Technical Service Information

TSI–06–12–19

This TSI replaces 00–12–05

Date: October, 2006

Subject File: ENGINE

Subject: Air Sensing Viscous Fan Drive Diagnostic Test Procedure

Vendor: BorgWarner

DESCRIPTION

A correctly operating air sensing viscous fan drive may be misdiagnosed as faulty using the procedures previously available. To reduce the number of misdiagnosed viscous fan drives, perform the updated service procedure that follows.

WARNING – To avoid property damage, personal injury, or death, read all safety instructions in the S12002Y service manual regarding use, application, or modification of a viscous fan drive and/or the fan it carries.

WARNING – To avoid property damage, personal injury, or death, DO NOT operate a vehicle with a fan drive or fan blades that are malfunctioning or damaged.

WARNING – To avoid property damage, personal injury, or death, DO NOT attempt to restrict fan blade rotation during engine operation.

DESCRIPTION (CONT.)

WARNING – To avoid property damage, personal injury, or death, comply with the following before performing tests on the fan drive:

- **Shift transmission to park or neutral, set parking brake, and block wheels.**
- **Wear safety glasses with side shields.**
- **Do not wear loose clothing that can come into contact with the rotating fan blades.**
- **Avoid contact with hot surfaces.**
- **Protect test leads from contact with rotating components.**

FOR SNAP ACTION BI-METAL OR COIL VISCOUS FAN DRIVE TEST PROCEDURE (AIR SENSING VISCOUS DRIVES ONLY)

NOTE – This test is most effective at an ambient air temperature of 80°F (26.7°C) or higher.

Diagnostic Procedure

NOTE – The engine must be off for Steps 1 through 8.

1. Check the torque of fan blade fasteners. Refer to Table 1, Torque Chart.

2. Check the torque of fan drive-to-pulley, hub and bracket assembly fasteners.

3. Check the torque of pulley, hub and bracket assembly-to-engine fasteners.

4. Check the fan drive, fan blade assembly, shroud, radiator and the immediately adjacent areas for evidence of interference between rotating and non-rotating parts. If damage is present, isolate and repair the problem and replace damaged parts.

5. Rotate the fan, by hand, through at least 360 degrees. It should turn smoothly, but with some internal resistance. Replace fan drive if it binds, jerks, or spins freely. Insure the fan does not contact other objects.

NOTE – The following step is used to detect looseness in the fan or fan drive mounting; when performing the Step, do not force the blade tip (cause the blade to deflect) because this will distort the resulting measurement.

6. Grasp one fan blade tip, and apply fore and aft pressure. At 10 inches (254 mm) radius from the center, the blade tip should not move more than 1/16 inch (1.6 mm). If the blade moves more than specified and the excess cannot be attributed to pulley/water pump bearing wear, fan blade deflection, or loose fasteners (fan to fan drive or fan drive to hub/pulley), replace the fan drive.

7. Check for obstructions in the radiator, charge air cooler, air conditioning condenser, and transmission cooler (if equipped). Remove any dirt, bugs, lint, or debris in the air path through the radiator to the engine. Pressure wash if necessary.

FOR SNAP ACTION BI-METAL OR COIL VISCOUS FAN DRIVE TEST PROCEDURE (AIR SENSING VISCOUS DRIVES ONLY) (CONT.)

WARNING – To avoid personal injury or death, wear heat protective gloves and safety glasses when working with hot liquids and objects.

CAUTION – To avoid property damage, DO NOT direct high-pressure spray onto the fan drive bi-metal. High-pressure sprays must be directed squarely at the front, or rear, of the radiator and other coolers to prevent fin damage. Bent fin or fin damage will negatively affect air flow and/or cooling capacity of the radiator and other coolers.

8. Ensure the cooling system is properly filled with the correct coolant mixtures (not to exceed 60% ethylene glycol).

NOTE – In the following Step, warming up a cold engine prior to test preparation will shorten the run-time during the test procedure.

9. If engine is cold, start engine and:

- turn air conditioning OFF,
- turn heater OFF (NOTE: on buses, turn heater supply valves OFF at the engine),
- run until thermostat opens; then, **turn engine OFF**.

WARNING – To avoid personal injury or death when working near a hot engine wear protective clothing and heat protective gloves.

NOTE – In the following Step, nylon fan blades (yellow in color) may require painting with flat black paint in order to measure fan speed.

10. Apply a strip of reflective tape to one (1) blade of the fan and another strip to the fan drive shaft so that fan RPM and fan drive shaft RPM can be measured with the digital photo-tachometer (Figure 1).

FOR SNAP ACTION BI-METAL OR COIL VISCOUS FAN DRIVE TEST PROCEDURE (AIR SENSING VISCOUS DRIVES ONLY) (CONT.)

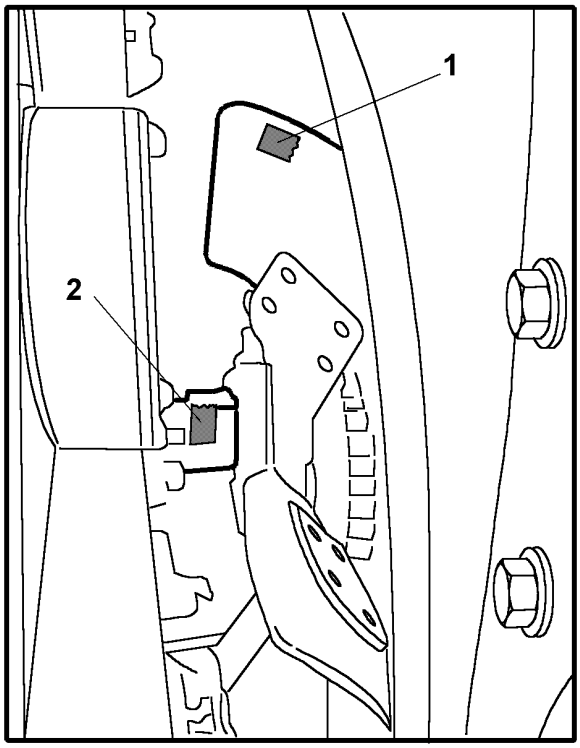

Figure 1 Placement of Reflective Tape

1. Reflective tape on fan blade
2. Reflective tape on fan drive shaft

11. Connect EZ-Tech service tool. If testing a non-electronic engine, measure coolant temperature with an accurate thermometer.

12. Fabricate a cardboard cover that covers the entire frontal area of the radiator. Cut a 5 inch (12.7 cm) hole in the area that aligns directly in front of the fan drive bi-metal switch or coil. Position the cardboard in front of the radiator and tape as necessary to hold in place.

13. Carefully position the temperature probe so that it measures air temperature within 1 inch (2.54 cm) of the fan drive bi-metal or coil. You can safely insert the probe through the A/C condenser, CAC, and radiator core (Figure 2 and Figure 3) .

FOR SNAP ACTION BI-METAL OR COIL VISCOUS FAN DRIVE TEST PROCEDURE (AIR SENSING VISCOUS DRIVES ONLY) (CONT.)

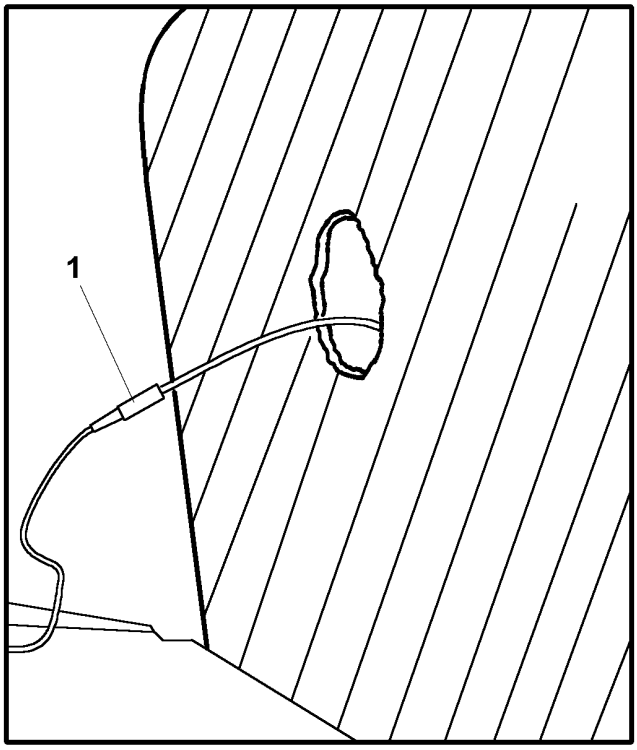

Figure 2 Temperature Probe Inserted through Cardboard and Front of Radiator

1. Temperature probe

FOR SNAP ACTION BI-METAL OR COIL VISCOUS FAN DRIVE TEST PROCEDURE (AIR SENSING VISCOUS DRIVES ONLY) (CONT.)

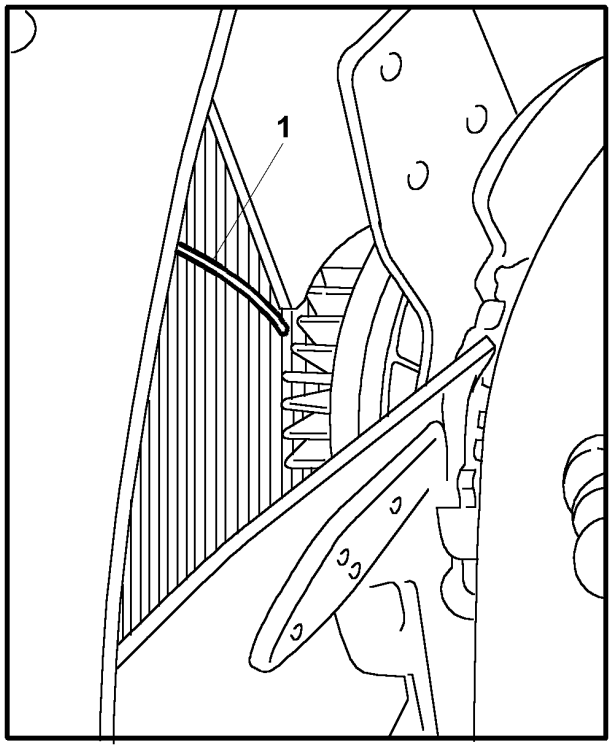

Figure 3 Positioning of Temperature Probe

1. Temperature probe must be positioned in this area [1 inch (2.54 cm) from bi-metal].

14. Start the engine and:

- recheck to ensure the air conditioning and heater are still OFF (on buses, turn heater supply valves OFF),
- turn electrical loads ON (lights, etc.).

NOTE – In the following Step the fan drive shaft speed is not the same as engine speed.

15. Raise the engine speed until the fan drive shaft reaches 2500 RPM (measured with digital photo-tach). Do not measure fan speed yet.

NOTE – Bright sunlight may make it difficult to read RPM measurements using the photo-tachometer.

16. Lock the throttle at this RPM (use PTO/cruise switches if available). This establishes the fan drive shaft **TEST** RPM.

    NOTE – If engine cannot achieve 2500 RPM fan drive shaft input speed, test at the highest obtainable RPM.

17. Measure fan blade speed with the digital photo-tachometer (Figure 4).

FOR SNAP ACTION BI-METAL OR COIL VISCOUS FAN DRIVE TEST PROCEDURE (AIR SENSING VISCOUS DRIVES ONLY) (CONT.)

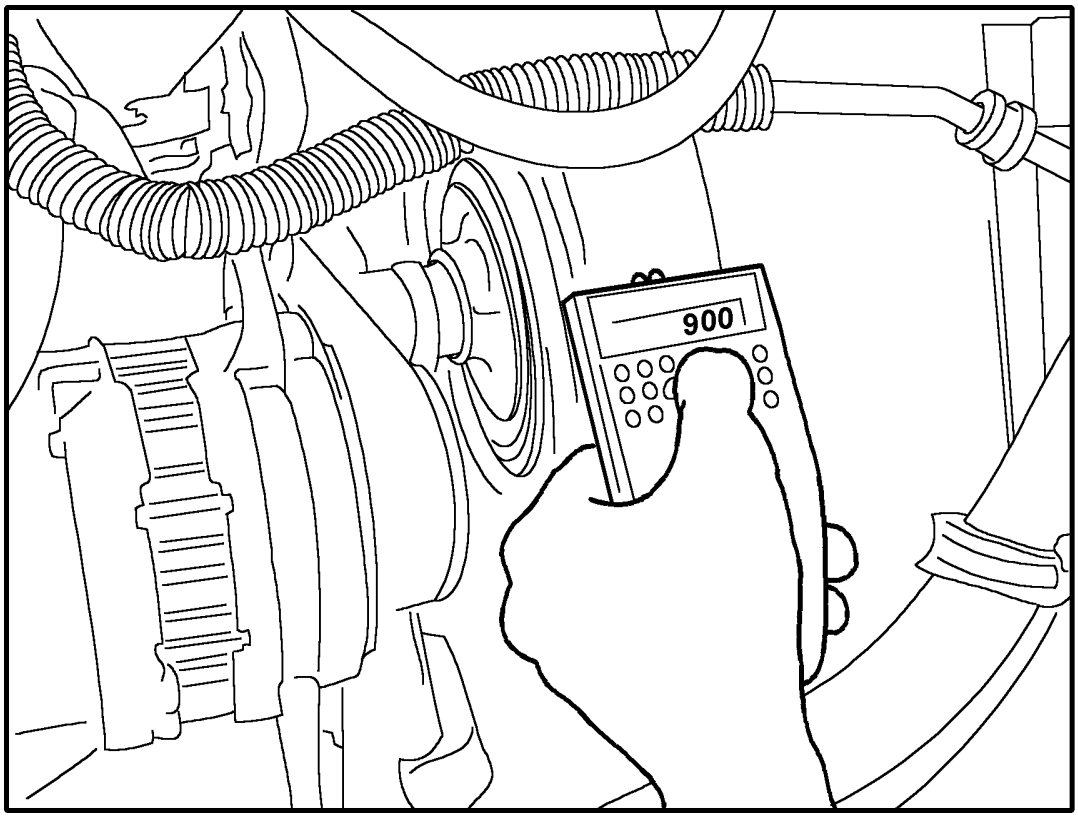

Figure 4 Measuring Fan Blade Speed with Digital Photo-Tachometer

NOTE – If the vehicle is equipped with shutters, they should open automatically before the fan drive engages.

18. As the engine is warming up:

    a. The fan RPM should stabilize between 700 and 1100 RPM. Some DD-30 and DD-34 fan drives may stabilize at up to 1300 RPM.

    b. As engine coolant temperature reaches 200–220°F (93.3–104.4°C)(Figure 5), fan speed should increase to 85% or more of the fan shaft RPM.

    c. The air temperature at the bi-metal or coil should be between 165°F (73.9°C) and 195°F (90.6°C) when the fan engages (Figure 5). Refer to the Borg Warner attachment for specific fan drive P/N calibration information.

FOR SNAP ACTION BI-METAL OR COIL VISCOUS FAN DRIVE TEST PROCEDURE (AIR SENSING VISCOUS DRIVES ONLY) (CONT.)

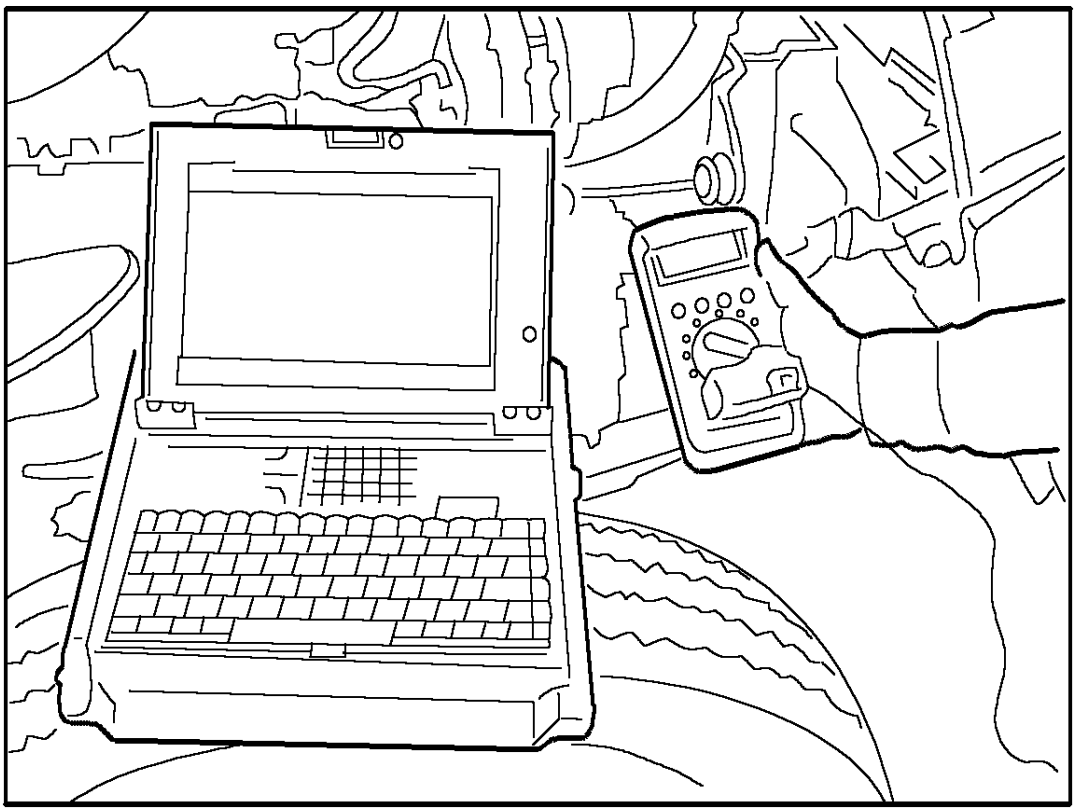

Figure 5 Measuring the Coolant and Air Temperatures

19. With the fan engaged, record fan RPM, coolant temperature, and air temperature at bi-metal or coil.

20. Maintain the **TEST** RPM, with the fan engaged, by keeping the engine speed constant. Remove the cardboard cover from the cooling module. As temperatures decrease, fan speed should begin to decrease. After 2-3 minutes the fan should slow to the initial fan speed (approximately 700 to 1100 RPM).

21. Allow fan to repeat this cycle several times while recording temperatures and fan RPM, utilizing cardboard cooling module cover as required to force fan drive engagement.

Conclusion:

1. If the fan fails to reach 85% of input speed at 200 – 220°F (93.3–104.4°C) coolant temperature, and the air temperature at the bi-metal exceeds 195°F (90.6°C), replace the viscous fan drive.

2. If the fan fails to reach 85% of fan input speed, and the coolant temperature exceeds 220°F (104.4°C), and the air temperature at the bi-metal or coil does not exceed 195°F (90.6°C); then the fan drive is not faulty. Inspect the vehicle for the following:

   a. Air flow restrictions (through the CAC and radiator)

   b. Internal radiator plugging

   c. Faulty thermostat

FOR SNAP ACTION BI-METAL OR COIL VISCOUS FAN DRIVE TEST PROCEDURE (AIR SENSING VISCOUS DRIVES ONLY) (CONT.)

d. Defective water pump

e. Refer to TSI-05–12–34 for additional diagnostic information

3. When the fan drive disengages (with the 2500 **TEST** RPM maintained), if the fan speed fails to slow to 700–1100 RPM; replace the fan drive (except DD-30 and DD-34 which could be in the 1300 RPM range).

4. Remove the air temperature sensing probe from the radiator.

5. Remove the cardboard from the front of the radiator.

6. Return the engine to “idle” and allow the engine to cool for two (2) minutes before shutting down.

NOTES:

A. Engagement air temperatures indicate test cell calibration and may vary in the vehicle.

B. Bi-metal and coil fan drives will have a gradual engagement speed until the fan is fully in the modulated ON position.

TORQUE CHART

Table 1 Torque Chart

Location	Ft-Lbs.	N•m
Fan-to-Drive Hardware (5/16 Inch)	13 - 16	18 - 22
Drive-to-Engine Bolt, (5/16 Inch)	20 - 22	27 - 30
Drive-to-Engine Bolt, (3/8 Inch	34 - 38	46 - 52
Drive-to-Hub Shaft (1 1/4–16 LH Thread)	120 - 150	163 - 203

NOTE – The fasteners MUST be S.A.E. Grade #8 or better.

SPECIAL TOOLS

Table 2 Tools Required

Tool Part Number	Tool Description	Purpose
	EZ-Tech Electronic Service Tool	To measure coolant temperature
ZTSE-4468	Kit, Viscous Fan Diagnostic (consisting of:)	
	(1) ZTSE-4468–1, Digital Photo-Tachometer	For measuring fan speed
	(1) ZTSE-4471–1, TK80 Temperature Probe (works with Fluke 88 DMM)	For measuring air temperature
	(1) ZTSE-4471–2, Thermo-Couple	For measuring air temperature

SPECIAL TOOLS (CONT.)

Notice

The following information has been furnished by the manufacturer for use with its product. International Truck and Engine Corporation reprints this information based on representations made to the Company. While users are urged to carefully follow the instructions accompanying the product, International cannot accept any responsibility for user errors, or mishaps resulting from such errors, or from any misuse of the product.

BorgWarner Emissions/Thermal Systems

Viscous Drive Service Part Numbers

All BorgWarner drives have the Part Numbers either etched or printed on the drive

BW Part Number Formats:

Prior to 2000:	xxxxxx	(6-digit series)
2000-2003:	1210-091xx-xx	(coded series)
Since 2004:	0x00xxxxx	(9-digit series)

MY04-MY06 Applications: MD Truck

Vehicle	Engine	Fan Drive	Temp. ºF	BWE/TS	International	Fan	BWE/TS	International
Stripped Chassis	V8 - all	750	170ºF	010019000	3585866C1	24" MD9 CW	4735-43783-	3539701C1
MD Truck43/4400 Conventional Bus	V8 - 175hp	750	170ºF	1210-09167-	3546534C2	24" MD9 CW	4735-43783-	3539701C1
	V8 - all	790	180ºF	010019721	3588739C1	25" MD9 CW	010019754	3588825C1
	I6 - 175hp	750	175ºF	010019561	3584452C1	28" CW 8-Blade	4735-41134-	3554682C1
	DT466	805	175ºF	010021526	3584438C2	28" MD9 CW	4735-43783-	3541257C1
MD Truck 73/7400	I6-2400rpm I6-2600rpm	805	175ºF	010021530	3540116C3	30" ECS 8-Blade	N/A	3588713C1
MD Truck 8500	DT466 2400rpm	805	175ºF	010021530	3540116C3	28" CW MD9	4735-43783-05	3541257C1
Bus-Transit: FE Model	I6 - DT466	805	175ºF	010021526	3584438C2	28" MD9 CW	4735-43783-	3541257C1
Bus - Transit: RE Model	V-8	Visctronic 712	n/a	020003074	3589802C1	24" 9-blade	4735-42622-	3602380C1
Blue Diamond Common Chassis (F650/750)	V8 - all	790	180ºF	010019721	3588739C1	25" MD9 CW	010019754	3588825C1
	ISB	750	170ºF	1210-09167-	3586345C2	26" CW MD9	4735-43783-	3546535C1
	CAT	805	175ºF	010021530	3540116C3	28" MD9 CW	4735-43783-	3541257C1
Blue Diamond LCF Model	V6 - 4.3L	585	185ºF	010011239	3593589C3	4035-43641-02	010020520	3593590C1

MY'03 Product: MD Truck/Bus

Vehicle	Engine	Fan Drive	Temp. ºF	BWE/TS	International	Fan	BWE/TS	International
Medium Truck/Bus 3000/4000 Models Viscous Applications (general)	V8 - T444E	750	160ºF	010020791	3540983C3	23.23" J7	918889	3512260C1
						24" CCW J7	918693	2022687C1
	V8 - T444E	750	170ºF	010020509	3547775C3	23.23" CCW MD9	4735-43787-02	3552162C1
			160ºF	010020552	2587815C1			
	V8- VT365	750	170ºF	1210-09167-	3546534C2	25" CW 8-Blade	4735-41134-	3565623C1
	I6	750	170ºF	010020914	3522786C3	26" ECS	NA	1647411C3
	I6 DT466	750	160ºF	010020755	3522788C3			
	I6	750	175ºF	1210-09167-	3533032C3	28" CW 8-Blade	4735-41134-	3554682C1
	I6	805	175ºF	010021530	3540116C3	28" CW MD9	4735-43783-	3541257C1
	I6-I530	805	175ºF	010021531	3552595C4	26" CW MD9	4735-43783-	3546535C1
Transit School Bus - FE Model	I6 - 175hp	750	170ºF	010020914	3522786C3	26" ECS	NA	1647411C3
	I6 > 175hp		160ºF	010020755	3522788C3			
Transit School Bus - RE Model	V-8	ED-30	n/a	167852	2036481C91	24" Metal CW	918747	2036480C1
	I6 - DT466	Visctronic 712	n/a	010003468	3604368C1	28" Metal CCW	918900	3516397C1
Blue Diamond Common Chassis	VT365	S-750	170ºF	1210-09167-02	3546534C2	25" CW 8-Blade	4735-41134-39	3565623C1
	Cat	S-805	175ºF	010021530	3540116C3	28" CW MD9	4735-43783-	3541257C1

Memo: Prior MD Product (QSP-Medium Duty Cooling Enhancement)

Vehicle	Engine	Fan Drive	Temp. ºF	BWE/TS	International	Fan	BWE/TS	International
T444E & Strip Chassis	12TSV	750	170ºF	010020509	3547775C3	24" CCW MD9	4735-43787-01	3547774C1
			160ºF	010020552	2587815C1			
	12TSW	750	160ºF	010020791	3540983C3	24" CCW J7	918693	2022687C1
						23.23" J7	918889	3512260C1
PTO	12TSV	750	170ºF	010020893	3540985C3	23" MD9	4735-43783-14	3548286C1
HPT w/DT466 Low HP		750	170ºF	1210-09167-03	3533032C3	28" 8 blade	4735-41134-24	3554682C1
HPT w/DT466		805	175ºF	010021530	3540116C2	28" MD9	4735-43783-05	3541257C1
DT466 Low HP (SxS)	12TSV	750	170ºF	010020914	3522786C3	26" ECS	NA	1647411C3
DT466 Low HP (FTB)			160ºF	010020755	3522788C3			
DT466 Hi HP	12TSY	805	175ºF	010021531	3552595C4	26" MD9	4735-43783-07	3546535C1

BorgWarner Emissions/Thermal Systems

NewGen Service Drive Upgrades

Working with International Truck, BorgWarner Thermal Systems is replacing older style viscous fan drives with the NewGen viscous fan drives. The new generation viscous fan drives have a bimetal coil that provides more accurate turn on capability which leads to better engine cooling. The new drives also have improved efficiency, less slippage, less heat, and more torque capacity than the drives they replace.

In response to requests from the field BorgWarner has also (in most cases) set the replacement drives *cooler* than the original equipment drives so the fan comes on sooner. These work better on older vehicles with older cooling systems.

The NewGen coil actuated viscous fan drives will provide improved performance for your vehicle application.

Time Period	Vehicle	Engine	BWETS #	International	Temp. °F	NewGen Drive	BWETS #	International	Temp. °F	Fan	BWETS #	International
Ends MY03	4700/4900	DT466 Side by Side	1210-09155-01	3522786C2	170ºF	750	010020914	3522786C3	160ºF	Metal CW 26"x8x2.7"	ECS 9351	1647411C3
1995-2001	4700/5000	DT466	166283	2004860C1	170ºF							
1995-2001	3000/4700	DT466	167046	2021376C1	170ºF					Metal CW 23"x7x3.23"	917809	1650477C1
Ends MY03	3800/4700/ 4900	DT466 Front2Back	1210-09157-01	3522788C2	180ºF	750	010020755	3522788C3	170ºF	Metal CW 26"x8x2.7"	ECS 9351	1647411C3
1995-2000	3000/4700	DT466	166054	2001023C1	180ºF							
1995-2001	3000/4700	DT466	167047	2021954C1	180ºF							
1995-2001	3000/4000	DT466	167341	2027495C1	190ºF					Metal CW 23"x7x3.23"	917809	1650477C1
1995-2001	5000	DT466	167524	2029206C1	190ºF							
Ends MY03	3800/4700	T444E	1210-09157-05	3547775C2	170ºF	750	010020552 or 010020509	2587815C1 or 3547775C3	160ºF (Rec.) or 170ºF (OE)	MD9 CCW 24"x9x3.6"	4735-43787-01	3547774C1
										MD9 CCW 23.25"x9x3.6"	4735-43787-02	3552162C1
Ends MY03	3000/4000?	T444E?	1210-09157-02	3540984C2	170ºF					Poly9-Bl 24"x9x3.5"	4735-42623-44	3541004C1
1995-2000	3000/4700	T444E	167981	2038840C1	182ºF	750	010020791	3540983C1	160ºF	Metal CCW 24"x7x2.4"	918694	2022688C1
Ends MY03	3800-4700	T444E	1210-09156-02	3540983C2	170ºF							
1995-2000	3000/4700/ 4700LPX	T444E	167421	2033827C1	182ºF					Metal CCW 23.25"x7x2.4"	918889	3512260C1
1997-2000	4700LPX	T444E	167071	2022686C1	182ºF							
?	?	T444E	1210-09153-01	3522784C1	182ºF					Metal CCW 24"x7x3.2"	918693	2022687C1
Ends MY03		DT466	1210-09157-03	3540985C2	180ºF	750	010020893	3540985C3	170ºF	MD9 CW 24"x9x3.6"	4735-43783-09	3539701C1
										Poly 9 BL 24"x9x3.5"	4735-41393-44	3541004C1
										MD9 CW 23"x9x3.6"	4735-43783-14	3548286C1
1997-2001	2000/5000/ 8000/8100	DT466/ INT530	166223	2005257C1	180ºF					Poly 6 BL 28"x6x2.9"	4035-35480-07	1606826C1
										Poly 8 BL 28"x8x3.9"	4735-38164-14	1611064C1
										Poly 8 BL 30"x8x3.0"	4735-42904-19	1670050C1
										Metal CW 28"x8x3.5"	ECS 412695	2039060C1
1992-1994	4900	DTA360	199807	1689479C1	170ºF	750	010021314	1689481C2	170ºF	Metal CW 26"x8x2.7"	ECS 9351	1647411C3
1992-1994	4900	DT466	199810	1689481C1	180ºF					Metal CW 23"x7x3.23"	917809	1650477C1
1992-1994	4900	DT466	199811	1689480C1	155ºF					Metal CW 23"x7x3.2"	916612	492146C1
1997-2001	8100	CAT C10 >335HP	197778	1666056C91	180ºF	810	010021524	1666056C92	170ºF	Poly 8 BL 30"x8x3.9"	4735-38585-02	1666626C1
										Poly 8 BL 28"x8x3.9"	4735-38585-07	1611610C1
1988-1992	9370/9670	CAT 3406 300-375HP	196133	1657425C91	180ºF					Poly 8 BL 28"x8x3.2"	4735-43439-05	1607711C1
										Poly 8 BL 28"x8x3.2"	4735-43439-05	1607711C1
1990-1994	2000/8100	CUMMINS L10	198859	1673889C91	180ºF					Metal CW 28"x8x3.5"	916797	507018C3
										Metal CW 30"x8x3.2"	916808	534919C1
1988-1990	9370/9670	CUMMINS N14	194767	1612269C1	150ºF	810	010021525	1612269C2	150ºF	Poly 8 BL 30"x8x3.9"	4735-38585-02	1666626C1
										Poly 8 BL 28"x8x3.9"	4735-38585-07	1611610C1
										Poly 8 BL 28"x8x3.2"	4735-43439-05	1607711C1
1980-88	9300/9670	CUMMINS NTC	187182	507271C2	150ºF					Poly 8 BL 28"x8x3.2"	4735-43439-05	1607711C1
										Metal CW 28"x8x3.5"	916797	507018C3
										Metal CW 30"x8x3.2"	916808	534919C1