

1. Scope

This document describes a set of technical requirements for an alternative service fill ATF to the Toyota Genuine ATF WS. Any product prepared on the basis of the following information as well as any repair or maintenance operation undertaken by any user on the basis of the following technical information is performed under the sole responsibility of its user. Toyota cannot be held liable for any bodily injury, damage to property, loss, expenses or any other damage, or any infringement to any laws or regulations, as a result of such product development or repair or maintenance operation.

2. Requirements

Table 1 shows physical and chemical requirements.

Table 2 shows performance requirements by laboratory test equipment. The ATF developer needs to consult with Toyota to prepare these standard fluid and test pieces (shown in the section 5 in the page 9). In order to consult with Toyota for these tests, the candidate product must meet all requirements shown in the Table 1.

Table 3 shows vehicle test requirements for the confirmation of the ATF practicality. The ATF developer needs to consult with Toyota for test details. In order to consult with Toyota for this test, the candidate product must meet all requirements shown in Table 1 and Table 2.

3. Approval

Toyota does not provide any approval to the product. The developer and the supplier of the alternative ATF product is responsible for meeting all technical requirements and ensuring the performance and the quality in the field.

Table 1. Physical and Chemical Properties

Item	Unit	Requirements	Test Procedure	
Appearance	---	Bright & Clear		
Color	---	Red		
ASTM Color	---	6.0 ~ 7.0	ASTM D1500	
Flash Point	°C	175 min	ASTM D92	
Density	g/cm ³	To be reported	ASTM D1298, D4052	
Kinematic Viscosity	100°C	mm ² /s	5.2 ~ 5.6	ASTM D445, D446
	40°C	mm ² /s	24.5 max	ASTM D445, D446
Base Oil Viscosity (100°C)	mm ² /s	To be reported	ASTM D445, D446	
Viscosity Index	---	To be reported	ASTM D2270	
Low Temperature Viscosity	-20°C	Pa-s	1.0 max	ASTM D2983
	-30°C	Pa-s	3 max	ASTM D2983
	-40°C	Pa-s	6 ~ 12	ASTM D2983
Pour Point	°C	-40 max	ASTM D97, D5950	
Aniline Point	°C	To be reported	ASTM D611	
NOACK Volatility (150°C x 2hrs)	mass%	7 max	ASTM D5800 modified	
Acid Number	mgKOH/g	To be reported	ASTM D664	
Base Number	mgKOH/g	To be reported	ASTM D4739	
Base Number	mgKOH/g	To be reported	ASTM D2896	
Elemental Analysis	Ca, Mg, Zn, B	mass%	To be reported	ASTM D4951
	P	mass%	To be reported	ASTM D1091, D4951
	N	mass%	To be reported	ASTM D5762, JIS K 2609
	S	mass%	To be reported	ASTM D3120, D5453
	Cl	mass%	Shall not be detected	ASTM D808
	Pb	mass%	Shall not be detected	ASTM D5185
	Si, and others	mass%	To be reported	ASTM D5185
Water Content after Production	mass ppm	300 max	ASTM D6304	
Insoluble Contamination	mg/100ml	0.5 max	ASTM D4898 with 10 microns filter	
Infrared Spectrum	---	To be reported	ASTM E334	

To be reported : This means “report only” item.

No specific criteria is set, but it has to be reported as reference information.

Table 2-a. Laboratory Test Requirements (1/3)

Item		Unit	Requirements	Test Procedure
Shear Stability	KV100 after Shear	mm ² /s	≥ Standard Fluid 1	100hrs with CEC L-45-A-99
	KV100 Loss	%	To be reported	
Copper Strip Test (150°C x 3hrs)		---	1 max	ASTM D130
Copper Corrosion Test		mass ppm	100 max	Inhouse Refer to 4.1
Forming Tendency and Stability Test	Sequence I	ml / ml	30 / 0 max	ASTM D892
	Sequence II	ml / ml	50 / 0 max	ASTM D892
	Sequence III	ml / ml	30 / 0 max	ASTM D892
	Sequence IV	ml / ml	120 / 50 max	ASTM D6082
Rust Prevention Test (60°C x 24hrs, distilled water)			No rust	ASTM D665 modified
Miscibility Test			No haziness, sediment, separation, or discoloration	Inhouse Refer to 4.2
Elastomer Compatibility	A305 Nitrile Rubber (120°C x 70hrs) Volume Change Hardness Change Elongation Rupture Change Tensile Strength Change Appearance (70 and 560hrs)	vol% points % %	0 ~ +5 -5 ~ +5 -30 ~ +10 -30 ~ +10 No crazing, no surface roughness	ASTM D471 modified Test for 560hrs must be run additionally to check the appearance of elastomer.
	T599 Acrylic Rubber (150°C x 70hrs) Volume Change Hardness Change Elongation Rupture Change Tensile Strength Change Appearance (70 and 560hrs)	vol% points % %	0 ~ +8 -5 ~ +5 -20 ~ +20 -15 ~ +10 No crazing, no surface roughness	ASTM D471 modified Test for 560hrs must be run additionally to check the appearance of elastomer.
Compatibility with Plastic Material Tensile Strength Retention		%	70 min	JASO M 350 (150°C x 500hrs)
Friction Coefficient between Metals			0.10 ~ 0.13	ASTM D2714 modified Refer to 4.3
4-Ball Wear Test		mm	≤ Standard Fluid 1	ASTM D4172 modified Refer to 4.4

To be reported : This means “report only” item.

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Table 2-b. Laboratory Test Requirements (2/3)

Item		Unit	Requirements	Test Procedure
4-Ball Extreme Pressure Test	Last Non-Seizure Load (LNL)	N	≥ Standard Fluid 1	ASTM D2783
	Welding Load (WL)	N	≥ Standard Fluid 1	ASTM D2783
Bearing Fatigue Life Test (Unisteel Bearing Tester)		cycles	≥ Standard Fluid 1	IP305 modified Refer to 4.5
ABOT (Aluminum Beaker Oxidation Test)	Hours until TAN reaches 6	hours	≥ Standard Fluid 1	Mercon® V 155°C x 792hrs Interim Inspections @ 576, 648, and 720hrs (10ml sampling for TAN analysis, no top-up)
ISOT (Indiana Stirring Oxidation Stability Test)	Viscosity Ratio @ 40°C	mm ² /s	1.6 max	JIS K2514 modified 165.5°C x 150hrs (Base Number : ASTM D4739)
	Increase in Acid Number	mgKOH/g	2.0 max	
	Base Number	mgKOH/g	To be reported	
	Strong Acid Number	mgKOH/g	To be reported	
	Lacquer Rating		None	

To be reported : This means “report only” item.

No specific criteria is set, but it has to be reported as reference information.

Table 2-c. Laboratory Test Requirements (3/3)

Item		Unit	Requirements	Test Procedure	
SAE No.2 Test	Friction Properties (Average of 3 test runs for each fluid)	μd		Standard Fluid 1 +/- 0.005	JASO M 348 modified Friction Plate = C-04FS All friction plates must be from the same production batch. Compare the results between 200 and 5,000 cycles.
		μs		Standard Fluid 1 +/- 0.005	
		μt		Standard Fluid 1 +/- 0.005	
		$\mu 0 / \mu d$		Standard Fluid 1 +/- 0.05	
		μi		Standard Fluid 1 +/- 0.005	
	Friction Plate (Max in all 3 runs)	Wear	mm / Plate	0.04 max	
		Discoloration		No blackening	
		Scraping and Separation		Shall not occur	
	Separator Plate (Max in all 3 runs)	Wear	mm / Plate	0.02 max	
		Discoloration		No blackening	
LVFA Test (Average of 3 test runs for each fluid)	Initial $d\mu / dV$		s / m	To be reported	JASO M 349 modified Test Pressure = 1.0MPa Friction Plate = NW193 All friction plates must be from the same production batch. $d\mu / dV$ measurement must be conducted at every 24 hours.
	Durability *1		hours	\geq Standard Fluid 1	
	Low Speed Friction Coefficient			\geq Standard Fluid 1	

*1 : When one of following conditions at 24hours or later is met, the test is terminated. Hours to the one previous inspection is recorded as duration of durability.

- $d\mu / dV$ (0.3) @ 40°C \leq - 2.5
- $d\mu / dV$ (0.9) @ 40°C \leq - 2.5
- $d\mu / dV$ (0.3) @ 80°C \leq - 2.5
- $d\mu / dV$ (0.9) @ 80°C \leq - 2.5
- $d\mu / dV$ (0.3) @ 120°C \leq - 2.5
- $d\mu / dV$ (0.9) @ 120°C \leq - 2.5

To be reported : This means “report only” item.

No specific criteria is set, but it has to be reported as reference information.

Table 3. Vehicle Tests for the Confirmation of Practicality

Item	Unit	Requirements	Test Procedure
Number of Test Vehicles per Fluid		3	
Vehicle Model Selection		Shall be equipped with representative AT unit	Consult with Toyota
Duration	km	200,000	
Test Route		Shall represent the market condition	Consult with Toyota
Inspection (noise and vibration)		Check if there is any noise and vibration from the AT Unit	Inspect during the whole test route at the start, 50,000km, 100,000km, 150,000km, and 200,000km Consult with Toyota for Inspection Details
Inspection (fluid analysis) KV100 KV40 VI TAN TBN (D4739) Pentane-B Insoluble (30,000G) Cu Content	mm ² /s mm ² /s mgKOH/g mgKOH/g mass% mass ppm	Equal to or better than Standard Fluid 1	0km, 50,000km, 100,000km, 150,000km, and 200,000km

4. Inhouse Test Procedures

4.1. Copper Corrosion Test

- (1) Prepare 10mm long copper wires by stripping AWG18-0.75SQ (0.18mm x 30) wire.
- (2) Place 5.0+/-0.1g of stripped wires in 200ml glass beaker.
- (3) Pour 50+/-1g of test fluid into the beaker.
- (4) Place the beaker in turntable type thermostatic chamber at 120°C for 96 hours. Rotate the turntable at 4r/min.
- (5) Sample the supernatant fluid and analyze copper content by ASTM D4951.

4.2. Miscibility Test

- (1) Mix 50ml of test fluid and 50ml of Standard Fluid 1 in 200ml beaker well.
- (2) Place the beaker at 120°C for 24 hours.
- (3) Place the beaker at -10°C for 168 hours.
- (4) Place the beaker until room temperature (20+/-5°C).
- (5) Check haziness, sediment, separation, and discoloration.

4.3. Friction Coefficient between Metals - FALEX Block on Ring Test

- (1) Conduct the test under the conditions shown in Table 4.

Table 4.

Item		Unit	Condition
Test Specimens	Block		H-60
	Ring		S-10
Break-in Conditions	Load	N	890
	Revolution Speed	r/min	548
	Fluid Temperature	°C	100
	Duration	Min	20
Test Conditions	Load	N	890
	Revolution Speed	r/min	438 → 274 → 137 → 68 → 41 → 14
	Fluid Temperature	°C	70, 100, 140
	Duration	min	3 at each speed
Measurement			Friction Coefficient at each Condition

4.4. Four-Ball Wear Test

(1) Conduct the test under the conditions shown in Table 5.

Table 5.

Item	Unit	Condition
Load	N	392
Revolution Speed	r/min	1800
Fluid Temperature	°C	80
Duration	min	30
Measurement of Wear	mm	Wear Scar Diameter

4.5. Bearing Fatigue Life Test

(1) Conduct the tests under the conditions shown in Table 6.

Table 6.

Item	Unit	Condition
Test Equipment		Unisteel Bearing Tester
Test Bearing		NSK No.51110 All bearings must be from the same production batch.
Preparation of Bearings		Remove 18 balls and leave 6 balls even pitch.
Bearing Ball in the Test		6
Revolution Speed of Bearing Race	r/min	1500
Load	kN	3.34
Vibration Detection Acceleration Limit	m/s ²	78.4
Fluid Temperature		No control
Fluid Supply		1 droplet per 30 sec
Number of Tests for the Weibull Analysis		11
Report Items		L10 and L50 with the Weibull Plot

5. Reference Materials

Please consult with Toyota for Reference Materials.

5.1. Standard Fluid 1

Toyota Genuine ATF WS (JWS3324)

5.2. Nitrile Rubber for Elastomer Compatibility

A305

5.3. Acrylic Rubber for Elastomer Compatibility

T599

5.4. Material Code of Friction Plate for SAE No.2 Test

C-04FS

5.5. Material Code of Friction Plate for LVFA Test

NW193