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Test Monitoring Center

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D4485 Information Letter 24-1
Sequence Number 16
March 25, 2024

ASTM consensus has not been obtained on this information letter. An appropriate ASTM ballot will be issued in order to achieve such consensus.

TO: D4485 Mailing List

SUBJECT: New EOEC Specification Limits using Reference Oil SL107.

At the June 29, 2022, meeting of the Heavy Duty Engine Oil Classification Panel, the Panel reviewed the successful letter ballot of the following revision to Standard D4485:

The current EOEC variable specification limits, using reference oil 1006, will be replaced by new variable specification limits using reference oil SL107. Revised versions of Tables 3, 4, & 5, along with a revised version of Annex A5, are attached.

The text of the revisions is shown in the attachment. These changes are effective with the approval of this information letter via ASTM ballot at Subcommittee B.

Joe Franklin
Chairman
ASTM Subcommittee B

Jeffrey A. Clark
Executive Director
Test Monitoring Center

Attachment
c: https://www.astmtmc.org/ftp/docs/d4485/procedure_and_ils/il24-1_D4485.pdf
Distribution: Email

TABLE 3 Diesel Engine Oil Category CI-4

Required Test Method	Engine Test Method	Rated or Measured Parameter		Primary Performance Criteria		
				One-test	Two-test[A]	Three-test[A]
1R (D6923) or 1P (D6681)	D6923	Weighted demerits (WDR), max		382	396	402
		Top groove carbon (TGC), demerits, max		52	57	59
		Top land carbon (TLC), demerits, max		31	35	36
		Initial oil consumption (IOC), (0 h – 252 h), g/h, average		13.1	13.1	13.1
		Final oil consumption,(432 h – 504 h), g/h, average, max		IOC + 1.8	IOC + 1.8	IOC + 1.8
		Piston, ring, and liner distress		none	none	none
		Ring sticking		none	none	none
	D6681	Weighted demerits (WDP), max		350	378	390
		Top groove carbon (TGC), demerits, max		36	39	41
		Top land carbon (TLC), demerits, max		40	46	49
		Average oil consumption, g/h (0 h – 360 h), max		12.4	12.4	12.4
		Final oil consumption, g/h (312 h – 360 h), max		14.6	14.6	14.6
		Piston, ring, and liner scuffing		none	none	none
T-10 (D6987/D6987M) or T-12 (D7422)	D6987/D6987M	Merit rating,[A] min		1000	1000	1000
	D7422	Merit rating,[A] min		1000	1000	1000
M11 EGR (D6975) or ISM (D7468)	D6975	Average crosshead mass. loss, mg, max		20.0	21.8	22.6
		Average top ring mass loss, mg		report	report	report
		Oil filter differential pressure at 250 h, kPa, max		275	320	341
		Average engine sludge, CRC merits at EOT, min		7.8	7.6	7.5
	D7468	Crosshead wear, mg, max		7.5	7.8	7.9
		Oil filter Δ pressure at 150 h, kPa, max		55	67	74
		Sludge rating, CRC Merits, min		8.1	8.0	8.0
Ext. T-8E (D5967)[B]	D5967	Relative viscosity at 4.8 % soot[C]		1.8	1.9	2.0
Sequence IIIF (D6984)[D] or Sequence IIIG (D7320)[E] or Sequence IIIH (D8111) or Sequence IIIH70 (D8111 using Appendix X5)	D6984	Kinematic viscosity (at 40 °C), percent increase, max		275	275 (MTAC)	275 (MTAC)
	D7320	Kinematic viscosity, percent increase at 40 °C max		150	150 (MTAC)	150 (MTAC)
	D8111	60 – 80 h[F] Kinematic viscosity, % increase at 40 °C max		370	370 (MTAC)	370 (MTAC)
	D8111 (Using IIIH70 Appendix X5 guideline)	70 h Kinematic viscosity, % increase at 40 °C max		181	181 (MTAC)	181 (MTAC)
1K (D6750)[G]	D6750	Weighted demerits (WDK), max		332	347	353
		Top groove fill (TGF), %, max		24	27	29
		Top land heavy carbon (TLHC), %, max		4	5	5
		Average oil consumption	g/kWh (0 h – 252 h), max	0.54	0.54	0.54
			g/MJ (0 h – 252 h), max	0.15	0.15	0.15
		Piston, ring, and liner scuffing		none	none	none
RFWT (D5966)	D5966	Average pin wear	mils, max	0.30	0.33	0.36
			µm, max	7.6	8.4	9.1
EOAT (D6894)[H]	D6894	Aeration, volume percent, max		8.0	8.0 (MTAC)[I]	8.0 (MTAC)[I]

CI-4 Bench Tests	Measured Parameter	Primary Performance Criteria
D4683 or D4741 or D5481[J]	High temperature/high shear viscosity at 150 °C[K], min	3.5 mPa-s
MRV-TP-1 (D4684)	The following limits are applied to SAE viscosity grades 0W, 5W, 10W, and 15W: Viscosity of 75 h used oil sample from T-10 test (or T-10A[L] test), or 100 h used oil sample from T-12 test (or T-12A[M] test, tested at –20 °C, mPa-s, max	25 000
	If yield stress is detected, use modified D4684[N] (external preheat), then mPa-s, max	25 000
	and yield stress, Pa	<35
Noack (D5800)	Evaporative loss at 250 °C, %, max	15

135 °C HTCBT (D6594)	Copper, mg/kg increase, max	20	
	Lead, mg/kg increase, max	120	
	Tin, mg/kg increase	report	
	Copper strip rating,[O] max	3	
D6278 or D7109 30 Cycles	Kinematic viscosity after shearing mm²/s at 100 °C, min	SAE XW-30	SAE XW-40
		9.3	12.5
D892 (Option A not allowed)	Foaming/settling,[P] mL, max		
	Sequence I	10/0	
	Sequence II	20/0	
	Sequence III	10/0	

D7216 (Elastomer Compatibility)

Note—These are the *unadjusted specification limits* for elastomer compatibility. Candidate oils shall, however, conform to the *adjusted specification limits*, the calculation of which is described in Annex A5.

Elastomer	Volume Change, %	Hardness Change, Points	Tensile Strength Change, %	Elongation at Break Change, %
Nitrile (NBR)	(+5, -3)	(+7, -5)	(+10, -SL107-30)	(+10, -SL107-17)
Silicone (VMQ)	(+SL107, -3)	(+5, -SL107)	(+10, -45)	(+20, -30)
Polyacrylate (ACM)	(+5, -3)	(+8, -5)	(+18, -15)	(+10, -35)
Fluoroelastomer (FKM)	(+5, -2)	(+7, -5)	(+10, -SL107+2)	(+10, -SL107)

Note—TMC SL107 is the designation for the reference oil used in this test method. This designation represents the original blend or subsequent approved re-blends of TMC SL107.

[A] See Annex A4 for additional information.

[B] A passing T-11 (TGA % soot at 12.0 mm²/s increase, at 100 °C, min)—6.00 (first test), 5.89 (second test), and 5.85 (third test)—can be used in place of a T-8E in the applicable categories. This is not intended to indicate equivalence.

[C] Relative Viscosity (RV) = viscosity at 4.8 % soot/viscosity of new oil sheared in Test Method D6278.

[D] Refer to RR:D02-1391.

[E] The Sequence IIIG limits shown are more restrictive than the corresponding limits in Sequence IIIF, and are not intended to indicate equivalence. Results meeting the Sequence IIIG criteria stated can be used in lieu of Sequence IIIF.

[F] 60 – 80 h value is interpolated according to the equation $$\mathrm{PVIS@(60-80)h} = \left(\frac{\sqrt{\mathrm{PVIS@60\,h}} + \sqrt{\mathrm{PVIS@80\,h}}}{2} \right)^2$$, where PVIS@60 h is percent viscosity increase at 60 h and PVIS@80 h is percent viscosity increase at 80 h.

[G] Refer to RR:D02-1273. Alternatively, Test Method D6750 (1N) can be used; if this test method is used, the measured parameters and primary performance criteria are the same as those shown for Test Method D6750 (1N) in the CJ-4 category.

[H] Refer to RR:D02-1379.

[I] See Annex A2; use method without transformations.

[J] Tests as allowed in SAE J300.

[K] Noncritical specification as defined by Practice D3244; may be superseded only by applicable higher limits set by SAE J300.

[L] The T-10A test is the name given to a T-10 test run for 75 h to generate the sample for measurement by Test Method D4684.

[M] The T-12A test is the name given to a T-12 test run for 100 h to generate the sample for measurement by Test Method D4684.

[N] Refer to RR:D02-1517.

[O] The rating system in Test Method D130 is used to rate the copper coupon in Test Method D6594.

[P] Ten minutes for Sequence I, II, and III.

TABLE 4 Diesel Engine Oil Category CJ-4

Required Test Method	Engine Test Method	Rated or Measured Parameter		Primary Performance Criteria		
				One-test	Two-test	Three-test
T-12 (D7422)	D7422	Merit rating,[A] min		1000	1000	1000
ISM (D7468)	D7468	Merit rating,[A] min		1000	1000	1000
		Top ring mass loss, mg, max		100	100	100
C13 (D7549)	D7549	Merit rating,[A] min		1000	1000	1000
		Hot-stuck piston ring		none	none	none
T-11 (D7156)	D7156	TGA % Soot at 4.0 mm^2/s increase, at 100 °C, min		3.5	3.4	3.3
		TGA % Soot at 12.0 mm^2/s increase, at 100 °C, min		6.0	5.9	5.9
		TGA % Soot at 15.0 mm^2/s increase, at 100 °C, min		6.7	6.6	6.5
ISB (D7484)	D7484	Slider tappet mass loss, mg, average, max		100	108	112
		Cam lobe wear, µm, average, max		55	59	61
		Crosshead mass loss, mg, average		report	report	report
1N (D6750)	D6750	Weighted demerits (WDN), max		286.2	311.7	323.0
		Top groove fill (TGF), %, max		20	23	25
		Top land heavy carbon (TLHC), %, max		3	4	5
		Oil consumption	g/kWh, (0 h – 252 h), max	0.54	0.54)	0.54
			g/MJ (0 h – 252 h), max	0.15	0.15	0.15
		Piston, ring, and liner scuffing		none	none	none
		Piston ring sticking		none	none	none
RFWT (D5966)	D5966	Average pin wear,	mils, max	0.30	0.33	0.36
			µm, max	(7.6)	(8.4)	(9.1)
Sequence IIIF (D6984) or Sequence IIIG (D7320)[B] or Sequence IIIH (D8111) or Sequence IIIH70 (D8111 using Appendix X5)	D6984	Kinematic viscosity (at 40 °C), % increase, max		275	275 (MTAC)	275 (MTAC)
	D7320	Kinematic viscosity (at 40 °C), % increase, max		150	150 (MTAC)	150 (MTAC)
	D8111	60 – 80 h[C] Kinematic viscosity, % increase at 40 °C max		370	370 (MTAC)	370 (MTAC)
	D8111(Using IIIH70 Appendix X5 guideline)	70 h Kinematic viscosity, % increase at 40 °C max		181	181 (MTAC)	181 (MTAC)
EOAT (D6894)	D6894	Aeration, volume, %, max		8.0	8.0 (MTAC)	8.0 (MTAC)
Bench Test Methods		Measured Parameter		Primary Performance Criteria		
D4683 or D4171 or D5481		High temperature/high shear viscosity at 150 °C, min		3.5 mPa-s		
HTCBT, 135 °C (D6594)		Copper, mg/kg increase, max		20		
		Lead, mg/kg increase, max		120		
		Copper strip rating,[D] max		3		
D7109		Kinematic viscosity after 90 pass shearing, mm^2/s at 100 °C, min		SAE XW-30	SAE XW-40	
				9.3	12.5	
Noack (D5800)		Evaporative loss at 250 °C, %, max		SAE < > 10W-30	SAE 10W-30	
				13	15	
Foam (D892)		Foaming/settling,[E] mL, max				
		Sequence I		10/0		
		Sequence II		20/0		
		Sequence III		10/0		
MRV TP-1 (D6896)		Viscosity of the 180 h used oil drain sample from a T-11 test, tested at –20 °C, mPa-s, max		25 000		
		If yield stress is detected, use the modified test method (external preheat), then measure the viscosity, mPa-s, max		25 000		
		Measure the yield stress, Pa		<35		
Chemical Limits (non-critical)						
Bench Test Methods		Measured Parameter		Primary Performance Criteria		
D874		Mass fraction sulfated ash, %, max		1.0		
D4951		Mass fraction phosphorus, %, max		0.12		
		Mass fraction sulfur, %, max		0.4		

D7216 (Elastomer Compatibility)				
Note—These are the *unadjusted specification limits* for elastomer compatibility. Candidate oils shall, however, conform to the *adjusted specification limits*, the calculation of which is described in Annex A5.				
Elastomer	Volume Change, %	Hardness Change, Points	Tensile Strength Change, %	Elongation at Break Change, %
Nitrile (NBR)	(+5, -3)	(+7, -5)	(+10, -SL107-30)	(+10, -SL107-17)
Silicone (VMQ)	(+SL107, -3)	(+5, -SL107)	(+10, -45)	(+20, -30)
Polyacrylate (ACM)	(+5, -3)	(+8, -5)	(+18, -15)	(+10, -35)
Fluoroelastomer (FKM)	(+5, -2)	(+7, -5)	(+10, -SL107+2)	(+10, -SL107)
Vamac G	(+SL107+2, -3)	(+5, -SL107-2)	(+10, -SL107+2)	(+10, -SL107+10)
Note—TMC SL107 is the designation for the reference oil used in this test method. This designation represents the original blend or subsequent approved re-blends of TMC SL107.				

[A] See Annex A6 for additional information.

[B] The Sequence IIIG limits shown are more restrictive than the corresponding limits in Sequence IIIF, and are not intended to indicate equivalence. Results meeting the Sequence IIIG criteria stated can be used in lieu of Sequence IIIF.

[C] 60 – 80 h value is interpolated according to the equation $\mathrm{PVIS@(60-80)h} = \left(\frac{\sqrt{\mathrm{PVIS@60\,h}} + \sqrt{\mathrm{PVIS@80\,h}}}{2} \right)^2$, where PVIS@60 h is percent viscosity increase at 60 h and PVIS@80 h is percent viscosity increase at 80 h.

[D] The rating system in Test Method D130 is used to rate the copper coupon in Test Method D6594.

[E] Ten minutes for Sequence I, II, and III.

TABLE 5 Diesel Engine Oil Category CK-4

Required Test Method	Engine Test Method	Rated or Measured Parameter		Primary Performance Criteria		
				One-test	Two-test[A]	Three-test[A]
T-12 (D7422)	D7422	Top Ring Mass Loss, mg, max		105	105	105
		Cylinder Liner Wear, µm, max		24.0	24.0	24.0
T-13 (D8048)	D8048	IR Peak at EOT, Abs., cm^{-1}		125	130	133
		Kinematic Viscosity Increase at 40 °C, % max		75	85	90
		Avg. Oil Consumption, 48 h to 192 h, g/h, max		Report	Report	Report
T-11 (D7156)	D7156	TGA % Soot at 4.0 mm^2/s increase, at 100 °C, min		3.5	3.4	3.3
		TGA % Soot at 12.0 mm^2/s increase, at 100 °C, min		6.0	5.9	5.9
		TGA % Soot at 15.0 mm^2/s increase, at 100 °C, min		6.7	6.6	6.5
C13 (D7549)	D7549	Merit rating,[A] min		1000	1000	1000
COAT (D8047)	D8047	Average Aeration,[A] 40 h to 50 h, %		11.8	11.8	11.8
ISB (D7484)	D7484	Slider tappet mass loss, mg, average, max		100	108	112
		Cam lobe wear, µm, average, max		55	59	61
		Crosshead mass loss, mg, average		Report	Report	Report
ISM (D7468)	D7468	Top Ring Mass Loss, mg, max		100	100	100
		Merit Rating, [A]		1000	1000	1000
1N (D6750)	D6750	Weighted demerits (WDN), max		286.2	311.7	323.0
		Top groove fill (TGF), %, max		20	23	25
		Top land heavy carbon (TLHC), %, max		3	4	5
		Oil consumption	g/kWh, (0 h to 252 h), max	0.54	0.54	0.54
			g/MJ (0 h to 252 h), max	0.15	0.15	0.15
		Piston, ring, and liner scuffing		none	none	none
		Piston ring sticking		none	none	none
RFWT (D5966)	D5966	Average pin wear,	mils, max	0.30	0.33	0.36
			µm, max	(7.6)	(8.4)	(9.1)

CK-4 Category Bench Tests

Test Method	Measured Parameter		Primary Performance Criteria		
	SAE J300 Viscosity Grade		SAE xW-30	SAE xW-40	
D4683 or D4741 or D5481	High temperature/high shear viscosity at 150 °C, mPa·s	min	3.5	Meets SAE J300	
		max	N/A		
HTCBT, 135 °C (D6594)	Copper, mg/kg increase, max		20	20	
	Lead, mg/kg increase, max		120	120	
	Copper strip rating,[B] max		3	3	
Noack (D5800)	Evaporative loss at 250 °C, %, max		13	13	
Foam (D892)	Foaming/settling,[C] Sequence I, mL, max		10/0	10/0	
	Foaming/settling,[C] Sequence II, mL, max		20/0	20/0	
	Foaming/settling,[C] Sequence III, mL, max		10/0	10/0	
D7109 and HTHS Viscosity after 90 pass shearing (see above methods)	Kinematic viscosity after 90 pass shearing, mm^2/s at 100 °C, min		xW-30	0W-40	Other xW-40
			9.3	12.5	12.8
	HTHS viscosity at 150 °C, mPa·s, min		3.4	N/A	N/A
Sooted Oil MRV TP-1 (D6896) (D7156 Engine test required)	Viscosity, 180 h used oil sample from a T-11/T-11A test, tested at –20 °C, mPa·s, max		25 000	25 000	
	Yield stress of the 180 h used oil sample above, Pa max		≤35	≤35	

Chemical Limits (non-critical)

Test Method	Measured Parameter	Primary Performance Criteria
D874	Mass fraction sulfated ash, %, max	1.0
D4951	Mass fraction phosphorus, %, max	0.12
	Mass fraction sulfur, %, max	0.4

D7216 (Elastomer Compatibility)				
Note—These are the *unadjusted specification limits* for elastomer compatibility. Candidate oils shall, however, conform to the *adjusted specification limits*, the calculation of which is described in Annex A5.				
Elastomer	Volume Change, %	Hardness Change, Points	Tensile Strength Change, %	Elongation at Break Change, %
Nitrile (NBR)	(+5, –3)	(+7, –5)	(+10, –SL107-30)	(+10, –SL107-17)
Silicone (VMQ)	(+SL107, -3)	(+5, –SL107)	(+10, -45)	(+20, –30)
Polyacrylate (ACM)	(+5, –3)	(+8, –5)	(+18, –15)	(+10, –35)
Fluoroelastomer (FKM)	(+5, –2)	(+7, –5)	(+10, –SL107+2)	(+10, –SL107)
Vamac G	(+SL107+2, -3)	(+5, –SL107-2)	(+10, –SL107+2)	(+10, –SL107+10)
Note—TMC SL107 is the designation for the reference oil used in this test method. This designation represents the original blend or subsequent approved re-blends of TMC SL107.				

[A] See Annex A7 for additional information.
[B] The rating system in Test Method D130 is used to rate the copper coupon in Test Method D6594.
[C] Ten minutes for Sequence I, II, and III.

TABLE 6 Diesel Engine Oil Category FA-4

Required Test Method	Engine Test Method	Rated or Measured Parameter		Primary Performance Criteria		
				One-test	Two-test[A]	Three-test[A]
T-12 (D7422)	D7422	Top Ring Mass Loss, mg, max		105	105	105
		Cylinder Liner Wear, µm, max		24.0	24.0	24.0
T-13 (D8048)	D8048	IR Peak at EOT, Abs., cm^{-1}		125	130	133
		Kinematic Viscosity Increase at 40 °C, % max		75	85	90
		Avg. Oil Consumption, 48 h to 192 h, g/h, max		Report	Report	Report
T-11 (D7156)	D7156	TGA % Soot at 4.0 mm^2/s increase, at 100 °C, min		3.5	3.4	3.3
		TGA % Soot at 12.0 mm^2/s increase, at 100 °C, min		6.0	5.9	5.9
		TGA % Soot at 15.0 mm^2/s increase, at 100 °C, min		6.7	6.6	6.5
C13 (D7549)	D7549	Merit rating,[A] min		1000	1000	1000
COAT (D8047)	D8047	Average Aeration,[A] 40 h to 50 h, %		11.8	11.8	11.8
ISB (D7484)	D7484	Slider tappet mass loss, mg, average, max		100	108	112
		Cam lobe wear, µm, average, max		55	59	61
		Crosshead mass loss, mg, average		Report	Report	Report
ISM (D7468)	D7468	Top Ring Mass Loss, mg, max		100	100	100
		Merit Rating, [A]		1000	1000	1000
1N (D6750)	D6750	Weighted demerits (WDN), max		286.2	311.7	323.0
		Top groove fill (TGF), %, max		20	23	25
		Top land heavy carbon (TLHC), %, max		3	4	5
		Oil consumption	g/kWh, (0 h to 252 h), max	0.54	0.54	0.54
			(g/MJ) (0 h to 252 h), max	(0.15)	(0.15)	(0.15)
		Piston, ring, and liner scuffing		none	none	none
		Piston ring sticking		none	none	none
RFWT (D5966)	D5966	Average pin wear,	mils, max	0.30	0.33	0.36
			(µm) max	(7.6)	(8.4)	(9.1)

FA-4 Category Bench Tests

Test Method	Measured Parameter		Primary Performance Criteria
D4683 or D4741 or D5481	SAE J300 Viscosity Grade		SAE xW-30
	High temperature/high shear viscosity at 150 °C, mPa·s	min	2.9
		max	3.2
HTCBT, 135 °F (D6594)	Copper, mg/kg increase, max		20
	Lead, mg/kg increase, max		120
	Copper strip rating,[B] max		3
Noack (D5800)	Evaporative loss at 250 °C, %, max		13
Foam (D892)	Foaming/settling,[C] Sequence I, mL, max		10/0
	Foaming/settling,[C] Sequence II, mL, max		20/0
	Foaming/settling,[C] Sequence III, mL, max		10/0
D7109 and HTHS Viscosity (see above methods) after 90 pass shearing	Kinematic viscosity after 90 pass shearing, mm^2/s at 100 °C, min		9.3
	HTHS Viscosity at 150 °C, mPa·s, min		2.8
Sooted Oil MRV TP-1 (D6896) (D7156 Engine test required)	Viscosity, 180 h used oil sample from a T-11/T-11A test, tested at –20 °C, mPa·s, max		25 000
	Yield stress of the 180 h used oil sample above, Pa max		≤35

Chemical Limits (non-critical)

Test Method	Measured Parameter	Primary Performance Criteria
D874	Mass fraction sulfated ash, %, max	1.0
D4951	Mass fraction phosphorus, %, max	0.12
	Mass fraction sulfur, %, max	0.4

D7216 (Elastomer Compatibility)				
Note—These are the *unadjusted specification limits* for elastomer compatibility. Candidate oils shall, however, conform to the *adjusted specification limits*, the calculation of which is described in Annex A5.				
Elastomer	Volume Change, %	Hardness Change, Points	Tensile Strength Change, %	Elongation at Break Change, %
Nitrile (NBR)	(+5, –3)	(+7, –5)	(+10, –SL107-30)	(+10, –SL107-17)
Silicone (VMQ)	(+SL107, -3)	(+5, –SL107)	(+10, –45)	(+20, –30)
Polyacrylate (ACM)	(+5, –3)	(+8, –5)	(+18, –15)	(+10, –35)
Fluoroelastomer (FKM)	(+5, –2)	(+7, –5)	(+10, –SL107+2)	(+10, –SL107)
Vamac G	(+SL107+2, -3)	(+5, –SL107-2)	(+10, –SL107+2)	(+10, –SL107+10)
Note—TMC SL107 is the designation for the reference oil used in this test method. This designation represents the original blend or subsequent approved re-blends of TMC SL107.				

[A] See Annex A7 for additional information.
[B] The rating system in Test Method D130 is used to rate the copper coupon in Test Method D6594.
[C] Ten minutes for Sequence I, II, and III.

NOTE 3—API has developed a symbol that can be licensed for use on containers of oils that conform to the requirements of one or more categories that are currently of commercial importance. API 1509 describes the symbol and licensing procedure.

NOTE 4—In practice, engine oils are often labeled with service category designations having some combination of both S and C prefixes.

NOTE 5—Intended service applications for the various categories described in 4.1.1 – 4.1.3 can be found in API 1509. Several applicable sections of that publication have been included in Appendix X2.

A5. PROCEDURE FOR DERIVING ADJUSTED SPECIFICATION LIMITS FOR ELASTOMER COMPATIBILITY

A5.1 Background

A5.1.1 This annex describes a statistical method to account for the inherent test variability in the elastomer compatibility test method. The need to take account of the inherent test variability arises in part because batch-to-batch, sheet-to-sheet and within-sheet variations in the properties of the reference elastomers (the four elastomers listed for the CI-4 category in Table 3; the five elastomers listed for the CJ-4 category in Table 4, the CK-4 category in Table 5 and the FA-4 category in Table 6) can be sufficiently large that they complicate making a decision as to whether or not a candidate oil has passed the elastomer compatibility requirements.

A5.1.2 Applying this statistical method to the unadjusted specification limits noted in Tables 3-6 produces the adjusted specification limits. *Passing* candidate-oil results shall lie within the range defined by the adjusted specification limits.

A5.1.3 The statistical method for determining the adjusted specification limits uses updated information about the industry test variability relevant to the time frame in which the candidate oil is tested. The TMC provides the updated information based on test results obtained by different test laboratories with different batches of reference elastomers on the same TMC SL107 reference oil.

A5.2 Unadjusted Specification Limits

A5.2.1 The unadjusted specification limits are shown for the CI-4 category in Table 3. (These are reproduced in Table A5.1 for comparison purposes.) The test method involves sixteen criteria. These criteria are the unadjusted specified limits for the four elastomer types (nitrile, silicone, polyacrylate and fluoroelastomer), with changes in four properties (volume, hardness, tensile strength and elongation at break). (The unadjusted specification limits are shown for the CJ-4 category in Table 4, the CK-4 category in Table 5 and the FA-4 category in Table 6.)

TABLE A5.1 Unadjusted Specification Limits for the Elastomer Test Method as Part of the CI-4 Engine Oil Category

Elastomer	Volume Change, %	Hardness Change, Points	Tensile Strength Change, MPa	Elongation at Break Change, %
Nitrile (NBR)	(+5, -3)	(+7, -5)	(+10, -SL107-30)	(+10, -SL107-17)
Silicone (VMQ)	(+SL107, -3)	(+5, -SL107)	(+10, -45)	(+20, -30)
Polyacrylate (ACM)	(+5, -3)	(+8, -5)	(+18, -15)	(+10, -35)
Fluoroelastomer (FKM)	(+5, -2)	(+7, -5)	(+10, -SL107+2)	(+10, -SL107)

A5.3 Adjusted Specification Limits

A5.3.1 The adjusted specification limits are calculated by adjusting the numerical limits in Tables 3-6 (referred to as *fixed limits*), and the TMC SL107 limit in Tables 3-6 (referred to as a *variable limit*). The reference oil TMC SL107 is run in parallel with the candidate oil as a control for each experiment. The TMC SL107 limit ties back to the original TMC 1006 performance; it is this tie-back that accounts for the additional +/- adjustment to the performance of TMC SL107.

A5.3.2 The adjusted specification limits are determined as the unadjusted specification limits plus (in absolute terms) an amount to account for test variability.

A5.4 Inherent Test Variability

A5.4.1 Table A5.2 shows the initial TMC SL107 standard deviation estimates of the four reference elastomers and the four performance parameters, as reported by the TMC. The standard deviation estimates, applicable at the time a test oil is evaluated, are obtained from the TMC website (https://www.astmtmc.org/ftp/docs/d4485/D7216_Adjusted_Specification_Limit_Data/). With the introduction of SL107 Adjusted Specification Limits in 2023, the standard deviation took into account the data to date. Starting in 2025, the standard deviation will take into account a rolling 24 months of data and will be updated annually in February.

TABLE A5.2 Total and Within-Laboratory Standard Deviation Estimates for the Four Reference Elastomers[A]

Elastomer		Volume Change	Hardness Change	Tensile Strength Change	Elongation at Break Change
Nitrile (NBR)	Total	0.57	1.16	5.53	6.57
Nitrile (NBR)	Within-Lab	0.53	1.12	5.22	6.36
Silicone (VMQ)	Total	3.08	2.13	5.14	6.82
Silicone (VMQ)	Within-Lab	1.72	1.40	4.42	6.18
Polyacrylate (ACM)	Total	0.57	1.70	7.14	10.50
Polyacrylate (ACM))	Within-Lab	0.54	1.63	6.93	10.24
Fluoroelastomer (FKM)	Total	0.21	2.14	4.02	6.20
Fluoroelastomer (FKM)	Within-Lab	0.20	1.58	2.82	4.64
Vamac G (MAC)	Total	1.88	1.46	5.82	7.84
Vamac G (MAC)	Within-Lab	1.69	1.37	5.84	7.44

[A] All data collected for EOEC Calibration runs using SL107 reference oil through December 31, 2023. Data is active through January 31, 2025. For future Standard Deviation Estimates, see "https://www.astmtmc.org/ftp/docs/d4485/D7216_Adjusted_Specification_Limit_Data/"

A5.5 Adjusted Specification Limits—Calculations

A5.5.1 *Calculation of Fixed Limits:*

A5.5.1.1 Calculate the standard error of the test-oil mean by dividing the appropriate *total standard deviation* estimate by the square root of the number of observations in the sample. The number of observations in the sample, in the absence of outliers, is six.

A5.5.1.2 Multiply the standard error of the test-oil mean by 2.0.

A5.5.1.3 Add or subtract the resulting number to or from the respective upper or lower unadjusted specification limits to obtain the *fixed* adjusted specification limit(s).

A5.5.2 *Calculation of Variable Limits:*

A5.5.2.1 Calculate the standard error of the test-oil mean by dividing the appropriate *total standard deviation* estimate by the square root of the number of observations in the sample. The number of observations in the sample, in the absence of outliers, is six.

A5.5.2.2 Multiply the standard error of the test-oil mean by 2.8.

A5.5.2.3 Add or subtract the resulting number to or from the mean result obtained with TMC SL107 (run in parallel with the test oil) to obtain either the upper or lower *variable* adjusted specification limit.

A5.5.3 Table A5.3 shows an example of the calculated adjusted specification limits.

TABLE A5.3 An Example of Adjusted Specification Limits for the Four Reference Elastomers—Applicable for the Period February 1, 2024 to January 31, 2025[A]

Elastomer	Volume Change, %	Hardness Change, Points	Tensile Strength Change, %	Elongation at Break Change, %
Nitrile (NBR)	(+5.7, -3.7)	(+8.5, -6.5)	(+16.3, -SL107 -38.5)	(+16.3, -SL107 -25.8)
Silicone (VMQ)	(+SL107 +2.6, -4.9)	(+7.1, -SL107 -1.8)	(+14.4, -49.4)	(-28.1, -38.1)
Polyacrylate (ACM)	(+5.7, -3.7)	(+9.6, -6.6)	(+26.3, -23.3)	(+19.1, -44.1)
Fluoroelastomer (FKM)	(+5.1, -2.1)	(+9.0, -7.0)	(+14.6, -SL107 -4.0)	(+18.6, -SL107 -9.6)
Vamac G (MAC)	(+SL107 +2.3, -4.9)	(+6.0, -SL107 -1.0)	(+17.4, -SL107 -9.8)	(+19.5, -SL107 -12.4)

[A] Based on unadjusted specification limits, standard deviation estimates shown in Table A5.2, and six observations in all cases.

A5.6 Comparison of Unadjusted and Adjusted Specification Limits

A5.6.1 Table A5.1 reproduces the unadjusted specification limits for comparison with the above adjusted specification limits.