CODE BULLETIN C-53

Reissue

American Chemistry Council
Product Approval Code of Practice
December 2010 Edition

To: **Practitioners of the American Chemistry Council Product Approval Code of Practice Interested Parties**

Original Issue date: **July 27, 2017**

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Re: **Appendix K Revision- Template for Acceptance of New Tests Product Approval Code of Practice – December 2010 Edition**

Industry feedback on Code Bulletin C-53 was received within 30 days of its issue date. The American Chemistry Council's (ACC) Product Approval Protocol Task Group (PAPTG) reached consensus to reissue Code Bulletin C-53 with updates based on feedback received.

The ACC PAPTG reached consensus to revise Appendix K for the purpose of updating the Acceptance Criteria and Template Checklist to better align with current industry practices. Existing text may be found by following this ftp link, which will be available for 30 days. Proposed edits to pages K-2 through K-9 and pages Addendum K-1 through K-7 of Appendix K are provided below.

The Code is available online at http://www.americanchemistry.com/paptg. Comments to this Code Bulletin (C-53) reissue should be sent to the PAPTG Manager W .D. (Doug) Anderson prior to October 20, 2017.

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RELATIONSHIP TO ENGINE OIL CATEGORIES

The Code specifies quality processes relating to engine tests, which when applied collectively with specific test limits, form the basis for defining an engine oil category. A demonstration oil is necessary to establish the performance limits of the tests comprising the category. Such an oil must meet the performance limits of each of the tests within the category.

ACCEPTANCE CRITERIA

The following are requirements for acceptance of new tests into the Code:

A. Precision, Discrimination and Parameter Redundancy

The quality of a test is measured by the capability of the test to yield mutual agreement between individual results and to differentiate adequately between passing and failing oils at the performance limit. Acceptance of a test into the Code is dependent upon the test's capability to meet the defined precision and discrimination criteria. ~~based upon a homogeneous data set. Any bias between test laboratories and/or test stands must be removed before calculating these parameters. Each pass/fail parameter must have a unique and significant purpose in terms of the engine oil performance standard~~.

Requirements

A.1 Discrimination

For each test parameter in A.2, at least one of the oils used in proof-of-concept testing, matrix testing, or reference testing must be significantly different from at least one of the remaining oils. This difference must be in the ~~correct~~ same direction as known performance of oils, ~~i.e., a poor oil should not perform significantly better than a good oil~~. Significant difference may be declared with a p-value of ~~10%~~0.10 or less. Multiple comparisons should be taken into account. ~~Note that these least-squares means are not necessarily proposed LTMS targets~~. ~~An example is provided below.~~

~~Parameter: AAAA~~

			~~p-value for t-test of equal means (Tukey)~~		
~~Oil~~	~~Least-Square Mean~~	~~95% Confidence Interval for Mean~~	~~Vs 1~~	~~Vs 2~~	~~Vs 3~~
~~1~~	~~314.3~~	~~277.8 to 350.8~~		~~0.48~~	~~0.002~~
~~2~~	~~345.1~~	~~304.9 to 385.3~~	~~0.48~~		~~*0.04*~~
~~3~~	~~415.6~~	~~375.6 to 455.7~~	~~*0.002*~~	~~*0.04*~~	

A.2 Precision

The value, E_p, of repeat runs on the same lubricant must be 1.0 or greater for all proposed pass/fail criteria ~~based on ASTM D4485~~. All calculations must be in transformed units, where applicable, at the pass/fail limit.

$E_p = dp/Spp$

Where,

dp = Smallest difference of practical importance as determined by the American Chemistry Council (ACC) with input from industry as appropriate, e.g., ASTM, API, SAE, AAM, EMA.

S_{pp} = Intermediate precision ~~Pooled~~ standard deviation based on precision matrix data ~~(best estimate using all available reference and replicate candidate data at target level of performance).~~

An example is provided below.

Parameter	dp	Spp	Ep	Ep≥1.0
A	0.3	0.2	1.5	Yes
B	0.3	0.4	0.75	No

A.3 Parameter Redundancy

If two criteria for a test must meet specified limits, there are three ways to fail the test (Pass/Fail, Fail/Pass, and Fail/Fail) and only one way to pass the test (Pass/Pass). If the repeat variability on equivalent oils were independent and the true performance level for each criterion were exactly at the pass limit, there would be a ¾ chance of failing the test and a ¼ chance of passing. If the two criteria measure the same performance characteristic of oil, i.e., if they were redundant criteria, the oil should have a ½ chance of passing the test. Therefore, if two criteria are significantly correlated across oils and the test-to-test variability within oils is not significantly correlated, this is evidence that specifying limits for the two criteria would subject oils to unjustified jeopardy.

Each pass/fail parameter has a unique and significant purpose in terms of the engine oil performance standard. Linear and non-linear relationships are possible and should be taken into account. If two passing criteria are significantly related across oils, they must also be highly related in repeated tests within oils to avoid multiple jeopardy that adds no value to evaluation of oil performance.
Statisticians will use appropriate methods to analyze data and parameters.

~~Parameter redundancy is concluded if a correlation coefficient is 0.85 or greater. An example is provided below.~~

~~Correlation Coefficients~~

	~~Parameter A~~	~~Parameter B~~	~~Parameter C~~	~~Parameter D~~
~~Parameter A~~	~~1.00~~	~~*0.91*~~	~~0.23~~	~~0.02~~

~~Parameter B~~	~~*0.91*~~	~~1.00~~	~~0.19~~	~~-0.01~~
~~Parameter C~~	~~0.23~~	~~0.19~~	~~1.00~~	~~0.56~~
~~Parameter D~~	~~0.02~~	~~-0.01~~	~~0.56~~	~~1.00~~

B. Severity and Precision Control Charting

A Lubricant Test Monitoring System (LTMS) is a key gauge for evaluating overall test performance. Key attributes of any LTMS system are the monitoring and tracking of severity and precision for both abrupt and long term changes, alarm points, and alarm responses at various levels (stand, lab, industry).

Requirements

B.1 A LTMS for reference oil tests that is consistent with ACC Code Appendix A is in place.

B.2 Appropriate data transforms are applied to test results as needed in order to assure the approximate normality of the data population and/or to minimize non-constant variance.

B.3 There is a laboratory, stand or engine-based ~~or stand-based~~ severity adjustment system which relies on reference oil performance to determine ~~corrections~~ adjustments in the mild or severe direction.

C. Interpretation of Multiple Test Results

The method of interpretation of multiple test results must be a data-based approach for evaluating the quality and performance of a formulation through the consideration of all operationally valid test results. The method ~~of multiple test result interpretation~~ selected should recognize the precision of the test and the statistical reality that confidence in ~~a result~~ oil performance increases as the number of tests on the oil increases. Additionally, the method selected should include a methodology for the handling of discordant results.

Requirements

C.1 There is a system to handle the results of repeat tests run on a candidate, which takes into account current industry precision.

C.2 The appropriateness of a statistical method for the determination and handling of outlier results has been determined and the method defined.

D. Action Plan

Action plans must be developed and in place that address the following items:

D.1 Reference Oils

The choice, quantity, quality, supply, and distribution of reference oils are critical elements of the template. ~~The oils chosen must include those used in calculating discrimination, dp.~~ Reference oils are typically selected from oils within the precision matrix and suitable for LTMS. Long-term consistency and availability must be assured through documented quality systems.

To ensure that the severity and precision control charts accurately reflect the severity and precision of the test, the appropriate number of reference oils must be included to help

determine shifts in test quality for all critical parameters.

Recommended Approaches

D.1.1 Consistent with the ASTM Test Development Flow Plan, at least one of the ~~majority of~~ reference oils used must be representative of technology "current" when the applicable engine oil performance standard was established.

D.1.2 The intent is to have a reference oil that is at the intended performance level of the new category.

~~Additionally, the majority of reference oils run must be of passing or borderline pass/fail performance.~~

D.1.3 Oil supply and distribution are handled through an independent monitoring organization.

D.1.4 A quality control plan is defined and in place to assure the long-term quality of oils.

D.1.5 A turnover plan is defined and in place to ensure the uninterrupted supply of existing reference oils and an orderly transition to reblends.

D.1.6 A process for the introduction of replacement reference oils is defined and in place.

D.1.7 Oils are blended in a single homogeneous quantity to last five years.

D.2 Test Parts

In alignment with ASTM International's policy, development of test methods based on generic equipment (parts and fluids) is encouraged. For equipment that has a technical-based effect on test precision or severity, it may be appropriate to classify equipment as critical and to identify the source.

Requirements

D.2.1 Critical test parts, defined as those parts, which may affect severity and/or precision, must be identified.

D.2.2 A system must be defined and in place to maintain all testing on uniform hardware through a consistent and stable single-source supply of critical parts.

D.2.3 There must be a formal system in place for engineering support and test parts supply.

Recommended Approaches

D.2.4 Critical parts are distributed through an equipment distributor (who may or may not be the test developer).

D.2.5 Critical parts are serialized, and their use documented, in the LTMS data set and test report.

D.2.6 All parts are used on a first in/first out basis.

D.2.7 All rejected (unused) critical parts are accounted for and returned to the equipment distributor.

D.2.8 The equipment distributor provides a status report to the independent industry-recognized body responsible for the calibration, monitoring, and surveillance of the test method, at least semi-annually.

D.2.9 Quality control and turnover plan is in place for critical test parts to help assure consistency of parts among laboratories. These plans include the identification and measurement of key part attributes. Furthermore, a system for part quality accountability is defined and operable. A turnover plan is in place to ensure that all testing facilities use new parts batches or supply sources simultaneously.

D.2.10 There is a formal system for engineering support and test parts supply. Examples of support include:

Active participation in the independent industry-recognized body, e.g., ASTM Surveillance Panel, CEC Surveillance Group, responsible for the calibration, monitoring, and surveillance of the test; and

Active participation in industry-sponsored test matrices.

D.3 Test Fuel

The test fuel is part of the test procedure; therefore, it is as important as any other aspect of an engine test. If small variations in test fuel quality influence the results of an engine test, the fuel must be considered a critical part.

Requirements

D.3.1 Fuel supplier(s) and fuel specification (chemical and physical properties) are identified.

Recommended Approaches

~~As a minimum, the following items are addressed:~~

- ~~Fuel supplier and fuel specification (chemical and physical properties) are identified~~.

D.3.2 Approval guidelines are in place for fuel certification (batch, supplier, etc.).

D.3.3 A process is in place to monitor fuel stability over time.

D.3.4 If the test fuel is treated as a critical part of the test procedure; the following additional items are addressed: Approval engine testing plan and severity monitoring plan for each fuel batch is in place.

D.3.5 A quality control plan is defined and in place to assure the long-term quality of the fuel.

D.3.6 A turnover plan is defined, in place and demonstrated to ensure the uninterrupted supply of existing test fuel and an orderly transition to reblends.

D.4 Test Procedure

The establishment of any continuous improvement efforts requires a clear statement of a starting point. This starting point is the written test procedure where key aspects related to the running, rebuilding, and rating of a test are documented.

Requirements

D.4.1 Test preparation, ~~and~~ operation, and validity are clearly documented in a standards format, e.g., ASTM, CEC.

D.4.2 Test stand configuration requirements are documented and standardized.

D.4.3 Operational validity is defined for all controlled parameters.

Recommended Approaches

D.4.4 A ~~technical~~ research report is published~~, consistent with the ASTM Test Development Flow Plan~~, that documents the test precision ~~for reference oils~~,

D.4.5 There are published documents that
- document field correlation, and
- document test development history.

~~D.4.2 Test preparation, and operation, are clearly documented in a standards format, e.g., ASTM, CEC.~~

~~D.4.3 Test stand configuration requirements are documented and standardized.~~

~~D.4.4 Milestones to measure precision improvements are established and routinely evaluated for progress.~~

D.4.6 Routine engine build~~er~~ workshops are conducted.

D.4.7 All reported ratings and measurements must have a defined basis for judging interpretation of the test, or performance against oil specifications.

D.5 Rating and Reporting of Results

Consistent test parameter rating and the use of severity-adjusted results improve test precision and accuracy. The rating of only relevant parameters helps ensure cost effective testing. To ensure that the severity and precision control charts accurately reflect the test labs' severity and precision, no referee ratings are to be used in the determination of final test results. All reference and candidate tests must be rated in the same manner by a qualified test laboratory rater.

Requirements

D.5.1 Reported ratings for any single parameter in a test must be from single raters. Averaging of ratings from various raters is not permitted.

Recommended Approaches

D.5.1 ~~Averaging of ratings from various raters is not permitted.~~
D.5.2 ~~There is a laboratory or stand-based severity adjustment system which relies on reference oil performance to determine corrections in the mild or severe direction.~~
D.5.3 ~~Each pass/fail parameter has a unique and significant purpose in terms of the engine oil performance standard.~~
D.5.4 ~~All rated items must have a defined basis for judging operational validity, interpretation of the test, or performance against oil specifications.~~
D.5.2 Routine rater workshops are conducted.

D.6 Calibration, Monitoring and Surveillance

The independent monitoring of test performance with blind reference oils provides the data necessary for tracking severity and precision. Test procedure acceptability and appropriate adjustments to test results are based on reference oil performance relative to industry targets. A reference oil system administered by an industry recognized independent body assures laboratory confidentiality and unbiased test surveillance.

Requirements ~~***Recommended Approaches***~~

D.6.1 A process is in place for independent monitoring of severity and precision with an action plan for maintaining calibration of all laboratories.

D.6.2 Control charts based on industry reference oil data are used to judge the calibration status of laboratories, stands, and industry.

D.6.3 The specified calibration test interval should allow no more than 15 non-reference oil tests between successful calibration tests. ~~The maximum allowable time between blind references within a test stand does not exceed 15 times the minimum length of time to conduct a standard candidate test (test time plus turnaround).~~ This maximum elapsed time between reference tests is defined in the test procedure.

D.6.4 An industry panel is in place to provide test surveillance.

D.7 Guidelines for Read Across

A plan is defined for the establishment of data to assist in the development of base oil and viscosity grade read across guidelines and interchangeability. This plan will have been developed in concert with other interested parties such as API, ASTM, etc.

~~Recommended Approaches~~

D.7.1 ~~A matrix that encompasses the investigation of viscosity grade influence as well as base oil influence has been developed as part of the test development process.~~

D.7.2 ~~Results of investigations into viscosity grade influence as well as base oil influence have been summarized and included in the Technical Report in D.4.1~~

ADDENDUM K1

TEMPLATE CHECKLIST

Purpose

The Checklist for Comparing Tests to the Template is used to assess progress in new engine test development against the Code Acceptance Criteria and Action Plans. The checklist is updated periodically during the course of test development and is provided to, and discussed with, the appropriate ASTM test development task force.

The rating scale for comparing test development to the Template is as follows:

A - Completed

B - In Progress

C - Planned

D - No Action

Test Name_____ **Assessment Date**_____

Appendix K - Template for Acceptance of New Tests

Checklist for Comparing Tests to the Template

A. Precision and Discrimination

A.1 Discrimination

Requirements

A.1.1 Proof of concept- does the test discriminate between oils of differing expected performance (for example- between good and bad oils)? _____

Recommended Approaches

A.1.2 Is there evidence of additional discrimination based on all available data? _____

Use this section to record proof-of concept testing discrimination. You may also include precision matrix test discrimination as applicable.

~~For each test parameter in A.1, at least one of the oils used in proof-of-concept testing, matrix testing, or calibration testing must be statistically significantly different from at least one of the remaining oils. This difference must be in the correct direction, i.e., a poor oil should not test out as significantly better than a good oil. Significant difference may be declared with a p-value of 10% or less. Multiple comparison techniques (Tukey, Scheffe, Bonferroni, etc.) for the least-square means of the oils are preferred comparison techniques and should be stated in the analysis. Note that these least-squares means are not necessarily proposed LTMS targets. An example is provided below.~~

~~Parameter: AAAAA~~

			~~p-value for t-test of equal means (Tukey)~~		
~~Oil~~	~~Least Square Mean~~	~~95% Confidence Interval for Mean~~	~~Vs 1~~	~~Vs 2~~	~~vs 3~~
~~1~~	~~314.3~~	~~277.8 to 350.8~~		~~0.48~~	~~0.002~~
~~2~~	~~345.1~~	~~304.9 to 385.3~~	~~0.48~~		~~*0.04*~~
~~3~~	~~415.6~~	~~375.6 to 455.7~~	~~*0.002*~~	~~*0.04*~~	

Comments:

A.2 Precision

Requirements

A.2.1 Is the E_p 1.0 or greater for all pass/fail criteria? _____

~~$E_p = d_p/Spp$, $E_p \geq 1.0$ for all pass/fail parameters~~

~~d_p = Smallest difference of practical importance~~

~~Spp = Pooled standard deviation at target level of performance~~

~~An example is provided below.~~

~~Parameter~~	~~dp~~	~~Spp~~	~~Ep~~	~~Ep≥1.0~~
~~A~~	~~0.3~~	~~0.2~~	~~1.5~~	~~Yes~~
~~B~~	~~0.3~~	~~0.4~~	~~0.75~~	~~*No*~~

Comments:

A.3 Parameter Redundancy

Requirements

A.3.1 For each pair of pass/fail parameters, is the correlation across oil means insignificant? If the correlation across oils is significant are these parameters closely related in repeat tests within oils? _____

~~Each pass/fail parameter has a unique and significant purpose in terms of the engine oil performance standard. Parameter redundancy is concluded if a correlation coefficient is 0.85 or greater. An example is provided below.~~

~~Correlation Coefficients~~

	~~Parameter A~~	~~Parameter B~~	~~Parameter C~~	~~Parameter D~~
~~Parameter A~~	~~1.00~~	~~*0.91*~~	~~0.23~~	~~0.02~~
~~Parameter B~~	~~*0.91*~~	~~1.00~~	~~0.19~~	~~-0.01~~
~~Parameter C~~	~~0.23~~	~~0.19~~	~~1.00~~	~~0.56~~
~~Parameter D~~	~~0.02~~	~~-0.01~~	~~0.56~~	~~1.00~~

B. Severity and Precision Control Charting

Requirements

B.1 Is an LTMS for reference oil tests in place which is consistent with the ACC Code Appendix A? _____

B.2 Are appropriate data transforms applied to test results? _____

B.3 Is a suitable severity adjustment system in place? _____

Comments:

C. Interpretation of Multiple Tests

Requirements

C.1 Is a suitable system in place to handle repeat tests on a candidate oil (MTEP)? _____
Type: MTAC ~~Tiered Limits~~ TLM ~~Other~~ MRS

RATING SCALE: A - Completed; B - In Progress; C - Planned; D - No Action

C.2 Has a method for the determination and handling of outlier results been defined? ____

Comments:

D. Action Plan

D.1 Reference Oils

Recommended Approaches

D.1.1 Does at least one of the ~~majority of~~ reference oils represent current technology? _____

D.1.2 Is there a reference oil that is at the intended performance level of the new category? ____

~~Are the majority of reference oils of passing or borderline pass/fail performance?~~

D.1.3 Is reference oil supply and distribution handled through an independent organization? _____

D.1.4 Is ~~a quality control plan~~ the storage of oils defined and in place? ____

D.1.5 Is a turnover plan defined/in place to ensure uninterrupted supply of reference oil and an orderly transition to reblends? _____

D.1.6 Is a process for introducing replacement reference oils defined and in place? ____

D.1.7 Are oils blended in a homogeneous quantity to last 5 years? ____

Comments:

D.2 Test Parts

Requirements

D.2.1 Are all critical parts identified? ____

D.2.2 Is a system defined/in place to maintain uniform hardware? _____

D.2.3 Is there a system for engineering support and test parts supply? _____

Recommended Approaches (if indicating yes on D.2.1, D.2.2-7 are requirements)

D.2.4 Are critical parts distributed through a Central Parts Distributor (CPD)? ____

D.2.5 Are critical parts serialized, and their use documented in test report? ____

RATING SCALE: A - Completed; B - In Progress; C - Planned; D - No Action

D.2.6 Are all parts used on a first in/first out basis? _____

D.2.7 Are all rejected critical parts accounted for and returned to the CPD? _____

D.2.8 Does the CPD make status reports to the test surveillance body at least semi-annually? _____

D.2.9 Is there a quality control and turnover plan in place for critical test parts, including identification and measurement of key part attributes, a system for parts quality accountability, a turnover plan in place for simultaneous industry-wide use of new parts or supply sources? _____

D.2.10 Is the CPD active in industry surveillance panel/group, and in industry sponsored test matrices? _____

Comments:

D.3 Test Fuel

Requirements

D.3.1 Is the fuel specified and the supplier(s) identified? _____

Recommended Approaches

D.3.1 ~~Is the fuel specified and the supplier(s) identified?~~

D.3.2 Is a process in place to monitor fuel stability over time? _____

D.3.3 Are approval guidelines in place for fuel certification? _____

D.3.4 If the test fuel is treated as a critical part of the test procedure: Is an approval plan and severity monitoring plan for each fuel batch in place? _____

D.3.5 Is a quality control plan defined and in place to assure long term quality of the fuel? _____

D.3.6 Is a turnover plan defined, in place and demonstrated to ensure uninterrupted supply of fuel? _____

Comments:

D.4 Test Procedure

Requirements

D.4.1 Are test preparation and operation clearly documented in _____

a standard format, e.g., ASTM, CEC?

D.4.2 Are test stand configuration requirements documented and standardized? ____

D.4.3 Is operational validity defined for all controlled parameters? ____

Recommended Approaches

D.4.4 Is a research report published documenting test precision for reference oils? ____

D.4.5 Are there published documents detailing:
Field correlation? ____
Test development history? ____

~~D.4.2 Are test preparation and operation clearly documented in a standard format, e.g., ASTM, CEC?~~ ____
~~D.4.3 Are test stand configuration requirements documented and standardized?~~ ____
~~D.4.4 Are milestones for precision improvements established?~~
D.4.6 Are routine engine builder workshops planned/conducted?

D.4.7 Do all rate and report parameters judge test interpretation or judge engine oil performance? ____

Comments:

D.5 Rating and Reporting of Results

Requirements

D.5.1 Are the reported ratings for any single parameter in a test from single raters (i.e. not averages from various raters)? ____

Recommended Approaches

D.5.1 ~~Are the reported ratings from single raters (i.e. not averages from various raters)?~~ ____
~~D.5.2 Is a suitable severity adjustment system in place?~~ ____
~~D.5.3 Is each pass/fail parameter unique and have a significant purpose for judging engine oil performance?~~ ____
~~D.5.4 Do all rate and report parameters judge operational validity, help in test interpretation or judge engine oil performance?~~ ____

D.5.2 Are routine rater workshops conducted/planned? ____

Comments:

RATING SCALE: A - Completed; B - In Progress; C - Planned; D - No Action

D.6 Calibration, Monitoring and Surveillance

Requirements ~~***Recommended Approaches***~~

D.6.1 Is a process in place for independent monitoring of severity and precision with an action plan for maintaining calibration of all laboratories? _____

D.6.2 Are stand, lab, and industry reference oil control charts of all pass/fail criteria parameters used to judge calibration status? _____

D.6.3 Does the specified calibration test interval allow no more than 15 non-reference oil tests between successful calibration tests? _____

D.6.4 Is an industry surveillance panel in place? _____

Comments:

RATING SCALE: A - Completed; B - In Progress; C - Planned; D - No Action