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

Form 1

Version 20021108

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:** CYLROCDE	
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.: ENGINE	**Run Number:** ENRUN	
Reference Oil CMIR		**Cylinder:** CYLROCDE
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.: ENGINE	**Run Number:** ENRUN	
Reference Oil : CMIR	**Industry Oil Code:** IND	**Cylinder:** CYLROCDE
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 Number	CYLROCDE	CYLOILCD
Laboratory Oil	RLABCODE	LABOCODE
Fuel Type	RFUEL	FUEL
Fuel / Oil Ratio	RFUELRAT	FUELRAT

Engine Inspection			
Cylinder Number		CYLROCDE	CYLOILCD
Piston Varnish	Thrust	RPVTHR	PVTHR
	Anti-Thrust	RPVATHR	PVATHR
	Average	RAVGPV	AVGPV
	Ring Land	RPVRNGL	PVRNGL
	Undercrown	RPVUC	PVUC
Wristpin	Varnish	RWPVARN	WPVARN
	Condition	RWPCOND	WPCOND
	Bearing Varnish	RWPBVARN	WPBVARN
	Bearing Condition	RWPBCOND	WPBCOND
Cylinder Liner Varnish		RCYLVARN	CYLVARN
Ring Sticking	Top Ring	RRSTOPRG	RSTOPRG
	Second Ring	RRS2RG	RS2RG
	-2.45 Correction Factor	RRSCOR	RSCOR
Deposits	Piston Crown	RPCCARB	PCCARB
	Cylinder Head	RCHCARB	CHCARB
	Exhaust Port Blocking %	REXHPBP	EXHPBP
Piston Scuffing	Thrust	RPSTHR	PSTHR
	Anti-Thrust	RPSATHR	PSATHR
Cylinder Liner Wear		RCLWR	CLWR
CRC Demerit Number	Ring Land	RCRCRL	CRCRL

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.: ENGINE	**Run Number:** ENRUN	
Reference Oil : CMIR	**Industry Oil Code:** IND	**Cylinder:** CYLROCDE
Non Reference Oil: OILCODE		**Cylinder:** CYLOILCD
Formulation / Stand Code: FORM		

Ring Lands - Carbon Ratings					
Cylinder Number		CYLROCDE		CYLOILCD	
Deposit Type	**Deposit Factor**	Area %	Demerit	Area %	Demerit
HC	1.000	RHCCCARB	RHCDEM	HCCCARB	HCDEM
MHC	0.750	RMHCCARB	RMHCDEM	MHCCARB	MHCDEM
MC	0.500	RMCCARB	RMCDEM	MCCARB	MCDEM
LC	0.250	RLCCARB	RLCDEM	LCCARB	LCDEM
VLC	0.150	RVLCCARB	RVLCDEM	VLCCARB	VLCDEM
Carbon Rating (demerits)		RCRBDTOT		CRBDTOT	

Ring Lands - Lacquer Ratings					
Cylinder Number		CYLROCDE		CYLOILCD	
Deposit Type	**Deposit Factor**	Area %	Demerit	Area %	Demerit
BL	0.100	RBLVARN	RBLDEM	BLVARN	BLDEM
DBRN	0.075	RDBRVARN	RDBRDEM	DBRVARN	DBRDEM
AL	0.050	RALVARN	RALDEM	ALVARN	ALDEM
LAL	0.025	RLALVARN	RLALDEM	LALVARN	LALDEM
VLAL	0.010	RVLAVARN	RVLADEM	VLAVARN	VLADEM
RL	0.001	RRLVARN	RRLDEM	RLVARN	RLDEM
Lacquer Rating		RVRNDTOT		VRNDTOT	
Clean	0	RRLCLNA	RRLCLND	RLCLNA	RLCLND

Zonal Rating (demerits)	RCRCRL	CRCRL

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.: ENGINE	**Run Number:** ENRUN	
Reference Oil : CMIR	**Industry Oil Code:** IND	**Cylinder:** CYLROCDE
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]
RCYLND1	RRINGNO1	RNMMA1	RCF1	RVR1	RAR1
RCYLND2	RRINGNO2	RNMMA2	RCF2	RVR2	RAR2
RCYLND3	RRINGNO3	RNMMA3	RCF3	RVR3	RAR3
CYLND1	RINGNO1	NMMA1	CF1	VR1	AR1
CYLND2	RINGNO2	NMMA2	CF2	VR2	AR2
CYLND3	RINGNO3	NMMA3	CF3	VR3	AR3

[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.: ENGINE	**Run Number:** ENRUN		
Reference Oil : CMIR	**Industry Oil Code:** IND	**Cylinder:** CYLROCIDE	
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 - Baseline	RXAFRAT1	RIAFRAT1	RAAFRAT1	RXAFRAT2	RIAFRAT2	RAAFRAT2
Air / Fuel Ratio - Test Oil	XAFRAT1	IAFRAT1	AAFRAT1	XAFRAT2	IAFRAT2	AAFRAT2
Air Flow lb / h - Baseline	RXAFLOW1	RIAFLOW1	RAAFLOW1	RXAFLOW2	RIAFLOW2	RAAFLOW2
Air Flow lb / h - Test Oil	XAFLOW1	IAFLOW1	AAFLOW1	XAFLOW2	IAFLOW2	AAFLOW2
Fuel Flow lb / h - Baseline	RXFFLOW1	RIFFLOW1	RAFFLOW1	RXFFLOW2	RIFFLOW2	RAFFLOW2
Fuel Flow lb / h - Test Oil	XFFLOW1	IFFLOW1	AFFLOW1	XFFLOW2	IFFLOW2	AFFLOW2
Pressures						
Fuel Pressure, psi - Baseline	RXFUELP1	RIFUELP1	RAFUELP1	RXFUELP2	RIFUELP2	RAFUELP2
Fuel Pressure, psi - Test Oil	XFUELP1	IFUELP1	AFUELP1	XFUELP2	IFUELP2	AFUELP2
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 - Baseline	RXSPKPT1	RISPKPT1	RASPKPT1	RXSPKPT2	RISPKPT2	RASPKPT2
Spark Plug - Test Oil	XSPKPT1	ISPKPT1	ASPKPT1	XSPKPT2	ISPKPT2	ASPKPT2
Cylinder Liner - Baseline	RXCYLLT1	RICYLLT1	RACYLLT1	RXCYLLT2	RICYLLT2	RACYLLT2
Cylinder Liner- Test Oil	XCYLLT1	ICYLLT1	ACYLLT1	XCYLLT2	ICYLLT2	ACYLLT2
Exhaust - Baseline	RXEXHT1	RIEXHT1	RAEXHT1	RXEXHT2	RIEXHT2	RAEXHT2
Exhaust - Test Oil	XEXHT1	IEXHT1	AEXHT1	XEXHT2	IEXHT2	AEXHT2
Fuel - Baseline	RXFUELT1	RIFUELT1	RAFUELT1	RXFUELT2	RIFUELT2	RAFUELT2
Fuel - Test Oil	XFUELT1	IFUELT1	AFUELT1	XFUELT2	IFUELT2	AFUELT2
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.: ENGINE	**Run Number:** ENRUN	
Reference Oil : CMIR	**Industry Oil Code:** IND	**Cylinder:** CYLROCDE
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.: ENGINE	**Run Number:** ENRUN			
Reference Oil : CMIR	**Industry Oil Code:** IND	**Cylinder:** CYLROCDE		
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.: ENGINE	**Run Number:** ENRUN		
Reference Oil : CMIR	**Industry Oil Code:** IND	**Cylinder:** CYLROCDE	
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.: ENGINE	**Run Number:** ENRUN	
Reference Oil : CMIR	**Industry Oil Code:** IND	**Cylinder:** CYLROCIDE
Non Reference Oil: OILCODE		**Cylinder:** CYLOILCD
Formulation / Stand Code: FORM		
Supplier : FUELSUP	**Batch Identifier:** 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