



Report of T-10 MRV Study Group

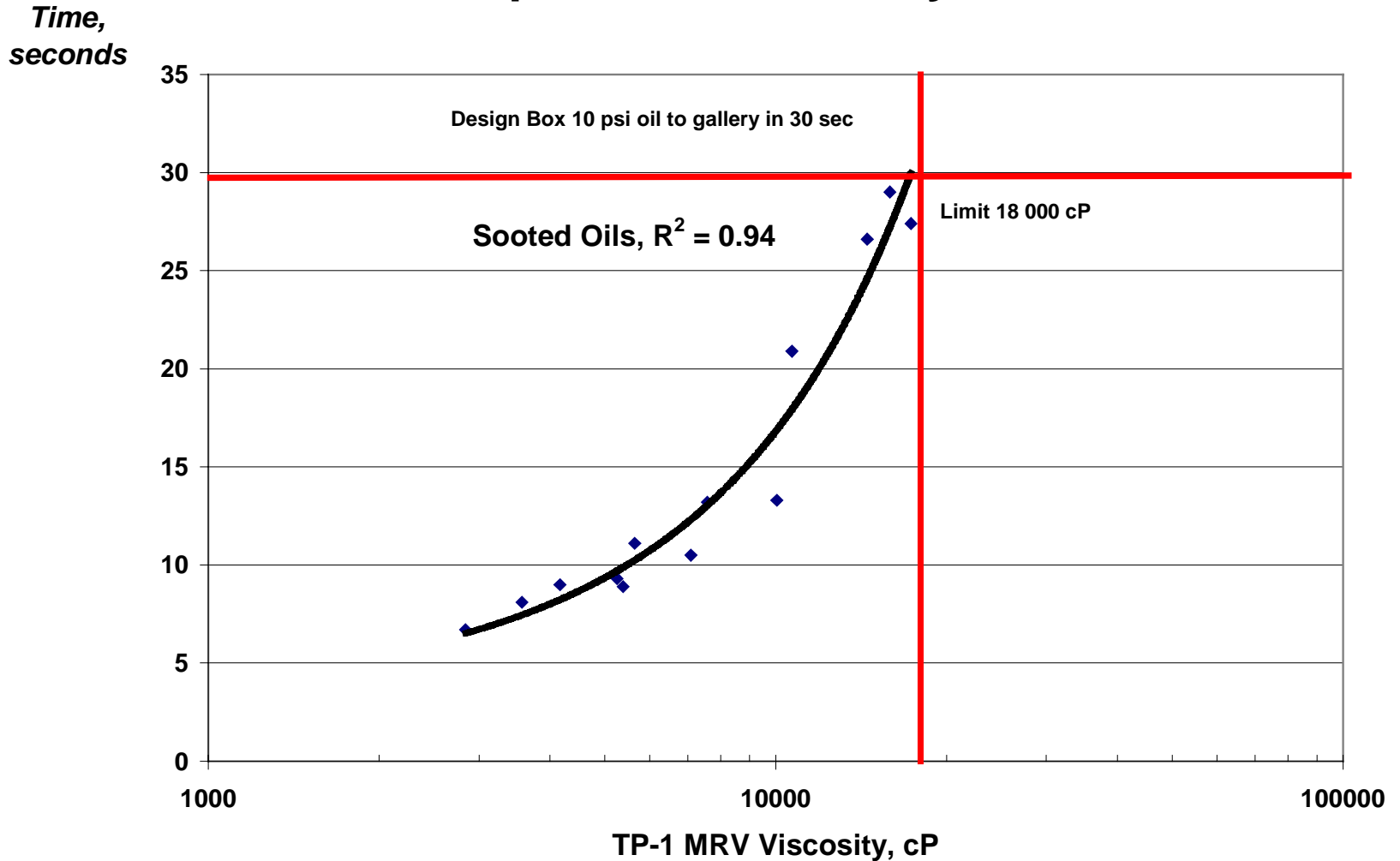
Committee Discussions

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September 12, 2001

M-11 Low Temp Pumpability Experiment

10 psi at Main Gallery



M-11 Low Temp Pumpability Experiment

○ Starting attempts at -25C with fresh oil:

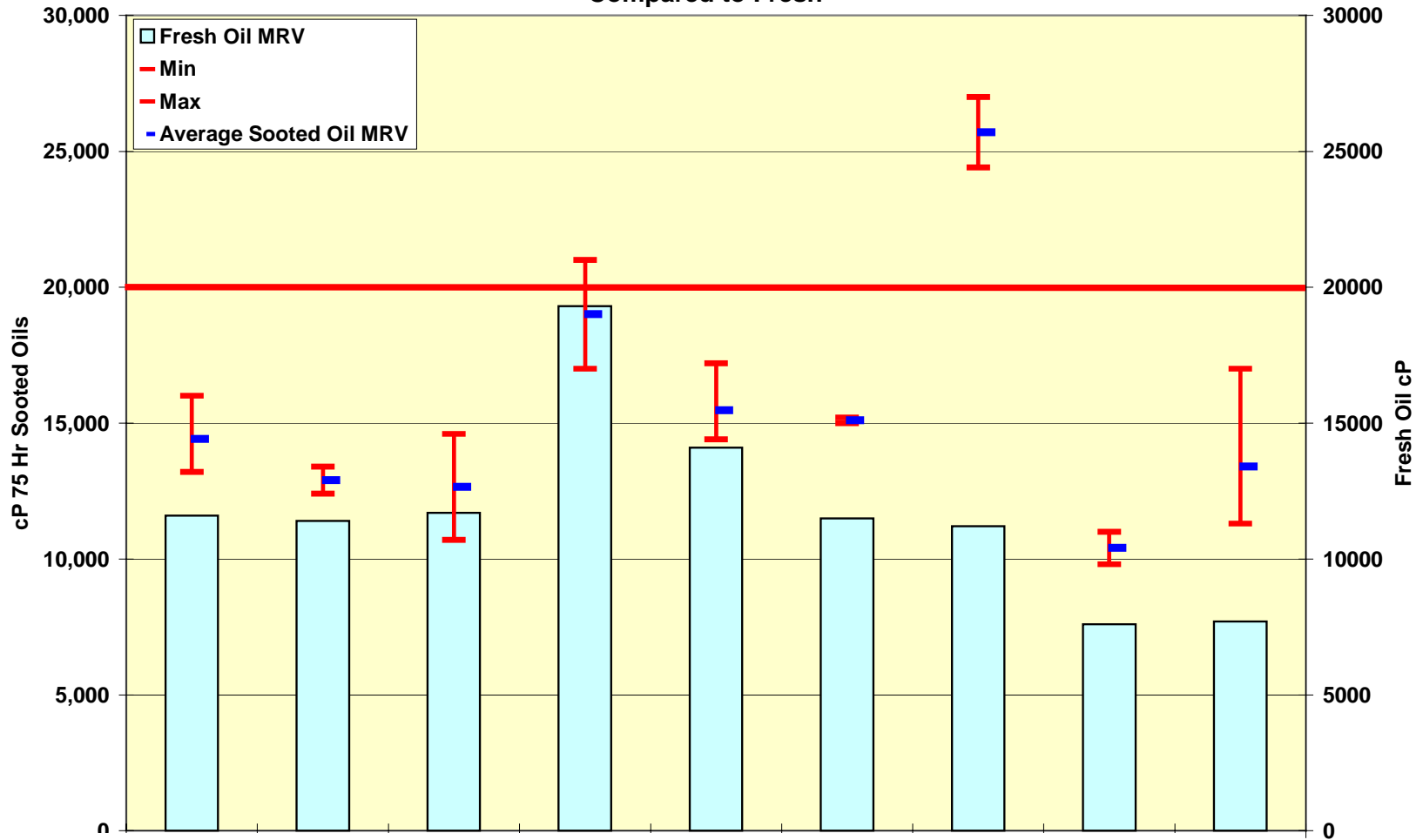
Oil	CCS cP @ C	MRV cP -15 C	MRV cP -20 C	MRV cP -25C	Comments @ -25
10W30	7150 @ -25	2610	4450	8610	Engine Started
15W40	6800 @ -20	5590	8390	15700	Terminated Engine Noise
15W40	6350 @ -20	5330	6600	18000	Terminated Drive Shaft Broke

From M-11 Low Temp Pumpability Experiment

- Cummins design box is to have 10 PSI oil pressure to gallery in 30 sec.
- Initial data on sooted oils suggests **18 000 cP** for a limit.
- Fresh oils at -25 C would not allow the engine to crank
- This suggests **20 000 cP** as a critical viscosity

Sooted Oil MRV Shows Base Oil and Additive Effects

Mack T-10 75 hr MRV @ -20
Compared to Fresh



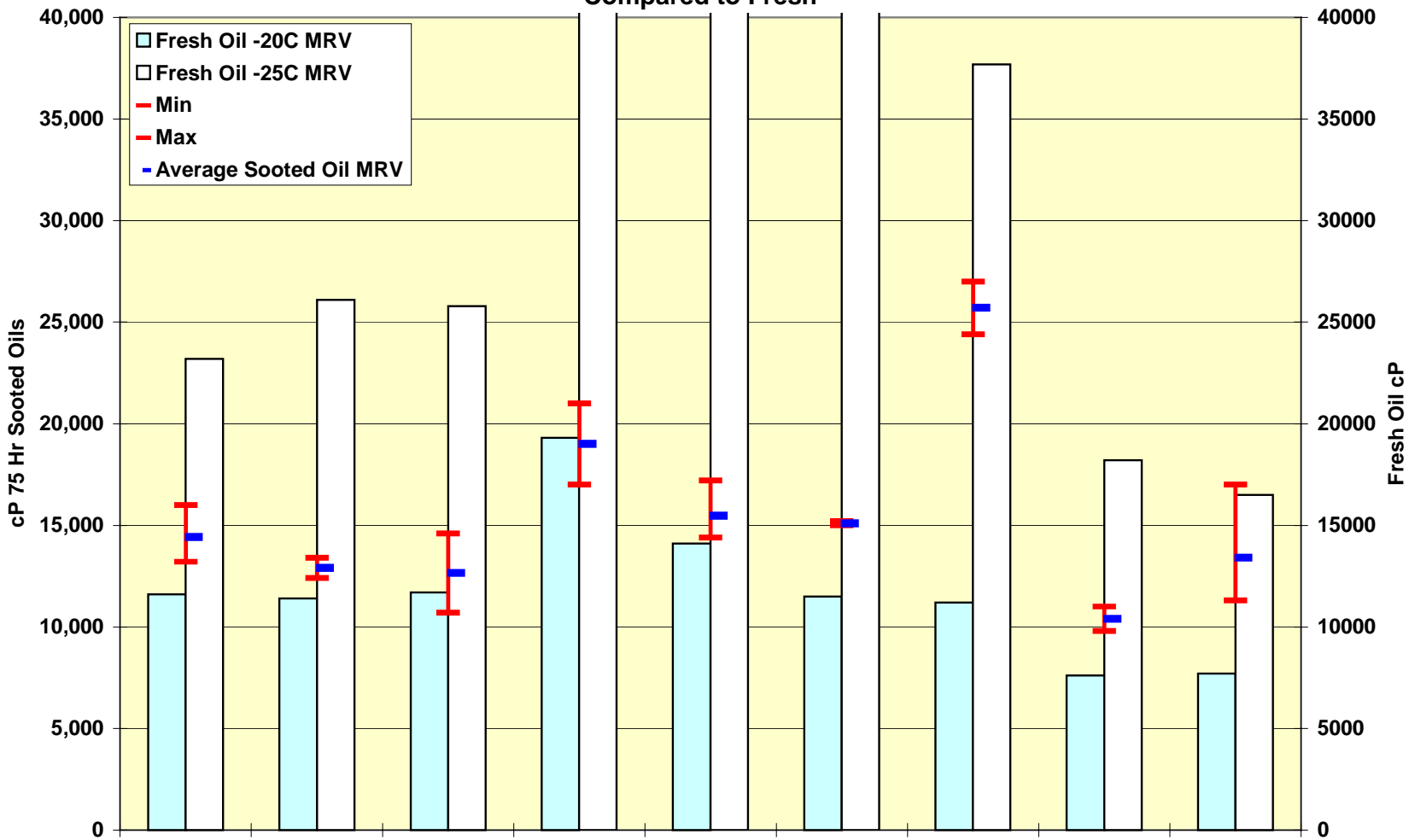
Oil:	A	B	C	D	E	F	G	H	J
Technology	X	X	X	Y	Y	Y	Z	Z	Z
Base Stock:	1	2	3	1	2	3	1	2	3

Observations from Sooted Oil MRV @ -20 C

- Oil G is bad actor
- Technology Z was a 10% under-treat
- Robust Technology will function in all basestocks
- Data would suggest high saturates could be an issue with marginal technology
- Oils D E F seemed close to trouble, but were formulated without flow improvers

Fresh Oil and Sooted Oil MRV

Mack T-10 75 hr MRV @ -20
Compared to Fresh

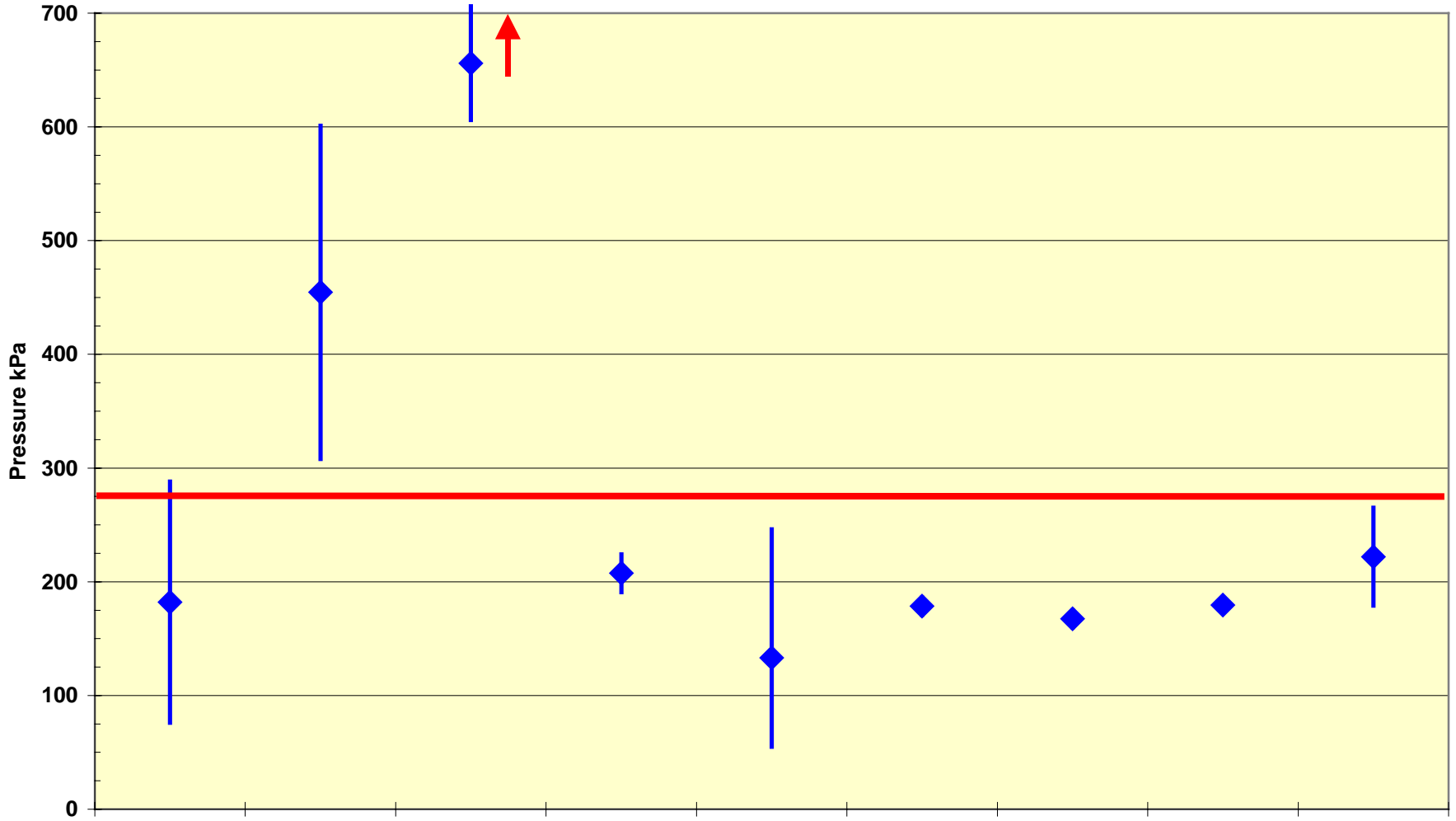


Oil:	A	B	C	D	E	F	G	H	J
Technology	X	X	X	Y	Y	Y	Z	Z	Z
Base Stock:	1	2	3	1	2	3	1	2	3

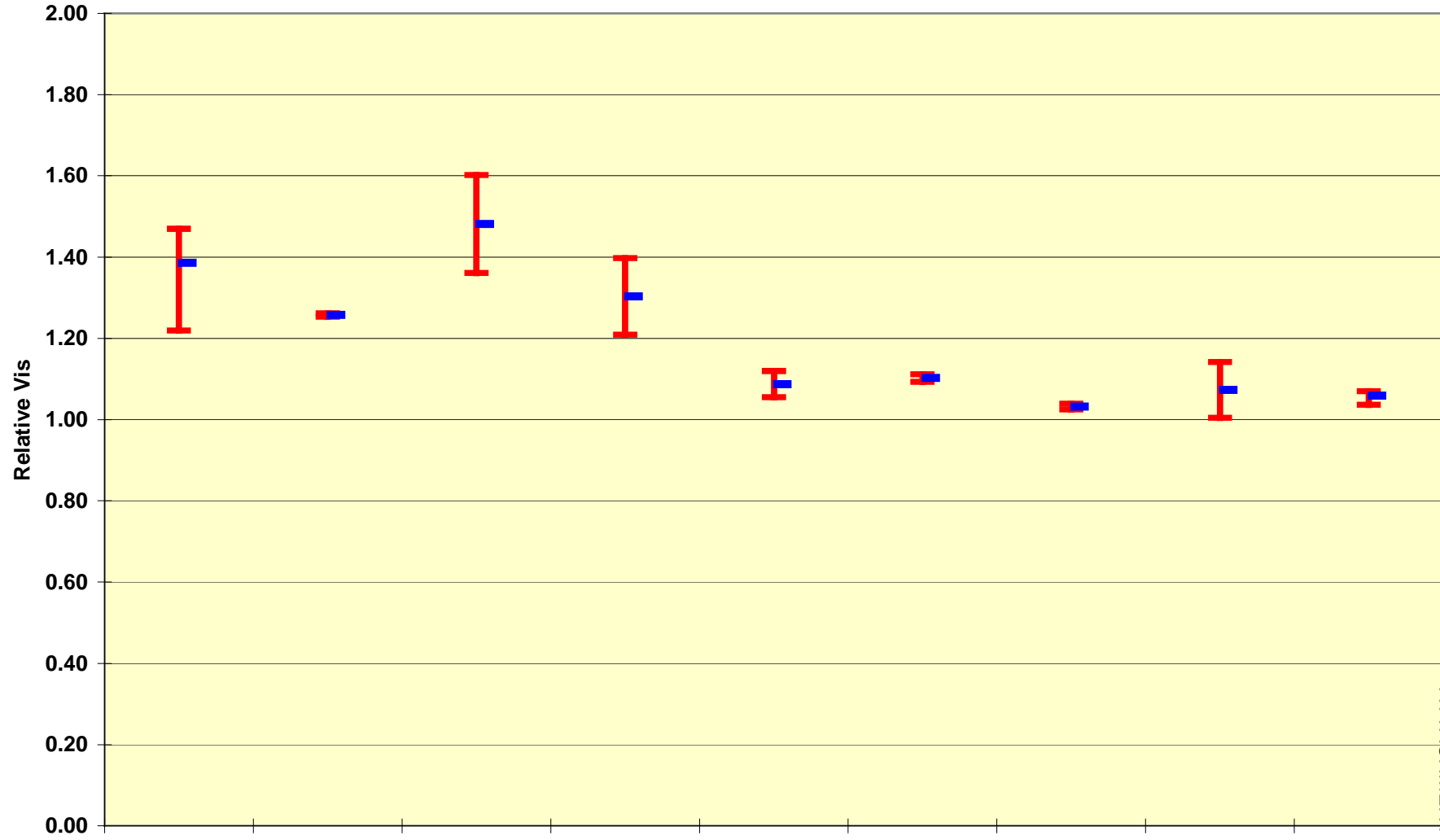
Fresh and Sooted oil MRV Observations

- Oils D E & F would have been caught by fresh oil MRV @ -25 C and fixed before spending \$\$ on a T-10
- Oil G passes the 60 000 cp @ -25 C
- If the T-10 75 hr MRV @ -20 catches an oil, a 30 000 cP MRV on fresh oil might assist as a read-across guideline.

M11 PC-9 Matrix Oil Filter Delta P @ 250 Hr.



T-10 Matrix Relative Viscosity



Oil:	A	B	C	D	E	F	G	H	J
Technology	X	X	X	Y	Y	Y	Z	Z	Z
Base Stock:	1	2	3	1	2	3	1	2	3

The Case for Used Oil MRV Limit

- **Data has shown that with used oil MRV:**
 - ✓ **There is a problem with marginal technology**
 - ✓ **It effects engine operation**
 - ✓ **Basestock effect is suggested**
- **It is not picked up by fresh oil data**
- **It is not seen in M11 filter delta P data**
- **It is not seen in KV 100 on the used oil**
- **Therefore, MRV @ -20C on 75 hr used T-10 oils is needed**

75 hr Mack T-10 MRV @ -20 C:

Observations

- A limit is 20 000 cP @ -20 C is supported by engine pumping data.
- Limit of 20 000 cP @ -20 C is generous
 - ✓ It catches only a problem oil (assuming oil D contained low temperature flow improvers)
- Used oil MRV seems most related to robustness of DI/VM technology
- A technology matrix covering base oil types should cover this issue.
- Mack T-10 BOI guidelines Group I reads to Group I; Group II reads to Group II
- Comparing 75 hr MRV of oils G and H seems to show sensitivity to higher saturates.

Proposed T10 Used Oil MRV Limit

- **Cummins proposes a limit of 20 000 cP @ -20 C on 75 hr used oil from Mack T-10**
- **BOI should follow Mack T-10**
 - ✓ **Group I reads to Group I**
 - ✓ **Group II reads to Group II**
- **Suggest API use a 30 000 cP @ -25 C on Fresh Oil for BOI as a safety.**
 - ✓ **Consider alternatives**