FC-W Catalyst Compatible®

Four-Stroke Cycle, Water-Cooled Gasoline Engine Lubricant

Product Approval System

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I. NMMA Product Approval System

The NMMA Product Approval System is a system of practices and procedures covering the execution of candidate programs, and the maintenance of engine test consistency.

The objective of the NMMA Product Approval System shall be to maintain consistent FC-W Catalyst Compatible® performance testing and thereby ensure the quality of candidate oils meeting the FC-W Catalyst Compatible™ performance specifications.

This NMMA Product Approval System references the following additional procedures and documents:

1. NMMA certification tests for FC-W Catalyst Compatible® four-stroke-cycle gasoline engine lubricants.

2. Office of Test Data Administration manual.

3. NMMA Oil Certification Committee Operating Guidelines.

II. Organization

A. Oil Certification Committee (OCC)

The Oil Certification Committee shall have the following responsibilities:

1. Meet on a regular basis to:
    - Review recommendations made by its subcommittees.
    - Review reference data collected by the Office of Test Data Administration.
    - Maintain and consider any changes to the NMMA protocol for licensing of candidate oils.
    - Consider requests for allocations of funding for test development or improvement.
2. Vote on approval of above items.
3. Make recommendations to the NMMA Engine Manufacturers Division (EMD) Board on matters requiring NMMA EMD Board approval.

B. Office of Test Data Administration (OTDA)

The OTDA shall perform the following functions:

1. Maintain data management systems and communications with sponsors and test sites for registration and cataloguing of candidate oils and candidate and reference engine tests.
2. Register and record all candidate oils, and candidate and reference engine tests.
3. Maintain a secure data management system to store results of engine tests run on candidate and reference oils.
4. Receive and record results for all candidate engine tests and reference engine tests per the OTDA manual.

5. Upon test sponsor's request, supply a listing of candidate test runs registered on a specific oil code to NMMA and the test sponsor.

6. Provide data contained in the reference oil data base to NMMA for the purpose of evaluating engine test precision and accuracy and/or consistency of FC-W Catalyst Compatible® reference oils.

C. NMMA Oil Surveillance Subcommittee (OSS)

The Oil Surveillance Subcommittee shall perform the following functions:

1. Report to the Oil Certification Committee.

2. Meet on a regular basis to review and monitor reference oil test results compiled by Office of Test Data Administration (OTDA).

3. Analyze data contained in the reference oil data base provided to NMMA by OTDA for the purpose of evaluating engine test precision and accuracy and/or consistency of FC-W® and FC-W Catalyst Compatible® reference oils.

4. Report to NMMA Oil Certification Committee on the status of key test issues.

5. Maintain and update the Product Approval System, as required.

D. Operations and Hardware Subcommittee (O&H)

The Operations and Hardware Subcommittee shall perform the following functions:

1. Report to the Oil Certification Committee.

2. Make technical recommendations to the Oil Certification Committee on:

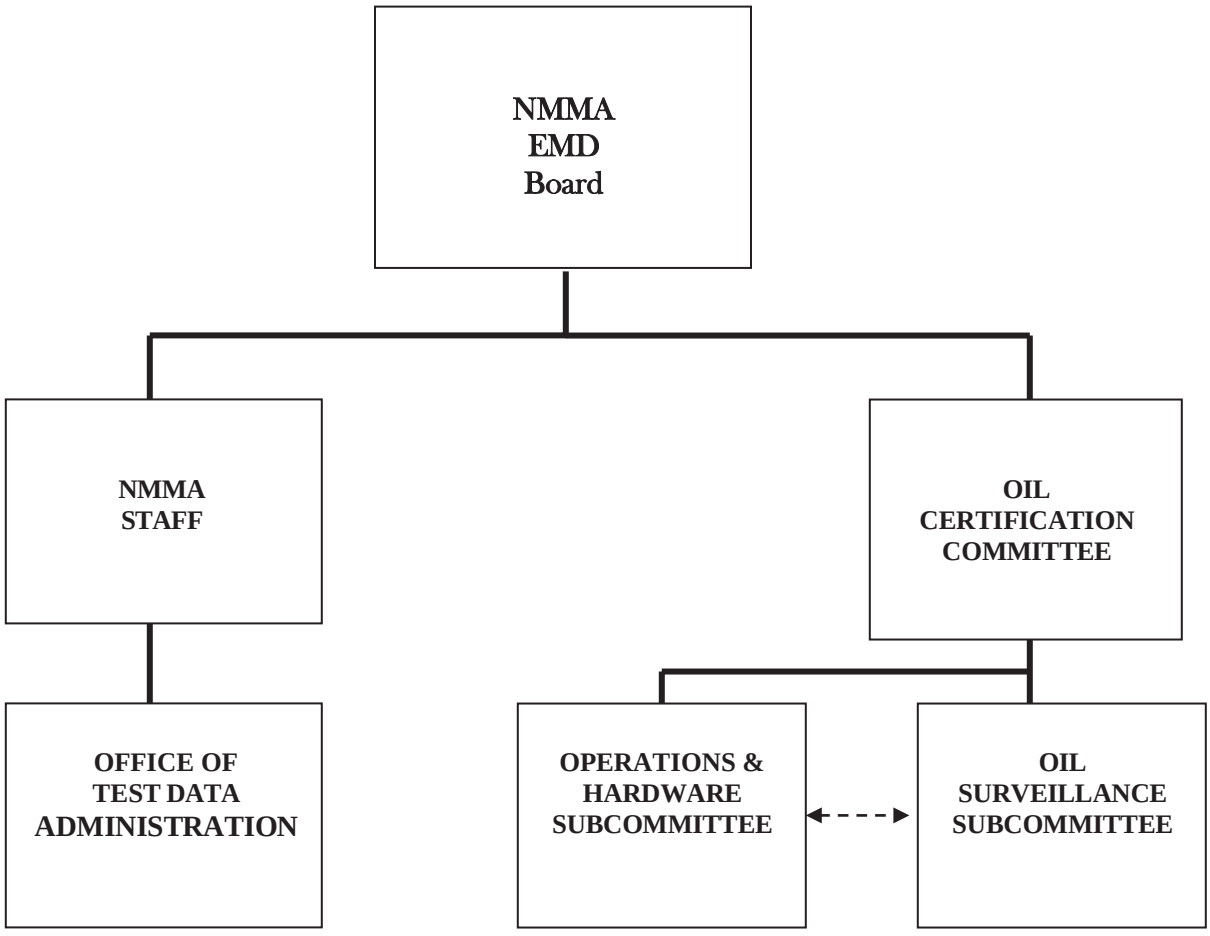
    - Test precision and severity improvements through test operation, hardware, or engine build-up techniques.

    - Test hardware variation improvements.

    - Written test procedures accuracy.

    - Other related areas.

E. Organization Chart



III. Approved FC-W Catalyst Compatible® Test Sites

Test Protocol	Intertek	SwRI
A. Performance Bench Testing		
NMMA Rust Test	X	X
B. Engine Testing		
NMMA 115 HP General Performance Engine Test (GPET)		X

Intertek = Intertek Automotive Research
SwRI = Southwest Research Institute

X = Approved by the NMMA OCC for product testing

Other labs are acceptable for other ASTM testing not shown.

IV. General Practices

1. All product certification testing shall be carried out per the most current specification document entitled "NMMA Certification Tests for FC-W Catalyst Compatible® Four-Stroke Cycle Gasoline Engine Lubricants."

2. All engine testing for product approval shall be conducted in labs that have been approved by the Oil Certification Committee (OCC), referenced per FC-W Catalyst Compatible® procedures, and participating in Office of Test Data Administration (OTDA) registration and reporting requirements.

3. Testing of a candidate in a particular engine test shall only commence following proper registration of that candidate oil with OTDA. OTDA shall assign a registration number to the candidate oil which shall be used to track any testing conducted on that candidate oil. Only one registration number shall be assigned to an individual candidate oil.

4. Any change in a candidate oil formulation shall necessitate a new OTDA registration number and complete testing of the new oil, except where approved read across guidelines are met.

5. The choice of test laboratory for any individual test shall be made by the sponsor.

6. The test laboratory shall supply the results of all tests initiated by registration with OTDA to both the sponsor and OTDA.

7. The test laboratory shall register all engine test reference runs with OTDA, and shall supply the results of all such reference runs to OTDA. These reference results shall be included by OTDA in a data base for determining and monitoring engine test precision.

8. The test laboratory may deem that a particular test was operationally invalid or may terminate a test due to mechanical problems. If this occurs, the test shall not be included as a reportable failure. However, the results shall be included in the end of program summary to NMMA.

9. All candidate oil test results submitted to the OTDA, or to the NMMA for oil certification purposes, shall be owned by the OTDA; however, candidate oil test results shall not be used, divulged or discussed by other than the test sponsor without the test sponsor's express written permission.

The NMMA may review candidate oil test results for discussion with the test sponsor.

Statistics involving candidate oils may be compiled by the OTDA at the request of the OCC if all of the following conditions are met:

- The data population shall be sufficiently large, and diverse in test sponsors.
- The statistics shall be the result of analysis of the entire data population. A listing of the data used in the analysis shall not be performed.
- Statistics on data from individual test sponsors shall not be provided, even if coded.

10. All rust results and pass/fail criteria shall be expressed in percent to the nearest single digit. All scuffing and ring wiping test results and pass/fail criteria shall be expressed to the nearest single digit, while all ring sticking and deposit test results and pass/fail criteria shall be expressed to the nearest tenths. All wear results shall be expressed in microns to the nearest single digit. The ASTM rounding method in E29 shall be used as the basis for rounding results to the appropriate precisions. The test sites, however, may use a greater number of significant digits in calculating results so long as the final results are reported to the above precisions.

11. The Oil Certification Committee (OCC) may declare any NMMA FC-W Catalyst Compatible® test out of control upon recommendation of either the Oil Surveillance Subcommittee (OSS) or the Operations and Hardware Subcommittee (O&H). The reasons for such a decision may include (but are not limited to):

    Lack of discrimination between references
    Poor repeatability/reproducibility

    The OCC may declare any NMMA FC-W Catalyst Compatible® test unavailable to the industry upon recommendation of either the OSS or the O&H. The reasons for such a decision may include (but are not limited to):

    Lack of uniform hardware
    Lack of approved fuel
    Lack of available test sites

Once a test (or tests) is declared out of control or unavailable to the industry, the NMMA shall provide Provisional Licenses to any applicant satisfying all other tests and requirements during the period that the test (or tests) is out of control or unavailable to the industry.

Once testing is resumed, the OCC shall determine the time frame within which the industry must complete the Provisional approvals.

V. Test Site Acceptance Procedures

A. NMMA 115 HP General Performance Engine Test Site Acceptance

1. The test lab shall run the prescribed brand and size of engine per the test procedure on the NMMA reference oil 4T-115B*, and show that the performance of the engine does not produce any unusual results. Two consecutive reference runs shall be made to gain test site acceptance.

2. Results shall be reviewed with and confirmed by the NMMA oil certification committee (OCC) prior to acceptance of the test site.

3. Acceptance results shall also be submitted to the Office of Test Data Administration (OTDA).

B. NMMA Rust Test Site Acceptance

1. The test lab shall concurrently run the prescribed test method on NMMA reference oil 5973* and NMMA calibration oil 49P52Z*. The average rust rating for NMMA reference oil 5973 must fall within the range of 20-40% rust, while the average rust rating for NMMA calibration oil 49P52Z must fall in the range of 40-60% rust. Additionally, the difference between the average rust ratings of the two oils must be at least 15%

2. The test lab shall concurrently run for a second time both the NMMA reference oil 5973 and the NMMA calibration oil 49P52Z, and again show average rust ratings within the ranges specified, as well as the required differentiation between the two oils.

3. Results shall be reviewed with and confirmed by the NMMA oil certification committee (OCC) prior to acceptance of the test site.

C. NMMA Test Site Acceptance for other than Engine or Rust Tests

1. Other test sites / laboratories are acceptable for individual tests other than engine or rust tests as long as the laboratory verifies in writing that the test and/or analysis cited in Attachment IX-1 were performed in accordance with ASTM test procedures with no deviations or modifications.

2. Test results must be provided in a suitable report format that can be submitted to NMMA as part of an oil certification.

VI. Test Referencing Frequencies

A. NMMA 115 HP General Performance Engine Test Referencing Frequency

To provide a baseline for gauging candidate performance, the NMMA 115 HP General Performance Engine Test shall require the NMMA reference oil 4T-115B* be run prior to candidate testing if more than 12 months have elapsed since the previous reference.

B. NMMA Rust (Salt Fog Test) (SFT) Referencing Frequency

This test procedure shall be periodically referenced. The referencing interval shall be 6 months. The test is considered to be satisfactorily referenced if:

- Reference Oil 5973 average rating falls between 20-40% inclusive, and
- Calibration Oil 49P52Z average rating falls between 40-60%, inclusive.

*Questions concerning the availability of NMMA reference and calibration oils should be directed to:

Engineering Standards Department
National Marine Manufacturers Association
231 S. LaSalle Street
Suite 2050
Chicago, IL 60604
Tel. (312) 946-6200
Fax (312) 946-0388

VII. Operational Test Validity for Engine Testing

1. This procedure applies only to the NMMA 115 HP General Performance Test.

2. The NMMA 115 HP General Performance Engine Test must be conducted according to the written test procedure approved by the Oil Certification Committee.

3. Total duration of unscheduled shutdowns during the test shall not exceed 48 hours, with no individual shutdown exceeding 24 hours. There shall be no limit on the number of individual shutdowns during the test. A shutdown shall be defined as a period during which the engine is at 0 rpm.

4. The occurrence of outliers in critical test parameters during the test (based on hourly readings) and the magnitude of such occurrences shall be weighted for each critical test parameter in the calculation of the deviation percentage. The deviation percentage for an individual critical test parameter shall be defined as:

$$D.P. = \left[\frac{\text{Amt. out of spec}}{\text{Spec Range}} \right] \times \left[\frac{\text{Hrs. out of spec}}{\text{Test Length Hrs.}} \right] \times 100$$

5. An out-of-spec reading shall be considered to have been an outlier for the full interval since the previous in-spec reading.

6. For each primary critical test parameter, the deviation percentage shall not exceed 5.0% over the entire test. For each secondary critical test parameter, the deviation percentage shall not exceed 10.0% over the entire test. The following shall be the list of critical test parameters:

	Primary	Secondary
Idle rpm	X	
Intermediate rpm's	X	
W.O.T. rpm	X	
Coolant in temperature	X	
Coolant out temperature		X
Air humidity	X	
Air supply temperature	X	
Max air temperature at WOT		X
Fuel flow		X
Oil pressure		X
Max oil sump temperature at WOT		X

7. For rpm parameters, the test length used in the deviation percentage calculation shall be adjusted to reflect the relative time operating at a specific speed.

8. For tests which terminate prematurely, the expected full test length shall be used in calculating the deviation percentage.

9. For determining test validity, the deviation percentage for each parameter shall be calculated and considered separately.

10. The test lab shall apply the shutdown and parameter deviation criteria for each test to determine operational test validity or invalidity.

11. Each test report shall state whether the test is operationally valid or invalid, with a reason provided for each invalid test.

12. For operational problems not covered by this procedure, the test lab(s) shall consult with the Oil Certification Committee.

VIII. Engine Test Hardware Control Guidelines

1. Purchase orders for engine short block assemblies from the OEM for the NMMA 115 HP General Performance Test shall be for the most recently updated and available stock. Ongoing design changes to the engine shall not be considered substantive unless the OEM alerts the OCC that a design change may significantly impact the performance of the test.

2. Test sites shall have the opportunity to evaluate engine short block assemblies for the NMMA 115 HP General Performance Test prior to ordering new blocks if design changes have been introduced that are felt to be substantive by the OEM. The OEM shall determine what actions to pursue if design changes are considered to be substantive.

IX. Dyes and Fragrances

Dye: any pigment compound exclusively intended to alter the apparent color of the finished lubricant

Fragrance: any cologne or perfume compound exclusively intended to alter the apparent odor of the finished product

Dyes and Fragrances are used for cosmetic purposes only and are not intended or allowed to have any impact on the technical performance of the finished lubricant.

X. FC-W Catalyst Compatible® Read Across Protocol

1. The FC-W Catalyst Compatible® Read Across Protocol shall allow companies to obtain new FC-W Catalyst Compatible® approvals to be issued based on existing FC-W Catalyst Compatible® approvals with testing necessary to ensure FC-W Catalyst Compatible® performance. The FCW Rust Test is only required for Demonstration Programs, and is not required for Viscosity Grade Read-Across(VGRA) programs.

2. A complete FC-W Catalyst Compatible® approval demonstration program meeting the NMMA requirements (Attachment X-1) shall include passing results in the following FC-W Catalyst Compatible® test areas:

   - FC-W Catalyst Compatible® Quality Documentation of the core technology
   - Statement of SAE viscosity grade
   - FC-W Catalyst Compatible® Identification testing
   - FC-W Catalyst Compatible® Viscosity Grade testing
   - FC-W Catalyst Compatible® Performance Bench testing
   - FC-W Catalyst Compatible® Engine testing

3. Once an FC-W Catalyst Compatible® approval demonstration program has been completed, the Read Across Protocol may be applied to any approval, unless noted.

4. The testing required shall be dictated by the most severe formulation change involved in the read across.

5. All percentages are in mass%, unless otherwise noted.

6. The definitions of *base stock*, *base stock slate*, and *base oil* shall be as defined in API Publication 1509 (API Base Oil Interchangeability Guidelines for Passenger Car Motor Oils and Diesel Engine Oils).

7. FC-W Catalyst Compatible® Identification testing, Shear Stability and HTHS after Shear, and Noack Volatility shall be completed with every read across program submitted to NMMA for FC-W Catalyst Compatible® certification.

8. FC-W Catalyst Compatible® Viscosity Grade testing requirements shall be completed and the SAE viscosity grade identified with every read across program submitted to NMMA for FC-W Catalyst Compatibility® certification.

9. Quality Documentation of the core package (Attachment X-2) shall be provided to NMMA by the test sponsor for each formulation tested as part of a complete FC-W Catalyst Compatible® approval demonstration program.

10. The NMMA shall allow uptreating of all or any part of the additive package (exclusive of viscosity modifier and pour point depressant) up to 30% in any formulation in which the additive package has not previously been increased beyond the additive treat rates in the FC-W Catalyst Compatible® approval demonstration program, provided that:

    - The 30% allowable uptreat in additive treat rate shall be relative to the base additive treat rate, and shall apply for either the total additive package or its individual components; for individual components, the increase in treat rate for each component shall not exceed 30% of the base treat rate for that component.

    - For additive package or individual component increases of greater than 10%, the oil marketer and the additive supplier shall agree based on technical data that the additive package or individual component increases are not expected to detract from the oil's performance.

    - The FC-W Catalyst Compatible® elemental limits on P and Si continue to be met.

11. Within a particular viscosity grade, the NMMA shall allow variations in type and/or treat rate of viscosity modifiers (excluding dispersant type), provided that:

    - The viscosity grade of the oil shall remain unchanged.

    - The Shear Stability and HTHS requirements shall be met.

12. The NMMA shall allow variations in pour point depressant type or treat rate.

13. The NMMA shall allow variations in foam inhibitor type or treat rate, provided that:

    - The Sequence I, II, III and IV Foam requirements shall be met.

14. The NMMA shall allow the following base stock ratio changes, intended to allow adjustments in the viscometrics of a formulation without affecting engine performance, provided that:

    - The viscosity grade of the oil shall remain unchanged.

    - The base stock ratio shall change by no more than 15% absolute.
      (Example: A formulation containing 60% base stock A and 20% base stock B, together with 20% other components, such as additives and viscosity modifier, has absolute percentages of base stocks A and B of 75% and 25%, respectively. A maximum allowable reduction of 15% absolute in base stock A would produce absolute percentages of 60% and 40% for A and B

respectively, corresponding to final formulation (relative) percentages of 48% A, 32% B, and 20% of other components.)

- The addition of a new base stock, in the same base stock slate, shall be limited to a maximum of 15% absolute of the base oil (base stock blend). (Example: A formulation contains 80% of a single base stock A, together with 20% other components, such as additives and viscosity modifier. A maximum allowable addition of 15% absolute of base stock B would allow a maximum substitution of 12% base stock B for base stock A, i.e. 80% x 15% = 12%.)

15. The NMMA shall allow the interchange of a single base stock meeting the definition of either Group I, Group II, Group III, or Group IV up to 10% absolute into an FC-W Catalyst Compatible® oil;

    a. or the interchange of a single Group III base stock up to 30% absolute into an FC-W Catalyst Compatible® oil formulated with Group I, Group II, and/or Group IV base stocks;

    b. or the interchange of a single Group IV base stock up to 30% absolute into an FC-W Catalyst Compatible® oil formulated with Group I, Group II, and/or Group III base stocks;

    Provided that all testing other than FC-W Catalyst Compatible® Engine testing is completed.

16. For blends using only Group I and/or Group II base stocks, the NMMA shall allow viscosity grade read across where indicated by an "X" in Table X-1, provided that:

    - The additive package, excluding pour point depressant and non-dispersant type viscosity modifier, shall remain the same as that of the original viscosity grade, and the treat rate shall be equal to or greater than that of the original viscosity grade, but limited to additive increases allowed in section 10.

    - Viscosity modifier, foam inhibitor, and pour point depressant treat levels and types may be adjusted for alternative viscosity grades.

Table X-1 – Read Across

Table Including 25W50											
Test Run On:	5W-30	10W-30	10W-40	15W-40	15W-50	20W-40	20W-50	25W-40	25W-50	30	40
5W-30	~	X	X	X	X	X	X	X	X	X	X
10W-30		~	X	X	X	X	X	X	X	X	X
10W-40		X	~	X	X	X	X	X	X	X	X
15W-40				~	X	X	X	X	X	X	X
15W-50					~	X	X	X	X	X	X
20W-40						~	X	X	X	X	X
20W-50							~	X	X	X	X
25W-40								~	X	X	X
25W-50									~	X	X
30										~	X
40											~
~ means core program											
X means that Read Across is permitted											
Blank space means that Read Across is not permitted											

17. For blends only using Group I or Group II base stocks with no more than 30% absolute of Group III, Group IV and/or Group V base stock included in the FC-W Catalyst Compatible® approval demonstration program formulation, the NMMA shall allow viscosity grade read across where indicated by an X in Table X-1, provided that:

    - The additive package, excluding pour point depressant and non-dispersant type viscosity modifier, shall remain the same as that of the original viscosity grade, and the treat rate shall be equal to or greater than that of the original viscosity grade, but limited to additive increases allowed in Section 10.

    - The same absolute level and ratio of Group III and/or Group IV base stock shall be present in the read across formulation as were present in the original formulation.

    - An equal amount of the same Group V base stock present in the formulation of the original viscosity grade must be present in the read-across viscosity grade.

    - Viscosity modifier, foam inhibitor, and pour point depressant treat levels and types may be adjusted for alternative viscosity grades.

18. For blends using only Group III, Group IV and/or Group V base stocks in the FC-W Catalyst Compatible® approval demonstration program formulation, the NMMA shall allow viscosity grade read across where indicated by an X in Table IX-1, provided that:

    - The additive package, excluding pour point depressant and non-dispersant type viscosity modifier, shall remain the same as that of the original viscosity grade, and the treat rate shall be equal to or greater than that of the original viscosity grade, but limited to additive increases allowed in Section 10.

- A similar ratio of Group III to Group IV base stock shall be present in the read across formulation as was present in the original formulation.

- An equal amount of the same Group V base stock present in the formulation of the original viscosity grade must be present in the read-across viscosity grade.

- Viscosity modifier, foam inhibitor, and pour point depressant treat levels and types may be adjusted for alternative viscosity grades.

19. NMMA shall require a complete FC-W Catalyst Compatible® demonstration program for:

    - Downtreats of any part of the additive package, excluding pour point depressant and non-dispersant viscosity modifier.

    - The substitution of any rust inhibitor.

    - The addition of any new additive component (excluding pour point depressant, foam inhibitor and non-dispersant viscosity modifier but limited to modifications stipulated in sections 11, 12 and 13).

    - Oils formulated with Group I and/or Group II base stocks containing more than 30% absolute of Group III, Group IV and/or Group V base stocks.

    - Base stock interchanges involving changes in base stock slate.

    - Any changes outside the scope of this Read Across Protocol.

20. An oil of any SAE viscosity grade can be certified to be NMMA FC-W Catalyst Compatible® by running a complete demonstration program. For readacross programs, SAE viscosity grades are limited to those shown in Table X-1.

Attachment X-1

FC-W Catalyst Compatible® Approval Demonstration Program Requirements

FC-W Catalyst Compatible® Quality Documentation

Minimum of SM Heritage (See Attachment X-2)

FC-W Catalyst Compatible® Identification Testing

		FC-W Catalyst Compatible® Limits
Kinematic Vis. @ 40°C	ASTM D445	Report only
Viscosity Index	ASTM D2270	Report only
Specific Gravity	ASTM D1298 or D4052	Report only
Total Base Number	ASTM D2896	Report only
Total Acid Number	ASTM D664	Report only
Elements	ASTM D4951, D4927, D4628 or D5185	
Barium		Report only
Boron		Report only
Calcium		Report only
Magnesium		Report only
Molybdenum		Report only
Phosphorus		0.06 - 0.08%
Silicon		0.002% max
Zinc		Report only
Sulfur Content	ASTM D5453, D2622, D4294 or D6443	Report only
Nitrogen Content	ASTM D5291 or D5762	Report only
IR Spectrum	ASTM E168	Report only

Statement of SAE Viscosity Grade

Based on Viscosity Grade Testing	Report only

FC-W Catalyst Compatible® Viscosity Grade Testing

Kinematic Vis. @ 100°C	ASTM D445	Per SAE J300 Grades
Cold Crank Viscosity	ASTM D5293	Per SAE J300 Grades
MRV-TP1 Viscosity	ASTM D4684	Per SAE J300 Grades

FC-W Catalyst Compatible® Performance Bench Testing

Foam, Seq. I, ml	ASTM D892	10/0 maximum
Foam, Seq. II, ml	ASTM D892	50/0 maximum
Foam, Seq. III, ml	ASTM D892	10/0 maximum
Foam, Seq. IV, ml	ASTM D6082	200/50 maximum
Shear Stability, KV100°C after 30 cycles, cSt	ASTM D6278	≥ 5.6 for XW-20 and SAE 20 ≥ 8.5 for XW-30 and SAE 30 ≥ 11.5 for XW-40 and SAE 40 ≥ 15.0 for XW-50 and SAE 50 ≥ 20.1 for XW-60 and SAE 60
HTHS (after D6278), cP	ASTM D4683, D4741 or D548	3.3 minimum
Rust, %	NMMA FC-W® method	≥ Reference Oil
Noack Volatility, %	ASTM D5800	≤ 22%
EOFT, % change	ASTM D6795	≤ 50

FC-W Catalyst Compatible® Engine Testing

115 HP GPET	NMMA FC-W® method	Pass

Attachment X-2

FC-W Catalyst Compatible® Quality Documentation

Sponsor Company Letterhead

This document verifies that oil_____ is formulated with a core additive technology that was based on a minimum of API SM performance quality. Any formulation changes that were made to meet NMMA FC-W Catalyst Compatible® requirements are not believed to detract from performance in the original API S-category tests. Nonetheless, this oil may no longer allow API SM (or higher) quality claims.

_____
Signature

_____
Title

_____
Date

_____
Phone Number

Attachment X-3

FC-W Catalyst Compatible® Testing Summary for Certification Submission

Circle test method used if more than one is allowed

FC-W Catalyst Compatible® Identification Testing

		Limits	Test Results
KV @ 40°C, cSt	ASTM D445	Report only	_____
Viscosity Index	ASTM D2270	Report only	_____
SG @ 60/60°F	ASTM D1298 or D4052	Report only	_____
TBN, mg KOH/ml	ASTM D2896	Report only	_____
TAN, mg KOH/ml	ASTM D664	Report only	_____
Elements	ASTM D4951, D4927, D4628 or D5185		
Barium, mass%		Report only	_____
Boron, mass%		Report only	_____
Calcium, mass%		Report only	_____
Magnesium, mass%		Report only	_____
Molybdenum, mass%		Report only	_____
Phosphorous, mass%		0.06-0.08%	_____
Silicon, mass%		0.002% max	_____
Zinc, mass%		Report only	_____
Sulfur, mass%	ASTM D5453, D2622, D4294 or D6443	Report only	_____
Nitrogen, mass%	ASTM D5291 or D5762	Report only	_____
IR Spectrum	ASTM E168	Report only	Attached

Statement of SAE Viscosity Grade

Based on Viscosity Grade Testing	Report only	_____

FC-W Catalyst Compatible® Viscosity Grade Testing

KV @ 100°C, cSt	ASTM D445	_____	_____
CCS, cP	ASTM D5293	_____	_____
MRV-TP1, cP	ASTM D4684	_____	_____
MRV-TP1, Yield stress	ASTM D4684	_____	_____

FC-W Catalyst Compatible® Performance Bench Testing

Foam, Seq. I, ml	ASTM D892	10/0 max	_____
Foam, Seq. II, ml	ASTM D892	50/0 max	_____
Foam, Seq. III, ml	ASTM D892	10/0 max	_____
Foam, Seq IV, ml	ASTM D6082	200/50 max	_____
Shear Stability, cSt	ASTM D6278	See below*	_____
Shear Stability, %	ASTM D6278	Report only	_____
HTHS (after D6278), cP	ASTM D4683, D4741 or D548	3.3 min	_____
Rust, %	NMMA FC-W® method	:: Ref Oil	_____
Noack Volatility, %	ASTM D5800	:: 22%	_____
EOFT, % change	ASTM D6795	:: 50	_____

FC-W Catalyst Compatible® Engine Testing

115 HP GPET	NMMA FC-W® method	Must pass	_____

* Shear Stability Limits:
  - 5.6 cSt @ 100°C for XW-20 and SAE 20
  - 8.5 cSt @ 100°C for XW-30 and SAE 30
  - 11.5 cSt @ 100°C for XW-40 and SAE 40
  - 15.0 cSt @ 100°C for XW-50 and SAE 50
  - 20.1 cSt @ 100°C for XW-60 and SAE 60

Attachment X-4

NMMA Reference Oils
Status Report
Outlook for the next two years

05-Feb-19

No Problems
Possible Issues
Problems

NMMA				Inventory (Gallon)		FC-W	FC-W	TC-W3	TC-W3	TC-W3	TC-W3	TC-W3	TC-W3	TC-W3	TC-W3
Name	Blended Oil Supplied By	Status	Notes	SwRI	IAR	115 hp	Rust	15 hp	40 hp	CE50	AF27	Preign	Rust	Comp	Filt
4T-115B	Infineum			22.6	0	Bench mark									
49P52Z	Shell			11	1		Calibr.								
5973	Infineum		1	0	<1 pint		Ref.								
71591	Oronite			115	0			High Ref.							
93738	Oronite			28.17	0			Low Ref.	High Ref.	Low Ref.		High Ref.	High Ref.	Ref.	Ref.
CITGO 93511	Lubrizol			0	0										Test Oil
DF413	Oronite			54.3	0				Low Ref.						
JATRE-3	JALOS			54.9	0						Low Ref.				
XPA3259	Lubrizol			14.4	0					High Ref.	High Ref.			Ref.	Ref.

Note 1: Will Need a new reference oil when current drum is depleted