GM	WORLDWIDE ENGINEERING STANDARDS	Material Specification	GMW17594

Manual Transmission Fluid

1 Scope

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose/Material Description. This specification covers a fluid intended for use worldwide in GM manual transmissions as initial and top off fill.

1.2 Symbols. Not applicable.

1.3 Applicability. General Motors global manual transmissions.

1.4 Remarks. This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this specification to establish appropriate health and safety practices and to determine the applicability of regulatory limitations prior to use.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM D92	ASTM D4739	CEC L-45-99	FZG PT C/9/90
ASTM D97	ASTM D4951	CEC L-48-A-00	GFKT C/8.3/90
ASTM D130	ASTM D5185	DIN 51 363-2	ISO 37
ASTM D445	ASTM D5762	DIN 51 363-3	ISO 48 Method M
ASTM D664	ASTM D5800	DIN 51 399-1	ISO 1817
ASTM D892	ASTM D6082	DIN 51 757 Part 4	ISO 2909
ASTM D2270	ASTM D6304	DIN 51819 T3	ISO 3016
ASTM D2983	ASTM D6443	DIN 51819-3_s	ISO 3104
ASTM D3228	ASTM D6922	EHDPROC 11	ISO 15597
ASTM D4052	CEC L-084-02	FZG-E-C/0	SAE J2643

2.2 GM Standards/Specifications.

GMW3059

2.3 Additional References. Not applicable.

3 Requirements

3.1 Requirements. Fluids qualified under this specification shall conform to the test methods as described in Appendix A; Table A1, Appendix B; Table B1 thru Table B7, Appendix C and Appendix D.

3.2 Additional Requirements.

3.2.1 The requirements given in this specification are minimum or maximum acceptance limits for valid tests. No adjustments for test precision are to be applied as test variability was taken into account in the determination of the requirements.

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3.2.2 General Motors fluids engineers and hardware design responsible engineers, together as a team, reserve the right to require any additional tests that may be deemed necessary to ensure satisfactory performance of fluids submitted for qualification as GM global manual transmission fluid.

3.3 Materials Compatibility. All materials must meet print specification compatibility tests with fluid. Tests must be conducted by a certified laboratory.

3.4 Validation Requirements. Testing necessary for validating the use of this lubricant shall be prescribed by Materials Engineering. Testing will include, but will not be limited to, tests included in Section 3 Requirements of this specification, Vehicle Fleet Testing, and Durability Tests.

3.5 All materials supplied to this standard must comply with GMW3059, Restricted and Reportable Substances. For raw materials, non-dimensional materials (e.g., fluids, greases) and/or bulk materials that require approval into the GM Materials Approved Source List (GMMASL), an International Material Data System (IMDS) submission must be made by the material supplier as a material Material Data Sheet (mMDS). After the mMDS is approved by the GM IMDS team, the materials supplier is to provide a “Header only report” to the responsible GM Materials Engineer. Further guidance can be found in the GM-specific instructions on the IMDS website.

4 Manufacturing Process

Not applicable.

5 Rules and Regulations

5.1 Legal Regulations. All materials must satisfy applicable laws, rules, regulations, and recommendations valid in the country of usage.

5.2 Language. In the event of conflict between the English and domestic language, the English language shall take precedence.

5.3 Inspection and Rejection. All shipments of material or parts under contract or purchase order manufactured to this specification shall be equivalent in every respect to the initial samples approved by Engineering. There shall be no changes in either formulation or manufacturing processes permitted without prior notification and approval by Engineering. Lack of notification by the supplier constitutes grounds for rejection of any shipment. While samples may be taken from incoming shipments and checked for conformance to this specification, the supplier shall accept the responsibility for incoming shipments meeting this specification without dependence upon purchaser’s inspection.

The series of tests used to approve each batch of product along with acceptance limits will be agreed upon by the purchaser and seller. The laboratory providing the certificate of analysis must also participate in a proficiency testing program (round robin) that is approved by the Fuels, Fluids, and Lubricants Global Subsystem Leadership Team (GSSLT) or designate. The Fuels, Fluids, and Lubricants GSSLT or designate must receive copies of the proficiency testing reports directly from the test program administrator.

5.4 Initial Source Approval. No shipment shall be made by any supplier until representative initial production samples have been approved by the Fuels, Fluids, and Lubricants Global Subsystem Leadership Team or designees meeting the requirements of this specification.

5.5 Material Safety Data Sheets/Safety Data Sheets (MSDS/SDS). For new product submissions, or when a change in chemical composition of an existing product has occurred, a complete copy of the Material Safety Data Sheet/Safety Data Sheet must be submitted in compliance with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) requirements or other country-specific MSDS/SDS requirements.

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6 Approved Sources

Materials supplied to this specification must be approved by General Motors.

The appropriate GM Materials Engineering department(s) must confirm material as meeting the requirements of this specification. Any test data sheets of material submitted to General Motors for such confirmation (e.g., during Production Part Approval Process (PPAP)) under this material specification must list all properties and must apply corresponding test methods of this material specification.

For other GM locations, the responsible engineering group should be contacted to obtain the approved source in that individual country.

7 Notes

7.1 Glossary. Not applicable.

7.2 Acronyms, Abbreviations, and Symbols.

%	Percent
°C	Degree Celsius
ACEA	Association des Constructeurs Européens d'Automobiles
ACM	SAE abbreviation for Polyacrylate
AD	Anderson-Darling Value
AEM	SAE abbreviation for Ethylene Acrylic Copolymer
ASTM	ASTM International
CEC	Coordinating European Council
CI	Confidence Interval
COF	Coefficient of Friction
cSt	Centistokes
DKA	Deutscher Koordinierungsausschuss
EHDPROC	Elastohydrodynamic Film Forming Properties of One Fluid
FLS	Failure Load Stage
FPM	ACEA abbreviation for Fluorocarbon
FSST	Fluid Screening System Test
FZG	Forschungsstelle für Zahnräder und Getriebebau
g/mL	grams per milliliter
GFKT	Grau Fleckigkeit Kurz Test
GHS	Globally Harmonized System of Classification and Labeling of Chemicals
GMMASL	GM Material Approved Source List
GSSLT	Global Subsystem Leadership Team
HNBR	Hydrogenated Nitrile Butadiene Rubber
ICP	Inductively Coupled Plasma
IRHD	International Rubber Hardness Degree
IMDS	International Material Data System
ISO	International Organization for Standardization
KRL	Kegel Rollen Lager
L	Liter
max	maximum
mg/kg	milligrams per kilograms
mgKOH/g	milligrams of potassium hydroxide/grams
mMDS	material Material Data Sheet

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MSDS	Material Safety Data Sheet
N	Number of Samples
NBR	Nitrile Butadiene Rubber
P-Value	Probability Value
PA	Polyamide
PPAP	Production Part Approval Process
rpm	Rotations per Minute
s	Seconds
SAE	SAE International
SDS	Safety Data Sheet
SRR	Slide-Roll-Ratio
XRF	X-ray Fluorescence

8 Coding System

8.1 This standard shall be referenced in other documents, drawings, etc., as follows:

GMW17594

9 Release and Revisions

This standard was originated in March 2016 It was first approved by Materials - Fuels, Fluids and Lubricants Global Subsystem Leadership Team in June 2016. It was first published in June 2016.

Issue	Publication Date	Description (Organization)
1	JUN 2016	Initial publication.
2	MAY 2021	Five Year Refresh. Updated to current template. (Materials – Fuels, Fluids & Lubricants Global Subsystem Leadership Team (GSSLT))

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Appendix A

Table A1: Chemical and Physical Test Requirements

Test	Method	Requirement
Appearance	Visual Inspection	Clear Amber Liquid
Miscibility	ASTM D6922	No Separation or Color Change
Barium	Established Inductively Coupled Plasma (ICP) Atomic Emissions Spectroscopy or X-ray Fluorescence (XRF) Spectroscopy Method	Report: milligrams per kilograms (mg/kg)
Boron	Established ICP or XRF method	Report mg/kg
Calcium	Established ICP or XRF method	Report mg/kg
Chlorine	ISO 15597 (XRF)	50 mg/kg maximum
Copper	Established ICP or XRF method	Report mg/kg
Lead	Established ICP or XRF method	Report mg/kg
Magnesium	Established ICP or XRF method	Report mg/kg
Molybdenum	ASTM D5185 (ICP) or DIN 51 399-1 (X-Ray)	Report mg/kg
Nitrogen	ASTM D5762, ASTM D3228	Report mg/kg
Phosphorus	DIN 51 363-3, ASTM D4951 (ICP) DIN 51 363-2, ASTM D6443 (XRF)	Report mg/kg
Silicon	Established ICP or XRF method	Report mg/kg
Sodium	Established ICP or XRF Method	Report mg/kg
Sulfur	Established ICP or XRF Method	Report mg/kg
Zinc	ASTM D5185 (ICP) or ASTM D6443 (X-Ray)	Report mg/kg
Water Content	ASTM D6304	< 0.1%
Kinematic Viscosity at 100 °C	ASTM D445, ISO 3104	5.7 cSt to 6 cSt maximum
Kinematic Viscosity at 40 °C	ASTM D445, ISO 3104	22.5 cSt to 25 cSt maximum
Viscosity Index	ASTM D2270, ISO 2909	200 minimum
Base Oil Viscosity	ASTM D445	Report: centistokes (cSt)
Brookfield Viscosity -40 °C	ASTM D2983	8000 cP maximum
Density	DIN 51 757 Part 4, ASTM D4052	Report grams per milliliter (g/mL)
Pour Point	ASTM D97, ISO 3016	-40 °C maximum
Flash Point	ASTM D92	190 °C minimum
Total Base Number	ASTM D4739	Report: milligrams of potassium hydroxide/grams (mgKOH/g)

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Test	Method	Requirement
Total Acid Number	ASTM D664	Report mgKOH/g
Copper Corrosion	ASTM D130 3 h, 150 °C	1B or Better
Deutscher Koordinierungsausschuss (DKA) Oxidation Stability	CEC L-48-A-00 160 °C for 192 h Method B	1: ΔkV40 ≤ 20% 2: ΔkV100 ≤ 15% 3: ΔTAN ≤ 3.0 mg KOH/g 4: Sludge Rating One (1) Maximum 5: Blotter, Report With Photo
Shear Stability, Kegel Rollen Lager (KRL)	CEC L-45-99 100 °C	Maximum Decrease to 5.0 cSt after 192 h Report 20 h and 100 h
Volatility at 150 °C	ASTM D5800, 1 h at 150 °C	5.5% maximum
Seals and Material Compatibility Hardness Tensile Strength Elongation at Rupture Volume Variation	ISO 48 Method M, Percent (%) International Rubber Hardness Degree (IRHD) ISO 37, Percent (%) IRHD ISO 37, Percent (%) IRHD ISO 1817, Percent (%) IRHD	See Appendix C, Table C1
Foam Test	ASTM D892 ASTM D6082	1 Sequence I: 20 mL/0 mL maximum 2 Sequence II: 50 mL/0 mL maximum 3 Sequence III: 20 mL/0 mL maximum 4 Sequence IV: 150 °C. 50 mL/0 mL maximum
Film Thickness	EHDPROC 11 See Appendix E, Table E1	Report
Traction Coefficient	EHDPROC 11 See Appendix E, Table E2	Report
Synchronizer Function	Synchronizer Step Test Synchronizer Durability Test Synchronizer µ-coefficients Lining Material Compatibility	See Appendix B
FE-8 Bearing Wear	DIN 51819 T3 80 h/80 kN/80 °C/7.5 rpm Thrust Bearings 81212, 15 Cylinder Roller Elements, Brass Cage	< 5 mg
FE-8 Bearing Pitting	DIN 51819-3_s Maximum 200 h/60 kN/100 °C/ 500 rpm (Run in 24 h) and	> 100 h in Fatigue Test with 750 rpm

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Test	Method	Requirement
	750 rpm (Fatigue Test 176 h) Thrust Bearings 81212 15 Cylinder Roller Elements, Polyamide (PA) Cage	
FZG Efficiency	FZG-E-C/0 (5:20/5:9/40:120)	Report
FZG Scuffing Protection	CEC L-084-02 (A10)16.6R/90C	Load Stage 10 Pass
Forschungsstelle für Zahnräder und Getriebebau (FZG) Pitting	FZG PT C/9/90	Report
FZG Micro Pitting	Grau Fleckigkeit Kurz Test: GFKT C/8.3/90	Failure Load Stage (FLS) > 9 and GFKT "High" at 90 °C
Fluid Screening System Test (FSST)	FSST Procedure, Three (3) Tests With Oil Candidate One Reference Test	See Appendix D, Figure D1, Figure D2, and Figure D3

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Appendix B

B1 Synchronizer Testing

Table B1: (1 of 3) Synchronizer Step Test with Sinter Lining Brass Based (HS49/90)

Synchronizer Data				Sinter Lining Brass Based (HS49) - 1/2 Gear Triple Cone								
Mean Friction Diameter		72.9 mm										
Mean Width		7.7 mm										
Mean Friction Surface		1763 mm²										
Cone Angle		7.5 Degree										
Number of Cones		3.0										
Synchronizer Run-In				**Friction Power Step Test**								
Stage				1	2	3	4	5	6	7	8	9
Pressure	N/mm²	2.0	4.0	2.0	4.0	6.0	6.0	8.0	8.0	10.0	10.0	4.0
Sliding Velocity	m/s	2.0	4.0	2.0	4.0	4.0	6.0	6.0	8.0	8.0	10.0	4.0
Inertia	kgm2	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Axial Force	N	460	921	460	921	1381	1381	1841	1841	2302	2302	921
Speed	1/minute	524	1048	524	1048	1048	1572	1572	2096	2096	2620	1048
Cycle Time	s	5	5	5	5	5	5	5	10	10	15	5
Oil Temperature	°C	80		80								
Oil Flow	Liter/minute	2.5		2.5								
Friction Work	J/mm²	0.02	0.09	0.02	0.09	0.09	0.20	0.20	0.36	0.36	0.57	0.09
Friction Work/Cycle Time	mW/mm²	75	75	75	75	75	75	75	75	75	75	75
Shifts/Stage	number	50	10 000	50	1000	1000	1000	1000	1000	1000	1000	1000
Duration	h	0.07	13.89	0.07	1.39	1.39	1.39	1.39	2.78	2.78	4.17	1.39
Shifts Total	number	10 050		8050								
Test Passed if				μ2 > lower limit of COF μ3 < tan (α) step five (5) completed, **Note:** no failed shifts until end of step five (5) when five (5) passed, **Note:** run until failure								

Note: COF = Coefficient of Friction.

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Table B1: (2 of 3) Synchronizer Step Test with Sinter Lining Brass Based (HS49/90)

Synchronizer Data				Sinter Lining Brass Based (HS49) - 3/4 Gear Double Cone								
Mean Friction Diameter		63.0 mm										
Mean Width		7.7 mm										
Mean Friction Surface		1524 mm²										
Cone Angle		7.5 Degree										
Number of Cones		2.0										
Synchronizer Run-In				**Friction Power Step Test**								
Stage		1	2	1	2	3	4	5	6	7	8	9
Pressure	N/mm²	2.0	4.0	2.0	4.0	6.0	6.0	8.0	8.0	10.0	10.0	4.0
Sliding Velocity	m/s	2.0	4.0	2.0	4.0	4.0	6.0	6.0	8.0	8.0	10.0	4.0
Inertia	kgm2	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Axial Force	N	398	796	398	796	1194	1194	1591	1591	1989	1989	796
Speed	1/minute	606	1213	606	1213	1213	1819	1819	2425	2425	3032	1213
Cycle Time	s	5	5	5	5	5	5	5	10	10	15	5
Oil Temperature	°C	80		80								
Oil Flow	Liter/minute	2.5		2.5								
Friction Work	J/mm²	0.05	0.21	0.05	0.21	0.21	0.48	0.48	0.85	0.85	1.32	0.21
Friction Work/Cycle Time	mW/mm²	75	75	75	75	75	75	75	75	75	75	75
Shifts/Stage	number	50	10 000	50	1000	1000	1000	1000	1000	1000	1000	1000
Duration	h	0.07	13.89	0.07	1.39	1.39	1.39	1.39	2.78	2.78	4.17	1.39
Shifts Total	number	10 050		8050								
Test Passed if				μ2 > lower limit of COF μ3 < tan (α) five (5) completed, **Note:** no failed shifts until end of five (5) when five (5) passed, **Note:** run until failure								

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