
Status of ISM / ISB Test Development

1/13/05

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To HDEOCP

Conclusions from Surveillance Panel

- **Several elements of the ISM test were approved to carry forward to PC-10**
 - **Data from 3 additional tests added to statistical analysis**
 - **Outlier criteria defined for individual parts**
 - **Panel voted to move forward with:**
 - **Wear: Crosshead and adjusting screw**
 - **OFDP @ 150 hrs**
 - **Sludge**

Conclusions from Surveillance Panel

- **Wear: Crosshead and adjusting screw**
 - 830 and 1004 discrimination statistically significant
 - Outlier rejection approved @ 95% for Intake & Exhaust Crossheads, and Inj. Adj. Screws
 - Soot Correction not needed within the window of operation which will go forward
- **OFDP**
 - 150 hr data
 - Natural log transformation
 - 830 and 1004 discrimination statistically significant
 - No soot correction
- **Sludge**
 - No transformations needed
 - Ratings equivalent to M11-EGR

Conclusions from Surveillance Panel

- **Voted to remove Valve Adj. Screw and Rod Bearing wt. loss from further analysis and the procedure.**

ISM Action Items

- **Surveillance Panel will continue to evaluate crosshead wear and injector adjusting screw data**
 - One more test due
- **SP will address lab severity issues**
- **SP will address correlation with M11 EGR**

Executive Summary

- **Both Levels of Soot Data Used in Analysis**
 - Crosshead Wear, Sludge, Oil Filter Delta Pressure, Injector Screw, Valve Adjusting Screw, Bearing Wear
- **Soot Correction for CWL and IAS Possible**
- **Oil Discrimination on Some Parameters**
- **Lab A has Significantly Higher Oil Consumption and Some Lower Sludge Ratings**
- **Lab D has Significantly Higher CWL**
- **Lab B has Significantly Higher BWL**
- **Outlier Criteria a Possibility, but NOT Used in Conjunction with Soot Correction**

ISM Matrix

Stage: Avg Soot	Lab A	Lab G	Lab B	Lab D
ISMA	1: 3.7% 2: None	1: 3.4% 2: None	1: None 2: None	1: None 2: None
1004-3	1: 3.5% 2: 4.3%	1: 3.4% 2: 3.9%	1: 3.5% 2: 3.9%	1: None 2: None
830-2	1: None 2: 4.0%	1: None 2: 3.8% 2: 3.8%	1: None 2: 4.1% 2: 3.7%	1: None 2: 3.8% 2: 4.0%

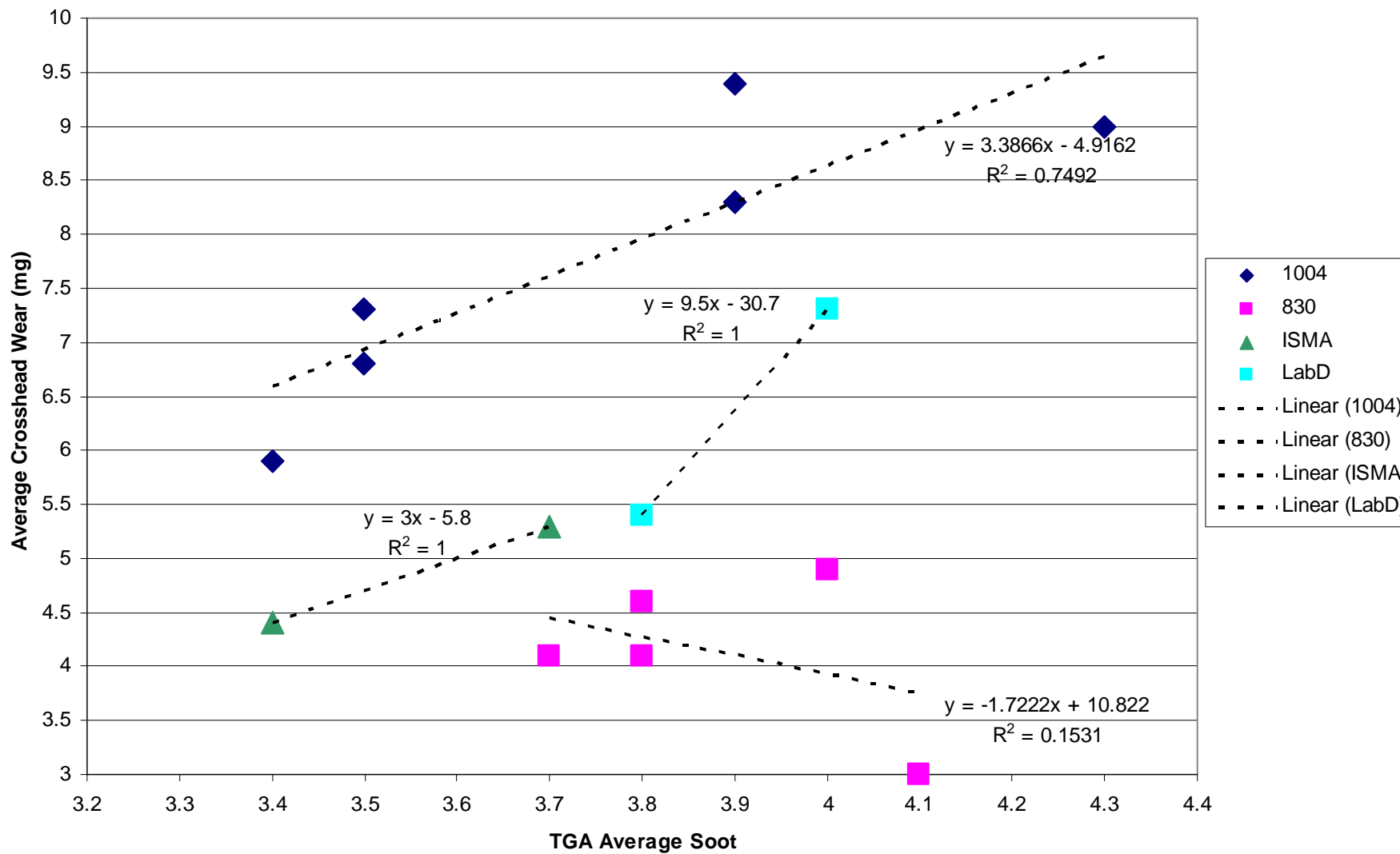
Cross Head Weight Loss

- **Model Fit: $CWL=f(\text{Lab, Oil, Average Soot})$**
 - Lab D Severe
 - All 3 Oils Statistically Significantly Different
 - CWL Increases 3.15 per 1% Avg Soot
- **With Outlier Criteria (95% and 99%)**
 - **Model Fit: $CWL=f(\text{Lab, Oil, High vs Low Soot Target})$**
 - Lab D Severe (Not Different from A with 95% Outlier Criteria)
 - All 3 Oils Statistically Significantly Different (ISMA:1004 Tukey p-value=0.06 with 95% Outlier Criteria)
 - **CWL Higher at Higher Soot Target, BUT CANNOT Establish Linear CWL:Soot Relationship**

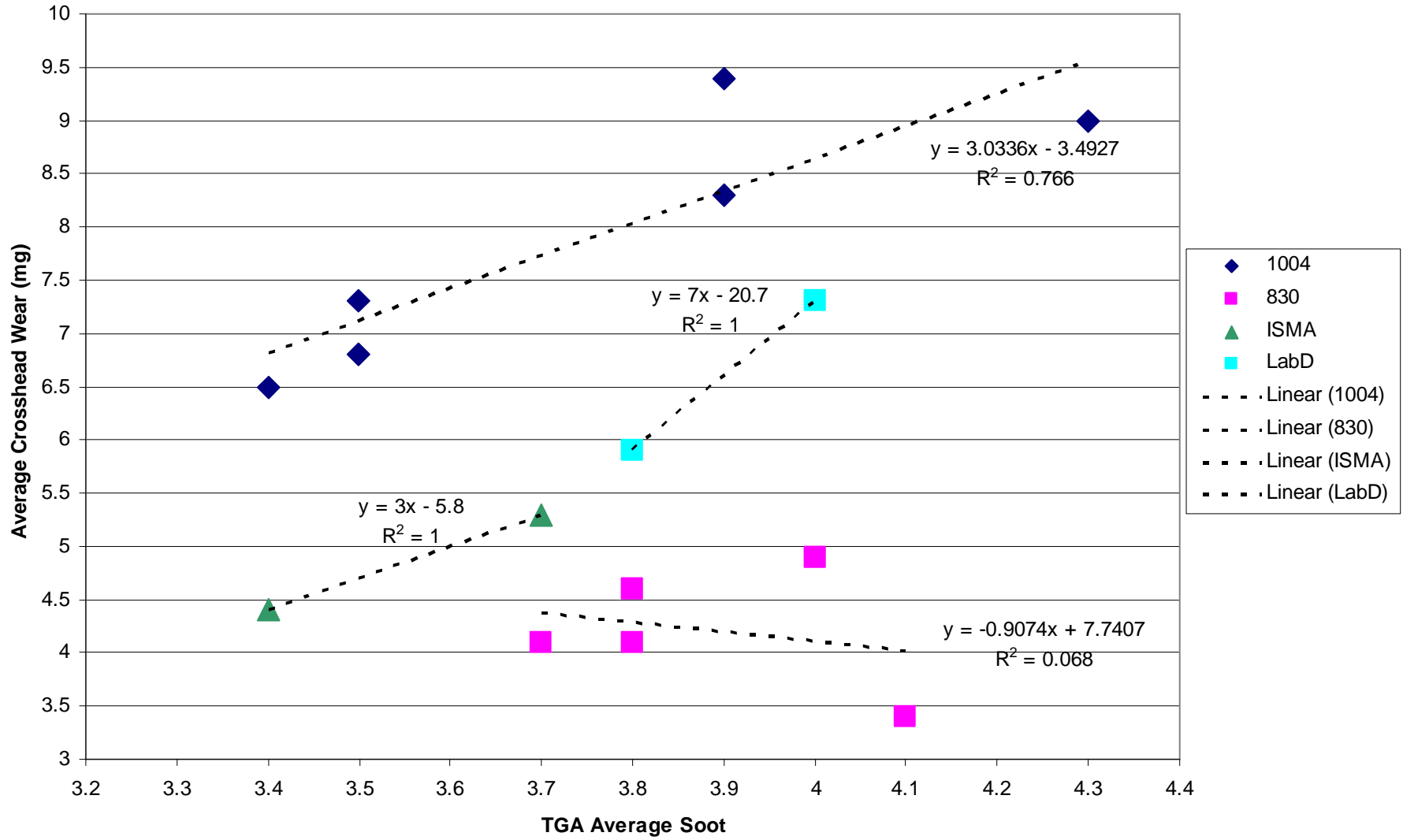
Cross Head Weight Loss

Crosshead Weight Loss			
At New Soot Level			
95% Outlier Criteria	Oil 1004	Oil 830	Oil ISMA
CWL LS Mean	9.4283	4.7652	7.5191
CWL Mean	8.9000	4.7714	7.0833
CWL StdDev	0.5704	1.3462	0.6364
CWL LS Mean (Lab D*)	8.9000	4.2369	6.9908
CWL Mean (Lab D*)	8.9000	4.1400	7.0833
CWL StdDev (Lab D*)	0.5704	0.7232	0.6364
Pooled s from Model	0.7472		
M11 EGR Target	99.8000	12.2000	5.1000
Crosshead Weight Loss			
At New Soot Level			
99% Outlier Criteria	Oil 1004	Oil 830	Oil ISMA
CWL LS Mean	9.4742	4.8774	7.3734
CWL Mean	8.9000	4.9000	6.8833
CWL StdDev	0.4351	1.3153	0.6364
CWL LS Mean (Lab D*)	8.9000	4.3032	6.7992
CWL Mean (Lab D*)	8.9000	4.2200	6.8833
CWL StdDev (Lab D*)	0.4351	0.5718	0.6364
Pooled s from Model	0.5674		
M11 EGR Target	99.8000	12.2000	5.1000

ISM Matrix Average Crosshead Wear as a Function of Soot
Two-Sided 95% Outlier Screening



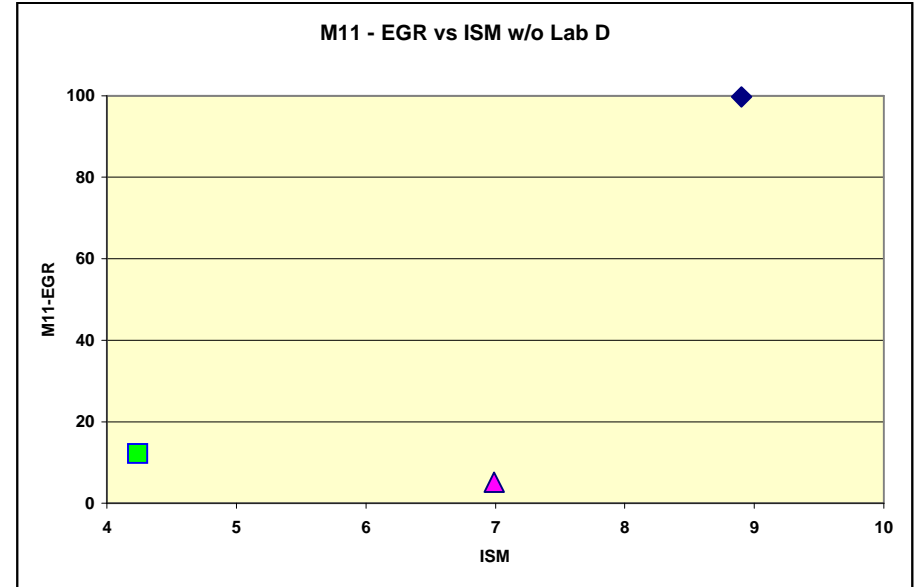
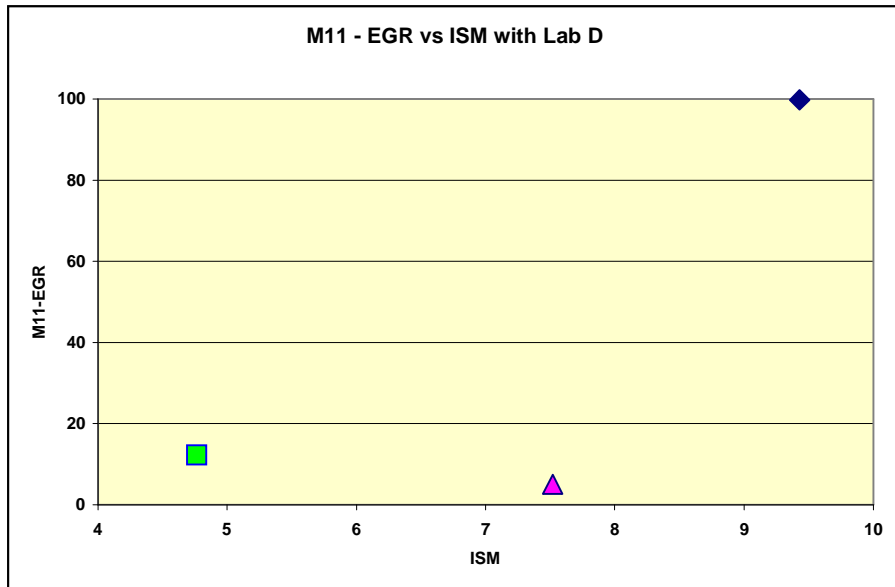
ISM Matrix Average Crosshead Wear as a Function of Soot
Two-Sided 99% Outlier Screening



Cross Head Weight Loss

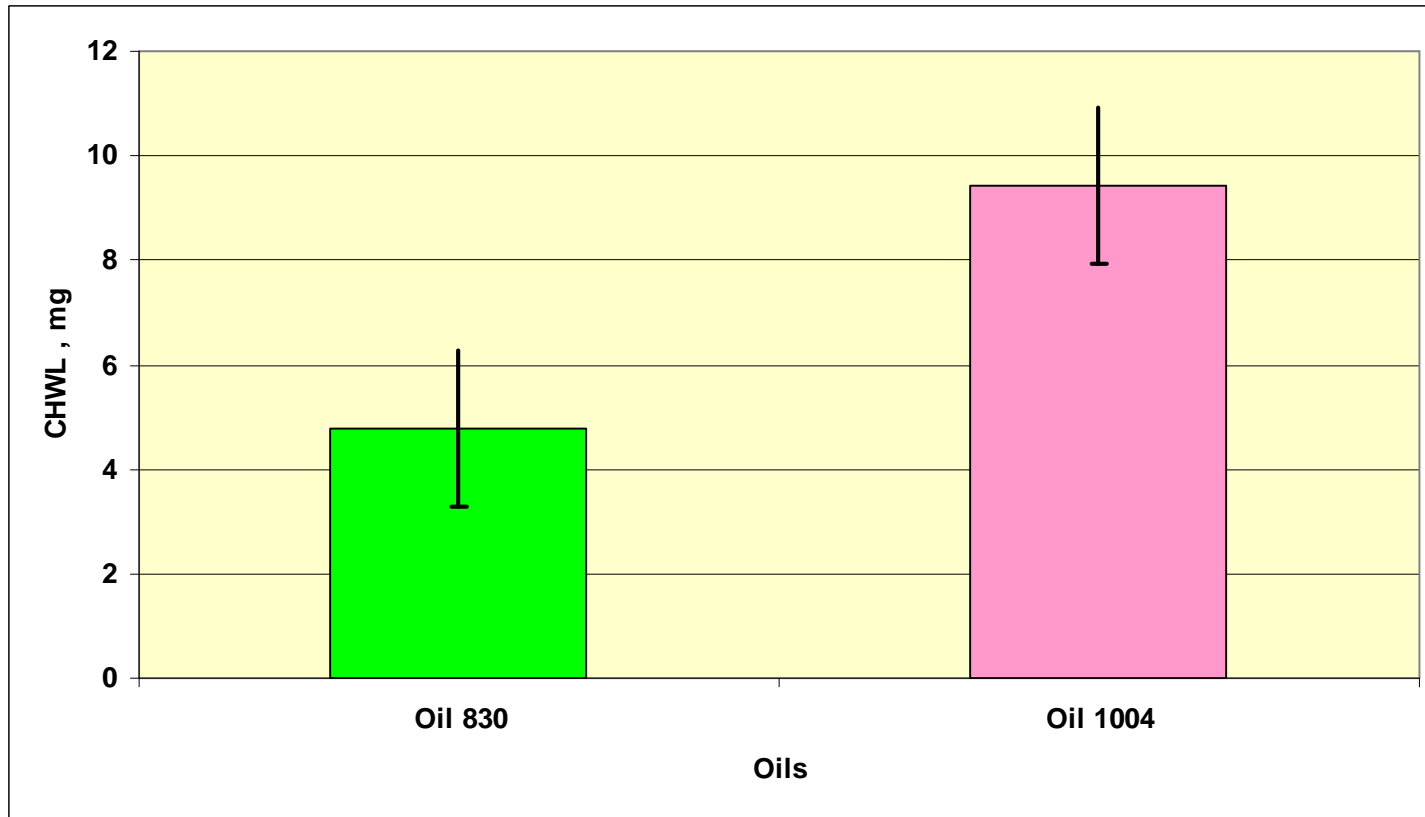
- **Within the band of soot values expected and the high condition going forward, and with outlier rejection, there is no need for a soot correction**
- **Good discrimination is maintained**
- **Repeat analysis with values in current soot window**

Relation of M11-EGR and ISM



Crosshead Wt Loss Discrimination

- High soot level
- CHWL +/- 2 sigma

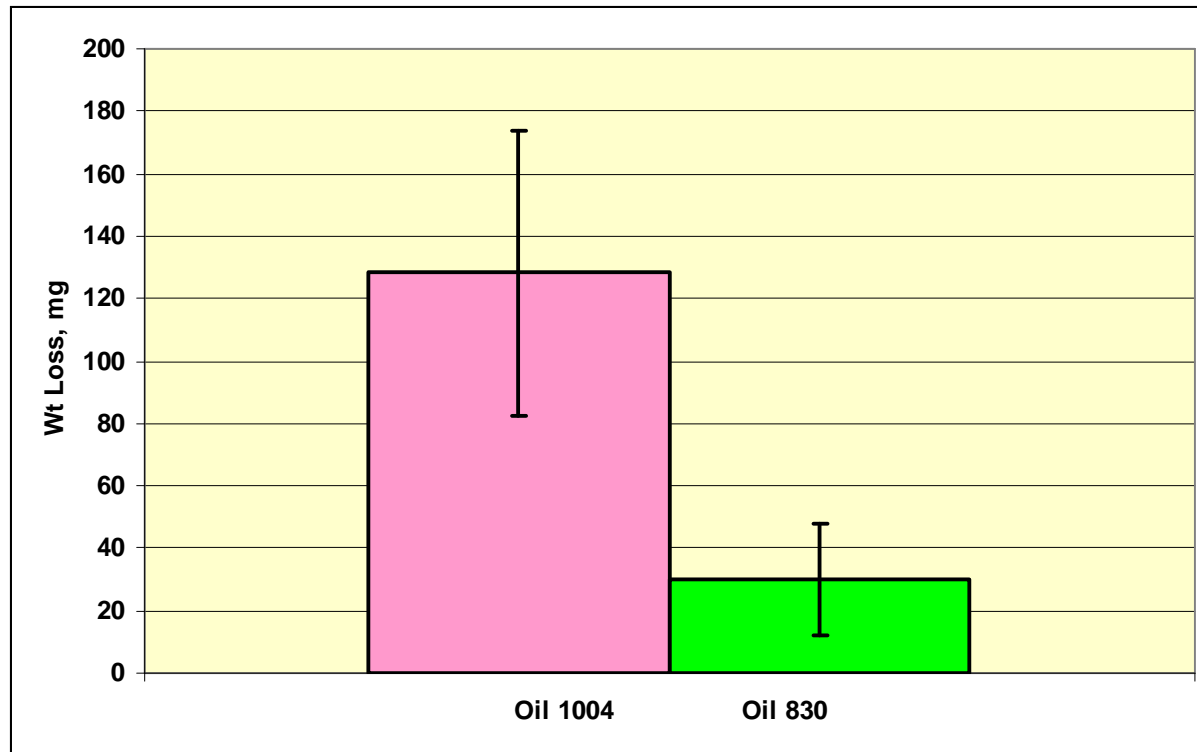


Injector Adjusting Screw Weight Loss

- **Model Fit: $AVGIAS=f(\text{Lab, Oil, Average Soot})$**
 - **No Lab Differences**
 - **Oil 830 Statistically Significantly Different**
 - **Oil 830 Marginally Statistically Significantly Different from Oil ISMA (Tukey p-value=0.07)**
 - **AVGIAS Increases 111.74 per 1% Avg Soot**
- **Repeat analysis with values from current soot window**

Injector Adjusting Screw Weight Loss

Injector Screw Wt Loss at New Soot Level	1004	830
IS LS Mean	128.3	30.2
StdDev	22.8	8.9

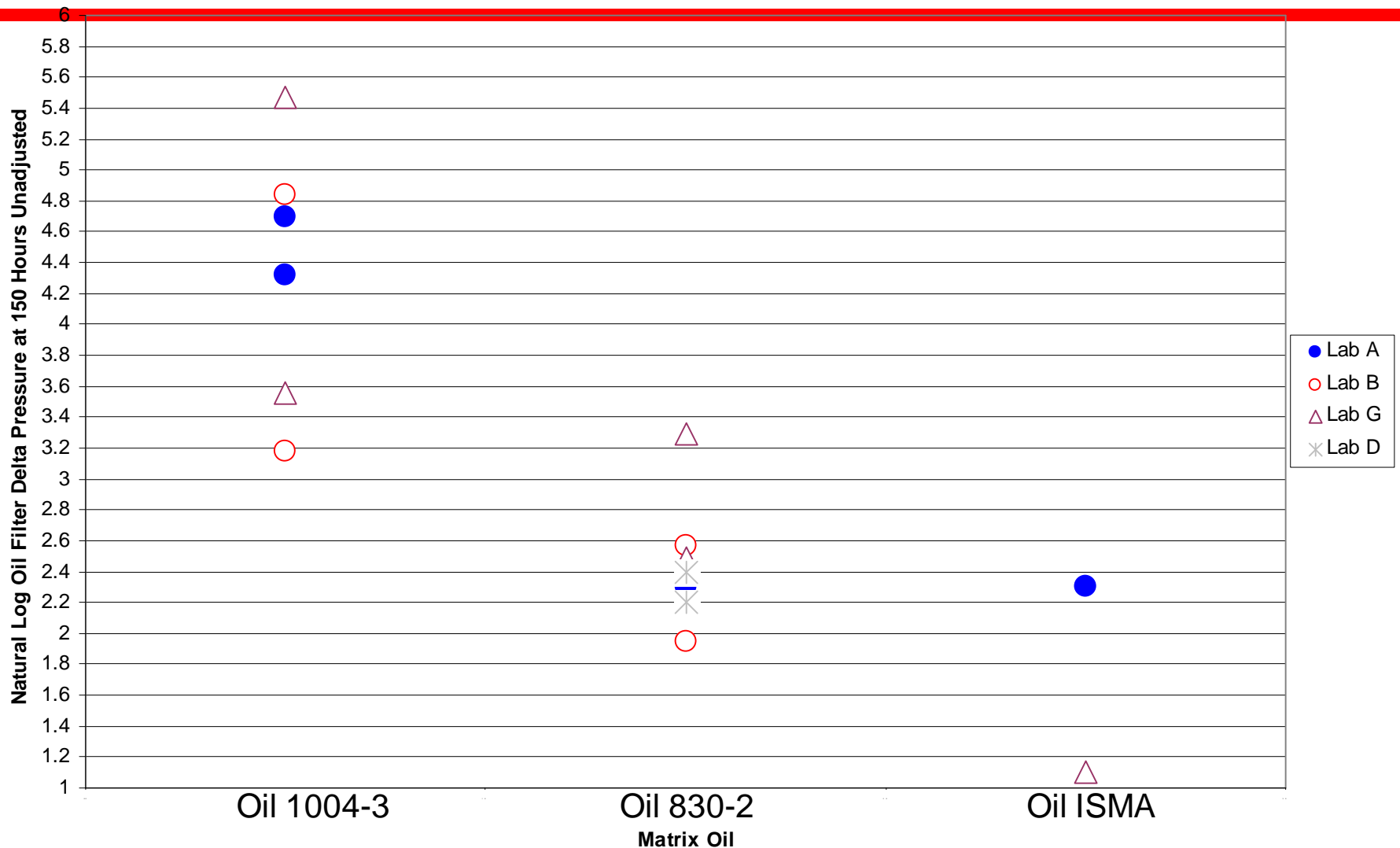


Oil Filter Delta Pressure

- **Model Fit: FDP=f(Lab, Oil)**
 - **No Lab Differences**
 - **Oil 830 Marginally Statistically Significantly Different from Oil 1004 (Tukey p-value=0.07)**

Oil Filter Delta Pressure	Oil 1004	Oil 830	Oil ISMA
FDP LS Mean	100.5075	12.4675	-1.7325
FDP Mean	101.3333	12.7143	6.5000
FDP StdDev	78.0197	6.6009	4.9497
Pooled s from Model	56.1800		
M11 EGR Target	182.0000	141.9000	144.0000

ISM Matrix Oil Filter Delta Pressure as a Function of Lab and Oil



ISM Action Items

- **Surveillance Panel will continue to evaluate crosshead wear and injector adjusting screw data**
 - One more test due
- **SP will address lab severity issues**
- **SP will address correlation with M11 EGR**

ISB Test Development Progress

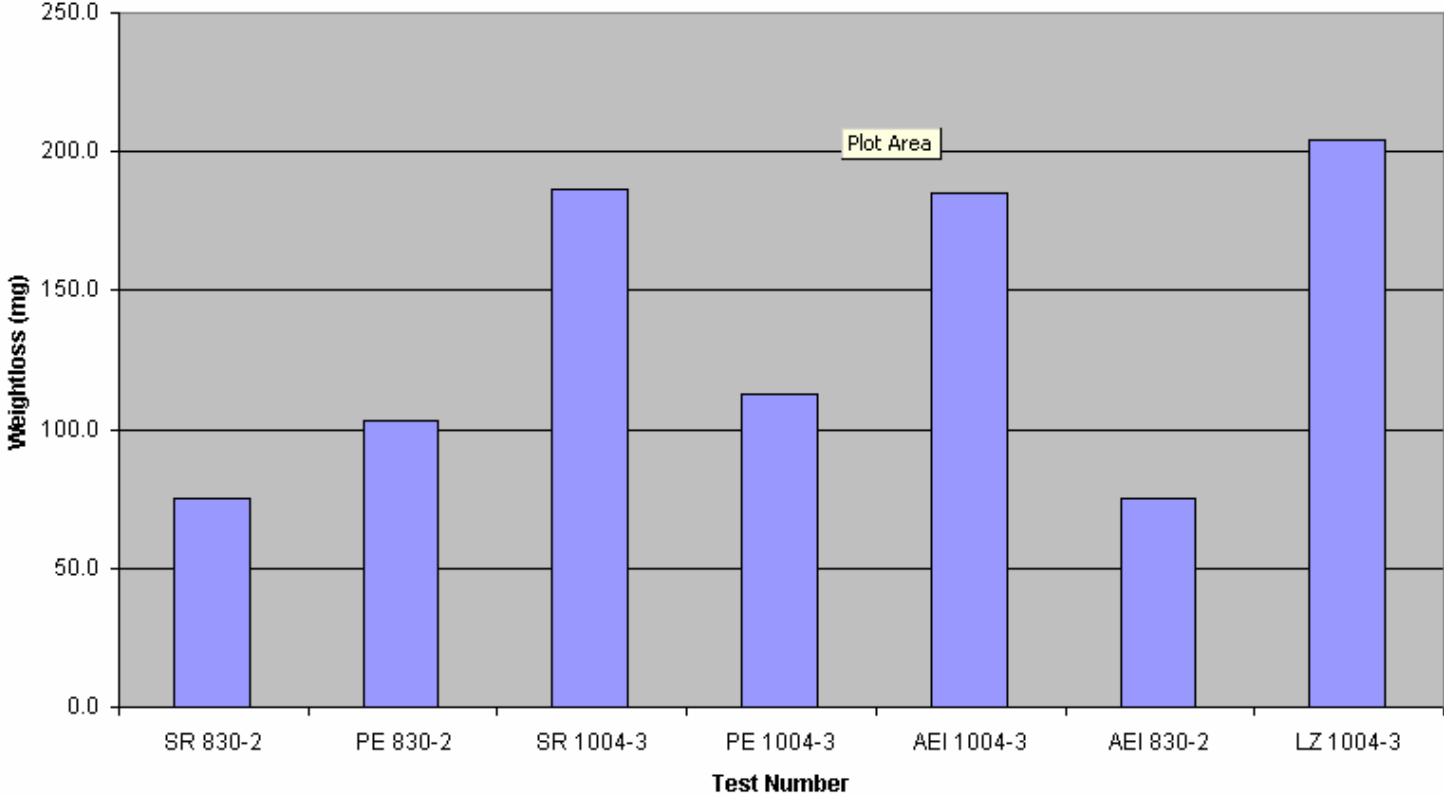
- **Labs and Engines**
- **Procedure**
- **Special Parts and Cam Measurement**
- **Modifications to Hardware and or Procedure**
- **Move Forward to Matrix**

ISB Engines at Labs

- **SwRI @ San Antonio, Completed 830-2 and 1004-3**
- **PE @ San Antonio, Completed two 830-2 and one 1004-3**
- **Lubrizol @ Wickliffe, Completed 1004-3**
- **ExxonMobil @ Paulsboro, Preparing to Run Reference Oil**
- **Valvoline, Ashland, May Run Older Engine Configuration**
- **Afton, Richmond, Waiting on Engine, Waiting on Cell Space**

Mini-Matrix Data

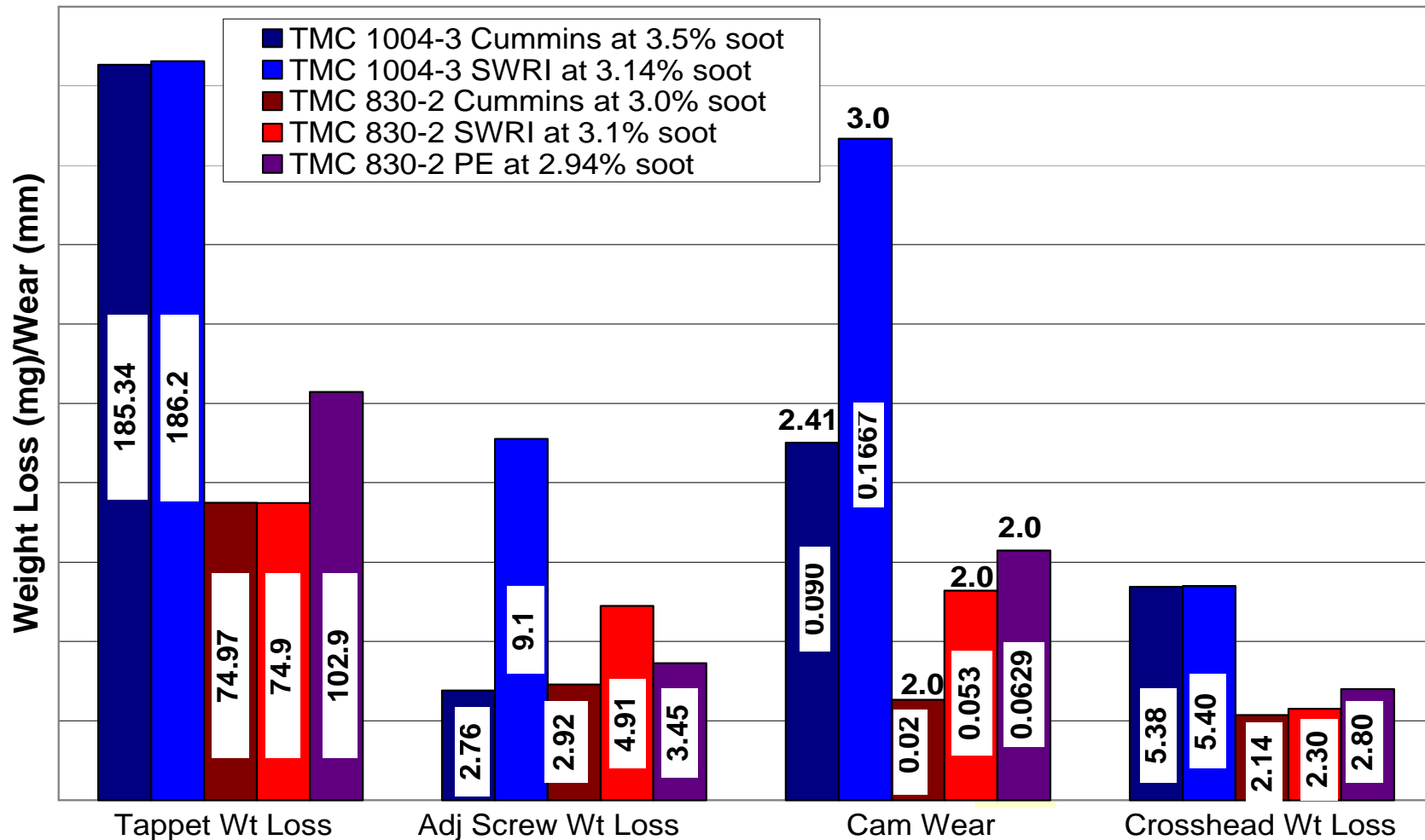
Slider Tappet AVG Weightloss



ISB Camshaft and Tappet Data

Discrimination/Repeatability

ISB Cam Cycle Test Data



ISB Status / Summary

- **Warren to Supply Updated Procedure in ASTM Format**
- **Discrimination maintained with Mini-Matrix**
 - Complete Cam wear data
 - Lab process / severity issues
- **Lab operational data review**
- **Build and Hardware Workshop Feb 1**
- **Matrix Design**