Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Title / Validity Declaration Page

Form 1

Version 20011127

Conducted

TSTSPON1
TSTSPON2

LABVALID	I = Invalid
	V =Valid

TSTOIL	RO = Reference Oil Test
	NR = All Other Test

Test Number			
Engine No.: ENGINE		**Engine Run** ENRUN	
EOT Time: EOTTIME		**EOT Date:** DTCOMP	
Reference Oil CMIR		**CYLINDER:** CYLCMIR	
Non Reference Oil OILCODE		**CYLINDER:** CYLOILCD	
Formulation/Stand FORM			
Alternate Codes:	ALTCODE1	ALTCODE2	ALTCODE3

In my opinion this test OPVALID been conducted in accordance with the Test Method D4857 and the appropriate amendments through information letter system. The remarks included in this report describe the anomalies with this test.

Submitted By:

SUBLAB
Testing Laboratory

SUBSIGIM
Signature

SUBNAME
Typed Name

SUBTITLE
Title

Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Table of Contents
Form 2

Lab: LAB	**EOT Date:** DTCOMP	**End Time:** EOTTIME
Engine No.: STAND	**Run Number:** ENRUN	
Reference Oil CMIR		**Cylinder:** CYLCMIR
Non Reference Oil OILCODE		**Cylinder:** CYLOILCD
Formulation / Stand Code: FORM		

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Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Objective / Summary of Procedure
Form 3

Objective

This procedure is designed to evaluate the perfomance of a two-cycle engine lubricant relative to engine cleanliness when tested in a two cylinder motorcycle engine. Particular attention will be given to the following characteristics.

1. Piston Skirt Varnish
2. Piston Ring Sticking
3. Spark Plug Fouling
4. Preignition
5. Combustion Chamber Deposits
6. Exhaust Port Blocking

Summary of Procedure

The engine selected for this evaluation is a Yamaha RD350B air-cooled, two cylinder, two-cycle engine with the following specifications:

Displacement	21.18 cu. in. (347 cm^3)
Cylinder Bore	2.250 in. (64 mm)
Stroke	2.126 in. (54 mm)
Compression Ratio	6.6:1
Piston / Cylinder Clearance	0.004 in.
1st Oversized Pistons	

The separate cylinder arrangement of this engine, with individual intake and exhaust systems for each cylinder, allows an evaluation of the benchmark reference oil and non-reference oil simultaneously.

A 2-h break-in is completed before the test begins, At the start of test and prior to each cycle, the engine is idled for five min. The transmission is in fourth gear during testing. The test operates on the following cyclic schedule:

	Phase I	Phase II
Engine, r/min	220 ± 200	6000 ± 5
Engine, bhp	0	8.5 ± 0.5
Air / Fuel Ratio	----	12.0 ± 0.20
Spark Plug Gasket Temp., ˚F	Record	375 ± 5
Exhaust Temp., ˚F	Record	Approx. 1240 ± 140
Duration, min.	5	25

This is repeated five times for 150 min. test time.

The engine is then shut down for a minumum of 60 min. to complete one cycle.

This cycle is repeated eight times for a total running time of 20-h .

Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Objective / Summary of Procedure
Form 3a (continued)

The Data Acquisition System used to support this test operation meets the Automated Systems requirements Phase I data is sampled every 10s and 6 data points are averaged during the last minute of Phase I to provide a reading. Phase II data is sampled every 10s and 112 data points are averaged during the last eighteen min. to provide a reading. All parameters are acquired and averaged by the Automated Data Acquisition System.

At the conclusion of the test, the engine is disassembled, examined and rated (according to appropriate CRC manuals).

At the June 22, 1999 Section D02.B0.06 meeting, the Section agreed to change the reference oil, used as both the calibration and benchmark reference oil from TMC 600 to TMC 606. Since this reference oil performs differently than the previous benchmark reference oil on second ring sticking, the Section also approved the implementation of a correction factor of -2.45 merits to be applied to the benchmark reference oil (TMC 606) second ring sticking results, when run with the non-reference oil. The correction factor was adjusted from -2.45 to -1.85 at the June 2000 Section D02.B0.06 meeting.

The following are the criteria for non-reference oil approval purposes:

In the test two runs are normally made, exchanging the oils between cylinders after the 20 h run, and the means of the ratings for the non-reference and benchmark reference oils are compared. A pass may be given to the non-reference oil without making the second run if the following conditions all exist after the first run:

Piston varnish rating for the non-reference oil is equal to or better than the benchmark reference oil.

Second ring sticking merit rating for the non-reference oil are 9.0 or better.

No incidence of preignition.

Not more than one incident of plug fouling with the non-reference oil.

Exhaust port blocking for the non-reference oil is not more than 5% greater than for the benchmark reference oil.

No scuffing or other lubricant related damage.

When the cross-over run must be made, the following conditions apply:

Piston Skirt-Varnish - The mean piston varnish rating of a non-reference oil shall be not more than 0.5 point below that of the benchmark reference oil.

Ring Sticking - The mean rating of the second rings of the non-reference oil pistons shall be not more than 0.5 point below that of the benchmark reference oil.

Preignition - Any occurrence of preignition in the non-reference oil cylinder shall constitute a failure.

Spark Plug Fouling - Not more than two more occurrences per complete test (2 runs) with the non-reference oil than with the benchmark reference oil.

Exhaust Port Blocking - The percentage of the exhaust port area blocked by deposits in either run of the test shall not be more than 10% greater for the non-reference oil than for the benchmark reference oil.

Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Test Result Summary
Form 4

Lab: LAB	**EOT Date:** DTCOMP	**End Time:** EOTTIME
Engine No.: STAND	**Run Number:** ENRUN	
Reference Oil CMIR		**Cylinder:** CYLCMIR
Non Reference Oil OILCODE		**Cylinder:** CYLOILCD
Formulation / Stand Code: FORM		

Date Test	DTSTRT	**Start Time:**	STRTTIME
Stand No.:	STAND	**Test Length:**	TESTLEN

Test Information	**Cylinder 1**	**Cylinder 2**
Laboratory Oil	LABCODE1	LABCODE2
Fuel Type	FUEL1	FUEL2
Fuel / Oil Ratio	FUELRAT1	FUELRAT2

Engine Inspection		**Cylinder 1**	**Cylinder 2**
Piston Varnish	Thrust	PVTHR1	PVTHR2
	Anti-Thrust	PVATHR1	PVATHR2
	Average	AVGPV1	AVGPV2
	Ring Land	PVRNGL1	PVRNGL2
	Undercrown	PVUC1	PVUC2
Wristpin	Varnish	WPVARN1	WPVARN2
	Condition	WPCOND1	WPCOND2
	Bearing Varnish	WPBVARN1	WPBVARN2
	Bearing Condition	WPBCOND1	WPBCOND2
Cylinder Liner Varnish		CYLVARN1	CYLVARN2
Ring Sticking	Top Ring	RSTOPRG1	RSTOPRG2
	Second Ring	RS2RG1	RS2RG2
	-1.85 Correction Factor	RSCOR1	RSCOR2
Deposits	Piston Crown	PCCARB1	PCCARB2
	Cylinder Head	CHCARB1	CHCARB2
	Exhaust Port Blocking	EXHPBP1	EXHPBP2
	Exhaust Port Blocking	EXHPB1	EXHPB2
Piston Scuffing	Thrust	PSTHR1	PSTHR2
	Anti-Thrust	PSATHR1	PSATHR2
Cylinder Liner Wear		CLWR1	CLWR2
CRC Demerit Number		CRCRL1	CRCRL2

Engine Specifications		**Cylinder 1**	**Cylinder 2**
Piston Batch		PISTBAT1	PISTBAT2
Cylinder Liner Batch		CYLLBAT1	CYLLBAT2
Ring Gap Increase, in.	Top Ring	RGINTR1	RGINTR2
	Second Ring	RGIN2R1	RGIN2R2
Ring Weight Loss, mg.	Top Ring	RWLTR1	RWLTR2
	Second Ring	RWL2R1	RWL2R2

Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Ring Land Ratings
Form 5

Lab: LAB	**EOT Date:** DTCOMP	**End Time:** EOTTIME
Engine No.: STAND	**Run Number:** ENRUN	
Reference Oil CMIR		**Cylinder:** CYLCMIR
Non Reference Oil OILCODE		**Cylinder:** CYLOILCD
Formulation / Stand Code: FORM		

Ring Lands - Carbon Ratings					
Deposit Type	**Deposit Factor**	**Cylinder 1**		**Cylinder 2**	
		Area %	Demerit	Area %	Demerit
HC	1.000	HCCCARB1	HCDEM1	HCCCARB2	HCDEM2
MHC	0.750	MHCCARB1	MHCDEM1	MHCCARB2	MHCDEM2
MC	0.500	MCCARB1	MCDEM1	MCCARB2	MCDEM2
LC	0.250	LCCARB1	LCDEM1	LCCARB2	LCDEM2
VLC	0.150	VLCCARB1	VLCDEM1	VLCCARB2	VLCDEM2
Carbon Rating (demerits)		CRBDTOT1		CRBDTOT2	

Ring Lands - Lacquer Ratings					
Deposit Type	**Deposit Factor**	**Cylinder 1**		**Cylinder 2**	
		Area %	Demerit	Area %	Demerit
BL	0.100	BLVARN1	BLDEM1	BLVARN2	BLDEM2
DBRN	0.075	DBRVARN1	DBRDEM1	DBRVARN2	DBRDEM2
AL	0.050	ALVARN1	ALDEM1	ALVARN2	ALDEM2
LAL	0.025	LALVARN1	LALDEM1	LALVARN2	LALDEM2
VLAL	0.010	VLAVARN1	VLADEM1	VLAVARN2	VLADEM2
RL	0.001	RLVARN1	RLDEM1	RLVARN2	RLDEM2
Lacquer Rating		VRNDTOT1		VRNDTOT2	
Clean	0	RLCLNA1	RLCLND1	RLCLNA2	RLCLND2

Zonal Rating (demerits)	CRCRL1	CRCRL2

Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Ring Ratings
Form 6

Lab: LAB	**EOT Date:** DTCOMP	**End Time:** EOTTIME
Engine No.: STAND	**Run Number:** ENRUN	
Reference Oil CMIR		**Cylinder:** CYLCMIR
Non Reference Oil OILCODE		**Cylinder:** CYLOILCD
Formulation / Stand Code: FORM		

Cylinder Number	Ring Number	NMMA Rating	-1.85 Correction Factor [A]	Visual Rating	Adjusted Rating [B]
CYLND11	RINGNO11	NMMA11	CF11	VR11	AR11
CYLND12	RINGNO12	NMMA12	CF12	VR12	AR12
CYLND13	RINGNO13	NMMA13	CF13	VR13	AR13
CYLND21	RINGNO21	NMMA21	CF21	VR21	AR21
CYLND22	RINGNO22	NMMA22	CF22	VR22	AR22
CYLND23	RINGNO23	NMMA23	CF23	VR23	AR23

[A] *A correction factor of -1.85 merits is applied to the benchmark reference oil (TMC 606) second ring sticking results, when run with the non-reference oil.*

[B] *The adjusted ring rating is calculated by averaging the NMMA ring rating and the visual ring rating. The visual ring rating is calculated by assessing the total number of degrees the ring visually appears to be stuck in the groove. The normal NMMA ring ratings are then applied as though the ring is firmly stuck over the area, even though in most cases rings in this condition can be forced to move throught the application of varying amounts of pressure.*

Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Operational Summary
Form 7

Lab: LAB	**EOT Date:** DTCOMP	**End Time:** EOTTIME
Engine No.: STAND	**Run Number:** ENRUN	
Reference Oil CMIR		**Cylinder:** CYLCMIR
Non Reference Oil OILCODE		**Cylinder:** CYLOILCD
Formulation / Stand Code: FORM		

Parameters	**Phase I**			**Phase II**		
	Maximum	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**
Engine Speed, r/min	XRPM1	IRPM1	ARPM1	XRPM2	IRPM2	ARPM2
Dynamometer Speed, r/min	XDYNRPM1	IDYNRPM1	ADYNRPM1	XDYNRPM2	IDYNRPM2	ADYNRPM2
Observed Load, hp	XOBLOAD1	IOBLOAD1	AOBLOAD1	XOBLOAD2	IOBLOAD2	AOBLOAD2
Corrected Load, hp	XCOLOAD1	ICOLOAD1	ACOLOAD1	XCOLOAD2	ICOLOAD2	ACOLOAD2
Air / Fuel Ratio #1	XAFRAT11	IAFRAT11	AAFRAT11	XAFRAT12	IAFRAT12	AAFRAT12
Air / Fuel Ratio #2	XAFRAT21	IAFRAT21	AAFRAT21	XAFRAT22	IAFRAT22	AAFRAT22
Air Flow #1 lb / h	XAFLOW11	IAFLOW11	AAFLOW11	XAFLOW12	IAFLOW12	AAFLOW12
Air Flow #2 lb / h	XAFLOW21	IAFLOW21	AAFLOW21	XAFLOW22	IAFLOW22	AAFLOW22
Fuel Flow #1 lb / h	XFFLOW11	IFFLOW11	AFFLOW11	XFFLOW12	IFFLOW12	AFFLOW12
Fuel Flow #2 lb / h	XFFLOW21	IFFLOW21	AFFLOW21	XFFLOW22	IFFLOW22	AFFLOW22
Pressures						
Fuel Pressure #1, psi	XFUELP11	IFUELP11	AFUELP11	XFUELP12	IFUELP12	AFUELP12
Fuel Pressure #2, psi	XFUELP21	IFUELP21	AFUELP21	XFUELP22	IFUELP22	AFUELP22
Intake Air Pressure, in. H_2O	XINAIRP1	IINAIRP1	AINAIRP1	XINAIRP2	IINAIRP2	AINAIRP2
Barometric Pressure, in. Hg	XBAROP1	IBAROP1	ABAROP1	XBAROP2	IBAROP2	ABAROP2
Temperatures, $^{\circ}$ F						
Spark Plug #1	XSPKPT11	ISPKPT11	ASPKPT11	XSPKPT12	ISPKPT12	ASPKPT12
Spark Plug #2	XSPKPT21	ISPKPT21	ASPKPT21	XSPKPT22	ISPKPT22	ASPKPT22
Cylinder Liner #1	XCYLLT11	ICYLLT11	ACYLLT11	XCYLLT12	ICYLLT12	ACYLLT12
Cylinder Liner #2	XCYLLT21	ICYLLT21	ACYLLT21	XCYLLT22	ICYLLT22	ACYLLT22
Exhaust #1	XEXHT11	IEXHT11	AEXHT11	XEXHT12	IEXHT12	AEXHT12
Exhaust #2	XEXHT21	IEXHT21	AEXHT21	XEXHT22	IEXHT22	AEXHT22
Fuel #1	XFUELT11	IFUELT11	AFUELT11	XFUELT12	IFUELT12	AFUELT12
Fuel #2	XFUELT21	IFUELT21	AFUELT21	XFUELT22	IFUELT22	AFUELT22
Intake Air, Carburetor	XINAIRT1	IINAIRT1	AINAIRT1	XINAIRT2	IINAIRT2	AINAIRT2
Intake Air Dew Point	XINDWPT1	IINDWPT1	AINDWPT1	XINDWPT2	IINDWPT2	AINDWPT2
Ambient	XINAMBT1	IINAMBT1	AINAMBT1	XINAMBT2	IINAMBT2	AINAMBT2

Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Remarks and Deviations

Form 8

Lab: LAB	**EOT Date:** DTCOMP	**End Time:** EOTTIME
Engine No.: STAND	**Run Number:** ENRUN	
Reference Oil CMIR		**Cylinder:** CYLCMIR
Non Reference Oil OILCODE		**Cylinder:** CYLOILCD
Formulation / Stand Code: FORM		

Other Comments

Number of Comment TOTCOM
OCOMR001

Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Phase II Air Fuel Ratio Plots

Form 9

Lab: LAB	**EOT Date:** DTCOMP	**End Time:** EOTTIME
Engine No.: STAND	**Run Number:** ENRUN	
Reference Oil CMIR		**Cylinder:** CYLCMIR
Non Reference Oil OILCODE		**Cylinder:** CYLOILCD
Formulation / Stand Code: FORM		

AFRATIM

Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Phase II Spark Plug Plots
Form 10

Lab: LAB	**EOT Date:** DTCOMP	**End Time:** EOTTIME
Engine No.:	**Run Number:**	
Reference Oil CMIR		**Cylinder:** CYLCMIR
Non Reference Oil OILCODE		**Cylinder:** CYLOILCD
Formulation / Stand Code: FORM		

SPKPTIM

Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Test Fuel Analysis (Last Batch)

Form 11

Lab: LAB	**EOT Date:** DTCOMP	**End Time:** EOTTIME
Engine No.: STAND	**Run Number:** ENRUN	
Reference Oil CMIR		**Cylinder:** CYLCMIR
Non Reference Oil OILCODE		**Cylinder:** CYLOILCD
Formulation / Stand Code: FORM		
Supplier: FUELSUP	**Batch Identifies:** FUELBTID	

Measurement	Specs.	Analysis	Test Method
Gravity, ˚API		APIGRNEW	
Color		FUELCOL	
Doctor Test		FUELDRT	
Copper Corrosion, 3h @ 212 ˚F	1 Maximum	FUELCU	D 130
Reid Vapor Pressure, psig		FUELREID	
Research Octane Number		ROCTANEN	
Motor Octane Number		MOCTANEN	
Research + Motor / 2		RMOTOR2	
Total Sulfur, % Weight	0.04 - 0.05	FUELSNEW	D 2622
Gum, mg/100 mL		FUELGUM	
Oxidation Stability, min		FUELOXS	
Lead, g/gal		FUELPB	
Distillation, ˚C			
IBP	Report	FUELIBP	D 86
10%	Report	FUEL10	D 86
50%	Report	FUEL50	D 86
90%	282 - 338	FUEL90	D 86
EP	Report	FUELEP	D 86
Recovery, %		FUELRECO	
Pona, % vol			
Paraffins + Napthenes		FUELPN	
Olefin	Report	FUELOLEF	D 1319
Aromatics % Vol.	28 - 33	FUELAROM	D 1319