Horton Fan Hub
Horton Fan Hub Failure Modes

Hub failures have two similar causes

- **Oil separation** due to excessive heat
- **Grease purge** due to excessive heat

Both causes lead to Hub Bearing Failure
Old Installation
Horton Fan Hub Status Update

Fan Hub Failure Timeline

Heat > 243°F

Additional Heat Generated

Grease Breakdown

Purge

Seal Failure

Cage Failure

Bearing Ball Shift

Fan Clutch Failure
Horton Fan Hub Failure Modes

Failure Modes:

• Oil Separation - leading to grease breakdown

• Grease Purge
Horton Fan Hub – Corrective Action

Grease Purge:
- Changed from GWP grease to GXK grease
- GWP grease failure rates were ~0.5%
- GXK grease failure rates are showing ~0.15%

Before (GWP grease)  After (GXK grease)
Horton Fan Hub – ’07 Design

Seal Improvements (grease purge): (February 07)

- Change to Viton seal
- Higher temp rating, improved grease retention

Before (NBR)  
After (Viton)
Horton Fan Hub – ’07 Design

Steel Bearing Cage (bearing life): (February 07)

- Change to Steel bearing cage from Plastic
- Higher temp rating, improved bearing retention

Before (plastic)  After (steel)
Horton Fan Hub – ’07 Design

Hardened Race (bearing life): (February 07)

• Change to Heat stabilized steel
• Consistent load at high temperature, improved bearing life

Before (standard race)  
After (heat stabilized)
Corrective Action Summary

Key Product Improvements for 2007 conditions:

• GXK grease: (May 2006)
  – Reduced oil separation at high temperature
  – Capable of -40º F to 356º F

• Viton seal: (February 2007)
  – Reduced risk of seal degradation at high temperature, resulting in less grease purge
  – Capable of -40º F to 392º F
**Horton Fan Hub – Corrective Action**

GXK Grease – (grease breakdown):
- Change to GXK grease (June 2006)
- Hot Box testing confirms field test results
Upgraded Bearings

The new bearing is expected to positively affect the robustness of the DriveMaster related to heat induced failures in 2007 and beyond.
Product Pictures

Model Year 2009
In anticipation of higher heat in 2010, Horton proactively developed a new sheave bearing package capable of handling extreme high heat applications. Due to the overwhelming benefits, this technology has been pulled forward for immediate implementation.

Introducing…
DM Advantage™
Spring-Engaged Fan Drive

A Climate of DURABILITY

Horton
• **Improvements**
  – High Durability Double Row Angular Contact (DRAC) bearing.
  – 40% longer life on air cartridge
    • Redesigned with longer wear length
    • Decreased maintenance intervals
  – Upgraded friction liners for high torque applications
    • Innovative dual-lipped backing plate stiffens assembly
    • Improved durability and lining protection helps prevent “chunking”
    • Backing plate doubles as a visual wear indicator
  – Available in on/off, Remanufactured, and 2-speed
• Double-Row Angular Contact (DRAC) sheave bearing.
  – More than a three-fold improvement in predicted reliability over the successful 2007 design.
  – Field testing of DRAC brg over the past three years in over 340 trucks and 71 million miles.
**Bearing Style Comparison**

**DM Advantage**
- DRAC bearing
- 14 Rolling elements/row
- Rolling elements fill nearly the entire bearing diameter
- Highest load capacity
- High contact angle – able to withstand more thrust load
- Dual lip Viton seals
- Highest temp grease available
- Size: 45x85x39mm

**DriveMaster**
- 6209 Deep Groove bearing 2 needed
- 10 Rolling elements/row
- Preloaded to increase stiffness
- Dual lip Viton seals
- Size: 45x85x19mm

**Other On/Off Mfg. (rear bearing)**
- 6209 Deep Groove bearing
- 9 Rolling elements/row
- Low load capacity
- Not preloaded
- Size: 45x85x19mm

**Other On/Off Mfg. (front bearing)**
- 6207 Deep Groove bearing
- 9 Rolling elements/row
- Not preloaded
- Lowest load capacity
- Small size: 35x72x17mm

CONFIDENTIAL
DriveMaster kits with bearings can NOT be used interchangeably with DM Advantage.

- DriveMaster kits with bearings can NOT be used interchangeably with DM Advantage.
• Confidence in product

- Backed with a 2 year / 200,000 mile nationwide warranty on OEM installations
  - 100,000 miles over base vehicle coverage

- 1 year / 100,000 mile warranty support on over the counter sales
Component Comparison

- Testing in hot box to confirm seal and grease life
- DM advantage bearing ran 10 times longer than the bearing used in the will fitter's clutch and master kit.
The smooth engagement of the DM Advantage prevents damage to belts and tensioners.
Summary

• Horton is again setting the benchmark for fan clutch durability

  – The DM Advantage has proven to have a superior sheave bearing design when compared to all other clutches and repair kits.

  – The DM Advantage is available NOW at all truck OEMs

  – A full line of DM Advantage Reman fan drives are available for upgrade and retrofits at no additional charge or core penalty
Typical Installations of Model Year 2007 & 2008 PACCAR Vehicles
Caterpillar C15 Installation-Driver Side

- (A) = 6 inch space
- (B) = Metal Ring
- (C) = Molded Shroud
Caterpillar C15 Installation-Pass. Side
Cummins ISX Installation-Driver Side

- (A) = 6 inch space
- (B) = Metal Ring
- (C) = Molded Shroud
Cummins ISX Installation-Pass. Side

- (A) = 6 inch space
- (B) = Metal Ring
- (C) = Molded Shroud
Standard Warning Label

- Label affixed to both sides of cooling module all on PACCAR products
Horton understands the need to bring a swift and effective solution to the current situation
Failures Since January 2005

- Failures have two similar causes
  - Oil separation due to excessive heat
  - Grease purge due to excessive heat

- If the rough bearing is not identified in time the following may occur
  - More heat - loss of oil / grease - more heat, etc. until a seal failure and/or cage failure.

- If the cage fails, the bearing balls can lose their alignment, allowing the raceways to separate.
Result

- There have been incremental improvements with the bearing revisions for DriveMaster.

- Peterbilt warranty remained higher than other OEM’s.
  - Extensive use of CAT C15 ACERT engine and
    - Under hood temperature?
    - Addition of ring shrouds?
    - Belt material and changes?
    - Different heat exchanger package?

- The change to the new grease is expected to significantly reduce the bearing failure rates for Horton products built since May, 2006.
Improvement from GWP to GXK

- Although the Peterbilt warranty data for ’06 build is somewhat immature, it does indicate a significant improvement.

- GWP grease failure rates were ~0.5% at 6 months
- GXK grease failure rates are showing ~0.15% at 6 months

- Breaking out the higher failure rates indicates 3 key Peterbilt Part Numbers to target.
Key Part Numbers

Failure by Part for Different Bearings

PB 989313
PB 989334
PB 989809
KW 989361
KW 989437
KW 989801

- NSK - >23 mo.
- All SKF, GWP - >7 mo.
- SKF, GSK - <7 mo.
PACCAR Bearing Failures

Kenworth and Peterbilt  Bearing Failure Percentages
6 and 12 Months of Service

What this graph shows:
Comparison of claims by In-Service Year & Month after 6 & 12 months of Service.
Proposed Upgrade Program

- Peterbilt trucks put into service in 2005 and 2006 with Horton part numbers 989313, 989334, or 989809 and pre-SKF GXK.
  - In service in 2005:
    - 995048 Kit at No Charge or
    - 995051 Special Super Kit at a 50% discount
  - In service date in 2006 and pre-SKF GXK:
    - 995048 Kit at No Charge or
    - 995051 Special Super Kit at a 50% discount
    - and
    - 2.5 hours of labor @ $80/hr.
  - If customer selects Special Super Kit they will have warranty extended by 1 year 100K miles from repair date
Proposed Upgrade Program

- Exclude trucks that have received a repair since 7/1/06. They have received the SKF with GXK grease.
- Upgrades to be performed by September 1st 2007
- Horton will be able to support up to a total of 2000 Kits/Week
- Horton would like PACCAR’s assistance in identifying the VINs of eligible trucks.
  - VIN range possible.
  - VIN of trucks that have been repaired since 7/1/06.
What do the upgrades get you?

- GXK grease (no change from current production)
  - Reduced oil separation at high temperature over original.
- Viton seal
  - Reduced risk of seal degradation at high temperature which will result in less grease purge.
- Steel cage
  - Higher temperature rating able to withstand the higher operating temperatures expected in 2007 without degradation.
  - Failure is less likely to result in the separation of the bearing races.
- Heat stabilized steel races
  - Reduces deformation of the races at high temperatures resulting in more consistent preload throughout operation.
- In field and lab testing, the new bearing grease/package has greatly improved the reliability of the DriveMaster fan drive.
Bearing Upgrade Kit

- 995048 Contents:
  - All Seals and lubricant
  - Upgraded Bearings
  - Main Nut (for fresh lock patch)
  - Liner Screws (for fresh lock patch)

- Omissions that can be shipped as necessary:
  - Cage Nut (tool for disassembly)
  - Torx 55 Plus Bit (tool for disassembly)
  - Literature
    - teardown/rebuild instructions available on the website or via mail, fax and e-mail
Special Super Kit Upgrade

• 995051 Special Super Kit Contents:
  • New FMFD
  • New Liner
  • New Clutch Pack
  • All Seals and lubricant
  • Upgraded Bearings
  • Main Nut (for fresh lock patch)
  • Liner Screws (for fresh lock patch)

• Omissions that can be shipped as necessary:
  • Cage Nut (tool for disassembly)
  • Torx 55 Plus Bit (tool for disassembly)
  • Literature
    • teardown/rebuild instructions available on the website or via mail, fax and e-mail
Upgrade Program Implementation

- Horton would prefer PACCAR assistance in distributing the parts and tracking the progress of the program.
  - Bearing kits will be shipped at N/C and thus no mark up $’s
  - Special Super Kits will be shipped at 50% off of the regular price of Super Kits with upgraded bearings
    - No parts credit necessary on repairs
    - Could be sold at standard mark up, or special lower mark up to encourage higher take rate
  - Package price - parts and labor - on special super kit to make it a more attractive option, particularly for 2005 vehicles?
Appendix
Key Applications

- 989313 – Peterbilt 387 with C15: 1.2:1 ratio
- 989334 – Peterbilt 379 with C15: 1.2:1 ratio
- 989809 – Peterbilt 379 with C15: 1.3:1 ratio
- 989361 – Kenworth W900L with C15: 1.25:1 ratio
- 989437 – Kenworth T600/800/C15: 1.25:1 ratio
- 989801 – Kenworth T2000 with ISX: 1.3:1 ratio
Kenworth Failures by Part Number

Units Shipped

Claims

Part Numbers:
- 989437
- 989801
- 989361
- 989360
- 989362
- 989366
- 989154
- 989198
- 989339
- 989816
- 989436
- 989421
- 989405
- 989233
- 989444
Kenworth Bearing Failures

Kenworth Part # 989347, 989361, 989801  Bearing Failure Percentages
6 Months of Service

What this graph shows:
Comparison of Part # by In-Service Year & Month after 6 months of In-Service.

SKF GWP
Kenworth Bearing Failures

Kenworth Part # 989361  Bearing Failure Percentages
3, 6, 9, 12 Months of Service

What this graph shows:
Comparison of Part # by In-Service Year & Month after 6, 3, 9, 12 months of Service.
Thank You

We value our partnership with PACCAR.

We continue to seek ways to improve our mutual customer’s satisfaction.
2007-09-24 Fan Drive Improvements – Peterbilt

Submitted to the Office of Chief Counsel

With a Request for Confidential Treatment
2007_Airflow_TG841_Design Review

Submitted to the Office of Chief Counsel

With a Request for Confidential Treatment
DecisionAnalysis_2007_FanSystemSupplier

Submitted to the Office of Chief Counsel

With a Request for Confidential Treatment
DFMEA_2007_PCP840-841

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Submitted to the Office of Chief Counsel
With a Request for Confidential Treatment
Reliability Predict 2007 Initial

Submitted to the Office of Chief Counsel

With a Request for Confidential Treatment