areas have Teflon inserts (shims) to inhibit squeaks and pops that can occur with any spring design. Inspect these key areas, see adjacent diagram, to ensure the inserts are in good condition. If standard inserts are intact and a noise is believed to be coming from the springs, contact the local Workhorse Service Center for inspection.



Stabil-Ride Springs (W16-W24)

The U-bolts attaching the rear axle to the leaf springs should be checked and retightened to the specified torque after the first 500 miles of operation. Recheck the U-bolt torque each 10,000 miles thereafter. The torque specification for the U-bolt nuts is 140 lb. ft. (190 NM) for the W Series chassis-15/16 socket, 152 lb. ft. (205 NM) for the P Series chassis with JB8 brake system-1 1/8" socket and 193 lb. ft. (260 NM) for the P Series chassis with JF9 brake system-1 1/8" socket.

W SERIES REAR LEAF SPRINGS AND SHOCKS

The W Series chassis utilize the Stabil-Ride leaf spring suspension system. This system has a two-leaf, parabolic taper, constant rate spring pack. The spring pack has a low friction design that includes Teflon inserts at the friction points (front and rear of the spring pack). The deflection of the main springs is slowed and controlled by an auxiliary elastomer spring positioned between the frame and the axle. The "Like-Air" auxiliary spring is a multi stage autothane unit that does not require maintenance or adjustment. Workhorse utilizes three "Like Air" auxiliary springs depending on the GAWR. The 10,500 lb. and 12,000 lb. rear suspensions utilize a gray auxiliary spring 3.622" tall, Workhorse part no. W0000459. The 13,500 lb. rear suspension utilizes a white auxiliary spring 3.622" tall, Workhorse part no. W0002002. The 14,500 lb. rear suspension also utilizes the gray auxiliary spring 3.622" tall, Workhorse part no. W0000459. The 15,000 lb. and 15,500 lb. rear suspensions utilize a white with red stripe 3.622" tall, Workhorse part no. W0002863. All Stabil-Ride rear suspensions came standard with custom tuned 46mm Monroe shocks, until late production 2004 model year. Starting the late production 2004 model year, a running change to custom tuned Bilstein shocks began and continues to be standard equipment. The suspension is equipped with an integral 2.5" rectangle stabilizer with steel-to-steel connection for immediate responsiveness. The stabilizer is attached to the rear of each leaf springs running laterally between them and provides stabilization through the torsional resistance of the rectangle tube.



W SERIES STABIL AIR™ SUSPENSION KIT

Workhorse has a Stabil-Air™ aftermarket air suspension kit available for installation on your W20, W22 and W24 chassis. Stabil-Air™ is a fully integrated air suspension system with all components artfully combined to deliver the ride and handling you would expect in more complex and more expensive air suspension systems.

Using advanced design principles and thorough testing, Stabil-Air™ was custom-engineered and to perform with only the key components necessary to provide the best ride and handling: new-technology parabolic springs, outboard-mounted air bags, patented integral stabilizer bar, and unique overload protection auxiliary spring. Also, new Koni shocks, specifically tuned to work with this air suspension, are included in the kit.

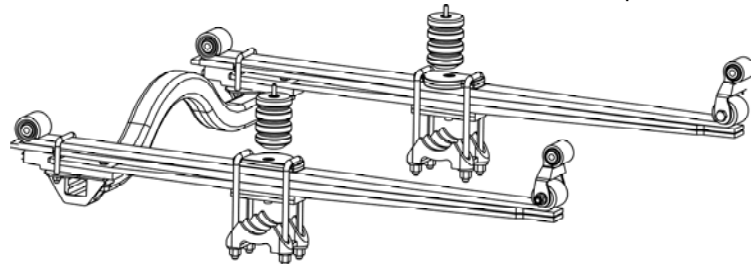
In addition, Stabil-Air™ comes with two new features: driver selectable heights and Horizon Leveling logic. Horizon Leveling is the combination of Stabil-Air™ and Firestone IntelliRide™ that makes it possible to easily level your motor home at campsites and in parking lots with the push of a button - without using house jacks! Visit the Workhorse website at www.workhorse.com for more information.

P SERIES REAR LEAF SPRINGS AND SHOCKS

The 12,300 lb. GVWR chassis utilizes a multi-leaf, multi-stage spring. Chassis with a 14,800 lb. thru 17,000 lb. GVWR utilize a constant rate four leaf tapered spring. Our 18,000 lb. GVWR chassis uses a constant rate, five leaf tapered spring. A revised constant rate spring was released as a running change in 2002 model year for 14,800 lb. thru 18,000 lb. GVWR chassis. This change consisted of Teflon buttons positioned toward the ends of each tapered leaf of the spring pack, other than this addition the springs remained identical. A "marshmallow" style bump stop is standard providing additional stability and support on 14,800 lb. and higher GVWR chassis when loads near maximum GAWR. P Series chassis with tapered leaf or multi leaf springs are equipped with a heavy-duty 1 $\frac{3}{4}$ " rear stabilizer bar that has rubber bushings at the connecting points on the rear axle and the frame.

A new rear suspension, Stabil-Ride, became standard for the P Series chassis with 11,000 lb. and 12,000 lb. rear GAWR, on the 17,000 lb. and 18,000 lb. GVWR chassis respectively. This suspension was integrated in stages, first on chassis with the 12,000 lb. rear suspensions starting with chassis built after 3/17/04. Then on chassis with the 11,000 lb. rear suspension built after 5/3/04. The Stabil-

Ride rear suspension system utilizes a three-leaf, parabolic taper, constant rate spring pack. The deflection of the main springs are slowed and controlled by an auxiliary elastomer spring positioned between the frame and the axle. The "Like-Air" springs



P Series Stabil-Ride Suspension

are three-stage autothane units that do not require maintenance or adjustment. Workhorse utilizes two 3.62" tall "Like Air" auxiliary springs depending on the GAWR. The 11,000 lb. rear suspension utilizes white auxiliary spring, Workhorse part no. W0000986, and the 12,000 lb. rear suspension utilize gray auxiliary springs, Workhorse part no. W0001805. The suspension is equipped with an integral 2.5" rectangular stabilizer with steel-to-steel connection for immediate responsiveness. The stabilizer is attached to the front of each leaf springs running laterally between the springs providing stabilization through the torsional resistance of the rectangular tube. The stabilizer tube is rounded to allow clearance for the drive shaft. The suspension uses the same spring hangers and mounting as the previous P Series suspension. This suspension has fewer parts than the previous suspension providing a weight savings. No lubrication or maintenance is required with this system.

Workhorse chassis are equipped with heavy-duty 35mm hydraulic shocks standard on all 12,300 lb., 14,800 lb. and 16,500 lb. GVWR chassis. The 15,000 lb., 17,000 lb. and 18,000 lb. GVWR chassis come standard with Bilstein high-pressurized gas charged shocks with a 1.81" working diameter piston. Periodically inspection for oil leakage or physical damage is recommended.

TIRES AND WHEELS

WHEELS

Workhorse chassis utilize different wheels depending on the GVWR.

The W Series 16,000 lb. and 18,000 lb. GVWR chassis have an 10 hole wheel with 5/8" wheel studs, 27mm lug nut and requires 150 lb. ft. torque. These wheels have a 3750 lb capacity. The W Series 20,700 lb., 22,000 lb. and 24,000 lb. GVWR chassis have an 8 hole wheel with 22mm wheel studs, 33mm lug nut and requires 475 lb. ft. torque. These wheels have a 5000 lb capacity. All W Series wheels are a hub centering style wheel.

The P Series 12,300 lb. chassis have 8 hole wheels with 9/16" wheels studs, 1" lug nut and require 140 lb. ft. torque. These wheels have a 2,440 lb. wheel capacity. The 14,800 lb., 15,000 lb., 16,500 lb., 17,000 lb., and 18,000 lb. chassis have 10 hole wheels with 5/8" studs, 1" lug nut and requires 175 lb. ft. torque. Both front and rear wheels have a 10 hole bolt pattern for proper tire rotation, although the front axle only utilizes 5 holes and the rear all 10 holes. This is due to the differences in carrying capacity, single compared to dual wheels, and the rear axle is the driving axle. Prior to the wide track suspension the wheels had a 2,760 lb. wheel capacity. All wide track suspension, which begin in 2000 model year, and the 14,800 lb. chassis starting on 1/21/02 have a 3,000 lb. capacity.

Workhorse has utilized three wheel suppliers Accuride, Maxon and Alcoa. Accuride provided all 19.5" steel wheels until 1/21/02 and the 22.5" steel wheels until 2/18/02. After those dates all chassis with 19.5" and 22.5" were standard with Maxon wheels. Alcoa manufactures all aluminum wheels utilized on our chassis. The following chart provides part numbers for the most current wheels utilized.

Chassis/GVWR	Wheel Size (inches)	Description	Workhorse Part No.	Manufacturer	Rating (lbs.)
P Series 14,800 lb. to 18,000 lb.	19.5X6.00	Gray, Steel	W1000011	Maxion	3,000
P Series 15,000 lb. to 18,000 lb.	19.5X6.00	Gray, Steel	W0001009	Accuride	3,000
W Series 16,000 lb. and 18,000 lb.	19.5X6.00	Gray Steel	W0007492	Maxion	3750
W Series 20,700 lb. & 22,000 lb.	19.5X6.75	Gray, Steel	W0002404	Maxion	5,000
W Series 22,000 lb. & 24,000 lb.	22.5X6.75	Gray, Steel	W0002403	Maxion	5,000
W Series 20,700 lb. & 22,000 lb.	19.5X7.50	Front, Aluminum	W0003192	Alcoa	5,000
W Series 20,700 lb. & 22,000 lb.	19.5X7.50	Rear outer, Alum.	W0003193	Alcoa	5,000
W Series 22,000 lb. & 24,000 lb.	22.5X7.50	Front, Aluminum	W0003194 or W0006709 **	Alcoa	5,000
W Series 22,000 lb. & 24,000 lb.	22.5X7.50	Rear outer, Alum.	W0003195 or W0006710 **	Alcoa	5,000

** Indicates Alcoa Dura-Bright treated wheels

In addition to the Workhorse 3 year 36,000 mile (whichever occurs first) warranty that includes all wheel types, Alcoa Dura-Bright wheels and surface treatment come with a limited warranty of 60 months from the date of manufacture as shown on the wheel. This portion of the warranty is administrated by Alcoa, contact Alcoa for any addition information (800) 242-9898.

Aluminum Wheels Required Hardware: The aluminum wheel option are outer wheels only, inner rear wheels are steel. This option requires front hub kit (W0003352), rear hub kit (W0004595), rear hub cover axle brackets (W0004592-qty. 2), plastic spacer disc (W0003197-qty. 4), valve stem extenders (W0004427-qty. 2) and valve steam extender stabilizers (W0003199-qty. 2 for 19.5" wheels, W0003200-qty. 2 for 22.5" wheels).

Aluminum Wheel Care: Workhorse has utilized both uncoated/untreated and the "Dura-Bright" surface treatment wheels from Alcoa. The change from untreated to Dura-Bright occurred as a running change beginning with chassis built in July-August of 2004. For uncoated wheels Alcoa recommends a three step aluminum care system which includes a cleaner, polish and sealant for uncoated un-anodized surfaces. Used in combination this system inhibits dulling for a shine up to six times longer then ordinary cleaners, per Alcoa. For the Dura-Bright wheels clean with soap and water. For additional information or product availability contact your local Alcoa dealer or visit their web site www.alcoawheels.com/maint/aluminum.

GENERAL TIRE INFORMATION

Workhorse utilizes various types of tires on our chassis. The three main types of tires are the Michelin Pilot XZA, Michelin XRV and Goodyear G670 RV. Different brands of tires should never be mismatched or mixed together even though they may be the same physical size. Tires are warranted by the tire manufacturer, not Workhorse. Contact the closest Workhorse dealer for information on the appropriate tire dealer near you.

The Michelin Pilot XZA tires were utilized on the 14,800-16,500 lb. GVWR Workhorse chassis for the 1999 model year. Their features included:

- Low center of gravity and wide footprint for enhanced handling and stability.
- Advanced rib tread design for smooth, even tread wear and improved handling.
- Sipes and variable grooves provide excellent traction on wet and dry surfaces.

The Michelin XRV tires are utilized on most of our 14,800 lb. and higher GVWR Workhorse chassis on 2000 and up model years. Their features include:

- Specially engineered for Recreational Vehicles only.
- Shallow, stable tread design generating lower heat for better durability and better handling.
- Increased ozone resistance in sidewalls for better weathering resistance.
- See through grooves increase drainage for improved wet traction.
- Multi-siping for better grip and wear.

The Goodyear G670 RV tires are utilized on some of our 20,700 lb. and 22,000 lb. GVWR chassis. Their features include:

- Unique Recreational Vehicle specific compounds for enhanced traction and tread wear.
- Tough sidewalls and designed for long-term durability.
- Strong two piece foundation belt system for smooth, comfortable ride.
- Premium fuel-efficient casing for improved fuel economy and retreadability.
- Industry-leading ozone/weather-resistant sidewall compounds.

TIRE INFLATION

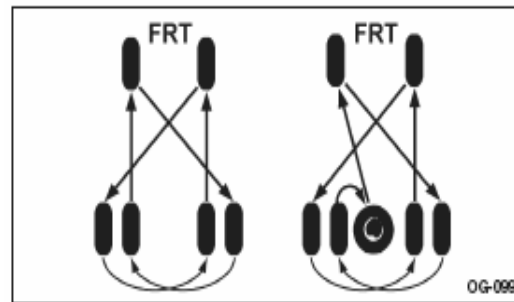
Tires are air filled supports between the road and the vehicles suspension; supporting the vehicle, providing traction and absorbing road irregularities. The amount of tire inflation can affect tire wear, vehicle handling and steering, as well as the ability to support the load of the vehicle. Excessive loads or under inflation can cause abnormal tire flexing, irregular tire wear and possible tire failure. Inflation pressure should be adjusted to support the maximum tire load and all tires on the axle should carry the same pressure. Inflation pressure should be checked cold, or before you have driven for the day.

The following recommended tire inflation pressures are for standard equipment tires only, with evenly distributed load/weight, and not exceeding the gross axle or vehicle weight ratings. If your vehicle does not meet these requirements tire pressures **MUST** be adjusted for the weight applied on each tire, see the following tire inflation charts. If the weight exceeds the maximum rating of the suspension, wheels or tires weight must be removed. Never exceed the maximum pressure noted on the wheel or tire. Contact the tire manufacturer for additional information or specifications.

- **12,300 lb. chassis** come standard with 7.50R-16, load range (D) tires. At maximum GAWR but not exceeding GVWR, the minimum recommended tire pressure is 65 PSI front and 60 PSI rear duals.
- **14,800 lb. chassis** come standard with Michelin 225/70-19.5, load range (F) tires, in 1999. At maximum GAWR but not exceeding GVWR, the minimum recommended tire pressure is 65 PSI front and 60 PSI rear duals. **2000 model year 14,800 lb. chassis** come standard with Michelin XRV 225/70-19.5 load range (F) tires. At maximum GAWR but not exceeding GVWR, the minimum recommended tire pressure is 70 PSI front and 70 PSI rear duals.
- **15,000 lb. chassis** come standard with Michelin XRV 225/70-19.5 load range (F) tires. At maximum GAWR but not exceeding GVWR, the minimum recommended tire pressure is 75 PSI front and 70 PSI rear duals.
- **16,000 lb. chassis (W Series 2006 MY and newer)** come standard with Michelin XRV-225/70-19.5 load range (F) tires. At maximum GAWR but not exceeding GVWR, the minimum recommended tire pressure is 85 PSI front and 70 PSI rear duals.
- **16,500 lb. chassis** come standard with Michelin 225/70-19.5 load range (F) tires. At maximum GAWR but not exceeding GVWR, recommended tire pressure is 65 PSI front and 65 PSI rear duals. **2000 model year 16,500 lb. chassis** come standard with Michelin XRV 225/70-19.5 load range (F) tires. At maximum GAWR but not exceeding GVWR, the minimum recommended tire pressure is 70 PSI front and 75 PSI rear duals.

- **17,000 lb. chassis** come standard with Michelin XRV-225/70-19.5 load range (F) tires. At maximum GAWR but not exceeding GVWR, the minimum recommended tire pressure is 75 PSI front and 75 PSI rear duals.
- **18,000 lb. chassis (P Series 2000-2005 MY)** come standard with Michelin XRV-225/70-19.5 load range (F) tires. At maximum GAWR but not exceeding GVWR, the minimum recommended tire pressure is 75 PSI front and 80 PSI rear duals.
- **18,000 lb. chassis (W Series 2006 MY and newer)** come standard with Michelin XRV-225/70-19.5 load range (F) tires. At maximum GAWR but not exceeding GVWR, the minimum recommended tire pressure is 95 PSI front and 80 PSI rear duals.
- **20,700 lb. chassis** come standard with Michelin XRV-245/70-19.5 load range (F) tires. At maximum GAWR but not exceeding GVWR, the minimum recommended tire pressure is 90 PSI front and 90 PSI rear duals. This chassis be optioned with a 14,500 lb. rear GAWR which comes standard with Goodyear G670 RV-245/70/19.5 load range (G) tires at maximum GAWR but not exceeding GVWR, the minimum recommended tire pressure is 80 PSI front and 80 PSI rear duals.
- **22,000 lb. chassis** come standard with Michelin XRV-235/80-22.5 load range (G) tires. A change in the load and inflation to these tires has been issued, for details refer to the following chart and the Technical Bulletin located in the bulletin section of this guide or contact Michelin at www.michelintruck.com. This change in markings, load and inflation was a running change starting with model built around August of 2002. At maximum GAWR but not exceeding GVWR and sidewall markings of 100 PSI maximum pressure, the minimum recommended tire pressure is 85 PSI front with standard 8,000 lb. GAWR, 90 PSI front with optional 8500 lb. GAWR, 85 PSI rear duals with 14,500 lb. or optional 15,000 lb. GAWR. At maximum GAWR but not exceeding GVWR and sidewall markings of 110 PSI maximum pressure, the minimum recommended tire pressure is 90 PSI front with standard 8,000 lb. GAWR, 100 PSI front with optional 8500 lb. GAWR, 90 PSI rear duals with 14,500 lb. or optional 15,000 lb. GAWR. This chassis can also be optioned with 19.5" wheels which comes standard with the Goodyear G670 RV-245/70/19.5 load range (G) tires at maximum GAWR but not exceeding GVWR, the minimum recommended tire pressure is 85 PSI front with standard 8,000 lb. GAWR, 95 PSI front with optional 8,500 lb. GAWR, 80 PSI rear duals with the standard 14,500 lb. GAWR, 85 PSI rear duals with optional 15,000 lb. GAWR.
- **24,000 lb. chassis** come standard with Michelin XRV-235/80-22.5 load range (G) tires. At maximum GAWR but not exceeding GVWR and sidewall markings of 110 PSI maximum pressure, the minimum recommended tire pressure is 105 PSI front and 95 PSI rear duals.

Tire care: Tire rotation is recommended every 6,000 miles. The diagram shows the correct rotation procedure if your chassis is equipped with steel wheels. If you have aluminum wheels or need additional information, refer to your Owner's Manual. Road oil and dirt build up holds the chemicals in the air next to the tire and will cause deterioration of the rubber, cleaning tires with soft brush and mild soap will remove this build up. If you use a dressing product to "protect" your tires use extra caution. Tire dressings that contain petroleum products or alcohol may cause deterioration or cracking.



Same Load Range and Tread Pattern
Front and Rear

Ply Rating (PR) or Load Rating: Used on conventional tires to identify the load and inflation limits of a given tire size when used in a specific type of service. Ply rating is indicated as 10PR, 12PR, 14PR, etc., but does not necessarily represent the number of cord plies in the tire. Load range is indicated as E, F, G, etc. For example, LT Metric (light truck-type) tires are offered with ply ratings of C (6PR), D (8PR), and E (10PR) and at various inflation pressures up to 80 psi. Workhorse utilizes truck type tires specifically designed for motor home applications with load ratings/ply ratings of D (8PR), E (10PR), F (12PR), and G (14PR). You can verify the load rating of your tires by the identification markings on the sidewall. Michelin markings will normally include LR prior to the load rating of the tires, e.g., D (LRD), E (LRE), F (LRF), etc.

INFLATION PRESSURE CHART FOR MICHELIN TIRES

Size/Model	Load Range	Inflation Pressures (PSI) Loads Per Position (in lbs.) at Different Pressures 1 Tires=Single (S) 2 Tires=Dual (D)												Max Speed
7.50R-16 XPS Rib 1999-2003	D (LRD)	PSI		35	40	45	50	55	60	65				MPH
		Lbs	S	1620	1770	1930	2060	2190	2310	2440				75
			D	2860	3130	3380	3630	3860	4080	4280				
225/70R 19.5 Pilot XZA	F (LRF)	PSI		70	75	80	85							MPH
		Lbs	S	3040	3220	3405	3640							75
			D	5840	6170	6500	6830							
225/70R 19.5 XRV	F (LRF)	PSI		70	75	80	85	90	95					MPH
		Lbs	S	2895	3040	3195	3315	3450	3640					75
			D	5440	5720	6000	6230	6490	6830					
225/70R 19.5 XRV See Note**	F (LRF)	PSI		65	70	75	80	85	90	95				MPH
		Lbs	S	2755	2895	3040	3195	3315	3450	3640				75
			D	5200	5440	5720	6000	6230	6490	6830				
245/70R 19.5 XRV	F (LRF)	PSI		70	75	80	85	90	95					MPH
		Lbs	S	3440	3540	3640	3740	3890	4080					75
			D	6430	6630	6830	7030	7310	7720					
245/70R 19.5 XRV See Note**	F (LRF)	PSI		80	85	90	95							MPH
		Lbs	S	3640	3740	3890	4080							75
			D	6830	7030	7310	7720							
235/80R 22.5 XRV See Note **	G (LRG)	PSI		75	80	85	90	95	100					MPH
		Lbs	S	3595	3815	4035	4280	4545	4675					75
			D	6790	7190	7630	8070	8555	8820					
235/80R 22.5 XRV See Note **	G (LRG)	PSI		65	70	75	80	85	90	95	100	105	110	MPH
		Lbs	S	3070	3255	3440	3625	3805	3980	4160	4330	4505	4675	75
			D	5790	6140	6490	6840	7180	7510	7840	8170	8500	8820	

****NOTE - NEW MARKINGS** refer to Michelin Technical Bulletin in the bulletin section.

INFLATION PRESSURE CHART FOR GOODYEAR TIRES

Size/Model	Load Range	Inflation Pressures (PSI) Loads Per Position (in lbs.) at Different Pressures 1 Tires=Single (S) 2 Tires=Dual (D)											Max Speed
225/70R 19.5 G670 RV	F	PSI		70	75	80	85	90	95				MPH
		Lbs	S	2895	3040	3195	3315	3450	3640				75
			D	5440	5720	6000	6230	6490	6830				
245/70R 19.5 G670 RV	F	PSI		70	75	80	85						MPH
		Lbs	S	3640	3740	3890	4080						75
			D	6830	7030	7310	7940						
245/70R 19.5 G670 RV	G	PSI		70	75	80	85	90	95	100			MPH
		Lbs	S	3640	3740	3890	4080	4190	4335	4540			75
			D	6830	7030	7310	7940	8230	8530	8820			
245/75R 22.5 G670 RV	G	PSI		70	75	80	85	90	95	100	105	110	MPH
		Lbs	S	3470	3645	3860	3980	4140	4300	4455	4610	4675	75
			D	6520	6850	7280	7480	7780	8160	8380	8670	8820	

ENGINES

Workhorse Custom Chassis motor homes are equipped with either an 8.1L, 7.4L, 6.0L or 5.7L GM Vortec gasoline engine, or the 6.5L Turbo diesel engine. Both the gasoline and diesel engines are four-cycle designs. That is, there are four distinct strokes (intake, compression, power and exhaust) in the power cycle of each engine cylinder. The power cycle of a cylinder takes place through two revolutions of the crankshaft. The gasoline Vortec engines are fueled by a Sequential Port Fuel Injection system (SPFI). SPFI is an extremely precise, high-pressure fuel delivery system that enables the engine to achieve its maximum horsepower and torque, without sacrifice in economy. The computer-controlled system uses individual injectors in the intake manifold for each cylinder to maximize its precision. The design improves cold starts and hot engine restarts and helps cut emissions to today's low-level standards.

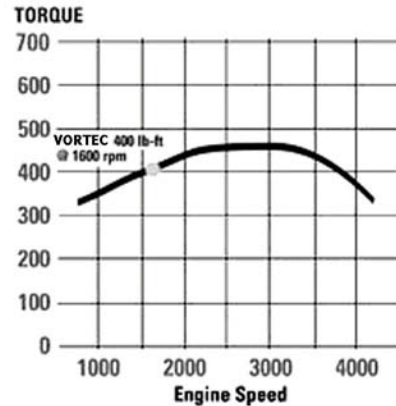
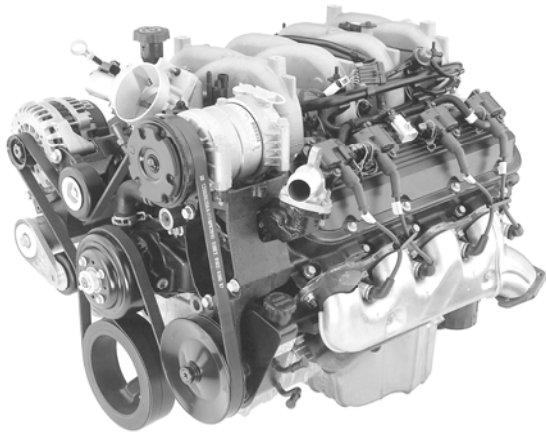
GASOLINE ENGINES

8100 Vortec

8.1L (496 cid) V8 - L18

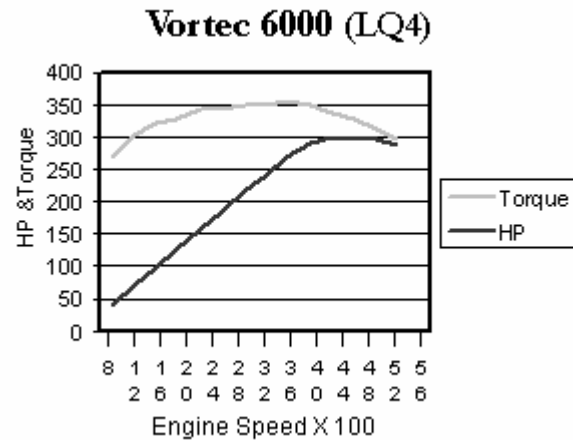
2001-Current Model Year

The 2001 model year marked the debut of the new highly refined General Motors big block V8, 8100 Vortec. The 8100 Vortec is essentially a new engine, nearly 80% of its parts have been completely redesigned, yet its foundation remains based off the General Motors big block engines. The 8100 Vortec block shares its valve and bore center, as well as its bore diameter, with the 7400 Vortec. Yet the stroke has been increased .37008 in. (9.4mm) to increase displacement 700cc and most importantly, to deliver more horsepower and torque. Some of the more notable 8100 Vortec refinements include; a new nodular internally balanced crankshaft with a revised firing order to reduce stress and wear on internal bearings, symmetrical port cylinder head for greater efficiency, exhaust manifolds are cast from stainless steel for more heat-resistance, Electronic Throttle Control (ETC) more accurate throttle control including integrated cruise control, all electronic ignition system (coil-near/per-plug) provides 50% more spark with more accuracy, revised water pump and enlarged coolant jackets for improved cooling, and a number of low maintenance components providing 100,000 miles of operation with only filter and oil changes required. With all these listed refinements GM was also able to achieve an estimated 200,000 mile life expectancy.



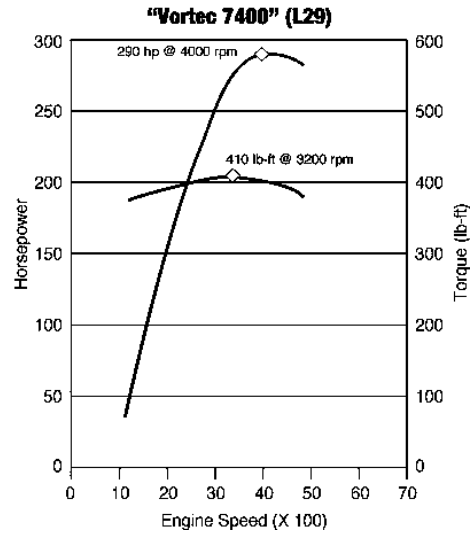
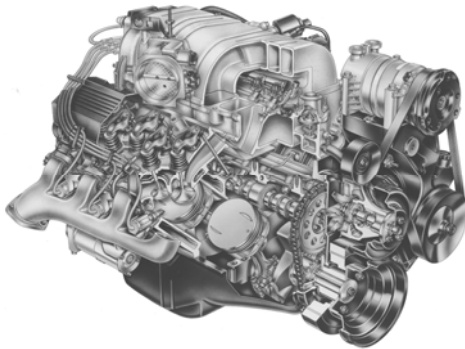
Vortec 8100 8.1L V-8 (L18)	2001 through Current Model Year
Type:	90 degree 8.1L V-8
Displacement:	8128 cc (496 cid)
Horsepower:	340 HP @ 4200 RPM
Torque:	455 lb-ft @ 3200 RPM
Fuel Shut Off:	5000 RPM
Compression Ratio:	9.1:1
Valve Configuration:	Overhead Valve (2 valves per cylinder)
Assembly Site:	Tonawanda, N.Y.
Valve Lifters:	Hydraulic Roller
Firing Order:	1 - 8 - 7 - 2 - 6 - 5 - 4 - 3
Balance Method:	Internal
Engine Rotation	Clockwise (from the front)
Bore x Stroke:	107.95 x 111mm (4.25 X 4.37 in.)
Main Bearing Caps:	4 - Bolt
Oil Pan Capacity:	6.4 qt. w/filter
Fuel System:	Sequential Fuel Injection
Emissions Controls:	Evaporative System, Catalytic Converter, Returnless Fuel System
MATERIALS	
Block:	Cast Iron
Cylinder Head:	Cast Iron
Intake Manifold:	Cast Aluminum
Exhaust Manifold:	Cast Stainless Steel
Main Bearing Caps:	Cast Nodular Iron
Crankshaft:	Cast Nodular Iron
Camshaft:	Steel
Connecting Rods:	Forged Steel
Additional Features:	Extended Life Spark Plugs, Extended Life Coolant, Coil-Near-Plug Ignition, Electronic Throttle Control

6000 Vortec
6.0L (364 cid) V8 – LQ4
2006 Model Year



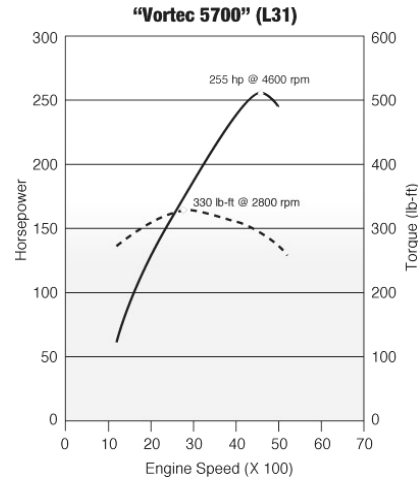
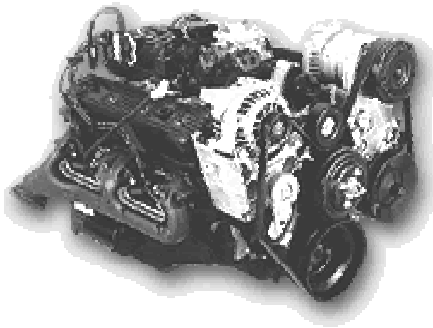
Vortec 6000 6.0L V-8 (LQ4)	2006 Model Year
Type:	6.0L V-8
Displacement:	5967cc (364 cid)
Horsepower:	300 HP @ 4400 RPM
Torque:	360 lb-ft @ 4000 RPM
Fuel shut off:	5600 RPM
Compression Ratio:	9.4:1
Valve Configuration:	Overhead Valve (2 valves per cylinder)
Assembly Site:	Romulus, MI
Valve Lifters:	Hydraulic Roller
Firing Order:	1 - 8 - 7 - 2 - 6 - 5 - 4 - 3
Balance Method:	Internal
Engine Rotation	Clockwise (from the front)
Bore x Stroke:	101.6 x 92 mm (4 X 3.62 in.)
Main Bearing Caps:	6 - Bolt
Oil Pan Capacity:	5.75 qt. w/filter
Fuel System:	Sequential Fuel Injection
Emissions Controls:	Evaporative System, Catalytic Converter, Returnless Fuel System, Positive Crankcase Ventilation
MATERIALS	
Block:	Cast Iron
Cylinder Head:	Cast Aluminum
Intake manifold:	Composite
Exhaust Manifold:	High Silicon Molybdenum Cast Nodular Iron
Main Bearing Caps:	Powdered Metal
Crankshaft:	Cast Nodular Iron
Camshaft:	Steel
Connecting Rods:	Forged Powdered Metal
Additional Features:	Extended Life Spark Plugs, Extended Life Coolant, Coil-Near-Plug Ignition, Electronic Throttle Control

7400 Vortec
7.4L (454 cid) V8 - L29
1999-2000 Model Years



Vortec 7400 7.4L V-8 (L29)	1999 & 2000 Model Years
Type:	90 degree 7.4L V-8
Displacement:	7439 cc (454 cid)
Horsepower:	290 HP @ 4200 RPM
Torque:	410 lb-ft @ 3200 RPM
Fuel Shut Off:	5000 RPM
Compression Ratio:	8.9:1
Valve Configuration:	Overhead Valve (2 valves per cylinder)
Assembly Site:	Tonawanda, N.Y.
Valve Lifters:	Hydraulic Roller
Firing Order:	1 - 8 - 4 - 3 - 6 - 5 - 7 - 2
Balance Method:	External
Engine Rotation	Clockwise (from the front)
Bore x Stroke:	107.95 x 101.6 mm (4.25 X 4 in.)
Main Bearing Caps:	4 - Bolt
Fuel System:	Sequential Fuel Injection
Emissions Controls:	Evaporative System, Catalytic Converter, Exhaust Gas Recirculation, Positive Crankcase Ventilation
MATERIALS	
Block:	Cast Iron
Cylinder Head:	Cast Iron
Intake Manifold:	Cast Aluminum
Exhaust Manifold:	High Silicon Molybdenum Cast Nodular Iron
Main Bearing Caps:	Cast Iron
Crankshaft:	Cast Nodular Iron
Camshaft:	Steel
Connecting Rods:	Forged Steel
Additional Features:	Extended Life Spark Plugs, Extended Life Coolant

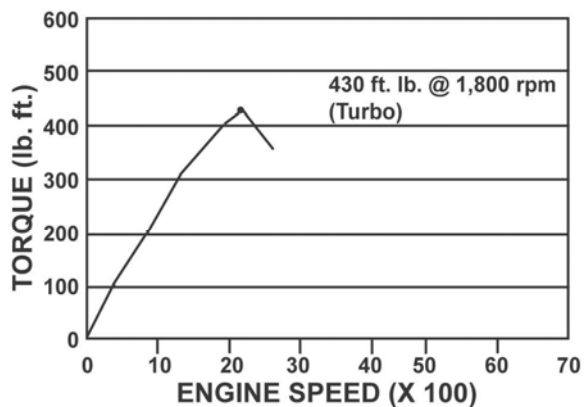
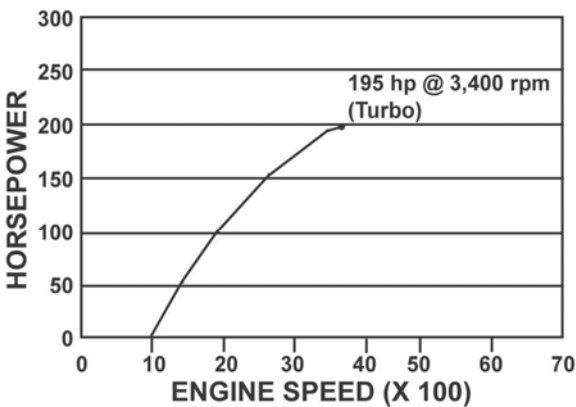
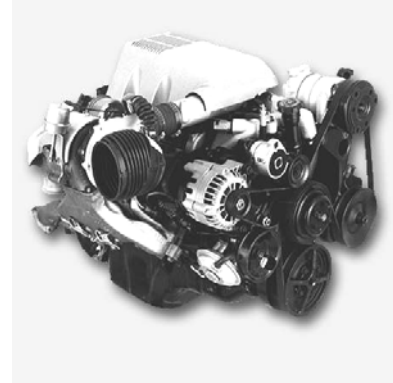
5700 Vortec
5.7L (350 cid) V8 – L31
2001-2002 Model Years



Vortec 5700 5.7L V-8 (L31)	2001 & 2002 Model Years
Type:	90 degree 5.7L V-8
Displacement:	5733 cc (350 cid)
Horsepower:	235 HP @ 4000 RPM
Torque:	325 lb-ft @ 2800 RPM
Fuel Shut Off:	5600 RPM
Compression Ratio:	9.4:1
Valve Configuration:	Overhead Valve (2 valves per cylinder)
Assembly Site:	Flint, N.Y.
Valve Lifters:	Hydraulic Roller
Firing Order:	1 - 8 - 4 - 3 - 6 - 5 - 7 - 2
Balance Method:	External
Engine Rotation	Clockwise (from the front)
Bore x Stroke:	101.60 x 88.39 mm (4 X 3.48 in.)
Fuel System:	Sequential Central Port Fuel Injection
Emissions Controls:	Evaporative System, Catalytic Converter, Exhaust Gas Recirculation, Positive Crankcase Ventilation
MATERIALS	
Block:	Cast Iron
Cylinder head:	Cast Iron
Intake manifold:	Cast Aluminum - Lower, Composite - Upper
Exhaust manifold:	High Silicon Molybdenum Cast Nodular Iron
Main bearing caps:	Cast Iron
Crankshaft:	Cast Iron
Camshaft:	Steel
Connecting rods:	Powdered Metal, Forged Steel
Additional Features:	Extended Life Spark Plugs, Extended Life Coolant

6.5L V8 - Turbo Diesel L65 1999-2003 Model Years

The 6.5L features a completely integrated Borg Warner/IHI turbo charger. This turbocharger is waste-gated on the exhaust side of the turbo with an all-new wastegate that is patented by GM and is specifically design for this system. By design, it reduces overall stress on the internal engine components. To accomplish this, the waste gate is designed to reduce turbo boost pressure after maximum torque is obtained. This turbocharger delivers a top boost of 10 psi at 1700 RPM and produces outstanding responsive acceleration on demand with no detectable turbo-lag.



6.5L DIESEL ENGINE HORSEPOWER AND TORQUE

6.5L V-8 Turbo Diesel (L65)	1999 through 2003 Model Years
Type:	6.5L V-8
Displacement:	6468 cc (395 cid)
Horsepower:	195 HP @ 3400 RPM
Torque:	430 lb-ft @ 1800 RPM
Fuel Shut Off:	3400 RPM
Compression Ratio:	20.2:1
Valve Configuration:	Overhead Valve (2 valves per cylinder)
Valve Lifters:	Hydraulic Roller
Firing Order:	1 - 8 - 7 - 2 - 6 - 5 - 4 - 3
Bore x Stroke:	103.00 x 97.03 mm (4.06 X 3.82 in.)
Fuel System:	Indirect Electronic Fuel Injection
Emissions Controls:	Positive Crankcase Ventilation
MATERIALS	
Block:	Cast Iron
Cylinder Head:	Cast Iron
Intake Manifold:	Cast Aluminum
Exhaust Manifold:	Cast Nodular Iron
Additional Features:	Extended Life Coolant

ENGINE LUBRICATION

The engines utilized by Workhorse are lubricated by petroleum oil stored in the engine oil pan. The oil is pumped from the pan through the engine oil filter, via an internal oil pump. The oil then flows to an external oil cooler, located forward and towards the bottom of the radiator, removing engine heat. The cooled oil flows back to the engine through internal galleries to the various moving engine parts. After being pumped to the critical engine components, oil drains back into the oil pan.

OIL QUALITY

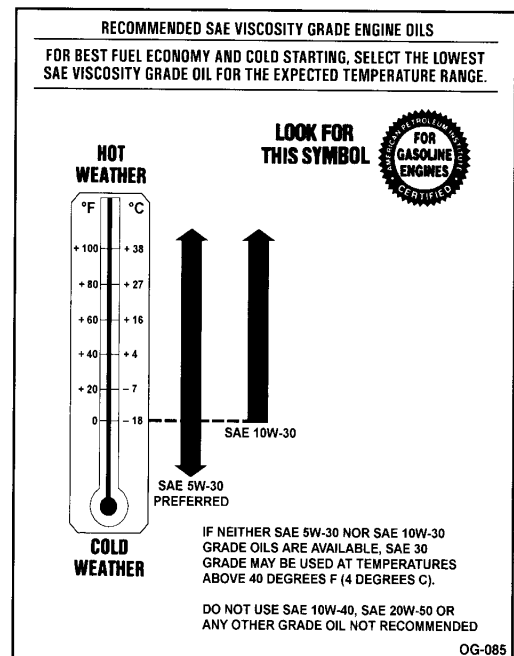
Engine oils are labeled on the containers with the API (American Petroleum Institute) designations of quality. For gasoline engines, recommended oils for your vehicle can be identified by the API "Starburst" certified symbol on the front of the oil container. For diesel engines Workhorse recommends the use of oil designated as API "CG-4" are best for your engine. The "CG-4" may appear alone or in combination with other API designations such as; "CG-4/SH", "CG-4/SJ", "SH/CG-4" or "SJ/CG-4" (see Owner's Manual for details).

VISCOSITY

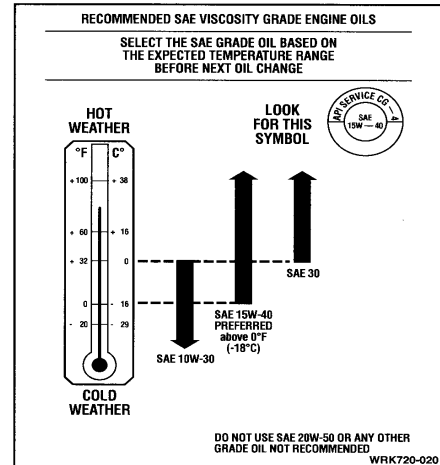
Engine oil viscosity (thickness) has an effect on fuel economy. Lower viscosity oils can provide better economy; however higher temperature weather conditions require higher viscosity engine oils for satisfactory lubrication. **Using any oil viscosity other than those recommended could cause engine damage.**

Gasoline Engines – For all temperature ranges the preferred oil for your engine is SAE 5W-30. However, you can use SAE 10W-30 if temperatures stay above 0 degrees F (18 degrees C). For heavy-duty driving in summer temperatures, above 40 degrees F (4 Degrees C), there can be an advantage to a single-viscosity straight SAE 30. Refer to adjacent chart.

Note: SAE 10W-40 has been removed from all Workhorse recommendations. Research Laboratories have found generally a 1.2% fuel economy penalty compared to 10W-30. Of the oils surveyed some contained inadequate additives and some did not meet the 10W-40 viscosity requirements. Testing showed 10W-40 oils tended to be more prone to high mileage ring sticking. These problems appeared more frequently in 10W-40 oils. Workhorse also does not recommend SAE 20W-50 viscosity oils.



Diesel Engine – For temperatures above 0 degrees F (-18 degrees C), SAE 15W-40 is the preferred viscosity grade. However, you can use SAE 10W-30 for temperatures cooler than 32 degrees F (0 degrees C). If temperatures are below 0 degrees F (-18 degrees C) SAE 10W-30 should be used. Also, SAE 30 may be used at temperature above freezing, 32 degrees F (0 degrees C).



OIL TEMPERATURE

Normal engine oil temperature in a heavy-duty truck is between the engine water temperature and 50 degrees above coolant temperature. When the temperature of the engine lubrication oil exceeds the temperature of the engine coolant by more than 50 degrees the engine oil is not doing its job and requires immediate attention. Severe oxidation problems will occur to lubrication oils that are subject to high heat and extended oil change intervals.

The oxidation rate of lubrication oils doubles with each 20 degrees of increase in oil temperature. Also, oxidation occurs in oil that is not being used or is in storage. Figure below indicates the expected oxidation rate of lubrication oil containing a moderate amount of oxidation inhibitor under temperature increases of 20 degrees.

DEGREES F	LIFE EXPECTANCY
70	100 years
90	50 years
110	25 years
130	12 years 6 months
150	6 years 3 months
170	3 years 1.5 months
190	570.70 days
210	285.35 days
230	142.67 days
250	71.33 days
270	35.66 days
290	17.83 days

Note: If an engine is run at overheated temperatures (see Owner's Manual or engine cooling section of this manual) for more than brief periods, oil may oxidize at a faster than normal rate. In addition, gaskets may distort, piston rings may stick, and excessive wear may result. Verify that all cooling system components are in proper working order.

MAINTENANCE AND INSPECTION

To provide proper engine lubrication for the engine and to help prevent engine damage, the oil level should be checked periodically to ensure that there is an adequate amount of oil. Also, the engine oil must be drained and replaced with fresh oil and the oil filter replaced at the intervals recommended in the appropriate maintenance schedule.

PROPER READING OF THE OIL LEVEL

The best time to check the engine oil is when the oil is warm, such as during a fuel stop or after at least 30 minutes of highway driving. The vehicle should be allowed to sit for at least 15 minutes, after the engine has been shut off, before taking an oil level reading to assure the oil has had enough time to drain back into the crankcase/oil pan. In order to ensure accurate results, the temperature of the oil should be close to the same temperature as the last time the oil level was checked.

The vehicle must be parked on a level surface to obtain accurate oil level readings. Verify that the dipstick tube is fully seated in the block. When checking the oil level, make sure the dipstick is wiped clean before taking an oil level reading and fully depress the dipstick until the shoulder bottoms out on the dipstick tube. The dipstick should be the proper part number for the engine/vehicle that is being checked

Note: If you check the oil level when the oil is cold, do not run the engine first. The cold oil will not drain back to the pan fast enough to give a true oil level.

NOTICE:

Oil level should not be over the full mark or more than one quart low. Oil can become aerated when overfilled or when more than one quart low. Aeration of the oil can cause valve lifters to collapse causing major damage to the engine.

CHANGING THE OIL

Oil can be drained from the engine through the drain hole in the bottom of the oil pan. Replacement oil is added through the fill tube at the top of the engine and near the radiator. Generally, the recommended oil change interval every 3 months or 3,000 miles, whichever comes first. More frequent intervals are recommended if any of the following severe operating conditions are encountered:

- Frequent long runs at high speeds and high ambient temperatures.
- Operating in dusty areas.
- Towing a trailer or tow vehicle.
- Idling for extended periods and/or low-speed operation.
- Operating when outside temperatures remain below freezing and when most trips are less than 4 miles.

Refer to the Owner's Manual for recommended change intervals.

Note: Following an oil change, verify that the proper amount and type of oil was put in the engine and that the oil level on the dipstick is not above the full mark or below the add marks.

Note: You should consider the following fact when storing your motor home for long periods of time, in excess of three months. Used engine oil contains harmful contaminants that has the potential to pit and/or corrode engine bearings when exposed for longer periods of time. It is also possible for condensation to collect in the oil pan area as well as the cylinder head and piston/ring areas; engine failure could result due to water and acid contamination of the oil. Therefore, it is important that the oil be changed before the motor home is put in storage as well as after storage, if the motor home is stored for more than one season.

OIL CONSUMPTION

All engines require oil to lubricate and protect the load bearing and internal moving parts from wear including cylinder walls, pistons, and piston rings. When a piston moves down its cylinder, a thin film of oil is left on the cylinder wall. During the combustion process, part of this oil layer is consumed. As a result, varying rates of oil consumption are accepted as normal in all engines.

Oil usage has a direct relationship with the amount of fuel used. The harder an engine works the more fuel and oil it will use. Therefore, oil usage as a factor of fuel usage is a more accurate indicator of acceptable oil consumption levels than vehicle mileage for vehicles at or above 8,600 GVW.

Many factors can affect an owner's concern with oil consumption. Driving habits and vehicle maintenance vary from owner to owner.

High Speed or High RPM Operation: Continuous driving at high speeds/high RPMs may increase oil consumption. Because this may not always be an everyday occurrence, it is hard to determine exactly how much the oil economy will be affected.

Towing or Heavy Usage: Towing a trailer or hauling additional weight may increase oil consumption. Large frontal area trailers will further increase the work required from the engine, especially at highway speeds, and thus increases the rate of oil consumption.

CAUTION:

When towing heavy loads reduce your speed and increase the distance between you and other vehicles.

Crankcase Ventilation System: Verify that the positive crankcase ventilation (PCV) system is operating properly. Blockages, restrictions, or damage to the PCV system can result in increased oil use.

Oil Dilution from Condensation: On vehicles that are usually driven short distances, less than 8 km (5 mi), especially in colder weather, condensation generated from cold engine operation may not get hot enough to evaporate out of the oil. When this occurs, the dipstick may indicate that the oil level is over-full. Subsequent driving on a trip of sufficient length to enable normal engine operating temperature for 30 minutes or more, in order to vaporize excess moisture, may give you the impression of excessive oil consumption.

Measurement of Oil Consumption: Engines require a period of time to BREAK IN so that moving parts are properly seated. Therefore, oil economy should not be tested until the vehicle has accumulated at least 8000 km (5000 mi) and the oil has been changed for the first time. Manufacturers of piston rings state that piston rings in today's engines, control oil very effectively. For example, if $1/10^{\text{th}}$ of a drop of oil would be consumed per explosion when driving at 60 MPH, an eight-cylinder vehicle would use about 90 quarts of oil on a 600-mile trip. The actual average consumption of oil per explosion in today's engines is from $1/1,000^{\text{th}}$ to $2/1,000^{\text{th}}$ of a drop.

Oil consumption is often more related to duty cycle than mileage. A good GM guideline is one quart per 100 gallons of fuel used.

ENGINE COOLING

The operation of the cooling system is to remove excess heat from the engine to maintain normal operating temperatures. Components of a typical system include the water pump, thermostat, radiator, coolant recovery tank, and hoses. The pump, generally driven by the engine crankshaft via a drive belt, circulates coolant through passages in the engine cylinder block and heads where it absorbs heat. The hot coolant flows out of the engine through a thermostat and hose to the radiator. In the radiator, the coolant loses heat to the outside air circulating around the radiator core tubes. Cooled coolant then flows out of the radiator, through hoses back to the engine.

Air circulating around the radiator core tubes, as described in the above paragraph, is where the coolant loses its heat in turn cooling the engine. It is extremely important to ensure air flow is allowed to circulate through the radiator. Although the body manufacturers are responsible to ensure the opening is of the correct size, restricting the flow through the grill opening with a screen or other any other item will reduce the chassis ability to cool the engine and the associated components. In efforts to direct all air available through the radiator Workhorse provides on all W Series chassis air diversion fabric to go between coach body and the radiator. Since this is rubber material it does require inspect for signs aging as well as fitment to the body. This material is provided in three sections top, Workhorse part no. W0005312, and two sides, Workhorse part no. W0005313 and W0005314.

COOLANT

The coolant level, appearance and strength should be checked periodically. It should be drained and replaced at the intervals recommended in your maintenance schedule, or sooner if it is contaminated. Hoses should be checked regularly for signs of damage or deterioration and hose clamps tightened if necessary.

Check hoses for cuts or abrasion damage. If the hoses have become hard and brittle and show signs of cracking as a result of engine heat, they should be replaced. Hoses should also be replaced if they are soft and spongy, or swollen as a result of exposure to oil and grease. Any flaking or deterioration of inner lining of the hose is also reason for replacement. Such particles can clog the cooling system, reducing its efficiency. The radiator cap should be washed with clean water and pressure checked every 12 months.

DEX COOL™

All Workhorse chassis come standard with a long life engine coolant called Dex-Cool™. Dex-Cool™ is reddish-orange in color and has a service interval of 5 years or 150,000 miles, whichever comes first. If adding coolant, it is important that you use only Dex-Cool™, or an equivalent silicate-free coolant. If coolant other than Dex-Cool™, or equivalent, is added to the system premature engine, heater core or radiator corrosion may result. In addition, the coolant service interval will be reduced requiring replacement at 24 months or 30,000 miles, whichever occurs first.

ENGINE OPERATING TEMPERATURES

Normal operating temperatures are between 190 to 240 degrees. Engine temperatures will increase as ambient temperatures and the load on the engine is increased. Temperatures of 247 degrees and up should be suspected of overheat and necessary precautions must be observed to

prevent engine damage. The Workhorse supplied instrument clusters on 1999-2002 chassis do not have an overheat warning indicator, but a gauge is supplied. As a general rule for gasoline engine chassis the start of the amber or red area of the temperature gauge is the "overheat" zone, roughly 260 degrees.

Note: Factory installed temperature gauges have been calibrated so the owner sees a mid-range reading as the "normal" operating temperature. The reason for this is that many owners tend to perceive 212 degrees F as the boiling point. However, this is not the case in an engine with a 15-lb. pressure system and a 50/50 solution of engine coolant and water, as shown in the below charts. If the engine is equipped with a master gauge, one of the various electronic gauges installed by body manufacturer, the temperature reading of the engine will be higher than that of the factory-installed system. No matter which gauge system is utilized, the motor home owner must realize that the purpose of any gauge is to provide warning of any rapid change in temperature from the "normal" reading of that particular gauge.

BOILING POINT VS. PRESSURE CHART WATER/GLYCOL		
PRESSURE* (LBS./SQ.IN.)	BOILING POINT	
	WATER	GLYCOL MIX (50/50)
0	212	223.5
1	215.3	227.2
2	218.5	230.0
3	221.6	233.0
4	224.6	236.0
5	227.4	238.8
6	229.8	241.6
7	232.8	244.0
8	234.8	246.2
9	237.1	249.2
10	239.4	251.7
11	241.6	254.5
12	243.7	256.3
13	245.7	258.3
14	247.8	260.3
15	249.7	262.5
15	251.7	264.4
17	253.6	266.2
*Normal Pressure Under Normal Conditions		

COOLANT FREEZE POINT/FLASH POINT		
FREEZING POINT & BOILING POINT	TEMPERATURE (In degrees F)	
	FREEZE	BOIL*
33% by Volume Solution	0	220
40% by Volume Solution	-12	222
50% by Volume Solution	-34	227
60 % by Volume Solution	-63	232
68% by Volume Solution	-90	241
(Maximum Freezing Protection)		
Concentrated	-8	320
Flash Point (Cleveland Open Cup)		
68% by Volume Solution		None
Concentrated		257
Fire Point (Cleveland Open Cup)		
68% by Volume Solution		None
Concentrated		266
* At sea level atmospheric pressure. Boiling point decreases about 2 degrees F per 1,000 feet of altitude and increases about 2.5 degrees F per pound of pressure developed in the system		

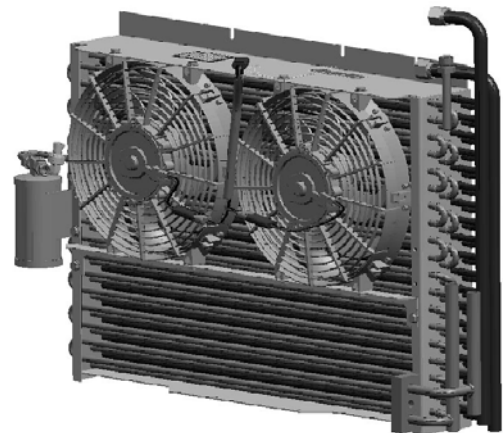
ENGINE COOLING FANS

The main engine-cooling fan is mounted on the front of the water pump driven by the drive belt and positioned inside a fan shroud behind the radiator. This engine fan is a variable drive fan controlled by a temperature sensitive clutch. The clutch housing is a lightweight metal construction that is filled with silicone oil and hermetically sealed. During periods of operation when the radiator discharge air temperature is low, below 150 degrees, the fan clutch limits fan speed to 800 - 1,400 RPM. As operating air temperatures increase, above 150 degrees, a temperature-sensitive bi-metal coil tightens to move the sliding valve plate, allowing the flow of silicone oil into the clutch chamber to engage the clutch, providing maximum fan speed.

When the main engine fan kicks in (very often when climbing an up-grade or when towing in hot ambient conditions) a roar can be heard. The fan requires additional horsepower and can even result in a downshift. Many owners mistake this noise as a transmission or engine problem whereas it is normal operation.

The electric condenser fan(s) also assists with engine cooling. The condenser fan(s) are mounted either on the air conditioning condenser or on the transmission external oil cooler. Both the condenser and external transmission oil cooler are mounted in front of the radiator. One large electronic fan was utilized on all chassis prior to 2001 model year, and all chassis 15,000 lb. GVWR or lower, or if equipped with a 6.5L diesel engine regardless of model year. All other chassis 2001 model year or newer will be equipped with two smaller electric fans, see adjacent diagram. These fan(s) are controlled by

the Powertrain Control Module (PCM) and operate whenever the dash air conditioning compressor is operating or if the engine temperature is above 221 degrees F.



Condenser, Transmission/Engine Oil Cooler and Electric Fan Assembly

FUEL SYSTEMS

The fuel system on the gasoline engine is computer controlled by an electronic Powertrain Control Module (PCM). The PCM monitors engine operating conditions including inlet airflow, oxygen in exhaust, timing, engine temperature, throttle position, manifold pressure, etc. The PCM uses this information to deliver the precise amount of high-pressure fuel through individual injectors to each cylinder for maximum efficiency. This type of fuel injection system is referred to as Sequential Port Fuel Injection (SPFI). Sequential indicates fuel is delivered to each individual cylinder when required. Port, referring to the position of the injectors, positioned in the intake manifold firing directly into the cylinder head port. Fuel Injection referring to precise high-pressure fuel delivered through injectors.

GASOLINE ENGINE FUELS

Lead Substitute Additives-Workhorse has *not* issued a service bulletin recommending the use of any lead substitute additive by the individual customer. Workhorse has taken the position that many additives on the market today do not have sufficient data testing to factually back up some of the claims being made. Some additives may in fact actually be counterproductive to the governments reasoning for lead removal and create undesirable emissions problems as well as being detrimental to overall engine life. There is a consensus among fuel and lube engineers that the use of lead substitute additives should *not* be a consumer decision and that if the *need* for an additive becomes established, the product should be blended into the gasoline as the fuel is produced by the gasoline supplier to ensure better chemistry control.

Gasohol-Gasohol, a mixture of 10 percent ethanol (grain alcohol) and 90 percent gasoline may be used in GM gasoline engines without voiding the warranty. However, because of the composition of gasohol, engines will tend to operate leaner with gasohol than with gasoline.

This can result in drivability conditions usually associated with leaner mixtures. Also the increased volatility of gasohol can contribute to hot weather drivability problems if adjustments are not made to the gasoline blend during the refining process. The higher octane rating of gasohol, compared to most unleaded gasoline, could help reduce the tendency for spark knock. But, gasohol contains less energy than gasoline, and fuel economy may or may not be quite as good. However, in some instances, depending on the entire design, calibrations and certain operating conditions, it is possible to get improved fuel economy.

Exhaust emission levels may change up or down with the use of gasohol, again, depending on the calibration of the engine. At the present time, however, the EPA has not restricted the use of gasohol.

If gasohol is spilled on a painted surface, some dulling or softening of paint may result.

Non-Reformulated Fuels – Some gasoline is not reformulated for low emissions and may contain an octane-enhancing additive called Methylcyclopentadienyl Manganese Tricarbonyl (MMT): ask your service station operator whether or not the fuel contains MMT. Workhorse does not recommend the use of such gasoline. If fuels containing MMT are used, spark plug life may be reduced and your emissions control system performance may be affected. The malfunction indicator lamp on your instrument panel may turn on. If this occurs go to your authorized dealer for service.

DIESEL ENGINE FUELS

Note: Do not use starting fluids. Such aids can cause immediate engine damage.

Diesel fuel is available in No. 1 or No. 2 grades. The difference between the grades is that No. 1 diesel fuel has had much of the paraffin (wax) removed. While the wax content increases the amount of energy in the fuel, it can clog the fuel filter(s) in cold weather, and stop the flow of fuel to the engine. In the United States, for best results use No. 2 diesel fuel year around (above and below freezing) as oil companies blend No. 2 to address the climate differences. No. 1 diesel fuels may be used in very cold temperatures (stays below 0 degrees F or -18 degrees C); however it will produce a power and economy loss. The use of No. 1 diesel fuel in warm climates may result in stalling, poor starting when engine is hot and may damage the fuel injection system.

The Cetane number used in rating diesel fuels is an indication of the energy content of the fuel-the higher the Cetane number, the higher the energy content. The higher Cetane rating will improve the cold-starting performance of the engine, as long as the higher wax content does not impede the flow of fuel through the system. This introduces two other factors that affect diesel fuel, cloud point and pour point. The cloud point represents the temperature at which a predetermined percentage of the wax content in the fuel solidifies. The pour point represents a lower temperature at which the fuel cannot be made to flow.

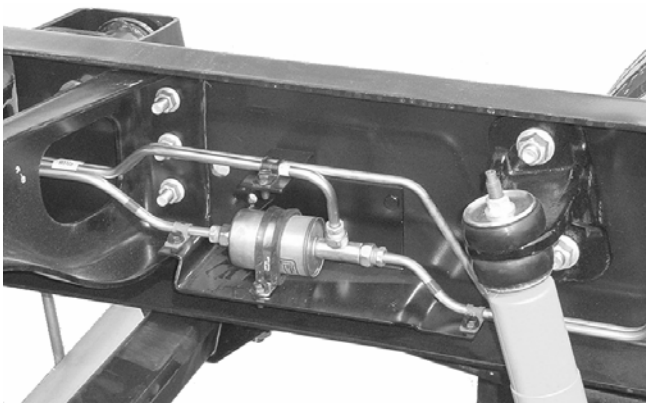
The moisture content of the fuel can also affect cold weather starting and performance. Water can separate out of the fuel, settling in low points of the fuel line and freezing, or forming minute ice particles which flow into the filter(s) and tend to clog the filter(s).

Additives can be used to lower the pour point of the fuel, and to prevent moisture freezing in the fuel. However, additives will have little effect on the cloud point. Mixing different grades of diesel fuel can also be used to change the pour point and to change the cloud point as well.

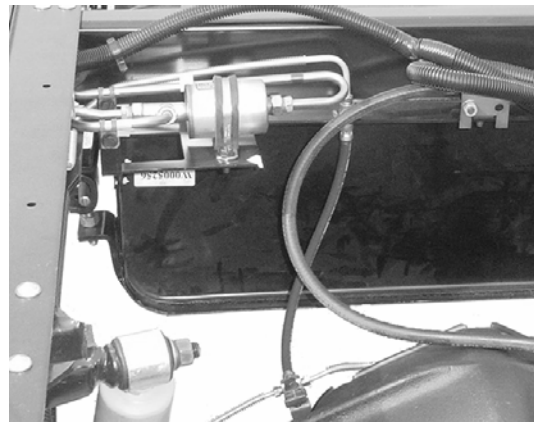
At a minimum, the diesel fuels you use should meet specifications ASTM D975-94 (Grade Low Sulfur) in the United States. In addition, the Engine Manufacturers Association (EMA) has identified properties of an improved diesel fuel for better engine performance and durability. Diesel fuels corresponding to the EMA description could provide better starting, less noise and better vehicle performance. If traveling in Canada please refer to your Owner's Manual for details.

FUEL FILTERS

The P Series chassis starting with the 2004 model year the 8.1 liter gas engine has one fuel filter located on the frame rail cross member rearward of rear axle. Prior to 2004 model year with either the 8.1 liter, 7.4 liter or the 5.7 liter Vortec gas engines the single fuel filter was located in the right (passenger side) inner frame rail forward of the rear axle. The W Series chassis with the 8.1 liter Vortec gas engine has one fuel filter located in the left (driver's side) inner frame rail rearward of the rear axle. These are in line filters and require tools to be replaced. Prior to 2004 model year these filters had single inlet and outlets, an additional outlet was added for all 2004 and later chassis. A trained service technician should perform replacement of the fuel filters. The filters should be replaced as required. A yearly inspection is suggested.



W Series Fuel Filter Location (2004 and newer)



P Series Fuel Filter Location (2004 newer)

The gasoline fuel filter has no periodic change interval. It can last for years or for hours if contaminated fuel is encountered. The symptoms of a plugged gasoline fuel filter are gradual loss of power until engine dies. The engine will often restart and run with reduced power. Symptoms of water contamination are engine miss, possible backfire, and failure to start after stalling. Some owners carry a spare fuel filter in the event that filter becomes clogged.

The 6.5L combines the fuel filter, water separator and fuel heater all in one canister. Its location (on the rear of the intake manifold) and top-load design allows easy filter cartridge replacement. The method of draining off the water has also been designed for convenience. The water separator draincock has been located up front on the top of the engine, to allow for draining when required.

FUEL TANKS

All 1999 Workhorse chassis came standard with 40 gallon tanks with optional 60 gallon or 75 gallon (178" base chassis or longer only) tanks were available. 2000 and newer chassis with 178" or longer wheelbase become standard with 75 gallon tanks, optional 60 gallon tank on P Series only. P Series and W Series chassis with 158.8 wheelbases come standard with 60 gallon tanks, a 40 gallon tank was optional on P Series chassis only.

Starting on 9/3/01 and with the 75 gallon tank, the fuel tank design was changed to a shorter and deeper style tank allowing additional room in the rear of the chassis for spare tires or other components. The new designed 60 gallon tanks began in 10/9/01 and the 40 gallon tanks in 11/01. A kit is available to through Workhorse Parts if an exchange of the previous style tank with the new redesigned tank is required.

All Workhorse RV chassis come with an auxiliary fuel pick-up tube in the fuel tank to supply fuel to the motor home's generator. The pick-up tube extends approximately $\frac{3}{4}$ of the tank depth leaving fuel for the vehicle engine operation. Tanks come with the outside painted and the inside coated with oil for rust protection. Workhorse recommends storing your motor home with a full tank of fuel mixed with a fuel stabilizer if the storing for prolonged periods of time, in excess of three months. A completely full fuel tank will prevent moisture build up by reducing condensation taking place which can corrode the inside of the fuel tank. All chassis should be stored with fuel stabilizer add to a full tank of fuel. Run the engine for several minutes after adding the stabilizer to ensure circulation throughout the fuel system.

Workhorse provides a fuel filler neck and non-locking gas cap to the body manufacturers. An optional locking style gas cap is also available. If your vehicle was not equipped with the locking style it can be ordered, Workhorse part no. 22660005. The various manufacturers will normally utilize the filler neck and gas cap during the build process, although some may install their own design. The installation of these components is critical and can affect fill rate during refueling. The 75 gallon fuel tanks were equipped with fuel fills on both driver and passenger side allowing for a fuel fill(s) on one or both side of the vehicle depending on the body manufactures design until January 12, 2005 – VIN 406245. After this point left hand fill only tanks became standard, Workhorse part no. W0007080. An optional tank with dual fills is available, option code NDF, Workhorse part no. W0005256. The 40 and 60 gallon fuel tanks were equipped with fuel fill on driver side only.

EXHAUST SYSTEMS

The exhaust manifolds used on the big block gas engines were redesigned with the introduction of the 7.4L Vortec. The redesigned manifolds promote maximum airflow through the engine for maximum horsepower and torque as well as reduce tail pipe emissions. The manifolds are constructed from a nodular cast iron that has some of the same properties as cast but are not as prone to cracking or warping. In 2001 on the 8.1L Vortec the design remained very similar but the construction material changed to a stainless steel casting, increasing the heat resistance and longer life. The manifolds are sealed to the engines cylinder heads by multi-layer stainless steel exhaust manifold gaskets that provide a positive seal, Workhorse part no. 12558275.

The exhaust system on all 7.4L Vortec engines came with enlarged dual pipes running through two catalytic converters, for maximum airflow. Both exhaust pipes then enter into a single muffler with one larger diameter pipe exiting to the driver's side of the vehicle behind the rear tires.

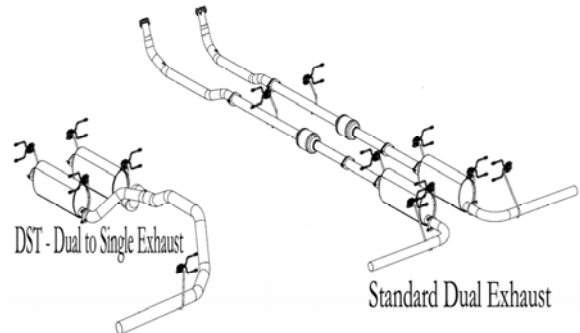
The 8.1L exhaust was redesigned for even higher flow for additional horsepower and torque. Large diameter pipes are utilized with two high flow catalytic converters and two low restriction mufflers. The standard exhaust is routed down the inside of each frame rail and exits on both sides of the chassis prior to the rear axle. The optional exhaust is identical to the standard exhaust through the mufflers; the optional exhaust then connects into one enlarged pipe exiting behind the driver's side tire. Adjacent are diagrams of both exhaust systems. Either system provides minimal restriction and utilizes long life components.

The standard dual exhaust can be changed to the single exiting style if desired. The change requires a Y-Pipe, Workhorse part no. W0006196, exhaust pipe assembly, Workhorse part no. W0003731, and connecting clamp, Workhorse part no. W0005673. Reuse of the two muffler clamps and one frame exhaust hanger is also required.

The W16 (16,000 lb. GVWR) and W18 (18,000 lb. GVWR) equipped with the 6.0L Vortec as well as P Series chassis with the 5.7L Vortec or the 6.5L

Diesel engine come standard with a high flow single exhaust system exiting behind the rear tire on the passenger side, no optional exhaust systems are available for these engines

P Series chassis are standard with a heat/splash shield on the right side for the engine attached to the frame, Workhorse part no. 15983041. This provides airflow along the right side exhaust manifold and spark plug wires, thereby cooling these components and extending service life. The driver's island, on the left side, provides similar airflow down this side of the engine, also acting as a splash shield. This cooling is necessary due to the extreme heat that is developed by the exhaust manifolds during normal engine operation, especially under heavy loads such as climbing hills. Due to the repositioning of the engine in the W Series chassis, these shields were not required to provide adequate airflow around the engine exhaust manifolds providing the front cap of the coach allows adequate air flow in the engine bay. If it is determined that additional airflow is needed an airflow routing kit has been developed, Workhorse part no. W8002069.



With these long high-flow exhaust systems the exiting exhaust cools rapidly as it travels through that exhaust system and exits at a considerable lower temperature than at the exhaust manifolds. With these lower temperatures normal exhaust vapors including carbon (soot) condenses along the pipe giving it a black coloring. During high engine load conditions (such as climbing long grades) exhaust pipe temperatures elevate to the point that this soot can vaporize in heavy concentrations, in combination with moisture (which is a normal by product of the catalytic converters) this can produce black smoke. This is normal operation and should not be confused with the engine running rich, as that condition would be detected by the oxygen sensors and set a check engine light.

ENGINE AND CHASSIS ELECTRICAL

BATTERY

Workhorse utilizes maintenance free batteries standard on all configurations of chassis. Although all batteries are maintenance free, two styles and brands may be utilized. The first and most common are Delco Freedom sealed top, maintenance free style batteries. The gas engine chassis are equipped with one battery having 690 Cold Cranking Amps @ 0 degrees F, 115 minutes Reserve Capacity @ 80 degrees F. The 6.5L diesel engine chassis are equipped with two batteries both having 600 Cold Cranking Amps @ 0 degrees F, 115 minutes Reserve Capacity @ 80 degrees F. The second style of batteries is Workhorse branded maintenance free with removable fluid inspection/fill caps. The Workhorse brand batteries utilized on the gas engine chassis only and have 690 Cold Cranking Amps @ 0 degrees F, 115 minutes Reserve Capacity @ 80 degrees F. The physical size of all batteries utilized is 10.22" long, 6.77" wide, 7.22" height and weight 37.50 lbs. each. The BCI group size is 78; replacement model numbers are 78-7YR for the Delco and 78-72 for Workhorse batteries.

CHECKING BATTERY CONDITION

First, examine the battery externally. Check for any cracks or holes in the case, vents or cover, through which electrolyte (battery fluid) will leak. If damage is found, replace the battery. Electrolyte is a corrosive fluid and can damage surrounding components, use care when handling or inspecting a battery. The battery should have clean tight cable connections free of dirt and corrosion. Make sure the battery should be mounted securely and level.

The Delco Freedom sealed-top batteries that have a built-in temperature compensated hydrometer in the top of the battery. This hydrometer can be used to determine the condition, state of charge, of the battery. The hydrometer "eye" is located on the top of the battery. Under normal operation two indications can be observed and occasionally a third.

1. Green Dot visible, battery is ready for testing, do not charge.
2. Dark-green dot not visible, the battery must be recharged until the green dot is visible before testing.
3. Clear or light yellow, this means the fluid is below the bottom of the hydrometer. This may be caused by tipped battery, cracked case, etc. The battery should be replaced.

Workhorse brand batteries require only a physical inspection. If additional battery testing is desired or deemed necessary, a trained service technician should perform the testing with the appropriate equipment.

BATTERY CARE

A battery is not designed to last indefinitely, however, with proper care it will provide many years of service. If the battery tests as "good" but fails to perform satisfactorily in service, the following are some of the more important factors that may point to the cause of the trouble.

1. Accessories left on overnight.
2. Slow average driving speeds for short periods.
3. The vehicle's electrical load is more than the generator output particularly with the addition of aftermarket equipment such as radio equipment, air conditioning, window defoggers or light systems.
4. Defects in the charging system such as electrical shorts, slipping fan belt, faulty generator or voltage regulator.
5. Battery abuse, including failure to keep the battery cable terminals clean and tight, check for cracked case or cover, or a loose battery (one that is not securely held in place).
6. Batteries in vehicles stored for long periods of time become discharged with sulfation occurring. Sulfation of the plates reduces the battery's capacity for accepting a charge.
7. Conditions of high ambient temperature, the temperature of the electrolyte may become excessive-causing boiling and loss of electrolyte.

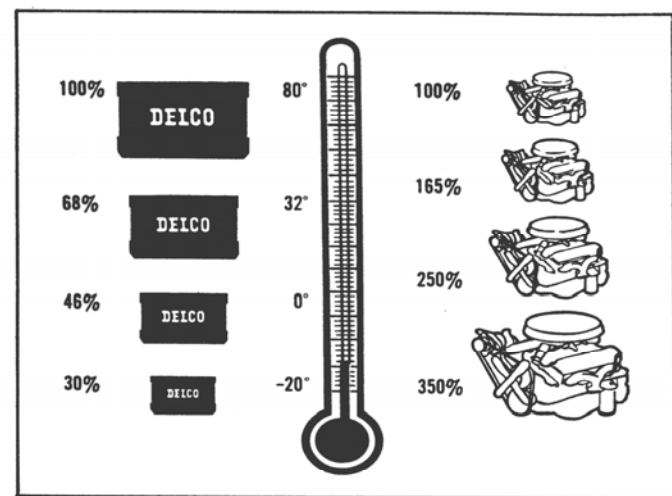
CAUTION:

Electrolyte can freeze when stored in cold climates. A battery that has had the electrolyte frozen has the potential for internal damage of connections as well as external damage. Once the internal connections have been damaged there is a high potential for the battery to explode during charging or jump-starts.

BATTERY CAPACITY

The following information is provided as an aid to the motor home owner in understanding battery size and cranking capacity in relation to temperature.

The adjacent chart explains why a battery of sufficient electrical size is essential if satisfactory cranking of the engine is to be achieved at low temperatures. At temperatures below 0 degrees F, the capacity of the battery at full charge is about 30% of rated capacity at 80 degrees F. At the same time, the load imposed on the battery by the engine is about 3½ times the normal cranking load at 80 degrees F. In effect, at lower temperatures the battery would seem "smaller" while the engine would appear to be "larger", as depicted in the following chart.



Battery Cranking vs. Temperature

The charts below provide an example of the “shrinking” battery in terms of Cold Cranking Amps (CCA) in relation to temperature.

100% FULL-CHARGED BATTERY

	405 CCA BATTERY	650CCA BATTERY
80°F	880 CCA	1413 CCA
32 °F	598 CCA	960 CCA
0 °F S	405 CCA	650 CCA
-20 °F	264 CCA	423 CCA

65% FULL-CHARGED BATTERY

	405 CCA BATTERY	650 CCA BATTERY
80 °F	572 CCA	918 CCA
32 °F	389 CCA	624 CCA
0 °F	263 CCA	422 CCA
-20 °F	171 CCA	275 CCA

Just as low winter temperatures can create cold-start cranking problems due to the electrical size and cranking capacity of a battery, the majority of winter engine damage is scuffed and seized bearings that occur upon initial start up. The reason for these problems is oil starvation from drain-off and the fact that the oil is too thick to pump quickly to the bearings.

For the best fuel economy and cold starting protection to engine surfaces, consider the range of temperatures your vehicle will be operated in during the next oil change. Refer to the engine lubrication section of this manual for the correct weight of oil based on outside ambient temperatures and engine type of where the motor home will be operating. *Additional oil weight recommendations can found in the Owner's Manual.*

CHARGING SYSTEM

The function of the charging system is to provide electrical power to the engine electrical systems, accessories and to restore power lost from the battery.

The primary component of the system is the generator, or more commonly referred to as the alternator. The generator assembly includes the rotor, stator, and rectifier subassemblies and an integral voltage regulator. When the engine is operating and turning the rotor, an alternating current flow is induced in the stator assembly by the electromagnetic field established in the rotor. The alternating current produced in the stator is changed to the direct current needed in the vehicle's electrical system by the rectifier assembly. This is accomplished through the use of diodes in the rectifier assembly that allows current flow in one direction only. The voltage regulator controls the output of the generator. The voltage regulator does this by varying the strength of the electromagnetic field in the rotor assembly.

The size of your generator (alternator) will depend on the model year of your chassis. Workhorse has increased the size of the generators on your motor home chassis to meet the expanding needs of the chassis and coach electrical systems. In 1999 and 2000 model years a 124 amp maximum output generator was utilized. In 2001 the generator maximum output was increased to 130 amps and in 2002 to 145 amps. An optional 200 amp maximum output generator was also made available starting in the 2003 model year.

BATTERY ISOLATOR

A battery isolator is a solid-state device used to isolate the motor homes deep cycle battery(s), which operates the motor home electrical systems, from the chassis battery(s) use to operate the engine electrical systems. The isolator disconnects the motor homes battery(s) from the chassis electrical system when the engine is shut off. This prevents the chassis battery from losing charge through the use of the motor homes electrical components. Once the vehicle has started, the isolator will reconnect the motor home battery(s) back into the charging system to re-charge the motor home battery(s).

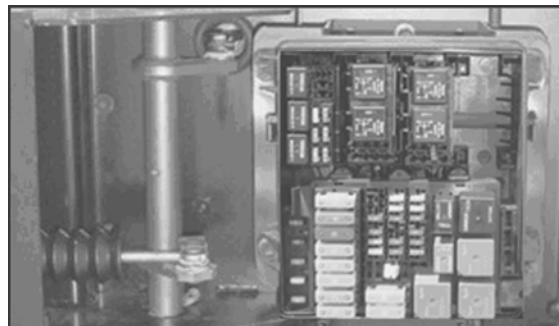
Note: The isolator and the motor home battery(s) are installed by the body manufacturer and are not covered by the Workhorse Limited Warranty.

FUSES AND CIRCUIT BREAKERS

Prior to 2001 the body manufacturers positioned all the fuses and relay centers generally under the dash or by the steering column. Starting in 2001 for all gas engine chassis a redesigned electrical system was integrated. The wiring that extends the length of the chassis was moved to the inside of the frame rail for added protection. A centralized main external fuse center became standard. This center included all the main chassis relays, fuses and circuit breakers. It is located under the hood to the left side (driver's side) of the radiator, see below. An additional small interior fuse block is also utilized, again positioned by the body manufacturer generally under the dash or by the steering column.



2002 - 2005 UNDERHOOD FUSE & RELAY BOX



2006 UNDERHOOD FUSE & RELAY BOX

CRUISE CONTROL

All Workhorse motor home chassis come with electronic speed control (cruise control) as standard equipment. In the 2001 model year, motor home chassis with the 8.1L engine integrated the cruise control unit in the engine electronics. The 6.0L engine also uses the integrated cruise control system. All other gasoline engine combinations operate the cruise control with a separate component. Neither system requires any routine maintenance.

INSTRUMENTATION

Workhorse has utilized two uniquely different instrument clusters. In 1999-2002 model years the standard cluster utilized a typical design of the automotive industry. It included a tachometer, speedometer, fuel gauge, voltmeter, oil pressure and engine coolant temperature analog style gauges. A number of warning indicator lights were also included. This cluster continued to be utilized on the 6.5L Turbo Diesel applications for 2003.

Starting in 2003 model year all gas chassis became standard with a revised instrument cluster; see the following picture, which includes a number of new functionalities. The cluster includes a tachometer, speedometer, fuel and engine coolant temperature analog style gauges, similar to the previous cluster. The revised cluster includes a "Message Center", a LCD screen located in the bottom center of the speedometer gauge. The oil pressure and voltmeter were integrated into the message center along with the odometer, trip odometer and gear selector indicator (gear selector indicator W Series only - P Series indicator located on the steering column). Additional features of the message center are selected by the mode/trip buttons located below the temperature gauge, lower right of the below picture. These features include a trip computer that calculates instantaneous fuel consumption, average fuel consumption, fuel range, average vehicle speed and outside temperature (temperature probe subject to installation by body manufacturer). The message center also provides warnings for low fuel, low oil pressure, low oil level (oil level started in 2004 model year), engine coolant temperature, battery voltage and an oil change reminder.



MESSAGE CENTER OIL CHANGE RESET & CONTRAST ADJUSTMENT

To reset the oil change reminder, turn the ignition switch to the "ON" position but do not start the engine. Fully depress and release the accelerator pedal three times within five seconds, and turn the ignition switch to the "OFF" position for at least 10 seconds.

To adjustment contrast enter the cluster diagnostic menu. Turn ignition switch to the "ON" position but do not start the engine. Press and hold the Mode button for 5 sec, the cluster will enter the diagnostic menu with the Contrast Adjustment as the first item and highlighted. Wait 3 seconds with Contrast Adjustment highlighted, the cluster will enter the contrast adjustment mode. Use the Trip to increase contrast and the Mode button to decrease contrast. After the adjustment is made wait 3 seconds and the diagnostic menu will appear. Scroll to the Exit listing on the menu, wait 3 seconds, this will exit you from the diagnostic menu.

Refer to the Owner's Manual for additional information on the instrument cluster(s).

If it ever becomes necessary to remove fine scratches, haziness and abrasions from the plastic lens of the instrument cluster it is recommended to utilize Novus No. 2, fine scratch remover. For the nearest distributor call toll free (800) 548-6872. Information on this and other Novus products can be found on their web site www.novuspolish.com.

TRANSMISSIONS

Workhorse motor home chassis come standard with automatic transmissions. Workhorse utilizes two types of transmissions depending on the Series of the chassis. The P Series chassis utilized the GM Hydra-Matic 4L80-E 4-speed automatic transmission on all chassis in the 1999-2002 model year chassis. In the 2003 model year GM introduced the 4L85-E Hydra-Matic transmission, a heavy-duty version of the 4L80-E. The 4L85-E became standard in all P Series chassis with the 8.1L engine. Prior to the 2006 model year the W Series 20,700 lb. and 22,000 lb. GVWR chassis used the Allison™ LCT 1000 or 1000MH 5-speed automatic transmission while the W Series 24,000 lb. GVWR chassis used the Allison™ 2100MH 5-speed automatic transmission. Beginning with 2006 model year all Allison™ transmissions will provide 6 forward speeds. All transmissions are electronically controlled rear wheel drive models. The gear shifting points and shift feel are determined by electrical signals sent from the Powertrain Control Module (PCM) on the GM transmission, and from the Transmission Control Module (TCM) on the Allison™ transmission. The PCM or TCM receives input from sensors based on throttle position, vehicle speed, gear range, altitude, temperature, engine load, etc. The PCM or TCM processes this data and transmits signals to the valve body shift solenoids activating the shift valves for precise shift execution.

The 4L80-E, 4L85-E, LCT 1000, 1000MH and 2100MH are constructed with similar main components and consist primarily of a torque converter and three planetary gear sets. A series of multiple disc clutches, sprag and/or roller clutches as well as bands provide the friction elements required to obtain the desired function of the planetary gear sets. A hydraulic pump and an electronically controlled valve body are used to operate the various systems within the transmission.

The torque converter contains a stator, turbine, impeller, and a clutch plate splined to the turbine. The torque converter acts as a fluid coupling to smoothly transmit torque from the engine to the transmission. It also hydraulically provides additional torque multiplication when required. The clutch pressure plate, when applied, provides mechanical “direct drive” coupling of the engine to the transmission.

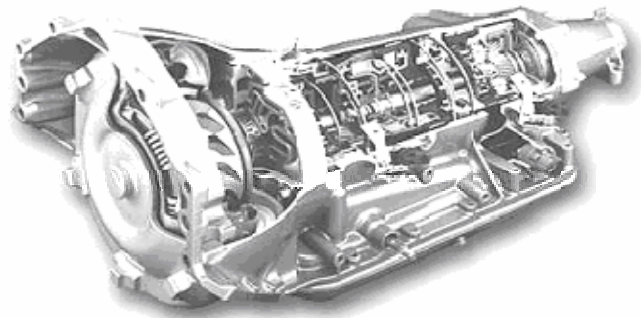
ALLISON™ TRANSMISSIONS **SPECIFICATIONS**



ALLISON™ 1000MH & 2100MH							2006 Model Year
Type:	Six speed rear-wheel-drive, electronically controlled, automatic overdrive transmission with a torque converter clutch						
Maximum Engine Torque:	545 lb-ft (740 Nm) gross (LCT1000) 600 lb ft (813 Nm) gross (2100MH)						
Maximum Horsepower Input:	340 hp (254 kW)						
Gear Ratios:	1 st	2 nd	3 rd	4 th	5 th	6 th	Rev
	3.10	1.81	1.41	1.00	0.71	0.61	-4.49
Case Material:	Aluminum						
Maximum Gross Vehicle Weight:	22,000 lb. motor home (1000MH) 24,000 lb. motor home (2100MH)						
Transmission Weight:	Dry - 330 lb (150 kg)						
Fluid Type:	1000MH - TranSynd™ 2100MH - TranSynd™						
Fluid Capacity (Approximate-Refill):	Bottom Pan Removal - 10.6 qt (10L)						
Main circuit oil filter:	Spin-on canister (front driver's side of transmission)						
Power Takeoff:	Left or Right side						
Towing Capacity:	26,000 lb (11,800 kg) Maximum Gross Combined Vehicle Weight (1000MH) 30,000 lb. (13,600 kg) Maximum Gross Combined Vehicle Weight (2100MH)						
7-Position Quadrant:	P,R,N,D,3,2,1 - 5 th & 6 th gears (overdrive) are controlled by a disable switch on the dash with an indicator in the instrument cluster						
Control Systems:	Electronic, closed loop, adaptive with stand alone Transmission Control Module (TCM)						
Transmission Coolers:	Internal radiator and external transmission oil to air fluid coolers standard.						
Converter Lock-up:	Torque converter lock-up at all speeds in 2 nd , 3 rd , 4 th , 5 th and 6 th gears. Lockup prevents excessive heat build-up, increases fuel mileage and provides improved engine braking.						
Drivetrain Interface:	Maximum output shaft speed 5000 rpm (LCT 1000), 4500 rpm (2100MH)						
Manufactured:	Indianapolis, IN						

Allison™ 1000 & 2100 Series				2001 Through 2005		
Type:	Five speed rear-wheel-drive, electronically controlled, automatic overdrive transmission with a torque converter clutch					
Maximum Engine Torque:	545 lb-ft (740 Nm) gross (LCT1000) 600 lb ft (813 Nm) gross (2100MH)					
Maximum Horsepower Input:	340 hp (254 kW)					
Gear Ratios:	1 st	2 nd	3 rd	4 th	5 th	Rev
	3.10	1.81	1.41	1.00	0.71	-4.49
Case Material:	Aluminum					
Maximum Gross Vehicle Weight:	22,000 lb. motor home (LCT 1000) 24,000 lb. motor home (2100MH)					
Transmission Weight:	Dry - 330 lb (150 kg)					
Fluid Type:	LCT1000 & 1000MH - Dexron® III (2001 Model Year Chassis through April 5, 2005 chassis build) LCT1000 & 1000MH - TranSynd™ (April 6, 2005 and newer chassis builds) 2100MH - Dexron® III (2004 Model Year Chassis through April 5, 2005) 2100MH - TranSynd™ (April 6, 2005 and newer chassis builds)					
Fluid Capacity (Approximate-Refill):	Bottom Pan Removal -10.6 qt (10L)					
Main circuit oil filter:	Spin-on canister (front driver's side of transmission)					
Power Takeoff:	Left or Right side					
Towing Capacity:	26,000 lb (11,800 kg) Maximum Gross Combined Vehicle Weight (LCT 1000 & 1000MH) 30,000 lb. (13,600 kg) Maximum Gross Combined Vehicle Weight (2100MH)					
7-Position Quadrant:	P,R,N,D,3,2,1 - 5 th gear (overdrive) is controlled by a disable switch on the dash with an indicator in the instrument cluster					
Control Systems:	Electronic, closed loop, adaptive with stand alone Transmission Control Module (TCM)					
Transmission Coolers:	Internal radiator and external transmission oil to air fluid coolers standard.					
Converter Lock-up:	Torque converter lock-up at all speeds in 2 nd , 3 rd , 4 th , and 5 th gears. Lockup prevents excessive heat build-up, increases fuel mileage and provides improved engine braking					
Drivetrain Interface:	Maximum output shaft speed 5000 rpm (LCT 1000 & 1000MH) Maximum output shaft speed 4500 rpm (2100MH)					
Manufactured:	Indianapolis, IN					

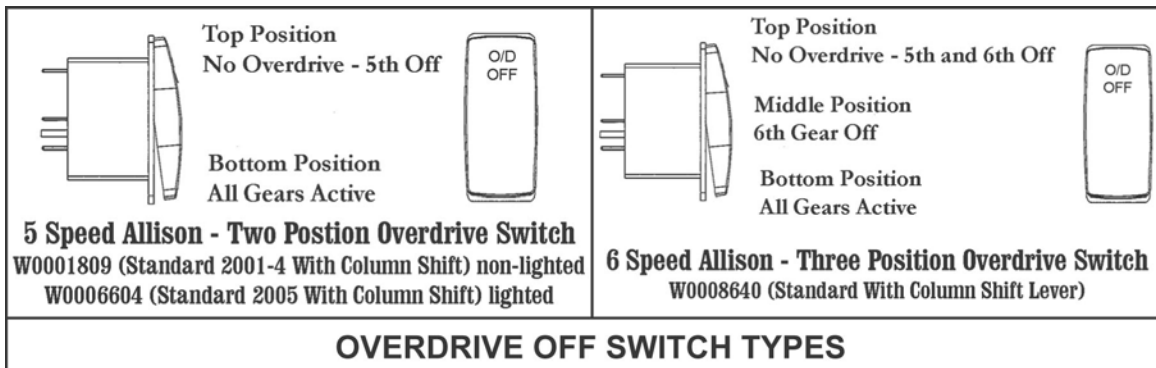
GM HYDRA-MATIC TRANSMISSION SPECIFICATIONS



4L80-E/4L85-E Hydra-Matic			1999 Through Current		
Type:	Four speed rear-wheel-drive, electronically controlled, automatic overdrive transmission with a torque converter clutch				
Maximum Engine Torque:	440 lb-ft (4L80-E) 460 lb-ft (4L85-E)				
Maximum Gearbox Torque:	885 lb-ft (1200 Nm)				
Gear Ratios:	1 st	2 nd	3 rd	4 th	Rev
	2.482	1.482	1.000	0.750	-2.077
Case Material:	Die Cast Aluminum				
Maximum Gross Vehicle Weight:	7200 lb (3265 kg) to 18,000 lb (7483 kg) (application and axle ratio dependant)				
Transmission Weight:	Wet -254 lb (115 kg)				
Fluid Type:	4L80E - Dexron® VI (Dexron® III 2005 and previous models) 4L85E - Dexron® VI (Dexron® III 2005 and previous models)				
Fluid Capacity (Approximate-Refill):	Bottom Pan Removal - 5.0 qt (4.7L)				
Main Circuit Oil Filter:	Internal (removal of transmission pan required)				
Towing Capacity:	19,000 lb to 22,000 lb Maximum Gross Combined Vehicle Weight (Application & Axle Ratio Dependant)				
7-Position Quadrant:	P,R,N,OD,D,2,1				
Control Systems:	Shift Pattern - (2) Two-way on/off solenoids Shift Quality - Force motor control Torque Converter Clutch - Pulse width modulated solenoid control				
Pressure Taps Available:	Line pressure				
Transmission Coolers:	Internal radiator and external transmission oil to air fluid coolers standard.				
Converter Size:	310 mm (reference) (Diameter of torque converter turbine) Dual stator torque converter for durability and increase torque multiplication				
Converter Lock-up:	Torque converter lock-up at cruising speeds in 2 nd , 3 rd , and 4 th gears. Lockup prevents excessive heat build-up, increases fuel mileage and provides improved engine braking				
Fail Safe:	Fail-safe mode puts transmission in 2nd gear and locks the converter if oil sump temperatures go above 270 degrees				
Manufactured:	Willow Run - Ypsilanti, MI				

TRANSMISSION GEAR SELECTION

All Workhorse Chassis are standard with manual shift via the shift lever on the steering column. There are four forward selections with the shift lever (overdrive, third, second and first). The Allison™ LCT 1000, 1000MH and the 2100MH five and six speed transmissions will utilize all gears when column shift lever is in the overdrive position. The manual selection of fourth, fifth and sixth are controlled by the overdrive toggle switch, see below diagrams. Chassis equipped with the five-speed transmission have an indicator light that will illuminate on the instrument cluster indicating when overdrive is disabled. If equipped with the six-speed transmission, the instrument cluster message center will indicate what gear is selected and current active gear. The overdrive switch is installed by the body manufacturer and generally located in close proximity of the headlamp switch.



Below is a chart showing acceptable speeds for the various gears of your transmission. This will apply in all driving conditions including inclines and declines when manually selecting gears. Shifting out of overdrive on downhill grades allows the engine/transmission to be part of the braking process and is highly recommended by Workhorse. This practice will provide better engine/transmission cooling and minimize wear to the service brakes. Although the Allison™ transmissions have a built in range inhibitor feature in the TCM (transmission control module) that restricts the transmission from shifting into certain gears if it may damage the transmission or engine, it is best to observe the speed limitation as shown for the Hydra-Matic 4-speed transmission.

Speed Limitation of Manual Forward Gear Selection						
Gear	4-Speed Hydra-Matic	Not To Exceed	5-Speed Allison™	Not To Exceed	6-Speed Allison™	Not To Exceed
Sixth	N/A	N/A			6 (OD Switch bottom position)	
Fifth	N/A	N/A	5 (OD Switch bottom position)	--	5 (OD Switch middle position)	--
Fourth	OD	--	4 (OD Switch top position - off)	--	4 (OD Switch top position - off)	--
Third	3	--	3	Does not apply	3	Does not apply
Second	2	40 MPH (64 km/h)	2	Does not apply	2	Does not apply
First	1	30 MPH (48 km/h)	1	Does not apply	1	Does not apply

Beginning in 2005 the Grade Braking feature was added to all chassis utilizing the Allison™ transmissions. This is a selectable feature that uses the engine and transmission to control vehicle speed during downhill grades. This feature is enabled by a toggle switch labeled GRADE BRAKE, physically similar to the overdrive switch. Once engaged the green grade brake symbol will illuminate in the instrument cluster, see adjacent picture.



When the driver depresses the brake pedal the transmission will downshift and assist with controlling the vehicle speed. The Grade Brake switch is installed by the body manufacturer and generally located in close proximity of the head light switch.

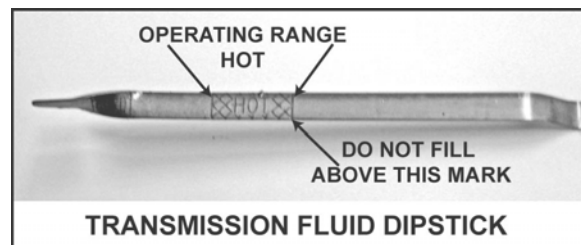
The Allison™ 2100MH (W24 Chassis) five & six speed transmissions have an optional shift by wire, Electronic Control Shifter (ECS) available. This option became available on the Allison™ 1000 (W20 & W22 Chassis) five & six speed transmissions in March 2005. The shift selector has been designed to provide easier driver operation and features. The features include push-button operation, integrated safety features, and solid-state construction for reliability. The ECS has 7 or 8 selections that include "P" PARK, "R" REVERSE, "N" NEUTRAL, "D" DRIVE, up and down arrows for manual gear selection, and the "Mode" switch (the mode switch function is not used on Workhorse chassis). The ECS also eliminates the "O/D" on/off dash mounted toggle switch, manual gear selection of all gears are controlled with the up and down arrows. Refer to the operation manual for additional functionality of this electronic control system.



CHECKING AND ADDING FLUID

Transmission malfunction can be traced to an incorrect fluid level or improper reading of the dipstick. A fluid level that is too high or too low can cause overheating and clutch plate damage. Fluid level should be at the "FULL HOT" mark with transmission fluid at normal operating temperature of 180 degrees F. The normal operating temperature is obtained only after at least 15 miles of highway-type driving.

Note: Automatic transmissions are frequently overfilled because the fluid is checked when it is cold and the dipstick indicates fluid should be added. However, the lower reading is normal since the level will rise as fluid temperature increases. A change of over ¾ inch will occur as fluid temperature rises from room temperature (60 degrees F) to operating temperature (180 degrees F), see the adjacent picture.



Overfilling can cause foaming and loss of fluid through the vent. With too much fluid, the rotating members churn the fluid, producing aeration that reduces the fluid's cooling effectiveness. Slippage and transmission failure can result.

Low level can cause transmission pump cavitations, a loss of main lubrication fluid pressure and overheating the fluid, resulting in clutch damage. It can cause slipping particular when the transmission is cold or the vehicle is on a hill.

To determine proper level, proceed as follows with transmission at normal operating temperature.

CAUTION:

With normal operating temperatures the dipstick will be extremely hot to the touch, use care to avoid burns.

1. Park your vehicle on a level surface. Apply the parking brake and block the vehicle wheels.
2. With the gear selector in the PARK position start the engine, **DO NOT RACE THE ENGINE**. With brake pedal applied, move the selector through each range, pausing for about three seconds in each range. Then position the shift lever in PARK.
3. Locate the transmission dipstick in front and above the radiator.
4. Immediately check the fluid with the selector lever in PARK, engine running at SLOW IDLE.
5. Check the level by pulling out the dipstick, wiping with clean towel or rag, push dipstick back in all the way, wait three seconds, then pull it back out again, check both sides of the dipstick, and read level.
6. The fluid level on the dipstick should be at the "FULL HOT" mark.
7. If additional fluid is required, add fluid using the transmission dipstick tube (filler).
8. Add **ONLY** sufficient fluid to bring the dipstick level to the "FULL HOT" mark.

NOTICE:

Check the fluid condition by visual inspection of the fluid and by smelling the fluid. Fluid should be bright red in appearance. If your fluid is a darkened color or has a pungent odor, have your vehicle serviced immediately.

MAINTENANCE AND INSPECTION

The automatic transmission fluid should be checked regularly (minimum at each engine oil change). Inspect fluid for color and smell; if fluid is dark in color and has a burnt smell this would indicate overheating of the fluid and would require replacement (see Transmission Fluids in this section for more detail on overheating/oxidization). The recommended transmission service intervals, if the fluid has not been overheated, are located in the Maintenance Schedule of your vehicle Owner's Manual. In addition, the fluid cooler lines, electrical lines, vacuum lines, control linkage, and transmission should be checked periodically for leaks, damage or deterioration.

Note: Transmission failure can occur if the vehicle is overloaded beyond the GVWR or GCWR limits. Caution must be taken when towing with the motor home not exceed the recommended GCWR. Remember that GCWR - actual motor home weight (fully loaded including passengers) = Towing Capacity. Refer to "Towing" and "RV Weights and Loading" sections of this manual for further information on correct loading and towing of your motor home.

Beginning in the 2006 Model Year the GM 4L80-E/GM 4L85-E transmissions are filled with **Dexron® VI** ATF (Automatic Transmission Fluid). Previous model years utilized Dexron® III ATF. Dexron® VI ATF is fully compatible with the previous Dexron® III ATF and may be used to top of older chassis equipped with Hydra-Matic transmissions. The recommended interval for changing the fluid and filter is every 50,000 miles, Workhorse filter kit part no. 24210956. The Allison[™] transmissions were filled with Dexron® III ATF until April 5, 2005.

Beginning April 6, 2005 the fluid in all Allison™ transmissions changed to TranSynd™ ATF. Regardless on fluid type, Allison™ recommends replacing the spin on filter only (fluid change is not required) after the first 5,000 miles of operation, Allison™/Workhorse part no. 29539579. The Allison™ recommended service interval with Dexron® III is to change the fluid and spin-on filter is every 25,000 miles or 12 months, whichever comes first. Allison™ transmissions with the synthetic fluid ATF TranSynd™ have a service interval of 4 years or 100,000 miles, whichever comes first.

NOTICE:

The 4L80E and 4L85E transmissions have a vent hose attached to a tube on top of transmission. During storage, it is possible for certain mud dauber wasps to build a nest inside these hoses. This will plug the hose. As a result, transmission oil can be blown out the fill tube. In areas where these insects are known to exist, it is suggested that vent hose be checked after extended storage.

TRANSMISSION FLUIDS

Automatic transmission fluid can provide up to 100,000 miles of service before oxidation occurs under normal operating temperatures of about 175 to 180 degrees F. Above normal operating temperatures, the oxidation rate doubles (useful life of the fluid is cut in half) with each 20 degree increase in temperature. Refer to the adjacent chart for petroleum base ATF.

Note: The adjacent chart assumes that oil temperature remains constant for the miles indicated. Temperatures that appear for short periods, such as climbing hills, etc., would need to be averaged against normal operating temperatures to determine actual life expectancy.

TRANSMISSION FLUID – LIFE EXPECTANCY vs. TEMPERATURE	
DEGREES F	MILES
175	100,000
195	50,000
212	25,000
235	12,000
255	6,000
275	3,000
295	1,500
315	750
335	325
355	160
375	80
390	40
415	Less then 30 Min.

OIL TEMPERATURE MEASURE AT CONVERTER OUTLET TO COOLER

350 degrees F is the maximum temperature. This is the normal place to install a temperature gauge or signal. The temperature in this location will vary significantly with each vehicle start-up or hill. If the temperature reaches 350 degrees F, reduce throttle. To lower the transmission temperature with the transmission in NEUTRAL, run the engine at 1,200 RPM for 2-3 minutes to cool the oil. DO NOT allow the converter outlet temperature to exceed 350 degrees F.

OIL TEMPERATURE MEASURED IN THE SUMP OR OIL PAN

- 150 degrees F – Minimum operating temperature for continuous operation.
- 180–200 degrees F – Proper oil level checking temperature
- 200 degrees F – Maximum oil level checking temperature.
- 285 degrees F – Maximum sump/oil pan temperature for short duration, such as a long hill climb.
- 300 degrees F – Metal parts inside transmission begin to warp and distort in varying degrees, seals melt rapidly and transmission fluid life is extremely short due to oxidation and distress.

BRAKES

There are two brake systems on a Workhorse motor home chassis, the service brakes and the parking brakes.

The service brakes use hydraulic pressure from a foot-pedal-operated master cylinder to actuate cylinders that apply brakes at each wheel. Fluid lines and hoses connect the master cylinder with each of the wheel cylinders and calipers. Hydraulic pressure created by the master cylinder operation is transmitted through lines and hoses to the wheel cylinders and calipers. The hydraulic pressure forces the pistons in the wheel cylinders and/or calipers outward, causing the brakes to be applied. Braking action occurs as a result of friction between the brake lining and the metal surface of the rotor disc or the drum.

Parking brake system on Workhorse Chassis is either a manual mechanic application or an automatic applied system. The manual system is operated by a lever and strut or a pedal, which will active the rear brakes only or the transmission mounted propshaft drum style brake on chassis with 12,300 lb., 14,800 lb., 15,000 lb., 16,000 lb., 20,700 lb. and 22,000 lb. GVWR. The parking brake on chassis with 16,500 lb., 17,000 lb., 18,000 lb. and 24,000 lb. GVWR is referred to as automatic apply parking brake. This style of parking brake is spring applied and hydraulically released via an electro-hydraulic pump; refer to the Automatic Apply Parking Brake section for detailed operation.

SERVICING BRAKES

The Workhorse 12,300 lb. GVWR chassis has front disc and rear drum brakes system, JB8. The P Series 14,800 lb. thru 18,000 lb. GVWR chassis have four-wheel disc brakes system, JF9. The W Series 16,000 lb. and 18,000 lb. GVWR chassis have four-wheel disc brakes system, JM6. The W Series 20,700 and 22,000 lb. chassis also has s four-wheel disc brakes system, JLP. The 24,000 lb. chassis also has four-wheel disc brakes system, JM8. All P Series chassis have a 3-channel Four-Wheel Anti-Lock braking systems standard. The W Series chassis have a 4-channel Four-Wheel Anti-Lock braking system standard.

PARKING BRAKE

The 12,300 lb. GVWR chassis use the rear axle drum service brakes also as the parking brake. All higher GVWR Workhorse chassis use a brake mounted on the rear of the transmission connected to the propshaft (driveline). The 16,500 lb., 17,000 lb., 18,000 lb. and 24,000 lb. GVWR chassis have an automatic apply parking brake system. The 16,500 lb., 17,000 lb. and 18,000 lb GVWR chassis utilize the J71 drum style auto park brake system through 2004 model year. The 17,000 lb. and 18,000 lb. GVWR chassis starting with the 2005 model year utilize the J72 enclosed disc auto park system. All 24,000 lb. GVWR chassis have utilized the J72 enclosed disc auto park system. The auto park brake is spring applied when the transmission is shifted into park and released hydraulically when vehicle is shifted out of park by an electro-hydraulic pump. Auto apply parking brake can be released mechanically on the J71 system in an emergency, refer to the Owner's Manual for procedure or contact the local authorized Workhorse service center.

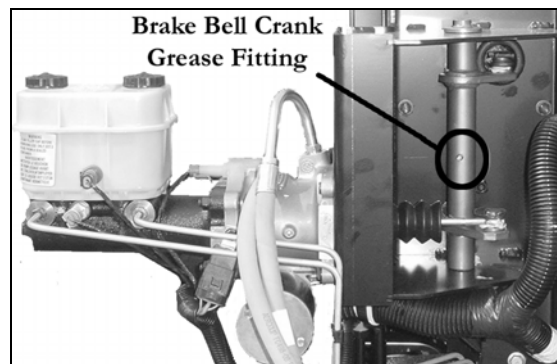
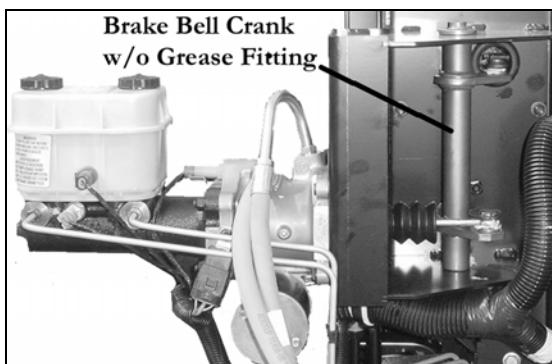
HYDRO-BOOST

Hydro-Boost system receives hydraulic pressure from the power steering pump to assist with the effort required to operate braking system. Hydro-Boost unit is located between the brake pedal linkage and the master cylinder. When the brake pedal is depressed, linkage moves the pushrod into the master cylinder to create hydraulic brake pressure. The hydraulic brake booster is supplied hydraulic pressure from the power steering pump assisting with the movement of the pushrod into the master cylinder. This in turn lowers the amount of effort required by the operator.

HYDRO-MAX BY BOSCH

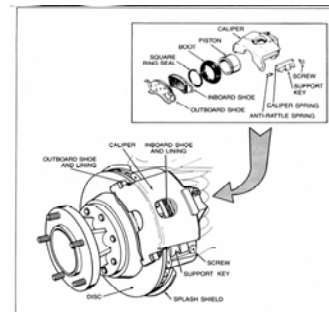
This system is utilized on all W Series chassis. It works on the same principle as a Hydro-Boost system but also incorporates a safety feature to retain power brake assistance with the engine on or off. With the Hydro-Boost type system, the engine must be operating to provide hydraulic pressure from the power steering pump to assist with the movement of the pushrod into the master cylinder. The Hydro-Max system also relies on hydraulic pressure for operation of the hydraulic power brake booster but has two sources. The primary source is from the power steering pump, as in the hydro-boost system. The secondary source is an electric-hydraulic pump mounted on the hydraulic brake booster. It monitors the hydraulic pressure when the brake is depressed and activates the electric hydraulic pump if hydraulic pressure is not available from the power steering pump. For example, if the engine dies or is turned off a sensor detects no hydraulic pressure in the system and activates the electrical-hydraulic motor to provide hydraulic power brake assistance for normal brake operation.

With the positioning of the master cylinder on all W Series chassis it was necessary to incorporate a bell crank between the linkage of the brake pedal and the power brake booster, see below picture. The bell crank does require periodical lubrication and inspection, roughly every 6 to 12 months. On chassis that were produced prior to June of 2004 this required removal of the pivoting shaft of the bell crank. The pivoting shaft is removed by unbolting the retainer on the top of the shaft, pull the shaft upward, clean grease and reinstall. On some body designs it does not allow for complete removal of the shaft before it hits the body of the coach. On these units pull shaft as high as possible until it hits the body. Fill cavity with grease while blocking the bottom to prevent grease from being totally pushed out, and work the shaft down into the grease until it comes out the bottom of the bell crank lever. To easier grease the bell crank a grease fitting was incorporated as on May 17, 2004 with chassis VIN ending in 43394330, see below picture. A grease fitting can be installed for easier lubrication on pre-grease fitting bell cranks.



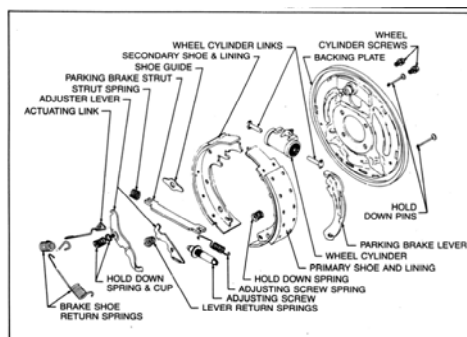
DISC BRAKES

All Workhorse Chassis, with the exception of the rear axle brakes on the 12,300 lb. GVWR chassis, are four wheel disc brake systems. Workhorse uses two types of disc brake systems, floating and non-floating calipers. The floating caliper design applies hydraulic pressure to the piston(s) that is transmitted to the inner lining, forcing the lining against the inner rotor surface. The pressure applied to the bottom of the piston bore(s) forces the caliper to slide or move (float) on the mounting bolts toward the inside, or towards the vehicle. Since the caliper is one piece, this movement causes the outer section of the caliper to apply pressure against the back of the outer lining assembly, forcing the lining against the outer rotor surface. See below adjacent diagram of single piston floating brake caliper. The non-floating caliper design, 24,000 lb. GVWR chassis only, utilizes pistons positioned on both the inner and outer sections of the caliper. The applied hydraulic pressure to the pistons is transmitted to the inner and outer linings simultaneously, forcing the linings against the rotor surfaces.



DRUM BRAKES

The Workhorse 12,300 lb. GVWR chassis utilize drum brakes on the rear axle. Hydraulic fluid pressure applied to pistons inside a wheel cylinder. The wheel cylinder links are then forced out against the brake shoes, which exert braking action on the drum. When hydraulic pressure is released, springs pull the shoes away from the drum. See adjacent diagram.



BRAKE SPECIFICATIONS

Chassis (GVWR)/ Brake system	Front Disc Rotor Size	Front Caliper Piston Size	Rear Disc Rotor Size	Rear Caliper Piston Size
12,300/JB8	12.5 x 1.54 in.	Single 3.38 in.	13 x 3.5 (drum)	N/A
14,800/JF9	14.0 x 1.44 in.	Twin 2.6 in.	13.6 x 1.44 in.	Twin 2.6 in.
15,000/JF9	14.0 x 1.44 in.	Twin 2.6 in.	13.6 x 1.44 in.	Twin 2.6 in.
16,000/JM6	12.68 x 1.18 in.	Twin 2.68 in.	12.68 x 1.44 in.	Twin 2.68 in.
16,500/JF9	14.0 x 1.44 in.	Twin 2.6 in.	13.6 x 1.44 in.	Twin 2.6 in.
17,000/JF9	14.0 x 1.44 in.	Twin 2.6 in.	13.6 x 1.44 in.	Twin 2.6 in.
18,000/JF9	14.0 x 1.44 in.	Twin 2.6 in.	13.6 x 1.44 in.	Twin 2.6 in.
18,000/JM6	12.68 x 1.18 in.	Twin 2.68 in.	12.68 x 1.44 in.	Twin 2.68 in.
20,700/JLP	15.0 x 1.44 in.	Twin 2.6 in.	15.0 x 1.44 in.	Twin 2.6 in.
22,000/JLP	15.0 x 1.44 in.	Twin 2.6 in.	15.0 x 1.44 in.	Twin 2.6 in.
24,000/JM8	15.375 x 1.54 in.	Four 2.75 in.	15.375 x 1.54 in.	Four 2.75in.

BRAKE MAINTENCE AND INSPECTION

PEDAL TRAVEL CHECK

At periodic intervals, the motor home owner should inspect the vehicle brake system for "pedal travel." Brake pedal travel is the distance the brake pedal moves toward the floor from the fully released position (foot not applied to the brake). Brake pedal inspection should be made with the brakes "cold" and with the engine turned off. Depress the brake pedal a minimum of four (4) times to exhaust all vacuum and/or accumulator pressure. Applying approximately 90 pounds of pedal pressure, the approximate distance the brake pedal should travel is as follows:

- Chassis with disc front and drum rear brakes (JB8) 3.5 inches
- Chassis with disc front and rear brakes (JF9) 6.0 inches
- Chassis with disc front and rear brakes (JLP, JM8 and JM6) 2.5 inches

Note: Total pedal stroke that would be achievable during the bleeding process for the JB8 and JF9, P Series, is 9.66 inches. Total pedal stroke for the JLP, JM8 and JM6 systems, W Series chassis, is 8.3 inches.

FILLING THE MASTER CYLINDER

The master cylinder must be kept properly filled to ensure adequate reserve and to prevent air from entering the hydraulic system. However, because of expansion due to heat absorbed from the brakes and from the engine, the master cylinder must not be overfilled.

The master cylinder is located on the P Series chassis under the floor on the driver's side of the engine. The position of the master cylinder on the chassis may require the use of a flashlight and mirror to check the fluid level. Access to the master cylinder is normally through the driver's side wheel well. On the W Series chassis the master cylinder is located just above and forward of the radiator on the driver's side of the chassis.

Thoroughly clean the reservoir cover before removal to avoid getting dirt into the reservoir. Remove the cover and inner rubber diaphragm, add fluid as required. Use Delco Supreme No. 11 Hydraulic Brake Fluid (Dot No. 3) or equivalent.

CAUTION:

Do not add DOT 5 brake fluid to the master cylinder reservoir. DOT 5 fluid is silicon base whereas the correct DOT 3 fluid is Glycol based. The two will not mix and the DOT 5 fluid can cause major damage to the anti-lock brake module and other brake components.

CAUTION:

Do not use shock absorber fluid or any other fluid that contains mineral oil. Do not use a container that has been used for mineral oil or a container that is wet from water. Mineral oil will cause swelling and distortion of rubber parts in the hydraulic brake system and water will mix with brake fluid, lowering the fluid boiling point. Keep all fluid containers capped to prevent water contamination.

NOTICE:

CHECK FOR LEAKS IF A LARGE AMOUNT OF FLUID IS REQUIRED.

BRAKE FLUID CHANGE

Although there is not a recommend service interval to change the brake fluid listed in your Owner's Manual, the recommendation by a number of the brake manufacturers is every two to three years. If the fluid becomes contaminated, change immediately. Use Delco Supreme No. 11 Hydraulic Brake Fluid (Dot No. 3) or equivalent.

New brake fluid is clear with a brown-orange tint. Brake fluid absorbs water and prevents it from settling in lines causing damage. As water is absorbed, the fluid will darken to the point that it appears to be almost black. This would be a good time to change the fluid.

BLEEDING BRAKE HYDRAULIC SYSTEM

A bleeding operation is necessary to remove air whenever air is introduced into the hydraulic brake system. It is recommended for a trained service technician to perform this procedure.

This procedure would be necessary if air has been introduced into the hydraulic system through low fluid or the disconnecting the brake pipes anywhere in the system. If a brake pipe is disconnected at any wheel cylinder, then that wheel cylinder needs to be bled. If pipes are disconnected at any fitting located between the master cylinder and the wheel cylinders, then all wheel cylinders served by the disconnected pipe must be bled.

DISC BRAKE SQUEAL OR SQUEAK

A persistent amount of "squeal or squeak" is often associated with heavy-duty disc brake usage. These noises are common for both foreign and domestic disc brake systems. Heat, humidity and severity of usage seem to be contributing factors to brake noise. Changing the brake pads or rotor refinishing as a repair is often considered a temporary repair or by some technicians as useless. The recommended approach is to have an inspection to assure free and proper operation of all caliper parts. At this point, the owner should realize that the brake noise exists, but is not detrimental to overall brake life.

AUTOMATIC APPLY PARKING BRAKE

The parking brake on the P Series 16,500 lb., 17,000 lb., 18,000 lb. as well as the W Series 18,000 lb. and 24,000 lb. GVWR chassis incorporates a unique automatic apply feature. The parking brake is spring applied and hydraulic release. The automatic electric/hydraulic parking system controls the transmission/propeller shaft mounted parking brake. Workhorse utilizes two designs of automatic apply park brake systems, the J71 and J72. All P Series 16,500 lb., 17,000 lb. and 18,000 lb. GVWR chassis were equipped with the J71 system through the 2004 model year. Starting in the 2005 model year the 17,000 lb. and 18,000 lb. chassis became equipped with either the J72 system. All W Series 24,000 lb. GVWR chassis are equipped with the J72 system. Both systems components and operation are outlined in the following pages.

J72 AUTOMATIC APPLY PARKING BRAKE

The J72 system incorporates a unique full-circle parking brake. The automatic electric/hydraulic parking system controls the transmission/propeller shaft mounted parking brake. This system consists of a pump motor relay, vehicle ignition relay, electric/hydraulic pump, reservoir, proportional relief solenoid valve, pressure transducer, and an electronic control module (ECM). The ECM monitors seven inputs from the vehicle and controls the pump motor relay, auto-park light, park brake warning light, buzzer, proportional valve, and pressure transducer.

To release the parking brake, push in the park brake switch pull-button and move the shift lever on the steering column from the park position or select "D", "N" or "R" on the push button shift control (optional Allison™ transmission control). Note both situations must occur for the brake to release. Once the ECM receives the signals from the transmission and button contacts, the ECM closes the solenoid valve and closes the pump/motor relay allowing current to flow to the motor. The pump/motor then supplies fluid to the brake assembly. The brake assembly includes a friction disc clamped by a piston through force of an internal spring. The fluid pressure acts on the piston overcoming the spring tension that clamps the friction disc, releasing the brake. The pump motor will shut off when the transducer reads the fluid pressure of approximately 1400 psi. The solenoid valve holds pressure in the system while the brake is in a released state. The ECM monitors system pressure from the pressure transducer and energizes the pump motor when system pressure drops below approximately 1200 psi.

Putting the shift lever back to park, selecting "P" on the push button shift control, turning off the ignition, or pulling the push/pull switch prompts the ECM to de-energize the solenoid valve dumping fluid back into the reservoir. As the pressure decreases, the spring force clamps the piston back against the friction disc and applies the park brake.

The "AUTO PARK" WARNING LAMP turns on when the system pressure is less than 900 psi and the ECM receives the signal from the transmission.

The PARKING BRAKE WARNING LAMP turns on when system is below 900 PSI and when the parking brake pull-button is pulled out.

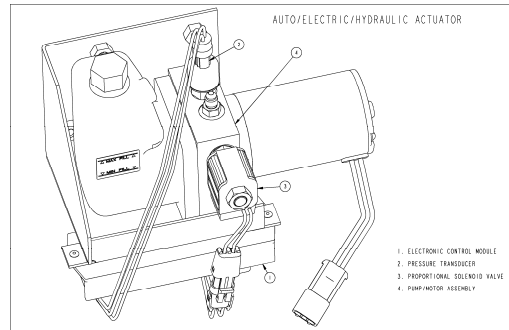
The PARK BRAKE PULL SWITCH is mounted on the instrument panel. This is a manual activation switch for the park brake. This switch is normally closed, pushed in. The body manufacturer determines final location of this switch.

The PARK BRAKE PUMP MOTOR RELAY is located above the fuse box on the front driver's side of the radiator core support. It receives ground from the ECM and acts as the automatic control circuit for the high voltage current required to run the pump motor. When the ECM supplies ground to the relay switch, the contacts close to complete the feed circuit to the pump motor.

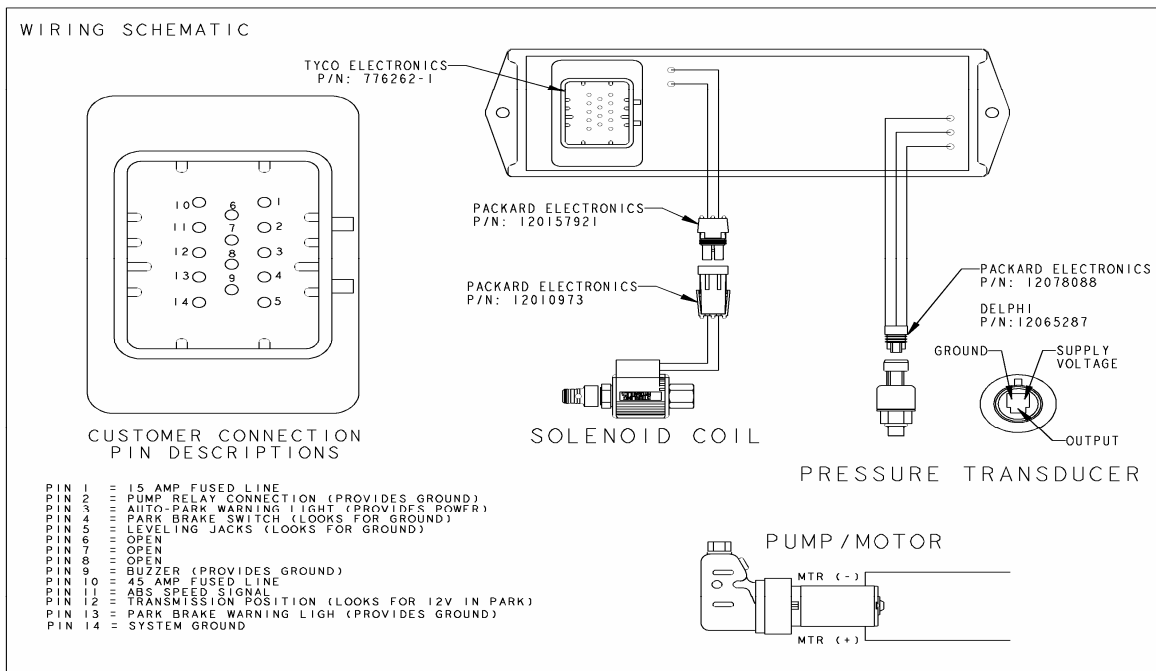
The IGNITION RELAY is located next to the park brake pump motor relay on the front driver's side of the radiator core support. It monitors the vehicle's ignition switch to turn on/off the supply of the fifteen and forty-five amp fused-lines that the ECM and electric motor use. If the relay was not present, the ECM would be continually powered since it would be directly connected to the batteries.

J72 ELECTRICAL-HYDRAULIC ACTUATOR

This unit mounts on the driver's side of the radiator core support and is self-contained/environmentally sealed. The AUTO/ELECTRIC/HYDRAULIC ACTUATOR controls the pressure in the park brake system to either set or release the park brake. The actuator consists of a mounting bracket and the following components:



The ELECTRONIC CONTROL MODULE or ECM is an analog logic device that monitors the various vehicle conditions then controls the actuator accordingly. It is the "black box" mounted underneath the actuator mounting bracket. It connects to the vehicle via a fourteen pin connector, to the proportional solenoid valve via a two pin connector, and a pressure transducer via a three pin connector. The ECM is powered by two different sources. First, it receives power primarily through a fifteen amp fuse. Secondly, the ECM receives power off of the forty-five amp fused-line that the pump motor relay also uses. Below is a detail of the pin connections of the ECM as well as the solenoid valve and pressure transducer.

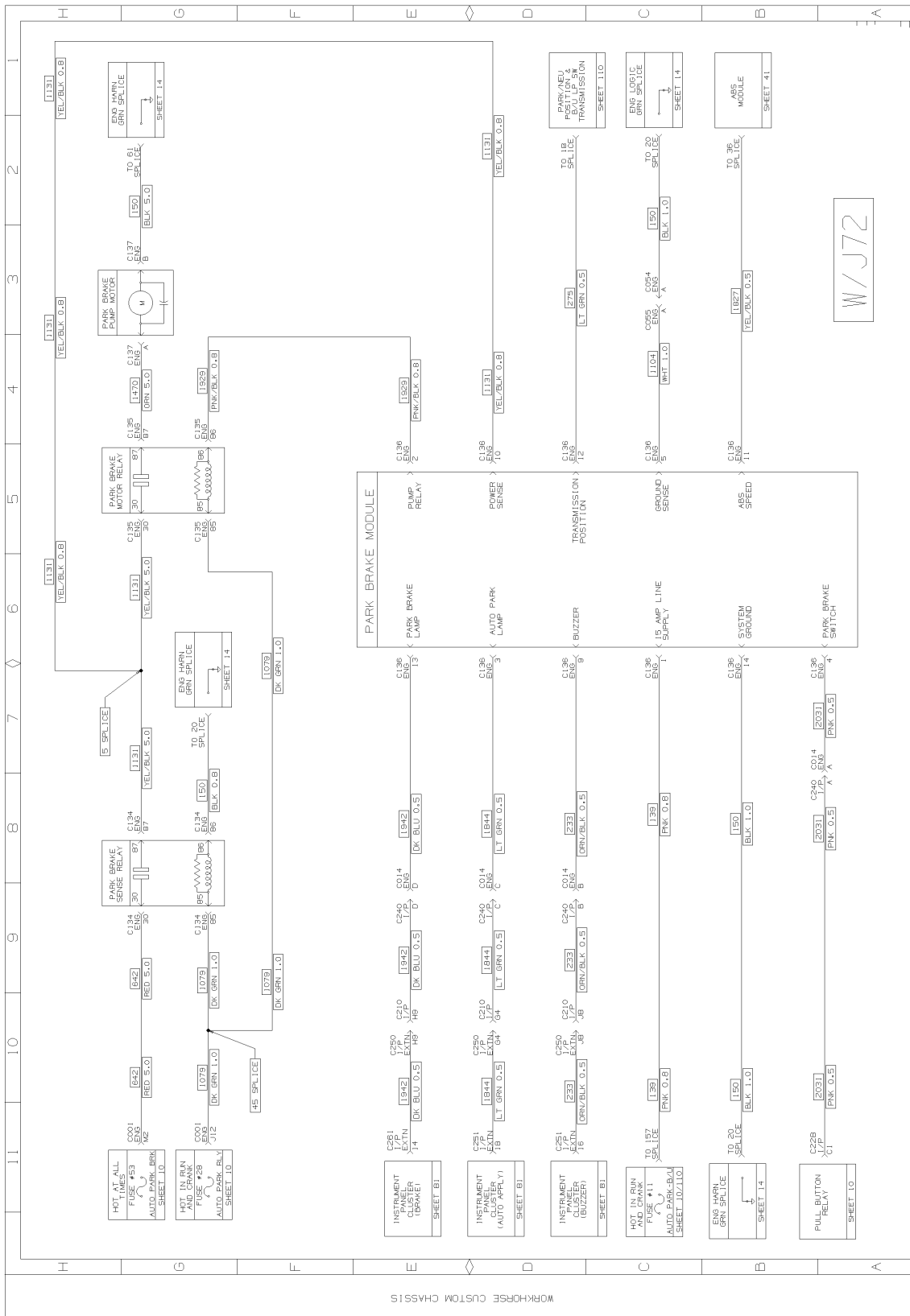


The PUMP/MOTOR ASSEMBLY consists of an electric motor, geared pump, aluminum port block, and a semi-transparent fluid reservoir. The port block holds the proportional solenoid valve and pressure transducer. The pump provides fluid pressure for the system. A pressure relief valve in the port block limits system pressure to around 1700 psi.

The PROPORTIONAL SOLENOID VALVE controls when fluid can return to the pump reservoir. When the parking brake is released, the valve is closed to hold pressure in the system. When the parking brake is applied, the valve opens to allow fluid to return to the pump reservoir. If the vehicle is at a speed greater than five miles per hour (5mph) and the pull button is pulled, the valve will remain open for a few moments and then release the pressure slowly for a gradual apply of the brake. NOTE: The park brake is NOT designed for dynamic stops; if a dynamic stop occurs see the nearest service center for brake inspection.

The PRESSURE TRANSDUCER monitors the pressure of the system and relays that information back to the ECM. The critical pressure values are the cut-in and out for the motor which are 1200 psi and 1400 psi, respectively.

J72 AUTO PARK BRAKE CONTROL (W SERIES & P SERIES)



J71 AUTOMATIC APPLY PARKING BRAKE

The J71 system has an internal expanding parking brake. It consists of a park brake motor switch (pressure maintenance switch), park brake switch relay, electric/hydraulic pump, reservoir, high-pressure actuator, solenoid valve, light switch, park/neutral relay, park/neutral switch, and manual push-pull switch.

To release the electric/auto park brake, move the shift lever on the steering column from the park position and push in the park brake switch push-button. Note both conditions must occur for the brake to release. Once these conditions exist, the circuit to the park/neutral switch opens in turn closing the park/neutral relay allowing current to flow to the solenoid valve. The solenoid valve closes and holds system pressure. The park/neutral relay also supplies current to the park brake pump motor switch (pressure maintenance switch). The park brake motor switch closes at pressures below 1200 psi turning on the pump to supply fluid pressure to the actuator. The actuator has a large spring inside that applies the parking brake. Fluid pressure overcomes spring tension and moves the piston in the actuator. This movement is transferred to the parking brake through the parking brake cable. When the fluid pressure reaches approximately 1600 psi the park brake motor switch opens and the pump shuts off. The solenoid valve is holding pressure. The park brake motor switch opens and closes depending on system pressure.

Putting the shift lever back to park, turning off the ignition, or pulling the push/pull switch de-energizes the solenoid valve dumping fluid back into the reservoir. As the pressure decreases the spring tension in the actuator moves the piston and applies the park brake through the movement of the parking brake cable.

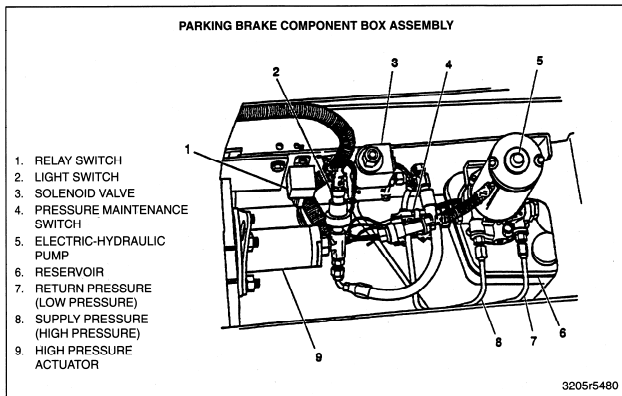
The "AUTO PARK" WARNING LAMP turns on when the system pressure is less than 450 psi or when the electric/hydraulic pump is running due to the park brake motor switch being closed. The lamp will flash at partial release pressures.

The PARKING BRAKE LIGHT SWITCH is located on the back of the actuator assembly. The switch controls the groundside of the "AUTO PARK" lamp. The lamp switch closes when system is below 450 PSI turning on the light when the ignition is on.

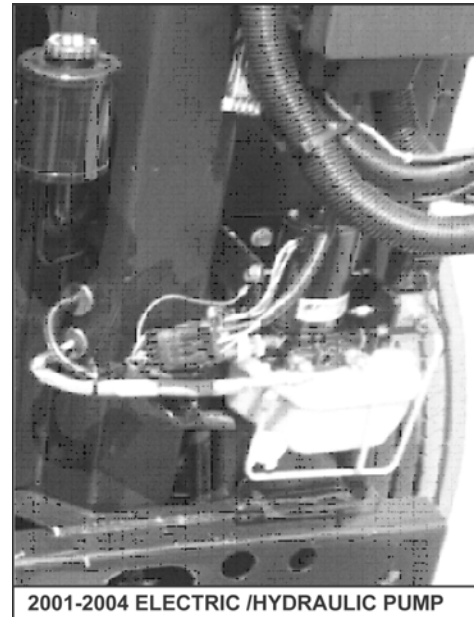
The PARK BRAKE PULL SWITCH is mounted on the instrument panel. This is a manual activation switch for the park brake. This switch is normally closed, pushed in. When pulled, this opens the circuit to the park/neutral relay and in turn the solenoid valve allowing fluid pressure to return to the reservoir applying the park brake. The body manufacturer determines final location of this switch.



The PARKING BRAKE PUMP ASSEMBLY is located in a component box on the passengers' side of the vehicle on 1999 and 2000 model year chassis. The component box is on the inside of the right frame rail behind the transmission. On 2001 through 2004 P Series models the pump assembly was moved to the front driver's side radiator core support. The pump assembly consists mainly of an electric pump and fluid reservoir. The pump provides fluid pressure for the system. A pressure relief valve in the pump limits system pressure to 1800 psi.



**1999 AND 2000 COMPONENT BOX
(P Series 16,500 lb. through 18,000 lb. GVWR)**



The PARK BRAKE MOTOR SWITCH (pressure maintenance switch) mounts to the parking brake pump assembly housing. It is a hydraulic pressure switch that operates within a certain pressure range turning the pump motor on and off. The park brake motor switch closes when system pressure is below 1200 psi and opens when system pressure reaches approximately 1600 psi. The park brake motor switch applies B+ to the coil side (control side) of the park brake motor relay.

The PARKING BRAKE SOLENOID VALVE switch is a solenoid and valve assembly located in the component box in the underside of the vehicle on 1999 and 2000 model year chassis. On 2001 through 2004 models on the pump assembly, including the solenoid valve was moved to the front driver's side radiator core support. The solenoid controls when fluid can return to the pump reservoir. When the parking brake is released, the valve closes to hold pressure in the system. When the parking brake is applied, the valve opens to allow fluid to return to the pump reservoir.

The PARK BRAKE PUMP MOTOR RELAY is located in the component box underneath the vehicle on the inside of the passenger frame rail in 1999 and 2000 model year chassis. On 2001 and 2002 models the pump assembly, including the relay, was moved to the front driver's side of the radiator core support. It receives B+ from the park brake motor switch and acts as the automatic control circuit for the high voltage current required to run the pump motor. When the park brake motor switch supplies B+ to the relay switch, the contacts close to complete the feed circuit to the pump motor.

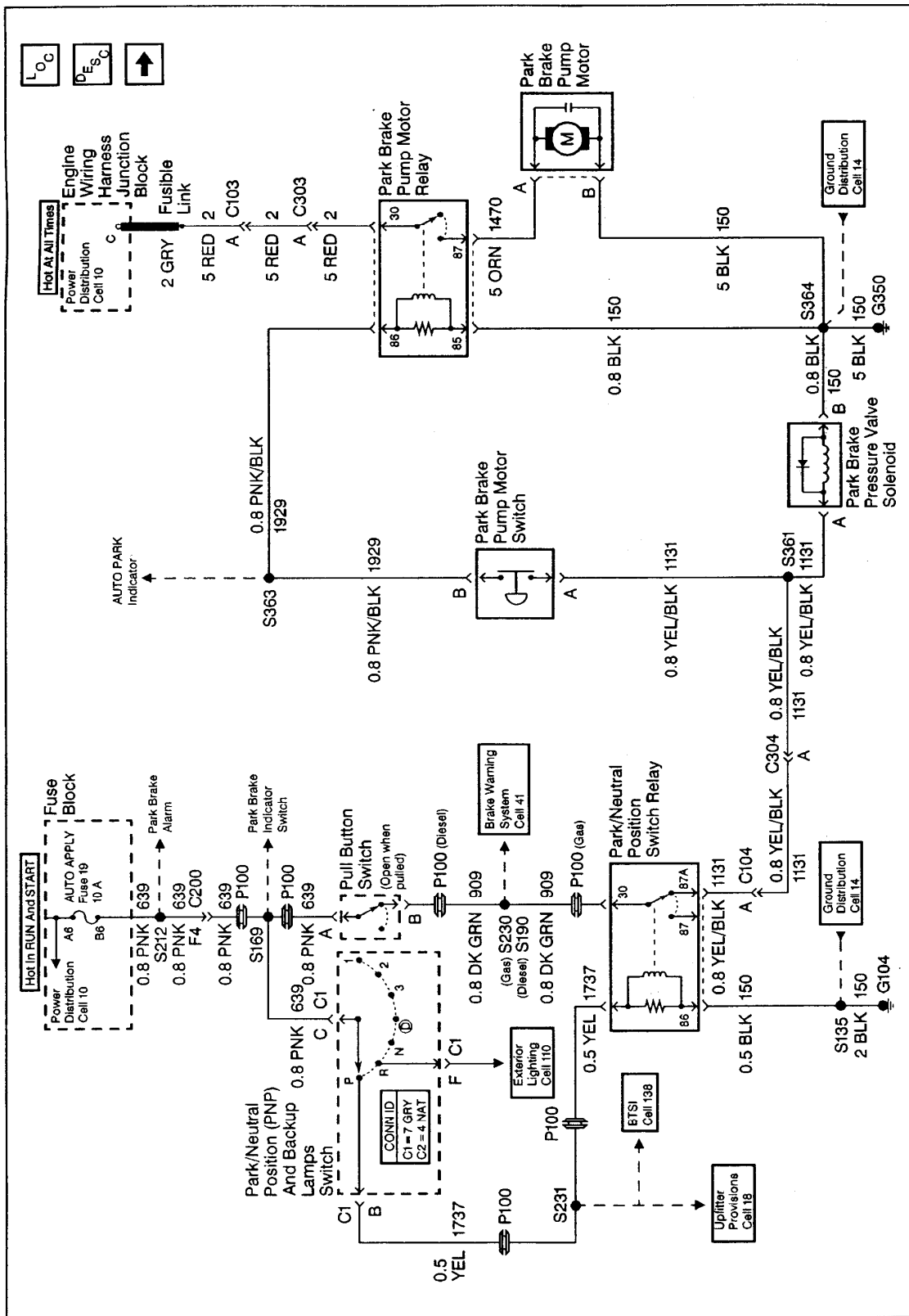
The ACTUATOR is located on the inside of the right frame rail in the component box in 1999 and 2000, underneath the vehicle. The location of the actuator did not change in 2001 through 2004 but the other components that were located in the component box were relocated. The actuator is a spring-loaded device that operates the parking brake cable. A large spring inside the actuator applies the parking brake. When hydraulic fluid pressure is applied against the actuator piston it overcomes the spring tension and pushes the brake cable to release the parking brake.

The PARK/NEUTRAL POSITION SWITCH is located on the left side of the transmission near the middle. When the column shifter is in the park position the switch is closed to supply current to the park/neutral relay opening the circuit to the park brake motor switch and the solenoid valve. When the column shifter moves out of the park position the switch opens. Once the circuit is open this allows the park/neutral relay to close providing B+ to the park brake motor switch and the solenoid valve.

The PARK/NEUTRAL POSITION SWITCH RELAY is located above the engine, mounted to the right hand side of the driver's island on 1999 and 2000 chassis; refer to the service manual for location on 2001 and newer chassis. It is a normally closed switch that is open when the park/neutral position switch is in the park position supplying B+ current to the relay. When the column shifter moves out of the park position the park/neutral position switch opens. Once the circuit is open this allows the park/neutral relay to close routing B+ current to the park brake motor switch and the solenoid valve.

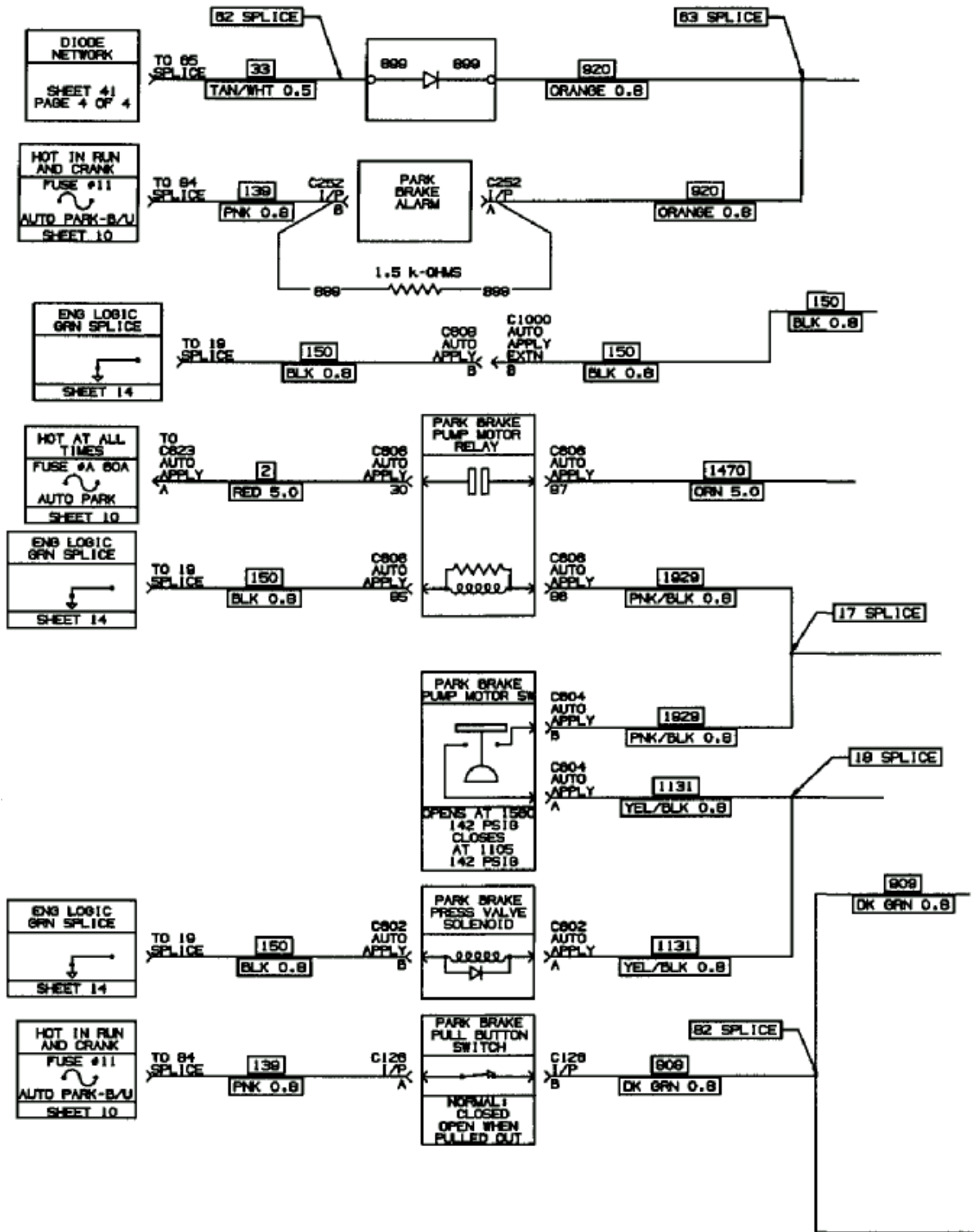


1999 AND 2000 AUTO PARK PUMP CONTROL (P Series 16,500 lb. - 18,000 lb. GVWR)

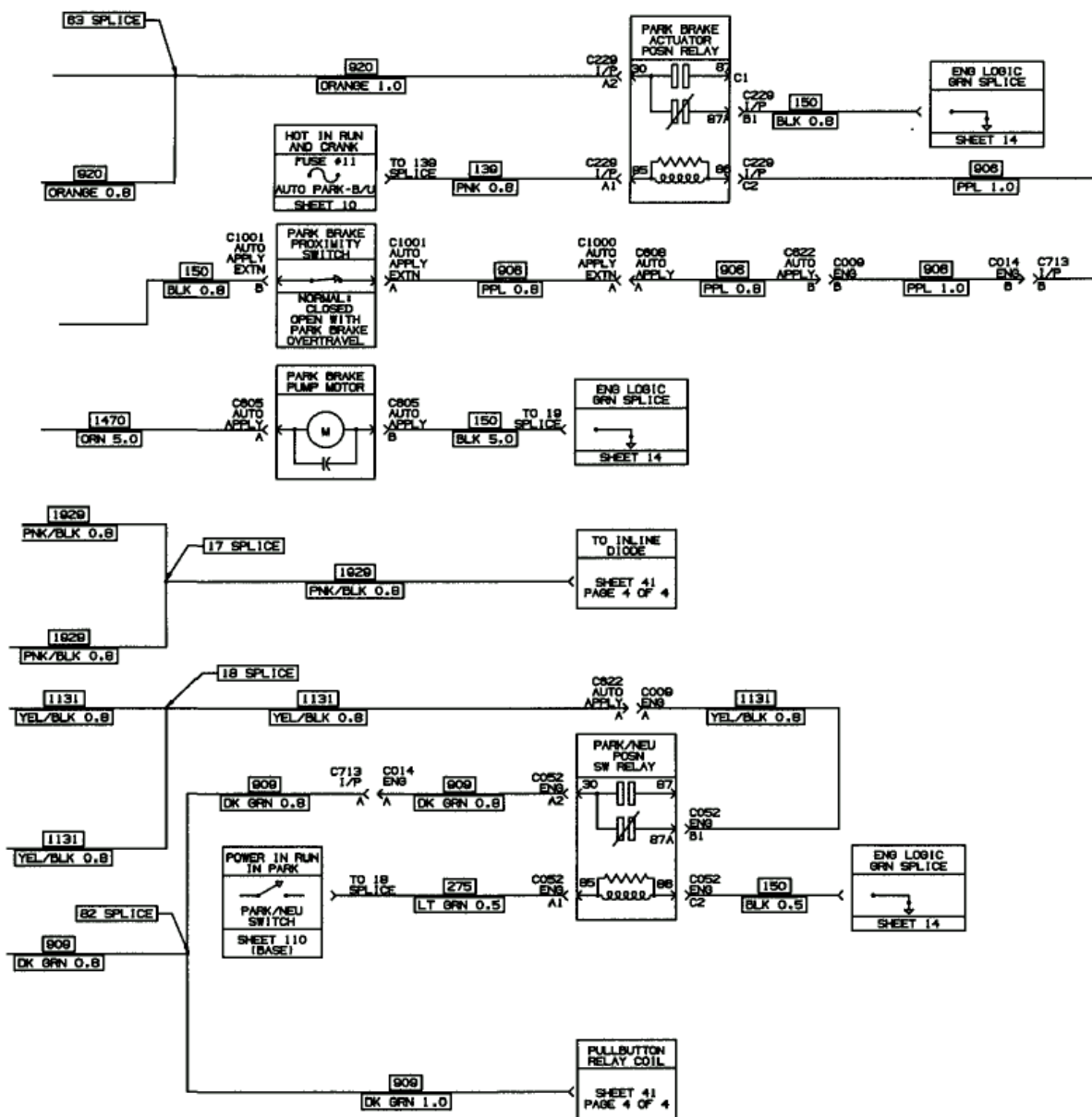


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2001 THRU 2004 AUTO PARK PUMP CONTROL PART 1 OF 2 (P Series 17,000 lb. & 18,000 lb. GVWR)



2001 THRU 2004 AUTO PARK PUMP CONTROL PART 2 OF 2
(P Series 17,000 lb. & 18,000 lb. GVWR)



FRAMES

W SERIES

The Workhorse 16,000 lb. and 18,000 lb. GVWR chassis utilizes a constant section frame rail design measuring 8.5 x 3.0 x .250 inches with a 7.8 cubic inch section modulus and utilizing 50,000 psi frame steel. The Workhorse 20,700 lb., 22,000 lb. and 24,000 lb. GVWR chassis utilizes a constant section frame rail design measuring 9.625 x 3.0 x .250 inches with a 10.13 cubic inch section modulus and utilizing 50,000 psi frame steel. The constant section (straight rail) design retains the maximum rail height through out the frame, eliminating all tapers and maximizing strength. The frame splays (widens) forward of the rear of the transmission allowing the engine and transmission combination to be lowered between the rails. The 16,000 lb. and 18,000 lb. GVWR chassis are offered 158.5", 178", 190", 208" and 228" wheelbases. The 20,700 lb GVWR chassis are offered in 190", 208" and 228" wheelbases. The 22,000 lb. and 24,000 lb. GVWR chassis are offered in 208", 228" and 242" wheelbases.

P SERIES

The Workhorse P series chassis have a maximum section of 7.01 x 2.57 x .213 inches with a taper rearward of the rear axle to 4.64 inches. The tapered section of the frame includes inner reinforcement (double lined) on the higher GVWR chassis. The section modulus is 6.12 cubic inches and utilizes 32,000 psi frame steel. The P32 18,000 lb. GVWR chassis includes an outer reinforcement (structural glove) over the tapered portion (rearward of the rear axle) of the frame continuing the maximum section of the frame rail past the fuel tank. P Series frames are offered in 158.8", 178", 190", 208" and 228" wheelbases.

Note: Some body manufacturers will modify the frame by extending (adding length rearward of the rear axle) or stretching (adding a section between the axles) which can cause concerns with the operation of the motor home. Extensions can involve the addition of a tag axle (non powered axle rearward for the main drive axle) and extending the frame beyond original length. Stretching generally includes cutting the frame adding a section between the axles enlarging the wheelbase. If the chassis is cut for lengthening forward to the main drive axle, there is a potential for misalignment of the frame and improper driveline specific angles that can cause chassis related concerns. These concerns would workmanship related and the responsibility of the modifier; the New Workhorse Custom Chassis Warranty would not cover this type of concern.

PROPELLER SHAFTS AND UNIVERSAL JOINTS

PROPELLER SHAFTS

The propeller shaft is a steel tube that is used to transmit power from the transmission output shaft to the differential. To accommodate various models, wheelbases and transmission combinations, drive shafts differ in length, diameter and the type of splined yoke. Each shaft is installed in a similar manner. Two or more universal joints, a steel tube and a splined slip yoke are located between the transmission rear extension housing and the rear axle yoke. The slip yoke permits fore and aft movement of the drive shaft as the differential assembly moves up and down.

One, two and three-piece propeller shafts are used depending on the model. On models that use two or more piece shafts, the shaft is supported near its splined end in a rubber-cushioned ball bearing, commonly referred to as the center bearing or carrier bearing. The center bearing is mounted in a bracket attached to a frame cross member. The center bearing is permanently lubricated and sealed.

Since the propeller shaft is a balanced unit, it should be kept completely free of undercoating and other foreign material that would upset the balance. An unbalanced propeller shaft will produce a vibration during operation that will be transmitted into the passenger compartment.

UNIVERSAL JOINTS

The simple universal joint is basically two Y-shaped yokes connected by a cross member called a spider. The spider is shaped like an "X" and the arms that extend from it are called trunnions. The spider allows the two yoke shafts to operate at an angle to each other.

It is important to note, although the design of the universal joint allow yokes to operate on an angle, universal joints have specific operating working angles that must be observed. The working angles of each pair of universal joints must be within one-half of a degree of being equal to ensure cancellation of vibrations encountered with normal operation of a universal joint. Refer to the shop manual for more detailed information as well as procedures for measuring and adjusting the working angles of the universal joints and yokes.

MAINTENANCE AND INSPECTION

Generally, the propeller shafts and universal joints require little maintenance. Periodic inspection is recommended for proper propeller operation. Inspect for physical damage and to ensure shafts/joints are free of foreign material. Also inspect the universal caps if they appear to be excessively dry, it may indicate a need for bearing re-lubrication or universal joint replacement. A failing universal joint often squeaks on start-up or "clunks" with direction change. The universal joints should be greased regularly during chassis lubrication, approximately every 6,000 to 7,000 miles.

If the center bearing is replaced, the bearing itself does not need to be packed with grease. However, chassis lubricant should be packed within the dust shields to form a dam to aid in preventing water and dirt from reaching the bearing. The dust shields are staked into position following the procedure in the shop manual.

REAR-DRIVE AXLE

The rear drive axle assembly consists of the drive pinion, ring gear, differential, and axle shafts in one housing. The drive pinion transfers power input from the propeller shaft to the ring gear which drives the axle shafts and the rear wheels. The ring gear is a reduction gear that lowers the speed (RPM) of the propeller shaft to a speed that is usable for driving the rear wheels.

MAINTENANCE AND INSPECTION

The differential requires little maintenance; however, periodic fluid level checks are recommended to ensure smooth operation. The fluid level check and add if required should be performed at each engine oil change interval. In addition, the fluid should be changed periodically depending on the fluid type and usage.

Beginning on July 10, 2000, chassis VIN number last eight digits Y3325061, synthetic gear lubricate became standard. The Dana 80/M80/S110/S130/S135 axles with the synthetic gear lubricate has a service interval as high as 250,000 miles if not contaminated or driving in dusty, sandy, or wet conditions areas. If lubricate becomes contaminated change immediately or if driving in the listed conditions change lubricate every 25,000 miles or 6 months. The American Axles with the synthetic gear lubricate has a service interval as high as 100,000 miles if not contaminated or driving in dusty, sandy, or wet conditions areas. If lubricate becomes contaminated change immediately or if driving in the listed conditions lubricate every 15,000 miles. Prior to July 10, 2000, chassis VIN number last eight digits Y3325061, a petroleum gear lubricate was utilized. If driving in dusty, sandy, or wet conditions areas or towing it is suggested to drain the fluid every 15,000 miles with American Axle. If equipped with the Dana 70/80/S110/S130/S135 axle and driving the listed conditions change lubricant every 25,000 miles or 6 months, whichever occurs first.

Refer to the Owner's Manual for additional information

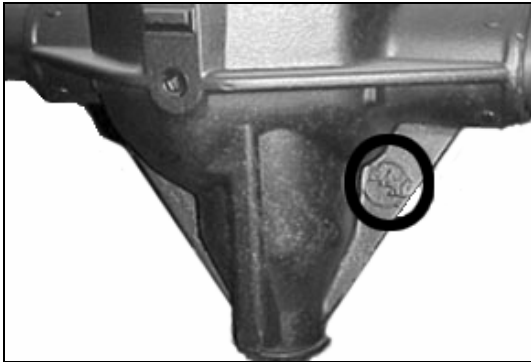
REAR AXLE FLUID TYPE, CAPACITY AND IDENTIFICATION

All Workhorse chassis built after 7/10/2000, last eight of the chassis VIN number Y3325061, come standard with synthetic gear lubricate, SAE 75W-90 GL-5, prior to this time a petroleum based gear oil, SAE 80W-90 GL-5. Capacities are listed in the below chart and physical identification on the following pages.

<u>AXLE FLUID CAPACITY, RING GEAR AND AXLE RATIO</u>			
Manufacturer – Model	Ring Gear (Inches)	Fluid Capacity (Pints/Liters)	Gear Ratio
American Axle 10 ½	10.5	7.2/3.4	4.63
Dana 80	11	8.2/4	4.63
American Axle 11 ½	11.5	7.3/3.6	4.63
Dana M80 (W16 w/6.0L)	11.5	8.1/3.9	5.13
Dana M80 (W18 w/6.0L)	11.5	8.1/3.9	5.38
Dana M80 (W16 & W18 w/8.1L)	11.5	8.1/3.9	4.63
Dana S110	11.8	16/6.6	4.88
Dana S110 (Allison Six Speed)	11.8	16/6.6	5.13
Dana S135/150 (19.5" tires)	14	24.5/11.6	4.78
Dana S135/150 (Allison Six Speed w/19.5" tires)	14	24.5/11.6	5.13
Dana S135/150 (22.5" tires)	14	24.5/11.6	5.38
Dana S135/150 (Allison Six Speed w/22.5" tires)	14	24.5/11.6	5.86*
Dana S130	12.2	16/6.6	5.13
Dana S130	12.2	16/6.6	5.86

*6.14 interim ratio for 2006 MY start of production

Workhorse utilizes various rear axles, as listed on the previous page. The use of each axle is dependent on the application and GVWR. Following are views of each axle indicating the various identification marks of each axle.



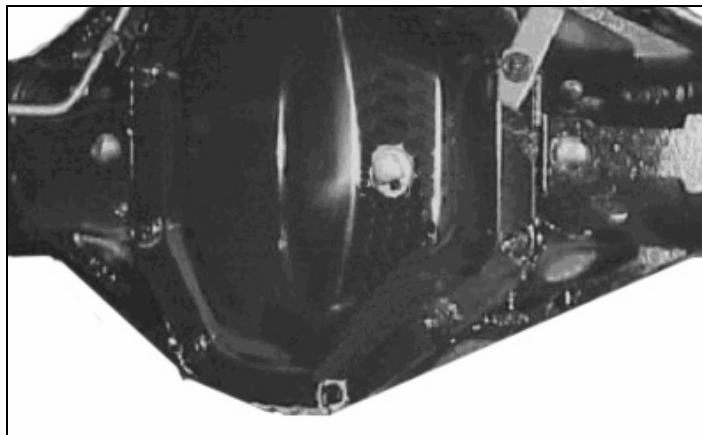
American Axle Bottom
(AAM stamped on web)



American Axle Rear



Dana 80 Top
(Two holes in web and BW1 on tape around front pinion)



Dana 80 Rear



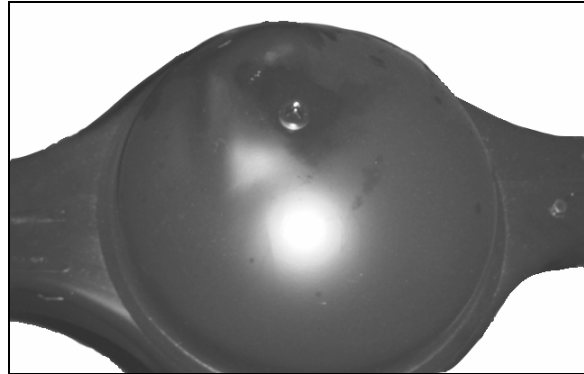
Dana M80 Top Front



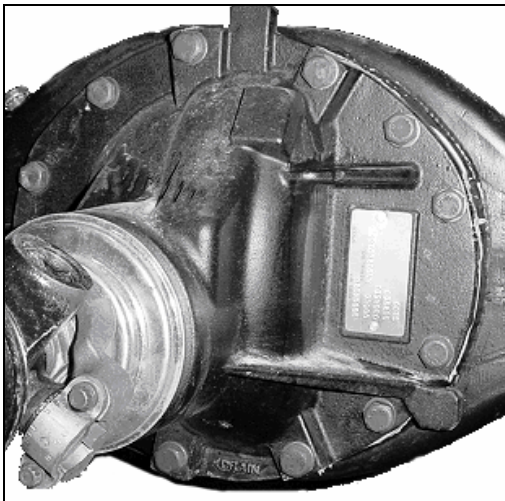
Dana M80 Rear



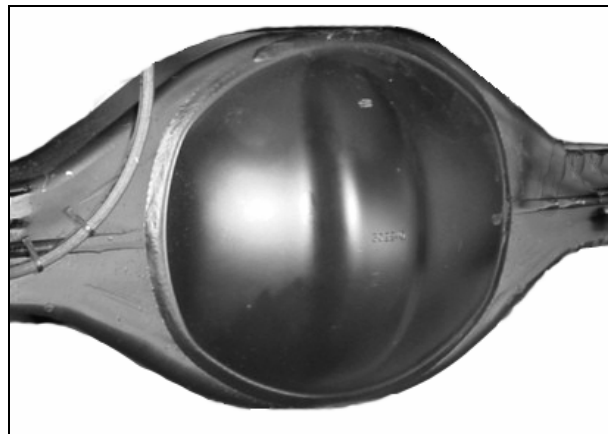
Dana S110 Front
(ID tag on rear driver's side of carrier)



Dana S110 Rear



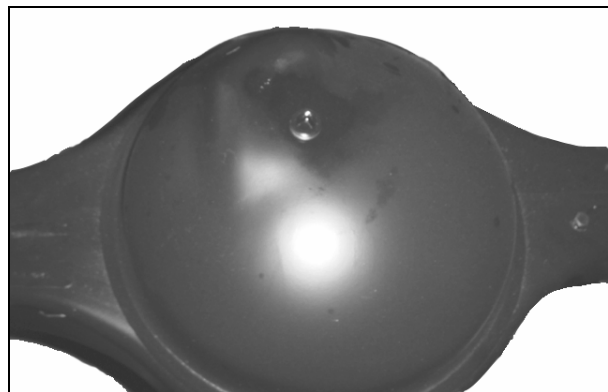
Dana S130 Front
ID tag on rear driver's side of carrier



Dana S130 Rear



Dana S135/150
(ID tag on front section of carrier)



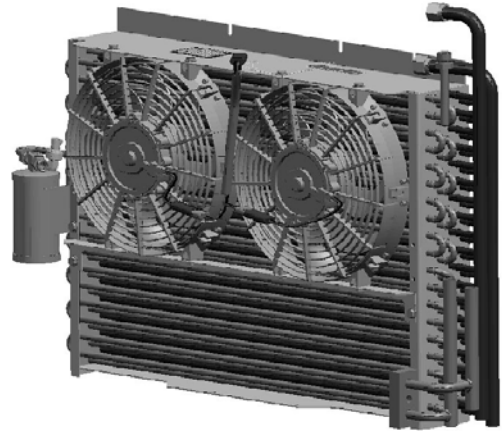
Dana S135/150 Rear

AIR CONDITIONING

Workhorse motor home chassis come standard with approximately half of the dash air conditioning components. The components supplied by Workhorse are mounted to the chassis during chassis manufacturing. The remaining components are installed by the body manufacturers due to the multiple interior configurations. The components provided by Workhorse are:

WORKHORSE RESPONSIBILITY

1. Delphi/Harrison compressor used on all motor home chassis.
2. Condenser, mounted in front of the radiator (has been offered with a pre-charge of 1.5 lbs. of refrigerant-**total system capacity determined by body manufacturer**).
3. High-pressure switch, mounted by the receiver dryer.
4. Receiver drier mounted to the right hand side of the condenser.
5. Electric Condenser fan(s) mounted on the condenser or on the external transmission cooler, position in front of the condenser, controlled by the PCM.
6. Compressor discharge hose (shipped loose).
7. Low-pressure switch (shipped loose).

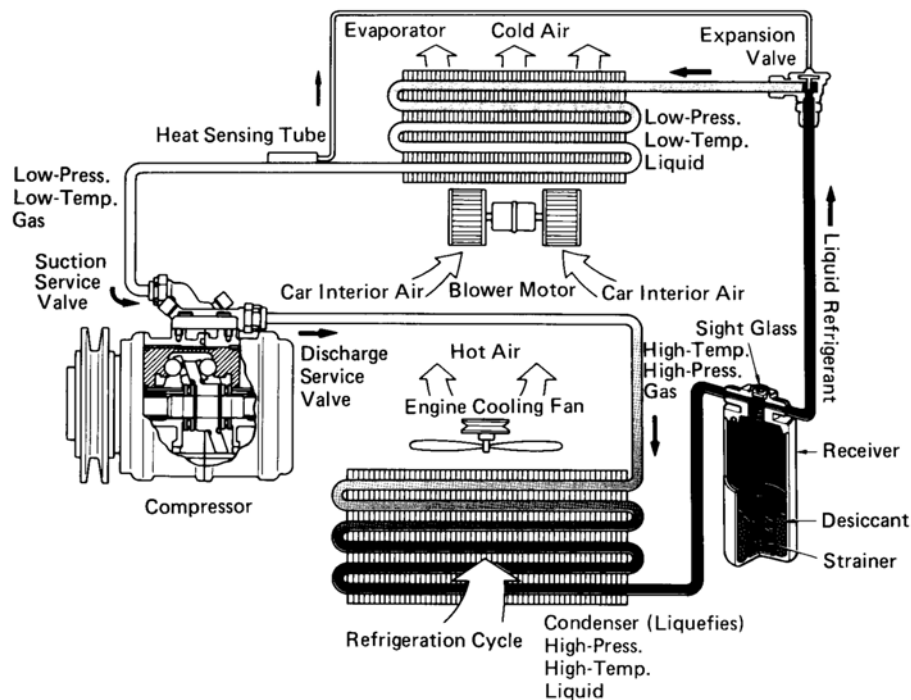


Component supplied by the body manufacturer:

NOT WORKHORSE RESPONSIBILITY

1. A/C and heater controls.
2. All other A/C hoses.
3. Evaporator core.
4. Ducts and vent work.
5. Blower motor.
6. Other switches and wiring.
7. All dash heating components.
8. Heater control valve.
9. Thermostatic expansion valve or orifice tube.
10. Final refrigerant/oil fill and testing.

The air conditioning system operates on the same principles of refrigeration. That is, a liquid refrigerant absorbs heat as it vaporizes and loses heat as it condenses from a vapor back to a liquid. By varying the pressure within an air conditioning system, the refrigerant can be vaporized to absorb heat from inside the vehicle, and then condensed to release the heat to the outside atmosphere. System components include a compressor, condenser, expansion tube or a thermostatic expansion valve, evaporator and an accumulator or a receiver dryer. In operation, the compressor produces the pressure that moves refrigerant through the system. Liquid refrigerant passing through the restriction of the expansion tube, or valve, changes into a vapor as it enters the low-pressure environment of the evaporator. See the following schematic.



Basic Air Conditioning System

As it changes to vapor, it absorbs heat from the air being circulated around the evaporator. Suction created by the compressor draws the refrigerant vapor through the line from the evaporator. The vapor, which has been under low pressure, is pumped out of the compressor under high pressure. The high pressure in this part of the system is due to the expansion tube (or thermostatic expansion valve) which places a restriction in the line. As the high-pressure refrigerant vapor flows into the condenser, it changes to a liquid as it loses heat to the air flowing around the condenser. The liquid refrigerant flows through the line from the condenser to the expansion tube (or thermostatic valve) to repeat the cycle.

System temperature is controlled by running the compressor intermittently, automatically turning it on and off as necessary to maintain proper temperatures. The compressor is started and stopped through the use of an electromagnetic clutch on the compressor pulley. The clutch is operated by a temperature-sensing switch (thermostatic switch).

In addition to the components described above, the air conditioning system is also equipped with a receiver-dehydrator. The receiver-dehydrator, mounted near the condenser, serves as a reservoir, for storage of high-pressure liquid produced in the condenser. It incorporates a screen sack filled with the dehydrating agent. Although the primary use is a liquid storage tank, the receiver-dehydrator also functions to trap minute quantities of moisture and foreign material that may have entered the system after installation or service operation. A refrigerant sight glass is built into the receiver-hydrator to be used as a quick check of the state and condition of charge of the entire system.

PREPARING THE MOTOR HOME FOR STORAGE

Special consideration may be required when conditions for high humidity, extreme temperatures or outdoor storage are encountered. Local experience will dictate any additional protective measures for such conditions.

STORING VEHICLE FOR EXTENDED PERIOD (3 months or longer)

- Check battery / batteries for state of charge. On Delco Freedom maintenance free batteries inspect test hydrometer for green eye and charge if green dot is not visible to avoid freezing and deterioration. On Workhorse batteries check battery voltage to verify charged battery, 12.6 volt is a fully charged battery. Both battery cables should be disconnected at the battery(s) to prevent gradual discharge and the possibility of fire due to short circuits, remove negative cable first but first verify ignition key is in the off position. On conventional batteries, check electrolyte specific gravity and charge if below 1.255. (Also refer battery maintenance in the Engine Electrical section)

Battery Maintenance During Storage: Parasitic loads (drains) from the radio, clock, ECM, courtesy lights, and other accessories will discharge batteries in vehicles that are not used for an extended period of time, or especially during vehicle storage. Provisions to maintain the battery(s) at a proper state of charge are necessary. A discharged battery(s) can freeze at temperatures as high as 32 degrees F, resulting in permanent damage. A battery that has been frozen has the potential for internal damage that can cause an explosion during charging or jump-starts, use extreme caution. Other permanent damage may also result if batteries are allowed to stand discharged for extended periods.

NOTICE:

Workhorse recommends that you maintain proper battery charge level with the use of a small trickle charger or "Battery Minder" during long storage periods. This will prevent battery damage due to discharge and reduce the need for periodic battery inspection and charging during the storage period.

If a trickle charger is not used, the negative battery cable should be disconnected on vehicles that are not going to be in service within a 20-day period to reduce battery discharge. If this is not possible, batteries should be checked every 20-45 days, and recharged if necessary. Disconnected batteries will also self-discharge, especially in higher ambient temperatures; therefore, even disconnected batteries should be checked every four months and recharged if necessary.

CAUTION:

The ignition switch **MUST BE OFF** when connecting the battery cables or a battery charger. Failure to do so may overload or damage the PCM or other electric components from voltage spikes, which can occur during these operations. When connecting the battery cables or battery charger the negative battery connection should always be connected last.

- Prior to storage, fill fuel tank(s) add fuel stabilizer, run engine and generator to insure stabilized fuel is circulated throughout the complete fuel system.
- Keep motor home windows closed. Make sure all covers are in place.
- Avoid trees in parking area to eliminate potential damage from tree sap or bird dropping. Remove high weed growth, which affects paint by attracting insects or causing stains.

- Wash the coach removing all dirt, grime, mud, salt, etc. If coach is stored inside or covered allow ample airtime before it is stored. If the coach is stored outside rinse, wash and wipe horizontal surfaces of motor home at least once per to remove accumulations that settle on flat surfaces.
- Vehicle storage surface should be clean, firm, well drained and reasonably level or with front of chassis slightly higher than rear if level surfaces are not available. This is to prevent gasoline draining into engine over a long period causing possible damage to engine by “hydrostatic lock” when started (carbureted gas engines only).
- Park the tires of the coach on plywood to help alleviate the potential of flat spots in the tires for sitting for long periods of time, the plywood helps evenly distribute the weight of the coach.
- Check engine coolant for correct level and mixture; adjust as necessary (refer to the Engine Coolant section for details).
- Check and secure all caps to prevent water, snow and dirt from entering engine.
- Check and keep tires inflated maximum recommended tire pressure. Cover tires if unit is stored outside in sunlight and avoid black asphalt or other heat absorbent surfaces.
- Remove windshield wiper arms and blades and store in vehicle.
- Start and run engine until completely warm. Drain engine oil and replace filter element. Refill with fresh oil, see lubrication section for addition details. If vehicle is equipped with air conditioning, the unit should be operated during the final engine warm-up to lubricate compressor seal.

REACTIVATING VEHICLE AFTER EXTENDED STORAGE

- Check oil and fluid levels and replenish as necessary in the following components: engine, radiator, crankcase, transmission and differential. Check gasoline supply. If the vehicle is equipped with air conditioning, refer to the procedure on the following page.
- Check under hood and under vehicle for nesting creatures and evidence of leakage of oils or fluids or physical damage.
- Inflate tires and front air bags (air bags P Series only) to proper operating pressures.
- Inspect battery for any leakage or physical damage, clean battery end of cables, verify fully charged battery and reconnect battery cables connecting the negative battery cable last with the ignition key in the off position.
- Drain engine oil and replace filter element. Refill with fresh oil, see lubrication section for addition details.
- Lubricate chassis suspension and steering components.
- Check brake operation and fluid level. Bleed and adjust brakes if necessary, refer to the brake section.
- Check and clean air filter assembly, replace filter as required.
- The 4L80E and 4L85E transmissions have a vent hose attached to a tube on top of transmission. During storage, it is possible for certain mud dauber wasps to build a nest inside these hoses. This will plug the hose. As a result, transmission oil can be blown out the fill tube. In areas where these insects are known to exist, it is suggested that vent hose be checked after extended storage.

IF VEHICLE IS EQUIPPED WITH AIR CONDITIONING

- Disconnect the compressor clutch wires before attempting to start vehicle.
- Check to see if compressor hub and clutch driver can be turned by hand. If not, the unit should be broken loose by manually turning the shaft with a wrench on the shaft lockout on the clutch driver plate. A few “rocking” turns should be sufficient so that the shaft can be turned by hand.
- Reconnect coil wires and check belt tension. Run engine with air conditioning on for a minute or two to reseal system.
- Check the dash A/C refrigerant. This can be done by checking for air bubbles in the sight glass on the top of the receiver-dehydrator (on vehicles equipped with the sight glass).

PREFERED MAINTENANCE FOR TROUBLE FREE OPERATION

Below are twelve items we recommend to check per the outlined schedule. These suggested maintenance inspections and operations are recommended to give the utmost trouble free operation as well as protect your investment. This schedule does not replace the maintenance schedule in your owner manual nor recommendations in this guide.

Schedule:

- A) During tire rotation or once per year
- B) Once a year
- C) After extended storage
- D) At engine oil change/chassis lubrication
- E) Before every trip or daily on long trip
- F) At every fuel tank fill

<u>Schedule</u>	<u>Maintenance Items</u>
D & C	Brake pedal to master cylinder linkage pivot and joint lubrication.
A & C	Inspect brake caliper slides for corrosion and proper movement, lubricate as required or once per year.
A or B	Front wheel bearing adjustment and lubrication.
D	Auto park brake – general inspection, check adjustments and fluid level when equipped (16,500 lb, 17,000 lb., 18,000 lb. and 24,000 lb. chassis).
B	Check front and rear U-Bolt torque.
D	Check all lines, hoses and fittings for seepage or leakage. Check engine oil, brake fluid, power steering fluid, engine coolant, rear axle fluid, and transmission fluid levels.
D & A	Check front and rear shocks for leakage.
D & A	Check all wheel nuts for proper torque.
E & C	Check tire pressure and suspension air bag pressure when equipped (P Series).
C & F	Check engine oil.
C & E	Check all exterior lights for operation (stop, turn signal, head, tail, running).
D & E	Check all fluids.

RECOMMENDED FLUIDS AND LUBRICANTS

<i>USAGE</i>	<i>FLUID/LUBRICANT</i>
Engine Oil (Gasoline)- 3,000 Miles	Engine oil with American Petroleum Institute For Gasoline Engines "StarBurst" symbol of the proper viscosity; see engine lubrication section or Owner's Manual.
Engine Coolant- 5 years or 150,000 miles	50/50 mixture of clean, drinkable water and use DEX-COOL™ coolant or equivalent extended life engine coolant.
Engine Oil (Diesel)	Engine oil with American Petroleum Institute (API) certification of "CG-4". It may appear alone or in combination with other API designations such as; "CG-4/SH", "CG-4/SJ", "SH/CG-4" or "SJ/CG-4".
Hydraulic Brake System	Brake Fluid (P/N 12377967 or equivalent DOT-3 brake fluid)
Parking Brake Cable Guides	Chassis lubrication (P/N 12377985 or equivalent) or lubrication meeting requirements of NLGI #2, Category LB or GC-LB
Power Steering System	Power Steering Fluid (P/N 1052884 – 1 pint, 1050017 – 1 quart, or equivalent)
Automatic Transmission	Dexron® VI for GM Hydra-Matic transmission beginning in 2006 Model Year, this fluid is compatible with previous Dexron® formulations. Dexron® III for GM Hydra-Matic transmission prior to 2006 and also Allison™ transmissions in Workhorse chassis built prior to April 5, 2005. TranSynd™ for Allison™ transmissions in Workhorse chassis built on April 6, 2005 and newer.
Chassis Lubrication- 3,000 - 6000 Miles	Chassis lubrication (P/N 12377985 or equivalent) or lubrication meeting requirements of NLGI #2, Category LB or GC-LB
Front Wheel Bearings- 15,000 Miles	P Series Chassis Only - Wheel bearing lubricate meeting requirements of NLGI #2, Category LB or GC-LB, (P/N 1051344 or equivalent). W Series Chassis – SAE 90W GL-5 gear oil (P/N 1052227).
Rear Axle Differentials	SAE 80W-90 GL-5, axle lubricant for 1999 and 2000 chassis VIN Y3325061 or lower. All other chassis utilize synthetic gear lubricant SAE 75W-90 GL-5, Emgard2984 (P/N 12345841)
Propeller Shaft Slip Spline and U-Joints	Chassis lubrication (P/N 12377985 or equivalent) or lubrication meeting requirements of NLGI #2, Category LB or GC-LB
Electrical Hydraulic Auto Parking Brake	Dexron® VI Automatic Transmission fluid beginning in 2006 Model Year, this fluid is compatible with previous Dexron® formulations. Dexron® III Automatic Transmission fluid prior to 2005 Chassis Model Year.
Automatic Transmission Shift Linkage	Chassis lubrication (P/N 12377985 or equivalent) or lubrication meeting requirements of NLGI #2, Category LB or GC-LB
Key Lock Cylinder	Lockeze

MAINTENANCE ITEMS

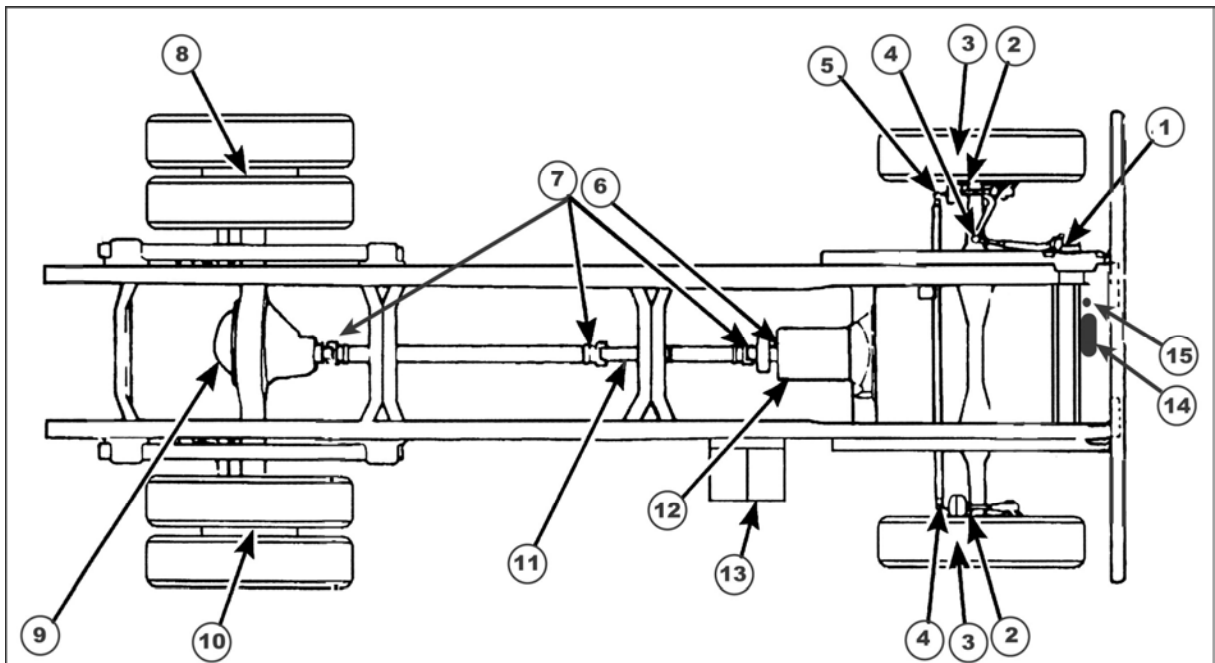
ENGINE	8.1 LITER 496 C.I.D	8.1 LITER 496 C.I.D	6.0 LITER 364 C.I.D	7.4 LITER 454 C.I.D	7.4 LITER 454 C.I.D	6.5 LITER TURBO DIESEL	5.7 LITER 350 C.I.D
8TH # OF VIN	G	G	U	J	N	F	R
RPO	L18	L18	LQ4	L29	L19	L65	L31
YEARS	2004-UP	2001-2003	2006	1996-2000	1992-1996	1996-2003	2001-2002
AIR FILTER AC Part no. WCC Part no.	A1236C W8800481	A1236C W8800481	A1236C W8800481	A1236C W8800481	A348C 6484235	A1236C W8800481	A1236C W8800481
AIR FILTER BOX ACCESS COVER CLIPS GM/WCC Part no.	25169408	25169408	25169408	25169408	N/A	25169408	25169408
FUEL FILTER AC Part No. WCC Part No.	N/A W0004996	GF481 W8800482	N/A W0004996	GF481 W8800482	GF481 W8800482	TP1263 12554082	GF481 W8800482
OIL FILTER AC Part No. WCC Part No.	PF454 25324052	PF454 25324052	PF46 W8800470	PF1218 W8800474	PF1218 W8800474	PF1218 W8800474	PF52 W8800466
SPARK PLUG AC Part No. WCC Part No.	41-983 W8000518	41-983 W8000518	41-985 W8800472	41-933 25320206	CR43TS 5614029	<i>Glow Plug</i> 60G W8000549	41-932 W8800468
PCV VALVE AC Part No. WCC Part No.	Internal Internal	Internal Internal	N/A W8800471	CV769C W8800467	CV774C 6487779	N/A N/A	CV769C W8800467
RADIATOR CAP AC No. WCC No.	RC33 W8800752	RC33 W8800752	RC33 W8800752	RC33 W8800752	RC33 W8800752	RC33 W8800752	RC33 W8800752

GM Transmission Filter Kit	Models 4L80E and 4L85E	WCC Part No. 24210956
Allison Spin On Filter	Models 1000 and 2100	WCC Part No. 29539579

LUBRICATION POINTS

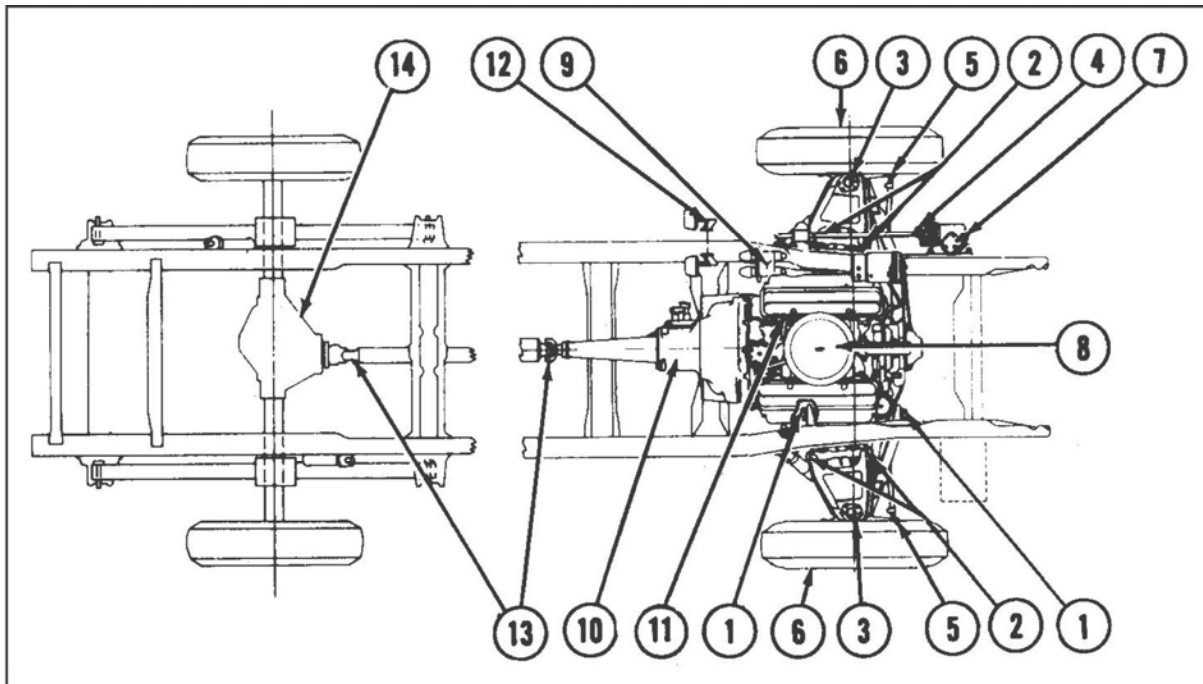
W SERIES

1. Steering Drag Link (Front)
2. Front Steering Knuckles
3. Front Wheel Bearings (oil lubricated)
4. Steering Drag Link (Rear)
5. Steering Tie Rod Ends (rearward of front axle)
6. Parking brake clevis pin (Foot-applied park brake only)
7. Universal Joints
8. Left Rear Wheel Bearings
9. Rear Axle
10. Right Rear Wheel Bearings
11. Prop Shaft Slip Joint
12. Transmission
13. Battery Terminals (Battery shipping location)
14. Master Cylinder (located above radiator front left of chassis)
15. Brake Pedal Relay Lever pivot



P SERIES

1. Lower Control Arms
2. Upper Control Arms
3. Upper and Lower Control Arm Ball Joints
4. Intermediate Steering Shaft
5. Tie Rod Ends
6. Wheel Bearings (packed grease lubricated)
7. Steering Gear
8. Air Filter (Models Prior to SPFI)
9. Master Cylinder
10. Automatic Transmission
11. Throttle Plate Linkage
12. Brake Pedal Spring
13. Universal Joints and Spline
14. Rear Axle



MOTOR HOME GLOSSARY

AIR BAG - A pneumatic spring that is installed on the front suspension of Workhorse P Series chassis. Workhorse does not provide air bag cylinders used on the rear suspension. The body manufacturers, dealers or aftermarket companies install them.

AIR SUSPENSION - An aftermarket suspension that is sometimes used to support the drive axle and/or tag axle on a motor home. The Workhorse Warranty does not cover complications arising from the installation of this suspension. When a body manufacture installs an air suspension, care must be taken to ensure the driveline angles will not be changed. Some of the manufacturers of air suspensions include Jet Air and Granning.

ALIGNMENT - The process of adjusting the front suspension for proper handling and tire wear. The initial alignment is the responsibility of body builder.

ANTI-LOCK BRAKES (ABS) - A crash avoidance system designed to help keep you in control by minimizing wheel/tire lockup and skidding on most slippery surfaces.

AUTOMATIC APPLY PARKING BRAKE - A parking brake used on P Series Chassis with 16,500 lb., 17,000 lb. and 18,000 lb. GVWR. This brake is spring applied and hydraulically released with hydraulic fluid from an electrically driven pump.

BATTERY ISOLATOR - A solid-state device used to isolate the RV battery(s), which runs the entire interior coach electrical systems, from the chassis battery(s). The isolator disconnects the RV battery from the chassis when the engine is shut off. This prevents the chassis battery from losing charge from the use of the RV electrical components when the alternator is not charging. Once the vehicle has started, the isolator will reconnect the RV battery(s) back into the system to charge the RV battery. Also, please note that the isolator and the RV battery are not Workhorse components.

CAMBER - One of three adjustments made during a front wheel alignment. Simply put, camber is the leaning of a tire to the left or right of the chassis.

CASTER - One of the three adjustments made during a front wheel alignment. Simply put, caster is the tilt of the steering knuckle to the front or rear of the chassis.

CCC - Cargo Carrying Capacity: This rating is the remaining weight the vehicle can carry with full fresh water, full water heater, full LP tank and the SCWR. This rating is calculated by adding the fresh water capacity times 8.3 pounds (3.8kg) per gallon, LP capacity times 4.5 pounds (2kg) per gallon, the SCWR and the UVW then subtracting the sum from the GVWR. This does not take into account dealer installed options.

CLASS A RECREATIONAL VEHICLE - A motor home built on a chassis such as the Workhorse chassis.

CLASS B RECREATIONAL VEHICLE - An upfitted or conversion van.

CLASS C RECREATIONAL VEHICLE - A motor home built on a cutaway full size van.

DEXRON® III - The type of fluid used in the automatic transmission and the electro-hydraulic park brake system on the Workhorse Chassis. This fluid can be mixed with Dexron® II and used in any GM automatic transmission built since 1949. This is also the standard fluid for the Allison™ transmissions in Workhorse chassis built prior to April 5, 2005.

DEXRON® VI - The type of fluid used in the Hydra-Matic automatic transmissions and the electro-hydraulic park brake system beginning in the 2006 model year. DEXRON® VI is compatible with previous Dexron® formulations.

DIESEL FUEL - The fuel used in diesel engines. Number 1-D diesel is recommended in temperatures below 20 degrees Fahrenheit, and Number 2-D diesel is recommended at all other times since it has higher energy content than 1-D.

ELECTRONIC THROTTLE CONTROL (ETC) - This engine control system is standard on the 8100 Vortec engine. There is no mechanical link between the accelerator pedal and the throttle. A potentiometer at the pedal measures pedal angle and sends a signal to the PCM; the PCM then directs an electric motor to open the throttle appropriately.

EXHAUST MANIFOLDS - A vessel used to route exhaust gases from the engine to the exhaust pipes.

FRAME STRETCHING - Metal added to lengthen the frame of a chassis. A body manufacture may do this to increase the wheelbase of a Workhorse chassis. If complications were to arise because of a frame extension, they would not be covered under the Workhorse Custom Chassis Limited Warranty.

FUEL FILTER - The gas engine filter is located along the right or left inside frame rail forward of the rear axle, depending on the chassis Series. The 6.5 Turbo Diesel, the fuel filter/heater/water separator is located on top of the engine.

GAWR - *Gross Axle Weight Rating*: The maximum amount of weight on a single axle. This is measured between the ground and all the tires on a single axle.

GCWR - *Gross Combination Weight Rating*: The maximum amount of combined weight of the chassis including cargo, fluids and passengers as well as any item that is being towed (trailer, boat, vehicle, etc.).

GVWR - *Gross Vehicle Weight Rating*: The maximum weight the chassis was designed to carry including cargo, fluids, and passengers, this does not include the weight of any item being towed but does include the tongue weight of towed item.

HYDRO-BOOST - A power assist brake system used many Workhorse chassis. This system uses hydraulic fluid from the power steering system to assist the driver in stopping the vehicle. Backup power assistance is provided through the use on a hydraulic accumulator.

HYDRO-MAX - A power assist brake system used many Workhorse chassis. This system uses hydraulic fluid from the power steering system to assist the driver in stopping the vehicle. Backup power assistance is provided by a hydraulic pump driven by an integral electric motor.

NCC - *Net Carrying Capacity*: The maximum weight of all personal belongings, food, fresh water, LP gas, dealer installed accessories, people, etc. that can be carried by the vehicle. This is usually calculated by subtracting the UVW from the GVWR. On RVIA labels this has been replaced by CCC (Cargo Carrying Capacity).

OXYGEN SENSOR - An electrical device that sends signals to the PCM advising of the oxygen content in the exhaust stream. The PCM uses this information to determine if it should provide more or less fuel to the engines air/fuel ratio.

PCM - *Powertrain Control Module*: The computer that controls the fuel, ignition and emission components for the engine. It can also control shifting points and TCC lock-up for the transmission certain applications.

RPM - *Revolutions Per Minute*: Typically used to represent how quickly the engine crankshaft is turning inside the engine. May also be used to represent tire rotational speeds.

SCWR - *Sleeping Capacity Weight Rating*: The manufacturers designated sleeping positions of the motor home. This rating is calculated by multiplying the number of sleeping positions by 154 pounds (70kg) and is utilized in calculating the CCC.

SFI - *Sequential fuel injection*: Fuel injection with injectors aimed directly at each cylinders intake valve and fired a precise timing of the valve opening. Improves performance, engine efficiency, and emissions output. Computer controlled fuel release.

STEERING DAMPER - A shock absorber that absorbs road shock inputs in the steering system, thereby, decreasing the tendency of the vehicle to wander on the highway.

STEERING SUPPORT ASSEMBLIES - These devices help support the steering linkage. There is one located on each frame rail on P Series chassis that rotate as the linkage is moved. Some technicians may refer to these as "bell cranks." Sometimes the supports may have excessive play and would require adjusting, refer to the Steering section for details.

TOE - One of the three adjustments made during an alignment. Toe measures how much the tires are pointed in or out from each other.

TORQUE CONVERTER - A device used with an automatic transmission in order to provide a fluid coupling from the engine to the transmission as well as to multiply torque in load situations.

TCC - *Torque Converter Clutch*: A mechanical coupling located inside the torque converter. This clutch is similar to the clutch used with a manual transmission except that it runs in and is applied hydraulically with automatic transmission fluid. The clutch is engaged on the 4L80-E transmission in 2nd through 4th gears when the vehicle is at cruising speeds. The AllisonTM transmission engages this clutch in all gears except first. This increases fuel economy by preventing slippage in the torque converter.

TCM - *Transmission Control Module*: Computer that controls all the operation of the transmission getting input from various sensors and the PCM.

TPS - *Throttle Position Sensor*: An electronic device that senses how far the throttle has been opened or how much the driver is pushing on the gas pedal. The PCM uses this information to determine fuel mixture and transmission shifting points.

TOWING CAPACITY - GCWR minus the actual weight of a fully loaded motor home, including passengers, fluids, and cargo equals towing capacity.

UVW - *Unloaded Vehicle Weight*: The weight of the vehicle as it leaves the body manufacturers factory with full fuel (5.6 pounds per gallon-gas, 6.8 pounds per gallon-diesel), engine oil, and coolant. This does not include dealer-installed options.

VCM - *Vehicle Control Module*: Computer that controls all vehicle operations including electronic engine, emission, and transmission.

BULLETINS: TECHNICAL, SERVICE AND SAFETY CAMPAIGNS

(Listed by date then bulletin number)



WORKHORSE CUSTOM CHASSIS SERVICE BULLETIN

BULLETIN NO.: 30001-I **January, 2000**
BULLETIN TYPE: Information - Motorhome
SUBJECT: Wide Track Independent Front Suspension
MODELS: 2000 with Wide Track IFS

The new Workhorse Custom Chassis widetrack front motorhome suspension entered production during the week of 11-22-99 (2000 Model Year). The new suspension is 13.25 inches wider than the old narrow track IFS unit. Following is a comparison of the Narrow Track (NT) and Wide Track (WT) front suspensions:

<u>ITEM</u>	<u>NEW WIDE TRACK</u>	<u>OLD NARROW TRACK</u>
GAWR	6,000 lbs.	5,500 lbs.
Front Track	82.95 inches	69.70 inches
Front Stabilizer	1.625" Diameter	1.25" Diameter
Front Shocks	Bilstein gas charged	Delphi non-gas
Air Bag	110 psi thick wall	90 psi
Wheel	3,000 lb. Capacity	2,760 lb. Capacity

The increased width was accomplished by moving the A-frame assemblies 6.63 inches on each side. A RH and LH box assembly is fitted to the former frame web mounting area and bolts to the chassis frame in the same way as the narrow track IFS unit. (Refer to figure 1)

The increased Gross Axle Weight Rating was accomplished by numerous upgrades in the structure of the crossmember and A-Frame assemblies, higher capacity air bag, and thicker web wheels.

ALIGNMENT

Alignment specifications (as outlined by WCC Service Manual) have not changed and are outlined as follows:

Camber	0.25 Degree +/- 0.25 Degree
Toe-In	0 Degree to 0.1 Degree (1/16 +/- 1/16 inch)
Caster	3 Degree to 5 1/2 Degree as determined by ride height and adjusted for frame angle. (Refer to WCC Service Manual).

Bulletin No. 30001-I 1 of 5

MAINTENANCE

Inspection, lubrication, and general maintenance recommendations for the new wide track IFS remain the same as for the narrow track system.

PARTS INFORMATION

It is essential that all service replacement parts be identical to the original wide track parts. Many of the narrow track parts may fit the wide track IFS unit, but they are not interchangeable, may cause vehicle damage, and the vehicle would not be certified as designed. Following is a list of the new WCC parts used on the new wide track IFS system;

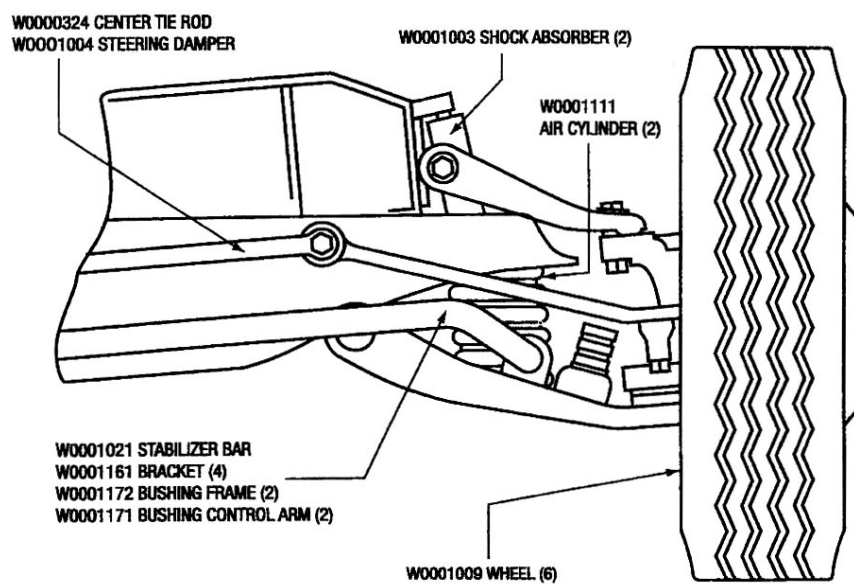
<u>WCC Part No.</u>	<u>Qty. Veh.</u>	<u>Description</u>	<u>Identification</u>
W0001116	1	Crossmember Asm.	13.25" wider than old asm. Additional Welded Supports. Will not fit NT system
W0001054	1	RH Box Assembly	will not fit NT system
W0001059	1	LH Box Assembly	will not fit NT system
W0001111	2	Air Cylinder Asm.	110 psi. thick wall air cylinder Replaces 90 psi air bag used on NT system. The new air bag can be used on the NT system at 90psi.
W0001013	1	LH Frt. Brake Line	200mm Longer than NT brake line Will not fit NT system
W0001015	1	RH Frt. Brake Line	100mm Longer than NT brake line Will not fit NT system
W0000324	1	Center Tie-Rod	13.25" longer than NT rod Will not fit NT system
W0001009	6	3000# Wheel	Part no. 29207 stamped on Backside of Rim. NOTE: Do not use the NT wheel on WT system.

W0001021	1	Frt. Stabilizer bar	1 5/8" Dia. The NT has 1 1/4" Dia. Stabilizer bar. The NT bar should not be used on the WT system
W0001161	4	Bushing bracket	For W0001021 1 5/8" bar
W0001172	2	Bushing	1 5/8" bar attachment to lower Control arm
W0001171	2	Bushing	1 5/8" bar attachment to frame
W0001096	1	LH Lower Control Arm Assembly	Welded reinforced assembly NOTE: Do not use NT lower Control arm on WT system
W0001097	1	RH Lower Control Arm Assembly	Welded reinforced assembly NOTE: Do not use NT lower Control arm on WT system
W0001011	1	LH Brake Sensor	Longer pigtail wiring harness
W0001012	1	RH Brake Sensor	Longer pigtail wiring harness
W0001004	1	Steering Damper	Bilstein
W0001003	4	Front and rear Shock absorber	Bilstein

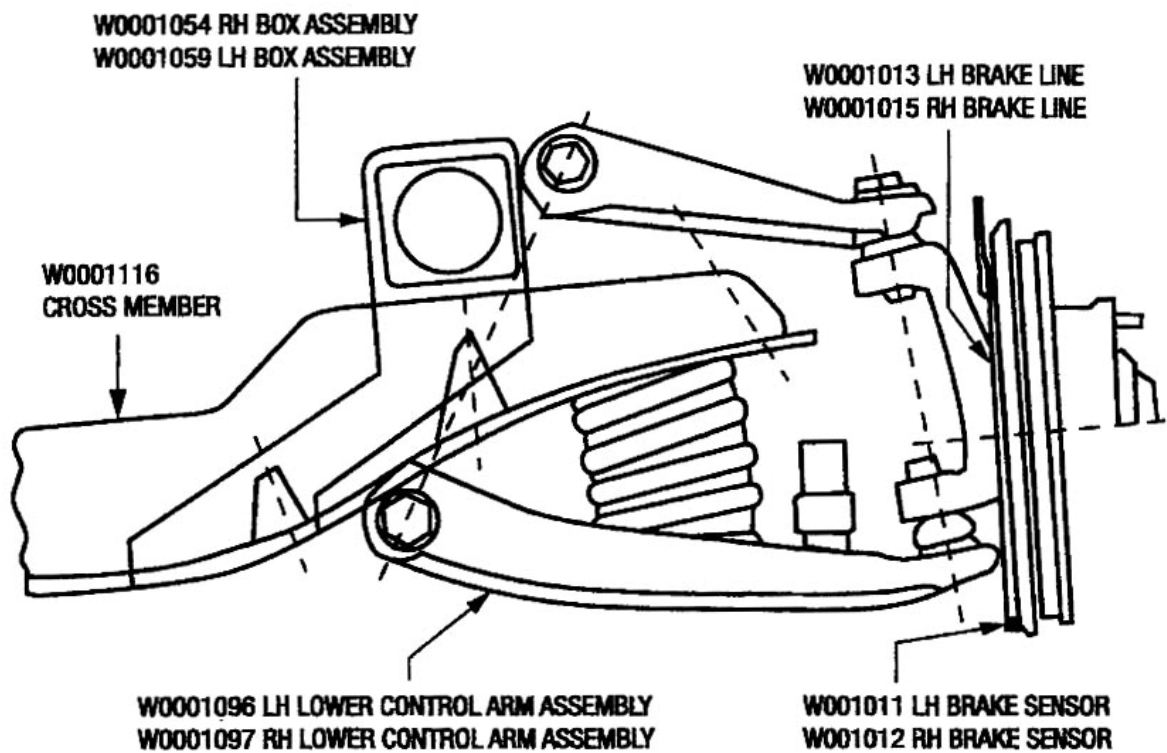
NOTE: It important to understand that the installation of the above parts (that fit) on the old NT system does not increase the GAWR of the NT system.

The above Workhorse Custom Chassis parts can be obtained through the normal Workhorse parts system.

Call 1-877-446-7731 or fax order to 773-376-8644.



(FIGURE 1)



(FIGURE 2)



WORKHORSE CUSTOM CHASSIS SERVICE BULLETIN

BULLETIN NO.: 30101-C **September, 2001**

BULLETIN TYPE: **CAMPAIGN-SAFETY**
Commercial and Motorhome Chassis

SUBJECT: **Rear Axle U-Bolt Torque**

MODELS: **All 2001 models built between April 1, and July 30**

Workhorse Custom Chassis has determined that all Motor-home and Commercial chassis's built between April 01, 2001 and July 30, 2001 may have incorrect torque on the rear axle U-bolts. Incorrect torque on rear axle U-bolts can result in a clunking noise at the rear axle during braking and acceleration. Also, it is possible for rear axle to come loose from the vehicle resulting in loss of vehicle control and possible vehicle crash.

Correction for this condition is to check the rear axle U-bolts for proper nut torque and torque to proper specification.

VEHICLES INVOLVED

All models built in the April through July time span described above. The vehicle VIN range is 5B4MP67G113332411 through 5T4GP41W723338901. There are 5011 vehicles involved.

OWNER NOTIFICATION

Workhorse Custom Chassis will notify retail owners on this campaign as owner data becomes available. The owner will be requested to make an appointment and take their vehicle to nearest Workhorse dealer to check and correct rear axle U-bolt torque.

DEALER CAMPAIGN RESPONSIBILITY

1. WCC dealers must perform this campaign on identified customer vehicles at their request at no charge regardless of time or vehicle mileage.
2. All dealer stock must be held and repaired before delivery to retail customer. It is a violation of law to deliver a non-repaired vehicle to retail customer.

Bulletin No. 30101-I 1 of 2

3. At the request of body builders or WCC, certain dealers may be requested to assist body builders to complete units in their stock.
4. WCC dealers are to provide owner data on all units delivered based on specific lists sent to them.

BODY BUILDER RESPONSIBILITY

All vehicles involved in this campaign were shipped to body builders and body builders provide the final vehicle certification. A listing of vehicles will be provided to all involved body builders with the mailing of this bulletin. Body builders are requested to assist as follows:

1. Unless other arrangements have been made, body builders are asked to contact their local WCC dealer to complete this campaign on all stock units. Units should not be shipped until this campaign is completed.
2. Provide information to body builder dealers to contact WCC dealers to complete all stock vehicles not delivered to retail customers.
3. Provide available customer data on all units delivered to retail customers so that WCC can contact those customers to complete this campaign.

SERVICE PROCEDURE

The service procedure is to check the rear axle U-bolt torque and tighten as necessary to the following torque values: (Refer to WCC service manual Section 4 for specific instructions)

Model	Rear axle U-bolt Torque		
W-series	190Nm	or	140 Ft-lbs
P-series (all with rear drum brakes)	205Nm	or	152 Ft-lbs
P-series (all with rear disc brakes)	260Nm	or	193 Ft-lbs

WARRANTY INFORMATION

Claim Type-----**Campaign**
Labor Operation Code-----**T3001**
Description-----**Campaign 30101-C**
Labor Hours-----**1.0 Hours (Includes 0.2 hrs administrative)**

Bulletin No. 30101-I 2 of 2



WORKHORSE CUSTOM CHASSIS SERVICE BULLETIN

BULLETIN NO.: 80101-T MAY, 2001

BULLETIN TYPE: Technical

SUBJECT: Chassis wiring improvements

MODELS: ALL 2001 MODELS

Effective January 29, 2001 with VIN 5B4LP57G713331060, all chassis wiring to frame grounds were improved by spot facing the ground terminal location on the frame or cross-member and by 100% torque check on ground terminal bolt. Oil was applied to connection to prevent rust. This change was made after it was determined that improper grounding was often the cause for some electrical component complaints.

Early 2001 model P32 motor homes were built with turn-signal flasher on the same circuit with back-up lights and J71 auto-park brake control. Effective March 12, 2001 with VIN 5B4LP57G513332188 an additional circuit was added for the turn signals. This change was made to provide additional capacity when vehicle is used to tow and a trailer connection is added into the turn signal circuit.

RECOMMENDATIONS

Grounds should be checked before replacing any major electrical component such as fuel pumps and brake control modules. Also, grounds (including engine to frame) should be checked during diagnosis of an electrical complaint. Grounds can be intermittent and a simple continuity check may not be sufficient. It may be necessary to remove the ground bolt and clean the connection point to bare metal.

Bulletin No. 80101-T 1 of 4

The added turn signal circuit is recommended when vehicle is equipped for towing and towed vehicle brake and turn signal is wired to chassis turn signal system. This will provide additional electrical power for the lights and will not interfere with the parking brake operation when turn signal circuit is shorted or overloaded. The added circuit can be installed as detailed by wiring instructions.

WIRING INSTRUCTIONS (2001 models only)

Figure 1 shows the early 2001 production combined wiring power feed diagram. Figure 2 shows the separated wiring power feed diagram. The change involves separating the turn signal and parking brake control circuits so that each are on their own 15 amp fuse, as outlined below:

1. Remove pink wire 139B and terminal from cavity J5 at fuse block (back of No. 10 fuse) and move to cavity L5 (back of No. 11 fuse). This is new Auto brake fuse location. (See Figure 4, IP fuse block Front and Rear view)
2. Remove wire 139C (0.8 pink) from turn-signal flasher connector. Cut this wire and tape into main harness.
3. Make up new 0.8mm pink wire 1800mm (71 inches) long with flasher signal terminal (12124512) on one end and fuse block terminal (12110649—for 0.8 wire). Install this wire from flasher unit to cavity J5 at fuse block 10 location. This remains to be the turn-signal fuse.
4. Make up new 3.00mm pink wire with fuse block terminal (12110652) on one end. Install this wire into cavity K6 (back of fuse 11) and splice (12089191) to pink wire 3 coming from fuse block pin H6. Use heat shrink to protect this splice connection. This wire provides power to fuse 11.
5. Install 15 amp fuse in position 11.

PARTS INFORMATION TO FABRICATE NEEDED HARNESS'S

<u>PART NAME</u>	<u>QTY</u>	<u>DELPHI (GM) PART NO.</u>
Terminal-Flasher signal connector	1	12124512
Terminal- Fuse Block- 0.8mm wire	1	12110649
Terminal- Fuse Block- 3.0mm wire	1	12110652
<u>SPLICE TERMINAL</u>	<u>1</u>	<u>12089191</u>
Fuse- 15 Amp.	1	12092078
Pink 0.8mm wire 1800mm (71 inches)		
Pink 3.00mm wire 220mm (9inches)		

PARTS INFORMATION FOR COMPLETE HARNESS ASSEMBLIES

<u>PART NAME</u>	<u>QTY</u>	<u>WORKHORSE PART NO.</u>
Kit with completed wiring harness's Includes harness from flasher to cavity J5 And harness from cavity K6 to wire from H	1	W8000047 Kit

WARRANTY INFORMATION

<u>Labor</u>	<u>Operation No.</u>	<u>Time</u>	<u>T Code</u>	<u>Description</u>
T8001		1.2 Hrs	96	Install Harness assemblies
T8002		1.5 Hrs	96	Make-up and install harness assemblies

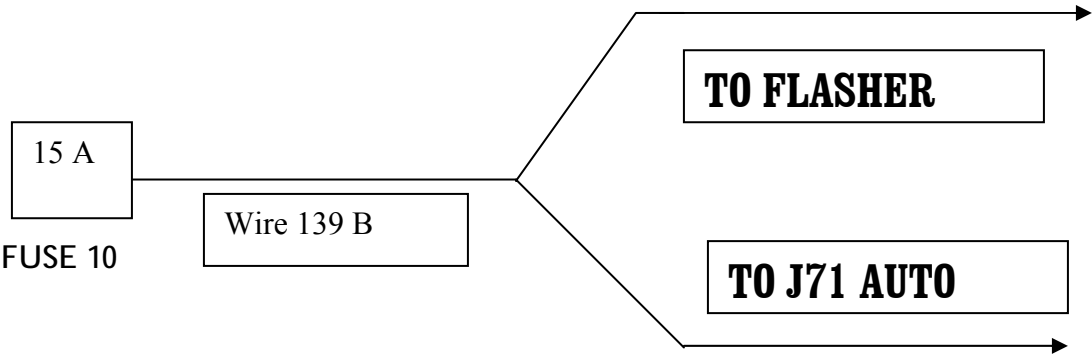
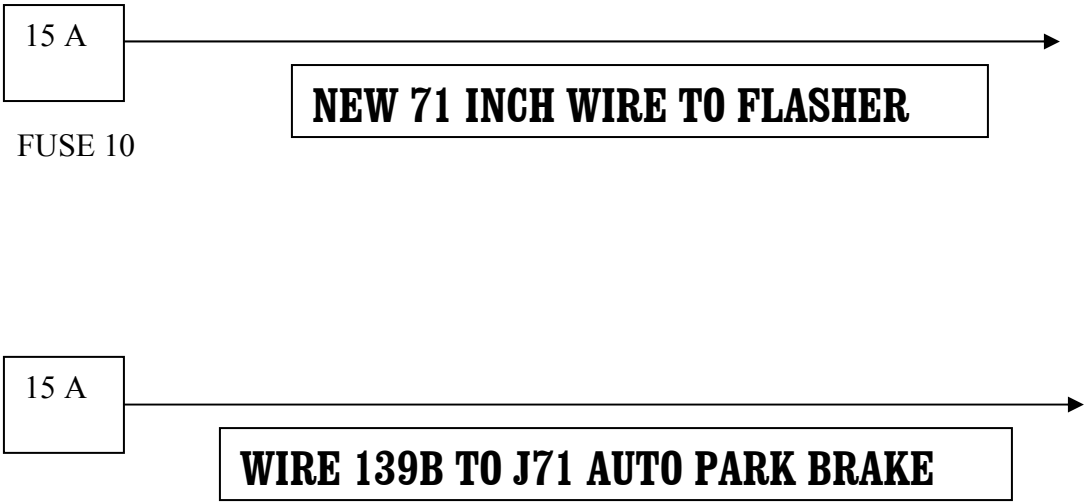


Figure 1

Power feed for early 2001 production





TECHNICAL BULLETIN

October 30, 2001

CHANGES TO LOAD AND INFLATION PRESSURE FOR COMMERCIAL TRUCK TIRES

2003 DOT standards require that both metric and English load, pressure and speed units are marked on tires. While preparing to meet this new requirement, Michelin is in the process of changing its maximum load at cold inflation pressure markings while ensuring alignment with standards published by T&RA (Tire & Rim Association), ETRTO (European Tire & Rim Technical Organization), etc. While the targeted effective date for the changeover process is January 1, 2002, several changes in tire markings have already been implemented. The process will continue throughout the remainder of 2001 until all changes have been completed. All Michelin truck tires manufactured after January 1, 2002 (DOT week 0102) should carry the new markings.

A new data book will be published in the first quarter of 2002 to reflect the changes in maximum loads at various cold pressures. The Michelin truck tire website, www.michelintruck.com will also be updated to reflect these changes.

ALWAYS REFER TO THE ACTUAL SIDEWALL MARKINGS FOR MAXIMUM LOAD AT COLD INFLATION PRESSURE INFORMATION.

During this period of transition, customers may receive tires for the same MSPN with different load and inflation markings. The guidelines below should be followed when mounting tires of the same size with different markings on the same vehicle.

1. Make sure the tire maximum load and cold inflation pressure markings do not exceed those of the wheel.
 2. If tires with different maximum load markings are mixed across an axle, apply the lowest load and cold pressure markings to all tires.
 3. Avoid mixing different markings in dual pairs on either drive axles or trailer axles.
 4. Ensure that the tire markings are adequate to meet the vehicle GAWR for all axles.
- If you have any questions, contact your local Michelin sales rep or contact Michelin directly through our website Contact Us form at www.michelintruck.com.

October 30, 2001

MICHELIN
Multiple solutions. One resource.



WORKHORSE CUSTOM CHASSIS SERVICE BULLETIN

BULLETIN NO.: 00201-I

May, 2002

BULLETIN TYPE: Information

SUBJECT: Reporting The Retail Sale Of A Workhorse Custom Chassis

MODELS: All New Sold Units

Attention: Service Manager

Attached is a copy of the Workhorse Custom Chassis Delay Warranty Start Form. This form is necessary to complete and mail into Workhorse Custom Chassis to report a vehicle Retail sale. This form starts the warranty for your customer and also provides Our Roadside Assistance Information reporting. Please refer to section 1.3.3 and section 1.4.5 Of the Workhorse Custom Chassis Policies And Procedures Manual for further information.

We would like to emphasize an important feature for Workhorse Custom Chassis Owners is a **FREE ROADSIDE ASSISTANCE PROGRAM**, for the regular duration of the standard chassis (Warranty 36 months or 36,000 miles).

Roadside Assistance provide the Following coverage for your customers:

- Jump-start**
- Towing to the nearest Workhorse Dealer**
- Winching Assistance (up to 25 feet from the main road)**
- Lock out service**
- Free Fuel delivery (\$5.00 dollars of fuel delivered if out of fuel)**
- Flat tire service – installing the customer's spare tire**
- Service location Assistance**
- Appointment Assistance**

Roadside Assistance phone number is 1 877 946 7731

No. _____

WORKHORSE CUSTOM CHASSIS DELAYED WARRANTY START	
Vehicle Information	
Vehicle Identification Number <small>(WCC VIN, ALL 17 CHARACTERS)</small>	<div style="display: flex; justify-content: space-between;"> <div style="text-align: center;"> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin: 0 auto;"></div> </div> <div style="display: flex; justify-content: space-between; font-size: 8px;"> 1234567891011121314151617 </div> </div> <div style="margin-top: 10px;"> Vehicle Date*: ____/____/____ Odometer Reading*: _____ <small>•X (NO 10ths) Check if kilometers</small> <input type="checkbox"/> </div> <div style="margin-top: 5px;"> Vehicle Application: RV Commercial / School Bus <div style="text-align: center; font-size: 8px;">(CIRCLE ONE ONLY)</div> </div> <div style="margin-top: 5px; font-size: 8px;"> <small>*Date, odometer reading at first retail sale of upfitted (special body / equipment) recreational, commercial or school bus vehicle. — or — *Date, odometer reading when vehicle is placed in service by WCC authorized fleet or political subdivision.</small> </div>
Customer Information	
Customer Name: _____ Customer Email Address: _____ Business: _____ Address: _____ / _____ / _____ / _____ <div style="display: flex; justify-content: space-around; font-size: 8px; margin-top: -10px;"> StreetCityState/ ProvinceZip/ Postal Code </div> Phone: (_____) _____ - _____ <div style="text-align: center; font-size: 8px; margin-top: -10px;">AREA</div> Customer Signature: _____ Date: ____/____/____	
Sales Information	
WCC Dealer/Retailer Code (if retailed by WCC dealer/retailer): _____ - _____ Retail Outlet: _____ Address: _____ / _____ / _____ / _____ <div style="display: flex; justify-content: space-around; font-size: 8px; margin-top: -10px;"> StreetCityState/ ProvinceZip/ Postal Code </div> Phone: (_____) _____ - _____ <div style="text-align: center; font-size: 8px; margin-top: -10px;">AREA</div> Retail Outlet/Dealer Signature : _____ Date: ____/____/____ Reason for Delayed Warranty Start: _____ _____ _____	
<div style="display: flex; justify-content: space-between;"> <div style="width: 60%;"> This form is to be completed, signed, and mailed to: </div> <div style="width: 35%; text-align: center;"> Warranty Department Workhorse Custom Chassis 922 S. State Route 32 Union City, IN 47390 </div> </div>	

W0004542
REV. 06/05

WHITE: WARRANTY DEPT.

•

YELLOW: CUSTOMER

•

PINK: FILE



WORKHORSE CUSTOM CHASSIS SERVICE BULLETIN

BULLETIN NO.: 00202-I

May, 2002

BULLETIN TYPE: Informational

SUBJECT: Service Manual And Owners Manual Error

MODELS: All Model Year W-22 And P-30 Series Chassis

Attention: Service Manager

It is stated in the Workhorse W-22 Series Chassis owners manual on page 30 and P-30 Series Chassis service manual on page 8-79 (volume 3 of 4), that the W-22 and P-30 Series Chassis have the headlamp "flash to pass" feature. It states, "To activate this feature all you need to do is pull back on the dimmer switch until the high beams illuminate and then release". This should, according to the manuals, happen before the detent (or click); and also be available in any headlamp state (i.e. off, DRL and low beam)". This is an ERROR. The "flash to pass" feature is not available with the W-22 or P-30 Series Chassis. This has been corrected for the 2003 W-22 and P-30 Series Chassis service and owners information.

Bulletin No. 00202-I 1 of 1



WORKHORSE CUSTOM CHASSIS SERVICE BULLETIN

BULLETIN NO.: 00207-I

May, 2002

BULLETIN TYPE: Informational

SUBJECT: Change Of Vehicle Ownership

MODELS: All Workhorse Custom Chassis

Attention Service Manager:

When a Workhorse Custom Chassis is sold used in the secondary market, the new owner information needs to be completed. Please fill out the attached form to document the change of vehicle ownership. This information is necessary to keep our ownership and warranty records updated and complete. This form will be included in the 2003 Owner Warranty Information supplement that will be included with the chassis paperwork.

- **There is no additional cost to the dealer or customer for making the warranty transfer.**
- **The vehicles warranty is for 3 years /36,000 miles (whichever comes first), regardless of ownership (from the date the vehicle is placed in service).**
- **The Workhorse Roadside assistance program will also remain active throughout the duration of the warranty period.**

If you have any questions regarding this procedure, please contact the Workhorse Custom Chassis Warranty Department at (877) 246-7731 or (248) 443-1515.

Bulletin No. 00207-I 1 of 2



WORKHORSE CUSTOM CHASSIS

CHANGE OF OWNERSHIP INFORMATION

**This Certificate Insures Proper Transfer Of Ownership
Information with Workhorse Custom Chassis. Please fill
Out Completely and Fax To: (248) 588-6978 or Mail To:**

**Workhorse Custom Chassis
Attn: Warranty Department
850 Stephenson Hwy, Suite 510
Troy, MI 48084**

New Owner: _____
Address: _____
City: _____
State: _____
Zip: _____
Telephone Number (Home) _____
Telephone Number (Work) _____
Odometer: _____ **VIN:** _____
Date: _____
Customer Signature: _____

BULLETIN 00207-I
Page 2

Bulletin No. 00207-I 2 of 2



WORKHORSE CUSTOM CHASSIS SERVICE BULLETIN

BULLETIN NO.: 80202-T

October 2002

BULLETIN TYPE: Technical

SUBJECT: Reversing DRL Wiring In Connectors B and C

MODELS: 2002 Workhorse W-20/W-22 Chassis

Attention: Service Manager

A condition may exist with certain 2002 Workhorse W-20/W-22 Series Chassis where the daytime running light function may not operate as designed due to a wire routing condition.

NOTE: Coach wiring systems differ per coach manufacturer. Models equipped with the following option codes could be suspect to a non-operational DRL condition:

8T2- Dual Rectangular Headlamp Provision and/or
HPR- Dual Rectangular Headlamps/with
5K1- Daytime Running Lights

SERVICE PROCEDURE

The following service procedure is intended to correct the Daytime Running Lamp (DRL) operation applying to the 2002 Workhorse W-20/W-22 Chassis. This procedure applies to models equipped with the dual rectangular headlamps with the DRL feature.

Step 1. Refer to the attached wiring schematic W0000338 (sheet 100 page 2) to Correct the Daytime Running Lamp (DRL) operation.

Step 2. Locate the forward lamp wiring harness part no. W0002812. NOTE: The Forward lamp harness connector at the bulkhead will have a label tag #2812.

Bulletin No. 80202-T 1 of 3

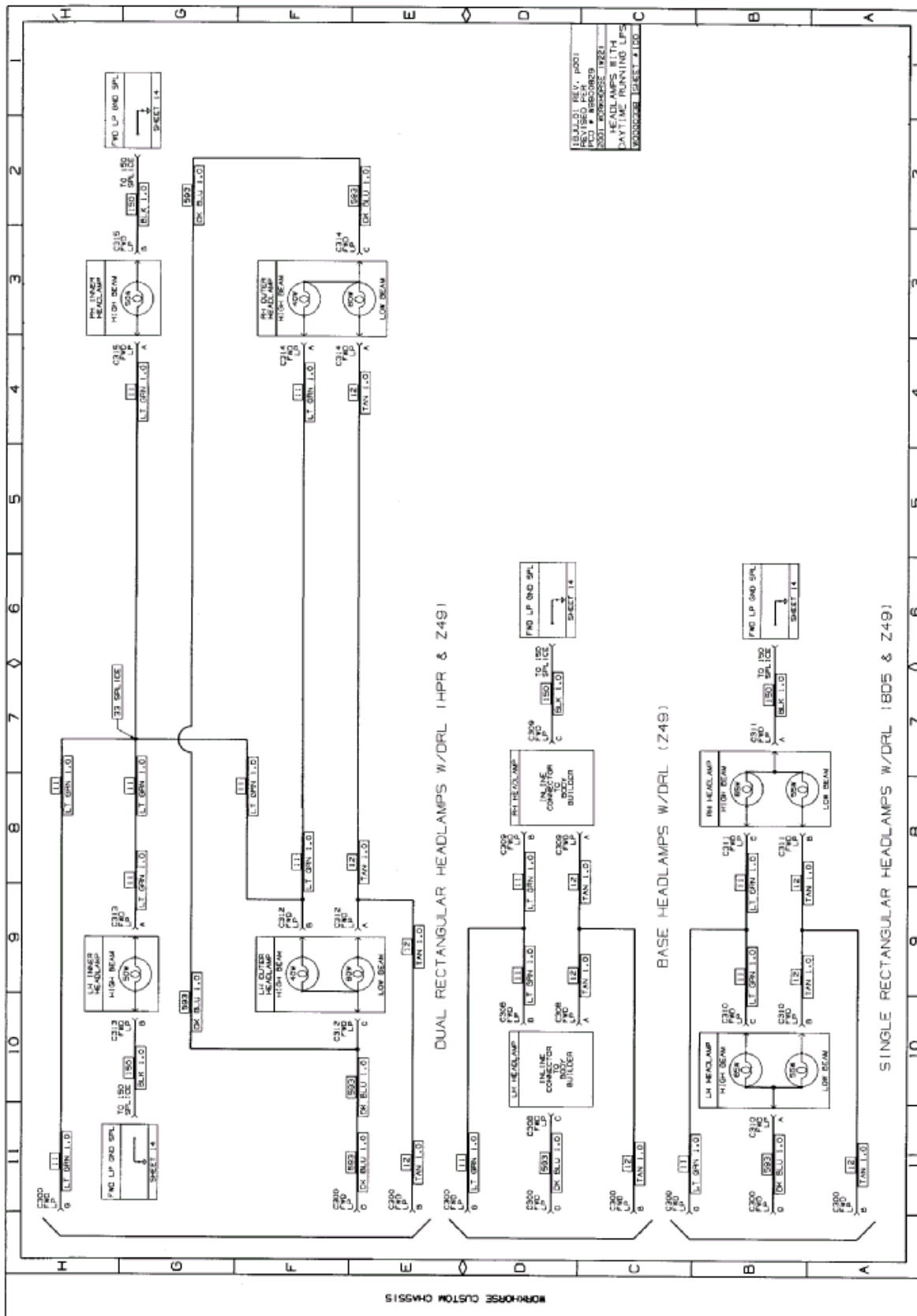
Step 3. Remove the black wire from the connector at pin B (left hand inner headlamp.)

Step 4. Remove the dark blue wire from the connector at pin C (left hand outer headlamp.)

Step 5. Insert the black wire into the connector at pin C (left hand outer headlamp.)

Step 6. Insert the dark blue wire into the connector at pin B (left hand inner headlamp.)

Step 7. Reinstall connectors to headlamps and test system





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WORKHORSE CUSTOM CHASSIS DEALER LETTER

MEMO NO: 00308-I

May, 2003

MEMO TYPE: Information

SUBJECT: Air Conditioning Performance

MODELS: All W Series Motor Home Chassis

On August 2, 2002, a letter was sent to all Motorhome Service Centers by an after-market A/C supplier. This letter discussed an Air Conditioning performance complaint on the Workhorse W series chassis. In response to the letter, Workhorse Custom Chassis has investigated the performance of the chassis supplied condenser when integrated in a complete air conditioning system by various body builders.

The results of this investigation are as follows:

- A) Cases of compressor head pressure in excess of 400 psi have been reported. Such head pressures are detrimental to the optimum operation of the complete A/C system.
- B) Workhorse Custom Chassis supplies a portion of this complete system: the compressor, the condenser and the dryer in both pre-charged and uncharged conditions.
- C) Integration of components such as the evaporator, air distribution ducts and expansion valves are the responsibility of the body manufacturers.
- D) Minimum airflow requirements for the proper operation of the entire cooling pack (engine, transmission and condenser) are specified by Workhorse but the final design of the front end, including frontal grille opening area, is the responsibility of the body manufacturer.
- E) Commissioning the system and charging it with the correct amount of refrigerant to ensure optimum performance is also the responsibility of the body manufacturer based on recommendations from its A/C system supplier.

F) To deliver optimum performance from the condenser supplied by Workhorse Custom Chassis and avoid excessive compressor head pressure, the body builder must meet the following list of conditions:

- Minimum clear grille opening in front end to be as specified in body builders manual (for W22 chassis the requirement is 548.7 sq in)
- Area between front-end body opening and cooling pack face to be sealed to avoid hot air re-circulation.
- A/C system to be charged with the correct amount of refrigerant gas; reducing the amount of refrigerant gas in the system is the quickest and simplest way to lower head pressure. The body builder should be contacted for the correct refrigerant specification.

G) Under certain ambient operating conditions (higher temperature together with higher relative humidity), some customers might perceive the level of performance delivered by an A/C system, meeting all requirements listed under F), as inadequate. For these particular applications, Workhorse Custom Chassis has released a High Performance kit available through normal WCC parts distribution channel as well as GVW Parts. The Kit (part number W8000486) will be available through normal WCC parts channels by mid to late June 2003.

The kit contains a remote mounted condenser and electric fan assembly, 2 liquid coolant hoses and a jumper harness. Installation and mounting of the condenser package can vary according to body configuration, it is therefore suggested that the body builder be contacted for kit installation instructions.

This letter should answer any concerns created by earlier correspondence to dealers and manufacturers and enable any dealer or service center to address the performance of the existing system by verifying and/or adjusting to the specification listed under F). The release and availability of the Workhorse High Performance kit will allow for additional cooling output for those customers requesting this option.

Workhorse does not design and warranty the vehicle (Motorhome or Commercial) Air Conditioning system. Workhorse does provide various purchased parts including the compressor and condenser as these are most efficiently installed during chassis build. Workhorse does warranty the items installed at the Workhorse factory, but not the system performance, or failures caused by system malfunctions. The Body Builders install the evaporator, controls, ductwork, blower fan, and other parts. They fill the system with refrigerant gas and do the final functional testing. It is sometimes difficult to determine warranty responsibility.

Workhorse is providing the attached guideline to assist dealers in determining warranty responsibility. The guidelines have two sections, repairs covered and WCC parts covered.

Air Conditioning Warranty guide--REPAIRS (also see PARTS)

Repairs Covered by Workhorse Custom Chassis Warranty

- Compressor mounting
- Compressor drive belt
- Compressor clutch installation including electrical.
- Compressor failure not resulting from system malfunction
- Condenser mounting
- Condenser leaking not caused by damage
- Condenser fan failure not caused by damage nor resulting from system malfunction
- System leaks caused by defective WCC parts (see parts list)
- Dryer leaking not caused by damage
- Dryer failure not resulting from system malfunction
- Hose, Compressor outlet to Condenser inlet, leaking not caused by damage or faulty installation by Body Builder
- Hose, Compressor outlet to Condenser inlet, failure not caused by system malfunction

Repairs NOT Covered by Workhorse Custom Chassis Warranty

- Damaged parts
- W22 performance kit and labor
- Air Conditioning performance not related to WCC parts failure
- System leaks other than defective WCC parts. Final system checking is a body builder responsibility.
- Leaks at any hose connections
- Low or overfilled with Freon
- A/C Controls inside vehicle
- Ductwork
- Blower fan
- All electrical except compressor clutch
- Clutch burnout caused by excessive head pressure
- Evaporator

W Series Air conditioning PARTS provided by Workhorse Custom Chassis

<u>Part Description</u>	<u>Part No</u>	<u>Qty</u>
COMPRESSOR ASM-A/C	15067135	1
BOLT/SCREW-A/C CMPR	11516704	4
SWITCH ASM-A/C CMPR LOW PRESS CUT OFF	10242579	1
SEAL-A/C CMPR HOSE	52455752	2
HOSE ASM-A/C CMPR & CNDSR (pre-charged)	15026328	1
HOSE ASM-A/C CMPR & CNDSR (w/out pre-charge)	15724142	1
CLAMP-A/C CMPR & CNDSR HOSE	15005885	1
CLAMP-A/C CMPR & CNDSR HOSE	15966651	1
BOLT/SCREW-A/C CMPR & CNDSR HOSE CLA	11508475	1
CLIP-A/C CMPR & CNDSR HOSE	00719177	1
BOLT-A/C CMPR & CNDSR HOSE CLIP	03846202	1
CONDENSER ASM-A/C & EOC & TOC (pre-charged)	W0000721	1
CONDENSER ASM-A/C & EOC & TOC (w/out pre-charge)	W0000722	1
BOLT/SCREW-A/C CNDSR	11500994	3
INSTRUCTION-A/C CNDSR INSTL	15724143	1



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WORKHORSE CUSTOM CHASSIS SERVICE BULLETIN

BULLETIN NO.: 70301-T November 2003

BULLETIN TYPE: Technical

SUBJECT: Transmission 5-3 downshifts

MODELS: Model 2001 and 2002 Workhorse W-Series
Motorhome chassis with Allison transmission

Some model year 01 and model year 02 W-Series Workhorse Custom Chassis Motorhome owners have experienced rapid 5-4-3 downshifts while in cruise control. This condition occurs with the cruise control active while driving on a slight and/or moderate incline. If the vehicle speed decreases more than 3 mph, while in cruise control, the engine control module will increase the speed to maintain the cruise speed that was set. In order to maintain the cruise set the engine has to shift down to get more power and sometimes down shift to the third gear to maintain the demanded performance.

Starting with the 2003 model year, Workhorse Custom Chassis and Allison Transmission have released new software for the Allison 1000-series control module as well as 8.1L engine. This new software will reduce the aggressiveness of transmission shifting and will prevent most downshifts to the third gear while in cruise control mode.

New calibrations have also been made available for 2001 and 2002 models and will correct the (above) condition if the chassis in question meets the stated criteria. This condition affects only the 2001 and 2002 W/20 or W/22 model with the 8.1 V-8 with the Allison LCT 1000 Transmission.

VEHICLES INVOLVED

Please check the VIN carefully before agreeing to the customer that we can apply the new calibrations.

1. The VIN must start with 5B4MP67G... indicating a W-series model that is equipped with the Allison Transmission.
2. It must be a 2001 or 2002 model year. 10th digit of VIN is 1 or 2.
3. The 2003 model year chassis have the new calibrations already installed in both controllers and are NOT INVOLVED.

SERVICE PROCEDURE

This procedure should be followed whenever a Workhorse customer has a transmission shift complaint as described earlier in this bulletin. Most customers are not likely to have this complaint as vehicle weight and specifications are major factors leading to the complaint.

1. 2001 model year W-Series chassis will need only to have the Allison TCM re-flashed. The customer must be directed to the nearest Allison Dealer. The Allison Dealer will provide this service at no expense to the customer as outlined by Allison Bulletin 18-1K-02, Rev. A
2. 2002 model year W-Series chassis will need to have BOTH the Allison TCM and Workhorse PCM controller flashed.
 - The Allison TCM will need to be flashed first. The customer must be directed to the nearest Allison dealer for this work. Allison does this procedure by re-flashing the TCM with the Allison computer and interface. The procedure usually takes 30-60 minutes. The Allison Dealer will provide this service at no expense to the customer as outlined by Allison Bulletin 18-1K-02, Rev. A
 - Once the Allison TCM has been done, the engine controller will need to be flashed by an authorized Workhorse/GM Dealer who has a valid GM Techline account (800) 828-6860. The new engine calibrations are available on GM Techline CD # 8 (which was mailed to all Techline approved dealers on 7-28-03).

Do NOT attempt to flash the TCM and engine controller of an MY01 vehicle with MY02 calibrations. This will cause Diagnostic Trouble Codes to be set in the engine controller which will force it into "limp home" mode.

WARRANTY INFORMATION

Labor Operation No.-----T7003
(limited to 3 years/ 36,000 miles on 2002 model year only)
Labor Hours-----1.0 Hours
Description-----Reprogram 2002 PCM for Bulletin

Keep in mind this is not a recall/campaign, but a calibration update for a limited number of vehicles to satisfy customer complaints on vehicles still covered by Workhorse warranty. This work should not be referred to as a campaign or recall. Please make sure customers and dealers understand this clearly, as this can set the tone for misunderstanding and negative perception.



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WORKHORSE CUSTOM CHASSIS SERVICE BULLETIN

BULLETIN NO.: 100405-I

February, 2004

BULLETIN TYPE: Information

SUBJECT: Vibration Procedure on Changed wheelbase units

MODELS: All Workhorse Custom Chassis models

Workhorse Custom Chassis has determined that some wheelbase changes on Motorhome chassis has resulted in vibration complaints. Such modification can change frame structure, fuel and brake lines along the rail, and prop shaft configuration. The result is a chassis that is no longer defined by Workhorse Custom Chassis Engineering specifications. Many wheelbase changes are done with little or no adverse effects. Others have caused chassis issues such as prop shaft vibration from balance, non-canceling working angles, and incorrect hanger bearing angles. More complex issues such as changes in component resonant frequency can result. Severe cases have resulted in rear axle pinion bearing failure or other axle problems.

Prop shaft vibration/noise is often improperly diagnosed as a rear axle problem as the vibration is transmitted through the rear axle, springs, and chassis to the body. There have been cases where rear axle repairs were made without affecting the complaint vibration. The prop shaft should be eliminated as the vibration source before any axle repairs are made. Workhorse provides classes on Vibration and rear axles. Contact 877-246-7731 X222 to obtain information on these classes.

Workhorse does not warranty complaints or failures caused by wheelbase changes. Therefore, proper vibration/noise diagnosis is essential to determine complaint responsibility. Workhorse Custom Chassis does have an obligation to eliminate any original chassis items that may be causing a vibration complaint such as tires and wheels. Also, Workhorse wishes to technically assist our Body Builder customers to resolve issues with our mutual retail customers.

Bulletin No. 10045-I 1 of 3

RECOMMENDED SERVICE PROCEDURE

The following procedure is recommended on all vibration/noise complaints. See bulletin 00311-I for vibration diagnosis. Dealers that are not trained on or do not have an EVA (Electronic Vibration Analyzer) should not be working on and submitting warranty on vibration complaints. Workhorse Bulletin 00219-I has information on where to obtain recommended tools. Wright Tool at 800-783-9826 is a good source to obtain an EVA.

1. Define the complaint to totally understand what vibration/noise that is the source of the customer complaint. A road test may be necessary. Most vehicles have various vibrations at various frequencies. The specific frequency that creates the customer complaint must be identified to prevent working on vibrations that are not part of the complaint.
2. Check VIN Information in WOW to determine Workhorse Production wheelbase. (See attached wheelbase chart)
3. Measure wheelbase to determine if wheelbase has been changed. Do not assume that wheelbase has not been changed if unit has an available WCC wheelbase as it could have been changed from one available wheelbase to another.
4. Verify a suspected changed wheelbase by examination of frame rail to see if it has been cut and re-welded.
5. If wheelbase has been changed, define the vibration with an EVA and eliminate wheels and tires and other non-wheelbase issues as source of the complaint. Vibration from a wheelbase change has most often been defined as prop-shaft balance, angle cancellation, phasing, hanger bearing installation, or change in resonant frequency. Extremely short or long prop assemblies can also cause vibration issues.
6. Close repair order at this point with explanation on how the complaint is related to the chassis modification and tires/wheels are eliminated as a vibration source.
7. Contact TAC at 877-246-7731 with body type, model, and body serial number. TAC will contact and work with the body company to resolve the issue.
8. Contact Body Company to determine further corrective action recommendations.

Body Manufacturer	Main Service Number
Airstream	937 596-6111
Coachmen RV	800 453-6064
Damon	574 264-2900
Fleetwood	260-724-5778
Forest River	574 389-4600
Four Winds	574 266-1111
Georgie Boy Mfg.	800 521-8733
Gulfstream	800 289-8787
Monaco & Holiday Rambler	800 450-6336
National RV	909 943-6007
Newmar	574 773-7791
Rexhall	800 444-9720
R-Vision	800-784-1498
Safari	800 450-6336
Tiffin	256 356-8661
Winnebago	800 628-7692

Model	Model Number	Wheelbase (inches)	
P32 (14,800 lbs. C3D, 15,000 lbs. C7W, 17,000 lbs. C7B, or 18,000 lbs. C7D GVWR)			
P32	P31432	158.8	
P32	P31832	178	
P32	P31932	190	
P32	P32032	208	
P32	P32132	228	
W20 (20,700 lbs. GVWR -Option Code C7V)			
W20	W31920	190	
W20	W32020	208	
W20	W32120	228	
W22 (22,000 lbs. GVWR - Option Code C7X)			
W22	W32022	208	
W22	W32122	228	
W22	W32522	242	
W24 (24,000 lbs. GVWR - Option Code C8Y)			
W24	W32024	208	
W24	W32124	228	
W24	W32524	242	

Bulletin No. 10045-I 3 of 3



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WORKHORSE CUSTOM CHASSIS SERVICE BULLETIN

BULLETIN NO.: 50401-C

July, 2004

BULLETIN TYPE: CAMPAIGN-SAFETY

SUBJECT: Bosch Brake Calipers

MODELS: Certain 2001, 2002, and 2003 Workhorse W series Motorhomes

Workhorse Custom Chassis has decided that a defect, which relates to motor vehicle safety, exists in certain 2001, 2002 and 2003 Workhorse W series chassis built with Bosch brake calipers.

The defect involves a brake caliper hanging in a partial apply position. A caliper in a partial apply position can overheat, causing damage. The brake system anti-lock feature may be lost if heat damages the anti-lock wheel sensor. There could also be a loss of brake performance.

Workhorse Custom Chassis is conducting a safety recall campaign to apply the Bosch repair remedy to involved vehicles.

VEHICLES INVOLVED

All W series motorhomes built between August 10, 2000 and July 29, 2002 are involved. The VIN range is as follows: (Last 8 digits of 17 digit VIN starting with 5B4)

Model Year 2001----13325068 to 13337849

Model Year 2002----23336034 to 23356051

Model Year 2003----33354476 to 33356806

OWNER NOTIFICATION

Workhorse Custom Chassis will notify retail owners on this campaign as owner data becomes available. Owners will be requested to make an appointment and take their vehicle to a Workhorse dealer to apply the Bosch remedy.

DEALER CAMPAIGN RESPONSIBILITY

1. WCC dealers must perform this campaign on identified customer vehicles at their request at no charge regardless of time or vehicle mileage.
2. All dealer stock (new or used) must be held and repaired before delivery to retail customers. It is a violation of law to deliver a non-repaired vehicle to a retail customer.

SERVICE PROCEDURE

- A. The Service procedure is to apply the Bosch remedy as described by the attached. Refer to Special notes to Parts Manager below.
- B. Complete brake system inspection is to be completed after Bosch remedy is applied.

This includes the following:

1. ABS operation.
2. Check linkage for binding or hanging and make sure it is returning to full return position and is not held down by brake light or cruise control switch.
3. Linkage joint lubrication including brake pedal pivot, rod ends, and relay lever shaft.

RECALL CAMPAIGN COMPLETION LABEL

Complete the Recall Campaign Completion Label and attach to air cleaner housing in a visible area. One label will be included with the Guide Pin Boot kits. Additional labels can be obtained from Workhorse Parts.

WARRANTY INFORMATION

Claim Type-----Safety Campaign
Labor Operation Code-----T5002
Labor Hours-----4.1 Hours (Includes 0.2 hrs administrative)



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WORKHORSE CUSTOM CHASSIS SERVICE BULLETIN

BULLETIN NO.: 60401-C

October 2004

BULLETIN TYPE: Campaign-Emissions-Motorhome chassis

SUBJECT: Incorrect Catalytic Converter

MODELS: Certain P32, W22, and W52 2003 models with 8.1L engine

Workhorse Custom Chassis has determined that certain model year 2003 motorhome chassis with option L18- 8.1L Vortec gasoline engine were built with an incorrect Catalytic Converter.

This condition must be corrected by replacing the catalytic converter assembly as outlined by instructions.

VEHICLES INVOLVED

A total of 11,711 model year 2003 vehicles built with 8.1 liter gasoline engine are involved. The Vehicle Identification Number (VIN) range is 355763 through 372635. All units with 8.1 engine with last six digits of VIN in this range will require catalytic converter replacement.

PARTS INFORMATION

Existing catalytic converter and pipe assembly must be replaced with new assembly using kits as follows:

<u>Model</u>	<u>Kit Part Number</u>	<u>Qty/Vehicle</u>	<u>Description</u>
W22	W8001469	1	Converter kit
P32	W8001470	1	Converter kit
W52	W8001507	1	Converter kit

Workhorse dealers can obtain these kits through normal parts channels.

Kit W8001469 used for W22 models includes the following detail parts:

<u>PART NO</u>	<u>QTY per KIT</u>	<u>DESCRIPTION</u>
W0005092	2	Converter/pipe assembly
15027074	4	Gasket---pipe flange
11514597	8	Nut---pipe flange
W9000042	8	Bolt---pipe flange
W8001493	1	Campaign Completion Label

Kit W8001470 used for P32 models includes the following detail parts:

W0005100	1	RH Converter/pipe assembly
W0005099	1	LH Converter/pipe assembly
11514597	10	Nut---Flange stud and bolt
15733192	6	Stud---Exhaust manifold to pipe
W9000042	4	Bolt---pipe flange
15020729	2	Seal---exhaust doughnut
15027074	2	Gasket---pipe flange
W8001493	1	Campaign Completion Label

Kit W8001507 for W52 models includes the following detail parts:

W0006644	2	LH and RH Converter pipe assembly
15027074	4	Gasket---pipe flange
11514597	8	Nut---Flange stud and bolt
W9000042	8	Bolt---pipe flange
W8001493	1	Campaign completion label

OWNER NOTIFICATION

Workhorse Custom Chassis will notify retail owners on this campaign. Owner letter is included with this bulletin. Owners will be provided a copy of this bulletin.

WORKHORSE DEALER CAMPAIGN RESPONSIBILITY

1. Dealers must perform this campaign service on all customer vehicles at the request of and appointment with the customer.
2. All dealer stock must be held and repaired before delivery to retail customer.
3. This campaign is to be completed with no charge to customer regardless of mileage or time.



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WORKHORSE CUSTOM CHASSIS SERVICE BULLETIN

BULLETIN NO: 50402-C

December 2004

BULLETIN TYPE: Campaign-Safety

SUBJECT: Actia Instrument Cluster

MODELS: Certain 2003 and 2004 models with Actia Cluster

Workhorse Custom Chassis has decided that a non-compliance with Federal Motor Vehicle Safety Standards (FMVSS) 101 and 105, which relates to motor vehicle safety, exists in certain subject models with Actia Instrument cluster.

The non-compliances involve incorrect software programmed into the cluster such that certain driver warnings required by Federal Motor Vehicle Safety Standards (FMVSS) are not displayed. Incorrect software may not have the ability to illuminate warning lamps indicating brake system failure codes. FMVSS require driver warning when brake failure codes are set.

Vehicles Involved

All models built between 07/17/2002 and 05/19/2004 with Actia clusters are involved. The VIN range is as follows: (Last 6 digits of 17 digit VIN starting with 5B4)

Model Year 2003 ----- 354720 to 376624 ----- (14692 units)

Model Year 2004 ----- 376625 to 394550 ----- (15649 units)

Owner Notification

Workhorse Custom Chassis will notify retail owners on this campaign as owner data becomes available. Owners will be requested to make an appointment and take their vehicle to a Workhorse dealer to have the Service procedure performed.

Dealer Campaign Responsibility

1. WCC dealers must perform this campaign on identified customer vehicles at their request at no charge regardless of time or vehicle mileage.
2. All dealer stock (new or used) must be held and repaired before delivery to retail customer. It is a violation of law to deliver a non-repaired vehicle to a retail customer.

Notes