



## **Coolant – Extended Life Automotive, Concentrate – Ethylene Glycol**

### **1 Scope**

**1.1 Material Description.** This specification details the materials and performance requirements of an engine coolant capable of satisfactory performance throughout an extended working life when used at recommended concentrations.

**1.2 Material Identification.** This specification covers concentrated ethylene glycol type compounds.

**1.3 Typical Application.** The extended life engine coolant is used to protect automotive engine cooling systems from corrosion, freezing and boil over. The extended life engine coolant concentrate is intended to be mixed with clean, potable water having the quality found in most parts of North America and at concentrations recommended in the vehicle owners manual.

### **2 References**

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

#### **2.1 External Standards/Specifications.**

ASTM D412	ASTM D2809
ASTM D471	ASTM D3634
ASTM D1119	ASTM D2570
ASTM D1120	ASTM D4340
ASTM D1121	ASTM D5185

ASTM D1122	ASTM D5827
ASTM D1123	ASTM D6660
ASTM D1176	ASTM E202
ASTM D1177	ISO 178
ASTM D1287	ISO 179
ASTM D1384	ISO 527-1
ASTM D1881	ISO 3167
ASTM D1882	ISO 11014-1
ASTM D2240	

#### **2.2 GM Standards/Specifications.**

9982257	GMP.PA66.054
GM1825M	GMW3001
GM6043M	GMW3059
GM6278M	GMW3155
GMN3922	GMW3739

### **3 Requirements**

**3.1 Chemical Requirements.** Coolants furnished to this specification shall contain NONE of the following materials: nitrite or ethanolamine containing salts or additives. Materials furnished to this specification shall have the composition shown in Table 1.

Table 1: Chemical Performance Requirements.

Properties	Test Methods	Requirement (weight %)
A. Ethylene Glycol	ASTM E202	85 min
B. Other Glycols	ASTM E202	10 max
C. Water <sup>(Note 1)</sup>	ASTM D1123	5 max (including water by hydration)
D. Ash	ASTM D1119	5 max
E. Chloride	ASTM D3634, ASTM D5827	25 ppm max
F. Silicon (from Silicate)	ASTM D5185	10 ppm max
G. Phosphorus	ASTM D5185	10 ppm max
H. Boron	ASTM D5185	10 ppm max

Note 1: Water may be used to aid in the dissolution of inhibitor salts, but the amount must be controlled so that the finished product conforms to the limits specified for freezing point.

**3.2 Physical Requirements.** Materials furnished to this specification shall meet the requirements shown in Table 2. The tests will be done on the coolant concentrate unless otherwise specified.

**3.3 Performance Requirements.** The GM Coolant Committee reserves the right to require any additional tests that may be deemed necessary to ensure satisfactory vehicle component performance with candidate engine coolants submitted for approval.

**3.4 General Corrosivity.** The extended life engine coolant shall be inhibited so that it will provide protection against metal corrosion in normally functioning systems for at least 5 years or 150,000 miles. The candidate engine coolant shall satisfy the corrosion limits shown in Table 3 for the glassware (ASTM D1384) and simulated service (ASTM D2570) tests.

**3.4.1 Glassware Test, ASTM D1384.** The glassware test shall be run both at the standard 0°F freezing point and at 50 volume %. In addition to the metals shown in Table 3, weight losses shall also be reported for high lead solder (97% Pb, 2.5% Sn, 0.5% Ag). The high lead solder weight loss is determined by repeating the ASTM D1384 test with high lead solder replacing the standard solder or by using a 7 metal

coupon bundle containing electrically coupled high lead solder, copper, standard solder and brass specimens.

**3.4.2 Simulated Service, ASTM D2570.** The ASTM D2570 simulated service test shall be run at 44 volume % coolant concentrate. In addition to the requirements shown in Table 3, there shall be no pitting, cavitation or erosion of metal components of the water pump, beyond a fairly uniform surface roughening, on conclusion of 1064 h in the Simulated Service Corrosion Test. Reserve Alkalinity (RA) shall also be determined and reported. The RA shall not decrease by more than 25% to the endpoint pH 4.5 after completion of the Simulated Service Test.

**3.4.3 Test Requirements.** The engine coolant shall satisfy the corrosion limits shown in Table 3 for the ASTM D1384 and ASTM D2570 tests. The corrosion limits are given for maximum weight loss per specimen in the test indicated. The limits shown apply to the average of triplicate determinations. Single high values exceeding twice the mean value shall be discarded and replaced by other determinations. Report any pitting and crevice corrosion which may be indications of inadequate corrosion inhibition, whether or not the weight loss exceeds the value shown.

Table 2: Physical Performance Requirements.

Properties	Test Methods	Requirement
A. Relative Density (15.5/15.5°C)	ASTM D1122	1.11 - 1.14
B. Reserve Alkalinity	ASTM D1121	Report titration curve
C. pH	ASTM D1287 1 part concentrate plus 2 parts distilled water, by volume	7 - 9
D. Equilibrium Boiling Point	ASTM D1120	163°C min
E. Freezing Point	ASTM D1177 or ASTM D6660: 50% concentrate plus 50% distilled water by volume	-37°C max
F. Color	Color Stability Test(s) as specified by Coolant Committee.	Color stable orange. Pantone 171-172.
G. Staining Characteristics (change in reflectance)	ASTM D1882 Use panels coated with current production, light color, automobile finish	No change in surface appearance by discoloration, loss of gloss, softening or swelling allowed.
H. Foaming Characteristics	ASTM D1881 33% by volume coolant and Type II water	Increase in volume during aeration: 88°C.....50 ml max 23 ± 3 °C.....125 ml max Foam break time after aeration is stopped: 88 °C.....within 5 s 23 ± 3 °C.....within 15 s

**3.4.4 General Corrosion Compatibility with Other Coolants.** The candidate engine coolant shall also meet the above glassware (ASTM D1384) standard when tested in 1:3, 1:1 and 3:1 volumetric mixtures with the following:

**A:** Other coolants previously approved and released under this specification, GM6277M.

**B:** A coolant satisfying GM6043M or, at the option of the GM Coolant Committee, another coolant satisfying GM1825M.

**3.5 Corrosion Inhibition at Aluminum Heat Rejecting Surfaces, ASTM D4340.** The candidate engine coolant shall provide protection against corrosion of aluminum heat rejecting surfaces. The testing shall follow the procedures of ASTM D4340 with the following additions:

**A: Test Solutions:** In addition to the standard ASTM D4340 test solution (25 volume % coolant concentrate, 100 ppm chloride {as NaCl} in complete test solution), duplicate

tests shall be run in 50 volume % coolant concentrate in deionized water on the test coolant.

**B: Cleaning Procedures:** Weight losses of both test samples and blanks not exposed to coolant shall be measured twice. The first measurement is taken after the sample has been vigorously rinsed with a flow of deionized water (remove any loose solids via gentle wiping with a plastic gloved finger), rinsed with acetone, dried in an oven and cooled in a dessicator. The second measurement is taken after subsequent treatment in the standard acid cleaning solution as specified in ASTM D4340. Both the water cleaned and acid cleaned results shall be reported, each corrected for the weight loss/gain of a similarly cleaned blank specimen.

**3.5.1 Compatibility with Other GM Approved Extended Life Coolants in Hot Aluminum Corrosion.** The candidate coolant shall also be tested under standard ASTM D4340 conditions (25% total coolant concentrate, 100

ppm chloride) in 1:3, 1:1 and 3:1 volumetric mixtures with each of the extended life coolants previously released under this specification. At the discretion of the GM Coolant Committee, satisfactory results of single tests rather than duplicates may be accepted as fulfillment of this requirement.

**3.5.2 Tolerance of Silicated Coolant Topoff in Hot Aluminum Corrosion.** Standard ASTM D4340 conditions shall also be run with the candidate coolant for  $48 \pm 1$  h at which point the heaters are turned off and the timer stopped. The candidate fluid is allowed to cool below the atmospheric boiling point. 25 volume % of the test solution is removed and replaced with an equal volume of a standard ASTM D4340 test solution prepared for meeting formula specification GM6043M, or at the option of the GM Coolant Committee, from another silicated coolant satisfying performance specification GM1825M. The heaters are turned back on, the timer restarted, and the test continued to a standard timer reading of  $168 \pm 1$  h.

**3.5.3 Tolerance of Initial Admixture with Silicated Coolant in Hot Aluminum Corrosion.** The test of 3.5.2 shall be rerun with freshly prepared aluminum sample and coolant, with the candidate and silicated coolant mixed before the initial filling of the ASTM D4340 apparatus. Both the water cleaned and acid cleaned results shall be reported.

**3.5.4 Test Requirements.** The maximum allowed ASTM D4340 (modified as above) corrosion rate in  $\text{mg}/\text{cm}^2$  in one week for the tests described above are shown in Table 4. The values are shown as averages of duplicate tests. However, as stated in 3.5.1, results of single tests may be acceptable for the candidate coolant and approved coolant mixes. The formation of a trace of solids in the test solution is permissible, but generation of enough solids to completely cover the sample after cool down is cause for rejection.

**3.6 Cavitation Erosion Testing, ASTM D2809.** The candidate coolant concentrate shall be tested under conditions outlined in ASTM D2809, Cavitation Erosion Test. A rating below 8 is considered basis for rejection.

**Table 3: ASTM D1384/D2570 Requirements.**

Corrosion Test	Maximum Weight Loss, mg			
	Copper & Brass	Solder	Steel & Cast Iron	Aluminum
Glassware (ASTM D1384)	10 mg	20 mg	10 mg	20 mg
Simulated Service (ASTM D2570)	20 mg	40 mg	20 mg	40 mg

Table 4: ASTM D4340 Requirements.

Candidate - Coolant Mix	Reference Section	Test Conditions	Maximum Corrosion Rate, mg/cm <sup>2</sup>	
			Water Cleaned	Acid Cleaned
Candidate Coolant	3.5	25% Concentrate, 100 ppm Chloride	0.3	1.0
Candidate Coolant	3.5	50% Concentrate, Deionized Water	1.0	2.0
Candidate Coolant, Approved Coolant 1:3	3.5.1	25% Concentrate, 100 ppm Chloride	0.5	1.0
Candidate Coolant, Approved Coolant 1:1	3.5.1	25% Concentrate, 100 ppm Chloride	0.5	1.0
Candidate Coolant, Approved Coolant 3:1	3.5.1	25% Concentrate, 100 ppm Chloride	0.5	1.0
Candidate Coolant, Silicated Top Off	3.5.2	25% Concentrate, 100 ppm Chloride	1.0	1.0
Candidate Coolant, Silicated Mix	3.5.2	25% Concentrate, 100 ppm Chloride	report	report

**3.7 Non Metallic Testing.** Candidate engine coolant as normally used in cooling systems shall have no deleterious effects on hoses, gaskets, seals, coatings and other cooling system components and materials. In addition to the tests defined below, additional testing of materials for compatibility may be required as defined by the GM Coolant Committee. Tests must be conducted with both the candidate engine coolant and an approved GM6277M coolant except for the hose testing which is done only with the candidate coolant. The candidate coolant is required to show results that meet or exceed the results for the approved GM6277M coolant previously released under this specification.

**3.7.1 Seal/Gasket Test Materials.** The materials to be tested are as follows:

**A** :Nylon: Dupont FE-5105 BK083 per GMP.PA66.054

**B**: Silicone rubber: General Electric SE4170X19-D1

**C** :RTV Silicone sealant: Three Bond 1217F per 9982257

**3.7.2 Test Method for Nylon and Silicone Rubber Materials.** Test specimens of a single material shall be immersed in a 50v/50v mixture of coolant and potable water for 1000 h at 125°C and 103 kPa pressure. The tests shown in Table

5 shall be performed on five specimens each after 168 and 1000 h of fluid immersion. Results for the unaged specimens (dry-as-molded for nylon) shall also be determined at the same time as the aged specimens.

**3.7.3 Pressure Vessel for Nylon and Silicone Rubber Materials.** The vessel must be capable of maintaining the required temperature  $\pm 2^\circ\text{C}$  and pressure  $\pm 20$  kPa for the duration of the test (no coolant/water additions allowed), and be large enough to ensure complete immersion of the test specimens. Each test specimen must be separated from any adjacent specimen and the walls of the vessel by approximately 6 mm. Temperature, pressure and coolant concentration shall also be reported at 168 and 1000 h.

**3.7.4 Compressive Stress Relaxation of Silicone Rubber Material.** The silicone rubber material shall be tested to GMN3922 VMQAC2ECDO. The % retained force must be reported.

**3.7.5 Test Method for RTV Silicone Sealant.** The RTV silicone sealant must be tested for compatibility with the candidate coolant according to the procedures of the GM specification 9982257 for cured sealant. Both the original properties, and properties after immersion in the 50v/50v mixture of coolant and potable water for

240 h at 125°C, are to be determined, see Table 5. All results must be reported.

**Table 5: Nylon and Silicone Testing Matrix.**

Property	Standard	Specimen	Conditions
<b>Nylon – Dupont FE-5105 BK083</b>			
Tensile Strength at Yield	ISO 527-1	ISO 3167 Type A	Test speed 5 mm/min
Tensile Strength at Break	ISO 527-1	ISO 3167 Type A	Test speed 5 mm/min
Flexural Modulus	ISO 178	80 X 10 X 4	Test speed 2 mm/min
Flexural Strength at Break	ISO 178	80 X 10 X 4	Test speed 2 mm/min
Charpy Impact Strength	ISO 179	80 X 10 X 4	23°C, edge impact
<b>Silicone – General Electric SE4170X19-D1</b>			
Tensile Strength	ASTM D412	Die C	Method A
Tensile Modulus	ASTM D412	Die C	Method A
Elongation at Break, %	ASTM D412	Die C	Method A
Hardness	ASTM D2240		Shore A Instantaneous
Volume Change	ASTM D471		
Weight Change	ASTM D471		
Compressive Stress Relaxation	GMN3922		1008 h, 125°C
<b>Silicone RTV – Three Bond 1217 F</b>			
Tensile Strength, kPa	ASTM D412	Die C	50 mm/min
Elongation at Break, %	ASTM D412	Die C	50 mm/min
Volume Change	ASTM D471		

**3.7.6 Sealability of Assemblies.** Various cooling joints shall be run on actual joint hardware using the GMW3155 procedure. The GM Powertrain Assembly, Sealing & Fastening HRC will select the assemblies and evaluate the results. There shall be no coolant leaking after completion of the test.

**3.8 Hose Testing.** Two GM6278M approved engine coolant hose compounds selected by the GM Coolant Committee must be tested with the candidate engine coolant per the sections of GM6278M shown below. The candidate coolant is required to satisfy the requirements shown in these selected sections of GM6278M. The hoses to be tested must be over 19 mm ID. The hoses shall be tested only with the candidate engine coolant.

Section 5: Original Properties

Section 5: 168 and 1000 h coolant immersion tests, properties after immersion

Section 6.4: Coolant Circulating Test

Section 6.9: Striation Resistance Test

Section 6.10: Pressure Impulse Test

**3.9 Water Pump Durability Testing.** The candidate coolant shall be tested according to GMW3739, GM Corporate Coolant Water Pump Durability Test. Tests must be run at a facility approved by GM Powertrain. The test shall consist of a minimum of 6 samples of a current production coolant pump and seal combination selected by GM Powertrain and the GM Coolant Committee. A minimum of three pumps are to be tested with the candidate coolant and a mini-

mum of three pumps are to be tested with an approved GM6277M coolant specified by the GM Coolant Committee. The candidate coolant shall show results as good as or better than an approved GM6277M coolant selected by the GM Coolant Committee.

**3.10 Other Coolant Component Testing.** The candidate coolant must pass any additional cooling system and/or component performance tests specified by the GM Coolant Committee.

**3.11 Fleet Testing.** A fleet or fleets of test vehicles will be built introducing the test coolant, mixed 1:1 with deionized or potable water, into clean cooling systems (not previously filled with coolant). The GM Coolant Committee will determine the fleet size, vehicle makeup, length of test and test parameters. Vehicles with aluminum cylinder heads, aluminum radiators and aluminum heater cores must be included in the fleet test. In addition, GM Divisional Release Engineers for the coolant may specify additional vehicle fleet test requirements to fulfill validation requirements for their specific vehicles and cooling system components. During the fleet test, coolant samples not to exceed 125 ml will be tested every six months and records of all coolant additions and other cooling system service operations are to be maintained. A significant drop in the concentration of any inhibitor will require further evaluation.

**3.11.1 End of Fleet Evaluation.** At the end of the fleet test, all coolant will be drained into a clean container and retained for corrosion testing. No significant functional degradation of any cooling system components, attributable to interactions with the coolant must occur. The GM Coolant Committee will provide a list of parts and components to be removed from the vehicles for evaluation. The end of test coolant will also be selected from well controlled vehicles by the GM Coolant Committee and must pass the following tests:

A. ASTM D1384 Glassware tests with the same requirements as for new coolant.

B. ASTM D4340 Hot Aluminum tests. Water rinsed and acid rinsed weight losses (average of duplicate tests) after 1 week must be less than 0.5 and 2.0 mg/sq.cm respectively, for the following test solutions prepared from the used coolant:

1. .25 volume % glycol, chloride added as NaCl to total not less than 100 ppm, deionized water used for dilution.

2. 50 volume % glycol (or as-received from vehicle, if glycol content is between 42 - 50 %), chloride added as NaCl to not less than 100 ppm, any needed dilution with deionized water.

C. The pH, % ethylene glycol, reserve alkalinity, depletion of inhibitors, glycol breakdown products and metals contents shall be determined and reported.

### 3.12 Stability Requirements.

**3.12.1 Storage Stability of Concentrate.** Allow an undiluted sample of the candidate coolant to stand for 24 h. Any separation into phases shall disqualify the candidate engine coolant. The test shall be repeated using a 1:1 volumetric mixture of the candidate coolant with a coolant previously approved to GM6277M.

**3.12.2 Hot Storage Stability of Concentrate.** 100 ml of the candidate coolant concentrate is placed in a 200 ml Erlenmeyer flask, covered with a watchglass and stored for 336 h at  $60 \pm 2.5^{\circ}\text{C}$ . After being cooled to room temperature for 30 minutes, the coolant is centrifuged. The precipitate is washed three times with 20 ml portions of methanol, then dried for 2 h at  $120^{\circ}\text{C}$ , cooled to room temperature in a dessicator and weighed. No more than 10 mg of residue is allowed from each 100 ml portion of coolant. The test shall be repeated using a 1:1 volumetric mixture of the candidate coolant with a coolant previously approved to GM6277M.

**3.12.3 Storage Stability of 50 Volume % Dilution.** Samples of candidate coolant concentrate shall show no separation or precipitation when diluted with hard water and tested as follows. Prepare the hard water by adding 0.275 g of  $\text{CaCl}_2$  to 1 L of the water described in ASTM D1384. Mix 100 ml of coolant concentrate plus 100 ml of hard water at room temperature in a 250 ml beaker and allow to stand in the dark for 24 h. Make a second mixture, as above, and heat to  $82^{\circ}\text{C}$  and allow to cool to room temperature and to stand in the dark 24 h. Slight cloudiness is permitted; but formation of a precipitate is considered sufficient to interfere with bulk storage and use of the mixtures.

### 3.13 Requirements on other Stages during Life Cycle.

**3.13.1 Form and Quality.** The utility of the coolant concentrate shall not be adversely affected by storage up to 2 years under climatic conditions normally encountered in distributing and marketing such products. When the coolant is

installed in a properly maintained cooling system, it shall be sufficiently stable so as not to impair its heat transfer or corrosion inhibiting properties.

#### 4 Manufacturing Process

Not applicable.

#### 5 Rules and Regulations

**5.1** All materials supplied to this specification must comply with the requirements of GMW3001, **Rules and Regulations for Material Specifications**

**5.2** All materials supplied to this specification must comply with the requirements of GMW3059, **Restricted and Reportable Substances for Parts**.

**5.3 Legal Regulations.** For use of this material, the valid laws and other regulations and recommendations in the country of usage must be followed.

**5.4 Inspection and Rejection.** All shipments of materials 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 formulation or manufacturing process 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 the purchaser's inspection.

**5.5 Initial Source Approval.** No shipments shall be made by any supplier until representative initial production samples have been approved by Materials Engineering as meeting the requirements of this specification.

**5.6 Material Safety Data Sheets.** Completed copies of the Material Safety Data Sheets meeting GM information requirements, consistent with ISO 11014-1 standard must be submitted with any new material submissions or where a composition change has occurred.

**5.7 Safety.** This specification may involve hazardous materials, operations, and equipment. This specification does not purport to address all of the safety problems associated with its use. It

is the responsibility of the user of this specification to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

#### 6 Approved Sources

Engineering qualification of an approved source is required for this specification. Only sources listed in the GM Approved Materials File (i.e., MATSPC) under this specification number have been qualified by Engineering as meeting the requirements of this specification.

**6.1 Trademark Licensing.** Licenses to use the trademark DEX-COOL<sup>®</sup> and related license identification numbers are issued only for engine coolants that have been approved by the GM Coolant Committee. For information on qualifying for a DEX-COOL<sup>®</sup> license, contact the General Motors Coolant Committee Chair, c/o GM Chassis/HVAC Materials Engineering, Mail Code 483-520-251, 2000 Centerpoint Parkway, Pontiac, MI 48341-3147.

#### 7 Coding System

This material specification shall be given in other documents, drawings, VTS, SSTs, CTS etc. as follows:

Extended Life Engine Coolant per GM6277M

#### 8 Release and Revisions

**8.1 Release.** This material specification was originated by the GM North American Materials Engineering Center in December 1994.

##### 8.2 Revisions.

Rev	Approval Date	Description (Organization)
B	MAR 1998	Moved to F&L Book (Fuels and Lubricant Specialists)
C	OCT 2003	Reformat, editorial revisions, expanded nonmetallic testing. (Fuels and Lubricant Specialists)