National Clean Cities Conference

May 4, 2004
AGENDA TOPICS

• Deere CNG Background
• Technology - *Today and the Future*
• Applications
• Product Support
MAJOR ENGINE MANUFACTURER

2002 Off-Highway Diesel Production
35 - 600 HP Range

- CAT/PERKINS
- CUMMINS
- DEERE
- DEUTZ
- KUBOTA
- FIAT/IVECOINH
- ISUZU
- YANMAR
- MINSK MOTORY
- DAIMLER
HEAVY-DUTY DIESEL HERITAGE

8.1L Engine Powers Deere On!!!

• Agriculture:  70%+ load factors continuous
• Construction: Variability in speed and loading
• Current diesel configuration rated over 400 HP
  - Higher peak firing pressure
  - Higher BMEP
Production released in 1996!

- In response to industry need for reliable/high performance NG engine

- Initial product development began in 1994
  - Original design incorporated today’s advanced technology
  - Generated 1.6 million test miles prior to production
  - Testing validated design and drove successful product launch
  - Focused approach for Transit Style school bus (250 HP @ 800 Lb-Ft)
Outstanding customer acceptance drove the release to other key applications!

- Medium-Duty Truck - 2000
- Refuse Truck - 2001
- 40’ Transit Bus - 2002

250 HP @ 735 Lb-Ft – 280 HP @ 900 Lb-Ft
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Customer Expectations of Deere CNG Engines

Diesel-like:

- Driveability
- Reliability
- Cost-of-ownership
  - Fuel economy
  - Maintenance
  - Durability
- Serviceability
DEERE PRODUCT FEATURES

Advanced Technology!

- 8.1L based on heavy-duty diesel engine platform
- Unique cylinder head
- Top liner cooling
- Lean burn combustion
- Full authority electronic control
HEAVY-DUTY ENGINE BLOCK

- 8.1 NG engine utilizes same bottom-end as diesel
  - Block
  - Crankshaft
  - Large bearing areas
  - Connecting rods
  - Hardened wet liners
  - Low mount oil pump
  - Oil spray piston cooling
• Cylinder head porting and configuration optimized for natural gas

• Stellite valve seats
  - Durable for high temperatures and prevents wear

• Stellite faced valves
  – Prevents valve recession
  – Extends valve adjustment intervals
COOLING SYSTEM

• Top liner cooling
  - Lowers upper-liner temperature significantly
  - Improves life of the power cylinder and head-to-block joint … joint integrity
  - Prevents head gasket failures in severe service applications

• Gear driven water pump
  - Maintenance advantage for key applications
    (Transit Bus & Refuse Trucks)
LEAN BURN COMBUSTION

• Lean burn combustion
  – Very lean air-fuel ratio

• Lean burn results in higher combustion efficiency
  – Less wasted heat
  – Lower exhaust temperatures
  – Lower under hood temperatures

• Less heat results in less thermal stress!!
• Monitors engine parameters and adapts to variant ambient conditions to maximize engine efficiency.

- Closed loop fuel control
- Adaptive learn
- Electronically controlled wastegated turbo
- Electronically controlled throttle
- Knock detection
- Humidity sensor
Next Generation Technology!!!

- Released July 2003

- Takes the 8.1L NG engine to the next level of capability!!
  - Reliability
  - Performance
  - Application flexibility
  - Platform for emission reduction
• Deere proprietary controller
  - Processing speed – calibration flexibility
  - Electronic features demanded by on-highway applications
• Combustion design improvements
  - Piston
  - Air management
• Incorporates new high volume/reliable engine components
• Engine performance enhancements
• CNG and LNG capable
• Emission Certification
EMISSION CERTIFICATION

• 8.1 certified to new aggressive levels

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<th>gr NOx+NMHC</th>
<th>PM</th>
<th>CO</th>
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  - MHHD
    • (250 HP @ 735 Lb-Ft) & (250 HP @ 800 Lb-Ft)
    • School Bus, Commercial Bus, and Medium Duty & Refuse Truck

  - HHDD
    • (275 HP @ 800Lb-Ft) & (280 HP @ 900 Lb-Ft)
    • Medium Duty & Refuse Trucks

  - URBAN BUS
    • (250 @ 735 Lb-Ft) & (280 HP @ 900 Lb-Ft)
    • Transit Bus 30 – 40’

• All certifications require a simple oxidation catalyst muffler
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OUT HERE IT’S SURVIVAL OF THE FITTEST
APPLICATION TAILORED OPTIONS

- Oil pans
  - Front sump, continuous, and Transit specific
- Transmission adaptation
  - Allison MD / HD and B300R / B400r
  - ZF
  - Voith
- Auxiliary gear drives SAE A & B
  - 13.2 & 16.5 CFM A/C
  - Air Conditioning A/C
- PTO, torsionally from crank pulley
- Fan drive, clutch
- Remote oil dipsticks
- Optimized Power Curves
- Programmable electronic features
FOCUS ELECTRONIC FEATURES

- Road Speed Governor
- Cruise Control
- Auto resume
- Elevated High Idle Control (for A/C)
- In-cab idle adjustment
- Remote PTO
- Dual Throttle
- ABS with Traction Control
- Engine brake interlock/ Decel Light
- Foot Pedal Inhibit/ Throttle interlock
- Engine protection (De-rate)
  - Coolant level input
  - Coolant temperature input
  - Oil pressure input
  - Intake air temperature input
  - Exhaust temperature input
  - Oil temperature input
- PWM fan control
- A/C input
- Coolant temperature input
- Throttle charge temperature
- Transmission sump temperature
- Engine protection (hard shutdown)
  - Coolant level input
  - Coolant temperature input
  - Oil pressure input
  - Intake air temperature input
  - Exhaust temperature input
  - Oil temperature input
  - Auxiliary Input
- Shutdown override switch
- Shutdown reset
- Shutdown alarm
- J1939 CAN
- J1587 w/bridge
JOHN DEERE

Type D – Transit Style School Bus

250 hp @ 800 lb ft
Certified to CARB 1.5 gr NOx+NMHC Standard
Blue Bird: All American RE

- A-Z Bus - Sacramento and Colton, CA
- Auto Safety House - Phoenix, AZ
- Atlantic Transportation Eqp. – Beltsville, MD
- Bryson Sales & Service – Bountiful, UT
- Zia Bus Sales Inc. – Albuquerque, NM
- M.A. Brightbill Body Works – Lebanon, PA
SCHOOL BUS DEALERS

Thomas Bus: Saf-T-Liner HDX

- California Bus Sales - Fresno, CA
- Bus West - Los Angeles, CA
- Nesco – New Windsor, NY
- Lewis Transportation Sales – Salt Lake City UT
JOHN DEERE

Transit/Commercial Bus Properties

250 hp @ 735 lb ft
280 hp @ 900 lb ft
Certified to the CARB 1.8 gr NOx+NMHC Standard
JOHN DEERE COMMERCIAL BUS

BlueBird: Xcel 102

- A-Z Bus - Sacramento and Colton, CA
- Auto Safety House - Phoenix, AZ
- Atlantic Transportation Eqp. – Beltsville, MD
- Zia Bus Sales Inc. – Albuquerque, NM

Powered by 8.1 L CNG
- 250 hp @ 735 Lb-Ft
JOHN DEERE TRANSIT BUS

Eldorado National:

- EZ Rider II
- HFX
- Axess 35’ & 40’

Powered by 8.1 L CNG or LNG
- 250 hp @ 735 Lb-Ft
- 280 hp @ 900 Lb-Ft
JOHN DEERE TRANSIT BUS

Orion Bus:

- Orion V & Orion VII

Powered by 8.1 L CNG or LNG
- 250 hp @ 735 Lb-Ft
- 280 hp @ 900 Lb-Ft
JOHN DEERE TRANSIT BUS

New Flyer:  

- 35’ and 40’ LF Transit Bus

Powered by 8.1 L CNG or LNG
- 250 hp @ 735 Lb-Ft
- 280 hp @ 900 Lb-Ft
JOHN DEERE

TRUCK FLEETS

250 hp @ 800 lb ft
275 hp @ 800 lb ft
280 hp @ 900 lb ft
Certified to the CARB 1.5 & 1.8 gr NOx+NMHC Standard
Crane Carrier Corporation:

- LCF & LET2

Powered by 8.1 L CNG or LNG

- 275 hp @ 735 Lb-Ft
- 280 hp @ 900 Lb-Ft
JOHN DEERE TRUCK FLEETS

Freightliner FL 70

Powered by 8.1 L CNG or LNG
- 250 hp @ 800 Lb-Ft
**APPLICATION CONCLUSIONS**

- Hardware and software specifically tailored to the application
- Power curves matched to the transmission/application for optimum performance
- All OEM installations meet Deere’s stringent application engineering standards

### Deere 8.1L CNG Engine

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**6081HFN Truck**
- 250 HP @ 800 Lb.Ft.
- 280 HP @ 900 Lb.Ft.

**6081HFN Bus**
- 250 HP @ 735 Lb.Ft.
- 280 HP @ 900 Lb.Ft.
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• Deere CNG Background
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• Applications
• Product Support
“PROVIDING GENUINE DEERE VALUE
WITH OUTSTANDING PRODUCT SUPPORT”

- Capable customer support network
  - Over 4000 Dealers worldwide
  - Qualified third-party
  - Fleet or Property
- Technical Assistance
  - DTAC’s provide 24 hour assistance
  - Technical publications
- Comprehensive product training
  - Waterloo, IA
  - Fleet or Property site
  - Other local facilities
- Parts availability
  - Communication system providing delivery within 24 hours in the U.S.
  - Recommended spare parts list
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</table>
PRODUCT SUPPORT

After Sales Support!

- Deere trademark value is a result from providing outstanding after sales support
- Maximized vehicle uptime…
  - Maintenance intervals
  - Serviceability
  - PC based diagnostics (Deere proprietary control system)
  - Extended warranty coverage options up to 6 yrs / 300,000 miles

DEERE QUALITY CONTINUES LONG AFTER YOU TAKE DELIVERY!!
Our Commitment to Natural Gas Technology Advancement, Customer Satisfaction, and a Cleaner Environment