

**TMC Analysis Summary of ROBO Mini Round Robin to Replace Oil 435 with Reblend 435-1**

- TMC’s reserve of oil 435 for ROBO reference testing is getting low
  - As of June 15, 2009, TMC has 4 gallons for ROBO use, which is about 50 ROBO samples
- Proposal was made to replace 435 with reblend, TMC Oil 435-1
- Mini Round Robin was run to confirm performance
- TMC was asked to compare MRV Viscosity and PVIS for 435-1 vs. 435 and propose initial targets and acceptance bands for 435-1

Oil	n	Mean PVIS % inc. <sup>(1)</sup>	s.d. PVIS % inc. <sup>(1)</sup>	Mean ln (MRV)	MRV Orig. Units cP	s.d. ln (MRV)	ln (MRV) Lower Acceptance Band (Fixed)	ln (MRV) 95% Upper Acceptance Band
435	15 <sup>(2)</sup>	222.5	44.9	11.4895	97,685	0.2932	11.0021 (60,000 cP)	12.0642 (173,546 cP)
435-1	16 <sup>(2)</sup>	180.5	44.9	11.2295	75,320	0.3513	11.0021 (60,000 cP)	11.9180 (149,941 cP)

(1) PVIS % Increase was calculated for each reported test result by using each reported KV40 test result on the aged oil and the TMC’s new oil KV40’s for 435 (46.36 cSt) and 435-1 (47.90 cst)

(2) Lab G’s MRV results were excluded when setting targets for 435, so Lab G’s PVIS results for 435 are also excluded in the statistical estimates above. However, Lab G is included in the 435-1 statistical estimates.

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- Box-Cox analysis suggests the MRV results should be transformed using natural log
- Box-Cox analysis suggests that the PVIS does not need a transformation
- Analysis of variance on the 435-1 data suggests that no lab stands out as significantly different from all the other labs for either PVIS or MRV
  - For oil 435, Lab G was excluded as significantly mild compared to the other labs in the original RR
- There are no outliers in the 435-1 data for PVIS or MRV using E178 at the 99% confidence level
- Oil 435-1 is significantly milder in performance than Oil 435 for both PVIS and MRV (analysis of variance)
  - Lab G is included in the analysis of oil 435-1, but excluded from the original RR analysis of 435
- Five of the 16 data RR MRV results on 435-1 are below 60,000 cP
  - Three of four results from Lab G and two of two results from Lab A
- Fixing the lower acceptance limit at 60,000 cp (transformed 11.0021):
  - 435 bands are presently -1.66 s.d. / +1.96 s.d.
  - 435-1 proposed bands would be -0.65 s.d. / +1.96 s.d.
- If 435-1 used 95% bands at  $\pm 1.96$  s.d. the acceptance limits would be:
  - 10.5410 (37,835 cP) – 11.9180 (149, 941 cP)
- As of 20090615, TMC reference testing on all three oils (434-1, 435 & 438) is running -0.71 s.d. mild from the RR (n=21).
  - By Oil:
    - 434-1 (n=6) is performing -0.76 s.d. mild
    - 435 (n=10) is performing -0.58 s.d. mild
    - 438 (n= 5) is performing -0.91 s.d. mild