Cummins ISB
Test Development Task Force

Cummins Surveillance Panel

Mark Sarlo, SwRI

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ISB Test Development Progress

- Labs and Engines
- Procedure and Soot Generation Slopes
- Special Parts and Cam Measurement
- Modifications to Hardware and or Procedure
- Move Forward to Matrix

ISB Engine

- 5.9L ISB MY04, CPL 8123. This engine is certified at 2.0 g NOx/bhp-hr
- Fuel system — Common Rail
- CPL — 8123
- Low idle — 800 RPM (ECM 750 RPM)
- High idle — 3,000 RPM
- Rated — 300 hp @ 2,600 RPM
- Torque peak — 600 lbf-ft @ 1,600 RPM

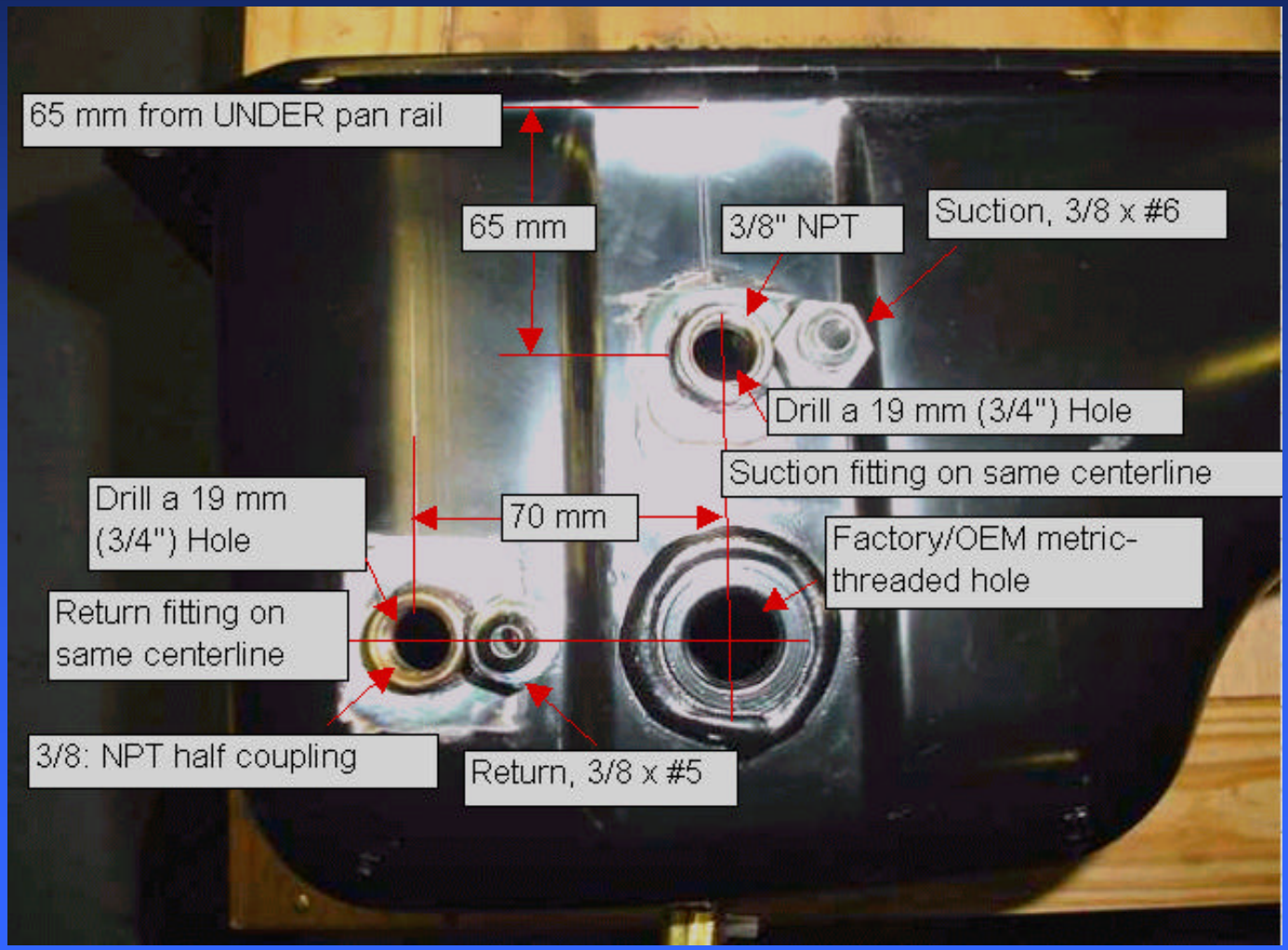
ISB Engines at Labs

- SwRI @ San Antonio, Ready to Build for First Run
- PE @ San Antonio, Tuning Cyclic Stage B Parameters
- Lubrizol @ Wickliffe, Tuning for Stage B Conditions
- ExxonMobil @ Paulsboro, Components Received
- Valvoline @ Ashland, Engine & Dyno Installed
- Afton, Richmond, Waiting on Engine, Waiting on Cell Space
- Esso @ Sarnia, Plan to Install an ISB?

ISB Procedure Highlights

- 350 Total Hours, (100-hr Stage A, 250-hr Cyclic Stage B)
- First 100 Hours at 1,600 RPM & 20 kg/hr, 107 kPa abs EBP, 110 C Oil Temp
- Retard Timing 14-16° to Generate Soot (use NGET)
- Soot Window of 3.25 +/- 0.25% at 100 Hours
- Charge Engine with 14.5kg Oil Total (Some into Filter)
- Two Flushes
- External Oil Adder System, External Oil Cooler
- Oil Sample @ 25, 50, 75, & 100 Hr, 1,000 g Forced Add
- Return Timing to Factory Spec for Final 250 hr Stage B
- Run Multi-step Valvetrain Wear Cycle for next 250 hr
- Oil Sample @ 150, 200, 250, 300, & 350 hr with No Additional Oil Adds

Cummins ISB Pan Fitting Locations for External Oil Adder System



ISB Procedure Highlights

- Coolant Out Temperature 99 Degrees C
- Engine Oil Sump Temperature 110 Degrees C
- Fuel Temperature 40 Degrees C
- Intake Manifold Air Temperature 68 Degrees C, 114mm
- Estimate 9,000 L Fuel per Test
- Use Cummins Complete PG Coolant
- 107 kPa Absolute Exhaust Back Pressure Set in Stage A

Cummins ISB Stages A & B

Table 2. Test conditions

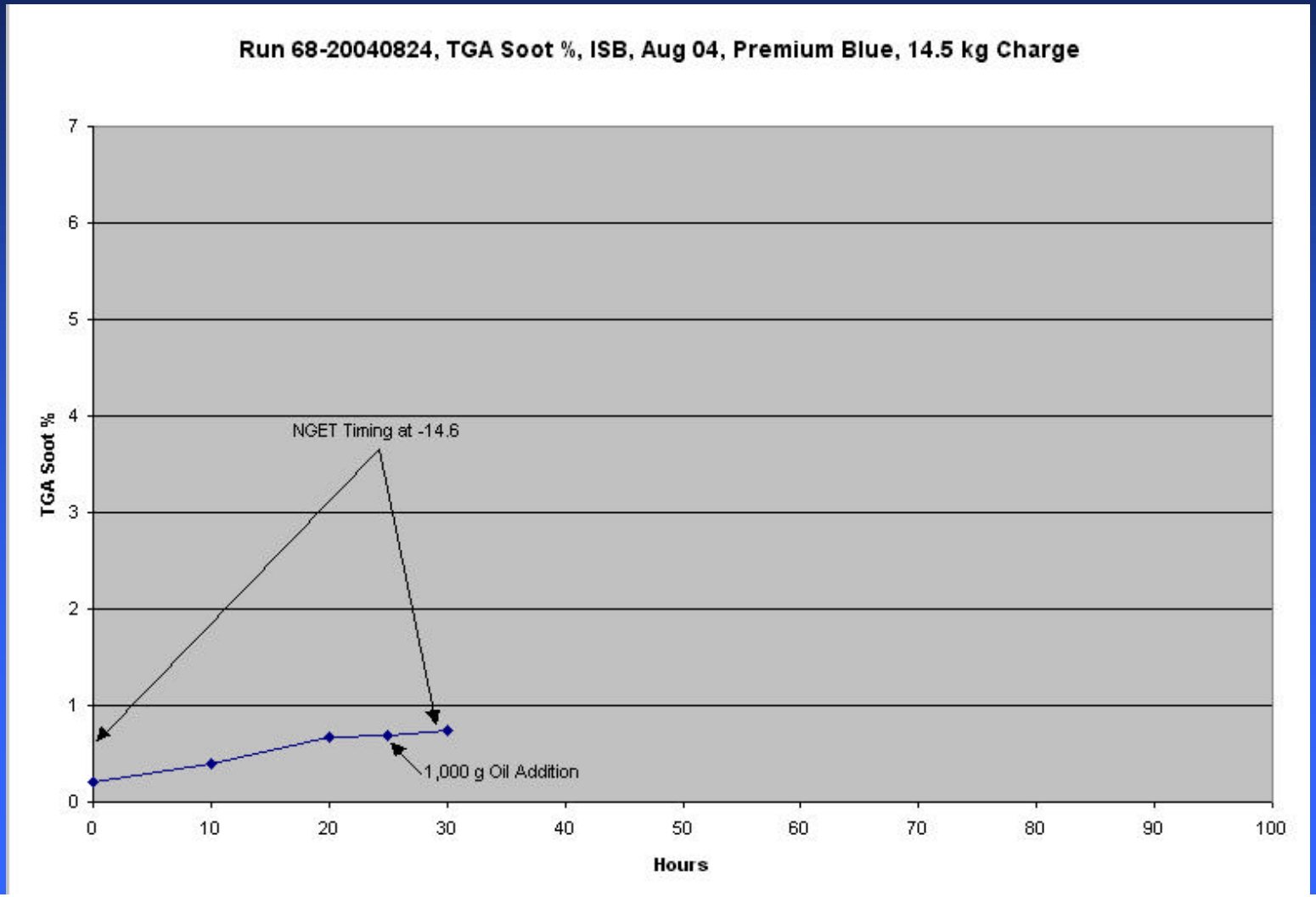
Test Parameter	Stage A	Stage B	Units	Limits
Time, hr	100	250***		
Engine speed	1,600	Varies	RPM	± 10
Torque	Resultant	Varies	Nm	
Fuel Rate	20.0	Varies	kg/hr	±
Coolant out temp	99	99	Deg. C.	± 3
Coolant reservoir pressure	99-107	99-107	kPa	±
Intake manifold temp.	Resultant	Varies	Deg. C.	±
Intake manifold pressure	Resultant	Varies	KPa	± 1.0%
Intake man, 144 mm Depth	68	68	Deg. C	± 2
Inlet air temp	25-35	25-35	Deg. C.	±
Turbine inlet temp	Resultant	Varies	Deg. C.	±
Oil pan temp	110	110	Deg. C.	± 2
Oil pressure	Resultant	Varies	kPa	± 7
Intake air restriction	94-98	Varies	KpaA	± 2
Exhaust back pressure	107	Varies**	KpaA	± 1
Fuel temp	40	40	Deg. C.	± 2
Fuel inlet restriction	*	**	Kpa	Max
Fuel return restriction	*	**	Kpa	Max

* Maintain to avoid cavitation at high pressure fuel pump

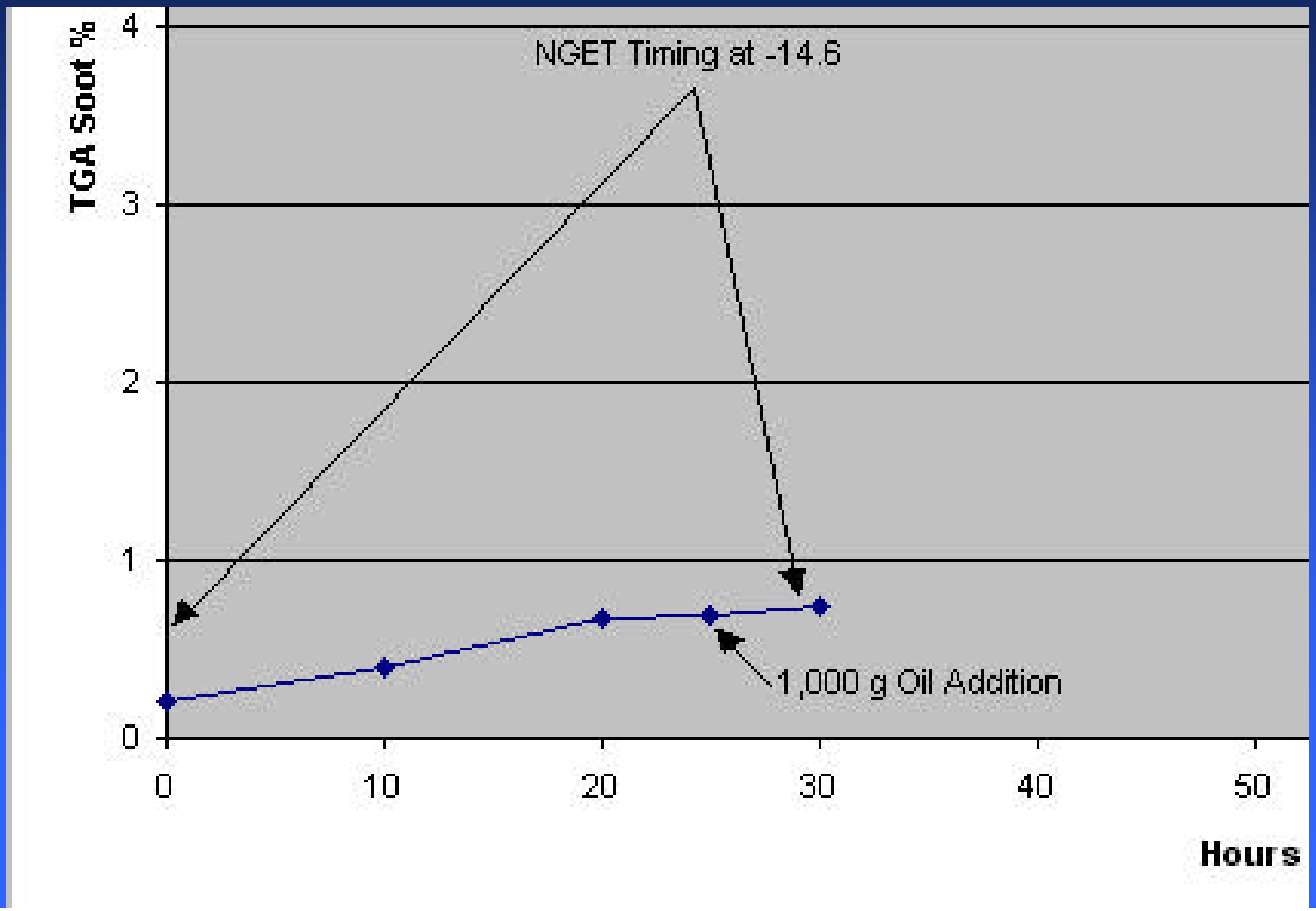
** Lock at final stage A output.

*** Stage B length is determined by test time. A minimum of 32,000 cycles shall be completed for the test to be valid.

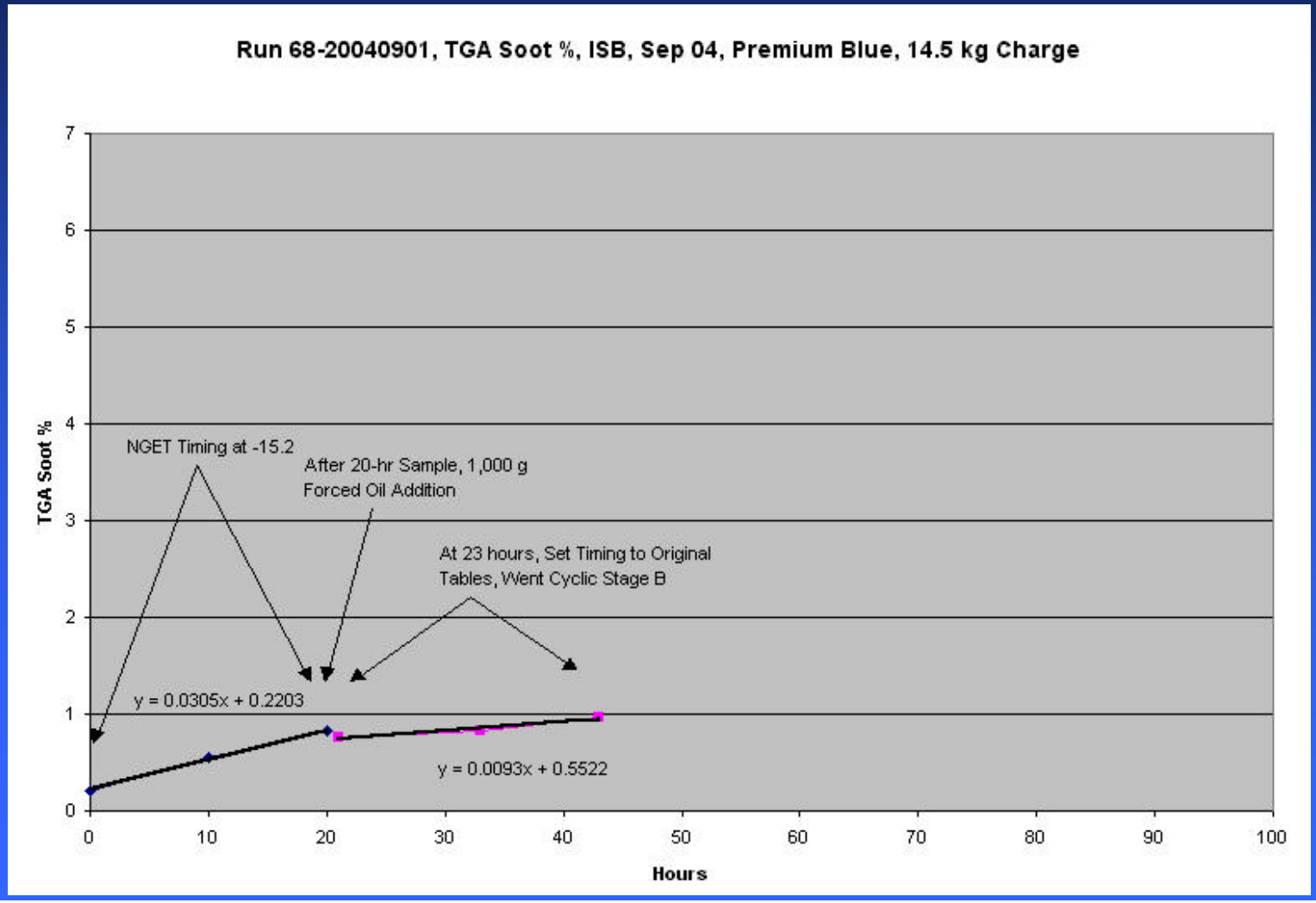
Cummins ISB Soot Map, Stage A



Cummins ISB Soot Map, Stage A



Cummins ISB Soot Map, Stage A then B



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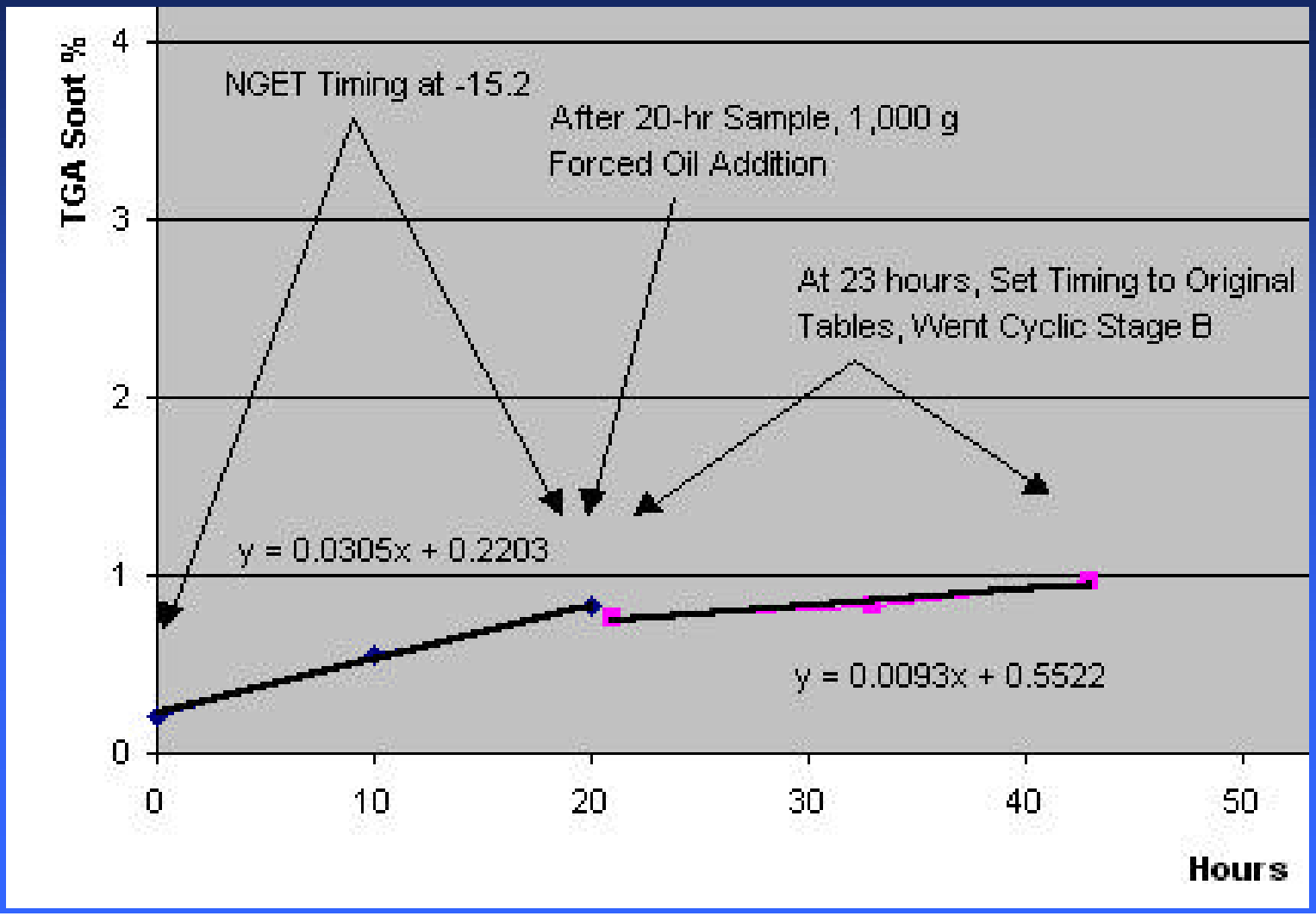

Cummins ISB Cyclic Stage B

Stage B –

The test cycle time is twenty-eight (28) seconds in duration. This cycle is repeated for 250 hours. Return timing to factory set default. Oil samples (4 oz) are taken every 50 hours, discarding 1oz purge. No fresh oil replacement or additions allowed throughout Stage B. Stage length is based on test time. A minimum of 32,000 cycles shall be completed for the test to be valid. The cycle counter advances at the completion of the last low idle step.

Parameter	Duration	Speed (rpm)	Load (Nm)
Accelerate to rated	2.5 s		
Rated speed	6.0 s	2600*	WOT (800 nominal)
Decelerate to idle	2.0 s		
Low idle	1.0 s	800 ± 25	No load excitation
Accelerate speed	2.5 s	1600 minimum	550 minimum
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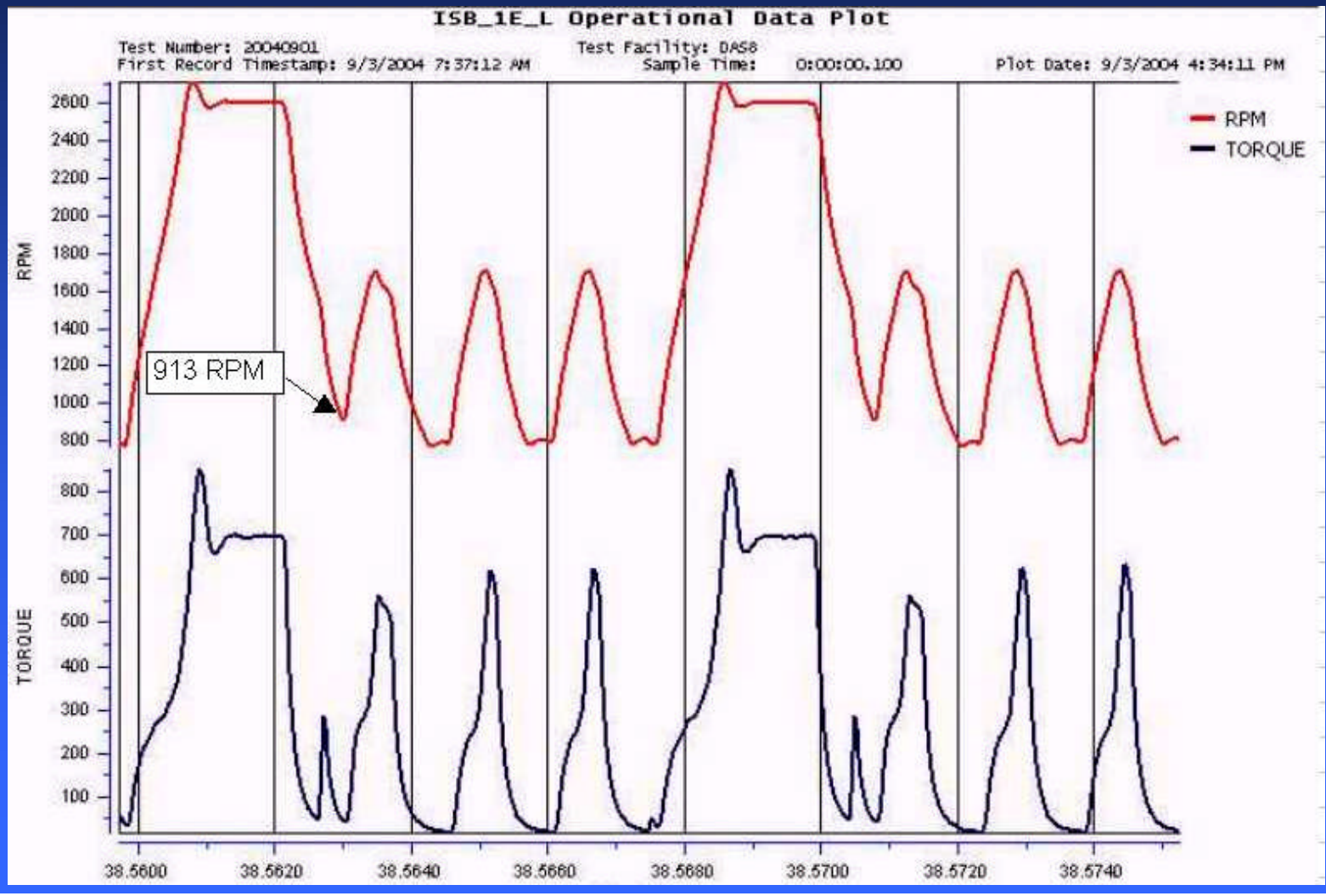
*Engine speed average (6 seconds) to be 2600 +/- 50 RPM.

Cummins ISB Stage B Cycle



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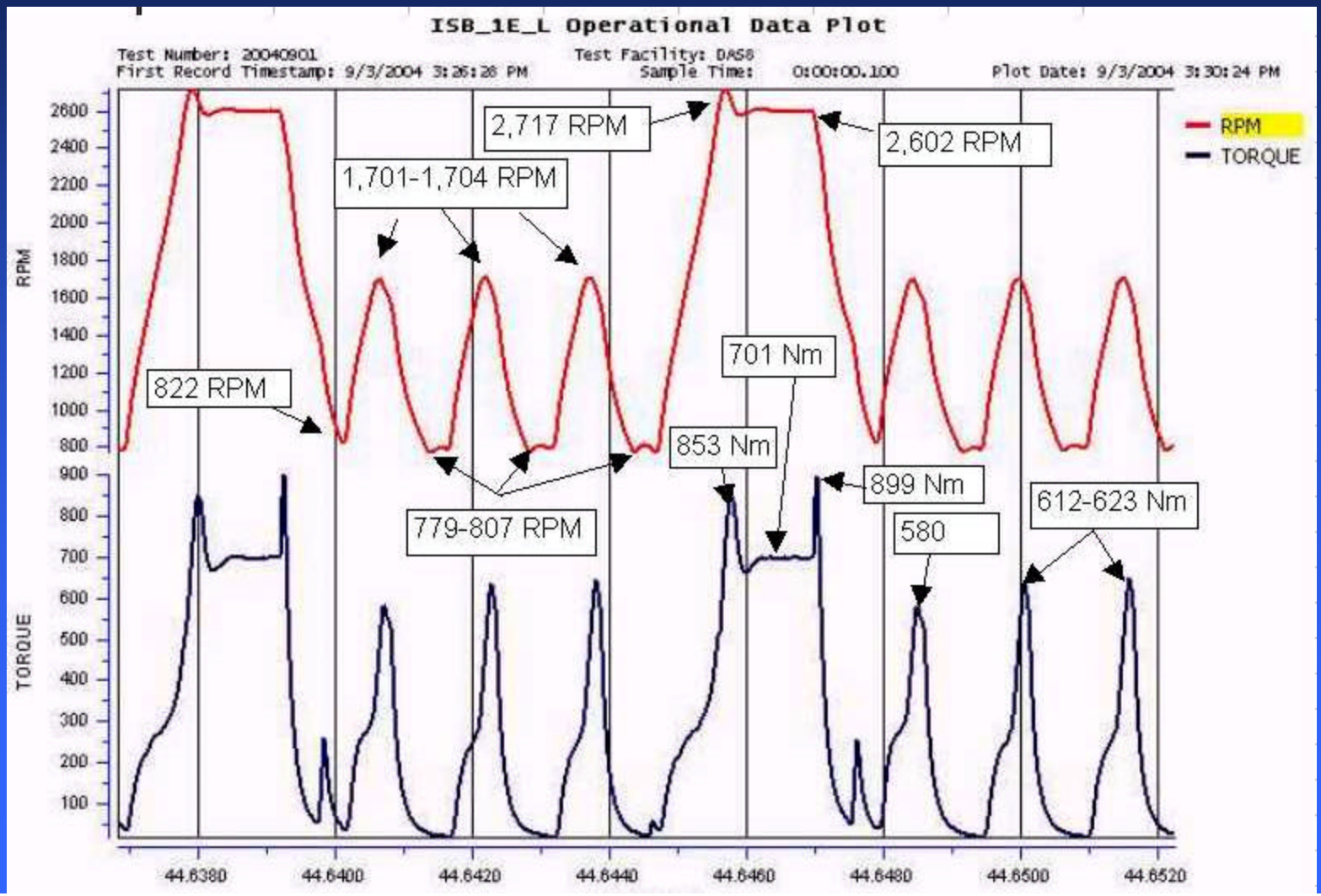


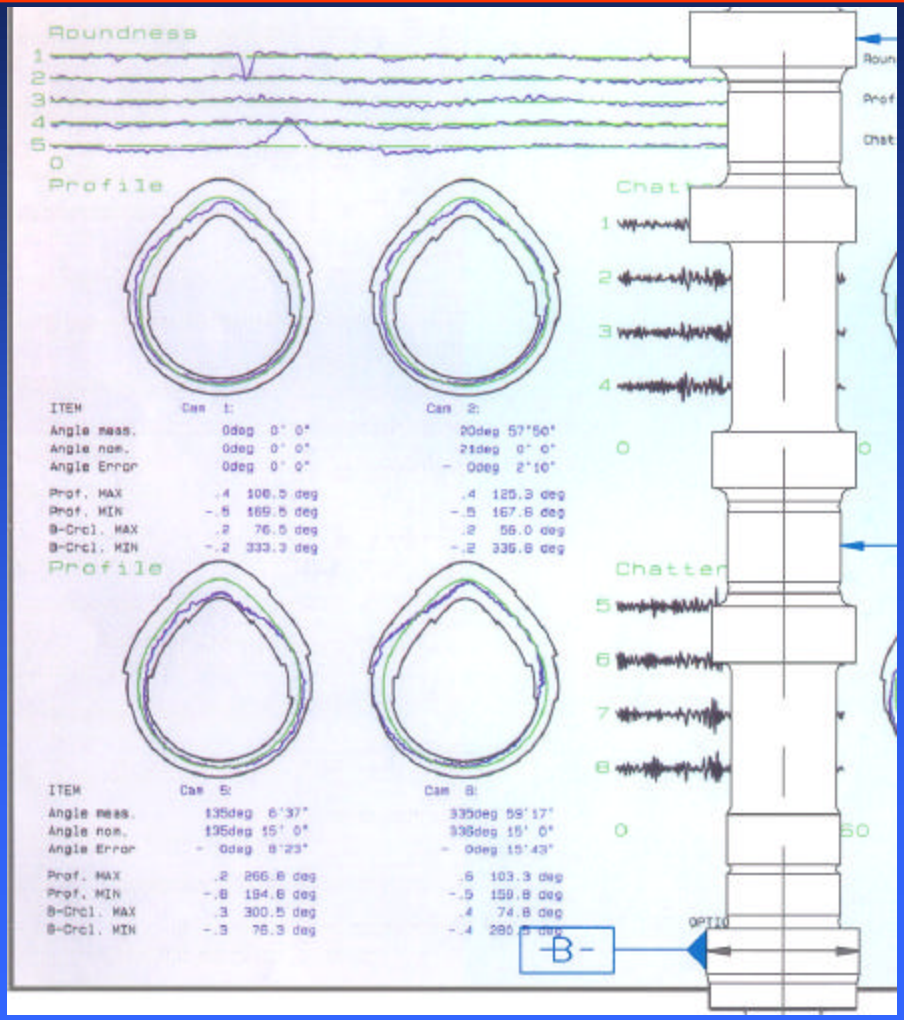
Special Parts

- CPD to Maintain and Etch Critical Parts
- Parts to be Etched in Sets and Sequentially, 1 Through 12
- CPD to Maintain Inventory of Three New Engines
- New Engine Will Require 80 hr Break-in
- Engine Life Dependent on Lubricants Evaluated
- Estimate Up-to Ten Tests per Engine Block
- Points of Wear Include Camshaft Bores in Block

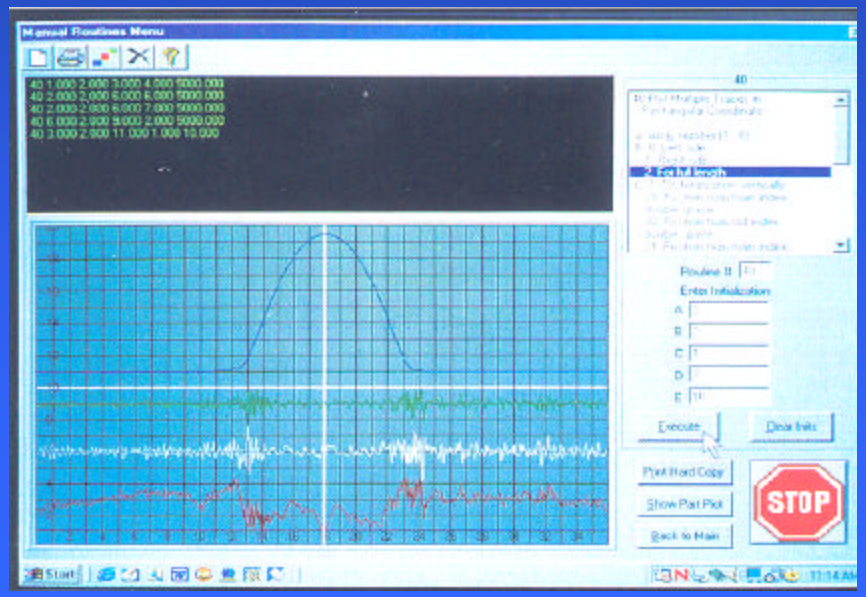
Camshaft Wear Measurements

- Camshaft Lobes are Flat (Not Tapered)
- Most Wear Occurs on Ramps, Not Nose
- Use Adcole Gage to Measure
- Cam Supplier to Measure
- Investigating Alternate Measurement
- Investigate Cam Shipping to Assure Safety

Camshaft Measurements



- Batch of Cams Pre-measured by Adcole
- CPD Maintains BOT Data



Special Parts Measurements

- Crosshead Weightloss (mg)
- Tappet Weightloss (mg) AFTER EnSolve® Cleaning
- Tappet Slider Surface Profile Wear in Two Planes @ 90°
- Rocker Arm Adjusting Screw Weightloss (mg)

New Generation Engineering Tool (NGET)®

- Warren to Send out Latest Version
- Each Lab Will Need License Agreement
- After Loading, Will Need to Call for Activation Code
- Parameters to Measure Sent Out as ISBParameter.lay File
- NGET® is Used to Adjust Timing for First 100 hr

Summary

- Test Development Task Force to Decide on Exh Back Pressure
- Panel to Agree on Shape of Cycle in Stage B
- Warren to Supply Updated Procedure in ASTM Format
- Consider Whether We Want EOT Cams Shipped (How?)
- Industry Participation, Stand Installation, Timing????