

**CATERPILLAR®**



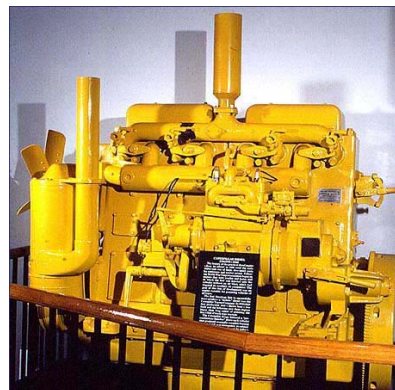
# Caterpillar Diesel Racing: Yesterday & Today

August 22, 2006

# OLD BETSY

## 75 Years of Technology Development

- D9900 (1931 Production)
- 5175 lbs
- 17.9L
- 66 kw @ 700 rpm
- 1<sup>st</sup> Prototype is in Smithsonian



- C18 ACERT (2006)
- 3330 lbs
- 18.1L
- 746 kw @ 2300 rpm Marine engine

Power to Weight has increased by 15x!  
From “Old Betsy” to ACERT

**“MAKING PROGRESS POSSIBLE”**

## Tractor Racing – Cat 30 circa 19??





# Caterpillar Offshore Powerboat Racing - 1988



# Cat's Offshore Powerboat Racing



**Tantalus**



**Scarab**



**McDonald Douglas**



**Spirit of America**

# U.K. Circumnavigation Record Holder - 1990 Four 3176's 750hp each



# Caterpillar Spirit of America



Three 3196's at 930hp each

# NASCAR – 2002 Daytona Winner



photo supplied by Caterpillar 1999

# Caterpillar European Super Truck Racing



# Super Truck Specification & Regulations

- Engine
  - 12 Liter Displacement
  - Single Stage Turbocharging
  - Stock Fuel System
  - No Black Smoke - Ceramic Filters
- Truck Chassis
  - 5000 Kg
  - Disc brakes front and rear, water cooled
  - Antilock brakes and traction control illegal
- Transmission
  - 5 speed semi-automatic



# Super Truck Specification & Regulations

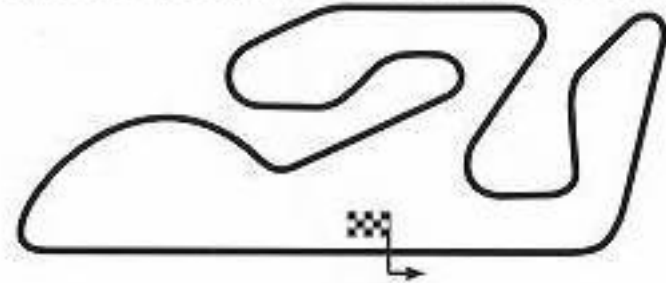
- Tires
  - Continental 315/70 R 22.5
- TRD Truck Performance
  - Maximum Speed Limit 160 KPH {100 MPH}
  - 0 - 60 MPH 3.9 Seconds {Traction Limiting}
  - 0 - 100 MPH ~8 Seconds {Traction Limiting}
  - Excess of 1 G Lateral During Cornering



# European Race Circuits

- 10 Events per season
- 4 Points races per Event
- Typical Race Circuit
  - Road Courses - Lots of Turns
  - 1.2 - 2.7 Miles
  - 10 to 17 Laps per race
  - 35 to 40 minutes per race
- Qualifying times within 0.5 seconds

*circuit length: 4.005Km/2.5miles*



*Circuit length: 3.636Km/2.259miles*



# Typical FIA Super Truck Schedule

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<b>Dijon</b>	<b>France</b>	<b>29 Apr</b>
<b>Valencia</b>	<b>Spain</b>	<b>13 May</b>
<b>Misano</b>	<b>Italy</b>	<b>27 May</b>
<b>A1 Ring</b>	<b>Austria</b>	<b>10 June</b>
<b>Nogaro</b>	<b>France</b>	<b>24 June</b>
<b>Nurburgring</b>	<b>Germany</b>	<b>14 July</b>
<b>Alastaro</b>	<b>Finland</b>	<b>5 Aug</b>
<b>Most</b>	<b>Czech Republic</b>	<b>9 Sept</b>
<b>Zolder</b>	<b>Belgium</b>	<b>15 Sept</b>
<b>Jarama</b>	<b>Spain</b>	<b>30 Sept</b>

# European Truck Competition

- Mercedes Benz - Germany
  - 12 Liter V6 Mercedes Engine
  - Race 3 Trucks
  - Large manufacturer support in \$\$\$ and manpower and equipment
  - Engine changes in less than 30 minutes
- MAN - Germany
  - 12 Liter inline 6 MAN Engine
  - Race 5 Trucks
  - Also large manufacturer support with \$\$\$ manpower and equipment
- Caterpillar TRD Team
  - 11.95 Liter inline 6 Engine
  - Race 1 Truck



# Caterpillar Super Truck Racing History

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- 1996 TRD - SISU Cab and New Chassis
  - New Driver - Harri Luostarinen
  - Engine Development = 1130 HP
- 1997 European Championship
  - Engine Development = 1230 HP
  - Telemetry for tuning truck chassis
- 1998 2nd Place in European Championship

# Caterpillar Super Truck Racing History

- 1999 3rd Place in European Championship
  - Tuned intake manifold increases Volumetric Efficiency
    - Stock Intake 95%
    - Tuned Intake 104%
  - Most powerful and responsive to date
  - Engine development = 1400 HP!
- 2000 – 2002: finishes in top 3 each year
  - Improvements to camshaft, cylinder head and tuned intake yields more efficient air flow
  - Volumetric Efficiency 109%
  - Engine Development = 1550 HP @ 2400 RPM
  - Peak Torque 3400 Lb\*Ft @ 2200 RPM FLAT back to 1500 RPM!!!!

# How to Quadruple Your C-12 Power Output

430 HP => 1550 HP



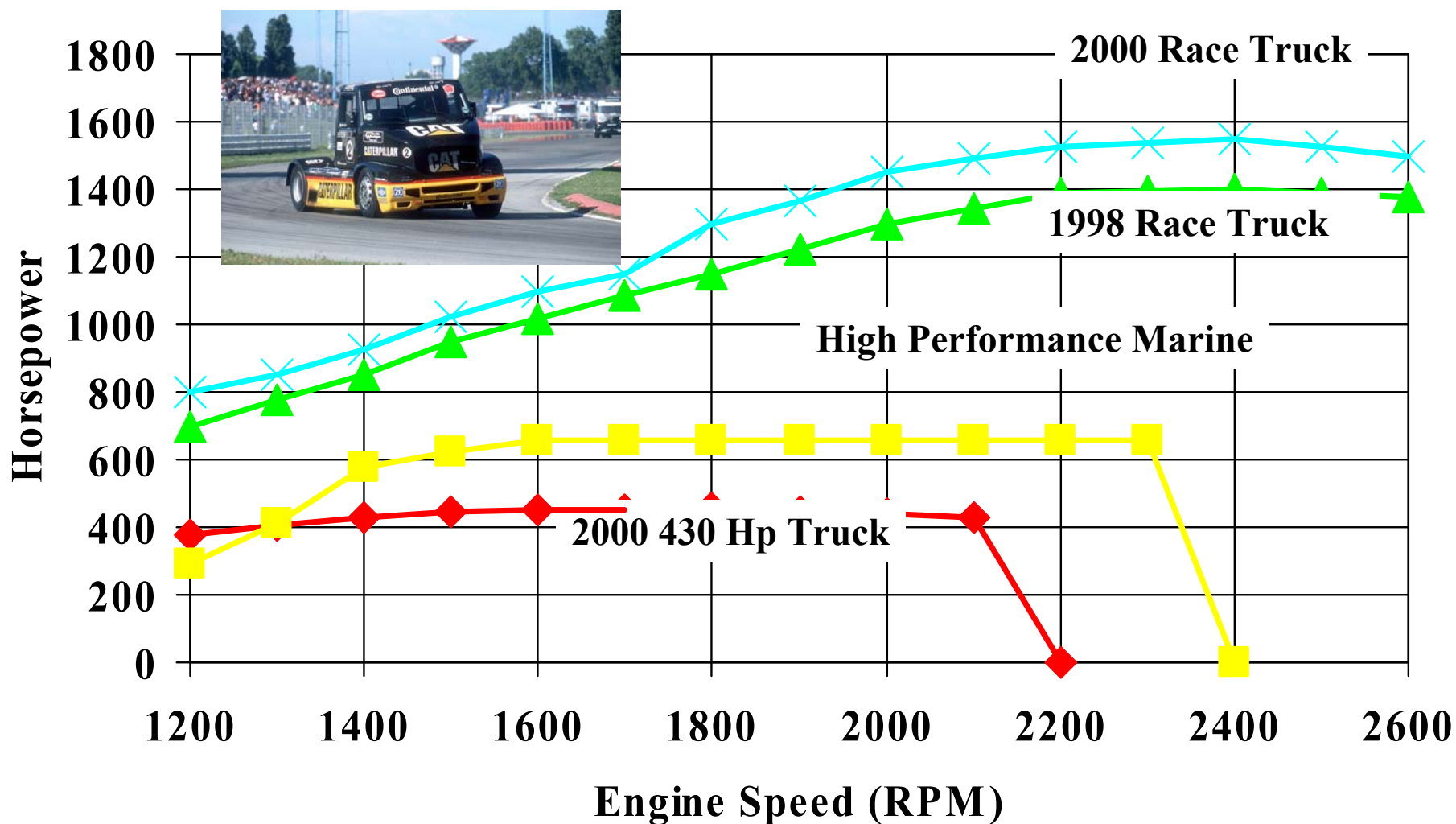
## C-12 Hardware

	2000 Truck	2000 Race Truck
Compression Ratio	16.25 : 1	14.33 : 1
Connecting Rods	Stock Length	1.5 mm Shorter
Fuel Cam	0.375 Decel	0.525 Decel
Injectors	EUI 10 mm	EUI 11 mm
Nozzles	6 X 0.179 X 130	8 X 0.274 X 147
Turbocharger	Single Garrett GT45 1.44 A/R	Twin Schwitzers S300 - 0.88 A/R
Cylinder Head	Standard 4 Valve	Modified 4 Valve
Valves	Standard Truck	Marine Niomic Ex. 3406 E Intake
Crankshaft	Standard	37% C'weighted
Intake Manifold	Standard	Tuned Manifold

# C-12 Engine Performance

	2000 Truck	2000 Race Truck
Power (HP)	455 @ 1800 RPM	1550 @ 2400 RPM
Torque (lb-ft)	1650 @ 1200 RPM	3400 @ 1500 RPM
Rated Fuel Rate (gal/hr)	20.2	88.5
Fuel Rack (mm)	11.2	15.0
Accel Air/Fuel Ratio	17.5	14.0
Airflow (lbs/hr)	3700	8500
Turbo Speed (rpm)	93,100	154,000
Boost (psi)	22	55
Cylinder Pressure (psi)	2,200	4,000 +
Exhaust Temp (deg C)	602	1,000 +
Injection Pressure (psi)	28,000	25,000
Timing (Deg BTDC)	13.9	20.0

## Comparison of C-12 Power







## Cat-VW v10 Diesel, 2005 LeMans





Audi R10, v12 diesel, 2006 LeMans Winner  
650hp, 5.5 liter, PM filters



# Cat C12 Supertruck Diesel vs. Audi LeMans Diesel

AUDI R10 LeMans Diesel

Cat Race Truck C-12

Config./displ.

Bore/stroke

V-12 / 5.5 liters

In-line 6 / 11.9 liters

3.13"/3.63"

Rated power

@ 4200rpm\*

5.12" 1550 hp @ 2400rpm

Torque

650 hp

3400 #ft @1500 to 2200 rpm

BMEP, PCP

812 #ft @ 366 psi, ?

705 psi, 4000+psi

Piston Speed

2700 ft/min

2400 ft/min

Thermal loading

7.0 hp/in<sup>2</sup>

12.6 hp/in<sup>2</sup>

Hp/displ

2.1 hp/in<sup>3</sup> (twice the bmep, half the rpm)

Life

24 hrs  
1.9 hp/in<sup>3</sup>

all season, 125 hrs

**If the Audi were able to live at the same levels of cylinder pressure and thermal loading that the C-12 does its power would be 1170 hp instead of 650hp.**

\* bore, stroke and peak power rpm not available for the Audi race engine. We are using best estimates that are consistent with public data.