

INDUSTRY SOCIETY STATUS

American Society for Testing and Materials (ASTM)

Passenger Car Engine Oil Classification Panel (PCEOCP)

Chairman: Frank Fernandez Tel: 201-731-5603

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12/01

The PCEOCP is the ASTM group that develops and maintains passenger car engine oil performance classifications such as GF-3. It has a balanced voting membership between OEMs and oil/additive companies. All members present have voting rights, however, the votes are weighted such that the balance is 50% OEM / 25% oil / 25% additive at each meeting.

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12/01

The ASTM PCEOCP met as follows where GF-4 issues were discussed:

- December 3, 2001 in Miami, Florida
- June 18, 2002 in Montreal, Canada
- December 10, 2002 in Anaheim, California
- February 20, 2003 in San Antonio, Texas
- April 17, 2003 in Detroit, Michigan
- June 17, 2003 in Norfolk, Virginia
- December 9, 2003 in Phoenix, Arizona
- **June 22, 2004 in Salt Lake City, Utah**

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8/04

There was little discussion of the GF-4 specification at the December 3 meeting since the future role of the PCEOCP in GF-4 development is currently an unknown until debate on "The New Specification Process" is concluded. This meeting only had brief updates on the API / ILSAC specification process proposal discussion and IIIG development. These items are covered in the respective sections (B and D) of this notebook. ILSAC has given API until year-end 2001 to respond to the latest ILSAC modifications to the API proposal for new specification development. The PCEOCP is not part of this debate.

August 2004

The role of the PCEOCP in the new engine oil specification development process was discussed. There was general agreement that the PCEOCP should continue most historic functions but that it would not establish "GF" performance requirements. Some specific areas agreed where PCEOCP input would continue were:

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8/02

- Document engine oil specifications in ASTM document D4485. It is recognized that ILSAC may want the "GF" specification only included in the appendix.
- Make recommendations on the readiness of tests for precision matrix prove out and the readiness of new specifications.
- ASTM Test surveillance panels and the TMC operated calibration system (LTMS) will continue all current functions and report to ASTM Technical Committee B. The PCEOCP will review items that have an impact on performance limits and test availability.
- Be an industry forum for input on new specification development via panel discussion and ballots.

The PCEOCP was expected to meet in late August to review the matrix test proposal for the IIIG and give input on the readiness of the IIIG. However, the PCEOCP did not meet until December 10, 2002 since the IIIG test was still under development and the MDTF was still gathering the required information to develop matrix proposals. The PCEOCP received two IIIG matrix proposals from the MDTF in late October. A 24 test matrix was the technically preferred proposal with an 18 test alternate if funds were limited. Both these proposals were balloted within the PCEOCP. The 24 test matrix received a tie vote and the 18 test matrix a slight majority but with numerous negative comments. At the December 10 meeting the panel debated how to proceed. The IIIG matrix Memo Of Understanding (MOA) will be written around the 18 test matrix. However, the panel approved including up to 6 donated tests from third parties to augment the 18 test matrix at the independent laboratories to achieve the technically recommended 24 test matrix.

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12/02

Bob Olree stated that GM feels the IIIG development is essentially complete but they will be running a few more tests and are looking for prototype GF-4 candidates for this activity. GM plans to seek IIIG acceptance of readiness by the ASTM Sequence III surveillance panel in late January for industry to proceed to the precision matrix.

An updated GF-4 development timeline estimate was presented by Cliff Venier as the API representative on ILSAC/Oil. The timeline predicts that GF-4 first use will occur about May 2004 and that mandatory use will occur about February 2005.

The PCEOCP met on February 20, 2003 to receive and debate inputs on the IIIG and precision matrix readiness from the Sequence IIIF surveillance panel, Matrix Design Task Force, and the Matrix Oil Selection Work group. All recommendations were approved.

- 1.) The three oils recommended for the IIIG matrix (ASTM 538, GF-4 prototypes 'B' and 'C') were agreed.
- 2.) The MDTF 24 test matrix was again confirmed, and it will include two cam batches as a design variable.
- 3.) The IIIG procedure was accepted as ready for the precision matrix once laboratory wear severity differences are resolved. The PCEOCP, however, did agree that no IIIG precision matrix testing can start until the group reviews the IIIG surveillance panel severity resolution report and concurs that the issue is acceptably resolved.

The PCEOCP also dealt with a redrafting of the panel scope in light of the new ILSAC/Oil engine oil specification development process. Some key elements of the PCEOCP scope, still in draft form and expected to be approved, are:

- 1.) The PCEOCP is a public forum for industry experts and other interested stakeholders to discuss issues, present and consider data and engage in the cooperative development of high quality passenger car engine oils.
- 2.) The PCEOCP is a consultant to the ILSAC/Oil committee in the development of ILSAC GF automotive engine oil performance specifications.
- 3.) The PCEOCP approves the designs of proposed test matrices and appoints managers. The panel reviews, and if appropriate, endorses surveillance panel recommendations regarding test severity, procedure changes, precision, availability, correlation, reference oils, and any other matter having a bearing on the suitability of tests.

The PCEOCP met on April 17 to determine again if the IIIG matrix was ready to commence. The Sequence IIII surveillance panel recommended that the IIIG test procedure was now ready for the precision matrix to commence by May 1. This recommendation was approved by the PCEOCP (with 3 OEM/6 Oil/5 Additive for, none opposed, 1 Oil/1 Additive abstaining).

A revised Scope for the PCEOCP was adopted and is included as page E-1B-1.

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4/03

April 2003

The PCEOCP met in Norfolk, Virginia, on June 17, 2003 to receive the IIF/IIIG report and recommendation regarding acceptability of the IIIG test procedure. The PCEOCP unanimously agreed that the IIIG test procedure was ready for inclusion in the GF-4 specification.

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7/03

The API liaison representative reported that API will develop a final draft proposal for 'SM' and plans to share this with the PCEOCP very soon. API stated that the 'SM' proposal is expected to differ from GF-4 for physical and chemical properties for viscosity grades not recommended by US OEMs.

At the December 9 meeting in Phoenix the PCEOCP decided that passing Sequence IIIG performance is acceptable to allow a claim if Sequence IIF performance for ILSAC viscosity grade oils with phosphorus content is greater than 0.06%. There was very little interest in developing Sequence IIIG equivalency to the Sequence IIF for API SL and prior performance, so no effort will be expended on this unless new, compelling information is brought forward. It was agreed to revise ASTM D4485 to eliminate obsolete tests and include API SM if requested or if this document continues to provide value to industry.

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12/03

At the June 22 meeting in Salt Lake City the PCEOCP discussed if and how the GF-4 and SM specifications would be included in ASTM D4485 since the specifications were developed through ILSAC/Oil and API with little input from ASTM. The planned action was to include them as supplements since only specifications developed via the ASTM consensus process can be included in the tables in D4485. Subsequently, the PCEOCP chairman has received guidance that GF-4 and SM specifications should be balloted within D02.B0 for inclusion in table 2 of ASTM D4485. A passing ballot will establish approval via the consensus process.

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8/04

A second topic of discussion was a preliminary review of possible GF-5 requirements and test method types by the chairman of ILSAC/Oil. These were only very general thoughts to help get GF-5 development planning started. It was stated that no serious GF-5 effort will begin until after a review of the GF-4 process is complete so that these learnings can be incorporated.

ASTM D02.B0.01 PASSENGER CAR ENGINE OIL CLASSIFICATION PANEL SCOPE

April 17, 2003

Composed of representatives from automobile manufactures, oil companies, and additive companies, the panel is a public forum for industry experts and other interested stakeholders to discuss issues, present and consider data, and engage in the cooperative development of passenger car engine oil standards.

The panel is responsible for maintaining existing API Passenger Car Engine Oil performance categories, for recommending elimination of those that become obsolete, and for developing new ones as directed. Fulfillment of this responsibility is documented through revisions to Specification D 4485.

In addition, the Panel provides input to the ILSAC-Oil Committee in the development of ILSAC GF automotive engine oil performance standards. The panel may offer recommendations to the ILSAC-Oil Committee on test usefulness, performance limits, or other matters related to the value and appropriateness of proposed ILSAC standards.

Consistent with these responsibilities, the Panel approves the designs of proposed test matrices and names matrix managers. The Panel reviews, and if appropriate endorses, surveillance panel recommendations regarding test severity, procedure changes, precision, availability, correlation, reference oils, and any other matter having a bearing on the suitability of tests. It may form special advisory task forces to facilitate accomplishment of these functions.

The Panel functions within a set of operating guidelines established by Panel members and approved by ASTM D.02.B.

April 2003

**Matrix Oil Selection Work Group Report
To
Passenger Car Engine Oil Classification Panel**

February 20, 2003

E-1-D

Work Group Members

- George Barth
- Gordon Farnsworth
- Frank Fernandez
- Pat Lang
- Charlie Leverett
- Robert Olree
- Ben Weber
- Lew Williams

Oils Considered for IIG Matrix Candidates

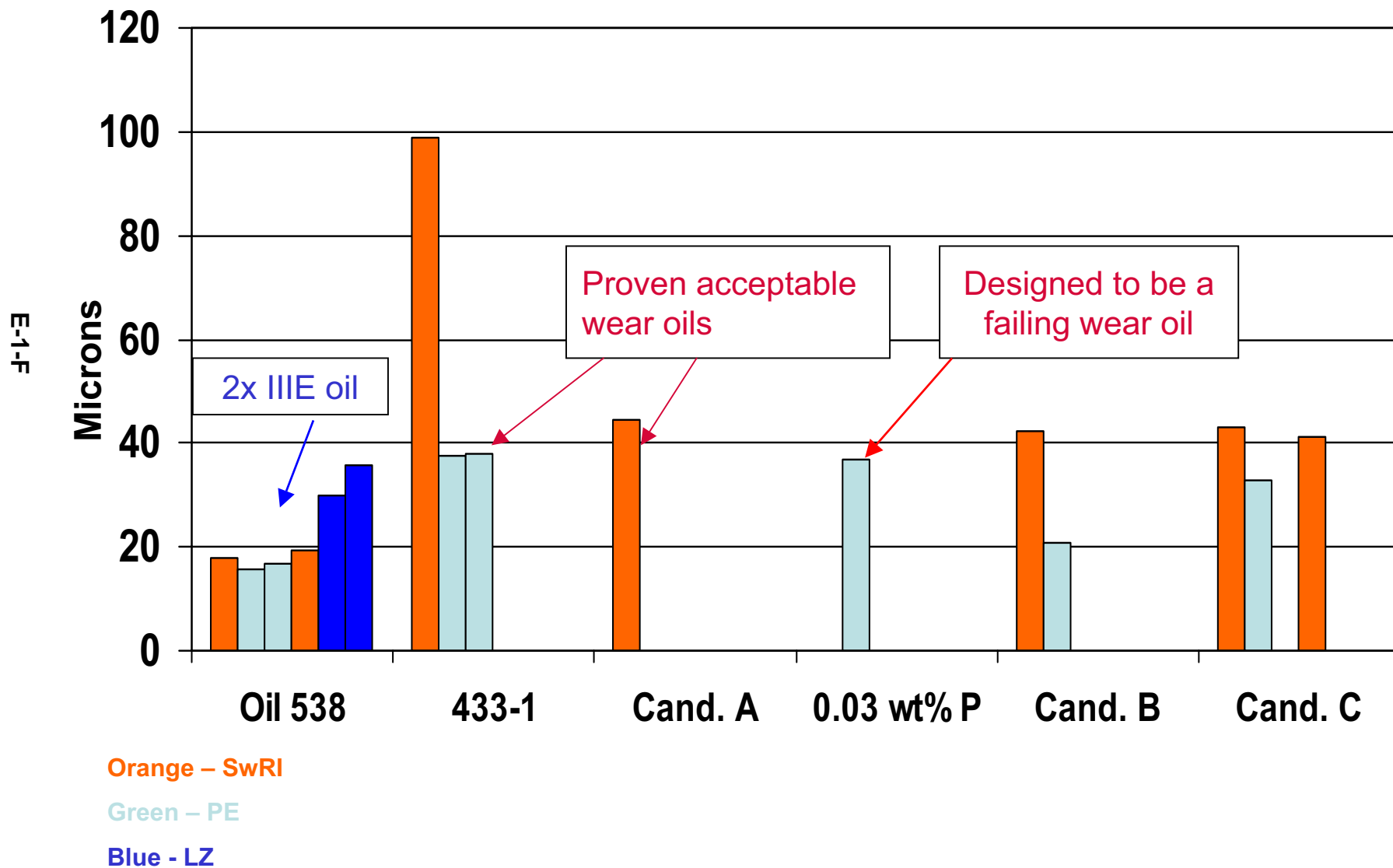
- **ASTM 538:** *5W-20 ASTM Sequence VIB reference oil*
 - 0.095% Phos. Oil with data from six IIG tests
 - **Oil B:** *5W-30 GF-4 proto-type oil*
 - 0.075% Phos. oil with data from two IIG tests
 - **Oil C:** *5W-20 GF-4 proto-type oil*
 - 0.075% Phos. oil with data from two IIG tests
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E-1-E

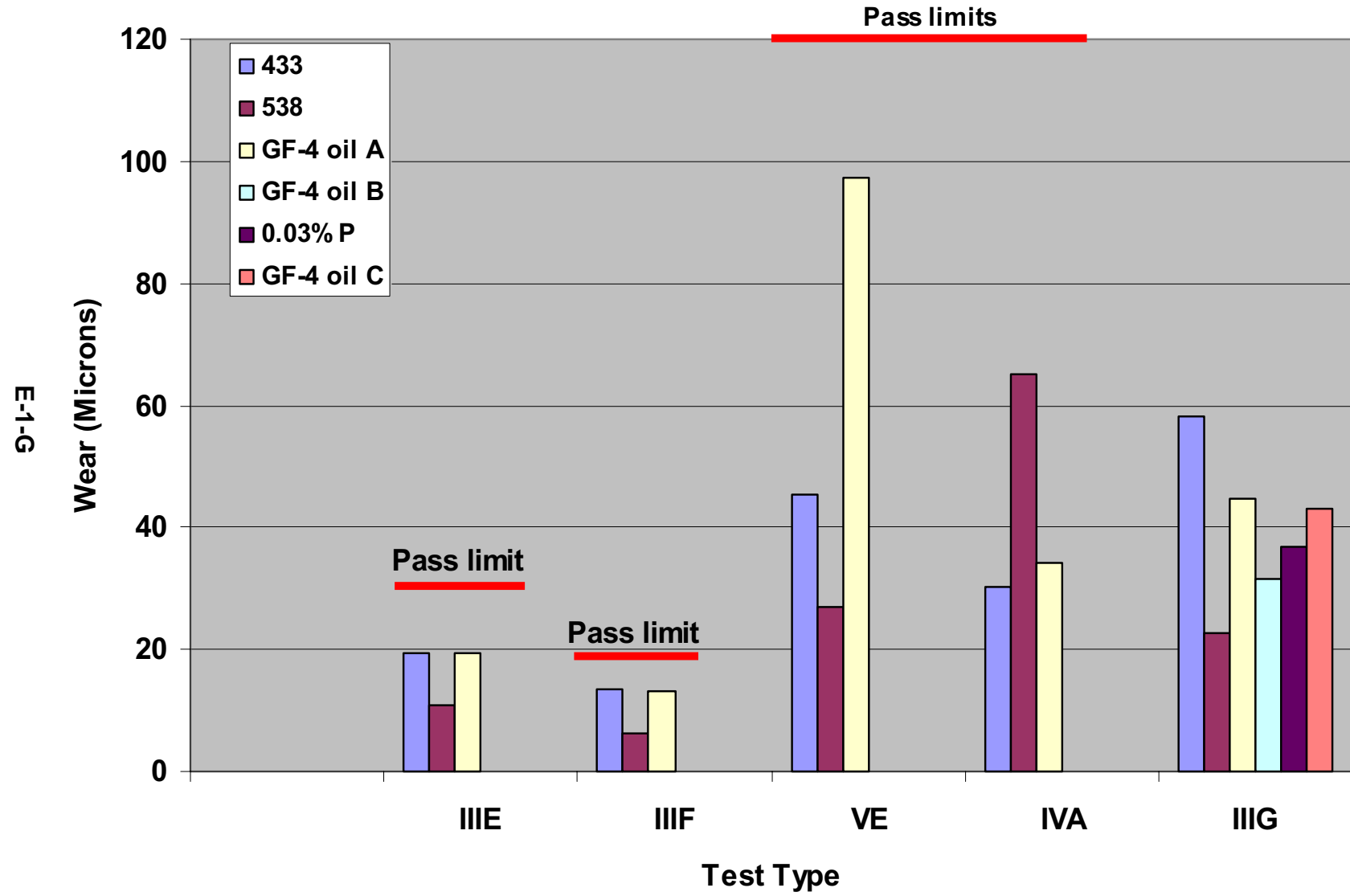
- **ASTM Oil 433:** *5W30 ASTM Sequence IIIF reference oil*
 - 0.095% Phos. oil with data from three IIG tests
- **Oil A:** *5W-20 GF-4 proto-type oil*
 - 0.095% Phos. oil with data from one IIG test
- **Low Phos. Oil:** *5W-30 oil expected to give high wear*
 - 0.03% Phos. Oil with one data IIG test

All IIG data mentioned above was with latest camshaft hardware 'NF200'

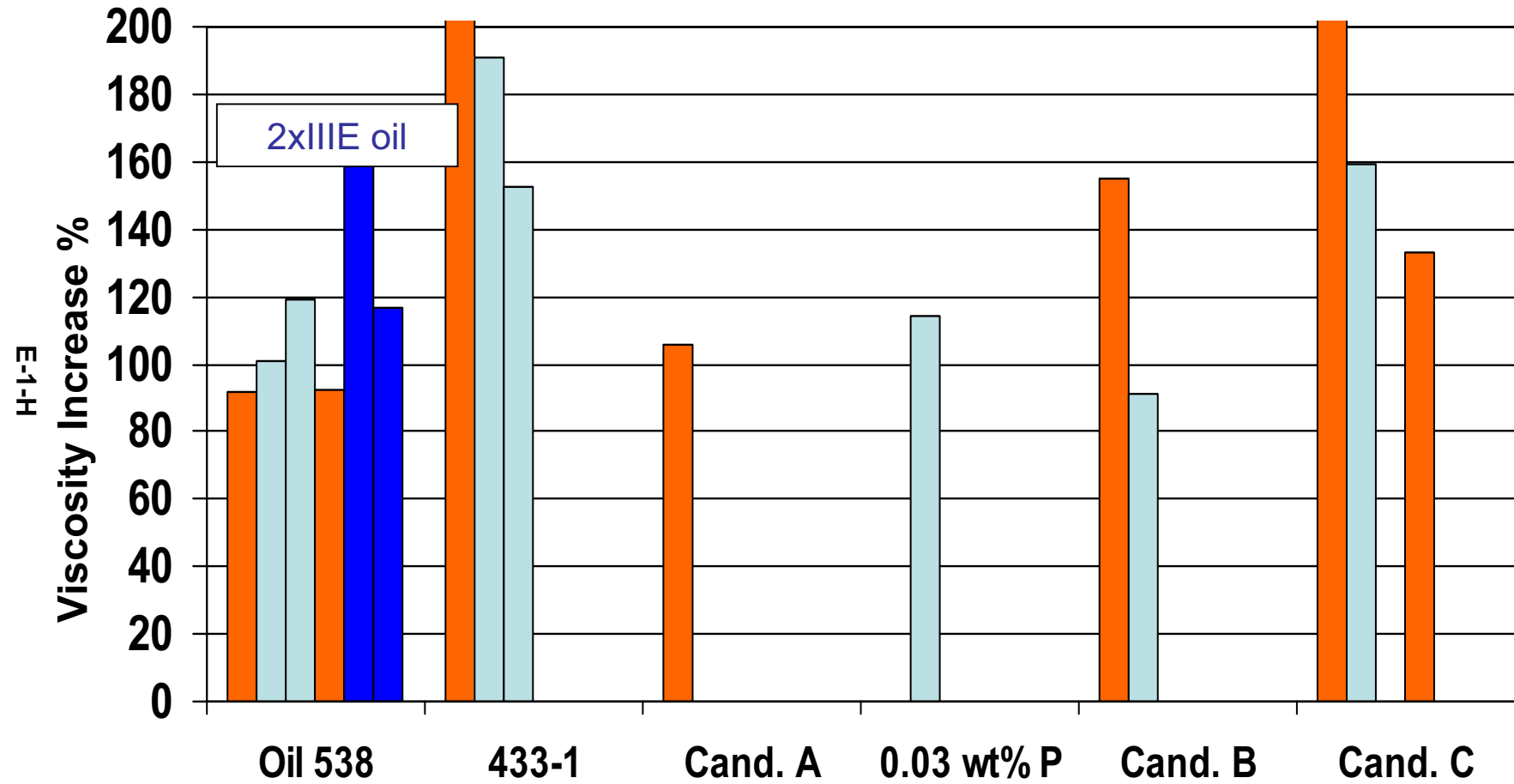
Sequence IIIG Wear



Average valvetrain wear



Sequence IIIG Viscosity Increase

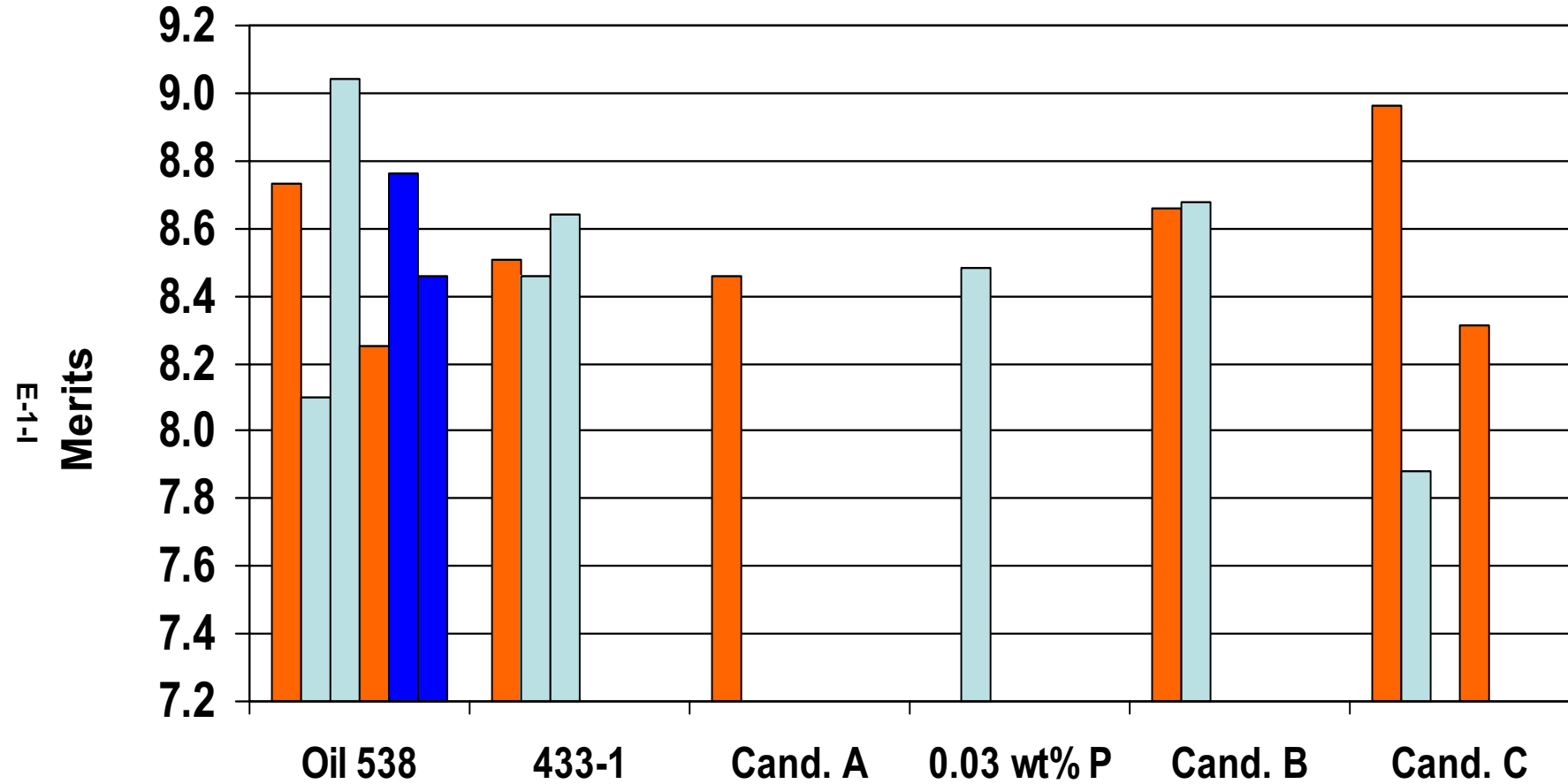


Orange – SwRI

Green – PE

Blue - LZ

Sequence IIIG PSV

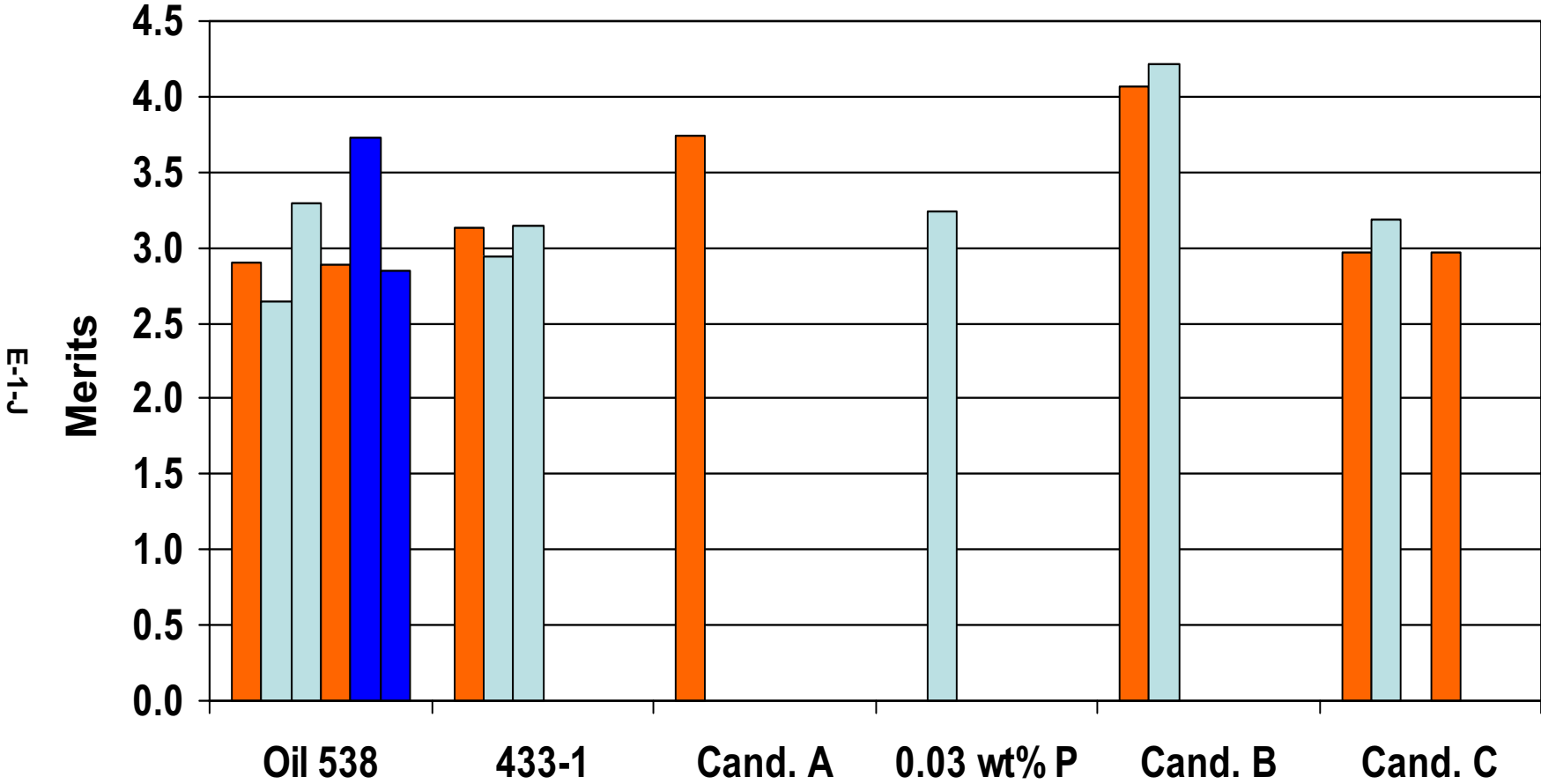


Orange – SwRI

Green – PE

Blue - LZ

Sequence IIIG WPD

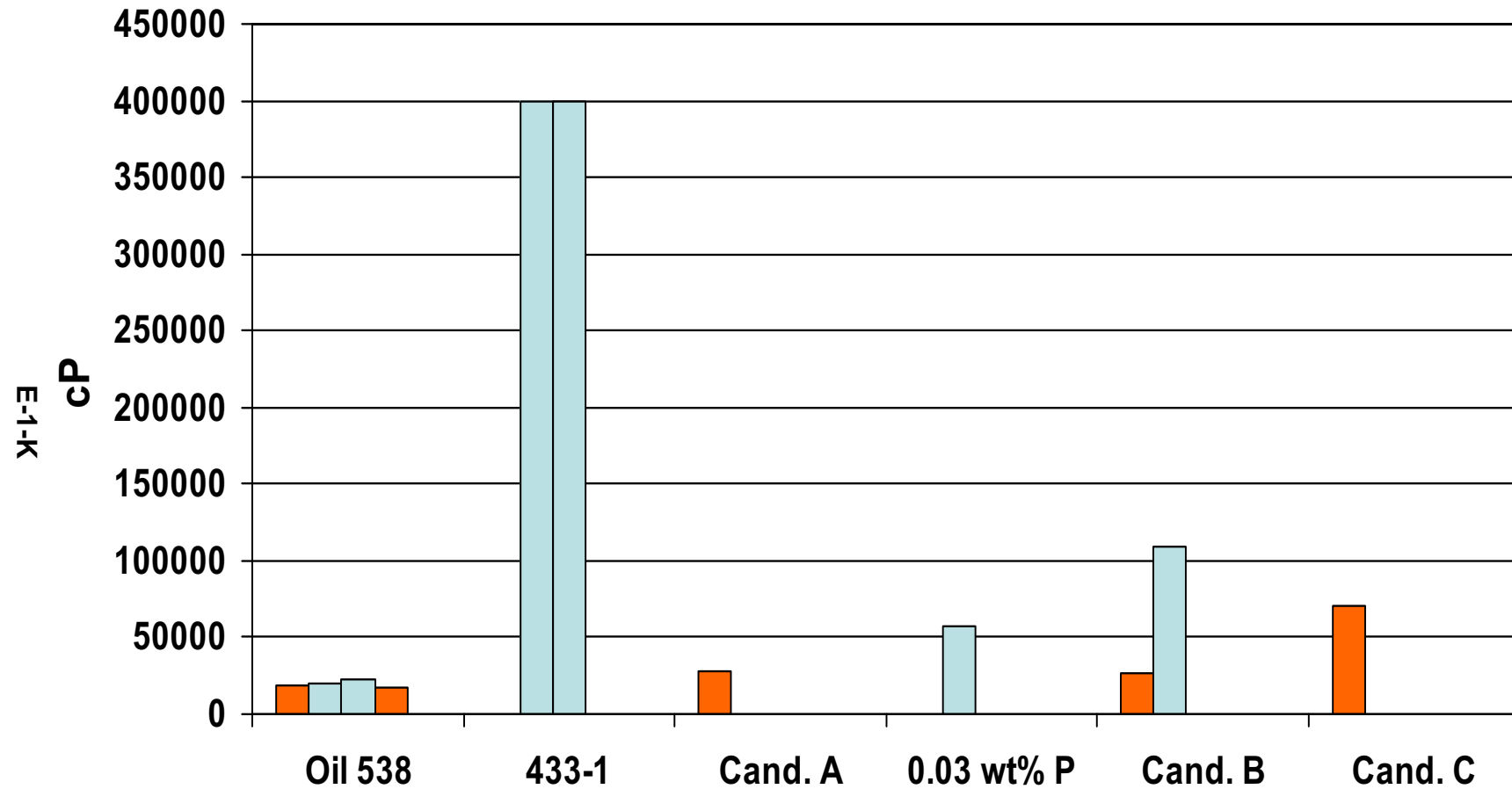


Orange – SwRI

Green – PE

Blue - LZ

Sequence IIIG MRV



Orange – SwRI

Green – PE

Blue - LZ

Sequence IIIG Matrix Oils Performance in Other Tests

E-1-L

Matrix Oil	TMC 538	Oil B	Oil C
SAE Grade	5W-20	5W-30	5W-20
% Phosphorous	0.095	0.075	0.075
Sequence IIIE	BL fail ORLD		
Sequence 2x IIIE	MTAC pass		
Sequence IIIF	MTAC pass	Pass (modeling data)	
Sequence 2XIIIF	Pass		Pass
Sequence IVA	Pass	Pass (modeling data)	Pass
Sequence VE	Pass		
Sequence VG	Pass	Pass (modeling data)	Pass
Sequence VIB	1.89/1.55*	1.5/1.1 (modeling data)	Pass (GF-3)
Sequence VIII	Pass	Pass (modeling data)	Pass
BRT	Pass	Pass (modeling data)	Pass
TEOST 33	<20		Pass (GF-3)
TEOST MHT-4	<25	29 (modeling data)	Pass (GF-3)
Field Tests	Commercial		Ford & DC

* Current LTMS taroets

Sequence IIIG Recommended Matrix Oils

IIIG Performance Data Available

E-1-M

	ASTM 538	Oil B	Oil C
SAE Grade	5W-20	5W-30	5W-20
# of Tests	5	2	2
Viscosity Increase %	113	123	194
PSV merits	8.58	8.67	8.42
WPD merits	3.09	4.14	3.08
ACLW micrometers	19.9	31.5	38

Other Sequence IIIG Matrix Oils Considered IIIG Performance Data Available

E-1-N

	ASTM 433	Oil A	0.03% P Oil
SAE Grade	5W-30	5W-20	5W-30
# of Tests	3	1	1
Viscosity Increase %	172	106	114
PSV merits	8.54	8.46	8.48
WPD merits	3.07	3.74	3.24
ACLW micrometers	58.1	44.6	36.7

Oil Supply

E-1-O

- **A minimum supply of 500 gallons of each oil is desired before starting the matrix**
- **Oil 538 is in current ASTM TMC inventory in large supply**
 - **1000 gallons should be assigned for IIIG use**
- **The suppliers of oils B & C have been requested to supply 500 gallons of oil to the ASTM TMC by the end of February**
 - **Oil B should meet this request**
 - **Oil C should meet this request**

ILSAC/Oil

Chairman: Bob Olree Tel: 810-947-0069

The ILSAC/Oil panel was formed in early 2002 as the forum to progress future engine oil specifications to address industry dissatisfaction with the old tripartite (SAE, ASTM, API) system (see Section B for details). The first ILSAC meeting was held on March 18, 2002, and the group has been meeting regularly since then.

<u>Meeting Dates</u>	<u>Location</u>
March 18, 2002	Detroit
April 10, 2002	Detroit
April 30, 2002	Detroit
May 17, 2002	Detroit
June 4, 2002	Detroit
June 20, 2002	Montreal
July 10, 2002	Detroit
August 6, 2002	Detroit
September 5, 2002	Detroit
October 15, 2002	Cancelled
January 14, 2003	Detroit
February 20, 2003	San Antonio
March 19, 2003	Detroit
April 15, 2003	Detroit
May 8, 2003	Detroit
June 9, 2003	Detroit
June 26, 2003	Detroit
July 30, 2003	Detroit
September 11, 2003	Detroit
October 22, 2003	Detroit
December 17, 2003	Detroit
January 8, 2004	Detroit
August 10, 2004	Detroit

The ILSAC/Oil panel has developed a GF-4 Needs Statement and gained group consensus on all the issues except backward compatibility to older vehicles.

The majority of time in each meeting has been dedicated to understanding the positions regarding backward compatibility in an effort to develop a way forward. The OEMs require GF-4 oils to be backward compatible to all vehicles for the following reasons:

- OEMs want to minimize the number of high phosphorus oils in the market so there would be minimal risk that 2004 model and newer vehicle owners would use incorrect oils.
- Use of oils with phosphorus content >0.05% would be expected to increase instances of premature emission system failure. If a significant number of vehicles fail in-use emission requirements, the OEMs could face emission system warranty claims and/or recertification testing for EPA.

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8/04

The oil marketers believe that the removal of half the ZDDP from current GF-3 and earlier technologies is a revolutionary oil reformulation. There are concerns that the new GF-4 technologies are not proven (no field data) in older engines with sliding contact valve train designs. The oil marketers want field performance demonstrated in older engine designs before approving GF-4 as backward compatible. Their concern is liability for possible engine wear failures in older wear-sensitive engines.

A field test to evaluate the performance of GF-4 oils in severe consumer service was proposed to evaluate backward compatibility. A minimum program of 40 vehicles was considered. This effort is unlikely as cost is estimated at about \$4 million.

The backward compatibility of GF-4 quality oils remains as an outstanding issue. At the June 4 meeting a brainstorming session was held to generate ideas to resolve this issue acceptably for ILSAC, Oil and additive interests. A list of 19 ideas was generated.

At the June 20 meeting, ILSAC/Oil and ACC reported their “order of preference” ranking of the brainstorming ideas in an effort to resolve the differing opinions about backward compatibility of GF-4 oils. The only options that both organizations listed as worthy of further discussion were options three and four (see Page E-4). API had not yet finalized their “order of preference” ranking. ILSAC announced that the opportunity (timing) to use GF-4 oils for 2004 model vehicles had now passed. ILSAC still wants the industry to continue development of the GF-4 specification in an expedient manner, but revised their expectations to the following:

- **A GF-4 specification finalized by July 1, 2003 or earlier**
- **First API licensing of GF-4 oils by April 1, 2004 or earlier**

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8/02

August 2002

The API inputs to the brainstorming ideas were discussed at the July 10 meeting. This resulted in a takeaway work item for each of the stakeholder groups to rank the acceptability of various combinations of phosphorus level, specification life and inclusion of a phosphorus volatility test. The objective of this effort was to determine if a compromise position acceptable to all could be reached that would allow GF-4 oils to be backward compatible. The table of 24 options is detailed on page E-5.

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8/02

At both the June 20 and July 10 meetings, Savant discussed a modified Noack test method under development to measure the volatility of phosphorus from engine oil. Ford Motor Company presented data comparing results from this preliminary procedure with catalyst degradation results from the field. Ford also suggested that an engine test such as the VIB might be able to evaluate the relative phosphorus volatility of engine oils. Ford's field data suggest that about 80% of the phosphorus from engine oil that reaches the exhaust system catalytic converter is due to phosphorus volatility, thus indicating that phosphorus volatility may be more important at that level. ILSAC does not believe that an industry accepted phosphorus volatility test and requirement are likely to meet GF-4 timing. The ILSAC/Oil panel is continuing to investigate the applicability of a phosphorus volatility test and established a Task Force, chaired by Charlie Sherwood of Ford, to determine what needs to be done to prove out the modified Noack test proposal. This timeline will be reviewed at the next ILSAC/Oil meeting, and then a decision will be taken relative to the viability of a phosphorus volatility requirement for GF-4.

August 2002

There were proposals from ACC and ILSAC at the August 6, 2002 meeting regarding acceptable combinations of phosphorus level and specification life to allow GF-4 oils to be acceptable for all model year passenger cars. The ACC proposals favored 0.10% P and five years specification life while the ILSAC proposals were biased toward 0.05% / 0.075% P and six/three years specification life. After lengthy debate ILSAC asked ACC and API to consider the acceptability of a compromise of 0.08% P maximum and four years minimum specification life. The results of the trade association review will be discussed at the next ILSAC/Oil meeting scheduled for September 5, 2002. There was also discussion on the significant decimal place (two or three) for phosphorus level and if the parameter should be critical or non-critical. These issues will also be discussed at the next ILSAC/Oil meeting.

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8/02

GM presented proposed minimum GF-4 performance limits for the IIG test (see Section D for details).

August 2002

Brainstorming

Number	Option
1	GF-4 as planned GF-4 performance with Phosphorus @ 0.10 max. Both oils available in the market
2	GF-4 @ 0.075 max Phosphorus.
3 (2A)	GF-4 @ 0.075 max Phosphorus and Phosphorus Volatility
4 (2B)	GF-4 @ 0.075 max Phosphorus and 3 years minimum life.
5 (2AB)	GF-4 @ 0.075 max Phosphorus and Phosphorus Volatility and 3 year minimum life
6	GF-4 @ 0.10 max Phosphorus.
7	GF-4 @ 0.05 max Phosphorus for 0W-XX, 5W-20, 5W-30 GF-4 @ 0.10 max Phosphorus all other LSAC vis grades
8	GF-4 @ 0.05 max Phosphorus for 0W-XX and 5W-20 GF-4 @ 0.10 max Phosphorus all other LSAC vis grades
9	GF-4 @ 0.05 max Phosphorus for LSAC vis grades GF-4 @ 0.08 Phosphorus Other vis grades
10	GF-4 without marketer liability statement
11	GF-3 plus III-G
12	GF-3 plus III-G plus GF-4 FEI and FER
13	GF-4 as proposed w/o Backward Compatibility
14	GF-4 as proposed w/o Backward Compatibility and continue GF-3
15	Individual OEM specs.
16	GF-4 w/o API licensing
17	New category for API licensed products: "Environmentally Friendly" is 0.05 max Phosphorus and FE requirements of GF-4.
18	Environmentally Friendly required for LSAC mark.
A	Add to any Option Phosphorus Volatility
B	Add to any Option 3 year category life min.

June 2002

GF-4 Options Which Ones Can You Live With?

Rate each of the 24 conditions on a stand-alone basis.

For this set of conditions:

- 1 My company (or association) can live with this.
- 2 My company (or association) is uncertain about this.
- 3 My company (or association) cannot live with this.

←
8/02

List of assumptions:

- (1) Phosphorus is a non-critical limit as it is today in D4485.
- (2) Category life is included in the needs statement, e.g., "This category is planned to last until 200X".
- (3) A phosphorus volatility specification (PVS) is included only if proven meaningful and appropriate.

Maximum Phosphorus		Planned Life of Category (Years)		
		3	4	5
0.10%	Without PVS			
	With PVS (If available)			
0.09%	Without PVS			
	With PVS (If available)			
0.08%	Without PVS			
	With PVS (If available)			
0.075%	Without PVS			
	With PVS (If available)			

August 2002

At the September 5 meeting discussion resumed the on GF-4 needs statement issues of maximum phosphorus limit and planned specification life. No agreement could be reached on these issues at this meeting. The group agreed to inform the API AGP that ILSAC/Oil was unable to come to consensus on a needs statement or a maximum phosphorus limit for GF-4. An ILSAC/Oil meeting planned for October 15 was, however, retained. Since the September 5 meeting, all stakeholders (ILSAC, API, ACC) have met separately in an attempt to find common ground. It appears that a maximum phosphorus limit of 0.08% will be accepted. The issue of GF-4 specification life has received less consensus as ACC still wants the needs statement to include discussion of minimum specification life. A proposal that specification life be reviewed in GF-4 development block #10 (see page B-45) appears to have ILSAC and API support. The planned October 15 meeting was cancelled as it was felt at the time that no progress would be made regarding the differences of opinion on the needs statement between ILSAC and Oil. Formal resolution of these differences awaits the next ILSAC/Oil meeting. The next meeting is scheduled for January 14, 2003.

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12/02

At the January 14, 2003 meeting the group finally gained majority consensus on a GF-4 needs statement (see page B-53). ACC was the only negative voter since it believes that one of the GF-4 needs is to establish a minimum category life. The issue of GF-4 category life will continue to be debated and resolution is expected by completion of ILSAC/Oil process step #10 (API decides on licensing of GF-4). GM presented an update on the IIIG procedure status and declared that test development is now complete. ACC presented data questioning the relevance and readiness of the IIIG. ACC also requested that cams be batch coded and that an industry group be formed to develop a recommended slate of reference oils for the IIIG precision matrix. The ASTM PCEOCP has now established a “Matrix Oil Selection Work Group” in response to the ACC request.

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1/03

ILSAC/Oil requested that the ASTM Sequence III Surveillance Panel and the PCEOCP meet by early February to review IIIG readiness, select IIIG matrix oils, and start the IIIG precision matrix if appropriate.

January 2003

The ILSAC/Oil Group met on February 20 in San Antonio immediately after the ASTM Sequence IIIF surveillance panel and PCEOCP meetings. The group received the PCEOCP report on IIIG readiness and accepted that a precision matrix will not start until wear severity differences between PE and SwRI are resolved. The group also discussed GF-4 specification timing and agreed that first licensing in May 2004 and mandatory licensing in February 2005 are acceptable. However, ILSAC stated that they cannot accept any further delay beyond this timing.

During the March 19 meeting an update of IIIG highlights was presented. The ASTM TMC reported that the three IIIG matrix oils would be coded as follows:

Oil 538	=	438
Candidate 'B'	=	434
Candidate 'C'	=	435

The TMC stated that candidates 'B' and 'C' had been received and were being processed by them. It was reported that the next Sequence IIIG surveillance panel meeting has been delayed from the original date of March 27 due to issues with oil filter plugging. It was noted that critical parts will be date coded and used on a first in-first out basis. Part batch information will be supplied to laboratories on a test by test basis as each is completed.

ACC has not yet signed the IIIG matrix Memo of Agreement (MOA) and has registered concerns especially about readiness of the IIIG procedure. These issues are being addressed.

The remainder of the March 19 meeting centered on discussion of GF-4 performance tests and limits. The maximum sulfur limit proposal of 0.5% was discussed but without resolution. Some expressed a desire for a higher limit. All three versions of the Noack test were agreed as acceptable with the pass limit at 15% maximum. The TEOST MHT-4 test limit proposal of 25 mg. maximum was discussed without resolution. The TEOST method 33 was discussed, and DaimlerChrysler (DC) agreed it was too late to add to GF-4. DC will propose, via letter to API, a new performance category that includes the TEOST method 33 be considered by the API lubricants committee for turbocharged vehicles.

The April 15 meeting dealt with IIIG matrix funding status and discussion of GF-4 specification items. It was reported that all parties had now signed the MOA for the 16 test IIIG matrix and that most had signed the addendum for the additional eight tests to be funded by ACC and API.

of the GF-4 specification proposal details has been created to follow the status of each item. **The items that have reached group consensus are denoted by a check mark (see pages E-8A to E-8G). This table will be updated after future meetings to reflect the latest agreements.** The issues discussed at this meeting follow:

Homogeneity and Miscibility – This was accepted as proposed with the updated reference oils.

Volatility - Noack volatility was accepted as proposed.

J 300 Viscosity – A motion was made to adopt J300 with the more restrictive GM factory fill requirements on fresh oil but no resolution was possible. This will be discussed again at the next meeting.

Gelation index – There was discussion of two items. First item was the minimum temperature for measuring gelation. The second item was the number of significant decimal places for reporting gelation pass/fail. Neither of these issues were resolved at this meeting.

TEOST MHT4 - Planned discussion was deferred since DC was not in a position to make their presentation supporting the need and proposed limits for this test.

Sequence IVA – *ILSAC reported that JAMA propose that the GF-4 pass limit for the Sequence IVA be lowered to 50 micrometers maximum from the current proposal of 120 micrometers. There was extensive debate on this topic but no resolution.*

Sulfur – the proposal of 0.80% maximum sulfur was debated without resolution. API and ACC were asked to bring data to the next meeting regarding additive and base stock contributions to finished oil sulfur.
~~The next ILSAC / Oil meeting was tentatively scheduled for May 7.~~

On May 2, 2003, Bob Olree of GM sent the following note to API regarding an updated IIIG limits proposal in preparation for discussion at the May 8 ILSAC/Oil meeting.

“At our August 6, 2002 meeting GM proposed some pass/fail limits for the Seq. IIIG test. In order to focus our ILSAC/Oil discussions, it may be helpful for GM to reissue its suggestions based on all of the IIIG testing that has gone on since last August. In subsequent ILSAC/Oil meetings I have indicated that some of our original proposals would need to be changed, but some members have said that they would like to see these in print. If it would help,

you could list the following proposed limits in our mark-up of the June 2001 Draft.”

<i>Viscosity Increase (Kv 40 deg. C)</i>	<i>150%</i>
<i>Low Temp Viscosity</i>	<i>Same as current mark-up</i>
<i>WPD</i>	<i>4.0</i>
<i>Average Piston Skirt Varnish</i>	<i>8.5</i>
<i>Stuck Rings</i>	<i>None</i>
<i>Max. Average Cam & Lifter Wear</i>	<i>60 microns</i>
<i>Max. Oil Consumption</i>	<i>TBD</i>

At the May 8, 2003 meeting, the group continued to discuss the remaining GF-4 performance parameters and pass/fail limits not resolved at earlier meetings. Three additional items were ultimately agreed.

J 300 Viscosity – Low temperature viscometric requirements will remain the same as currently for GF-3.

Gelation Index – The GI pass limit will be 12. It was also agreed that the GI would be measured down to 2 deg. C below the corresponding MRV-TP1 pumping temperature or 40,000Cp, whichever occurs first.

The items discussed without resolution were sulphur max. limit, phosphorus lower limit, TEOST MHT-4 and Sequence IVA limits. Discussion on the IIIG, VIB and VG limits was deferred to a later meeting. However, the Alliance did state they recognize the contradiction between the requests for better fuel economy and improved IIIG piston deposits; they are discussing this issue within their association. Also, Ford noted that the following parameters have been dropped from consideration as VG performance requirements: follower pin max., cylinder bore wear max. and avg., ring wear max. and timing chain wear.

API proposed that if ILSAC would accept a sulphur max. limit of 0.8%, then API would agree that no phosphorus minimum is needed. ILSAC will discuss this concept with JAMA. The group could not agree on the ILSAC proposed pass limit of 50 micrometers for the Sequence VIA but appeared to be willing to consider a limit below the GF-3 level of 120. ILSAC will discuss this issue further with JAMA.

The next meetings are scheduled for June 9 and 26.

The ILSAC/Oil group met in Detroit on June 9, 2003 to continue debate and attempt resolution of the outstanding GF-4 specification requirements. At this meeting the group reached resolution of the following items:

Sequence IVA – A pass/fail limit of 90 micrometers maximum cam lobe wear was approved. This was a middle ground compromise between the ILSAC proposal of 80 and the API proposal of 100.

Sequence VG – It was agreed that all GF-3 requirements would be carried forward to GF-4 with no change in limits. Debate continues on the possible addition of valve lifter roller pin and ring gap wear. Ford proposed limits of 30 micrometers maximum for pin wear and 225 for average ring gap increase. API proposed that these two wear parameters be rate and report only. Further discussion will occur at the next meeting.

Sequence VIII – A pass/fail limit of 26 mg. maximum for bearing weight loss was approved.

The MHT-4 TEOST limit was debated without reaching consensus. DC offered a maximum limit of 30 mg.; ACC countered with 45 and API with 40. The DC representative was asked to consider a compromise of 35 for discussion at the next meeting.

Discussion of the IIIG and VIB was stalemated since neither API nor ACC was in a position to offer any counterproposal to the limits already offered by ILSAC. Both organizations were asked to develop and circulate positions to the membership prior to the June 26 meeting.

The ILSAC/Oil group met on June 26 to discuss the remaining issues in the GF-4 specification proposal and to determine when ACC planned to begin registration for IIIG candidate testing. ACC stated that they were not yet ready to start IIIG registration as they had concern regarding oil consumption variability. The IIIG matrix analysis team had previously reported that viscosity increase is highly correlated with oil consumption. ACC plan to alert the IIIF/IIIG surveillance panel of their oil consumption concern and request help with further understanding of the scope and resolution of this issue by July 16, 2003.

Discussion of the remaining GF-4 specification criteria (IIIG, VG, VIB, MHT-4 TEOST, max. Sulfur, min. Phosphorus) gained no consensus. Ultimately, at the end of the meeting, ILSAC presented a 'GF-4 package deal' (i.e., not open for debate of individual items) for consideration.

This package has been agreed by the ILSAC members with all making some compromise. If the package is not acceptable to API and ACC, then ILSAC stated the individual items will revert back to the previous ILSAC proposal that has been the basis for discussion to this point. The ILSAC package deal for the remaining GF-4 items follows:

Sequence III G

<i>Vis. Inc. @40Kv</i>	150% max.
<i>WPD</i>	3.5 merits min.
<i>Cam plus lifter wear</i>	60 micrometers
<i>Low temp viscosity</i>	One viscosity grade increase in MRV
<i>Hot stuck rings</i>	None

Sequence VIB

<i>0W-20 & 5W-20</i>	2.3% FEI1 / 2.0% FEI2
<i>0W-30 & 5W-30</i>	1.9% FEI1 / 1.6% FEI2
<i>10W-30 & others</i>	1.1% FEI1 / 0.8% FEI2

Sequence VG

<i>Follower pin wear</i>	Rate & Report
<i>Ring gap increase</i>	Rate & Report

MHT-4 TEOST

<i>Deposits</i>	35 mg. max.
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Sulfur

<i>0W & 5W</i>	0.5% max.
<i>10Ws</i>	0.7% max.

Phosphorus

<i>All viscosity grades</i>	0.06% min.
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The next meeting is scheduled for July 30, 2003. The meeting date was extended from the original schedule of July 16 to give API and ACC sufficient time to consider the ILSAC 'package deal' and to develop any counterproposals.

July 30 Meeting

The majority of this meeting was spent discussing the new Sequence IIIG, and covered test issues and test limits. All agreed to register the Sequence IIIG test once some minor issues were resolved. ILSAC also agreed to decouple the used oil pumpability parameters of the Sequence IIIG and to set up a new test called the Sequence IIIGA.

Fuel economy limits were also agreed on, and a GF-4 specification will be finalized for ballot by August 4 with a 30-day comment period.

September 11 Meeting

Key topics of this meeting were a review of comments from the August 4 GF-4 draft specification and final acceptance. The meeting focused on Sequence IIIG issues as well as a potential correction equation for the test. ILMA and the Automotive Oil Change Association's (AOCAs) comments relating to Group II base stock availability and concern over backward compatibility were discussed in detail. ILSAC/Oil will review the comments and respond prior to the next meeting.

API responded that they had received an SAE 5W-20 and SAE 5W-30 demonstration oil, but the committee is still asking members for an SAE 10W-30 using Group I and Group II base stocks.

Consensus was reached for separating the used oil viscosity requirements for the Sequence IIIG into potential new test Sequence IIIGA.

Committee members agreed that if major changes were made to the specification draft with regard to the Sequence IIIG, then a second ballot and comment period would be required. Committee members also agreed that July 2004 would remain as the first licensing date.

October 21/22 Meeting

The primary objective of this meeting was to discuss reissue of the GF-4 specification and plans for final acceptance. After much work and improvement to the Sequence IIIG, it was decided that a correction equation would not be necessary. Final details around the Sequence IIIGA to evaluate used oil pumpability were discussed and agreed as were test methods for phosphorus and sulfur.

It was agreed that API staff would clean up and reissue the ballot no later than November 5, 2003 and a 30-day comment period would apply. The final GF-4 preamble would also be balloted. Despite these delays in acceptance of a final GF-4 specification, it was agreed that the final GF-4 timeline would not change.

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12/03

The last presentation of the meeting was made by Kline and Company and addressed a concern by ILMA regarding availability of Group II base stock in order to formulate GF-4 engine oils. The conclusion was that supply will be sufficient but “not by much.” This effort was sponsored by ILSAC and API.

December 17 Meeting

A workshop to improve the engine honing process was held on December 10, 2003 with all the laboratories represented. To date all the laboratories have been calibrated except one that will be completed in early January 2004. The Sequence IIIF honing process will be changed to be the same as agreed for the Sequence IIIG.

Editorial changes were incorporated into the GF-4 specification in preparation for final release.

Responses to comments received were discussed and generally agreed expect for base stock supply. It was decided to allow more time to consider this issue.

January 8, 2004 meeting

The ILSAC GF-4 Standard for Passenger Car Engine Oils, which was finalized at the December 17, 2003 meeting, was accepted as final. This specification is included as pages E-8H thru E-8K. The proposed timetable for GF-4 was discussed as (July 31, 2004, first licensing date for ILSAC GF-4; April 30, 2005, last licensing date for ILSAC GF-3; and GF-4 category life through July 2009).

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8/04

Based on this proposal, API issued a ballot with the proposed timeline in late January; the ballot passed. Also, API continued debate on a companion API ‘SM’ specification ballot. A final draft of API ‘SM’ was balloted and approved in April 2004. There was significant disagreement on the first licensing date of September 30, 2004 and thus discussion of this item continued. Finally, in July the first licensing date was modified to November 30, 2004. The ‘SM’ specification is included as page E-8L.

August 10, 2004 meeting

This meeting was focused on reviewing the GF-4 process from each stakeholder's perspective and discussing enhancements to the process for the next category development. An overview of the stakeholder comments follows.

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8/04

ILSAC:

They were disappointed that they did not get what they wanted. DaimlerChrysler wanted better low temperature pumpability and MHT TEOST. General Motors thought they got everything they wanted except a 4.0 merit minimum WPD in the Sequence IIIG. However, during the process they came to appreciate DaimlerChrysler's position on low temperature pumpability. Ford voiced that they did not get the fuel economy or phosphorus (0.05% max.) level desired.

API:

It was suggested that future test development could be improved via shared development from the beginning. It was proposed that the process could learn from the 'European model' – ILSAC/Oil define test needs and subscribed consortium picks engine and develops the performance test at one laboratory. They also felt that a more equitable distribution of meeting locations is needed to better distribute travel costs among all stakeholders.

ACC:

Several enhancements were proposed in three areas: new test development, meetings and general issues. For future specification development ACC believes:

- that the "needs" should be addressed early in the process
- test development should utilize ASTM Surveillance Panels or Test Development Task Forces
- there should be a clear consensus on "Decision Criteria" of test acceptance for precision matrices
- there should be more involvement of the ASTM PCEOCP and
- the voting structure of ASTM PCEOCP should be changed to be more equally weighted among the contributing trade organizations.

They recommended fewer but longer meetings and that stakeholder positions should be communicated prior to face-to-face meetings. Also, they recommended that ASTM, JAMA, ILMA, AOCA and EPA be informed of activities in ILSAC/Oil and their input requested on a timely basis. The general issues proposals were that a six month technology assessment phase be included prior to limit setting, the companion API specification be developed concurrent with the ILSAC specification, and there is a need to develop clear guidelines as to how the 'official' specification is defined (ILSAC, SAE J-300, ASTM D4485, etc).

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8/04

Representatives from the three trade organizations (API, ILSAC, ACC) will meet to review all the requested process enhancements and find common themes to propose for moving some enhancements forward to GF-5. The next ILSAC/Oil meeting is tentatively scheduled for October 5 in Detroit. This will be the GF-5 kickoff and the agenda will center on establishing a list of GF-5 needs, a timeline and review of specification development process enhancements.

A checklist of the GF-4 specification proposal details has been created to follow the status of each item. The items that reached group consensus prior to April 15 are denoted by a check mark (see pages E-8A to E-8G). The issues discussed at this meeting follow:

Homogeneity and Miscibility – This was accepted as proposed with the updated reference oils.

Volatility - Noack volatility was accepted as proposed.

J300 Viscosity – A motion was made to adopt J300 with the more restrictive GM factory fill requirements on fresh oil but no resolution was possible. This will be discussed again at the next meeting.

Gelation Index – There was discussion of two items. First was the minimum temperature for measuring gelation. Second was the number of significant decimal places for reporting gelation pass/fail. Neither of these issues was resolved at this meeting.

TEOST MHT-4 – Planned discussion was deferred since DC was not in a position to make their presentation supporting the need and proposed limits for this test.

Sequence IVA – ILSAC reported that JAMA proposed the GF-4 pass limit for the Sequence IVA be lowered to 50 micrometers maximum from the current proposal of 120 micrometers. There was extensive debate on this topic but no resolution.

Sulfur – The proposal of 0.80% maximum sulfur was debated without resolution. API and ACC were asked to bring data to the next meeting regarding additive and base stock contributions to finished oil sulfur.

The next ILSAC / Oil meeting was tentatively scheduled for May 7.

April 2003

ILSAC/Oil Committee Mark-Up of June 2001 ILSAC Draft GF-4 (May 8, 2003)

Item No.	Parameter	Limits	Status (✓ = Consensus Reached)
1.	FRESH OIL VISCOSITY REQUIREMENTS		
1.a	SAE J300	Oils shall meet all of the requirements of SAE J300 and the low temperature requirements of either SAE 0W, 5W or 10W viscosity grades.	✓
1.b	Gelation Index: ASTM D 5133	12 maximum	✓
1.c		To be evaluated from -5°C to temperature at which 40,000 cP is attained or -40°C, or 2°C below the appropriate MRV TP1 temperature, whichever occurs first.	✓
2.	ENGINE TEST REQUIREMENTS		
2.a	Engine Rusting: ASTM Ball Rust Test		
	• Average Gray Value	100 minimum	✓

E-8A

May 2003

E-8B

May 2003

Item No.	Parameter	Limits	Status (✓ = Consensus Reached)
2.b	Wear and Oil Thickening: ASTM Sequence IIIG Test		
2.b.1	<ul style="list-style-type: none"> • Viscosity Increase (kV 40°C) 	<u>150 % ?</u> maximum	
2.b.2	<ul style="list-style-type: none"> • Low Temp Viscosity 	Evaluate the drain oil sample with Test Method D 4684 (MRV TP-1). The viscosity of the drain oil sample must meet the requirements of its original grade or the next highest grade.	
2.b.3	<ul style="list-style-type: none"> • Average Piston Skirt Varnish Rating 	<u>8.5?</u> minimum	
2.b.4	<ul style="list-style-type: none"> • Weighted Piston Deposit Rating 	<u>4.0?</u> minimum	
2.b.5	<ul style="list-style-type: none"> • Hot Stuck Piston Rings 	None allowed	
	<ul style="list-style-type: none"> • Cam plus Lifter Wear 		
2.b.6	Maximum, μm	<u>? maximum</u>	
2.b.7	Average, μm	<u>60?</u> maximum	
2.b.8	<ul style="list-style-type: none"> • Oil Consumption, l 	? maximum	
2.c	Wear, Sludge and Varnish: ASTM Sequence VG Test		

Item No.	Parameter	Limits	Status (✓ = Consensus Reached)
2.c.1	• Average Engine Sludge Rating	7.8 minimum	✓
2.c.2	• Rocker Cover Sludge Rating	8.0 minimum	✓
2.c.3	• Average Engine Varnish Rating	8.9 minimum	✓
2.c.4	• Average Piston Skirt Varnish Rating	7.5 minimum	✓
2.c.5	• Oil Screen Clogging, %	20.0 maximum	✓
2.c.6	• Oil Screen Debris, %	Rate and report	✓
2.c.7	• Hot Stuck Compression Rings	None	✓
2.c.8	• Cold Stuck Rings	Rate and report	✓
2.c.9	• Oil Ring Clogging	Rate and report	✓
2.c.11	• Follower Pin Wear, Avg, μm	? maximum	
2.c.15	• Ring Wear, Avg, mg	? maximum	
2.d	Valve train Wear: Sequence IVA		
	• Average cam wear (7 position average), μm	90 maximum	✓
2.e	Bearing Corrosion: Sequence VIII		
	• Bearing Weight Loss, mg	26 maximum	✓
	additive (DI/VI) concentration. Read across results to all other		

Item No.	Parameter	Limits	Status (✓ = Consensus Reached)
2.f.2		2.1% FEI 2 minimum after 136 hours aging	
2.f.3	<ul style="list-style-type: none"> SAE 0W-30 and 5W-30 viscosity grades 	2.0% FEI 1 minimum after 16 hours aging	
2.f.4		1.7% FEI 2 minimum after 136 hours aging	
2.f.5	<ul style="list-style-type: none"> SAE 10W-30 and all other viscosity grades not listed above 	1.3% FEI 1 minimum after 16 hours aging	
2.f.6		1.0% FEI 2 minimum after 136 hours aging	
3.	BENCH TEST REQUIREMENTS		
3.a	<ul style="list-style-type: none"> Catalyst Compatibility: 		
3.a.1	Phosphorus content by Test Method D 4951 or D 5185	0.08% (mass) maximum	✓
3.a.3	<ul style="list-style-type: none"> Sulfur content, Test Method D1552 	0.50% (mass) maximum	
3.b	<ul style="list-style-type: none"> <u>Wear:</u> 		
	<u>Phosphorus content by Test Method D 4951 or D 5185</u>	<u>0.0X (mass) minimum</u>	
3.c	<ul style="list-style-type: none"> Volatility: 		
3.c.1	Evaporation Loss ASTM D5800	15% maximum, 1 h at 250°C <u>Note: Calculated</u>	✓

E-8E

May 2003

Item No.	Parameter	Limits	Status (✓ = Consensus Reached)
		<u>conversions specified in D 5800 are allowed.</u>	
	AND		
3.c.2	Simulated Distillation ASTM D6417	10% maximum at 371°C	✓
3.d	<ul style="list-style-type: none"> • High Temperature Deposits: TEOST MHT-4 		
	Deposit Weight, mg	25 maximum	
3.e	<ul style="list-style-type: none"> • Filterability: 		
3.e.1	EOFT	50% maximum flow reduction allowable	✓
3.e.2	EOFT with following modifications (EOWTT):	50% maximum flow reduction allowable	✓
	<ol style="list-style-type: none"> 1. Dry ice is not to be used during sample preparation. 2. Sample is to be placed in oven at 70°C for 6.0 hours (+/-0.25 hours) 3. Tests to be run at 0.6, 1.0, 2.0 and 3.0% H₂O. 4. Test formulation with highest additive (DI/VI) concentration. Read across results to all other base oil/viscosity grade formulations using same or lower 		

Item No.	Parameter	Limits	Status (✓ = Consensus Reached)
	concentration of identical additive (DI/VI) combination. Each different DI/VI combination must be tested.		
3.f	<ul style="list-style-type: none"> Foaming Tendency ASTM D892 (Option A) 	Foaming: After Settling*:	
3.f.1	Sequence I	10 ml maximum 0 ml maximum	✓
3.f.2	Sequence II	50 ml maximum 0 ml maximum	✓
3.f.3	Sequence III	10 ml maximum 0 ml maximum	✓
		*Settling Determined After 10 minutes	
3.h	<ul style="list-style-type: none"> Shear Stability: Sequence VIII test 		
	10-hour stripped 100°C kinematic viscosity	Must remain in original SAE viscosity grade	✓
3.i	<ul style="list-style-type: none"> Homogeneity and Miscibility: <u>ASTM D XXXX</u> 	Shall remain homogeneous and, when mixed with ASTM reference oils, shall remain miscible.	✓

Item No.	Parameter	Limits	Status (✓ = Consensus Reached)
	base oil/viscosity grade formulations using same or lower concentration of identical additive (DI/VI) combination. Each different DI/VI combination must be tested.		
3.f	<ul style="list-style-type: none"> Foaming Tendency ASTM D892 (Option A) 	Foaming: After Settling*:	
3.f.1	Sequence I	10 ml maximum 0 ml maximum	✓
3.f.2	Sequence II	50 ml maximum 0 ml maximum	✓
3.f.3	Sequence III	10 ml maximum 0 ml maximum	✓
		*Settling Determined After 10 minutes	
3.h	<ul style="list-style-type: none"> Shear Stability: Sequence VIII test 		
	10-hour stripped 100°C kinematic viscosity	Must remain in original SAE viscosity grade	✓
3.i	<ul style="list-style-type: none"> Homogeneity and Miscibility: <u>ASTM D XXXX</u> 	Shall remain homogeneous and, when mixed with ASTM reference oils, shall	✓

Item No.	Parameter	Limits	Status (✓ = Consensus Reached)
		remain miscible.	

4. APPLICABLE DOCUMENTS	
4.a	SAE Standard, Engine Oil Viscosity Classification - SAE J300, <i>SAE Handbook</i> .
4.b	ASTM Annual Book of Standards, Section 5, Petroleum Products and Lubricants, current edition.
4.c	ASTM Sequence VII Test Research Report.
4.d	ASTM Sequence IIIG Test Research Report.
4.e	M. Batco and D. F. Florkowski, "Low Temperature Rheological Properties of Aged Crankcase Oils," SAE Paper 2000-01-2943.
4.f	M. Batco and D. F. Florkowski, "Lubricant Requirements of an Advanced Designed High Performance, Fuel Efficient Low Emissions V-6 Engine," SAE Paper 01FL-265.

ILSAC GF-4 REQUIREMENTS

1. FRESH OIL VISCOSITY REQUIREMENTS

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8/04

1.a SAE J300

Oils shall meet all of the requirements of SAE J300. Viscosity grades are limited to SAE 0W, 5W, and 10W multigrade oils.

1.b Gelation Index: ASTM D 5133

12 maximum

To be evaluated from -5°C to the temperature at which 40,000 cP is attained or -40°C , or 2 Celsius degrees below the appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first.

2. ENGINE TEST REQUIREMENTS

2.a Wear and Oil Thickening: ASTM Sequence IIIG Test

Kinematic Viscosity Increase @ 40°C , %	150 maximum
Average Weighted Piston Deposits, merits	3.5 minimum
Hot Stuck Rings	None
Average Cam plus Lifter Wear, μm	60 maximum

2.b Aged Oil Low Temperature Viscosity: ASTM Sequence IIIGA Test

Evaluate the EOT oil from the ASTM
The D 4684 viscosity of the EOT
Sequence IIIGA test with ASTM D 4684 sample must meet the
(MRV TP-1) requirements of the original grade or the next higher grade.

2.c Wear, Sludge, and Varnish Test: Sequence VG, ASTM D 6593

Average Engine Sludge, merits	7.8 minimum
Average Rocker Cover Sludge, merits	8.0 minimum
Average Engine Varnish, merits	8.9 minimum

Average Piston Skirt Varnish, merits	7.5 minimum
Oil Screen Sludge, % area	20 maximum
Oil Screen Debris, % area	Rate and report
Hot Stuck Compression Rings	None
Cold Stuck Rings	Rate and report
Oil Ring Clogging, % area	Rate and report
Follower Pin Wear, cyl #8, avg, μm	Rate and report ^a
Ring Gap Increase, cyl #1 & #8, avg, μm	Rate and report ^a

^aASTM Surveillance Panel will review statistics annually.

2.d Valvetrain Wear: Sequence IVA, ASTM D 6891

Average Cam Wear (7 position average), μm 90 maximum

2.e Bearing Corrosion: Sequence VIII, ASTM D 6709

Bearing Weight Loss, mg 26 maximum

2.f Fuel Efficiency: Sequence VIB*, ASTM D 6837

SAE 0W-20 and 5W-20 viscosity grades:
 2.3% FEI 1 minimum after 16 hours aging
 2.0% FEI 2 minimum after 96 hours aging

SAE 0W-30 and 5W-30 viscosity grades:
 1.8% FEI 1 minimum after 16 hours aging
 1.5% FEI 2 minimum after 96 hours aging

SAE 10W-30 and all other viscosity grades not listed above:
 1.1% FEI 1 minimum after 16 hours aging
 0.8% FEI 2 minimum after 96 hours aging

*All FEI 1 and FEI 2 values determined relative to ASTM Reference Oil BC.

3. BENCH TEST REQUIREMENTS

3.a Catalyst Compatibility

Phosphorus Content, ASTM D 4951	0.08% (mass) maximum
Sulfur Content, ASTM D 4951 or D 2622	
SAE 0W and 5W multigrades	0.5% (mass) maximum
SAE 10W multigrades	0.7% (mass) maximum

3.b Wear

←
8/04

Phosphorus Content, ASTM D 4951 0.06% (mass) minimum

3.c Volatility

Evaporation Loss, ASTM D 5800 15% maximum, 1 h at 250°C
(Note: Calculated conversions specified in D 5800 are allowed.)

Simulated Distillation, ASTM D 6417 10% maximum at 371°C

3.d High Temperature Deposits, TEOST MHT

Deposit Weight, mg 35 maximum

3.e Filterability

EOWTT, ASTM D 6794

with 0.6% H ₂ O	50% maximum flow reduction
with 1.0% H ₂ O	50% maximum flow reduction
with 2.0% H ₂ O	50% maximum flow reduction
with 3.0% H ₂ O	50% maximum flow reduction

Test formulation with highest additive (DI/VI) concentration. Read across results to all other base oil/viscosity grade formulations using the same or lower concentration of the identical additive (DI/VI) combination. Each different DI/VI combination must be tested.

EOFT, ASTM D 6795 50% maximum flow reduction

3.f Foaming Characteristics, ASTM D 892 (Option A)

	<u>Tendency</u>	<u>Stability*</u>
Sequence I	10 mL maximum	0 mL maximum
Sequence II	50 mL maximum	0 mL maximum
Sequence III	10 mL maximum	0 mL maximum

*After 10-minute settling period

3.g High Temperature Foaming Characteristics, ASTM D 6082 (Option A)

	<u>Tendency</u>	<u>Stability*</u>
	100 mL maximum	0 mL maximum

*After 1-minute settling period

3.h Shear Stability, Sequence VIII, ASTM D 6709

10-hour stripped KV @ 100°C

Kinematic viscosity must remain in original SAE viscosity grade.

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8/04

3.i Homogeneity and Miscibility, ASTM D 6922

Shall remain homogeneous and, when mixed with SAE reference oils, shall remain miscible.

3.j Engine Rusting, Ball Rust Test , ASTM D 6557

Average Gray Value

100 minimum

4. APPLICABLE DOCUMENTS

4.a SAE Standard, Engine Oil Viscosity Classification - SAE J300, SAE Handbook.

4.b SAE Standard, Standard Reference Elastomers (SRE) for Characterizing the Effects on Vulcanized Rubbers, Proposed Draft 2003-5 - SAE J2643, SAE Handbook

4.c ASTM Annual Book of Standards, Volume 5, Petroleum Products and Lubricants, current edition.

4.d ASTM Sequence IIIG Test Research Report.

4.e M. Batko and D. F. Florkowski, "Low Temperature Rheological Properties of Aged Crankcase Oils," SAE Paper 2000-01-2943.

4.f M. Batko and D. F. Florkowski, "Lubricant Requirements of an Advanced Designed High Performance, Fuel Efficient Low Emissions V-6 Engine," SAE Paper 01FL-265.

Table G-4—Requirements for API Service Category SM

Engine Test Requirements ^a	Viscosity Grade Performance Requirements	
	SAE 0W-20, SAE 5W-20 SAE 0W-30, SAE 5W-30, SAE 10W-30	All Others
Sequence IIIG	Pass	Pass
Sequence IIIGA	Pass	NR
Sequence IVA (ASTM D 6891)	Pass	Pass
Sequence VG (ASTM D 6593)	Pass	Pass
Sequence VIII (ASTM D 6709)	Pass	Pass

Bench Test and Measured Parameter ^a	Viscosity Grade Performance Requirements	
	SAE 0W-20, SAE 5W-20 SAE 0W-30, SAE 5W-30, SAE 10W-30	All Others
ASTM D 6557 (Ball Rust Test), avg. gray value, min	100	100
ASTM D 5800, evaporation loss, 1 hour at 250°C, % max ^b	15	15
ASTM D 6417, simulated distillation at 371°C, % max	10	10
ASTM D 6795, EOFT, % flow reduction, max	50	50
ASTM D 6794, EOWTT, % flow reduction, max		
with 0.6% H ₂ O	50	50
with 1.0% H ₂ O	50	50
with 2.0% H ₂ O	50	50
with 3.0% H ₂ O	50	50
ASTM D 4951, phosphorus % mass, max ^c	0.08 ^d	NR
ASTM D 4951, phosphorus % mass, min ^c	0.06 ^d	0.06 ^d
ASTM D 4951, or D 2622, sulfur % mass, max ^c		NR
SAE 0W-20, 0W-30, 5W-20, and 5W-30 multigrades	0.5 ^d	
SAE 10W-30 multigrades	0.7 ^d	
ASTM D 892 (Option A), foaming tendency		
Sequence I, mL, max, tendency/stability ^e	10/0	10/0
Sequence II, mL, max, tendency/stability ^e	50/0	50/0
Sequence III, mL, max, tendency/stability ^e	10/0	10/0
ASTM D 6082 (Option A), high-temperature foaming tendency/stability ^f	100/0	100/0
ASTM D 6922, homogeneity and miscibility	^g	^g
ASTM D 6709, (Sequence VIII) shear stability	^h	^h
TEOST MHT, high temperature deposits, deposit wt, mg, max	35	45
ASTM D 5133, gelation index, max	12 ⁱ	NR

Note: All oils must meet the requirements of the most recent edition of SAE J300; NR = Not required.

^aTests are per ASTM requirements.

^bCalculated conversions specified in ASTM D 5800 are allowed.

^cFor all viscosity grades: If CF-4, CG-4, CH-4 and/or CI-4 categories precede the "S" category and there is no API Certification Mark, the limits for phosphorus and sulfur do not apply. Note that these oils have been formulated primarily for diesel engines and may not provide all of the performance requirements consistent with vehicle manufacturers' recommendations for gasoline-fueled engines.

^dThis is a non-critical specification as described in ASTM D 3244.

^eAfter 10-minute settling period.

^fAfter 1-minute settling period.

^gShall remain homogenous and, when mixed with SAE reference oils, shall remain miscible.

^hTen-hour stripped kinematic viscosity at 100°C. Kinematic viscosity must remain in original viscosity grade.

ⁱTo be evaluated from -5°C to temperature at which 40,000 cP is attained or -40°C, or 2 Celsius degrees below the appropriate MRV TP-1 temperature (defined by SAE J300), whichever occurs first.