BorgWarner

Subject: Viscous Fan Drive Test Procedure (Bi-Metal Drives Only)

Diagnostic Procedure

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

1. Check the torque of fan blade fasteners. Refer to Table 2, 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 rotation and non-rotation parts. If damage is present, isolate and repair the problem and replace defective parts.
5. By hand, rotate the fan at least one rotation (360 degrees.) It should turn smoothly, but with some internal resistance. If the rotation of the fan results in a strong or non-uniform resistance, replace the fan drive. Ensure the fan does not contact other objects.
6. Grasp the 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. The previous step is used to detect looseness in the fan or fan drive mounting; when performing these steps, do not force the blade tip (cause the blade to deflect) because this will distort the resulting measurement.
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 from the radiator to the engine. Pressure wash if necessary. To prevent damage, do not direct high-pressure spray onto the fan drive bi-metal. Also, the high-pressure wash must be directed squarely at the front, or rear, of the radiator and other coolers to prevent fin damage.
8. Ensure the cooling system is properly filled with the correct coolant mixtures (do not exceed 60% ethylene glycol) 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:
   a. Turn air conditioning OFF.
   b. Turn heater OFF (NOTE: on buses, turn heater supply valves OFF at the engine).
   c. Run until thermostat opens; then turn engine OFF. 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 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)

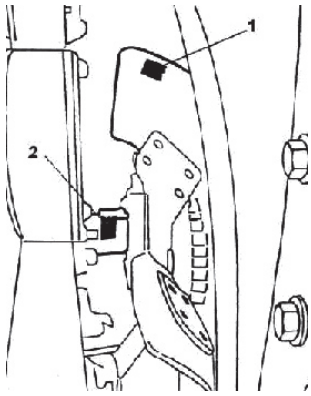

Figure 1 Placement of Reflective Tape
1. Reflective tape on fan blade
2. Reflective tape on fan drive shaft

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11. Connect electronic thermostat. 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 with the fan drive bi-metal. 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. You can safely insert the probe through the A/C condenser, CAC, and radiator core. (Figure 2 and Figure 3)
14. Start the engine and
    a. Recheck to ensure the air conditioning and heater are still OFF (on buses, turn heater supply valves OFF)
    b. Turn electrical loads ON (lights, etc)
15. Raise the engine speed until the fan drive shaft reaches 2500 RPM (measured with a digital photo-tach). Do not measure the fan speed yet. The fan drive shaft speed is not the same as engine speed. 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. 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) 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 800 and 1000 RPM. Some DD-30 and DD-34 fan drives may stabilize at up to 1300 RPM. Refer to Table 1 for fan drive information.
    b. As engine coolant temperature reaches 200- 220°F (93.3-104.4°C)(Figure 5), fan speed should increase to 2125 RPM or higher (85% or more of the test RPM).
    c. The air temperature at the bi-metal should be between 165°F (73.9°C) and 195°F (90.6°C) when the fan engages (Figure 5). Refer to Table 1 for specific fan drive P/N calibration information.
19. With the fan engaged, record fan RPM, coolant temperature, and air temperature at bi-metal.
20. With the fan engaged, maintain the TEST RPM, by keeping the engine speed constant. As temperatures decrease, fan speed should begin to decrease. After 2-3 minutes the fan should slow to the initial fan speed (approximately 40% of the TEST RPM).
21. Allow fan to repeat this cycle several times while recording temperatures and fan RPM.

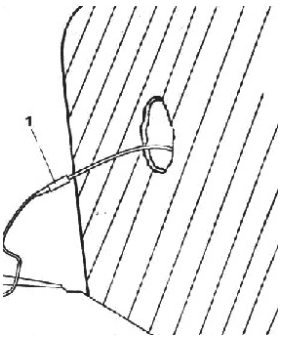

Figure 2 Temperature Probe Inserted through Cardboard and Front of Radiator
1. Temperature probe

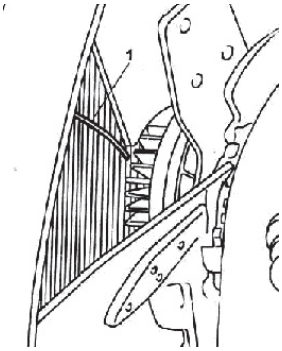

Figure 3. Positioning of Temperature Probe
1. Temperature probe must be positioned in this area [1 inch (2.54 cm) from bi-metal]

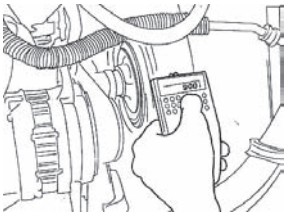

Figure 4. Measuring Fan Blade Speed with Digital Photo-Tachometer

Figure 5. Measuring the Coolant and Air Temperatures

Conclusion:

1. If the fan fails to reach 2125 RPM or higher (or85% 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 2125 RPM or higher (or 85% of input speed), and the coolant temperature exceeds 220°F (104.4°C), and the air temperature at the bi-metal 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
   d. Defective water pump
3. If the fan speed fails to slow down to 800-1000 RPM after the fan drive disengages (with the 2500 Test RPM maintained); 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 minutes before shutting down.

Table 2: TORQUE CHART

Location	Ft-lbs	N.m
Fan-to-Drive Hardware	13-16	18-22
Drive-to-Engine Bolt, 5/16 in	20-22	27-30
Drive-to-Engine Bolt, 3/8 in	34-38	46-52
Drive-to-Hub Shaft	120-150	163-203

Fasteners MUST be S.A.E. Grade #8 or better. Fasteners must be checked for length. Using bolts that are too long can damage the fan drive and the failure may result in personal injury.

Table 3: SPECIAL TOOLS REQUIRED

Tool Description	Purpose
Electronic thermostat (infrared)	Measures coolant temperature
Viscous Fan Diagnostic Kit consisting of: 1. Digital Photo-Tachometer 2. Temperature Probe (works with Fluke 88 DMM) 3. Thermo-Couple	Measures fan speed Measures air temperature Measures air temperature

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