HEAVY-DUTY ENGINE OIL CLASSIFICATION PANEL

OF

ASTM D02.B0.02

December 5, 2006

Hilton Walt Disney World Resort, Lake Buena Vista, FL

ACTION ITEMS

1. **Sequence III Surveillance Panel address separate test name for CJ-4 viscosity increase.**
2. **Issue exit criteria ballots for T-6 and M11HST limits and to rank improvement ideas.**

MINUTES

1.0 Call to order

1.1 The Heavy Duty Engine Oil Classification Panel (HDEOCP) was called to order by Chairman Jim McGeehan at 1:45 p.m. on Tuesday, December 5, 2006, in the Palm II Room of the Hilton Walt Disney World Resort, Lake Buena Vista, FL.

1.2 There were 16 members present and 59 guests present. The attendance list is shown as Attachment **2.**

2.0 Agenda

2.1 The agenda is included as Attachment **1**.

3.0 Minutes

3.1 The minutes of the June 27, 2006 meeting were approved as written.

4.0 Membership

4.1 There were no membership changes.

5.0 API Requests for API CJ-4

5.1 API requests a clearer description of the Sequence IIIF test since all parameters of the test are not used for CJ-4; only the viscosity increase is used. The options are IIIFHD or IIIFVIS. The specification only lists viscosity increase, so a separate designation may not be needed. Having a separate designation would make it clearer. The request did come from the API Lubes Committee. There is some difficulty distinguishing a IIIF for SL from a IIIF for viscosity increase for CJ-4. The Sequence III Surveillance Panel should address this and will be asked to.

5.2 Alternative tests to support other categories in which tests are unavailable will be covered by other agenda items later in the meeting.

6.0 Sulfated Ash Monitoring: API CJ-4

6.1 Eric Olsen gave an update on Sulfated Ash Monitoring. See Attachment **3**. The Sulfated Ash Surveillance Panel has been involved in updating the test. One main improvement is a LTMS referencing system. Many have been involved in the work to date. A round robin has been completed. The plan is to review the results and select reference oils for the blind monitoring system. Other actions are to recruit other labs and to plan workshops. There does not seem to be much interest in changing the method nor are there many ideas yet. One possibility is to develop coefficients for the elements to calculate sulfated ash. Something more precise than D874 for future LEDL specifications is desirable, but is unknown at this time. Only three labs expressed interest in continuing with the blind monitoring system. Chairman McGeehan asked for other labs to participate in the monitoring phase. Two other labs indicated participation. A question was asked if the differences on a calculation scheme are "irreconcilable". The differences are not "irreconcilable", but the task force focused on the round robin, not a calculation so it was not thoroughly explored or resolved.

7.0 Caterpillar ECF-2

7.1 Hind Abi-Akar presented CAT's new ECF-2 specification. See Attachment **4**. ECF-1 will be modified to ECF-1-a. ECF-1-a will be for CH-4 oils. ECF-2 will be for CI-4/CI-4PLUS oils. ECF-3 is for CJ-4 oils. ECF-1-a is CH-4 with 1P tests based on ash level. ECF-2 is CI-4 plus the C13 engine test with an ash limit of 1.50 wt%. Oils meeting API oil categories prior to API CI-4 may not claim ECF-2. ECF-3 is the API CJ-4 with no additional requirements. ECF-1-a and ECF-2 will be implemented March 1, 2007. ECF-3 is required now. A question was asked if ECF-2 is limited to CI-4 oils or can CJ-4 oils be ECF-2 since CJ-4 oils can claim CI-4. The probability is yes that if an oil passes all tests, ECF-2 and ECF-3 can be claimed.

8.0 Mack T-12 limits for Other Categories

8.1 Mark Cooper presented the Mack Surveillance Panel action dealing with the older Mack tests that are no longer available. See Attachment **5**. A request for data to compare the T-10A to the T-11A and the T-8 to the T-11 was sent out. No data has been submitted.

8.2 Alternative limits for a T-10 result from a T-12 test have been developed and approved. The Surveillance Panel worked on limits for the T-9 and the T-6 from a T-12. For the T-9 limits in a T-12, three proposals were presented and a compromise position was developed. These were approved at the Surveillance Panel level for recommendation to the HDEOCP. The T-6 is harder to do, but there were two proposals. A consensus proposal was developed that passed with one negative vote. The T-6 was introduced in 1981 and very different from the T-12. Greg Shank **moved** that the HDEOCP accept the Surveillance Panel recommendation for T-9 limits from a T-12 test. Pat Fetterman seconded. The liner wear value does not seem to be an average of the 3 proposals. The Afton proposal is based on the premise that T-9 limits should rank the same way as T-10 limits. The test sponsor does not want the limit as high as 35 and suggested an exit ballot should be used since there is some discussion. The motion is on the floor as accepting these limits today without an exit criteria ballot. The **motion passed** unanimously with 16 votes for, 0 against, and 0 waives.

8.3 The Surveillance Panel chairman **moved** that the HDEOCP accept the Surveillance Panel recommendation for the T-6 limits from a T-12 test. Lew Williams seconded. Lubrizol volunteered to run a T-12 test on the T-6 reference oil, but has not been able to get the oil. EMA discussed older categories and agreed that CF-4 is not required for them and does not recommend CF-4 oils any more. Lubrizol would like to see CF-4 as a licensable category. Not having a T-6 does not mean that the category will go away; it just means that CF-4 oils will be available without tests to back it up. Oronite stated that if new limits are created, then it is a new test and a new CF-4 category should be developed. Volvo can support the limits. An exit criteria ballot will be used for this motion. The request for a T-6 oil was repeated. DEOAP should decide if the category is needed and how to proceed.

The **motion passed** to issue an exit criteria ballot with 11 votes for, 2 votes against, and 3 waives.

9.0 Cummins ISM for Other Categories

9.1 Cathy Devlin presented a proposal for M11HST limits in an ISM test. See Attachment **6**. Shawn Whitacre stated that Cummins is looking at the situation. Afton conducted an ISM test on a CH-4 commercial oil. The OFDP was very high so an additional ISM test was run with an M11HST filter and the OFDP was also high. For related oils, OFDP behaved similarly. Due to the nature of the OFDP, the proposal is for OFDP at 100 hrs, not 150 hrs.

9.2 Phil Scinto looked at 1004 industry data. See Attachment **7**. Lubrizol proposes staying with 150 hours to report the OFDP.

9.3 Cummins prefers using the 1004 data and the 150 hour OFDP to develop limits. Phil Scinto **moved** to send their proposed limits for exit criteria ballot. Greg Shank seconded. The **motion passed** with 15 votes for, 1 vote against, and 0 waives.

10.0 Category Process Improvements

10.1 Lew Williams presented an update on process improvements using small teams. See Attachment **8**. Ideas include: more closely align API and OEM specs, expand API AMAP for API C category oils to include OEM specs, extend the life of PC-X for a minimum of 5 years, improve the timing of reaching consensus, plan for successful rollout of PC-11, improve communications throughout the PC-11 development process, improve the estimate of timing at all stages of the process in PC-11, generate the data needed in a timely way to correlate old to new tests, options for greater industry participation in engine and bench test development, better way to generate BOI/VGRA data early in the process, determine industry needs of engines that are not yet commercial. What is the way forward? One way is to issue an exit ballot of the list and ask members to rank them. Much work was done before. A major holdup for PC-10 was getting the engine tests developed. May need to consider using European tests as there are more global engines and additive companies and/or have a global oil specification. Consensus vote to issue an exit criteria ballot and rank the ideas with a number 1 as the first choice and a number 2 as the second choice, etc. Like a golf score, the lowest score wins and will have the highest priority.

11.0 EMA Bio-Diesel Task Force Request

11.1 Greg Shank presented the EMA concern with the impact of bio-diesel on engine lubes. See Attachment **9**. EMA is just beginning to look at the situation. EMA will review data internally and solicit funding for testing. A stronger recommendation should be available by the June 2007 meeting.

12.0 Universal Oils

12.1 Lew Williams presented the ACC-PAPTG report on universal oils. See Attachment **10**. ACC-PAPTG will propose to the API Lubes Committee that where the API C category is listed first for CI-4 and newer, that the requirement to run and measure the BRT, VG, IVA, VIII, gelation index, and deposits and wear from a IIIF be waived for SJ, SL, and SM with passing C category results. Oils that start as C category oils are robust enough to always pass the S category tests. There are limited runs in this data set. No fails were included in the data set because with a C category fail, no S category tests are run.

13.0 Next meetings

13.1 The next meeting will be at the call of the chairman.

14.0 The meeting was adjourned at 4:05 pm.

Final Agenda
ASTMSECTION D.02.BO.02
HEAVY-DUTY ENGINE OIL CLASSIFICATION PANELS

Hilton Walt Disney World Resort, Lake Buena Vista FL

December 5th, 2006
1:30 pm-4:30 pm

Chairman/ Secretary: **Jim Mc Geehan/Jim Moritz**
Purpose: **API C Categories**

Desired Outcomes: **Alternative tests limits to support categories.**
Next category fuel: % biodiesel

TOPIC	PROCESS	WHO	TIME
Agenda Review	• Desired Outcomes & Agenda	Group	1:30-1:35
Minutes Approval	• June 27th, 2006	Group	1:35-1:40
Membership	• Changes: Additions	Jim Mc Geehan	1:40-1:45
API Requests for API CJ-4	• IIIF/IIIG consider IIIFPVis /IIIGHD (Viscosity only test) • Alternative tests to support other categories in which tests are unavailable	Kevin Ferrick	1:45-2:00
Sulfated ash monitoring: API CJ-4	• Surveillance Panel report on Sulfated Ash Monitoring	Eric Olsen	2:00-2:15
Caterpillar ECF-2	• Need for ECF-2 • Requirements: Cat C13 test • Timing	Hind Abi-Akar	2:15-2:45
Mack T-12 limits for other categories	• API CJ-4 (T-12); API CI-4 (T-10); API CH-4 (T-9) and API CF-4 (T-6)	Greg Shank Mark Cooper	2:45-3:15
Cummins ISM for other categories	• Cummins M11 HST to ISM	Shawn Whitacre Cathy Devlin	3:15-3:30
Category Process improvements	• Report	Lew Williams	3:30-3:45
EMA Bio-diesel task-force request	• Task-force required for bio diesel fuel for next C category	Greg Shank	3:45-4:00
Universal Oils	• ACC-PAPTG report	Lew William	4:00-4:30
Old and new business	•		

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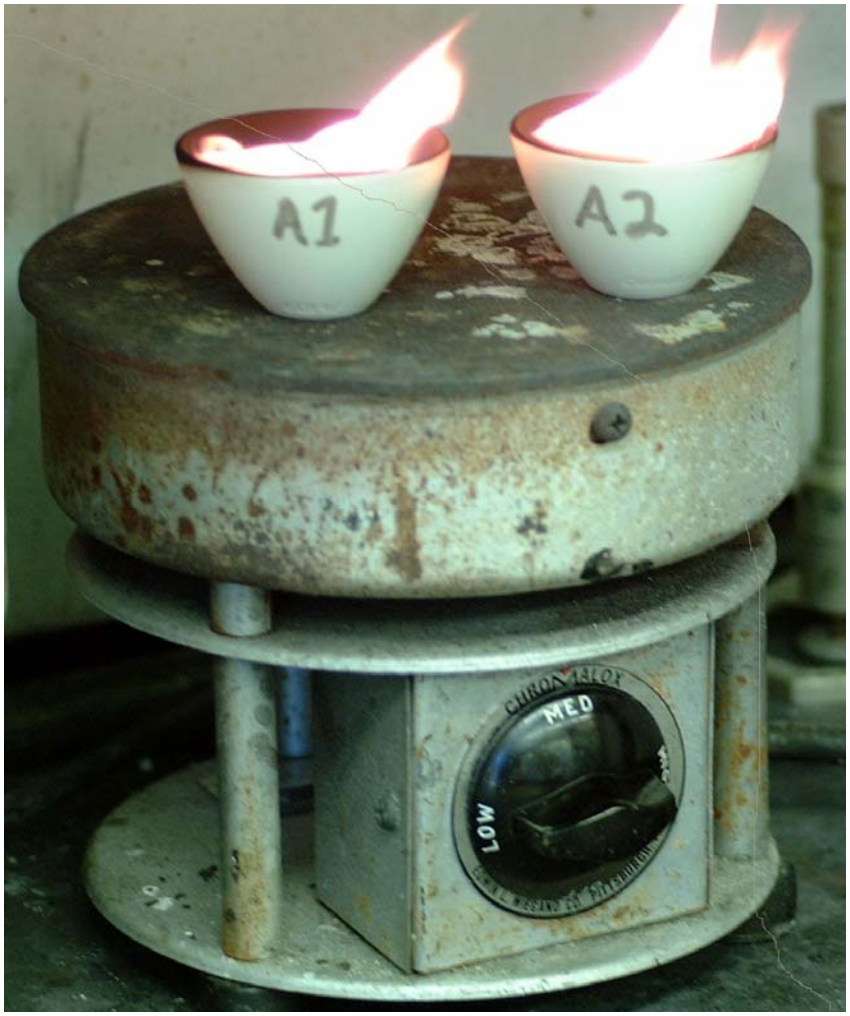
ASTM D02.B0.07
D874 Surveillance Panel



Objectives of this presentation

1. Update SP progress and next steps
2. Invite guidance on future directions

From D02.B0.07 mtg June 06 at Toronto

2006 Deliverables

- Detailed implementation plan for LTMS
  - Including selection of reference oils
  - Fully adopted before year-end, if possible
- Recommendation on future viability of a sulfated ash calculation method (e.g. SAE J1787),

A Team Effort

- Kishore Nadkarni
- Tom Schofield
- Joe Franklin
- Becky Grinfield
- John Mattern
- Pat Fetterman
- Lew Williams
- David Hwang
- And many others ….

Monitoring System

Option C was consensus selection

- Test reference oil RL90 once per calendar day on which candidate tests are conducted. This will encourage SPC charts.
- blind TMC samples will be tested at 90 day frequency.
- Cost per lab will be ~$2500 per year

Round Robin

- 8 participating labs
- 6 TMC reference oils
  - Not as broad spectrum as basis for existing D874 precision statement
  - Purpose is to select oils for blind referencing process
  - Triplicate determinations, on different days
- RR completed last week !

Oil	90	91	811-2	820-2	862-1	PC10A
n	21	21	21	21	20	21
Min	0.95	0.76	0.76	1.45	0.76	0.85
Average SAsh, Mass %	**1.08**	**0.82**	**0.92**	**1.58**	**0.82**	**0.89**
sR	0.08	0.05	0.09	0.08	0.05	0.03
Max	1.27	1.03	1.13	1.80	0.95	0.98
95% Upper	1.24	0.93	1.10	1.74	0.92	0.96
95% Lower	0.92	0.72	0.74	1.42	0.73	0.83
Median No. Resulfates	0	0	0	0	0	0
Median Final Furnace Cycles	5	3	4	3	4	3

Overall (6 oils)
sr = 0.041
sR = 0.069
r = 0.115
R = 0.193

D874-06 @ 1.0 Mass % SAsh

r = 0.060
R = 0.142

Interactions significant
(not all labs characterized the six oils the same way)

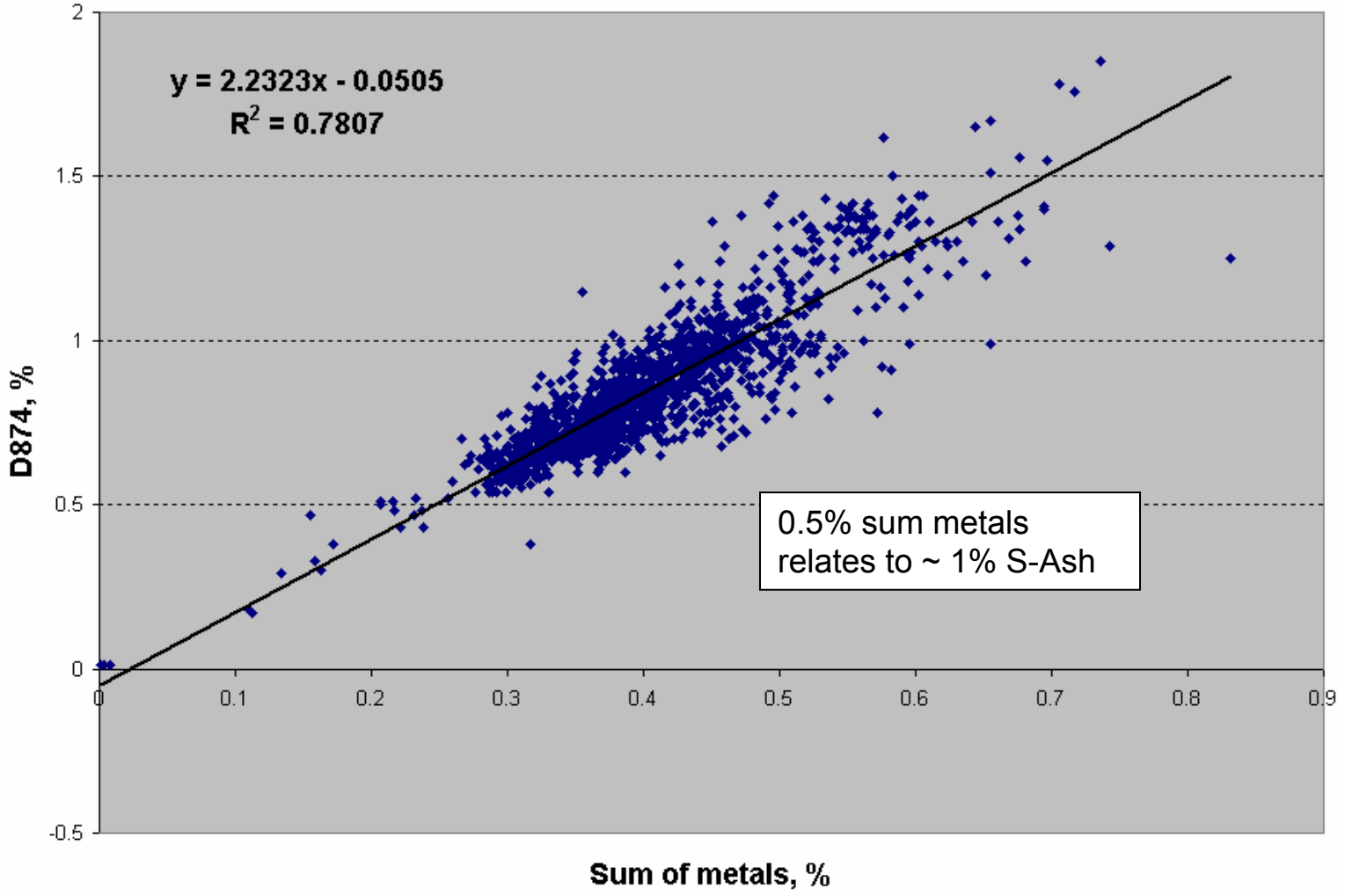
SP Next Steps

- Consensus on RR analysis
- Confirm selection of references for blind monitoring
- Recruit more participation
  - Presently only 3 labs
- Plan “rater” workshop(s), contingent on adequate participation

Limiting Factors

- D874 has many applications and a long history, and no one seems interested in changing it
- Technolgies for an improved D874 (wet-chemistry based) would require substantial development

SP found no support for development of calculation approach



What's Next ?

- Many questions remain to be answered about relationships between lube oil metals content and DPF plugging
- Everyone should want something more precise than D874 for future LEDL specifications, but what will it be?

Caterpillar Engine Oil Specifications

ASTM SECTION D.02.BO.02

HEAVY-DUTY ENGINE OIL CLASSIFICATION PANELS

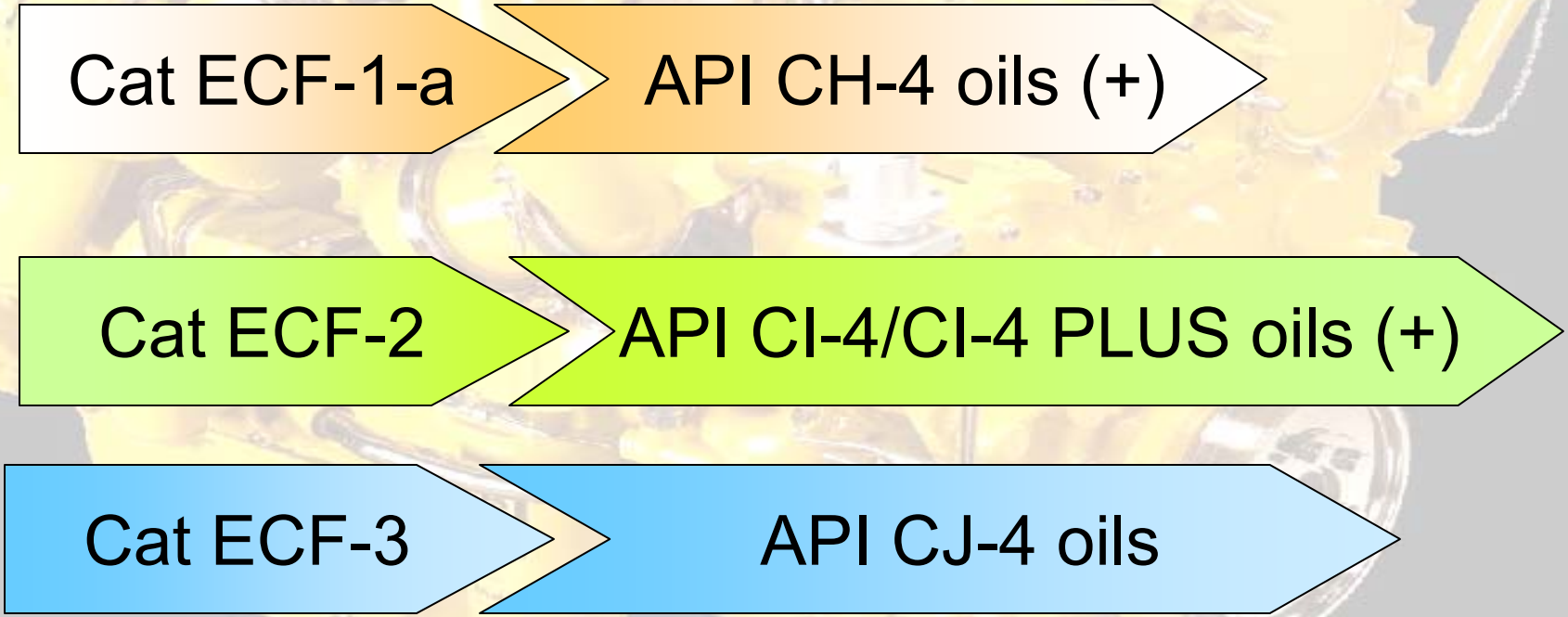
Orlando, Florida Dec 5, 2006

Cat Engine Crankcase Fluids (ECF) Specifications

Update

Cat ECF-1-a	Modified ECF-1
Cat ECF-2	New
Cat ECF-3	Released Sep 1, 2006

Summary of Cat ECF Specs



Cat ECF-1-a

Replaces cat ECF-1 specification

Now applicable only to API CH-4 oils with no other changes

Tests and limits

General	API CH-4 program (API Publication No. 1509, ACC Code of practice)
$\leq$ 1.30 wt % ash	1 1P SCOTE test (ASTM D6681)
1.30 < ash $\leq$ 1.50	2 1P SCOTE tests (ASTM D6681)
API Base Oil Interchange (BOI) read-across guidelines	Must be followed
API Viscosity Grade Read-Across (VGRA)	Allowed

Cat ECF-2

Applicable to API CI-4/API CI-4 PLUS oils

Tests and limits

General	API CI-4 program (API Publication No. 1509, ACC Code of practice)
Testing	Cat C13 500 hour engine test (as defined in the API CJ-4 oil category)
Limits	Ash level $\leq$ 1.50 wt% (ASTM D0874)
API Base Oil Interchange (BOI) read-across guidelines	Must be followed
API Viscosity Grade Read-Across (VGRA)	Allowed

Cat ECF-2

- Cat C13 Test: Ensures oils that offer advanced piston deposits and oil consumption control as well as protection from engine wear
- Upper limit on ash:
  - kept the limit from ECF-1 (ECF-1-a)
  - Supports a trend of lower ash oils
- Oils meeting API oil categories prior to API CI-4 may not claim Cat ECF-2

Cat ECF-3

Applicable to API CJ-4 oils

Tests and limits

Follows the API CJ-4 Program

Application

Specification	Application
Cat ECF-1-a	➢All 2006 and older Cat on-highway diesel engines ➢Cat 3500 Series and smaller commercial and machine diesel engines
Cat ECF-2	➢All 2006 and older Cat on-highway diesel engines ➢Cat 3500 Series and smaller commercial and machine diesel engines
Cat ECF-3	➢Strongly recommended for all Cat 2007 and newer on-highway diesel engines ➢All models and years Cat on-highway diesel engines ➢Cat 3500 Series and smaller commercial and machine diesel engines

Implementation

Cat ECF-1-a	March 1, 2007
Cat ECF-2	March 1, 2007
Cat ECF-3	Released Sep 1, 2006

Questions?

Mack T-12 and T11 Tests for Previous Mack Tests

Mark Cooper, Mack SP Chairman

December 5, 2006

Overview of Mack SP and HDEOCP Actions

- **Mack T-10A vs T-11A and T-8/E vs T-11**
  - **Jeff Clark (TMC) has sent out data request**
  - **No data has been received**

Overview of Mack SP and HDEOCP Actions

- **Mack T-12 for Mack T-10**
  - **approved by HDEOCP – June 2006**
  - **being implemented into D 4485**

- **Mack T-12 for Mack T-9 and Mack T-6**
  - **three SP teleconferences to finalize SP position**
    - **October 30**
    - **November 27**
    - **December 1**

Mack T-12 for Mack T-9

'Equivalency' proposed

	Oronite	Lubrizol	Afton
TRWL, mg	105	130	117
Liner Wear, microns	35	34	26
Max EOT lead, ppm	70	67	60

Mack T-12 for Mack T-9

	Oronite	Lubrizol	Afton	SP Recommendation
TRWL, mg	105	130	117	120
LW, microns	35	34	26	30
EOT lead, ppm	70	67	60	65

SP Recommendation passed:
5 affirmative, 0 negative and 5 waive

Mack T-12 for Mack T-6

'Equivalency' proposed

	Oronite	Lubrizol	Afton
TRWL, mg	Not possible	180	135
Liner Wear, microns	Not possible	47	38
Max EOT lead, ppm	N/A	N/A	N/A

Mack T-12 for Mack T-6

	Oronite	Lubrizol	Afton	SP Recommendation
TRWL, mg	Not possible	180	135	150
LW, microns	Not possible	47	38	40
EOT lead, ppm	N/A	N/A	N/A	N/A

SP Recommendation passed:
5 affirmative, 1 negative and 4 waive

Comments on Mack T-12 for T-6

	Intro Date	Purpose
T-12	2006	Top ring, liner, and bearing wear Soot abrasive and corrosive wear
T-6	1981	Piston Deposit Test

Comments on Mack T-12 for T-6

	Piston / Ring configuration
T-12	Coated top ring, 2 piece steel piston
T-6	No 2nd ring coating, Al trunk piston, w/ no ni resist

Comments on Mack T-12 for T-6

	Fuel / Combustion
T-12	ULSD, Cooled EGR – very high EGR rates
T-6	5000 ppm S fuel, ‘internal’ EGR

Comments on Mack T-12 for T-6

	Length	Oil Gallery
T-12	300 hr	116 C
T-6	600 hr	100 C

Comments on Mack T-12 for T-6

- **Extensive differences**
- **No common formulations run on both tests**

Proposed CH-4 Limits for Cummins ISM

December 5, 2006

Afton CHEMICAL

Candidate Oil A: M11HST vs. ISM Data

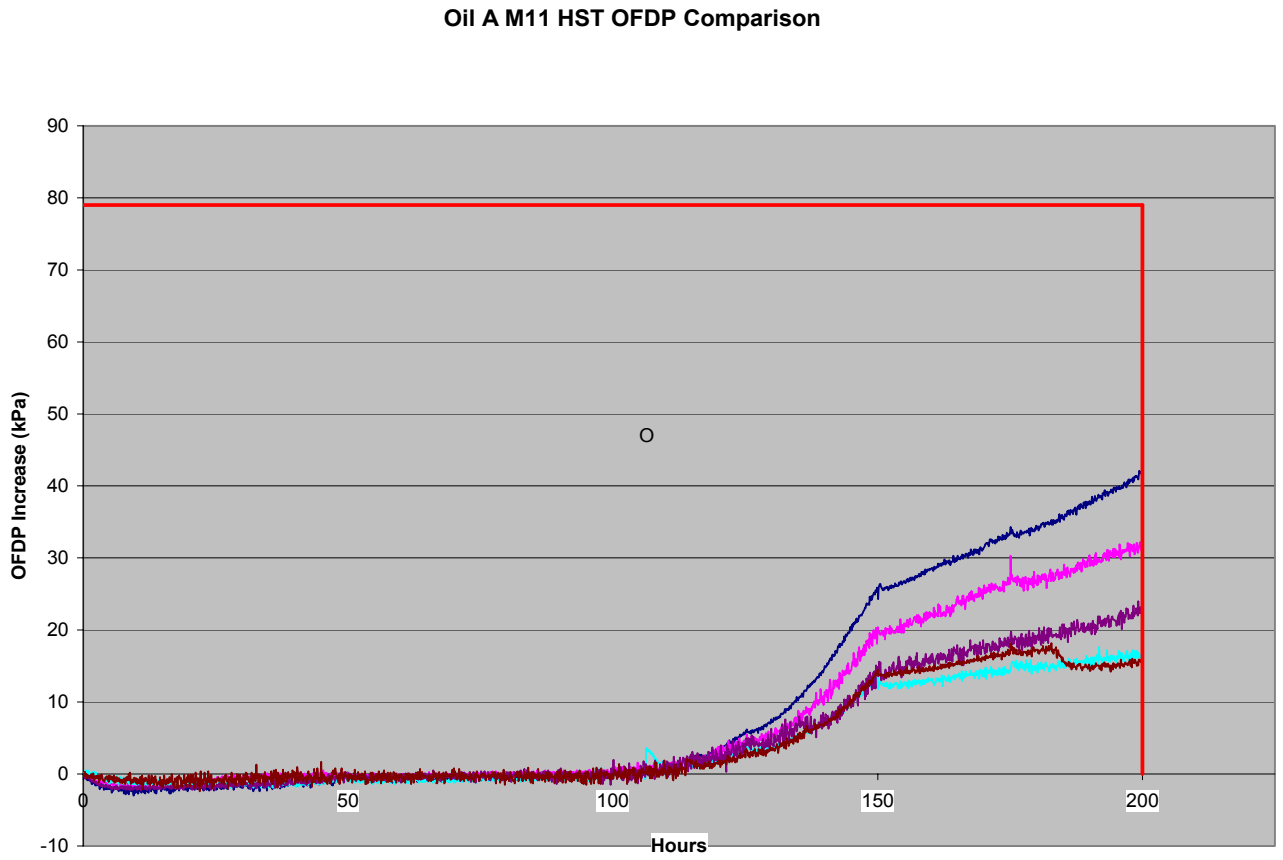
	Oil A	API CH-4 Limits
M11HST		
Xhead wt. loss, mg max.	6.5	6.5
Sludge, min.	8.8	8.7
Oil Filter Delta P, kPa, max.	42	79
ISM(200hrs)		Proposed Limits
Xhead wt loss, mg max.	5.8	7.5
Sludge, min.	8.2	7.9
Oil Filter Delta P(150hrs), kPa, max.	265	
Oil Filter Delta P(100hrs), kPa, max.	27	55
Injector Screw Wear, mg	7.5	
TRWL, mg	62.3	
ISM(200hrs) with M11HST Filter		
Xhead wt loss, mg max.	5.6	
Sludge, min.	8.5	
Oil Filter Delta P(150hrs), kPa, max.	294	
Oil Filter Delta P(100hrs), kPa, max.	11	
Injector Screw Wear, mg	11.5	
TRWL, mg	45.3	

API CH-4 Limits for ISM engine test

Engine Test Data	Oil A	Oil A*	API CH-4 Limits
M11HST			
Xhead wt. loss, mg max.	**6.5**	**3.1**	**6.5**
Sludge, min.	**8.8**	**9.0**	**8.7**
Oil Filter Delta P, kPa, max.	**42**	**24**	**79**
ISM(200hrs)			
Xhead wt loss, mg max.	**5.8**		
Sludge, min.	**8.2**		
Oil Filter Delta P(150hrs), kPa, max.	**265**		
Oil Filter Delta P(100hrs), kPa, max.	**27**		
Injector Screw Wear, mg	**7.5**		
TRWL, mg	**62.3**		
		***Inhibitor boosted**	

Afton™ CHEMICAL

M11HST OFDP on Oil A and Related Formulations



Afton CHEMICAL

API CH-4 Limits for ISM engine test

Based on API CI-4 limits for the ISM, we suggest the following limits for API CH-4 be considered:

Crosshead Wt loss, mg (200 hrs)	7.5 max
Sludge (200 hrs)	7.9 min
Filter Delta P, kPa (100 hrs)*	55 max

*The CH-4 level limit is the same as CI-4, except filter plugging is measured at *100 hrs*

Cummins ISM Proposed Limits for API CH-4

December, 2006

ISM Limits for API CH-4

- Proposal for CH-4 in Black
  - (CI-4 Established Limits in Blue)

	1 Test	2 Test	3 Test
Cross-Head Wear, mg, max	7.5 (7.5)	7.8 (7.8)	7.9 (7.9)
Oil Filter Delta Pressure @ 150 Hours, kPa, max	79 (55)	95 (67)	103 (74)
Sludge Rating, merits, min	8.1 (8.1)	8.0 (8.0)	8.0 (8.0)

ISM Limits for API CH-4

- Why are CH-4 Limits the Same as CI-4 for Crosshead Wear and Sludge?
  - Small Margin of Error Between Good and Poor Oils
  - Must Keep Poor Oils from Passing

ISM Limits for API CH-4

- Why are CH-4 Limits Different for Oil Filter Delta Pressure?
  - Limits as High as 90 kPa were Proposed for CI-4 Before Settling on 55 kPa
  - Oil 1004, a Borderline Oil for M11 OFDP in CH-4, Can be Made a Borderline Oil in ISM OFDP for CH-4
    - Based upon Limited Data, it Appears that Oil 1004 Behaves Similarly in Both Tests
    - Note that Tiered Limits were Calculated on the Natural Log Scale (+1) Using an s=0.3813 (from 12/2006 LTMS Manual).

ISM Limits for API CH-4

- Target and Pass Limit Comparisons

API CH-4	Test Limits	Oil 1004 Mean
M11 HST Oil Filter Delta Pressure, kPa, max	79/93/100	80 (78, 53, 89, 111)
ISM Oil Filter Delta Pressure, kPa, max	79/95/103	77 (LSM=72)

Process Improvement Ideas for PC-11

Presentation to HDEOCP

December 5, 2006

Background

- HDEOCP voted at the June meeting to form small teams to address the top 4 or 5 ideas for improving the PC-11 process.
- Greg Shank, Steve Kennedy and Lew Williams volunteered to offer a list of ideas for discussion and prioritization to facilitate the work for the small teams.

Ideas for Improving the PC-11 Process (Not in Order of Priority)

- What are the advantages of more closely aligning API C category and OEM specs in PC-11? How do we maximize the utilization of a new category?
- What are the advantages of expanding the API AMAP program for API C category oils? Do you feel the API AMAP program can replace the OEM spec audit process?
- How can we extend the life of PC-11 to a minimum of 5 years?

Ideas for Improving the PC-11 Process (Not in Order of Priority)

- How can we improve the timing of reaching consensus on key PC-11 Issues?
- How can we plan as an Industry for the successful roll out of PC-11?
- How do we improve the communications through out the PC-11 process?
- How do we improve the estimate of timing at all stages of the process in PC-11?

Ideas for Improving the PC-11 Process (Not in Order of Priority)

- How do we generate the data needed in a timely way to correlate old to new tests so we have fewer active tests?
- What are the options for greater industry participation in engine and bench test development? Is the Seq VID model an option?
- Is there a better way to generate BOI/VGRA data early in the PC-11 process?
- How do we better determine industry needs for engines that are not yet commercial?

Way Forward

- What do you think of the ideas?
- Any to add?
- How would you prioritize the ideas?
- Which team(s) would you like to lead?
- Which team(s) would you like to join?

Biodiesel Lubricant Effects

EMA has concerns with impact of Biodiesel on engine lubes

- Piston Deposits
- Soot Viscosity/Wear Control
- Corrosive Wear
- Fuel Dilution

- EMA will review data internally
- Solicit Funding for Testing
- Bring Recommendation to HDEOCP

Engine Manufacturers Association

PROPOSAL TO ASTM HDEOCP/PCEOCP

Prepared by:

ACC PAPTG

December 5, 2006

Proposal

- ACC PAPTG member companies have collected and analyzed candidate engine data to support the proposal to waive the engine tests listed below when qualifying an oil for a C category before the S category claim.
  - Ball Rust test
  - Sequence IVA
  - Sequence VG
  - Sequence VIII
  - Sequence IIIF piston deposits and wear—or use Sequence IIIFHD.
  - Gel Index

American Chemistry Council Good Chemistry Makes It Possible

Data to Support Proposal - 1

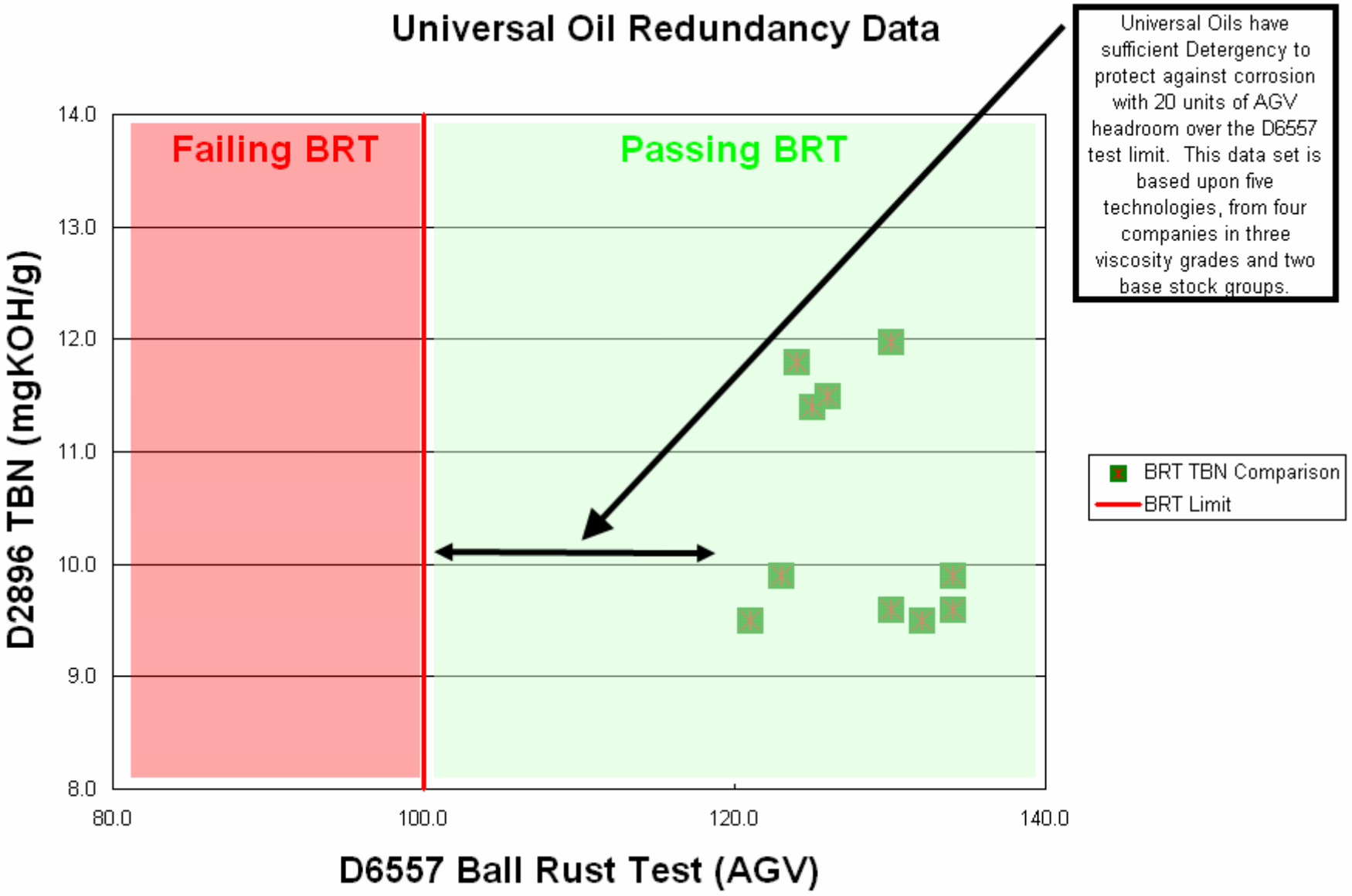
Data has been collected from four ACC companies on five CI-4 type technologies to support the proposal :

- BRT vs. TBN
  - Confirm that at HD TBN levels, BRT will always be passing
- Sequence IVA vs. RFWT and Sequence IVA vs. M11EGR
  - Confirm that passing RFWT and M11EGR wear parameters will always yield passing Sequence IVA
- M11EGR vs. VG Sludge and M11EGR vs. VG Varnish
  - Confirm that passing M11EGR sludge results in passing Sequence VG sludge and varnish
- Sequence VIII vs. Orbahn Shear; T10 Corrosion: HTCBT Corrosion
  - Confirm that KO shear pass will yield passing Sequence VIII shear and that HD lead corrosion measurements will yield passing Sequence VIII corrosion.

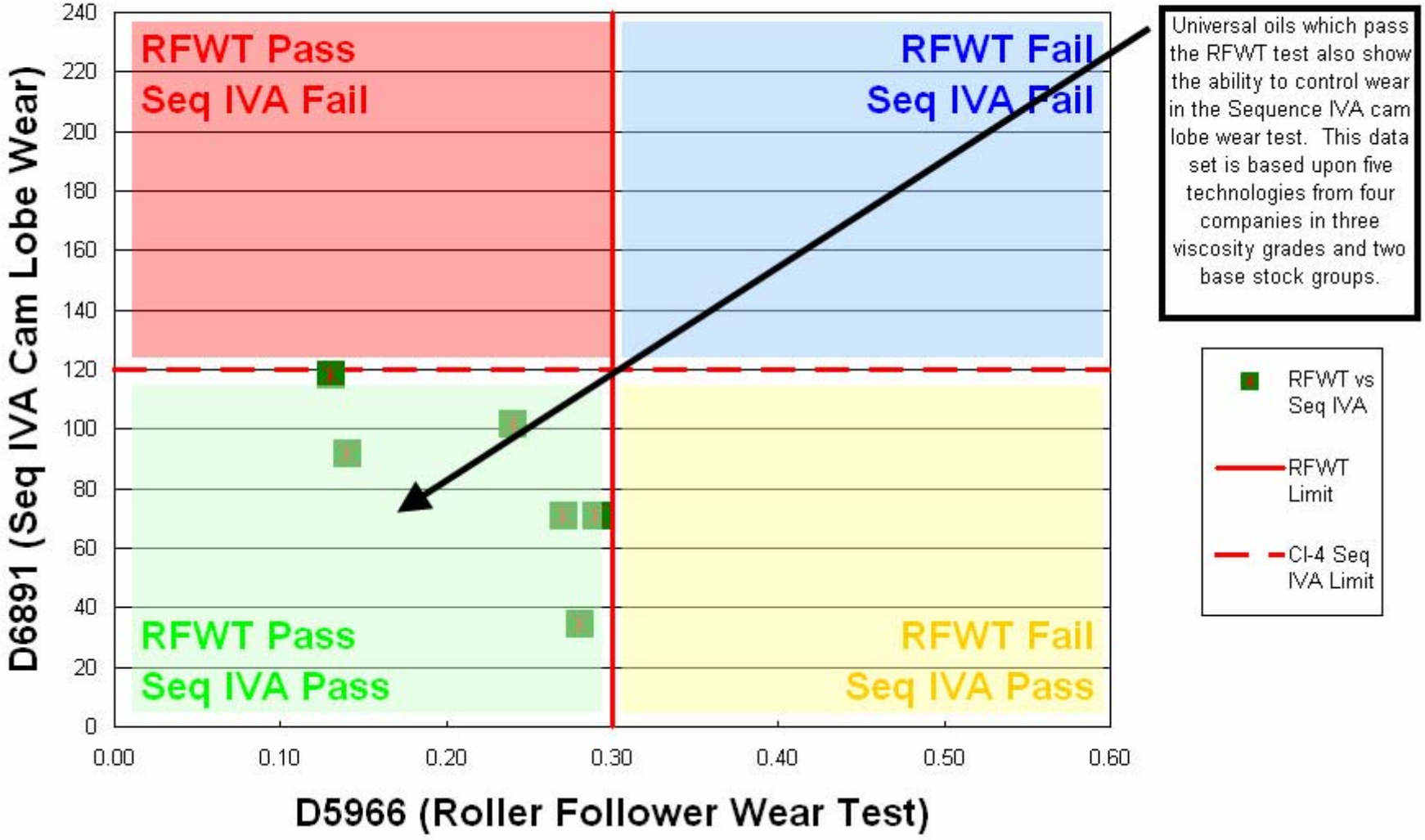
American Chemistry Council Good Chemistry Makes It Possible

Data to Support Proposal - 2

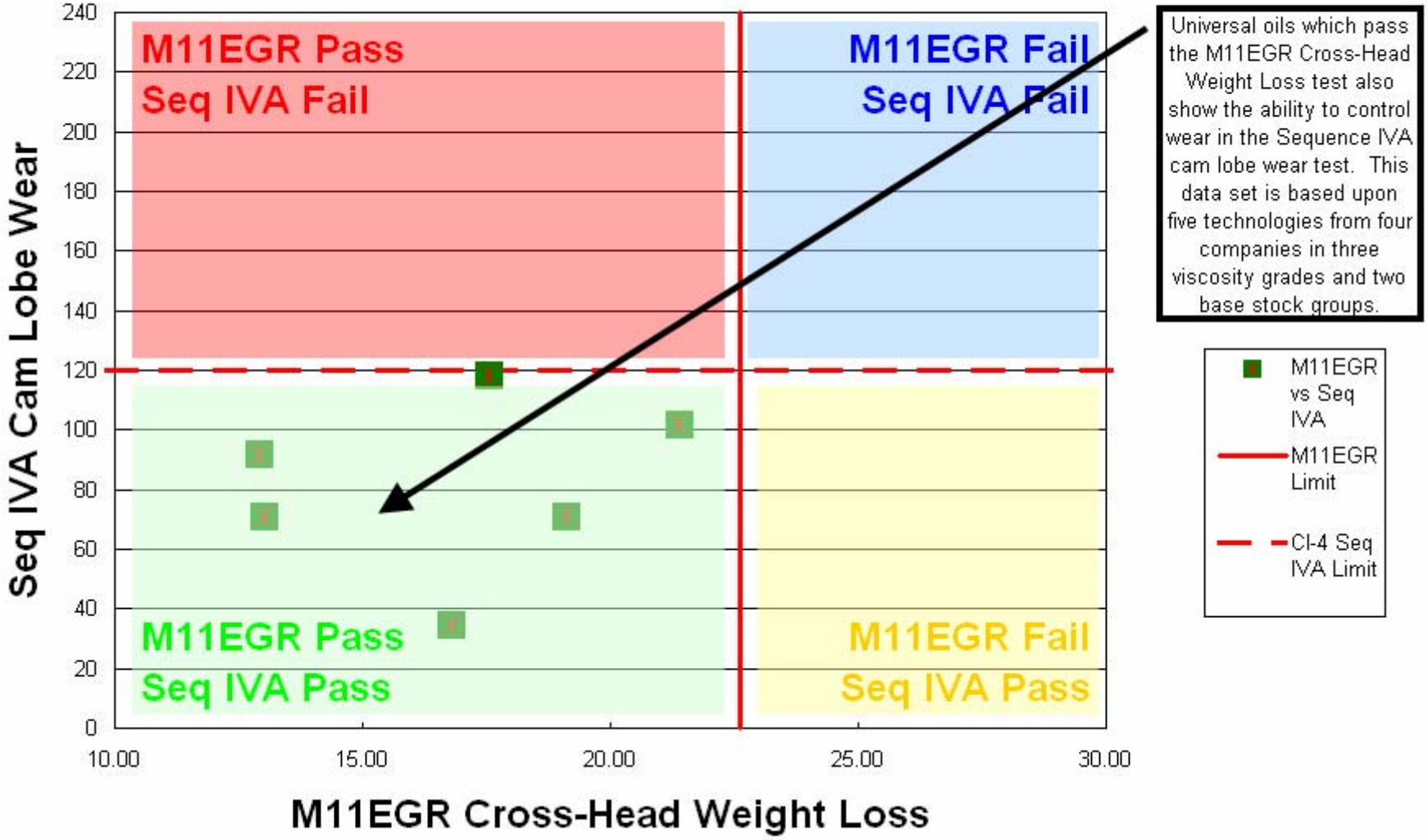
- Sequence IIIF Piston Deposits vs. 1R Piston Deposits
  - Confirm that passing Cat 1R piston deposits will yield passing results in the Sequence IIIF piston deposits
- Sequence IIIF Cam & Lifter Wear vs. M11EGR Cross-Head Weight Loss
  - Confirm that passing M11EGR cross-head weight loss will yield passing results in the Sequence IIIF cam and lifter wear
- Sequence IIIF Cam & Lifter Wear vs. RFWT
  - Confirm that passing RFWT will yield passing results in the Sequence IIIF cam & lifter wear
- Gelation Index vs. T10A and T11A
  - Passing used oil MRV in the T10A or T11A will result in passing Gelation Index

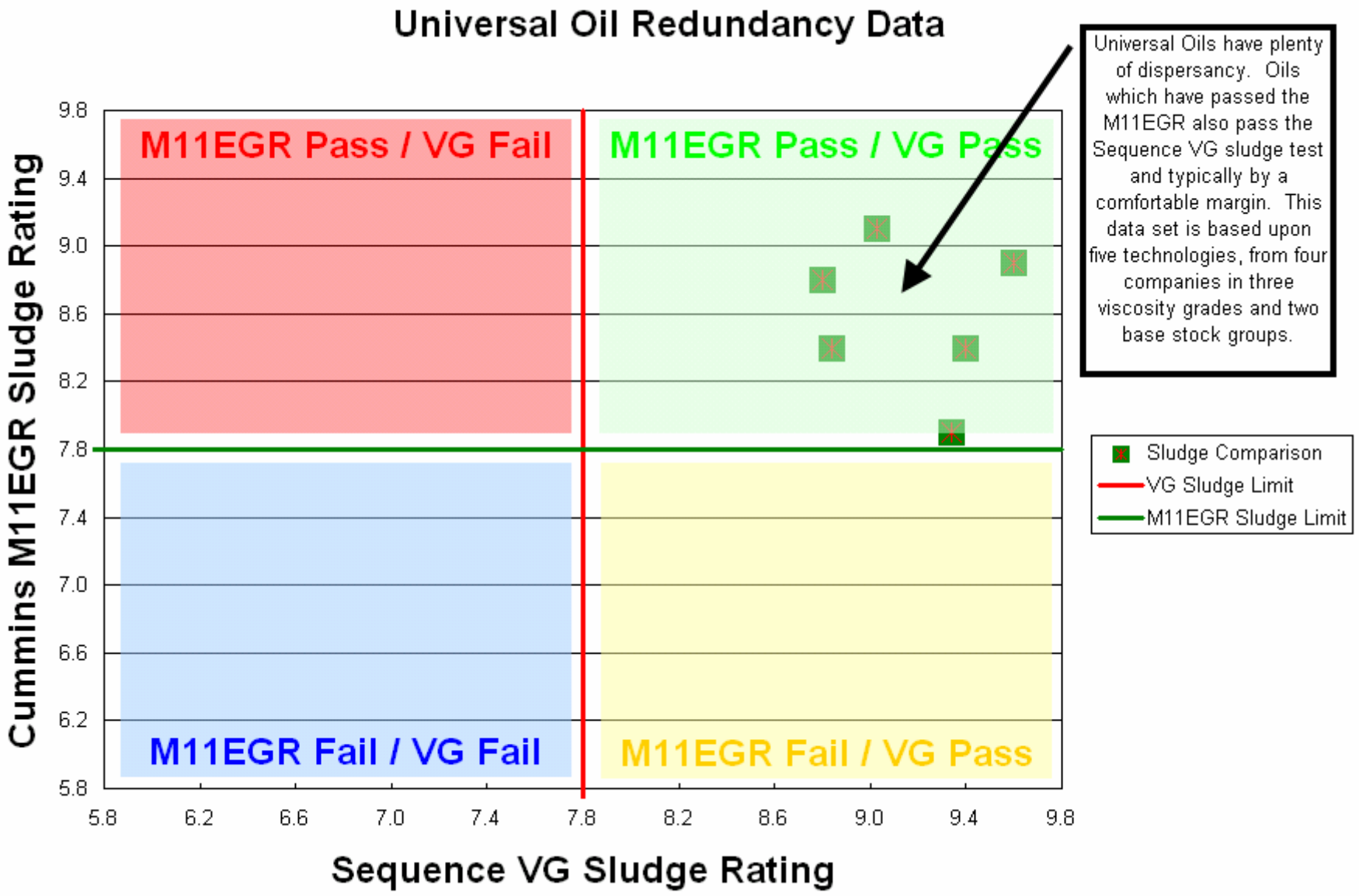

Universal Oil Redundancy Data
Universal Oils have sufficient Detergency to protect against corrosion with 20 units of AGV headroom over the D6557 test limit. This data set is based upon five technologies, from four companies in three viscosity grades and two base stock groups.
Failing BRT
Passing BRT
BRT TBN Comparison
BRT Limit
D2896 TBN (mgKOH/g)
14.0
13.0
12.0
11.0
10.0
9.0
8.0
80.0
100.0
120.0
140.0
D6557 Ball Rust Test (AGV)

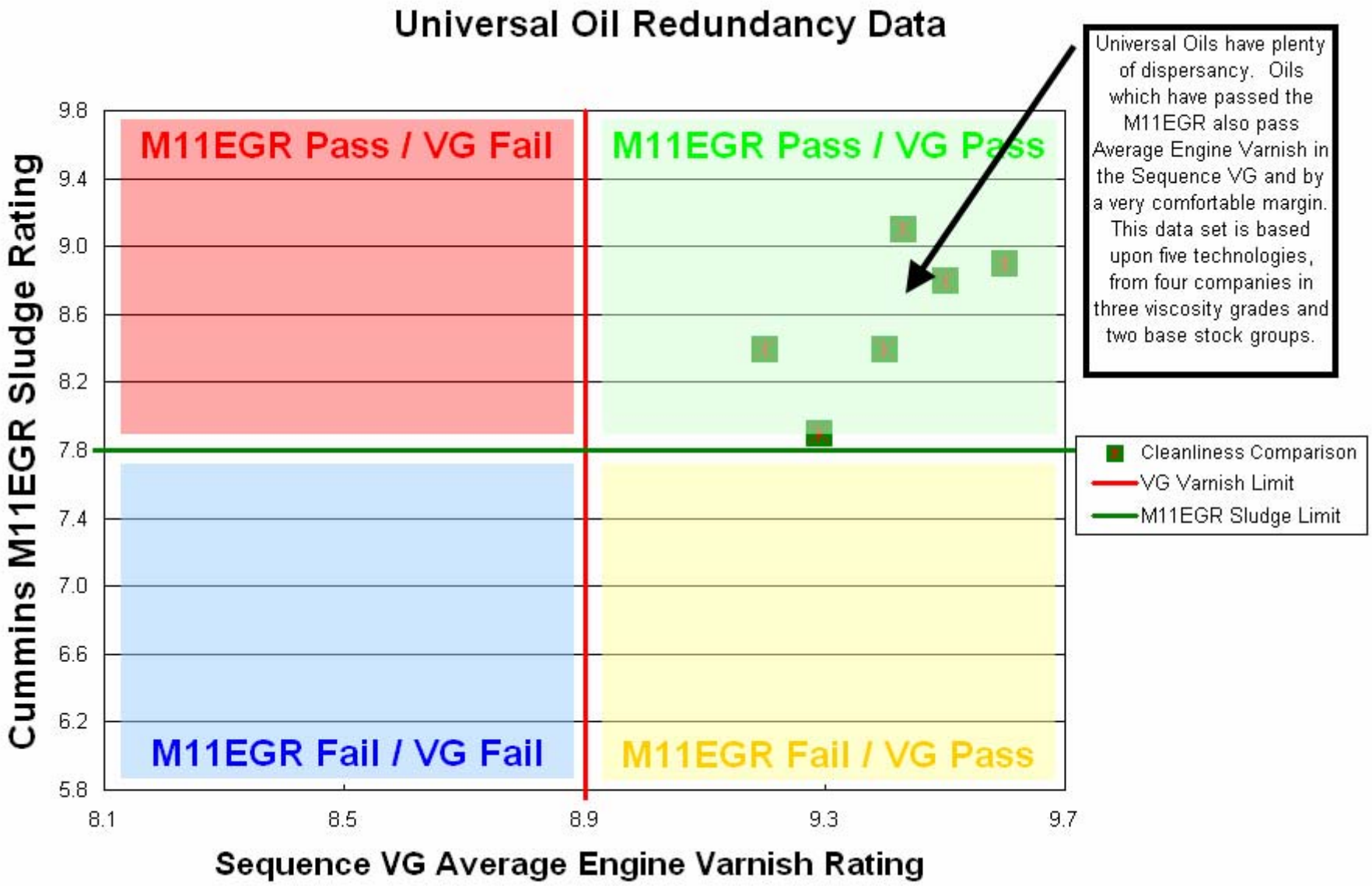
Universal Oil Redundancy Data

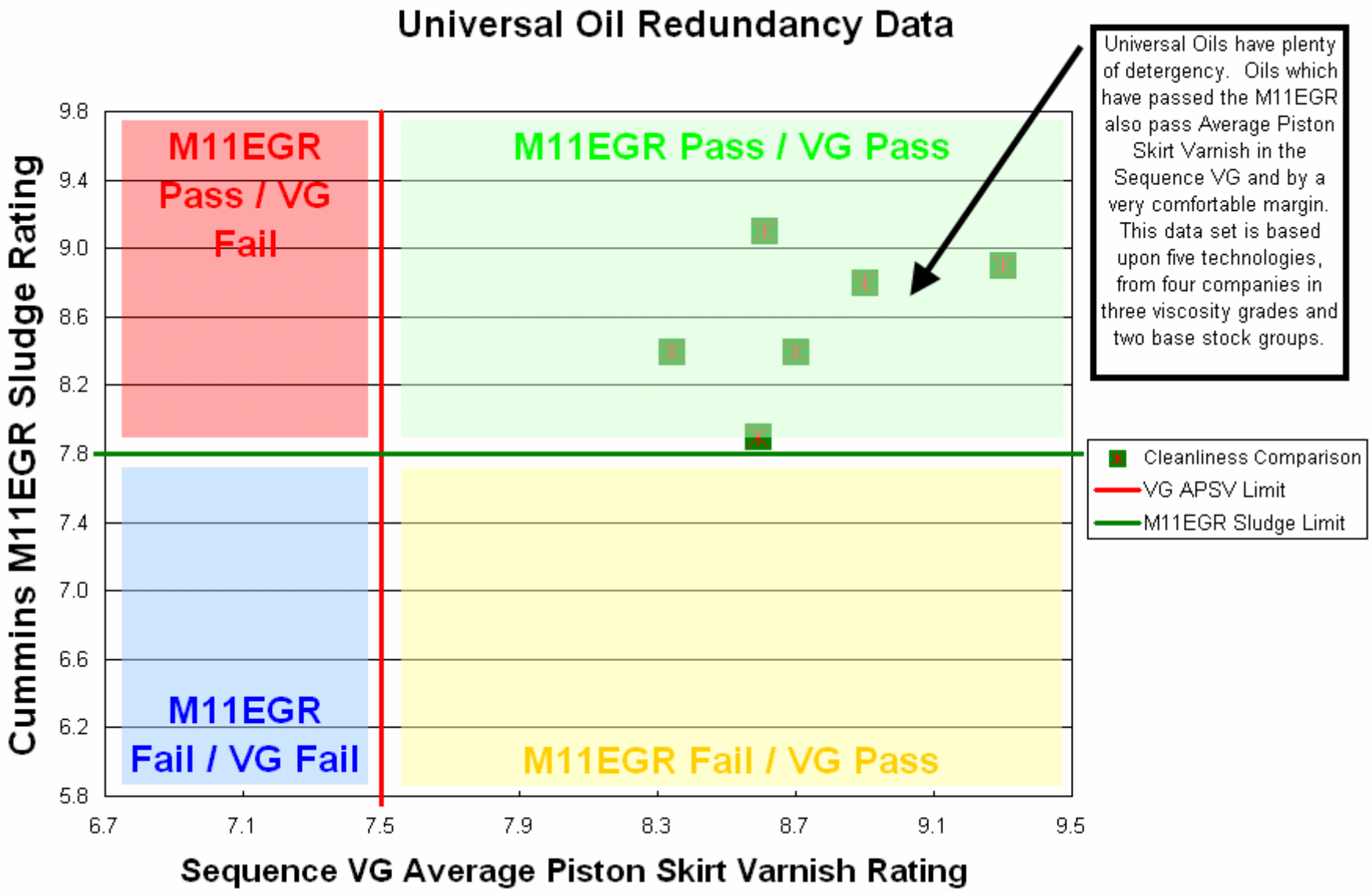


Universal Oil Redundancy Data

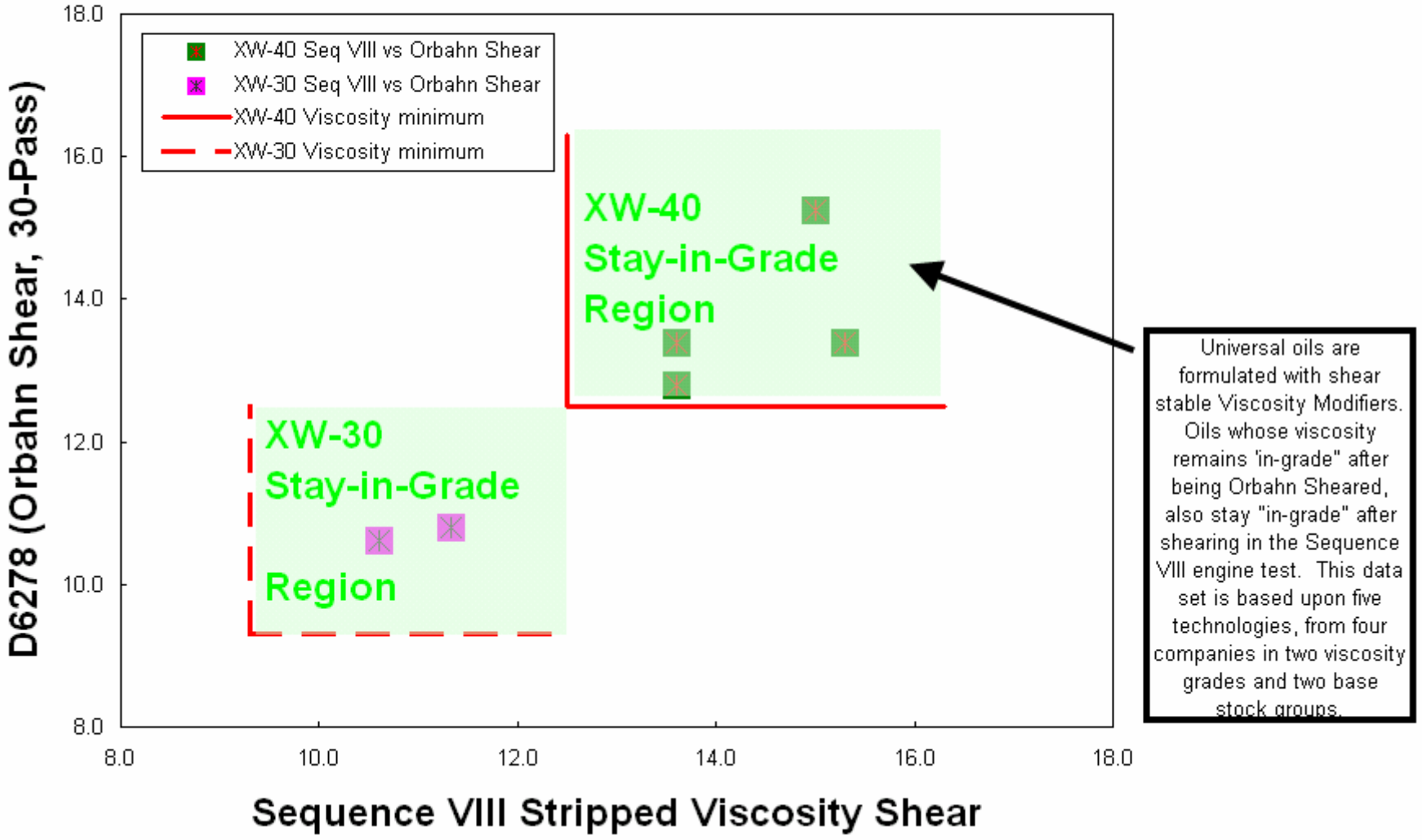


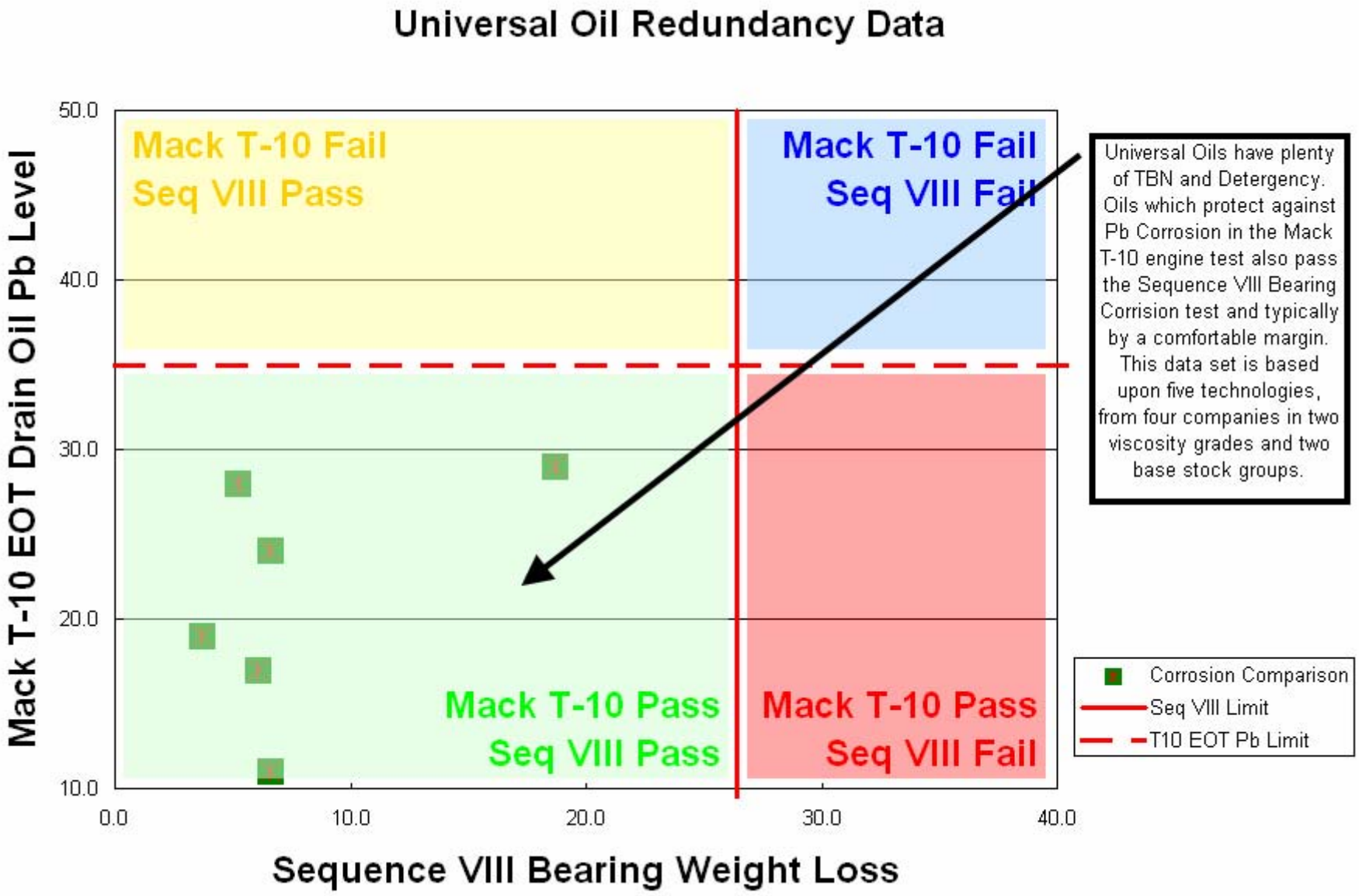

Universal Oil Redundancy Data
Universal Oils have plenty of dispersancy. Oils which have passed the M11EGR also pass the Sequence VG sludge test and typically by a comfortable margin. This data set is based upon five technologies, from four companies in three viscosity grades and two base stock groups.
M11EGR Pass / VG Fail
M11EGR Pass / VG Pass
M11EGR Fail / VG Fail
M11EGR Fail / VG Pass
Sludge Comparison
VG Sludge Limit
M11EGR Sludge Limit
Cummins M11EGR Sludge Rating
9.8
9.4
9.0
8.6
8.2
7.8
7.4
7.0
6.6
6.2
5.8
5.8
6.2
6.6
7.0
7.4
7.8
8.2
8.6
9.0
9.4
9.8
Sequence VG Sludge Rating

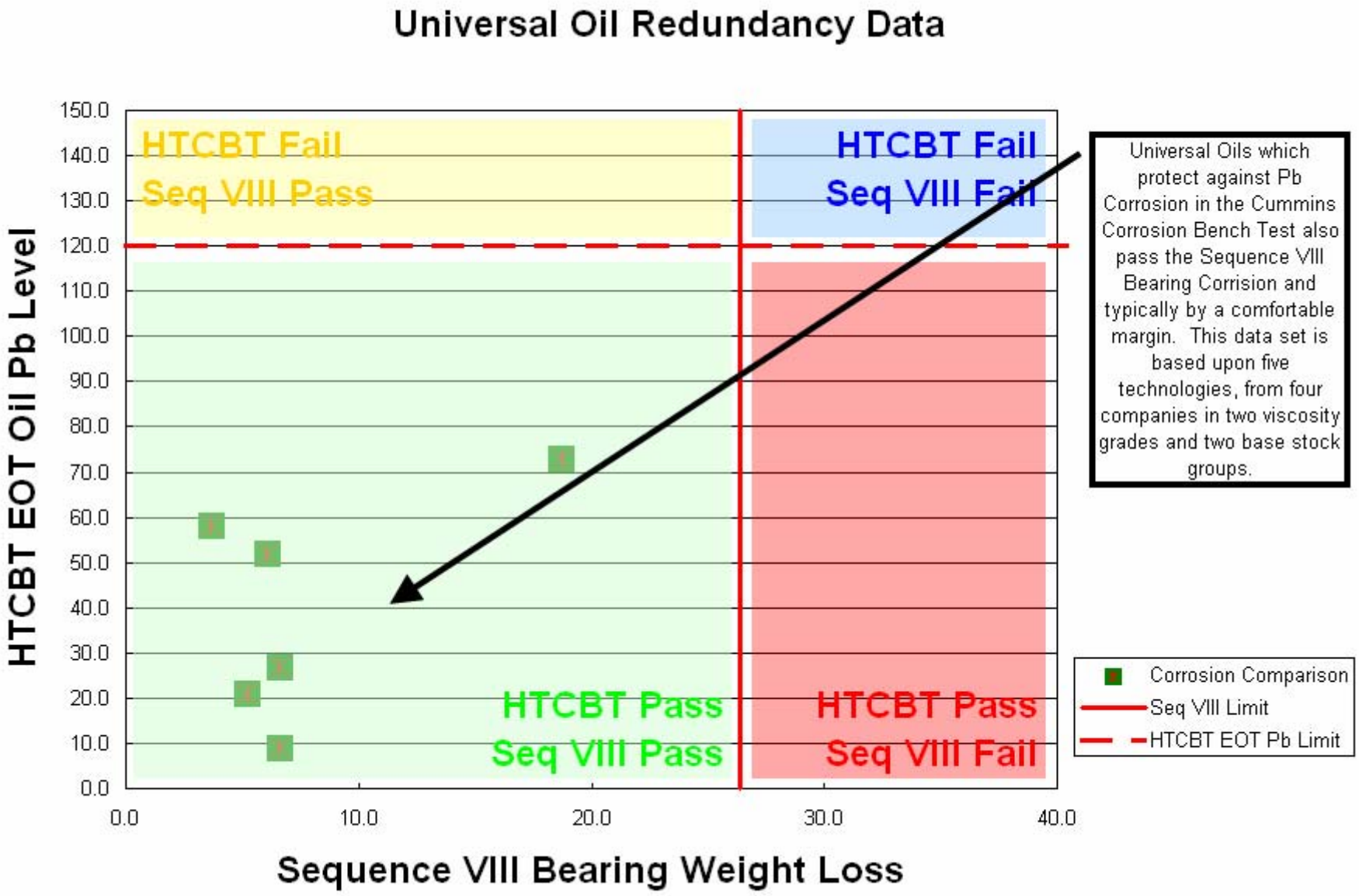

Universal Oil Redundancy Data
Universal Oils have plenty of dispersancy. Oils which have passed the M11EGR also pass Average Engine Varnish in the Sequence VG and by a very comfortable margin. This data set is based upon five technologies, from four companies in three viscosity grades and two base stock groups.
M11EGR Pass / VG Fail
M11EGR Pass / VG Pass
M11EGR Fail / VG Fail
M11EGR Fail / VG Pass
Cleanliness Comparison
VG Varnish Limit
M11EGR Sludge Limit
Cummins M11EGR Sludge Rating
9.8
9.4
9.0
8.6
8.2
7.8
7.4
7.0
6.6
6.2
5.8
8.1
8.5
8.9
9.3
9.7
Sequence VG Average Engine Varnish Rating

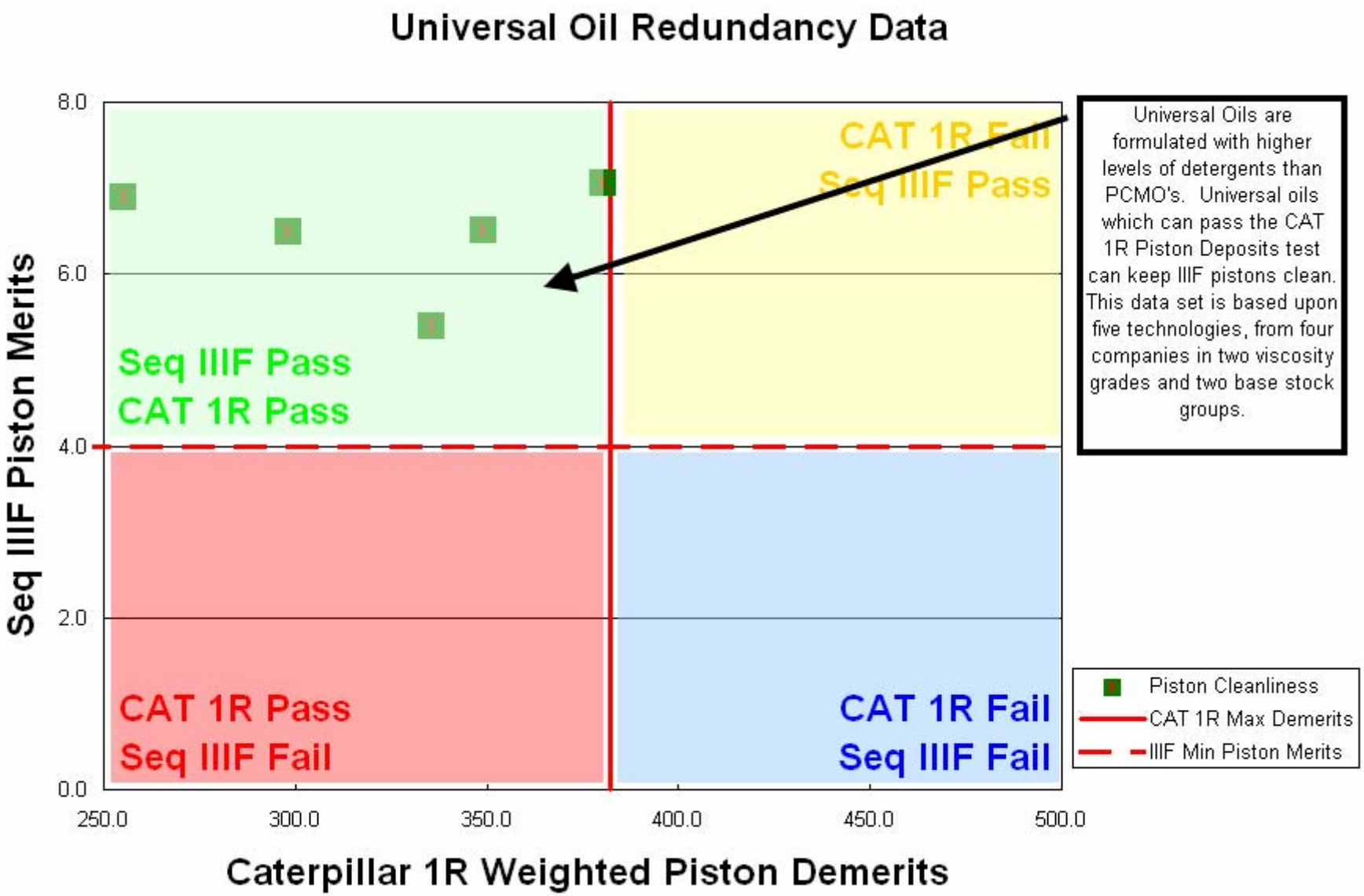

Universal Oil Redundancy Data
Universal Oils have plenty of detergency. Oils which have passed the M11EGR also pass Average Piston Skirt Varnish in the Sequence VG and by a very comfortable margin. This data set is based upon five technologies, from four companies in three viscosity grades and two base stock groups.
M11EGR Pass / VG Fail
M11EGR Pass / VG Pass
M11EGR Fail / VG Fail
M11EGR Fail / VG Pass
Cleanliness Comparison
VG APSV Limit
M11EGR Sludge Limit
Cummins M11EGR Sludge Rating
9.8
9.4
9.0
8.6
8.2
7.8
7.4
7.0
6.6
6.2
5.8
6.7
7.1
7.5
7.9
8.3
8.7
9.1
9.5
Sequence VG Average Piston Skirt Varnish Rating

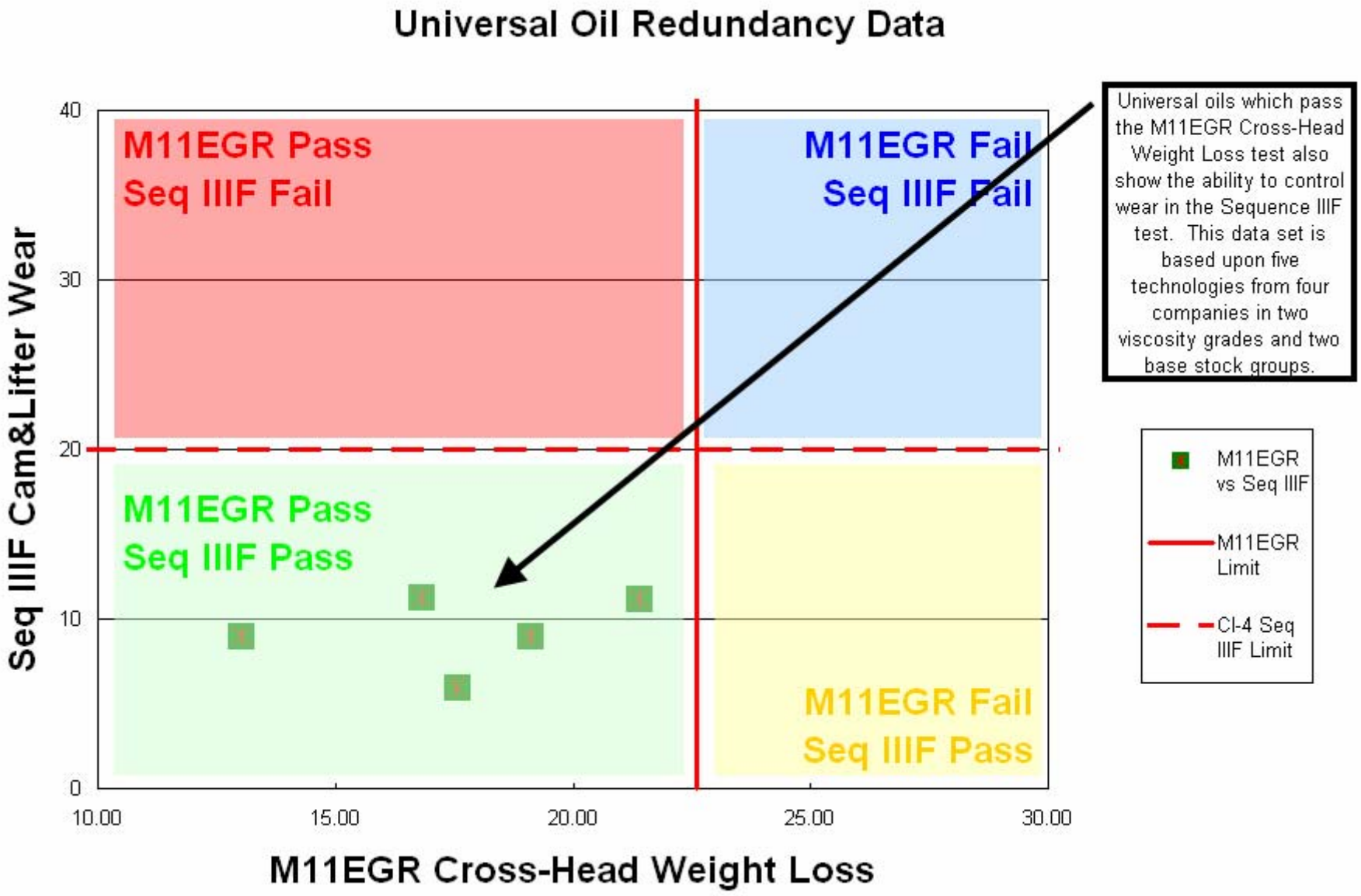
Universal Oil Redundancy Data

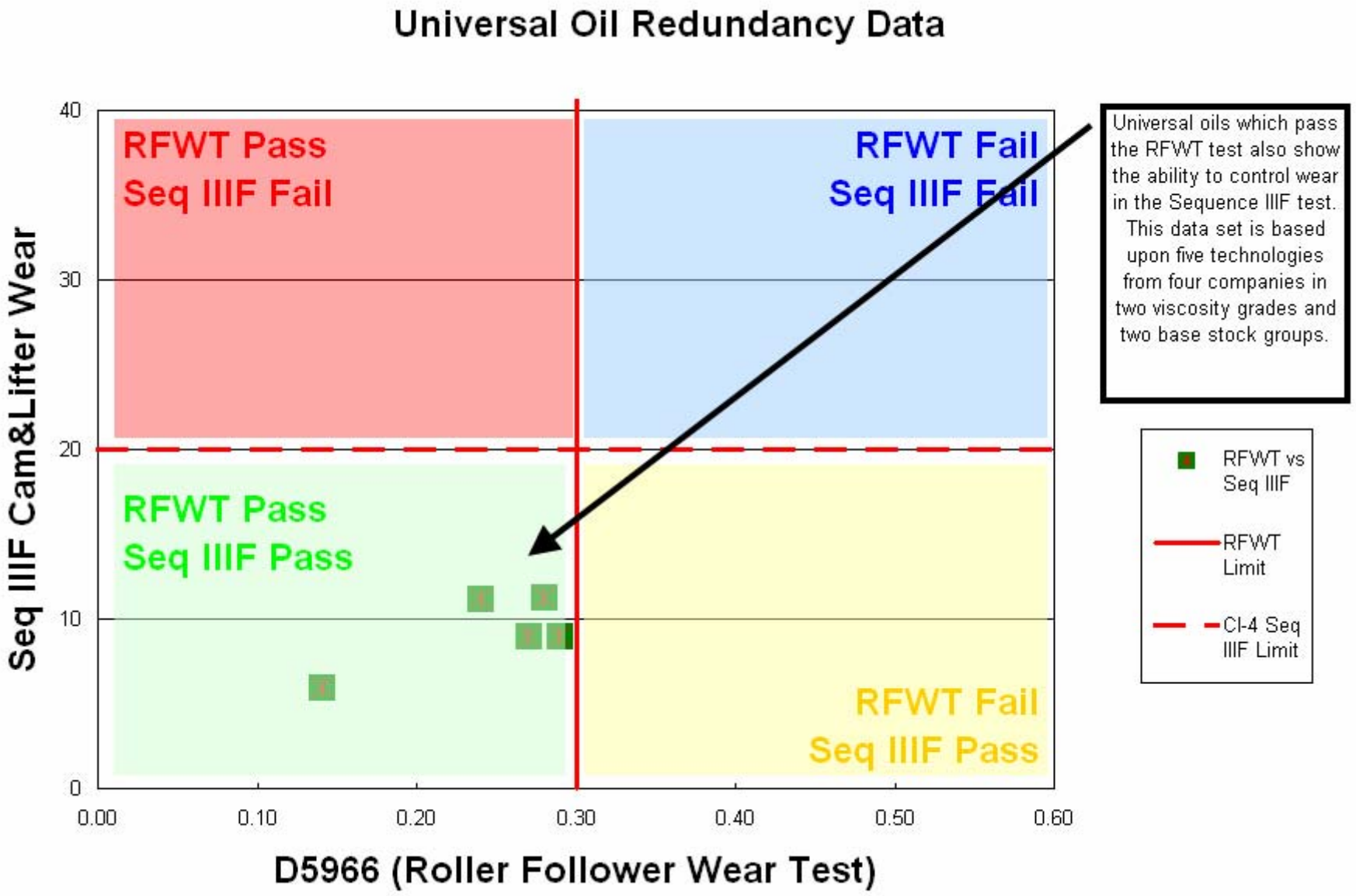



Universal Oil Redundancy Data
Mack T-10 EOT Drain Oil Pb Level
50.0
40.0
30.0
20.0
10.0
0.0
10.0
20.0
30.0
40.0
Sequence VIII Bearing Weight Loss
Mack T-10 Fail
Seq VIII Pass
Mack T-10 Fail
Seq VIII Fail
Mack T-10 Pass
Seq VIII Pass
Mack T-10 Pass
Seq VIII Fail
Universal Oils have plenty of TBN and Detergency. Oils which protect against Pb Corrosion in the Mack T-10 engine test also pass the Sequence VIII Bearing Corrision test and typically by a comfortable margin. This data set is based upon five technologies, from four companies in two viscosity grades and two base stock groups.
Corrosion Comparison
Seq VIII Limit
T10 EOT Pb Limit

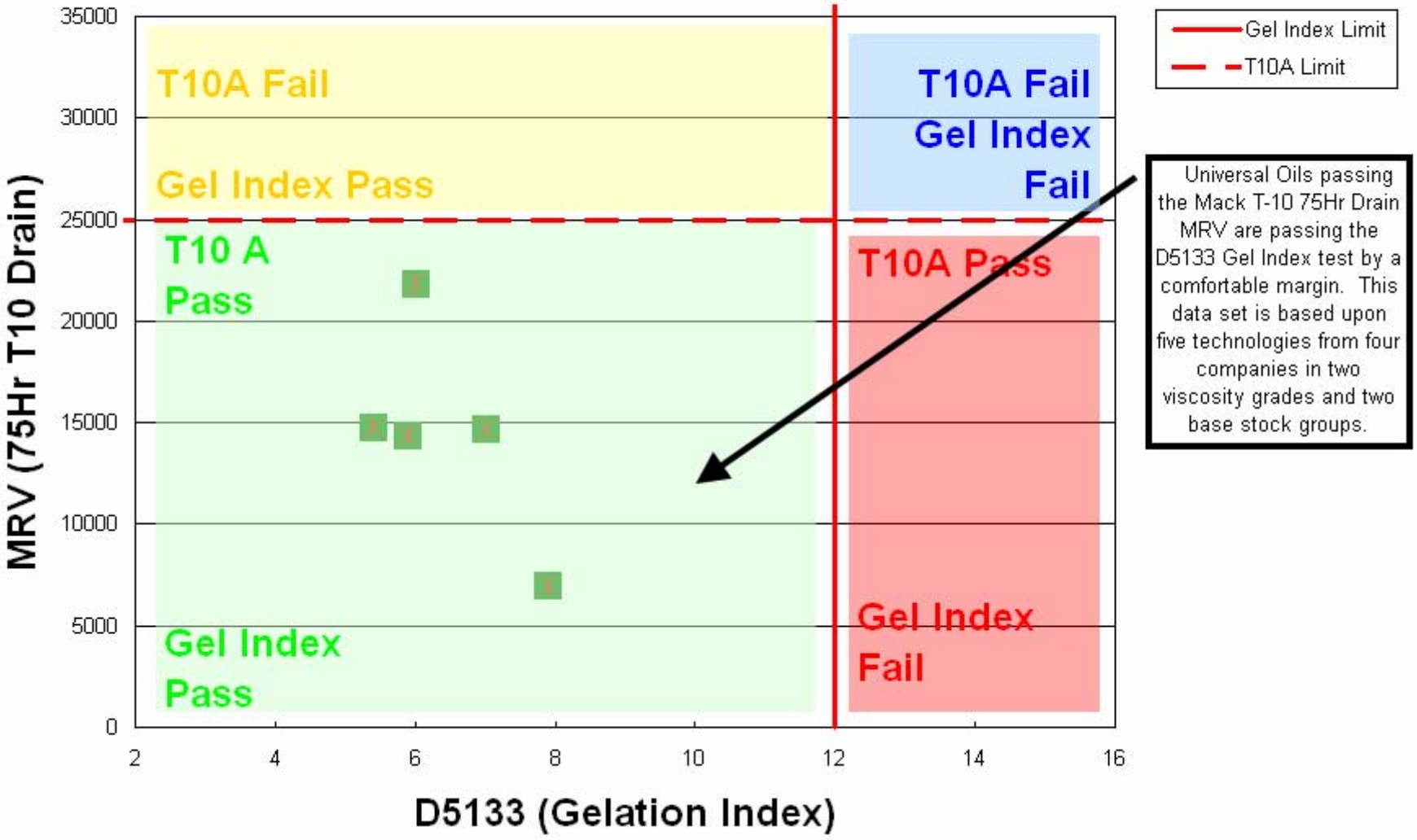

Universal Oil Redundancy Data
HTCBT EOT Oil Pb Level
Sequence VIII Bearing Weight Loss
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.0
10.0
20.0
30.0
40.0
HTCBT Fail
Seq VIII Pass
HTCBT Fail
Seq VIII Fail
HTCBT Pass
Seq VIII Pass
HTCBT Pass
Seq VIII Fail
Universal Oils which protect against Pb Corrosion in the Cummins Corrosion Bench Test also pass the Sequence VIII Bearing Corrision and typically by a comfortable margin. This data set is based upon five technologies, from four companies in two viscosity grades and two base stock groups.
Corrosion Comparison
Seq VIII Limit
HTCBT EOT Pb Limit

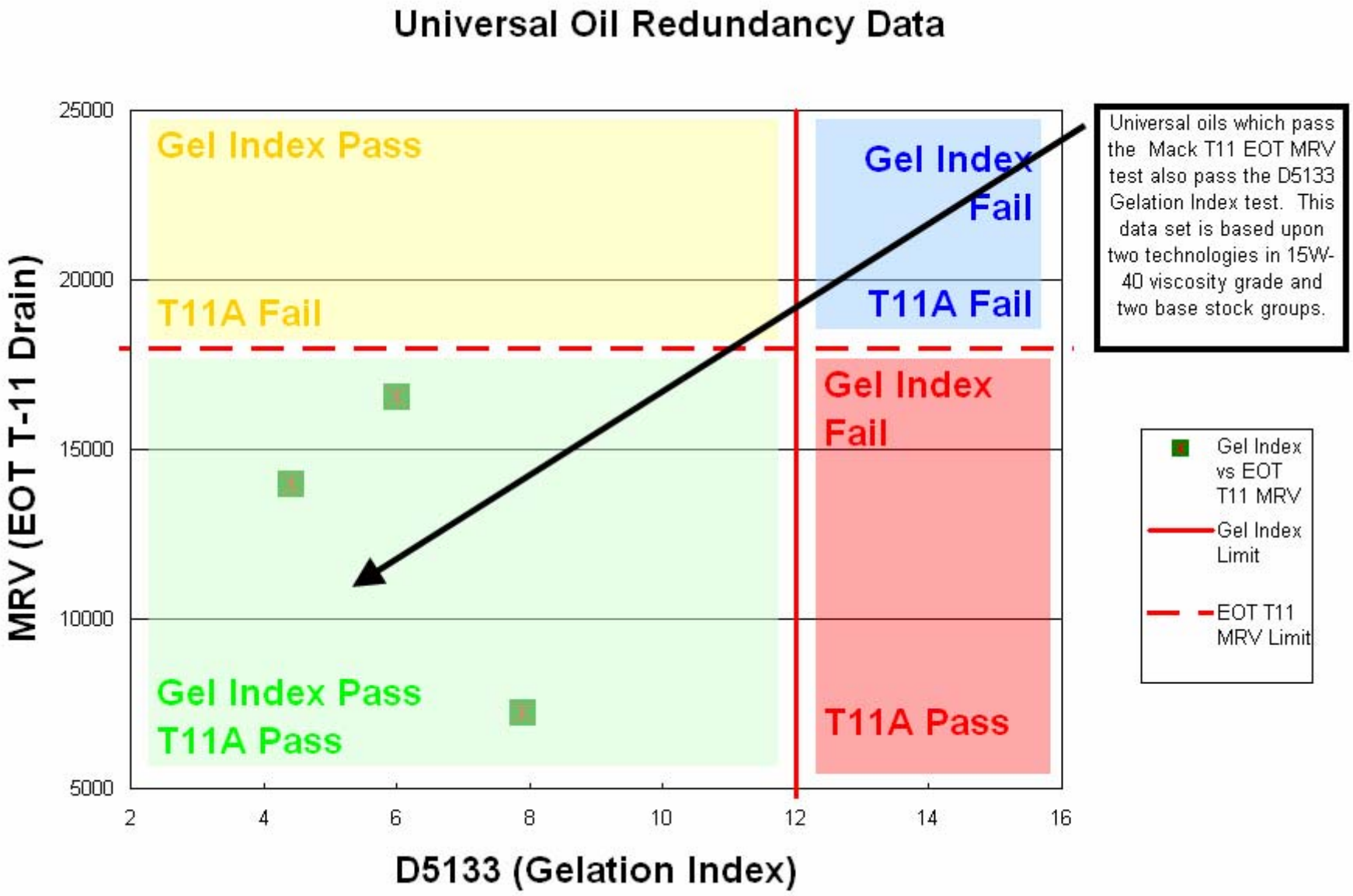

Universal Oil Redundancy Data
Seq IIIF Piston Merits
8.0
6.0
4.0
2.0
0.0
250.0
300.0
350.0
400.0
450.0
500.0
Caterpillar 1R Weighted Piston Demerits
CAT 1R Fail
Seq IIIF Pass
Seq IIIF Pass
CAT 1R Pass
CAT 1R Pass
Seq IIIF Fail
CAT 1R Fail
Seq IIIF Fail
Universal Oils are formulated with higher levels of detergents than PCMO's. Universal oils which can pass the CAT 1R Piston Deposits test can keep IIIF pistons clean. This data set is based upon five technologies, from four companies in two viscosity grades and two base stock groups.
Piston Cleanliness
CAT 1R Max Demerits
IIIF Min Piston Merits


Universal Oil Redundancy Data
M11EGR Pass
Seq IIIF Fail
M11EGR Fail
Seq IIIF Fail
M11EGR Pass
Seq IIIF Pass
M11EGR Fail
Seq IIIF Pass
Seq IIIF Cam&Lifter Wear
M11EGR Cross-Head Weight Loss
40
30
20
10
0
10.00
15.00
20.00
25.00
30.00
Universal oils which pass the M11EGR Cross-Head Weight Loss test also show the ability to control wear in the Sequence IIIF test. This data set is based upon five technologies from four companies in two viscosity grades and two base stock groups.
M11EGR vs Seq IIIF
M11EGR Limit
CI-4 Seq IIIF Limit


Universal Oil Redundancy Data
RFWT Pass
Seq IIIF Fail
RFWT Fail
Seq IIIF Fail
RFWT Pass
Seq IIIF Pass
RFWT Fail
Seq IIIF Pass
Seq IIIF Cam&Lifter Wear
D5966 (Roller Follower Wear Test)
0
10
20
30
40
0.00
0.10
0.20
0.30
0.40
0.50
0.60
Universal oils which pass the RFWT test also show the ability to control wear in the Sequence IIIF test. This data set is based upon five technologies from four companies in two viscosity grades and two base stock groups.
RFWT vs Seq IIIF
RFWT Limit
CI-4 Seq IIIF Limit

Universal Oil Redundancy Data




Universal Oil Redundancy Data
Gel Index Pass
T11A Fail
Gel Index Fail
T11A Fail
Gel Index Fail
Gel Index Pass
T11A Pass
T11A Pass
MRV (EOT T-11 Drain)
25000
20000
15000
10000
5000
2
4
6
8
10
12
14
16
D5133 (Gelation Index)
Universal oils which pass the Mack T11 EOT MRV test also pass the D5133 Gelation Index test. This data set is based upon two technologies in 15W-40 viscosity grade and two base stock groups.
Gel Index vs EOT T11 MRV
Gel Index Limit
EOT T11 MRV Limit

Summary of ACC Proposal on Universal Oils

Test/Parameter Eliminated	Performance Assured by Test/Parameter in API CI-4
BRT	TBN
Sequence IVA	RFWT & M11EGR
Sequence VIII	KO Shear, T10 corrosion, HTCBT
Sequence VG	M11EGR
Seq IIIF piston deposits	Cat 1R piston deposits
Seq IIIF cam/lifter wear	RFWT & M11EGR XHDWL
Gelation Index	T10A/T11A used oil MRV

American Chemistry Council Good Chemistry Makes it Possible

Next Steps

- Following positive feedback from both ASTM HDEOCP and PCEOCP, ACC PAPTG will take this proposal to API LC.
  - For API CI-4/SX, API CI-4Plus/SX, and API CJ-4/SX (where x=J,L,M) the requirement to run and measure the Sequence IVA, Sequence VG, Sequence IIIF piston deposits and wear, Sequence VIII, BRT, and Gelation Index is waived with passing API CI-4/CI-4 Plus/CJ-4 results.