



COOLANT, PHOSPHATED, ORGANIC ADDITIVE TECHNOLOGY (POAT), CONCENTRATE, FOR PASSENGER CAR AND LIGHT TRUCK

WSS-M97B57-A1

1. SCOPE

The material defined by this specification is a coolant concentrate composed essentially of virgin monoethylene glycol and OAT corrosion inhibitors and phosphate. When mixed 50%/50% with water it shall be a satisfactory fluid for vehicle cooling systems that contain aluminum engine components, radiators and heater cores, ferrous metals and copper brass. This material is for initial fill and service fill.

2. APPLICATION

This specification was released originally for passenger car and light truck and commercial truck applications without the use of nitrites.

2.1 LIMITATIONS

This material is not suitable for use with magnesium based alloys or zinc coatings (e.g. galvanized product).

3. REQUIREMENTS

3.1 APPROVED SOURCES

This specification requires the use of approved sources. Only the sources identified on the Ford Approved Source List (ASL) can be used when this specification is listed on the drawing, CAD file, or other documents. The list of approved sources is located within Ford at www.mats.ford.com or available externally through a Ford Materials Engineer.

3.2 DOCUMENTATION

3.2.1 Approval of a new formulation

Supplier must provide a completed and certified copy of the attached Supplement A and test reports demonstrating full compliance with all the requirements of this specification. Suppliers must provide full disclosure of their material formulation to, and be approved by, Materials Engineering. This disclosure is to a list of each additive by name, target wt%, min and max wt% with sub-supplier names for all components, in particular organic acid technology additives, azoles and other corrosion additives, and ethylene glycol. Disclosure to also include production range levels for pH, specific gravity, reserve alkalinity and water content. All tests must be certified by a qualified and authorized representative of the test facility. Supplier must furnish DFMEA, PFMEA, Process Flow Diagram, and Control Plan.

Final approval must be obtained from the Coolant Subject Matter Expert within Global Core Powertrain Cooling Engineering. A formulation/supplier/blending site cannot be added to the approved source list without this Coolant SME approval.

3.2.2 Approval of a new supplier to an approved formulation

Same as 3.2.1 with surrogate test data where approved by Ford and testing and documentation, at minimum, in a PVP&R to be provided by Powertrain Cooling Engineering (Supplement B is

Date	Action	Revisions	Rev. 0
2018 05 01	Released		



Documents

A. Reaume, NA



an example of the form).

- 3.2.3 Supplying an approved formulation from a superconcentrate (of an approved formulation) blended with ethylene glycol by a local blender.

Same as 3.2.1 with surrogate test data where approved by Ford and testing and documentation, at minimum, in a PVP&R to be provided by Powertrain Cooling Engineering (Supplement B is an example of the form). In process testing to be a minimum of quarterly report to Ford Powertrain Installations Core, Materials Engineering and Purchasing of coolant inhibitor analyses in X-R chart and ASTM D1881, along with annual re-certification per 3.7.

3.3 COOLANT COMPOSITION

Coolants supplied to this specification must adhere to the following:

- Minimum of 85% virgin monoethylene glycol per ASTM E1177, Type EG-1
- ASTM D5827
- Silicon, from silicates, at 10 ppm maximum.
- Silicone – none, no silicone-containing antifoam
- Boron, from borates, at 5 ppm maximum
- Chlorides at 25 ppm max
- Sulfates at 30 ppm max
- Glycolate at 10 ppm max
- Nitrite at 5 ppm max
- ASTM D6130, Metals, less than 5 ppm, each metal unless otherwise indicated
- Calcium - report result
- Copper
- Iron
- Lead
- Magnesium - report result
- Strontium - report result

3.4 LABORATORY MATERIAL TESTING

Requirements in sections 3.4.1 to 3.4.13 are screening tests to determine if coolants qualify for more intensive evaluations. Unless noted, testing is to be performed on the concentrate.

3.4.1	Freezing point (ASTM D1177, D3321, or D6660, diluted 50%)	-37 °C (-34 °F) max
3.4.2	Specific Gravity (ASTM D1122)	1.110 – 1.145
3.4.3	Water Content (ASTM D1123)	5% max
3.4.4	pH at 50/50 dilution (ASTM D1287)	7.5 – 9.0
3.4.5	Reserve Alkalinity (ASTM D1121)	Report range and typical result



3.4.6	Foaming Characteristics (ASTM D1881) Foam Volume Break Time	150 ml max 5 sec max
3.4.7	Effect on Automotive Finish (ASTM D1882)	None
3.4.8	Color (Visual)	Yellow
3.4.9	Glassware Corrosion Test (ASTM D1384, Average of 3 weight loss determinations)	
3.4.9.1	Cast iron, steel, brass and copper	10 mg max
3.4.9.2	Cast aluminum, low lead solder	10 mg max
3.4.10	Hot Surface Corrosion Test (ASTM D4340)	
	Measure and report weight loss after cleaning with both methods: 1) Clean with deionized water 2) Clean with acid per ASTM D4340	
3.4.10.1	Initial	0.5 mg/cm ² /wk, max
	Note: 0.25 – 0.49 mg/cm ² /wk is considered marginal. 0.20 to 0.24 mg/cm ² /wk is favorable. less than 0.19 mg/cm ² /wk is excellent.	
3.4.10.2	After ASTM D2570	1.0 mg/cm ² /wk, max
3.4.11	Galvano-static pitting test (FLTM BL 105-01)	-400 mV, min
3.4.12	Electrical Conductivity (ASTM D1125, 20 °C, 50% by vol)	2400 uS/cm, min
3.4.13	Thermal Conductivity (ASTM D2717 or equivalent 20 °C, 50% by vol, mW/cm C)	Report Value
3.4.14	Compatibility with Other Coolants	

List of coolants for compatibility testing to be supplied by Ford FCSD, Materials Engineering or Product Development.

Prepare solutions containing 30%/70%, 50%/50% and 70%/30% and 10%/90% and 90%/10% v/v of proposed coolant and each coolant recommended by Ford currently supplied to the market in which the coolant is to be used for both initial fill and service (aftermarket) applications.

If either of the 30%/70%, or 70%/30% samples fails any portion of either of the tests, test the 10%/90% or 90%/10% sample(s) to ASTM D1384 and ASTM D4340.



3.4.14.1 Glassware Corrosion Test (ASTM D1384)

Cast iron, steel, brass and copper 10 mg max
Cast aluminum, low lead solder 10 mg max

Test 30%/70%, 50%/50% and 70%/30% solutions

3.4.14.2 Hot Surface Corrosion Test (ASTM D4340)

0.5 mg/cm²/wk, max

Test 30%/70%, 50%/50% and 70%/30% solutions
Report pH and Reserve Alkalinity before and after test.

Measure and report weight loss after cleaning with both methods:

- 1) Clean with deionized water
- 2) Clean with acid per ASTM D4340

3.4.15 Water Quality

Water used in coolant dilution must meet the requirements of WSS-M99P25-C.

3.4.16 Compatibility with Service Cleaners (aka flushes) (ASTM D1384)

List of service cleaners for compatibility testing to be supplied by Ford FCSD, Materials Engineering or Product Development. Test currently released coolant and proposed coolant for comparison without further dilution than shown below.

Table 1 - Test Fluids

Coolant and Cleaner	Coolant Control	Cleaner Control	ASTM Corrosive Water
50% Coolant	50% Coolant	0% Coolant	0% Coolant
10% Flush Concentrate	0% Flush Concentrate	10% Flush Concentrate	0% Flush Concentrate
40% ASTM D1384 Corrosive Water	50% ASTM D1384 Corrosive Water	90% ASTM D1384 Corrosive Water	100% ASTM D1384 Corrosive Water

Report results; compare current coolant with proposed coolant

Table 2

Coupon metal weight change	Current Coolant	Current Coolant/ Cleaner	Proposed Coolant	Proposed Coolant/ Cleaner	Cleaner Control	ASTM Corrosive Water
Al	Not required		Not required			Not required
Iron						
Steel						
Brass						
Solder						
Copper						

- A negative result indicates a weight gain



3.4.17 Storage Stability – Hard water and temperature and post-braze flux

Supplier must report water quality conditions that may adversely affect the quality of the coolant (inhibitor depletion, lowered life, etc). The coolant concentrate form, quality and chemical composition shall not be adversely affected, changed or impacted by storage up to 5 years under environmental conditions of normal distribution and storage. In-vehicle, the coolant mixed with water shall be stable so as not to change in form, quality or composition to adversely affects heat transfer or corrosion inhibition.

3.4.17.1 Hard Water Solution

Prepare hard water by adding 275mg of calcium chloride (CaCl_2) to 1 liter synthetic corrosive water described in the test solution section of ASTM D1384. Prepare six 100 ml coolant samples using the test coolant and the hard water solution. Samples are to have coolant concentrations of 100% (samples 1 and 2), 75% (samples 3 and 4) and 50% (samples 5 and 6). Put all samples in clean, labeled polymethylpentene (PMP) bottles for testing. (French square-type bottle may aid visual check.) All samples must pass hot and cold storage stability testing for the coolant to pass. All samples are to be photographed post-test.

Hot Storage Stability - Samples 1, 3 and 5 are heat storage tested in a circulating air oven at $65 \pm 2^\circ\text{C}$ for 14 days. Remove a 20 ml sample on days 2, 4, 7, 10 and 14. Allow to cool to room temperature. Check for precipitates, deposits, gelation and phase separation. "Fish eyes" on the top (from defoamer) are acceptable. If anything other than "fish eyes" is present, such as gel or material in solution or precipitate, terminate test and write as failure. Analyze coolant and material to determine effect.

Cold Storage Stability - Samples 2, 4 and 6 are cold storage tested at -40°C for 14 days. Remove a 20 ml sample on days 2, 4, 7, 10 and 14. Allow to go to room temperature. Check for precipitates, deposits, gelation and phase separation. "Fish eyes" on the top (from defoamer) are acceptable. If anything other than "fish eyes" is present, such as gel or material in solution or precipitate, terminate test and consider as a failure. Analyze coolant and material to determine effect.

3.4.17.2 Flux Solution

Prepare flux solution by adding 0.50 wt% post-braze Nocolok flux to 500 ml synthetic corrosive water described in the test solution section of ASTM D1384. Stir solution for 5 days at 90°C . Prepare four 250 ml coolant samples using the test coolant and the flux solution. Filter the samples with 0.45 micron filter to capture any solids. Samples are to have coolant concentrations of 50% (samples 1 and 2) and 40% (samples 3 and 4). Put all samples in clean, labeled polymethylpentene (PMP) bottles for testing. (French square-type bottle may aid visual check.)

Hot Storage Stability - Samples 1 and 3 are heat storage tested in a circulating air oven at $80 \pm 2^\circ\text{C}$ for 14 days. Remove samples after 14 days. Allow to cool to room temperature. Check for precipitates, deposits, gelation and phase separation. "Fish eyes" on the top (from defoamer) are acceptable. Filter the samples with 0.45 micron filter to capture any solids. Analyze coolant and material (FTIR and EDS/XRF) and report. Loss of phosphate or other anti-corrosion additive may be considered a failure.



Cold Storage Stability –. Put samples 2 and 4 in cold storage at -40 °C for 14 days. Allow to go to room temperature. Check for precipitates, deposits, gelation and phase separation. “Fish eyes” on the top (from defoamer) are acceptable. Filter the samples with 0.45 micron filter to capture any solids. All solids are to be photographed post-test, wet and dry. Analyze coolant analysis (pH, % glycol, corrosion inhibitors, etc.) and solids (FTIR and EDS/XRF) and report. Loss of phosphate or other anti-corrosion additive may be considered a failure.

- 3.4.18 Compatibility with Engine Hot Test Fluids - Havoline XLI (Europe) or Delo XLI (NA)
(See compatibility method in WSS-M97B56-A1)

Any changes, other than “fish eyes” deem the hot test fluid incompatible with the coolant.

- 3.4.19 Compatibility with Coolant Seals and Gaskets ≥10% RSF
(Test per WSS-M9P12-A2, para 3.2.2)

Initial qualification is completed as part of DV testing, ongoing testing for new programs is the responsibility of the seal suppliers.

- 3.4.20 Compatibility with Thermoplastic Materials
(FLTM BO 130-01, 1000 h at 125 +/- 2 °C)
(Materials identified by program; contact Materials Engineering or PTI Core for a list.)

50%/50% coolant/water, 10 test specimens minimum, Unaged property values shall be determined at the time of the aged properties determination. Test plastics used in continuous contact with coolant).

Test new coolant with approved coolant for comparison.

- 3.4.20.1 Tensile Strength at Max Load Report
(ISO 527, 5mm/minute test speed)

- 3.4.20.2 Impact Strength, Charpy Report
(ISO 179, Test specimens to be notched before immersion, 23 +/- 2 °C)

- 3.4.21 Compatibility with Heater Hose Material

- 3.4.21.1 Burst Pressure after Wet Heat Aging (optional unless specified by Hose TS)
(ASTM D380, fill hose with 50%/50% coolant and deionized water. Heat to 104 +/- 2°C for 2000 hours)

	WSE-M96D34 -A2	-A3	-A4	WSS-M96D34-A5
% Change	-10	-45	-28	-28
All hose				
Diameters				

- 3.4.21.2 EPDM Hose Extraction Test (Zinc/ Zinc Compound Extraction)

Hoses for testing to be determined by Hose Technical Specialist. May include peroxide cured and sulfur cured compounds.

Testing to be performed using approved WSS-M97B44-D coolant and proposed coolant.



Sulfur cured EPDM compounds employ zinc oxide and fatty acids such as stearates in their formulations as cure activators. These activators can produce zinc stearate, which can be extracted by engine coolant and re-deposit elsewhere in the system. Excess amounts of this compound can potentially block coolant passages and cause overheat. The following procedure provides a method to evaluate the potential amount of zinc stearate deposits they may see throughout the cooling system based on a standard sample size.

Equipment and Materials

- Three 356 mm x 38.1 mm hose samples
- Six stainless steel 25 mm long plugs of ample outer diameter to seal hose, both ends
- Six worm gear clamps of sufficient size for the hose sample
- Three watch glasses approximately 120 mm diameter
- One electronic balance capable of weights of 0.001 grams
- Petroleum ether
- Approximately 320 ml of 45% / 55% coolant / distilled water mixture
- Convection oven capable of 100°C

Procedure

1. Plug 1 end of the hose and apply clamp to seal. Fill hose 305 mm deep full of coolant / water mixture. Plug and clamp the open end. Verify no leakage. Bake at 100°C for 168 hours.
2. Prior to removal of the hoses from the oven, dry out the filter paper at 100°C for 1 hour, or to constant weight. Record the filter paper weight.
3. Remove a plug from one end of a hose sample and carefully drain the contents into a beaker. Photograph the coolant in the beaker from the side and top.
4. Pour the contents of the beaker onto the filter paper / vacuum filter set up. Pour a small amount of petroleum ether into the hose, swirl water, drain and repeat the rinse. If any visual residue remains in the hose, repeat rinse as necessary.
5. Using petroleum ether, wash any solid residue away from the sides of the beaker to the filter paper surface.
6. Photograph the coolant in the beaker post-filtration from the side and top.
7. Tare the watch glass. Carefully remove the filter paper, place on watch glass, and if necessary, use a spatula to collect any additional residue from the funnel sides and add to the filter paper. Bake filter paper at 100°C for 24 hours, then compare the pre-test weight and the post-test weight of the filter paper.

Acceptance Criteria

Weight of extractables on the filter paper must weigh less than 1.0 g for the entire cooling system and weight of extractables with proposed coolant must be less than those with the current coolant