ISB Report Packet

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Scope

- Scope – To develop a lubricant performance test on a Cummins ISB test platform that can discriminate and provide a quality assessment of motor oils in a sliding tappet engine under cyclic conditions. The ISB test development will consider the following parameters for lubricant quality evaluation:

Primary Parameters	Secondary Parameters
Tappet Weight Loss	Push tube scuffing
Cam Lobe Wear	Sludge
Cam Journal Wear	Oil filter delta P
	Adjusting screw wt. loss
	Crosshead weight loss

Objectives

1. Draft of test procedure   12/03
    -   **Preliminary draft completed 01/04**
    -   **"ASTM-like" – in process**

2. Test engines to six labs   1/04
    -   ExxonMobil, Lubrizol, SwRI, Valvoline
    -   PerkinElmer and Ethyl engines 2/04

3. Initiate matrix design   1/04
    -   **Preliminary proposal**

4. Begin matrix testing   To meet API timing

Test Development

- The test method is derived from proven tests at Cummins and will have the same repeatability and discrimination

- Labs will receive 1 engine for shakedown and matrix testing

- Labs will receive all necessary parts for matrix testing

- This test will need to have completed matrix testing and be available to the industry by 3Q 2005

- ➢ Remember that sliding tappets will be used on the design of the 2007 engine

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ISB Operating Conditions

- 2004 EPA Compliant ISB engine rated at 300 HP and 600 ft-lbs torque
  - 100 hours at 1600 RPM and 325 ft-lbs torque
    - 13 – 16 deg retarded timing to meet soot target
    - Soot target 3.5% at 100 hours
  - 250 hours engine wear cycle

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ISB Test Parameters

- Parameters to be rated
  - Primary Parameters
    - Tappet Wear
      - mg wt loss
    - Cam lobe wear
      - mm wear
        » ADCOLE measurement
        » Cams will be pre and post measured by CPD
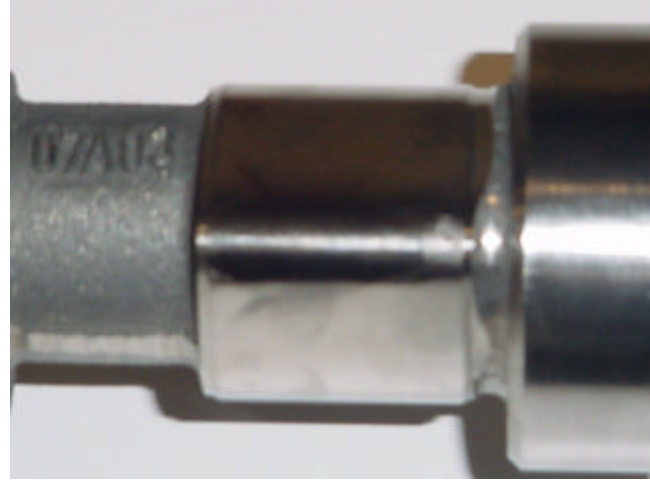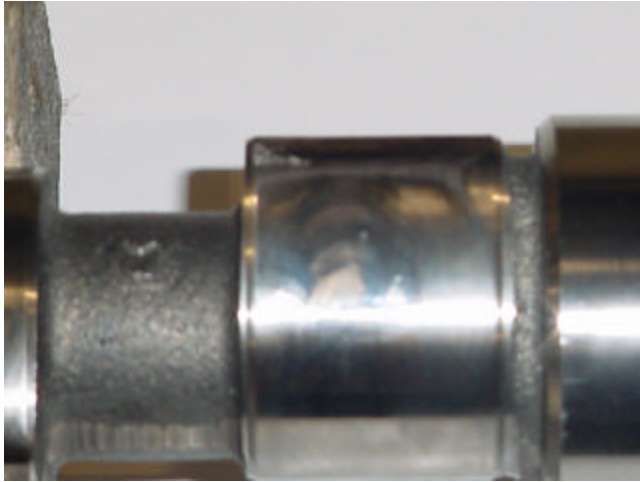   - Cam journal wear
      - mm wear
        » ADCOLE measurement
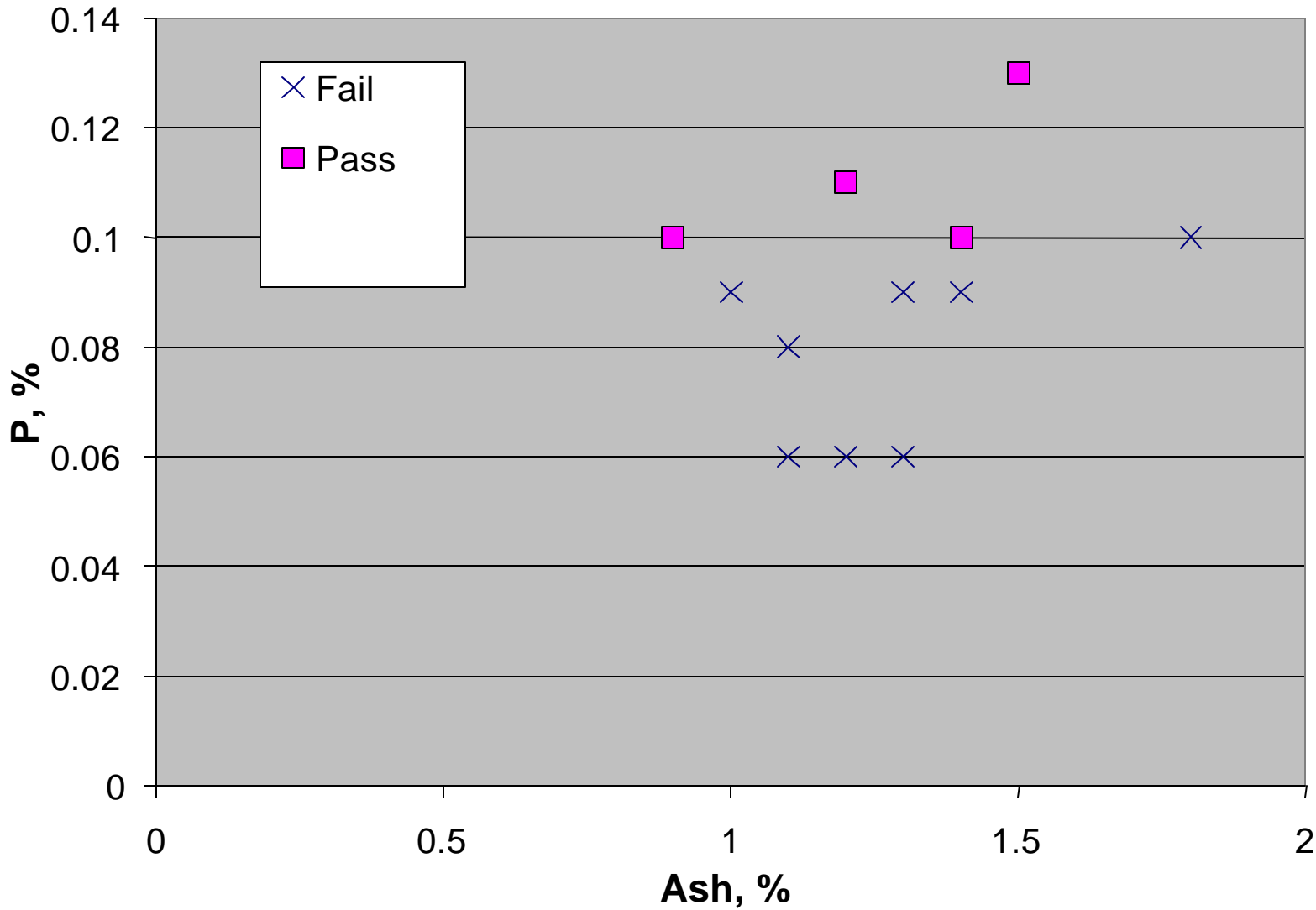
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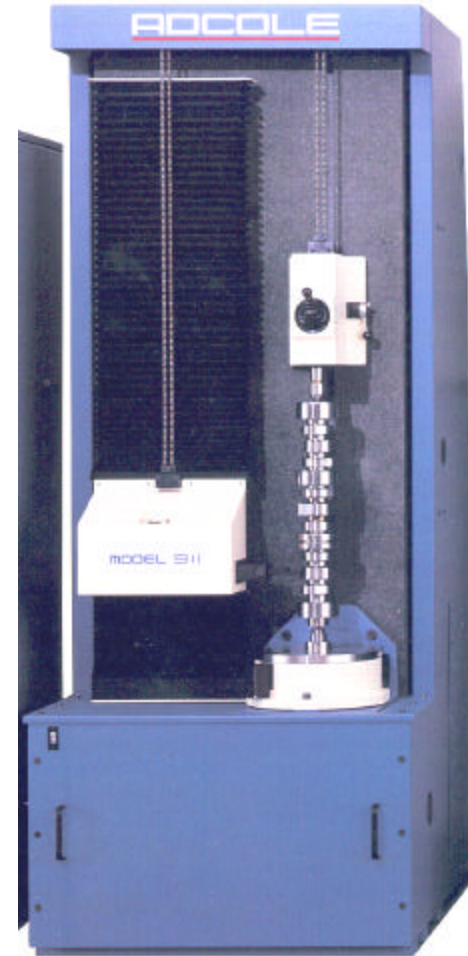
ISB Test Parameters

- Parameters to be rated
  - Secondary Parameters
    - Overhead wear
      - Crosshead Weight Loss, mg loss
      - Adjusting Screw Weight Loss, mg loss
      - Push Tube Scuffing
    - Other parameters
      - Oil Filter Delta Pressure, kPa
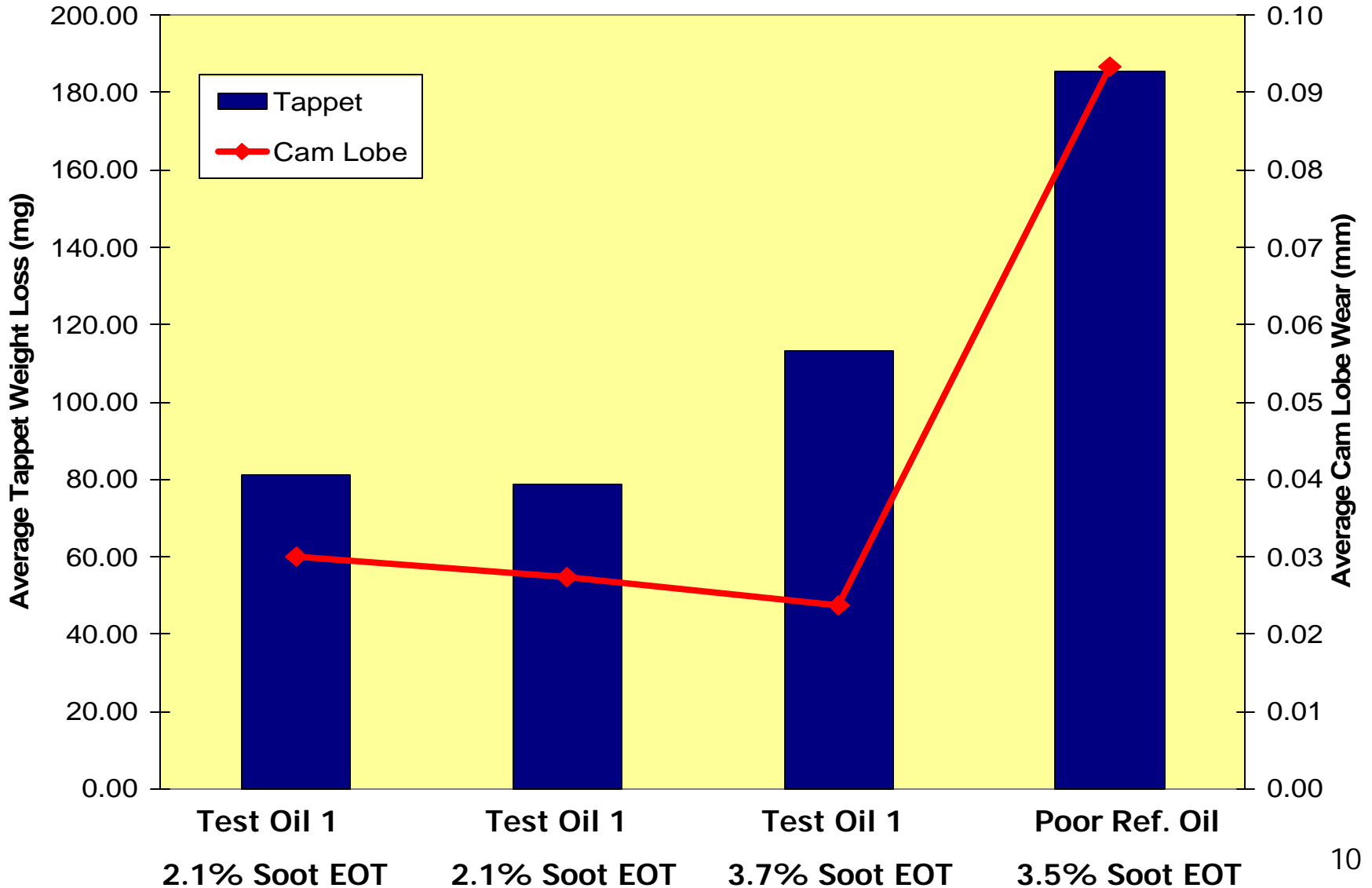   - Sludge, rocker cover and oil pan
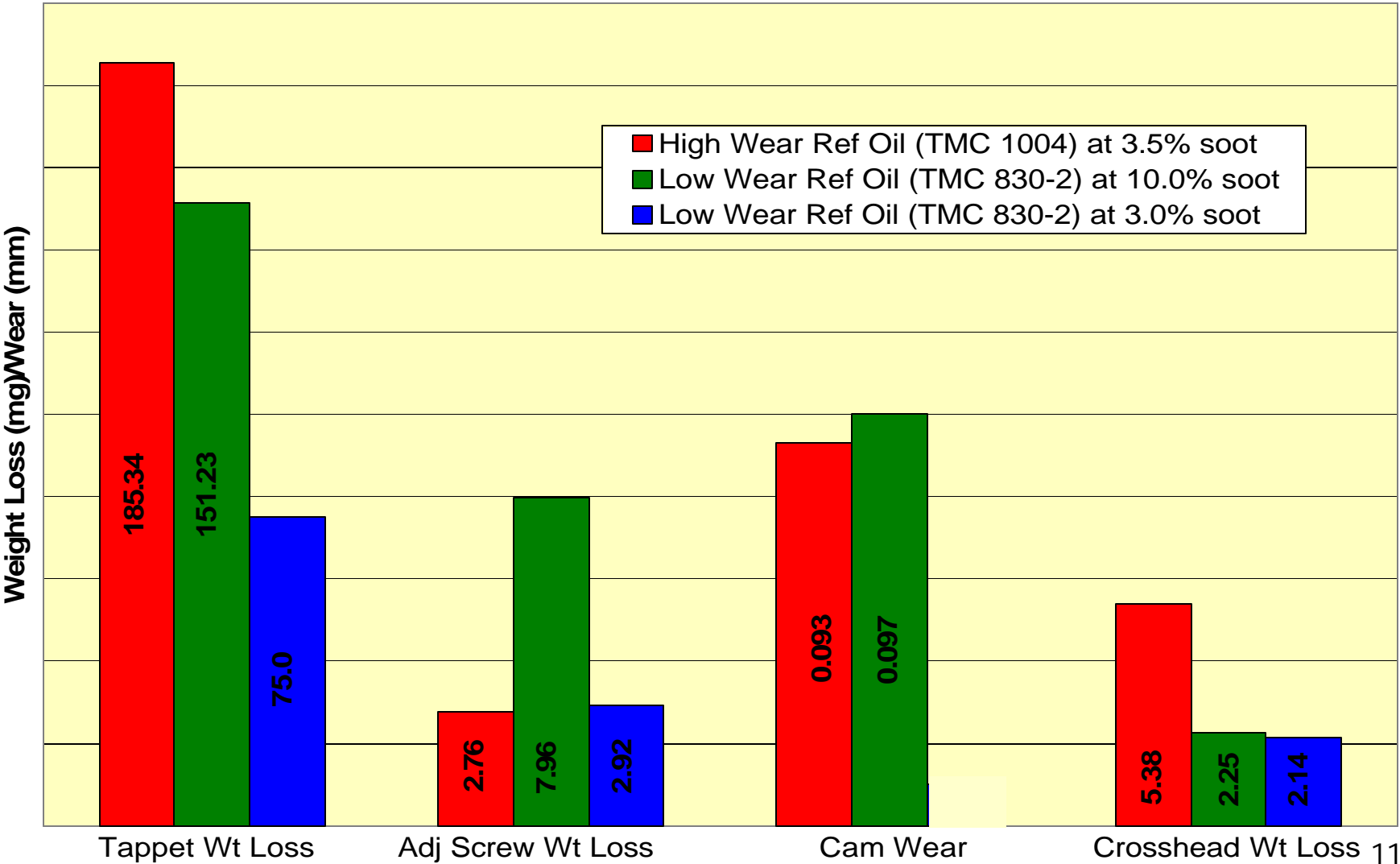
Cam and Tappets After Test

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B Cam Test History

ISB '02 Repeatability/Discrimination

ISB '02 Wear Data

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Preliminary ISB Matrix Designs

Assumptions

- 3 DI/VI combinations, 3 base oils, and 1 Reference Oil
- Every factor level should be run at least 3 times to maintain Power, and at least 4 valid test results in each Matrix stand to account for bias
- At least 8 degrees of freedom (DF) to estimate test variability, and at least 6 repeats on identified Reference Oils
- Main effects and 2-Way Interactions (Except with Stand) are estimable
- No VGRA
- Decision rules for Industry Matrix Testing have been satisfied

Preliminary ISB Matrix Designs

Experimental Test Matrix Design Oils

- 9 matrix oils are formed. Note that PC-10A is the primary featured oil and
- PC-10H is the secondary featured oil.

Base Oil	Technology		
	X	Y	Z
Base Oil 1	PC-10A	PC-10D	PC-10G
Base Oil 2	PC-10B	PC-10E	PC-10H
Base Oil 3	PC-10C	PC-10F	PC-10J

Preliminary ISB Matrix Designs

Test Design 1

Stand 1	Stand 2	Stand 3	Stand 4
J	D	G	B
E	H	C	F
F	C	E	H
G	B	D	J
A	A	A	A
A	A	A	A

- 24 Runs
- BOI but No VGRA
- 8 Runs on One Reference Oil
- 12 df to Estimate Test Standard Deviation

Preliminary ISB Matrix Designs

Test Design 2

Stand 1	Stand 2	Stand 3	Stand 4
A	B	C	C
E	F	D	E
J	G	H	G
B	D	J	A
A	A	A	A

- 20 Runs
- BOI but No VGRA
- 6 Runs on One Reference Oil
- 8 df to Estimate Test Standard Deviation

Preliminary ISB Matrix Designs

Test Design 3

Stand 1	Stand 2	Stand 3	Stand 4
A	B	C	C
E	F	D	E
J	G	H	G
B	D	J	A
A	A	A	A
H	H	H	H

- 24 Runs
- BOI but No VGRA
- 6 Runs on Primary Reference Oil and 5 Runs on Secondary Reference Oil
- 12 df to Estimate Test Standard Deviation

Hardware Modifications