

**AMERICAN CHEMISTRY COUNCIL
PRODUCT APPROVAL
CODE OF PRACTICE**

APPENDIX K

Template for Acceptance of New Tests

APPENDIX K

TEMPLATE FOR ACCEPTANCE OF NEW TESTS

Introduction

This Template defines the elements and the limits required for achieving precise and discriminating engine tests, processes for controlling key variables that can affect precision and discrimination, and methods to measure those key performance variables.

The “Acceptance Criteria” represent:

- the minimum acceptable levels of precision and discrimination;
- methods for precision and severity control charting;
- methods for handling multiple test results; and
- “Action Plans” for addressing variables that can affect precision and discrimination over the life of the test, or for addressing procedures that must be done during test development.

The “Action Plans”, with recommended approaches, address:

- reference oils;
- test parts;
- test fuels;
- test procedures;
- rating and reporting of results;
- calibration, monitoring, and surveillance; and
- development of guidelines for read-across and interchangeability.

Purpose

The main objective of the Template is to ensure through the “Acceptance Criteria” and the “Action Plans” that the accuracy of the measuring tools, the integrity of the data developed, and the interpretation of the results from these tools are founded upon technically correct and statistically sound principles; and that processes are in place to maintain quality. The end result will be more cost-effective testing and a greater confidence that a lubricant meets its intended performance.

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 Precision

The value, E_p , of repeat runs on the same lubricant must be 1.0 or greater for all pass/fail criteria based on ASTM D 4485. All calculations must be in transformed units, where applicable, at the pass/fail limit.

$$E_p = dp/S_{pp}$$

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} = Pooled standard deviation (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.2 Discrimination

For each test parameter in A.1, 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 direction, 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% or less. Note that these least-squares means are not necessarily proposed LTMS targets. An example is provided below.

Parameter: AAAA

Oil	Least-Square Mean	95% Confidence Interval for Mean	p-value for t-test of equal means (Tukey)		
			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.3 Parameter Redundancy

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

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.

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 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, D_d . Long-term consistency and availability must be assured through documented quality systems.

Consistent with the ASTM Test Development Flow Plan, the majority of reference oils used must be representative of technology “current” when the applicable engine oil performance standard was established.

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.

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

Recommended Approaches

- D.1.1 Oil supply and distribution are handled through an independent monitoring organization.
- D.1.2 A quality control plan is defined and in place to assure the long-term quality of oils.
- D.1.3 A turnover plan is defined and in place to ensure the uninterrupted supply of existing reference oils and an orderly transition to reblends.
- D.1.4 A process for the introduction of replacement reference oils is defined and in place.
- D.1.5 Oils are blended in a single homogeneous quantity to last five years.

D.2 Test Parts

Critical test parts, defined as those parts, which may affect severity and/or precision, must be identified. 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. There must be a formal system in place for engineering support and test parts supply.

Recommended Approaches

- D.2.1 Critical parts are distributed through an equipment distributor (who may or may not be the test developer).
- D.2.2 Critical parts are serialized, and their use documented, in the test report.
- D.2.3 All parts are used on a first in/first out basis.
- D.2.4 All rejected (unused) critical parts are accounted for and returned to the equipment distributor.
- D.2.5 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.2.6 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.2.7 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. The fuel must be specified and the supplier(s) must be identified.

If small variations in test fuel quality influence the results of an engine test, the fuel must be considered a critical part.

Recommended Approaches

- D.3.1 As a minimum, the following items are addressed:
 - Fuel supplier and fuel specification (chemical and physical properties) are identified.
 - Approval guidelines are in place for fuel certification (batch, supplier, etc.).
 - A process is in place to monitor fuel stability over time.

D.3.2 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.
- A quality control plan is defined and in place to assure the long-term quality of the fuel.
- 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.

Recommended Approaches

D.4.1 A technical report is published, consistent with the ASTM Test Development Flow Plan, that

- documents test precision for reference oils,
- documents field correlation, and
- documents 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.4.5 Routine engine builder workshops are conducted.

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.

Recommended Approaches

D.5.1 Averaging of ratings from various raters is not permitted.

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- 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.5.5 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.

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 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 Precision

$E_p = d_p/S_{pp}$, $E_p \geq 1.0$ for all pass/fail parameters
 d_p = Smallest difference of practical importance
 S_{pp} = 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.2 Discrimination

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

Oil	Least-Square Mean	95% Confidence Interval for Mean	p-value for t-test of equal means (Tukey)		
			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.3 Parameter Redundancy

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? _____

Comments:

C. Interpretation of Multiple Tests

Requirements

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

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

Comments:

D. Action Plan

D.1 Reference Oils

Do the majority of reference oils represent current technology? _____

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

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

Recommended Approaches

- D.1.1 Is reference oil supply and distribution handled through an independent organization? _____
- D.1.2 Is a quality control plan defined and in place? _____
- D.1.3 Is a turnover plan defined/in place to ensure uninterrupted supply of reference oil and an orderly transition to reblends? _____
- D.1.4 Is a process for introducing replacement reference oils defined and in place? _____
- D.1.5 Are oils blended in a homogeneous quantity to last 5 years? _____

Comments:

D.2 Test Parts

- Are all critical parts identified? _____
- Is a system defined/in place to maintain uniform hardware? _____
- Is there a system for engineering support and test parts supply? _____

Recommended Approaches

- D.2.1 Are critical parts distributed through a Central Parts Distributor (CPD)? _____
- D.2.2 Are critical parts serialized, and their use documented in test report? _____
- D.2.3 Are all parts used on a first in/first out basis? _____
- D.2.4 Are all rejected critical parts accounted for and returned to the CPD? _____
- D.2.5 Does the CPD make status reports to the test surveillance body at least semi-annually? _____
- D.2.6 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.2.7 Is the CPD active in industry surveillance panel/group, and in industry sponsored test matrices? _____

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

Comments:

D.3 Test Fuel

Recommended Approaches

- D.3.1 Is the fuel specified and the supplier(s) identified? _____
- Is a process in place to monitor fuel stability over time? _____
- Are approval guidelines in place for fuel certification? _____
- D.3.2 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? _____
- Is a quality control plan defined and in place to assure long term quality of the fuel? _____
- Is a turnover plan defined, in place and demonstrated to ensure uninterrupted supply of fuel? _____

Comments:

D.4 Test Procedure

Recommended Approaches

- D.4.1 Is a technical report published documenting, per ASTM Flow Plan:
Test precision for reference oils? _____
- 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.4.5 Are routine engine builder workshops planned/conducted? _____

Comments:

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

D.5 Rating and Reporting of Results

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.5.5 Are routine rater workshops conducted/planned? _____

Comments:

D.6 Calibration, Monitoring and Surveillance

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

D.7 Guidelines for Read Across

Recommended Approaches

D.7.1 Is a plan defined to establish data for development of BOI and VGRA? _____

D.7.2 Has VGRA and BOI data been summarized and included in the technical report in D.4.1? _____

Comments:

Rating Scale: A - Completed; B - In Progress; C - Planned; D - No Action