CONTENTS

ILLUSTRATIONS

1. DESCRIPTION

X3 Series coaches may be provided with either an Allison automatic transmission or a Volvo I-Shift transmission while X3-45 VIP and XLII Bus Shells are provided with an Allison automatic transmission.

1.1 ALLISON AUTOMATIC TRANSMISSION

The Series 4000 (B500 for coaches and 4000MH for motorhomes) Allison Transmission has 6 speeds with two top range (fifth and sixth) overdrives. Total coverage is determined by dividing the highest gear ratio by the lowest gear ratio. Total coverage expresses the transmission gear ratio versatility. Transmissions with larger total coverage number have a wider variety of available ratios.

An electronic control allows the transmission to shift at exactly the right point on the engine's fuel consumption curve for best economy. Early lockup maintains the highest possible mechanical efficiency through the closely-spaced gear steps, culminating in two overdrive ratios. This combination allows progressive shifting techniques, where engine speeds are reduced for higher efficiency and lower fuel consumption.

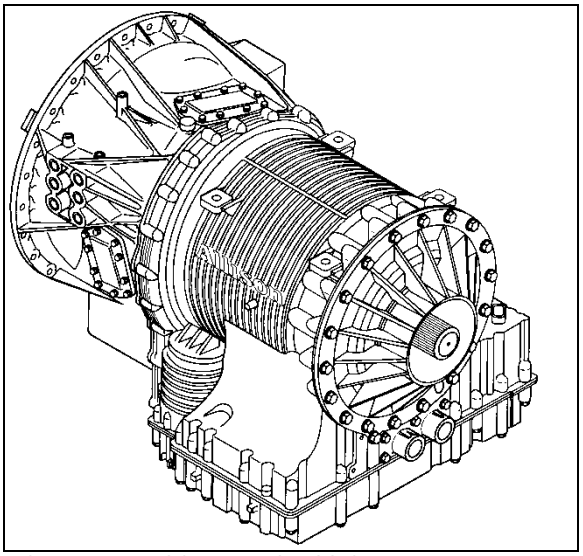

FIGURE 1: ALLISON TRANSMISSION 07136

Gear selection and torque converter modes are controlled by a microcomputer-based electronic transmission management system. It is fed information regarding throttle position, operator range selection, engine speed, turbine speed, transmission output speed and various system pressures from special electronic sensors. With this information, it computes shift points and clutch pressures to meet immediate needs. Using closed loop adaptive logic; the electronic control looks at a number of parameters during the shift, and makes minute adjustments to match the shift to desired profile stored in its memory. It then looks at these adjustments and resets the parameters, which allow the transmission to quickly compensate for variations in load, terrain or environment and to adjust for clutch wear and engine power changes. A Diagnostic Data Reader can be connected to the electronic control unit to provide a self-check of all systems in the transmission. Five-digit trouble codes greatly reduce the time it takes to pinpoint potential problems. (Refer to paragraph *"8. TROUBLESHOOTING"* in this section).

1.1.1 Retarder (if applicable)

This optional auxiliary braking device for the automatic transmission is integrated into the basic envelope of the transmission and transmits its braking force directly to the propeller shaft. It requires no additional length and adds only 75 pounds (34 kg) of weight. Operation of the retarder is controlled electronically by the driver's use of the brake and/or by hand control lever.

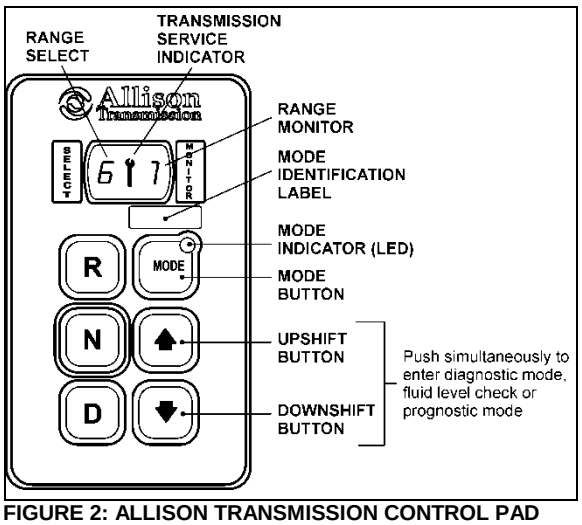

FIGURE 2: ALLISON TRANSMISSION CONTROL PAD
07142

When activated, fluid enters a cavity and provides resistance to the turning of rotor blades revolving with the output shaft. This effectively slows the vehicle to the point where the service brakes are needed only for final stopping. The retarder is fully modulated and is compatible with ABS.

2. WELDING PROCEDURES

These procedures are intended only for vehicles equipped with transmission electronic controls. When frame or other welding is required on the

vehicle, precautions are to be taken to protect the electronic control components. Refer to section 00: GENERAL INFORMATION, paragraph 3: “Precautions to be observed before welding” for complete procedure.

3. ALLISON TRANSMISSION MAINTENANCE

3.1 MANUAL FLUID LEVEL CHECK

Take note that an oil level sensor (OLS) is standard in your transmission. With the OLS and Allison 5th generation shift selector, you can get a more accurate electronic fluid level check than with a dipstick.

To gain access to the dipstick, open the engine compartment rear doors; dipstick is located on the radiator side of the engine (Figure 3).

DANGER

When checking the oil level, be sure that the parking brake and/or emergency brakes are set and properly engaged, and the wheels are chocked. Unexpected and possible sudden vehicle movement may occur if these precautions are not taken.

- Special care must be taken not to touch the engine coolant tubing and/or exhaust pipe, since this could cause severe burns.
- Do not wear loose clothing and, stay away from rotating parts during procedure; personal injury could occur.

Clean all dirt from around the end of the oil filler tube before removing the dipstick. Dirt or foreign matter must not be permitted to enter the oil system since it will cause valves to stick, undue wear of transmission parts, and clogged passages. Check the oil level using the procedures in Cold Check and Hot Check. Record any abnormal level on your *"Maintenance Records".*

Always check the oil level reading at least twice when the engine is running. Consistency is important in maintaining the accuracy of the reading. If inconsistent readings persist, check the transmission breather to ensure it is clean and free of debris.

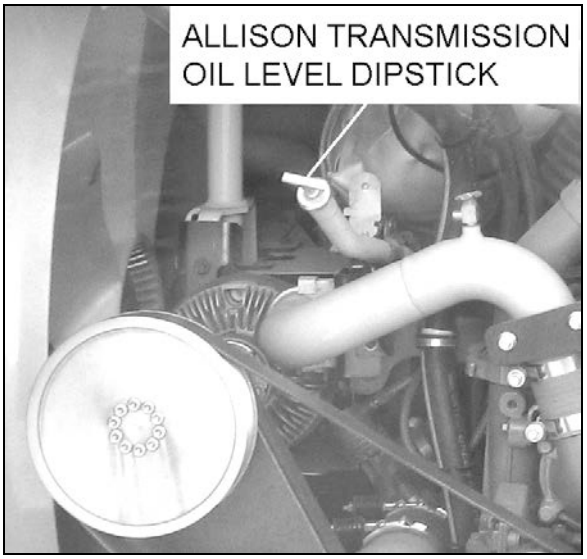

FIGURE 3: OIL LEVEL DIPSTICK (AUTO. TRANS.) 07113

3.1.1 Cold Check

The purpose of the **Cold Check** is to determine if the transmission has enough fluid to be operated safely until a **Hot Check** can be made.

CAUTION

The oil level rises as sump temperature increases. DO NOT fill above the Cold Run band if the transmission oil is below normal operating temperature. During operation, an overfull transmission can become overheated, leading to transmission damage.

1. Move the vehicle to a level surface, put transmission in «N» (Neutral), and set the parking brake.
2. With the engine idling (500 - 800 rpm), shift to «D» (Drive) and then shift to «R» (Reverse) to clear the hydraulic system of air.
3. Run the engine at idle in «N» (Neutral) for about one minute.
4. While the engine is running, remove the dipstick from the tube and wipe it clean (Figure 3). Insert the dipstick into the fill tube, pushing down until it stops.
5. Remove the dipstick and observe the fluid level. Repeat the check procedure to verify the reading. If the fluid on the dipstick is within the COLD CHECK band, the level is satisfactory for operating the transmission until the oil is hot enough to perform a **Hot Check**. If the fluid level **is not** within this

band, add or drain fluid as necessary to bring the level within the COLD CHECK band.

6. Perform a **Hot Check** at the first opportunity after the normal operating temperature of 160ºF to 200ºF (71ºC to 93ºC) is attained.

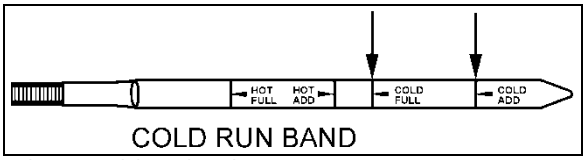

FIGURE 4: COLD CHECK 07050

CAUTION

DO NOT operate the transmission for extended periods of time until a **Hot Check** has verified proper fluid level. Transmission damage can result from extended operation at improper fluid level conditions.

CAUTION

Obtain an accurate fluid level by imposing the following conditions:

- Engine is idling (500-800 rpm) in «N» (Neutral).
- Transmission fluid is at normal operating temperature.
- The vehicle is on a level surface.

3.1.2 Hot Check

To perform a **Hot Check**, do the following:

1. The **Hot Check** can be performed when the transmission oil reaches the normal operating temperature (160ºF to 200ºF / 71ºC to 93ºC). The transmission oil temperature can be checked with the Driver Information Display (DID) when selecting the Gauge menu (refer to the ''Operator's Manual'' for added information).

CAUTION

The oil **must be hot** to obtain an accurate check because the fluid level rises as temperature increases.

2. Park the vehicle on a level surface and shift to «N» (Neutral). Apply the parking brake and allow the engine to idle (500 - 800 rpm).
3. Remove the dipstick from the tube and wipe it clean. Insert the dipstick into the fill tube, pushing down until it stops.
4. Remove the dipstick and observe the fluid level. The safe operating level is anywhere within the HOT RUN band on the dipstick. Repeat the check procedure to verify the reading.
5. If the level **is not** within this band, add or drain fluid as necessary to bring the level within the HOT RUN band.
6. Be sure fluid level checks are consistent. Check level more than once and if readings are not consistent, check to be sure the transmission breather is clean and not clogged. If readings are still not consistent, contact your nearest Allison dealer or distributor.

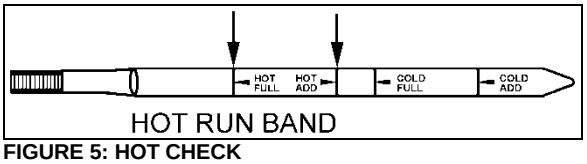

FIGURE 5: HOT CHECK

NOTE

The Cold Check is more appropriate for verifying the oil level after the first fill-up. In case of conflict, the Hot Check has priority over the Cold Check; ***the fluid level check using the pushbutton shift selector has priority over the Hot Check.***

3.2 FLUID LEVEL CHECK USING THE PUSHBUTTON SHIFT SELECTOR

The oil level sensor (OLS) is standard in your transmission. With the OLS and Allison 5th generation shift selector, you can get a more accurate electronic fluid level check than with a dipstick.

Oil level codes are obtained as follows:

1. Park vehicle on a level surface, select «N» (neutral) on the pushbutton shift selector and apply parking brake.
2. Wait for at least 2 minutes to allow the oil to settle;
3. Press simultaneously the ▲ (Upshift) and ▼ (Downshift) arrow buttons once.
4. Oil level codes are displayed once the following parameters are met :

- **The vehicle has been stationary for approximately 2 minutes to allow the oil to settle;**
- **Engine at idle;**
- **Oil at normal operating temperature, between 104°F (40°C) and 220°F (104°C);**
- **Transmission in «N» (Neutral);**
- **Transmission output shaft stopped;**
- **Oil level sensor present and working.**

5. Correct fluid level is displayed as shown.

6. Low fluid level is displayed as shown. The number indicates the number of quarts of fluid the transmission requires.

7. High fluid level condition with the number of quarts in excess is displayed as shown.

NOTE
Confirm a low fluid level condition by making a manual fluid level check.

8. To exit the Oil Level Display Mode, press any range button «R», «N» or «D» at any time.

NOTE
Note that the quantities LO 4 and HI 3 are the largest values displayed and that the actual variation in oil level may exceed these numbers.

If the fluid level check cannot be completed, an Invalid for Display fault is reported. Refer to table below to review the codes and conditions.

CODE	CAUSE OF FAULT CODE
SETTLING OK	Settling time too short
ENG RPM TOO LOW	Engine speed (rpm) too low
ENG RPM TOO HIGH	Engine speed (rpm) too high
MUST BE IN NEU	N (Neutral) must be selected
OIL TEMP TOO LOW	Sump fluid temperature too low
OIL TEMP TOO HIGH	Sump fluid temperature too high
VEH SPD TOO HI	Output shaft speed
SENSOR FAILED	Sensor failure

3.3 RECOMMENDED AUTOMATIC TRANSMISSION FLUID

Only use fluids meeting Allison Transmission specification TES295 or TES389 in your transmission. Refer to TES295 or TES389 Approved Fluids list, found under the Service/Fluids heading on the home page of the Allison Transmission web site **www.allisontransmission.com.**

Allison Transmission recommends you take the following into consideration when selecting the appropriate fluid type for your transmission:

- Fluids meeting specification TES295 are preferred over TES389 fluids for use in all 4000 Product Families transmission applications.
- TES295 fluids are fully qualified for Severe Duty and Extended Drain intervals.
- A TES295 fluid allows you to operate at a lower ambient temperature than a TES389 type fluid.
- TES389 fluid is the minimum fluid requirement approved for use in 4000 Product Families transmissions.
- To extend the TES389 fluid drain intervals beyond the recommended mileage or hours change interval, use a fluid analysis program.

When choosing a fluid type to use, consider what the minimum fluid operating temperature of the fluid will be based on the ambient temperatures reached in the geographical location for the vehicle.

Transmission Fluid Operating Temperature Requirements

Fluid type	Minimum operating temperature	
	Celsius	Fahrenheit
TES295	-35	-31
TES389	-25	-13

CAUTION

Disregarding minimum fluid temperature limits can result in transmission malfunction or reduced transmission life.

NOTE

The use of an arctic preheat kit is recommended at temperatures below -25ºF (-32ºC). If a preheat kit is not available, the TCM will restrict full operation until the sump temperature is increased.

3.3.1 Importance of Proper Fluid Level

It is important that the proper fluid level be maintained at all times because the transmission fluid cools, lubricates, and transmits hydraulic power. If the fluid level is too low, the converter and clutches do not receive an adequate supply of fluid. If fluid level is too high, the fluid can aerate, causing the transmission to shift erratically or overheat.

3.3.2 Keeping Fluid Clean

Oil must be handled in clean containers, fillers, etc., to prevent foreign material from entering the transmission. Place the dipstick on a clean surface area while filling the transmission.

CAUTION

Containers or fillers that have been used to handle antifreeze or engine coolant must NEVER be used for handling transmission fluid. Antifreeze and coolant solutions contain ethylene glycol that, if introduced into the

transmission, can cause the clutch plates to fail.

3.3.3 Oil Contamination

At each oil change, examine the drained oil for evidence of dirt or water. A nominal amount of condensation will emulsify during operation of the transmission. However, if there is evidence of water; check the cooler (heat exchanger) for other signs of leakage. This, however, may also indicate leakage from the engine oil system.

3.3.4 Metal Particles

Metal particles in the oil (except for minute particles normally trapped in the oil filter) indicate damage has occurred in the transmission. When these particles are found in the sump, the transmission must be disassembled and closely inspected to find the source. Metal contamination will require complete disassembly of the transmission and cleaning of all internal and external circuits, coolers, and all other areas where the particles could lodge.

CAUTION

If excessive metal contamination has occurred, replacement of the oil cooler and replacement of all bearings within the transmission is recommended.

3.3.5 Coolant Leakage

If engine coolant leaks into the transmission oil system, immediate action must be taken to prevent malfunction and possible serious damage. The transmission must be completely disassembled, inspected, and cleaned. All traces of the coolant contamination must be removed. Friction clutch plates contaminated with ethylene glycol must be replaced.

3.4 ALLISON RECOMMENDED OIL AND FILTER CHANGE INTERVAL

TABLE 1

Allison Transmission Recommended Fluid And Filter Change Intervals (Prognostics Mode Disabled) Using TES389 or Mixture					
Severe vocation[3] Coaches or MTH equipped with retarder			**General vocation[4] Coaches or MTH without retarder**		
Fluid	**Filters**		**Fluid**	**Filters**	
	Main & Lube	**Internal**		**Main & Lube**	**Internal**
Whichever is the first of the following: 12,000 Miles (20 000 km) 6 Months/ 500hrs *Note: always replace main and lube filters with the fluid change*	Whichever is the first of the following: 12,000 Miles (20 000 km) 6 Months/ 500hrs *Note: always replace main and lube filters with the fluid change*	Overhaul	Whichever is the first of the following: 25,000 Miles 40 000 km 12 Months/ 1000hrs *Note: always replace main and lube filters with the fluid change*	Whichever is the first of the following: 25,000 Miles 40 000 km 12 Months/ 1000hrs *Note: always replace main and lube filters with the fluid change*	Overhaul

TABLE 2

Allison Transmission Recommended Fluid And Filter Change Intervals[1] (Prognostics Mode Disabled) Using 100% TranSynd or TES295 Approved Fluid[2]					
Severe vocation[3] Coaches or MTH equipped with retarder			**General vocation[4] Coaches or MTH without retarder**		
Fluid	**Filters**		**Fluid**	**Filters**	
	Main & Lube	**Internal**		**Main & Lube**	**Internal**
Whichever is the first of the following: 150,000 Miles (240 000 km) 48 Months/ 6000hrs *Note: always replace main and lube filters with the fluid change*	Whichever is the first of the following: 75,000 Miles (120 000 km) 36 Months/ 3000hrs *Note: always replace main and lube filters with the fluid change*	Overhaul	Whichever is the first of the following: 300,000 Miles (480 000 km) 48 Months 6000hrs *Note: always replace main and lube filters with the fluid change*	Whichever is the first of the following: 75,000 Miles (120 000 km) 36 Months 3000hrs *Note: always replace main and lube filters with the fluid change*	Overhaul

[1] Extended TrandSyndTES295 fluid and filter change intervals are only allowed with Allison High-Capacity filters.

[2] Less than 100% concentration of TranSynd or TES295 approved fluid is considered a mixture and should utilize TES389 change intervals. If the customer replaces non-TranSynd or non-TES295 fluid with TranSynd or TES295 equivalent, the change interval recommendations of TES389 or mixture must be followed. Upon the next oil change, if the customer reinstall TranSynd or TES295 equivalent, the fluid & filter change recommendation outlined in 100% TES295 approved fluids must be followed.

[3] Severe vocation= All retarder, On/Off highway, transit and intercity coach with duty cycle greater than one (1) stop per mile.

[4] General vocation= intercity coach with duty cycle less than or equal to one (1) stop per mile and all other vocations not listed in severe vocation.

3.4.1 Oil and Filter Change Interval

Allison transmissions are factory fill with **Castrol TranSynd** fluid. Oil change must be performed with the vehicle on a flat and level surface and with parking brake applied. Oil and filter change frequency is determined by the severity of service and operating conditions of the transmission and by the filter equipment installed. See *"TABLE 1 or TABLE 2"* for oil and filter change intervals. More frequent changes may be required when operations are subject to high levels of contamination or overheating. Filters must be changed at or before recommended intervals.

IMPORTANT NOTE
*Your transmission is equipped with **High Capacity filters**. High Capacity filters allow for increased fluid and filter change intervals in transmissions utilizing TES295 approved fluid or TranSynd. High Capacity filters eliminate the requirement of the initial 5000 miles (8000km) main filter change.*

IMPORTANT NOTE
Allison Transmission recommends that customers use fluid analysis as the primary method for determining fluid change intervals. Many customers have a systematical annual transmission fluid change while, in many cases, fluid analysis could demonstrate that the transmission fluid is still in good condition and a fluid change is not required. In the absence of a fluid analysis program, the fluid change interval listed in TABLE 1 & TABLE 2 should be used.

IMPORTANT NOTE
A mixture of TES295 and TES389 fluid must continue to use the TES389 fluid change intervals, until two fluid changes with only TES295 fluid have occurred, at which time the TES295 schedule may be used.

3.5 FLUID AND FILTER CHANGE PROCEDURE

3.5.1 Drain

1. The transmission should be at an operating temperature of 160ºF (71ºC) to 200ºF (93ºC) when the oil is drained. This will ensure quicker and more complete fluid drainage.
2. Remove the drain plug from under the transmission (Figure 6) and allow the oil to drain into a suitable container. Check the condition of the oil as described previously.
3. Remove twelve bolts (item 1), two filter covers (item 2), two gaskets (item 3), two O-rings (item 4), two O-rings (item 5) and the two filters (item 6) from the bottom of the control module (Figure 6).
4. When reinstalling parts, lubricate and install new O-rings (4) and (5) on each cover (2). Lubricate O-ring inside filter (6) and push filter onto cover (2). Install new gaskets (3) on cover (2) and align holes in gaskets with holes in cover.

CAUTION
Do not use bolts to draw the cover to sump. This can damage the cover, seal, or sump.

5. Install filter and cover assemblies into the filter compartment. Align each filter/cover assembly with the holes in the channel plate/sump. Push the cover assemblies in by hand to seat the seals.
6. Install twelve bolts and both covers, and then tighten to 38-45 Ft-lbs (51-61 Nm).
7. Inspect the drain plug and O-ring. Replace if necessary. Reinstall the drain plug and tighten to 18-24 Ft-lbs (25-32 Nm).

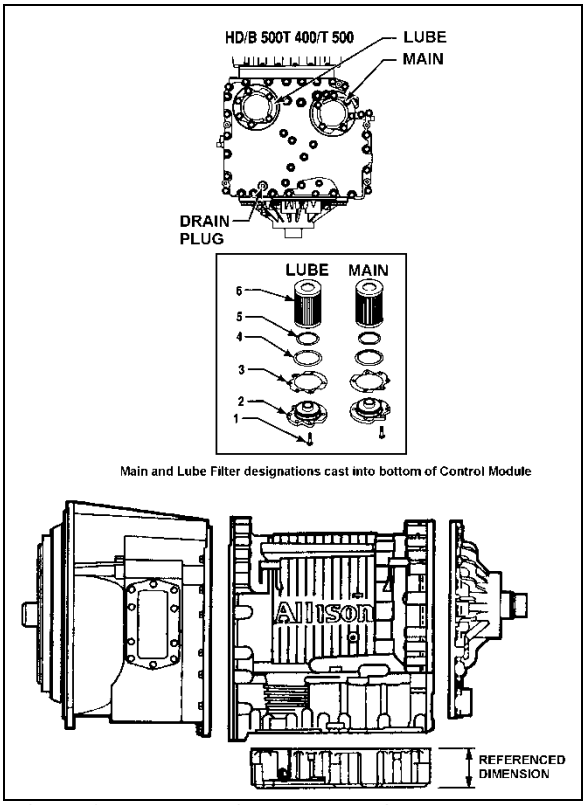

FIGURE 6: DRAIN PLUG AND FILTERS 07052

Fluid loss with filter change only

When changing main and lube filters at recommended intervals, approximate fluid loss for each filter as follows:

Main filter = 2 quarts (1.9 liters)
Lube filter =8 quarts (7.6 liters)

3.5.2 Refill transmission

The amount of refill fluid is less than the amount used for the initial fill. Fluid remains in the external circuits and transmission cavities after draining the transmission.

NOTE
Quantities listed below are approximations and do not include external oil cooler lines.

Using the oil level dipstick filler tube, refill with 24 US qts (23 liters), 28 US qts (26.5 liters) if equipped with retarder, and check the oil level using the **Fluid Level Check Using Pushbutton Shift Selector** procedure in this section. Add transmission fluid according to pushbutton shit selector fluid level check.

3.6 CLEANING AND INSPECTION OF ALLISON AUTOMATIC TRANSMISSION

The exterior of the transmission should be cleaned and inspected at regular intervals. The length of service and severity of operating conditions will determine the frequency of such inspections. Inspect the transmission for:

1. Loosen bolts (transmission and mounting components);
2. Oil leaks (correct immediately);
3. Loose, dirty, or improperly adjusted throttle sensor linkage;
4. Damaged or loose oil lines;
5. Worn or frayed electrical harnesses, improper routing;
6. Worn or out of phase drive line U-joint and slip fittings.

CAUTION
DO NOT pressure wash the transmission electrical connectors. Water and detergent will cause the contacts to corrode or become faulty.

3.6.1 Breather

The breather is located on the engine, flywheel side near the valve cover. It serves to prevent pressure build-up within the transmission and must be cleaned to keep the passage opened. The prevalence of dust and dirt will determine the frequency at which the breather requires cleaning. Use care when cleaning the engine. Spraying steam, water or cleaning solution directly at the breather can force the water or solution into the transmission. Always use care when removing the hose connector from transmission to prevent the entry of foreign matter.

4. TRANSMISSION OIL COOLER REMOVAL

4.1 TRANSMISSION WITHOUT RETARDER

Stop engine and allow engine to cool. Close both heater line shutoff valves (refer to Section 05 *''Cooling''*).

To drain the cooling system, proceed as per Section 05 *''Cooling''*, paragraph 5: Draining. If the cooling system is contaminated, flush

system as per Section 05 *''Cooling''*, paragraph 7: Flushing.

1. Remove the rear L.H. side tag axle wheel, then remove the rear L.H. side fender panel.
2. Disconnect the two transmission hoses from oil cooler. Cover hose ends and fittings to prevent fluid contamination (Figure 7).

WARNING

A significant amount of oil may drain from oil lines when they are disconnected.

3. Unfasten the constant-torque hose clamps and remove the two hoses.
4. Unscrew the four holding nuts and remove the U-bolts, remove the oil cooler from engine compartment.
5. Reinstall transmission oil cooler by using reverse procedure.

4.2 TRANSMISSION WITH RETARDER

Stop engine and allow engine to cool. Close both heater line shutoff valves (refer to Section 05 *''Cooling''*).

1. To drain the cooling system, proceed as per Section 05 *''Cooling''*, paragraph 5: Draining. If the cooling system is contaminated, flush system as per Section 05 *''Cooling''*, paragraph 7: Flushing.
2. Remove the rear L.H. side tag axle wheel, then remove the rear L.H. side fender panel.
3. Disconnect the transmission hoses from oil cooler. Cover hose ends and fittings to prevent fluid contamination.

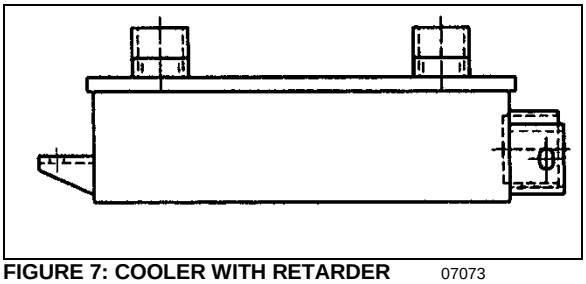

FIGURE 7: COOLER WITH RETARDER 07073

WARNING

A significant amount of oil may drain from oil lines when they are disconnected.

4. Unfasten the constant-torque hose clamps and remove the two hoses.
5. Unscrew the holding bolts and nuts and remove the oil cooler from engine compartment.

5. ALLISON TRANSMISSION INSTALLATION

1. Place the transmission on a transmission jack.
2. Install a headless guide bolt into one of the 12 threaded holes for flexible plate attaching screws in the flywheel.

NOTE

For more clearance between the tag axle and transmission, the tag axle may be unloaded and jacked up, or retracted (if applicable).

With the starter motor removed, align one of the 12 attaching screw holes in the flexible plate with the access opening.

3. Lubricate the flywheel center pilot boss with molybdenum disulfide grease (Molycote G, or equivalent).
4. Raise transmission and position the flywheel pilot boss into the flexible plate adapter. Align the guide bolt previously installed in the flywheel with the flexible plate hole facing the access opening in the flywheel housing.

WARNING

Severe damages and/or personal injury can occur if transmission is not adequately supported.

5. Seat the transmission against the engine flywheel housing. NO FORCE IS REQUIRED. If interference is encountered, move the transmission away from engine, then investigate the cause.

CAUTION

The torque converter housing must be seated against the flywheel housing prior to tightening any screws. DO NOT USE SCREWS TO SEAT THE HOUSING.

6. Start all torque converter housing screws, and then tighten four of them gradually and in a criss-cross sequence around the housing. Tighten the 12 remaining screws.

Recommended torque is between 42-50 Lbf-ft (57-68 Nm).

7. Remove the guide bolt through the access opening in the flywheel housing. Replace it with a self-locking screw, finger-tighten then start the remaining screws; tighten to 17-21 lbf-ft (23-28 Nm). Place a wrench on the crankshaft pulley attaching screw to turn the converter to gain access to the threaded holes.

NOTE

Remove the plug located below starter motor and install cranking tool (88800014). Crank the engine to gain access to the threaded holes by turning the cranking tool using a suitable adapter.

Reinstall starter motor and connect cables.

Reinstall access plug below starter motor.

8. Remove jack from under transmission.
9. Connect all sensors.
10. Connect the main wiring harness.
11. Connect the air supply line (steel-braided hose) to the retarder control valve (if applicable).
12. Connect the two transmission oil cooler hoses as they were previously.
13. Reinstall clamps and brackets, and replace locking ties previously removed during removal procedure.
14. Install propeller shaft and its safety guard. Refer to Section 09, *"PROPELLER SHAFT".*
15. Install transmission dipstick and filler tube.
16. Install cross member under transmission.
17. Install engine splash guards.
18. Adjust the retarder pressure to 80 ± 3 psi with the air pressure regulator. For more information refer to Section 12, *"BRAKE AND AIR SYSTEM*", under heading *"AIR PRESSURE REGULATOR".* The air pressure regulator is located at back of engine compartment, on R.H. side (Figure 8) or in the R.H. side rear service compartment.
19. Make sure that the drain plug is in place, and then remove the transmission dipstick and pour approximately 24 US quarts (23 L) of automatic transmission fluid through the filler tube. Check and adjust oil level.

CAUTION

Do not overfill the transmission. Overfilling can cause oil aeration (milky appearance) and overheating. If overfilling occurs, drain oil as required to bring it to the proper level.

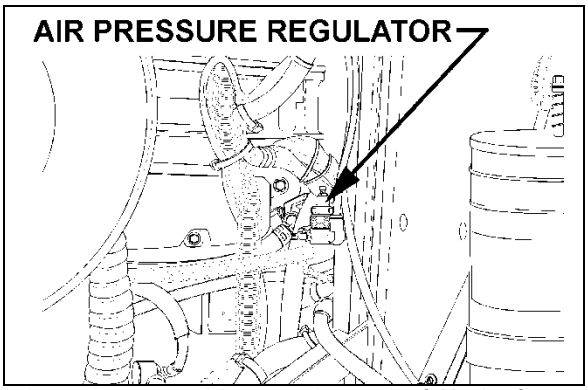

FIGURE 8: AIR PRESSURE REGULATOR (TYPICAL) 07037

6. ALLISON TRANSMISSION TROUBLESHOOTING

The Allison transmission has a new Transmission Control Module (TCM) which involves specific diagnostic incident codes. The TCM unit is located in the coach main power compartment.

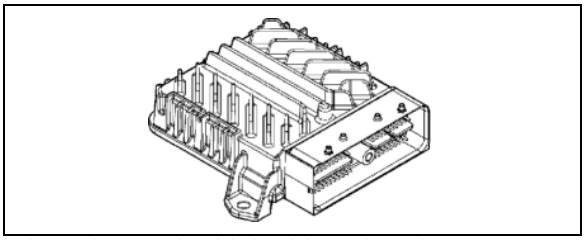

FIGURE 9: TRANSMISSION CONTROL MODULE 07140

TCM Replacement

The TCM is a non-serviceable electronic device. When it fails, it must be replaced using the following procedure:

- Open the coach main power compartment in order to get access to the TCM;
- Remove the electrical cable connectors;
- Unscrew the TCM unit;
- Replace by reversing the procedure.

CAUTION

Place the battery master switch to the ''OFF'' position.

6.1 DIAGNOSTIC TROUBLESHOOTING CODES (DTC) — ALLISON 5TH GENERATION CONTROLS

Diagnostic features are provided with the transmission control system to assist in troubleshooting of malfunctions and/or the monitoring of specific operating parameters. When a control system malfunction is detected, a series of Diagnostic Trouble Codes (DTCs) are used to identify and clarify the nature of the malfunction. These DTCs are each named by a 5 character alphanumeric string that refers to a diagnostic algorithm running pass/fail tests to help identify a malfunction in the transmission or vehicle operation. Most DTCs have some kind of diagnostic response that the operator notices, such as an illuminated CHECK light, selector display change, lock in range, or inhibit shifts condition.

DTCs are logged in the Transmission Control Module (TCM) memory by severity and by their active/inactive status with the most severe and active codes listed first. A maximum of five DTCs (numbered d1- d5) from most recent to oldest may be read from the shift selector. As DTCs are added, the oldest inactive DTC (historic) is dropped from the list. If all DTCs are active, the DTC with the lowest priority is dropped from the list.

An active code is any code that is current in the TCM decision-making process and has failed the DTC test(s) associated with that specific diagnostic algorithm. Historical codes, which are by definition inactive, are codes that are no longer failing their algorithm but are retained in the TCM in order to help the technician analyze possible causes and provide them direction if the vehicle is brought in before they are cleared from the queue.

DTCs can be cleared manually by the operator or they clear automatically from last (d5) to first (d1) in the queue after a number of engine starts, without becoming active again.

6.1.1 Using Shift Selector for Accessing Diagnostics Information

DTCs can be displayed on the display portion of the shift selector. A DTC is either active or historic. An active DTC is a DTC that is current in the TCM decision-making process. Historic DTCs are retained in the TCM memory and do not necessarily affect the TCM decision-making process.

6.1.2 Display Sequence

Up to five DTCs may be displayed one at a time from the selector once the diagnostic display mode has been initiated by the operator. Each DTC is 5 characters in length. The DTC status active or inactive is shown below the DTC.

Shows active DTC P0730

The operator presses the MODE button to read the next OTC in the queue (if any) or requests to exit diagnostics mode. The diagnostics mode times out and returns the selector to normal operating mode after approximately 10 minutes of operator inactivity.

6.1.3 Diagnostic Code Display and Clearing Procedure

Diagnostic codes can be read and cleared by two methods:

- Using an Allison DOC™ diagnostic tool. For specific instructions on how to use an Allison DOC™ diagnostic tool, refer to the User Guide.
- Using the pushbutton shift selector.

To begin the diagnostic process:

1. Bring the vehicle to a stop at a safe location.
2. Apply the parking brake.

To display stored codes:

1. Simultaneously press the ▲ (Upshift) and ▼ (Downshift) arrow buttons five times (Prognostics enabled) to access the Diagnostic Display Mode. With Prognostics disabled, press the ▲ (Upshift) and ▼ (Downshift) arrow buttons twice.
2. Press the MODE button to read the next code in the queue, if any.

To clear all active stored codes:

While in Diagnostic Mode, clear all active codes by pressing and holding the MODE button for approximately three seconds until the MODE message flashes. Release the MODE button. The MODE message should not remain illuminated if the active DTC shown in the display has cleared.

While in Diagnostic Mode, press and hold the MODE button for 10 seconds to clear both active

codes and inactive codes. The MODE message flashes a second time indicating all codes are cleared from the queue.

6.1.4 Exiting Diagnostic Mode

Exit the diagnostic mode by one of the following methods:

1. Press simultaneously the ▲ (Upshift) and ▼ (Downshift) arrow buttons at the same time on the pushbutton shift selector.
2. Press any range button «D», «N» or «R» on the pushbutton shift selector.
3. After approximately 10 minutes of inactivity at the pushbutton shift selector, the diagnostic mode automatically exits and returns to normal operating mode.
4. Turn off power to the TCM (shut off the engine using the ignition key).

NOTE
Be sure to record all codes displayed before they are cleared. This is essential for troubleshooting.

NOTE
If clearing a code while locked in a «D» (Drive) or «R» (Reverse) position (fail-to-range), the transmission will still be in «D» (Drive) or «R» (Reverse) when the clearing procedure is completed. «N» (Neutral) must be manually selected.

6.1.5 Diagnostic Trouble Code Response

The electronic control system is programmed to inform the operator of a problem with the transmission system via the CHECK light and shift selector display while it automatically takes action to protect the operator, vehicle, and transmission. When the Transmission Control Module (TCM) flags a Diagnostic Trouble Code (DTC) as active, the TCM may take a combination of diagnostic responses as listed in the following table.

6.2 DIAGNOSTIC TROUBLESHOOTING CODES (DTC) LIST - ALLISON 5TH GENERATION CONTROLS

DTC	Description	CHECK Light	Inhibited Operation Description
C1312	Retarder Request Sensor Failed Low	No	May inhibit retarder operation if not using J1939 datalink
C1313	Retarder Request Sensor Failed High	No	May inhibit retarder operation if not using J1939 datalink
P0122	Pedal Position Sensor Circuit Low Voltage	No	Use default throttle values. Freezes shift adapts.
P0123	Pedal Position Sensor Circuit High Voltage	No	Use default throttle values. Freezes shift adapts.
P0218	Transmission Fluid Over Temperature	Yes	Use default sump temp
P0562	System Voltage Low	No	Inhibit TCC Operation, DNA
P0602	TCM Not Programmed	Yes	Lock in Neutral
P0604	Control module random access memory (RAM)	Yes	Lock in Neutral
P0614	Torque Control Data Mismatch - ECM/TCM	Yes	Allows operation only in reverse and second range.
P0634	TCM Internal Temperature Too High	Yes	SOL OFF (hydraulic default)
P0642	Sensor Reference Voltage "A" Circuit Low	Yes	Default sensor data used
P0643	Sensor Reference Voltage "A" Circuit High	Yes	Default sensor data used
P0657	Actuator Supply Circuit Voltage 1 Open (HSD 1)	Yes	SOL OFF, DNA, Inhibit TCC operation, Inhibit main modulation
P0658	Actuator Supply Voltage 1 (HSD1) Low	Yes	DNS, SOL OFF (hydraulic default)
P0659	Actuator Supply Voltage 1 (HSD1) High	Yes	DNS, SOL OFF (hydraulic default)
P0703	Brake Switch Circuit Malfunction	No	No Neutral to Drive shifts for refuse packer. TCM inhibits retarder operation if a TPS code is also active.
P0708	Transmission Range Sensor Circuit High Input	Yes	Ignore defective strip selector inputs
P070C	Transmission Fluid Level Sensor Circuit – Low Input	No	None
P070D	Transmission Fluid Level Sensor Circuit – High Input	No	None
P0712	Transmission Fluid Temperature Sensor Circuit Low Input	Yes	Use default sump temp
P0713	Transmission Fluid Temperature Sensor Circuit High Input	Yes	Use default sump temp
P0715	Turbine Shaft Speed Sensor Circuit	Yes	DNS, Lock in current range
P0716	Turbine Shaft Speed Sensor Circuit Performance	Yes	DNS, Lock in current range
P0717	Turbine Shaft Speed Sensor Circuit No Signal	Yes	DNS, Lock in current range
P071A	RELS Input Failed On	Yes	Inhibit RELS operation
P071D	General Purpose Input Fault	Yes	None
P0720	Output Shaft Speed Sensor Circuit	Yes	DNS, Lock in current range
P0721	Output Shaft Speed Sensor Circuit Performance	Yes	DNS, Lock in current range
P0722	Output Speed Sensor Circuit No Signal	Yes	DNS, Lock in current range
P0725	Engine Speed Sensor Circuit	No	Default to turbine speed
P0726	Engine Speed Sensor Circuit Performance	No	Default to turbine speed
P0727	Engine Speed Sensor Circuit No Signal	No	Default to turbine speed
P0729	Incorrect 6th Gear Ratio	Yes	DNS, Attempt 5th, then 3rd
P0731	Incorrect 1st Gear ratio	Yes	DNS, Attempt 2nd, then 5th
P0732	Incorrect 2nd Gear ratio	Yes	DNS, Attempt 3rd, then 5th
P0733	Incorrect 3rd Gear ratio	Yes	DNS, Attempt 4th, then 6th
P0734	Incorrect 4th Gear ratio	Yes	DNS, Attempt 5th, then 3rd
P0735	Incorrect 5th Gear ratio	Yes	DNS, Attempt 6th, then 3rd, then 2nd
P0736	Incorrect Reverse Gear ratio	Yes	DNS, Lock in Neutral
P0741	Torque Converter Clutch System Stuck Off	Yes	None
P0752	Shift Solenoid 1 Valve Performance-Stuck On	Yes	DNS
P0776	Pressure Control Solenoid (PCS) 2 Stuck Off	Yes	DNS, RPR
P0777	Pressure Control Solenoid 2 Stuck On	Yes	DNS, RPR
P0796	Pressure Control Solenoid 3 Stuck Off	Yes	DNS, RPR
P0797	Pressure Control Solenoid 3 Stuck On	Yes	DNS, RPR
P0842	Transmission Fluid Pressure Switch 1 Circuit Low	Yes	DNS, Lock in current range

DTC	Description	CHECK Light	Inhibited Operation Description
P0843	Transmission Fluid Pressure Switch 1 Circuit High	Yes	DNS, Lock in current range
P0847	Transmission Fluid Pressure Switch 2 Circuit Low	Yes	None
P0848	Transmission Fluid Pressure Switch 2 Circuit High	Yes	None
P088A	Transmission Fluid Filter Maintenance Alert	No	None
P088B	Transmission Fluid Filter Maintenance Required	No	None
P0880	TCM Power Input Signal	No	None
P0881	TCM Power Input Signal Performance	No	None
P0882	TCM Power Input Signal Low	Yes	DNS, SOL OFF (hydraulic default)
P0883	TCM Power Input Signal High	No	None
P0894	Unexpected Mechanical Gear Disengagement	Yes	DNS, Lock in first
P0897	Transmission Fluid Deteriorated	No	None
P0960	Main Pressure Modulator Solenoid Control Circuit Open	Yes	None
P0962	Main Pressure Modulator Solenoid Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P0963	Main Pressure Modulator Solenoid Control Circuit High	Yes	None
P0964	Pressure Control Solenoid 2 (PCS2) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P0966	Pressure Control Solenoid 2 (PCS2) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P0967	Pressure Control Solenoid 2 (PCS2) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P0968	Pressure Control Solenoid 3 (PCS3) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P0970	Pressure Control Solenoid 3 (PCS3) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P0971	Pressure Control Solenoid 3 (PCS3) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P0973	Shift Solenoid 1 (SS1) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P0974	Shift Solenoid 1 (SS1) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P0976	Shift Solenoid 2 (SS2) Control Circuit Low	Yes	7-speed: Allow 2 through 6, N, R Inhibit TCC operation
P0977	Shift Solenoid 2 (SS2) Control Circuit High	Yes	7-speed: Allow 2 through 6, N, R
P097A	Shift Solenoid 1 (SS1) Control Circuit Open	Yes	Lock in range
P097B	Shift Solenoid 2 (SS2) Control Circuit Open	Yes	7-speed: Allow 2 through 6, N, R
P0989	Retarder Pressure Sensor Circuit Low	No	None
P0990	Retarder Pressure Sensor Circuit High	No	None
P1739	Incorrect Low Gear Ratio	Yes	Command 2nd and allow shifts 2 through 6, N, R
P1790	Gear Shift Module 1 Calibrated Invalid	Yes	Shift selector language or units incorrect
P1791	Gear Shift Module 2 Calibrated Invalid	Yes	Shift selector language or units incorrect
P1891	Throttle Position Sensor PWM Signal Low	No	Use default throttle values
P1892	Throttle Position Sensor PWM Signal High	No	Use default throttle values
P2184	Engine Coolant Temperature Sensor 2 Circuit Low Input	No	Use default engine coolant values
P2185	Engine Coolant Temperature Sensor 2 Circuit High Input	No	Use default engine coolant values
P2637	Torque Management Feedback Signal (A)	Yes	Inhibit SEM
P2641	Torque Management Feedback Signal (B)	Yes	Inhibit LRTP
P2669	Actuator Supply Circuit Voltage 2 Open (HSD2)	Yes	SOL OFF, Inhibit TCC operation, Inhibit Main modulation, ONA
P2670	Actuator Supply Voltage 2 (HSD2) Low	Yes	DNS, SOL OFF (hydraulic default)
P2671	Actuator Supply Voltage 2 (HSD2) High	Yes	DNS, SOL OFF (hydraulic default)
P2684	Actuator Supply Circuit Voltage 3 Open (HSD3)	Yes	SOL OFF, Inhibit TCC operation, Inhibit Main modulation, ONA
P2685	Actuator Supply Voltage 3 (HSD3) Low	Yes	DNS, SOL OFF (hydraulic default)
P2686	Actuator Supply Voltage 3 (HSD3) High	Yes	DNS, SOL OFF (hydraulic default)
P2714	Pressure Control Solenoid 4 (PCS4) Stuck Off	Yes	DNS, RPR
P2715	Pressure Control Solenoid 4 (PCS4) Stuck On	Yes	DNS, SOL OFF (hydraulic default)
P2718	Pressure Control Solenoid 4 (PCS4) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P2720	Pressure Control Solenoid 4 (PCS4) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P2721	Pressure Control Solenoid 4 (PCS4) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P2723	Pressure Control Solenoid 1 (PCS1) Stuck Off	Yes	DNS, RPR
P2724	Pressure Control Solenoid 1 (PCS1) Stuck On	Yes	DNS, RPR

DTC	Description	CHECK Light	Inhibited Operation Description
P2727	Pressure Control Solenoid 1 (PCS1) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P2729	Pressure Control Solenoid 1 (PCS1) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P2730	Pressure Control Solenoid 1 (PCS1) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P2736	Pressure Control Solenoid 5 (PCS5) Control Circuit Open	Yes	Inhibit retarder operation
P2738	Pressure Control Solenoid 5 (PCS5) Control Circuit Low	Yes	Allow 2 through 6, N, R. Inhibit retarder and TCC operation
P2739	Pressure Control Solenoid 5 (PCS5) Control Circuit High	Yes	Inhibit retarder operation
P273F	Retarder Oil Temperature Sensor Over Temperature Condition	No	None
P2742	Retarder Oil Temperature Sensor Circuit – Low	No	Use default retarder temp values
P2743	Retarder Oil Temperature Sensor Circuit – High	No	Use default retarder temp values
P2761	TCC PCS Control Circuit Open	Yes	Inhibit TCC operation
P2763	TCC PCS Control Circuit High	Yes	Inhibit TCC operation
P2764	TCC PCS Control Circuit Low	Yes	7-speed: Allow 2 through 6, N, R. Inhibit TCC operation
P2789	Transmission Clutch Life Expired (Clutch Adaptive Learning at Limit)	No	None
P2793	Gear Shift Direction Circuit	Yes	Ignores PWM input from shift selector
P2808	Pressure Control Solenoid 6 (PCS6) Stuck Off	Yes	DNS, RPR
P2809	Pressure Control Solenoid 6 (PCS6) Stuck On	Yes	DNS, RPR
P2812	Pressure Control Solenoid 6 (PCS6) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P2814	Pressure Control Solenoid 6 (PCS6) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P2815	Pressure Control Solenoid 6 (PCS6) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
U0073	CAN Communication Bus 1 Off	No	Use default values
U0074	CAN Communication Bus 2 Off	No	Use default values
U0100	Lost Communications with ECM A	Yes	Use default values
U0103	Lost Communication with Gear Shift Module (Shift Selector) 1	Yes	Maintain range selected, observe gear shift direction circuit
U0291	Lost Communication with Gear Shift Module (Shift Selector) 2	Yes	Maintain range selected, observe gear shift direction circuit
U0304	Incompatible Gear Shift Module 1 (Shift Selector)	Yes	Ignore shift selector inputs
U0333	Incompatible Gear Shift Module 2 (Shift Selector)	Yes	Ignore shift selector inputs
U0404	Invalid Data Received From Gear Shift Module (Shift Selector) 1	Yes	Maintain range selected, observe gear shift direction circuit
U0592	Invalid Data Received From Gear Shift Module (Shift Selector) 2	Yes	Maintain range selected, observe gear shift direction circuit

7. SPECIFICATIONS

ALLISON AUTOMATIC TRANSMISSION WITH RETARDER

X3-45
Gross input power (maximum).....500 HP (373 kW)
Gross input torque (maximum).....1525 Lbf-ft- (2068 Nm)
Rated input speed (minimum-maximum).....1600-2300 rpm

Mounting:
Engine.....SAE #1 flywheel housing, flex disk drive

Torque converter:
Type..... One stage, three element, polyphase
Stall torque ratio..... TC 551-1.8
Lockup clutch with torsional damper..... Integral/standard

Gearing:
Type..... Patented, constant mesh, helical, planetary

Ratio:
First.....3.51:1
Second.....1.91:1
Third.....1.43:1
Fourth.....1.00:1
Fifth.....0.74:1
Sixth.....0.64:1
Reverse.....4.80:1

Ratio coverage:
6 speed.....5.48:1

*** Gear ratios do not include torque converter multiplication.**

Oil System:
Oil type.....TRANSYND
Capacity (excluding external circuits)..... Initial fill 47 US qts (45 liters)
Oil change..... 24 US qts (23 liters)
Oil change (with retarder)..... 27.6 US qts (26 liters)

Oil Filters:
Make.....Allison Transmission
Type..... Disposable cartridge

8. SECTION CHANGE LOG

	DESCRIPTION	DATE
1		
2		
3		
4		
5		
6		