Warren CAT

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Gamma88 Dynamometer Trials
Odessa, Texas
13 – 24 April 2009

Scope of Dynamometer Trial

A Caterpillar (CAT) D3508, 900-horsepower engine was tested for 57 operating hours using ultra-low sulfur diesel (ULSD) fuel. Each phase consisted of a three-hour operating segment and a one-hour shutdown segment. During the entire demonstration, engine performance statistics were computer generated and electronically captured. Fuel consumption was measured, recorded and verified. After establishing a baseline, a total of 17 four-hour phases were performed on the engine with Gamma88 added to the ULSD, as noted in this report. This protocol was followed to allow for the absorption of Gamma88 (chemisorption) by the conclusion of the demonstration.

Following is the breakdown of phases:

- Two *baseline* phases – with only raw ULSD and CAT recommended engine oil (no Gamma88).

- 12 *implementation* phases at a *5x* rate of Gamma88 introduced into the ULSD (5 times the normal usage amount), and a 1x normal usage rate introduced into the engine oil.

- Two *implementation* phases at a *3x* rate of Gamma88 into the ULSD and a 1x normal usage rate into the engine oil.

- Three *sustainment* phases at a *1x* normal usage rate of Gamma88 into the fuel and a 1x normal usage rate into the engine oil.

At all times, the engine was controlled by an electronic throttle control and a programmable logic controller (PLC) that maintained the engine at prescribed horsepower and RPM settings. The following identical steps were performed during each individual phase:

- Engine was run at 1217 rpms @ 700 horsepower for five minutes and at 800 rpms @ 300 horsepower for two minutes.
    - This seven (7) minute cycle was repeated throughout the 3-hour operating segment.
- Engine performance data was electronically recorded every 21 minutes at both the high and low rpm settings.
- Every hour the fuel volume was measured.
- 350 gallon (baseline and 5x phases) and 200 (3x and 1x phases) gallon fuel tanks were filled and measured at the conclusion of each phase.

• At the end of the operating segment, the fuel tank was re-filled using a 44-gallon graduated drum, a three-gallon graduated bucket and a one-gallon graduated bucket to ensure accurate fuel consumption and measurements.

See Appendix A for the graphically represented dynamometer measurements, displaying identical engine profiles for each phase.

Equipment / Products Used

1. Taylor Dynamometer – Model DX38 (See Appendix C)
2. Taylor Dynamometer Monitor System – TaDac
3. IBM ThinkPad Laptop Computer w/Caterpillar "Electronic Technician" Software
4. Electronic Throttle Control w/PLC
5. CAT approved/recommended engine oil (CAT 15w40 – p/n 155-6199) and oil filters (CAT – p/n 1R-0726)
6. CAT approved/recommended fuel filters (CAT p/n 1R-756)
7. ULSD fuel
8. Gamma88 Fuel Reformulator
9. Various graduated containers to verify fuel volumes

Observers of Test

- Warren CAT
  - Eric Hawkins – Engine Service Manager
  - Cogo Woods – Engine Shop Supervisor
  - Ronnie Smith – Engine Component Supervisor
  - Terry Gwin – Main Dynamometer Operator
  - Devin Smith – Dynamometer Operator

- Gamma88
  - Nick Cross
  - Buzz Waid

Phase Protocols and Results

Baseline Phases

Two baseline phases were performed:
-Raw ULSD fuel
-Zero Gamma88

- First Baseline Phase
  - At the end of the first baseline phase the engine consumed a total of 97.5 gallons of fuel.

- Second Baseline Phase
  - At the end of the second baseline phase the engine consumed a total of 100.1 gallons of fuel.

Average Baseline Phase Fuel Consumption: 98.8 gallons

5x Implementation Rate Phases

Twelve 5x implementation phases were performed:

Gamma88 introduced at a 5x normal usage rate (5 ounces / Ten (10) gallons of ULSD) – 175 ounces total added to 350 gallons of ULSD

Gamma88 introduced at a 1x usage rate (1 ounce / quart of engine oil) – 256 ounces total added to oil

- First 5x Implementation Phase
    - At the end of the first 5x implementation phase the engine consumed a total of 91.5 gallons of fuel (7.39% savings compared to baseline average).

- Second 5x Implementation Phase
    - At the end of the second 5x implementation phase the engine consumed a total of 91 gallons of fuel (7.89% savings compared to baseline average).

- Third 5x Implementation Phase
    - At the end of the third 5x implementation phase the engine consumed a total of 91.25 gallons of fuel (7.64% savings compared to baseline average).

- Fourth 5x Implementation Phase
    - At the end of the fourth 5x implementation phase the engine consumed a total of 92 gallons of fuel (6.88% savings compared to baseline average).

- Fifth 5x Implementation Phase
    - At the end of the fifth 5x implementation phase the engine consumed a total of 91.0 gallons of fuel (7.89% savings compared to baseline average).

- Sixth 5x Implementation Phase
    - At the end of the sixth 5x implementation phase the engine consumed a total of 90.0 gallons of fuel (8.91% savings compared to baseline average).

- Seventh 5x Implementation Phase
    - At the end of the seventh 5x implementation phase the engine consumed a total of 89.75 gallons of fuel (9.16% savings compared to baseline average).

- Eighth 5x Implementation Phase
    - At the end of the eighth 5x implementation phase the engine consumed a total of 92.25 gallons of fuel (6.63% savings compared to baseline average).

- Ninth 5x Implementation Phase
    - At the end of the ninth 5x implementation phase the engine consumed a total of 91.0 gallons of fuel (7.89% savings compared to baseline average).

- Tenth 5x Implementation Phase
    - At the end of the tenth 5x implementation phase the engine consumed a total of 90.0 gallons of fuel (8.91% savings compared to baseline average).

- Eleventh 5x Implementation Phase
    - At the end of the eleventh 5x implementation phase the engine consumed a total of 86.1 gallons of fuel (12.85% savings compared to baseline average).

- Twelfth 5x Implementation Phase
    - At the end of the twelfth 5x implementation phase the engine consumed a total of 89.0 gallons of fuel (9.92% savings compared to baseline average).

Average 5x Implementation Phase Fuel Consumption: 90.4 gallons
Average 8.5% Savings Compared to Baseline

3x Implementation Rate Phases

Two 3x implementation phases were performed:
Gamma88 reduced to a 3x normal usage rate (3 ounces / Ten (10) gallons of ULSD) – 60 ounces total added to 200 gallons of ULSD
Gamma88 maintained at a 1x usage rate (1 ounce / quart of engine oil) – 256 ounces total added to oil

- First 3x Implementation Phase
    - At the end of the first 3x implementation phase the engine consumed a total of 90.5 gallons of fuel (8.40% savings compared to baseline average).

- Second 3x Implementation Phase
    - At the end of the second 3x implementation phase the engine consumed a total of 91.5 gallons of fuel (7.39% savings compared to baseline average).

Average 3x Implementation Phase Fuel Consumption: 91.0 gallons
Average 7.89% Savings Compared to Baseline

1x Sustainment Rate Phases

Three (3) 1x sustainment phases were performed:
Gamma88 reduced further to a 1x normal usage rate (1 ounce / Ten (10) gallons of ULSD) – 20 ounces total added to 200 gallons of ULSD
Gamma88 maintained at a 1x usage rate (1 ounce / quart of engine oil) – 256 ounces total added to oil

- First 1oz Sustainment Phase
    - At the end of the first 1x implementation phase the engine consumed a total of 94.5 gallons of fuel (4.35% savings compared to baseline average).

- Second 1oz Sustainment Phase
    - At the end of the second 1x implementation phase the engine consumed a total of 92.0 gallons of fuel (6.88% savings compared to baseline average).

- Third 1oz Sustainment Phase
    - At the end of the third 1x implementation phase the engine consumed a total of 87.5 gallons of fuel (11.44% savings compared to baseline average).

Average 1x Implementation Phase Fuel Consumption: 91.3 gallons
Average 7.59% Savings Compared to Baseline

Conclusions

At all times, Warren CAT personnel participated in and/or monitored the procedures of this demonstration, as well as the introduction of Gamma88 into the ULSD fuel consumed by the Caterpillar 3508 demonstration engine. Throughout the entire demonstration, a number of positive changes occurred:

1. A computer documented increase in horsepower (Appendix B)
2. A computer documented increase in torque (Appendix B)
3. A visible reduction in carbon buildup in the engine (Appendix D)
4. A measured reduction of fuel consumption while using identical profiles over a 57-hour operating evaluation period.

What can't currently be displayed by this demonstration - although can be deduced from performance increases and photographs (Appendix D) - is that engine life will likely be increased and maintenance will likely be decreased based on the photographs of how the chemisorption and cleansing process of Gamma88 occurs.

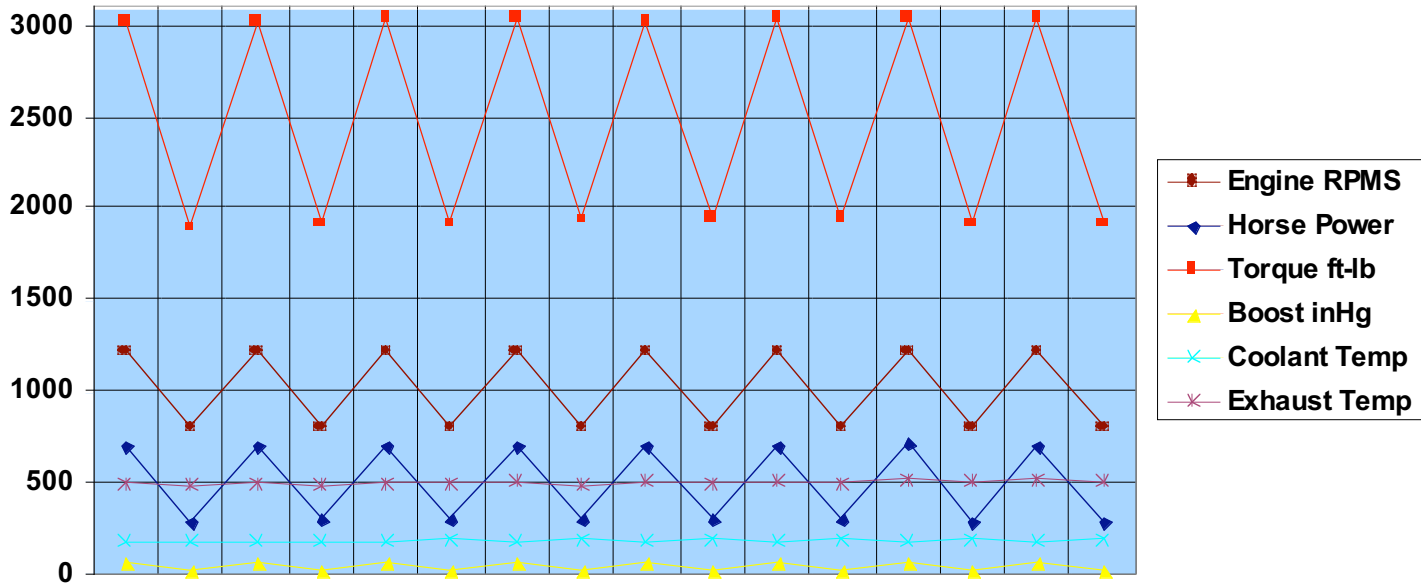
At the end of the trial, neither my mechanics nor I detected any negative effects Gamma88 had on the engine or any of its components – in fact they were cleaner than before the demonstration.

Finally, it is our conclusion that by following the Gamma88 company recommended protocol for implementation, ultimately adding Gamma88 to the fuel and oil tanks at the 1x sustainment rate significantly reduced fuel consumption/increased fuel efficiency. **Our study resulted in an average decrease in fuel consumption of 7.59%** compared to the baseline average. Particularly notable is fuel efficiency increase during each sustainment phase - from 4.4% to 6.9% to 11.4%. This demonstrates that the effectiveness of Gamma88 continued to increase throughout the sustainment phase.

Eric Hawkins
Engine Service Manager

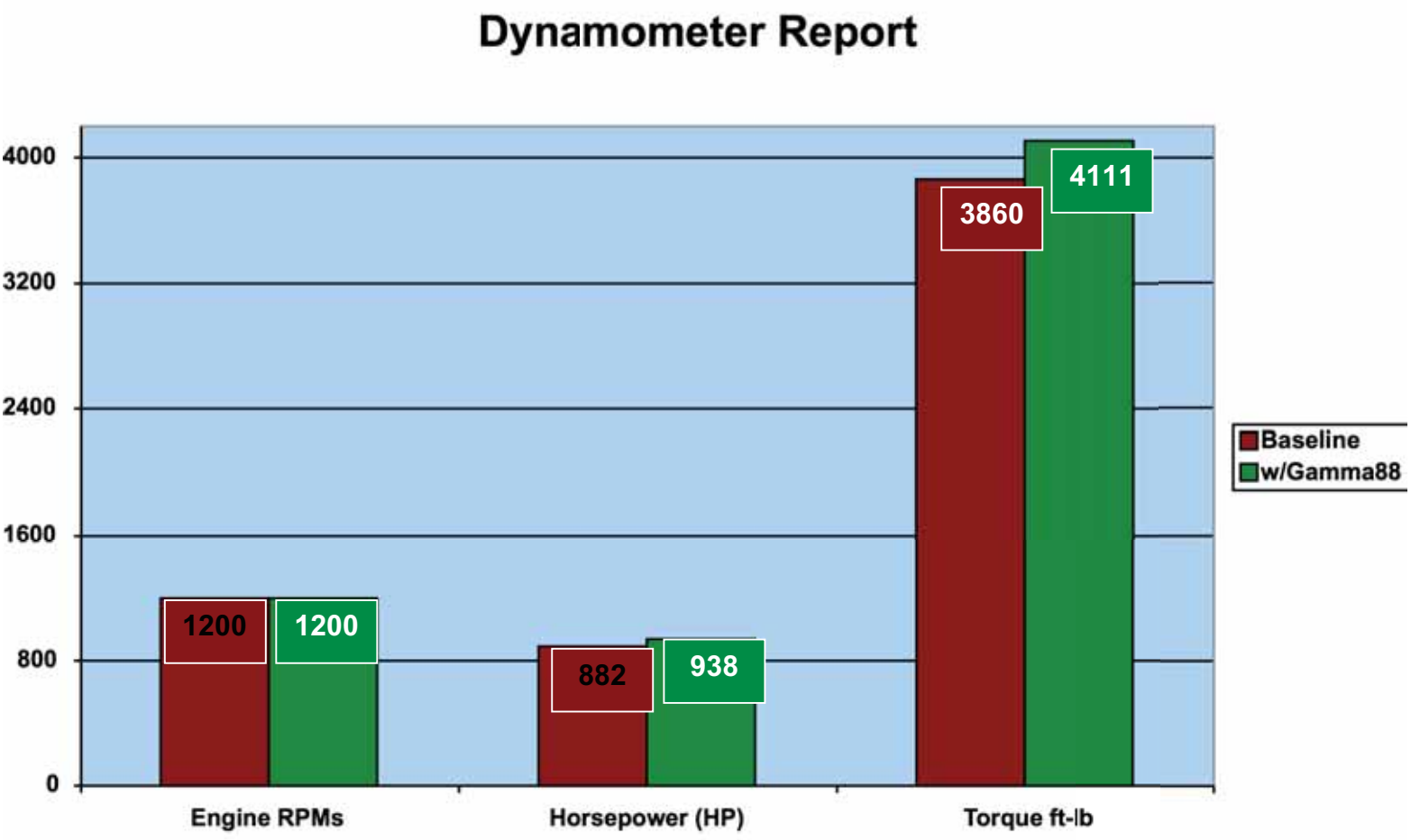
Appendix A

Dynamometer Report



Engine RPMS	1218	797	1217	799	1217	799	1217	799	1217	799	1217	799	1217	798	1217	798
Horse Power	700	288	700	292	705	291	706	294	699	296	706	297	707	290	704	290
Torque ft-lb	3022	1899	3023	1922	3046	1915	3048	1935	3018	1951	3049	1953	3049	1913	3041	1913
Boost inHg	61	11	60	11	60	11	60	11	60	11	59	11	59	10	59	10
Coolant Temp	178	180	177	180	178	181	179	181	179	181	179	181	179	181	180	182
Exhaust Temp	495	483	494	485	498	488	501	487	503	490	506	496	512	501	514	506

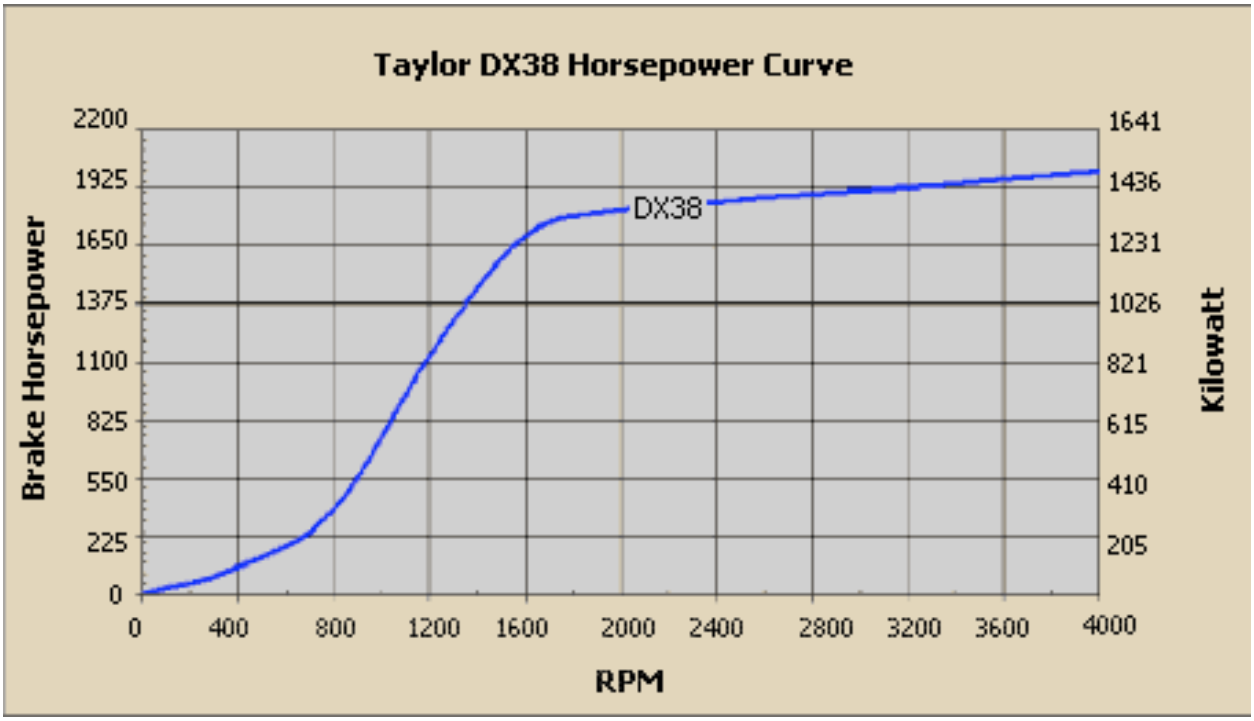
Appendix B

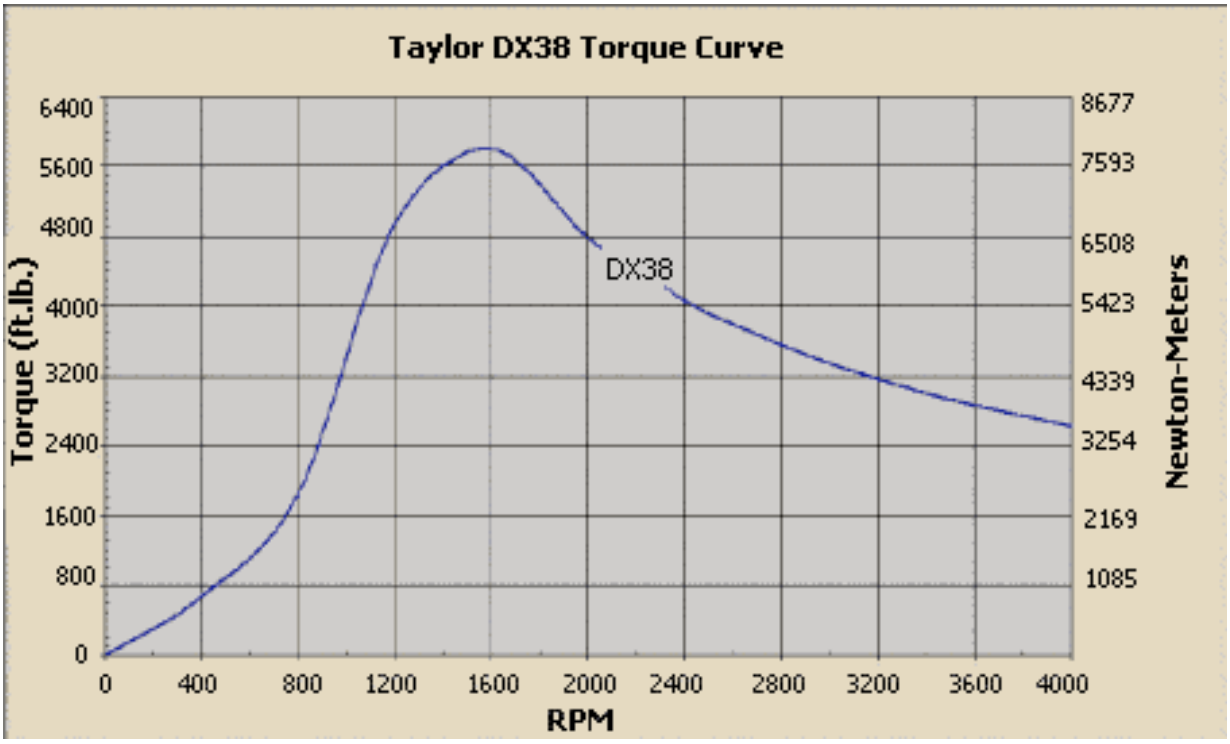


The Bar Graph depicts Gamma88's positive effect on HP and torque. While holding RPM constant and comparing the baseline with raw ULSD (red) and ULSD with Gamma88 added (green), **the percentage gain in HP was 6.35% and Torque was 6.50%.**

Appendix C

HP: 2000 hp (1491 kw)
Torque: 5800 ft. lbs. (7864 Nm)
Speed: 4000 RPM
Water Use: 145 GPM (9.1 L/s) (No Cooling System)
Shipping Weight: 2634 lbs. (1195 kg)





Appendix D

Photo Prior to using Gamma88

Photo after 51 operating hours using Gamma88

Appendix D (cont)

Photo prior to using Gamma88

Photo after 51 operating hours using Gamma88