SEQUENCE IX ALTERNAT FUEL SUPPLIER TASK FORCE

Date: 16 Aug 22

ATTENDANCE	
SWRI	Khaled Rais, Christine Eickstead, Pat Lang, Travis Kostan
INTERTEK	Jason Soto, Al Lopez
LUBRIZOL	George Szappanos
TMC	Rich Grundza
AFTON	Ben Maddock
APL	Tim Hadaway
INFINEUM	Andrew Ritchie, Doyle Boese
FORD	Michael Deegan
HALTERMANN CAERLESS	Izabela Gabrel

Stats Group DOE Power Calc Presentation (Travis) [see attached]

- Key points for the proposed matrix: 2-4 engine stand with 6-8 tests per stand were considered. To detect 1 standard deviation differences with power above 80% would require 32 tests across 4 stands, 1.5 standard deviations would require 16 tests across two stands.

➔ Andy Ritchie – This is a lot of engine testing given the known relationship between LSPI and key fuel parameters like T90 temp, aromatic content, octane and maybe a few others. With our CofA already setting limits on these properties, do we need this much testing?

➔ Mike Deegan – We can look at the CofA with fuel experts at Ford and get their opinion on how effective it is at limiting the impact of fuel variation on LSPI.

- ***Action*: Mike** to consult Ford Fuel expert(s) before next meeting

➔ Rich – CofA might be too much of a macro look. What about the influence of specific compounds?

➔ Khaled – I don't know if the impact of specific compounds is available in the literature, but the Ford expert would likely be able to tell us if the CofA is constraining the fuel enough or not.

➔ Al Lopez - In the VH, the SA isn't on the engine itself, so how would it work in this case?

➔ Travis – It would just be a bigger SA, unless we find that we need a correction factor.

➔ Doyle – The calibration window would just close on one side if there is a fuel-related offset making it harder to calibrate.

➔ Al Lopez – Feels the CofA doesn't count for much without testing to back it up.

➔ Andy – Some tests do not have clear fuel influences for example the IVB but that is the not the case for the Sequence IX since there has been a lot of study on the influence of fuel on preignition.

- ***Action:*** **Rich** to share how many EEE fuel batch changes have occurred to date with the group. There was discussion on correlating fuel batch changes with LSPI but the fuel is always comingled with previous batches.

➔ ***Travis –*** Maybe there are other options if there is a high degree of confidence in the CofA.

- ***Action: Travis*** to put together a list of additional questions for the next meeting before we move to the whole Surveillance Panel

Sequence IX Alternate Fuel Supplier DOE Power Calculations

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Statistics Group

- Amanda Stone, Afton
- Doyle Boese, Infineum
- Jo Martinez, Chevron Oronite
- Martin Chadwick, Intertek
- Phil Scinto, Lubrizol
- Rich Grundza, Test Monitoring Center
- Travis Kostan, Southwest Research Institute

Initial Task Force Meeting Questions and Answers

1. How many engines?
2. How many stands?
3. How many labs?
4. How many reference oils?
   - **Task force decision:** 221 and 224. Think about 220?
5. Engine age requirements?
   - **Task force decision:** No brand new engines
6. All alternate fuel tests or should both fuels be run in an alternating fashion like the Sequence VI?
   - **Task force decision:** Alternate as frequent as needed. Don't worry about logistical concerns.

Statistical Power

If the *true difference* (unknown in advance) is "x", then the statistical power is the probability that a statistically significant difference will show up in the final model.

- Based on choice of significance level (often 0.05 or 0.10).
- Values of "x" are calculated as standard deviation differences, but tables are provided to help translate in average number of pre-ignition events.

Statistical Designs Considered

- 2-4 Engine-Stands
- 6 or 8 runs per Engine-Stand

- Current Fuel
- Alternative Fuel

Run Order	Engine-Stand #1	Engine-Stand #2	Engine-Stand #3	Engine-Stand #4
1	221	224	224	221
2	221	224	224	221
3	224	221	221	224
4	224	221	221	224
5	221	224	224	221
6	221	224	224	221
7	224	221	221	224
8	224	221	221	224

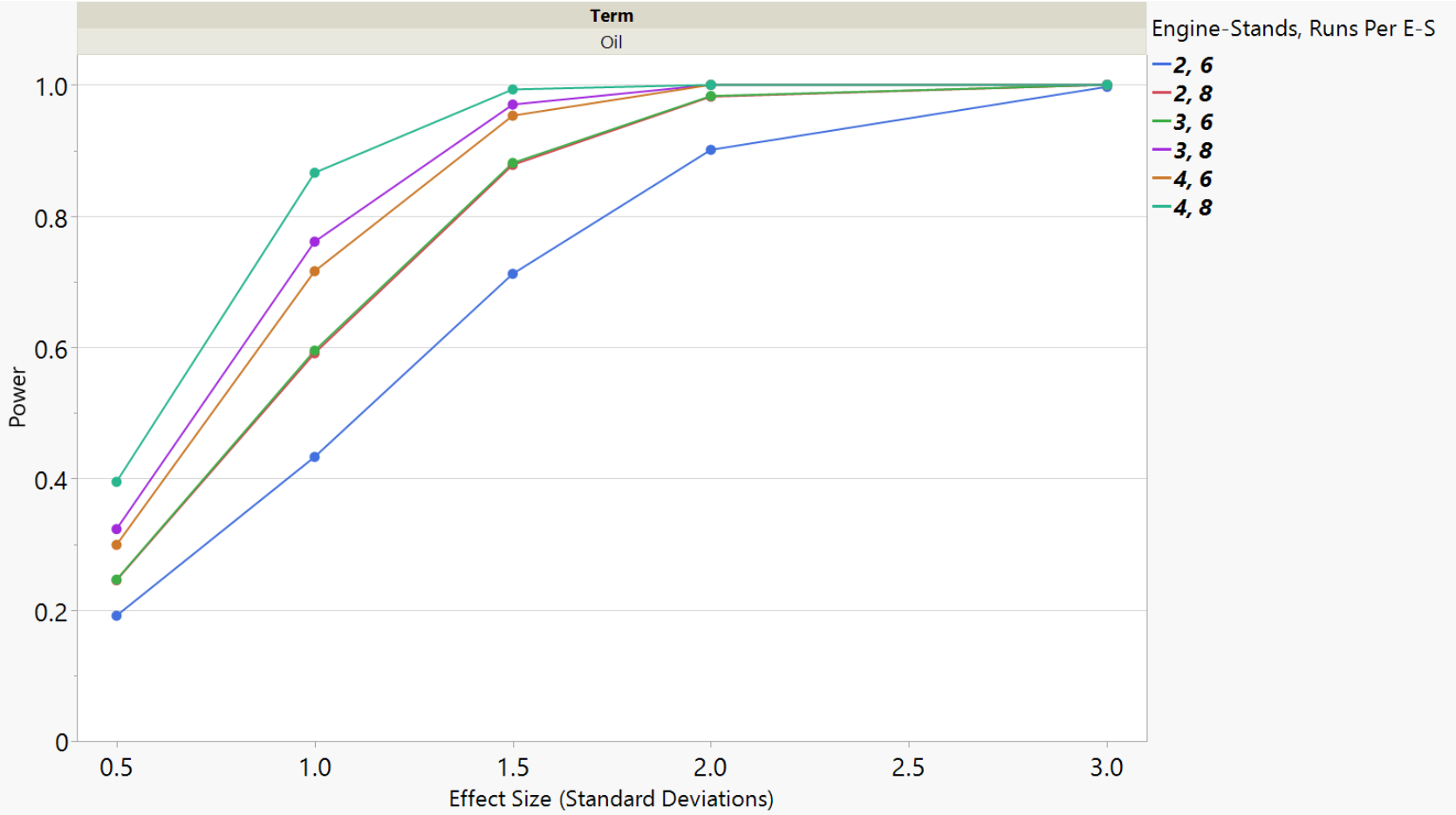
Table of Standard Deviation Differences

The table below can be used for reference in the power calculations to understand what the standard deviation differences would translate to for an oil with an average number of events of 5.0. Only one direction shown.

Original Average # of Events, Untransformed	Standard Deviation Change	New Average # of Events, Untransformed
5.0	0.5	5.9
5.0	1.0	6.9
5.0	1.5	8.0
5.0	2.0	9.1
5.0	3.0	11.6

Power for the Oil Term, Significance Level 0.10

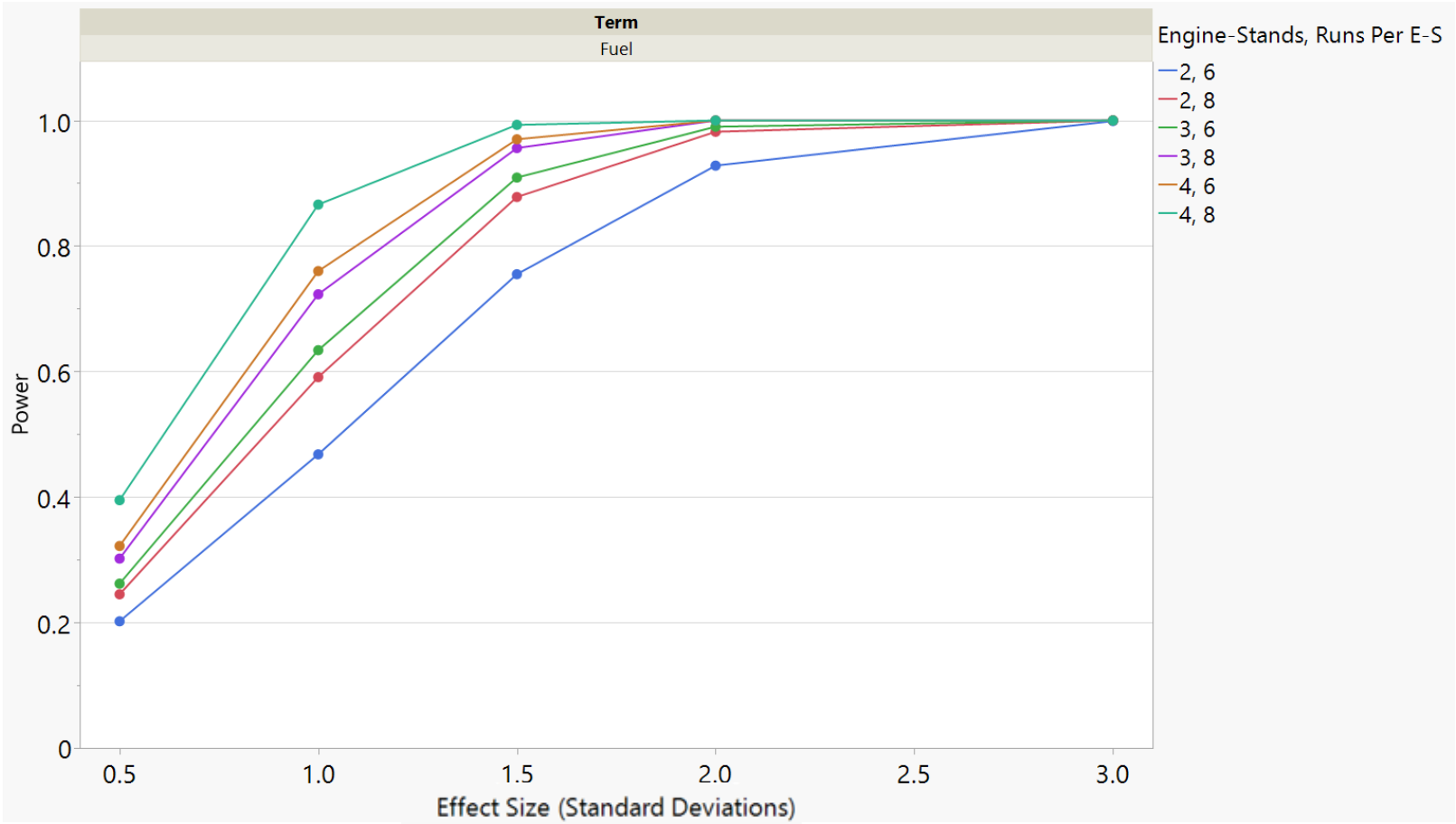
Since 221 and 224 are estimated to separate by 3.5 standard deviations, there should be no problem in any of the designs with seeing oil discrimination.



Power for the Fuel Term, Significance Level 0.10

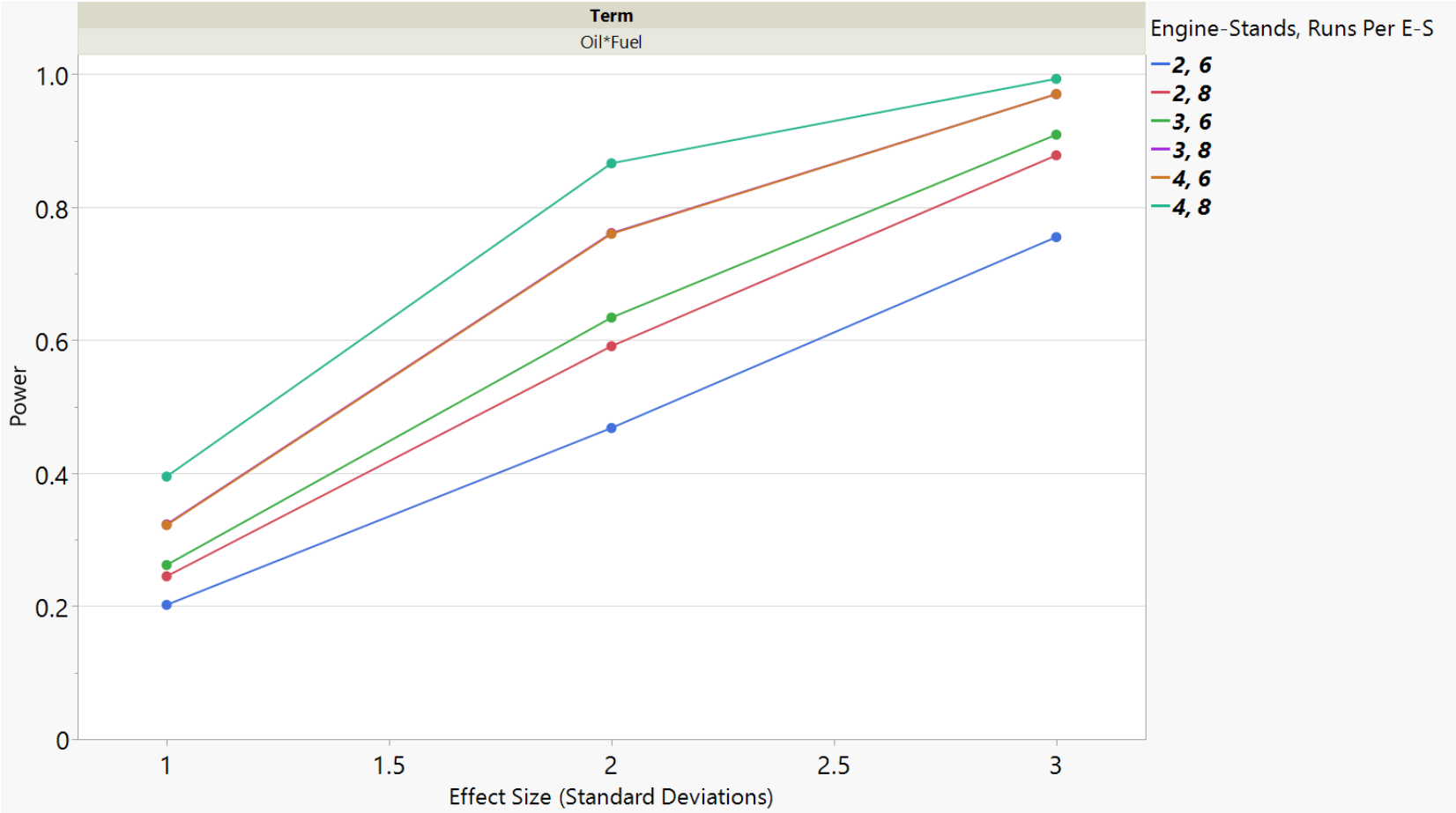
All designs but the 2 engine-stands X 6 runs each achieve near or better than 80% power for detecting fuel differences of 1.5 standard deviations or greater. For 1 standard deviation fuel differences, only the designs with at least 24 runs achieve near or better than 80% power.

Zi limit for this test is +/- 1.5 standard deviations.



Power for the Oil*Fuel Interaction Term, Significance Level 0.10

None of the designs have good power for detecting oil*fuel interaction effects for effects smaller than 2 standard deviations.



Summary

- 6 designs considered.
  - 2-4 Engine-Stands with 6 or 8 runs per Engine-Stand
- All designs would be able to show that oil discrimination between 221 and 224 is retained.
- For estimating fuel differences, it is recommended to consider criteria based on a significance level of 0.10.
- If smaller than 1 standard deviation differences between fuels need to be detectable, or if interaction effects need to be detectable, designs with more tests would be needed.

Original Average # of Events, Untransformed	Standard Deviation Change	New Average # of Events, Untransformed
5.0	0.5	5.9
5.0	1.0	6.9
5.0	1.5	8.0
5.0	2.0	9.1
5.0	3.0	11.6