# ISB Report Packet

Warren Totten

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Chicago, IL

# **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

Tappet Weight Loss

Cam Lobe Wear

Cam Journal Wear

Secondary Parameters

Push tube scuffing

Sludge

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

# 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

# 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
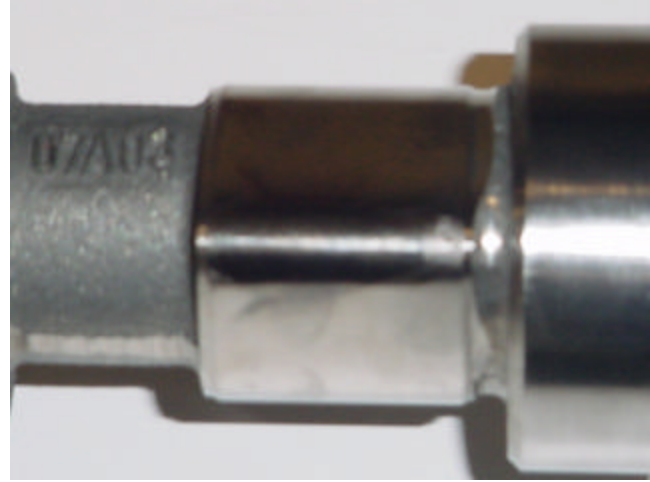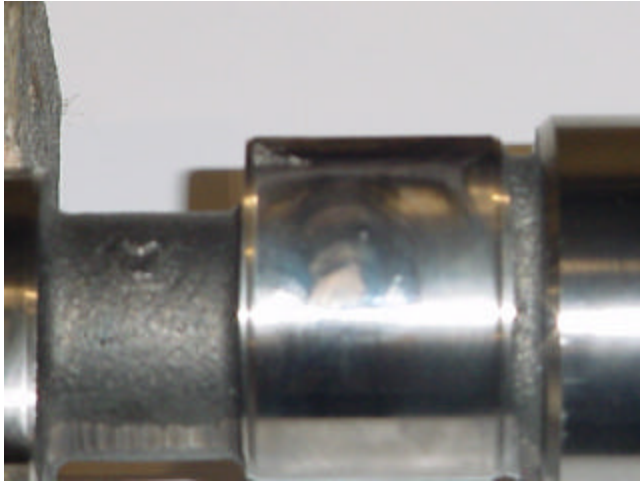      - mm wear
        » ADCOLE measurement
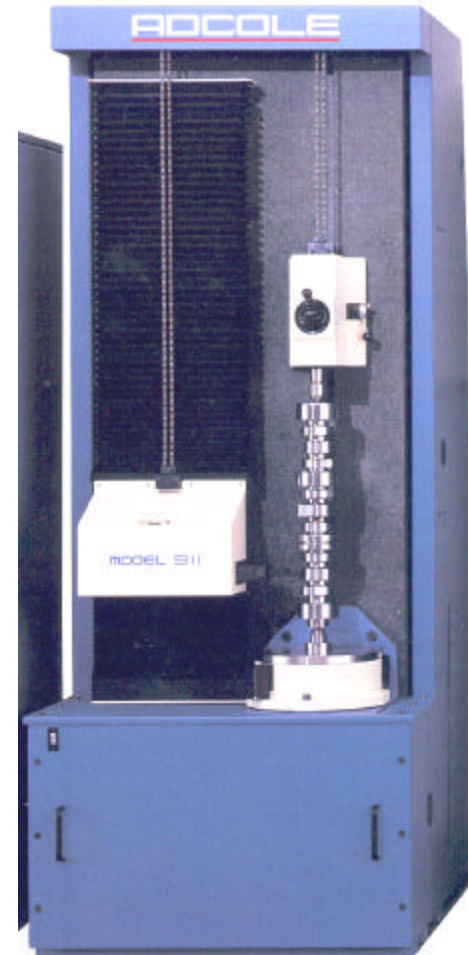
# ISB Test Parameters

- 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
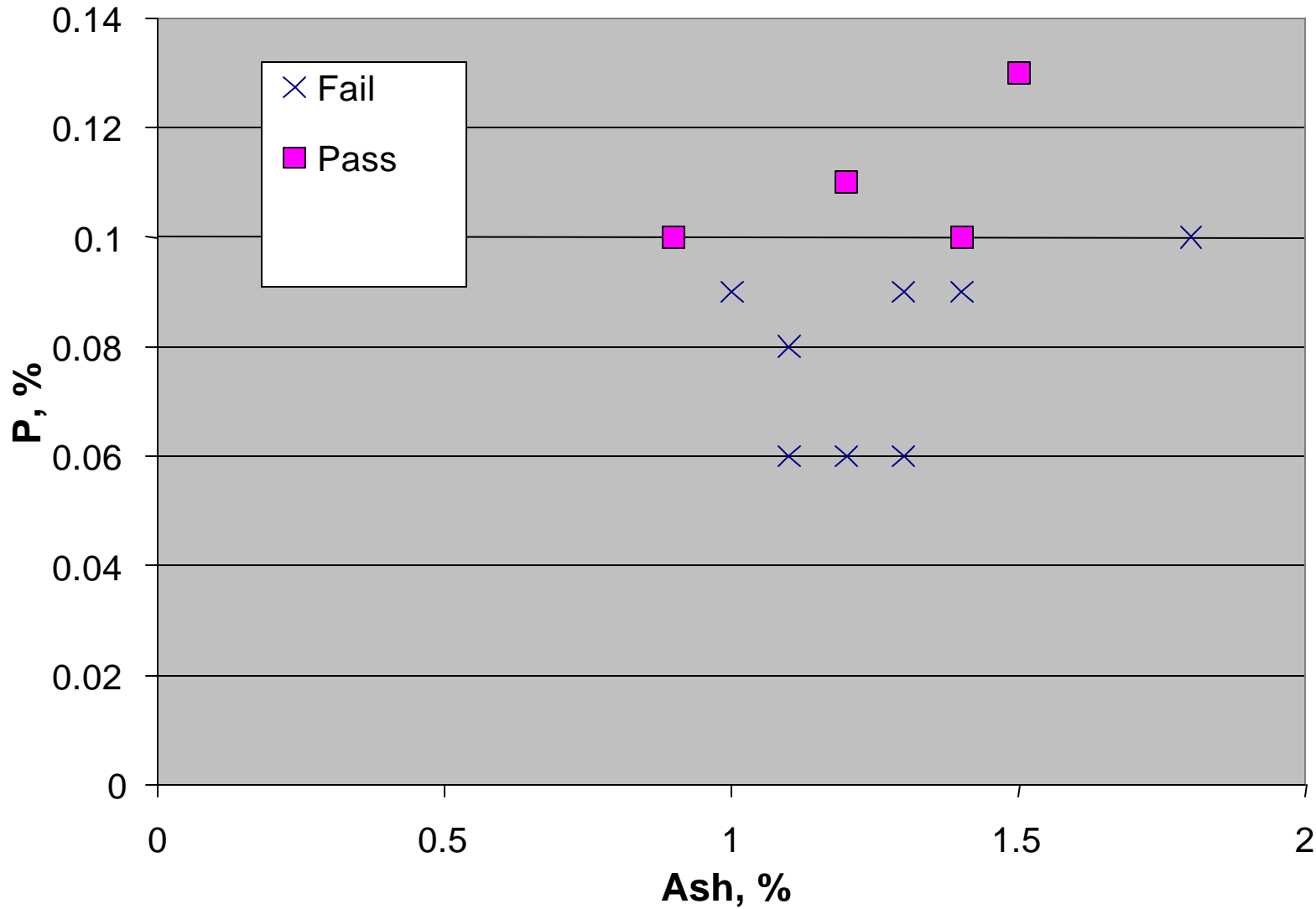
# Cam and Tappets After Test

# B Cam Test History

# ISB '02 Repeatability/Discrimination

# ISB '02 Wear Data



**Legend:**
- ■ High Wear Ref Oil (TMC 1004) at 3.5% soot
- ■ Low Wear Ref Oil (TMC 830-2) at 10.0% soot
- ■ Low Wear Ref Oil (TMC 830-2) at 3.0% soot

**Y-axis:** Weight Loss (mg)Wear (mm)

| Category | High Wear (red) | Low Wear 10.0% (green) | Low Wear 3.0% (blue) |
|---|---|---|---|
| Tappet Wt Loss | 185.34 | 151.23 | 75.0 |
| Adj Screw Wt Loss | 2.76 | 7.96 | 2.92 |
| Cam Wear | 0.093 | 0.097 | |
| Crosshead Wt Loss | 5.38 | 2.25 | 2.14 |
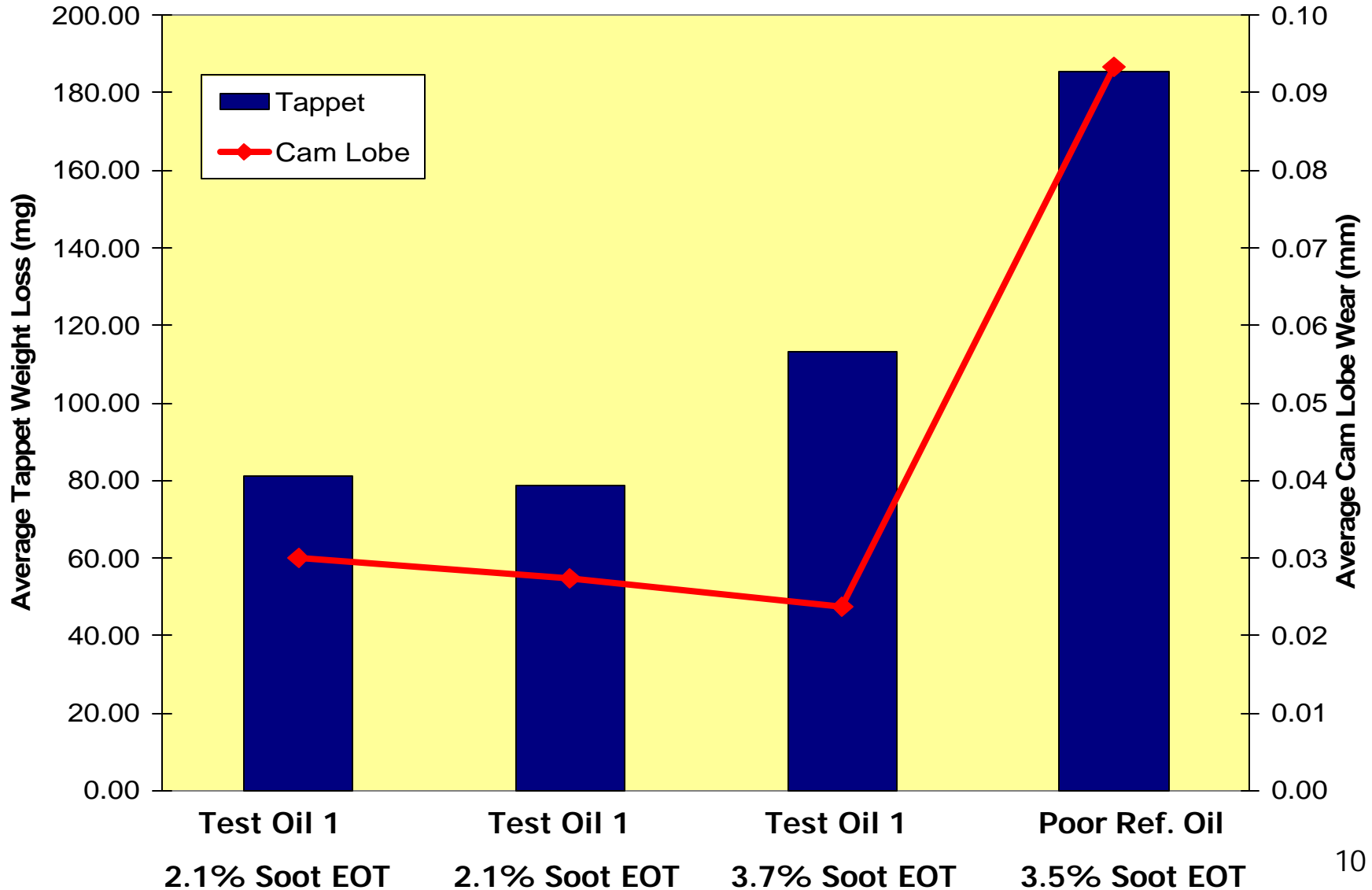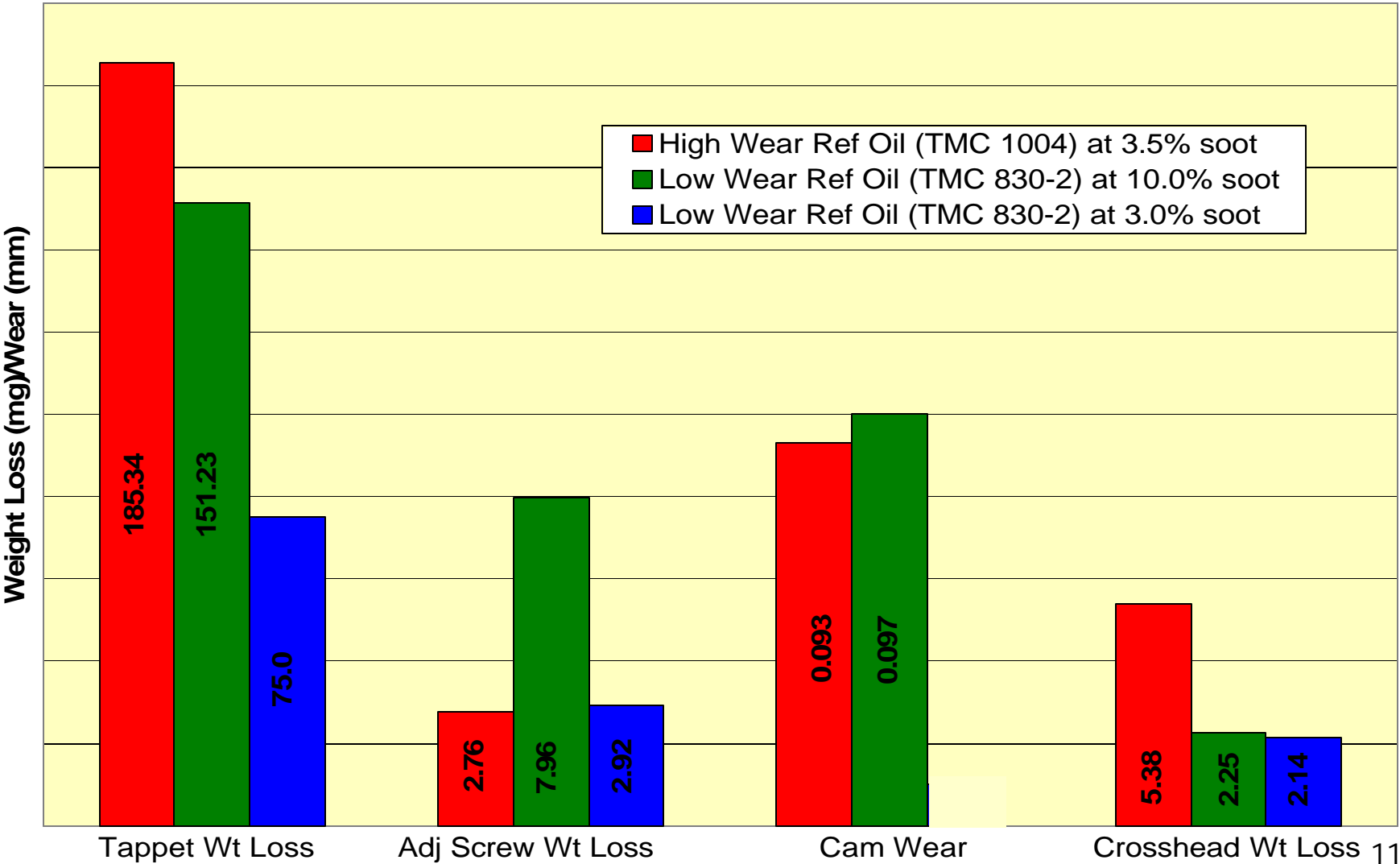
# Preliminary ISB Matrix Designs

## 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.

|  | Technology | | |
|---|---|---|---|
| Base Oil | 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