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Committee D-2 on PETROLEUM PRODUCTS AND LUBRICANTS

Chairman: E. W. WHITE, U.S. Navy Annapolis, David Taylor Naval Ship R & D Center, Code 2832, Annapolis, MD 21402

First Vice-Chairman: C. P. HENRY, JR., Du Pont Co., 19330, Petroleum Lab., Wilmington, DE 19898 (609-540-2891)

Second Vice-Chairman: E. N. DAVIS, 1507 Fisher St., Munster, IN 46321

Secretary: E. A. HAP THOMPSON, American Petroleum Institute, Marketing Dept., 1220 L St., NW, Washington, DC 20005 (202-682-8230)

Staff Manager: EARL R. SULLIVAN (215-299-5514)

June 6, 1991

DATA HANDLING FOR MULTIPLE SEQUENCE VI TEST RESULTS

To: Technical Guidance Committee Members and Invited Guests

Gentlemen:

I recently received a letter from the Chemical Manufacturers Association (CMA) requesting ASTM to develop "Statistical Test Guidelines" for the Sequence VI to deal with repeat test results. In anticipation of the Test Monitoring Board asking us to address this subject, I have included it on the agenda for our June 13 TGC meeting. To help you better prepare for this discussion, I am attaching the following:

- 1) The letter of request from the CMA.
- 2) A letter from Mr. Jim Newcombe proposing a method for dealing with repeat Sequence VI test results.

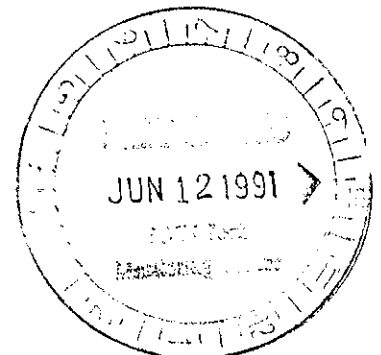
Please review these documents prior to our June 13 meeting as our agenda is rather full. Mr. D. Heath has conducted a survey of the Sequence VI Surveillance Panel membership regarding the proposal from Mr. Newcombe. He will present a summary of the responses.

Very truly yours,

GORDON R. FARNSWORTH
TGC Chairman

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Attachment



cc: Voting Members

A. Barajas
T. C. Boschert
G. E. Callis
B. D. Domonkos
W. P. Groff
A. C. Hahn
D. H. Heath
D. E. Larkin
R. Romano
L. T. Murphy
S. Norman
R. Rich
D. Smolenski
J. L. Zalar

Invited Guests

L. M. Bendele
G. E. Berriker - Secretary
A. Flamberg
T. G. Franklin - B.1 Chairman
J. W. Glaser
L. Hilliard
D. C. Ludwig
N. Nann
R. Oliver - CMA Liaison
J. E. Rutherford
A. Seymour
F. C. Wood
T. Zahalka



CHEMICAL MANUFACTURERS ASSOCIATION

May 13, 1991

Mr. Gordon R. Farnsworth, Chairman
ASTM Technical Guidance Panel
Paramins Exxon Chemical Co.
P.O. Box 536
Linden, NJ 07036-0536

Dear Mr. Farnsworth,

The CMA formally requests ASTM to develop a statistical test guideline for the Sequence VI fuel efficiency test. As you know, ASTM test guidelines have already been developed for all passenger car tests required to meet API SG. The Sequence VI test, though not required for SG, is particularly relevant to the test work CMA member companies perform for our customers requiring passenger car engine oils.

It would significantly enhance the CMA Product Approval Code of Practice if technically valid, statistically-based guidelines for the Sequence VI could be developed in time for implementation of the Code in September 1991.

Sincerely,

A handwritten signature in cursive script that reads "Henry K. Newhall". The signature is written in dark ink and includes a circled initial or mark at the end.

Henry K. Newhall
Chairman
Petroleum Additives
Product Approval Protocol Task Group

A handwritten signature in cursive script that reads "Carol R. Stack".

Carol R. Stack, Ph.D.
Manager
Petroleum Additives Panel



PARAMINS

EXXON CHEMICAL COMPANY
Performance Products Group

JAMES L. NEWCOMBE
Manager-Automotive Development

May 15, 1991

Dear Sirs: (See page 4)

RE: Sequence VI Statistical Test Guidelines

It is apparent, from the wide acceptance within our industry, that the ASTM Guidelines for dealing with multiple engine test results (ASTM letter to MVMA, July 10, 1990) are felt to be necessary, proper and timely. This is shown by the adoption of these guidelines by all participants in our industry -- automakers (MVMA), oil companies (API) and additive companies (CMA).

The first two groups -- MVMA and API -- have either suggested the adoption of these guidelines for a future system of oil certification or adopted them for a method of defining engine oil quality, either as a replacement for API SG or an enhancement to that category.

The third group -- CMA -- in development of a Code of Practice for all engine testing for passenger car engine oils has recently concluded that statistically sound test guidelines are necessary also for the Sequence VI test. As you are aware, the Sequence VI test is not part of either API SG or the ASTM Test Guidelines.

In support of the CMA request of ASTM for technically sound test guidelines for the Sequence VI test, within the spirit of the originally established goals of this test and the corresponding API categories, we believe that it is imperative that ASTM develop these guidelines.

After carefully reviewing the history of the test and the spirit of the techniques used to set the limits which classify an oil as Energy Conserving or Energy Conserving II, we suggest a method for treating multiple test results. This method is based on the statistical approach currently used for API CF-4 limits for the Caterpillar 1K test.

This method relies on the concept that one's confidence in an oil's performance increases as the number of results increase. We have extended the previous work done by the ASTM Test Development Panel, which formed the statistical basis for setting the original fuel economy limits based on a single test result.

Since "Tier I" development was closely tied to actual field performance (5-car fleet test), the current limit of 1.5 should be kept constant. However, the original "definition" of "Tier II" (in the spirit of the original work done by ASTM) was that the "Tier II" limits should ensure a

single result be significantly different from "Tier I." Since we are proposing limits for the mean of multiple results, it was necessary to develop new limits for the mean, which would reflect the increase in certainty resulting from multiple testing - while still conforming to the spirit and objective of the original work.

The calculations we have performed result in the following table which can be used to determine an oil's fuel economy when more than one result exists.

<u>Of Tests</u>	<u>Average of N Results Needed to Classify an Oil As</u>	
	<u>Energy Conserving</u>	<u>Energy Conserving II</u>
1	1.5	2.70
2	1.5	2.33
3	1.5	2.17
4	1.5	2.09

In order to fully appreciate the technical validity of this approach, it is useful to briefly review the history of the fuel economy tests and the techniques used to set the limits.

The Energy Conserving category, sometimes loosely referred to as "ECI" or "TIER I," was established in 1983 using the ASTM 5-Car Test. The purpose of this category was to identify oils that delivered positive fuel economy. Because the intent was to be very certain (95% confident) that the oil had greater than zero fuel economy relative to an industry reference oil, and because the tool (five cars) allowed a precision analysis, both an average limit and a lower confidence level were specified as test limits. At the time it was introduced, the average needed to be 1.0% or greater, and the lower confidence level had to be better than 0.3% fuel economy improvement relative to the reference.

Subsequent blends of the reference oil originally used had 0.5% ~~greater~~ ^{more} fuel economy than the original blend. This shift had to be incorporated into the test limits and when using HR2, HR3, etc., the average changed to 1.5% and the LCL (lower confidence level) moved up to 0.8%.

In 1984, the industry became interested in being able to identify oils with an even higher level of fuel economy. A statistical method was used by ASTM, which differentiated the population of 1.5% energy conserving oils from the population of higher performing oils. This was done in such a way as to minimize the chance of misclassifying an oil based on a single result. This method accounted for the ASTM 5-Car Test's precision (0.36%) and led to a 2.7% single test Energy Conserving II limit. Using this technique resulted in minimizing the probability of misclassification (population overlap between the 1.5% oils and the more fuel efficient

oils) to 10% or less. It is stated in the ASTM document that oils should not be compared based on a single result, that the test is only capable of a "go/no go" determination.

At about the same time that the work to identify a higher level fuel economy was taking place, the Sequence VI laboratory dynamometer test was nearing completion as a replacement for the cumbersome ASTM 5-Car Test.

Later, the Sequence VI test was shown to correlate to the ASTM 5-Car test with essentially the same precision. Because of this, the 2.7% (ASTM 5-Car) single test fuel economy work was carried forward and adopted to identify Energy Conserving II oils tested in the Sequence VI.

As previously stated, we have taken the original work done to set single result limits and applied it to cases where multiple results exist.

The method is conceptually the same one used to set limits in the 1K test, and we believe is consistent with the techniques and philosophy used for original limit setting in the Sequence VI. The numerical values to qualify as Energy Conserving or Energy Conserving II, as the number of tests increase, are illustrated in the table. These were developed using the precision of the Sequence VI when it was adopted as an industry tool.

These limits maintain the original confidence that a population of Energy Conserving II oils are statistically different from a population of Energy Conserving oils whose performance is centered at the 1.5% limit. Though the technique for dealing with multiple results appears to be fairly self-explanatory, a few numerical examples are useful to see how it would be applied in practice.

Example 1*

First Test	2.3
Second Test	<u>2.5</u>
Average	2.4

Energy Conserving II limit for two tests, from the table, is 2.33, so this product would meet Energy Conserving II requirements.

Example 2*

First Test	2.0
Second Test	1.6
Third Test	<u>2.7</u>
Average	2.1

Energy Conserving II limit for three tests, from the table, is 2.17, so this product does not meet Energy Conserving II.

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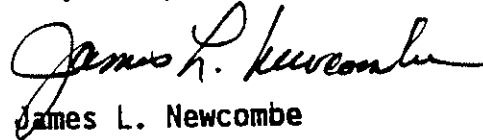
* It must be clear that similar products with small formulation changes cannot be used in the averaging of data method (i.e., no read across).

We believe that this means of determining the fuel economy performance of products and disclosing all of the fuel economy results to our customers is technically sound and a very logical extension of the ASTM Test Guidelines which already addresses the other relevant passenger car tests. We also feel that specifically addressing the Sequence VI will provide additional consistency and address the oversight which currently exists in the industry.

We request that ASTM take quick action on the request by CMA and consider our proposal as the appropriate response.

I will be glad to discuss this further to speed the process.

Very truly yours,



James L. Newcombe

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Francis R. Duffey
Chairman, ASTM D.02.B
Chrysler Corporation
12000 Chrysler Drive, CIMS 418-17
Highland Park, Michigan 48288-1118

Thomas M. Franklin
Chairman, ASTM D.02.B.01
Royal Lubricants Company
10999 IH 10 West, Suite 305
San Antonio, Texas 78230

Daniel H. Heath
Chairman, ASTM Sequence VI Surveillance Panel
Lubrizol Petroleum Chemicals Company
29400 Lakeland Blvd.
Wickliffe, Ohio 44092-2298

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Robert J. Main
Chairman, ASTM Passenger Car Oil Classification Panel
Lubrizol Petroleum Chemicals Company
29400 Lakeland Blvd.
Wickliffe, Ohio 44092-2298

Gordon R. Farnsworth
Chairman, ASTM Technical Guidance Panel
Exxon Chemical Company
P.O. Box 536
Linden, New Jersey 07036-0536