Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Title / Validity Declaration Page
Form 1

Version 20020830

Conducted

	I = Invalid
	V =Valid

	RO = Reference Oil Test
	NR = All Other Test

Test Number			
Engine No.:		**Engine Run**	
EOT Time:		**EOT Date:**	
Reference Oil			**CYLINDER:**
Non Reference Oil			**CYLINDER:**
Formulation/Stand			
Alternate Codes:			

In my opinion this test _____ 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: _____
Testing Laboratory

_____
Signature

_____
Typed Name

_____
Title

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

Lab:	**EOT Date:**	**End Time:**
Engine No.:	**Run Number:**	
Reference Oil		**Cylinder:**
Non Reference Oil		**Cylinder:**
Formulation / Stand Code:		

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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
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Test Result Summary
Form 4

Lab:	**EOT Date:**	**End Time:**
Engine No.:	**Run Number:**	
Reference Oil :	**Industry Oil Code:**	**Cylinder:**
Non Reference Oil:		**Cylinder:**
Formulation / Stand Code:		

Date Test	**Start Time:**
Stand No.:	**Test Length:**

Test Information		
Cylinder Number		
Laboratory Oil		
Fuel Type		
Fuel / Oil Ratio		

Engine Inspection			
Cylinder Number			
Piston Varnish	Thrust		
	Anti-Thrust		
	Average		
	Ring Land		
	Undercrown		
Wristpin	Varnish		
	Condition		
	Bearing Varnish		
	Bearing Condition		
Cylinder Liner Varnish			
Ring Sticking	Top Ring		
	Second Ring		
	-2.45 Correction Factor		
Deposits	Piston Crown		
	Cylinder Head		
	Exhaust Port Blocking %		
	Exhaust Port Blocking		
Piston Scuffing	Thrust		
	Anti-Thrust		
Cylinder Liner Wear			
CRC Demerit Number	Ring Land		

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

Lab:	**EOT Date:**	**End Time:**
Engine No.:	**Run Number:**	
Reference Oil :	**Industry Oil Code:**	**Cylinder:**
Non Reference Oil:		**Cylinder:**
Formulation / Stand Code:		

Ring Lands - Carbon Ratings					
Cylinder Number					
Deposit Type	**Deposit Factor**	Area %	Demerit	Area %	Demerit
HC	1.000				
MHC	0.750				
MC	0.500				
LC	0.250				
VLC	0.150				
Carbon Rating (demerits)					

Ring Lands - Lacquer Ratings					
Cylinder Number					
Deposit Type	**Deposit Factor**	Area %	Demerit	Area %	Demerit
BL	0.100				
DBRN	0.075				
AL	0.050				
LAL	0.025				
VLAL	0.010				
RL	0.001				
Lacquer Rating					
Clean	0				

Zonal Rating (demerits)		

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

Lab:	**EOT Date:**	**End Time:**
Engine No.:	**Run Number:**	
Reference Oil :	**Industry Oil Code:**	**Cylinder:**
Non Reference Oil:		**Cylinder:**
Formulation / Stand Code:		

Cylinder Number	Ring Number	NMMA Rating	-1.85 Correction Factor [A]	Visual Rating	Adjusted Rating [B]

[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:	**EOT Date:**	**End Time:**
Engine No.:	**Run Number:**	
Reference Oil :	**Industry Oil Code:**	**Cylinder:**
Non Reference Oil:		**Cylinder:**
Formulation / Stand Code:		

Parameters	**Phase I**			**Phase II**		
	Maximum	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**
Engine Speed, r/min						
Dynamometer Speed, r/min						
Observed Load, hp						
Corrected Load, hp						
Air / Fuel Ratio - Baseline						
Air / Fuel Ratio - Test Oil						
Air Flow lb / h - Baseline						
Air Flow lb / h - Test Oil						
Fuel Flow lb / h - Baseline						
Fuel Flow lb / h - Test Oil						
Pressures						
Fuel Pressure, psi - Baseline						
Fuel Pressure, psi - Test Oil						
Intake Air Pressure, in. H_2O						
Barometric Pressure, in. Hg						
Temperatures, ° F						
Spark Plug - Baseline						
Spark Plug - Test Oil						
Cylinder Liner - Baseline						
Cylinder Liner- Test Oil						
Exhaust - Baseline						
Exhaust - Test Oil						
Fuel - Baseline						
Fuel - Test Oil						
Intake Air, Carburetor						
Intake Air Dew Point						
Ambient						

Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Remarks and Deviations
Form 8

Lab:	**EOT Date:**	**End Time:**
Engine No.:	**Run Number:**	
Reference Oil :	**Industry Oil Code:**	**Cylinder:**
Non Reference Oil:		**Cylinder:**
Formulation / Stand Code:		

Other Comments
Number of Comment

Two-Stroke-Cycle Gasoline Engine Lubricant Evaluation
D4857 (Y350M2) ASTM TC Sequence I Test Procedure
Phase II Air Fuel Ratio Plots
Form 9

Lab:	**EOT Date:**	**End Time:**
Engine No.:	**Run Number:**	
Reference Oil :	**Industry Oil Code:**	**Cylinder:**
Non Reference Oil:		**Cylinder:**
Formulation / Stand Code:		

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

Lab:	**EOT Date:**	**End Time:**
Engine No.:	**Run Number:**	
Reference Oil :	**Industry Oil Code:**	**Cylinder:**
Non Reference Oil:		**Cylinder:**
Formulation / Stand Code:		

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

Form 11

Lab:	**EOT Date:**	**End Time:**
Engine No.:	**Run Number:**	
Reference Oil :	**Industry Oil Code:**	**Cylinder:**
Non Reference Oil:		**Cylinder:**
Formulation / Stand Code:		
Supplier :	**Batch Identifier:**	

Measurement	Specs.	Analysis	Test Method
Gravity, ˚API			
Color			
Doctor Test			
Copper Corrosion, 3h @ 212 ˚F	1 Maximum		D 130
Reid Vapor Pressure, psig			
Research Octane Number			
Motor Octane Number			
(Research + Motor) / 2			
Total Sulfur, % Weight	0.04 - 0.05		D 2622
Gum, mg/100 mL			
Oxidation Stability, min			
Lead, g/gal			
Distillation, ˚C			
IBP	Report		D 86
10%	Report		D 86
50%	Report		D 86
90%	282 - 338		D 86
EP	Report		D 86
Recovery, %			
Pona, % vol			
Paraffins + Napthenes			
Olefin	Report		D 1319
Aromatics % Vol.	28 - 33		D 1319