



Refrigerant to Coolant Heat Exchanger-Chiller

1 Introduction

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 Scope. The Refrigerant to Coolant Heat Exchanger (chiller) is for use in passenger car and light commercial vehicle air conditioning systems where the chiller is mounted to the vehicle (but not the powertrain) as a sprung mass; and the chiller's coolant is used as part of a battery thermal system.

1.2 Mission/Theme. This specification defines the minimum requirements for chiller cores of the passenger car air conditioning systems which are operated with refrigerant HFC R134a (GM Part No. 9985751), HFO1234yf (GM Part No. 9986319), Polyalkylene Glycol (PAG) compressor oil (GM Part No. 9985752) and Polyolester (POE) compressor oil (GM Part No. 88862657 United States/88862658 Canada), and coolant (GM Part No. 9986100 which is a 50/50 mix of engine coolant Part No. 9985809 and deionized water).

The chiller core causes the liquid refrigerant to turn to vapor, whereby the heat in the coolant/water mix passing the chiller core is transferred to the refrigerant. This action cools the coolant mixture that is supplied to the battery thermal system.

1.3 Classification. Not applicable.

2 References

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

2.1 External Standards/Specifications.

ASTM D1384	ASTM G43	DIN 8964-2	SAE J1726
ASTM D2570	ASTM G85A3	SAE J639	SAE J2842

2.2 GM Standards/Specifications.

GMW3059	GMW3286	GMW15760	GMW16151
GMW3172	GMW3600		

2.3 Additional References.

eSOR Appendices C1 & C2

GM1829 Analysis Development and Validation (ADV) Plan

GM Part No. 88862657 United States/88862658 Canada

GM Part No. 9985751

GM Part No. 9985752

GM Part No. 9985809

GM Part No. 9986100

GM Part No. 9986319

SOR Appendix G2

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3 Requirements

3.1 Resistance Against Substances. The chiller shall be resistant against:

3.1.1 Drying Medium. As specified by the responsible development department.

3.1.2 Refrigerant Polyalkylene Glycol (PAG) compressor oil (GM Part No. 9985752) and Polyolester (POE) compressor oil (GM Part No. 88862657 United States/88862658 Canada).

3.1.3 Refrigerant HFC R134a (GM Part No. 9985751) and HFO1234yf (GM Part No. 9986319).

3.1.4 Fluorescent Leak-tracing Medium. Fluorescent Leak-tracing Medium is used for detection of leaks and is added to the drying medium in the dryer or accumulator. The quantity is dependent upon the relevant vehicle system.

3.1.5 POE Oil. Poly-olefin-ester oil (POE).

3.1.6 Coolant (GM Part No. 9986100) which is a 50/50 mix of engine coolant Part No. 9985809 and deionized water.

3.2 Documentation. Samples of components or material released to this specification shall be tested for conformity with the requirements of this specification and approved by the responsible GM Department prior to the start of delivery of production level components or materials. Any change to the component or material, e.g., design, function, properties, manufacturing process and/or location of manufacture, requires a new release of the product. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process per GM's Production Part Approval Process (PPAP), and to apply for a new release. Unless otherwise agreed to, the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases a shorter test can be agreed to between the responsible GM Department and the supplier.

3.3 Connection with Air Conditioning (A/C) Line/Thermostatic Expansion Valve (TXV) and Sealing. Connection will be with slim-line block. Seal: Sealing washer. See component drawing (if not otherwise requested by the responsible GM department). In the as-delivered condition, the refrigerant connections and O-rings shall be sealed.

3.4 Operating Conditions. The function of the chiller core shall be guaranteed for permanent operation in an ambient temperature of -40 °C to +120 °C without failure (rupture or leaking).

3.5 Internal Cleanliness. The internal parts of the chiller shall be clean and free of all contamination that could impair the operation and/or the performance of the assembly including, but not limited to, metals particles, dirt, foreign material, flux, soluble flux residue, metal chips, residual manufacturing material, manufacturing lubricants, scale, and other contaminants that are associated with the function of the evaporator. Flux residue shall not be considered a corrosion contaminant if it is insoluble in water, HFO1234yf, R134a and oils, and does not contribute to corrosion in the system. The internal parts shall be free of burrs, sharp corners, etc., which may be detrimental to assembly and function. The soluble and solid residues of internal surface area of the evaporator which can be washed away with solvent shall not contain any abrasive materials.

The internal cleanliness test shall be performed by flushing forward and flushing backward with a solvent (such as ethanol). The effluent shall be collected by filtering through a 5 µm filter and dried per accepted laboratory methods. All residues shall be <10 mg/part. The maximum particle size shall be 0.5 mm × 0.5 mm × 1 mm. Internal contaminant levels for chiller core assembly shall meet the contaminant levels when parts are prepared and contaminants are collected in a manner similar to SAE J1726 (test three assemblies). Chillers used for fuel cell applications may require additional conductivity requirements.

3.6 Leakage.

3.6.1 Coolant Leakage. The chiller core and assembled connections must be tight. For verification, the chiller core shall be charged with air at a static pressure of 420 kPaA minimum. No more than 4 cc per minute may leak during the evaluation period. No visible deformation may occur after test. Chiller cores shall be 100% leak tested before shipping from the plant.

3.6.2 Leak Rate Test of Chiller and TXV Assembly (Refrigerant). This test shall be a 100% production inspection type test. Refer to SAE J2842 for test procedure and criteria unless specified otherwise. The test time for the leak test shall be sufficiently long enough to detect a leak that may be temporarily masked by elastomers, oil, or other materials.

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- a. The chiller assembly which includes the core, pipes, and TXV shall be leak tested using a helium mass spectrometer.
- b. Proof test the assembly at a minimum of 1570 kPaA $\pm$ 20 kPaA prior to leak test.
- c. The leak test shall be performed at a minimum pressure of 1600 kPaA $\pm$ 20 kPaA.

3.6.2.1 Acceptance Criteria. For systems using HFO1234yf, the permissible equivalent leak rate shall be ≤ 5 g/year of HFO1234yf corresponding to 0.65 MPa absolute pressure. For systems using R134a, the permissible equivalent leak rate shall be ≤ 5 g/year of R134a corresponding to 0.65 MPa absolute pressure. See Figure 3, in 5.7.1 in SAE J2842 for helium/refrigerant conversion.

3.7 Internal Tightness. One hundred percent (100%) production inspection type test.

3.7.1 Refrigerant Internal Tightness Under Pressure to the Coolant. The chiller test sample shall be charged to a static pressure of minimum 1600 kPaA on the refrigerant side of the core to verify internal tightness (between coolant and refrigerant) with the coolant side open to the test chamber. The permissible equivalent leak rate shall be ≤ 5 g/year. See Figure 3, in 5.7.1 in SAE J2842 for helium/refrigerant conversion.

3.7.2 Tightness Under Vacuum.

3.7.2.1 Refrigerant Side. The chiller core shall be able to withstand a static absolute pressure of 2.0 kPa for two minutes. It is not acceptable for any irreparable damage, functional impairment or leaks to occur during this test. The maximum permissible increase in pressure shall not exceed 1 kPa/h. This sequence must be repeated three times on each test sample. Upon completion of test, the chiller must be able to meet all leakage requirements.

3.7.2.2 Coolant Side. The chiller core shall provide sufficient strength and tightness under vacuum. The chiller core shall be able to withstand a static absolute pressure of 10.0 kPa for 2 minutes. It is not acceptable for any irreparable damage, functional impairment or leaks to occur during this test. The maximum permissible increase in pressure shall not exceed 1 kPa/h. This sequence must be repeated three times on each test sample. Upon completion of test, the chiller must be able to meet all leakage requirements.

3.7.3 Coolant Temperature Cycle Test. The chiller core shall be resistant against temperature cycles. For testing, the chiller core shall be mounted on a test stand and tested according to the following procedure:

3.7.3.1 Cold Coolant. Coolant flow for 7 minutes.

- $-20\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$.

3.7.3.2 Then change within 10 s to hot coolant flow for 5 minutes: $+45\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$.

- **Flow rate:** 20 L/minute.
- **Pressure absolute:** $+250\text{ kPa} \pm 10\text{ kPa}$.
- **Number of cycles:** 1000.

3.7.4 Refrigerant Temperature Cycle Test. Ten (10) temperature cycles from $-30\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ to $+90\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ with a heating and/or cooling rate of $0.5\text{ }^{\circ}\text{C}$ to $1\text{ }^{\circ}\text{C}$ per minute minimum. The duration of previously mentioned minimum/maximum values will be 30 minutes in each case, filling with R134a: 0.3 g/cm^3 internal volume. Subsequently, chiller must meet all leakage requirements.

3.8 Strength Including Pipes. The chiller core and its connecting pipes must be designed to provide adequate strength to withstand all requirements of transportation, vehicle installation and vehicle application. A chiller core assembled into a chiller or air conditioning unit may not show any functional deviations if an effort of 150 N is applied in direction of pipes or any other possible direction to the pipe ends. After completion of test, pipe end location must be within 2 mm of the original pipe end location. No permanent deformation of pipe ends is permitted if coolant hoses and clamps are assembled. The fastening torque of the clamp screw shall be 3.5 Nm.

3.9 Vibration Tests. Vibration durability testing shall be conducted on a tri-axial shaker. The chiller, and all components it supports, shall be mounted to the vehicle mounting structure using the production intent isolators which shall be secured to the tri-axial table. All coolant hoses and A/C lines shall be attached and retained in vehicle position. All heat exchangers shall be charged with the correct fluid and statically pressurized with compressed air to 200 kPaA. All heat exchangers shall be monitored with gages or transducers to record any pressure decay as a result of core damage and leaking. Reference GMW3172,

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Mechanical Loads, Code C (Car Sprung Mass). As an alternative, vibration durability can be assessed by evaluating the three axes in serial if a tri-axial shaker is not available.

3.10 Pressure Test.

3.10.1 Coolant Pressure Cycle Resistance. Chiller core shall be tested according to the following procedure:

3.10.1.1 Pressure Cycle.

- Test fluid: Hydraulic oil
- Number of cycles: 250 000
- Temperature: $+70\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$
- Flow rate: 20 L/minute
- Pressure cycle rate: 2 Hz
- Upper pressure limit ($p_{\max}$): 400 kPaA
 - Lower pressure limit ($p_{\min}$): 120 kPaA
 - Upper holding time ($t_{\max}$): 0.25 s
 - Lower holding time ($t_{\min}$): 0.25 s
 - Transient time (t_{trans}): 0.25 s
 - Time duration cycle: 1 s
 - Time duration test: 28 h

3.10.1.2 After every 50 000 cycles, one pressure cycle from 100 kPaA to 450 kPaA pressure shall be applied. The total test shall be 250 000 pressure cycles. After this test, the chiller cores must be completely functional. Following this test, the chiller core may not show any defects and must fulfill the vibration, heat transfer, and leakage requirements.

3.10.2 Refrigerant Pressure Cycle Resistance. The following test conditions apply:

3.10.2.1 Load Cycles: 150 000.

3.10.2.2 Temperature: $+60\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

3.10.2.3 Pressure Cycle Rate: $15 \pm 5/\text{minutes}$.

- Lower pressure limit: 200 kPaA.
- Upper pressure limit: 1300 kPaA.

3.10.2.4 After test, the chiller must meet all leakage requirements.

3.10.3 Coolant Burst Pressure Resistance. After the pressure cycle test, the chiller core shall be charged with water and submitted to a slowly increasing pressure of 50 kPa per minute until a leak occurs. No leaks may occur until a pressure of 900 kPaA is reached.

3.10.4 Refrigerant Burst Pressure Resistance. The burst pressure is the internal pressure which causes chiller structural failure and/or deformation that could lead to leakage. Refer to SAE J2842 and SAE J639 for more details.

- a. Prior to Burst Testing, a Tube Bending test, according to 3.2.1.6 in GMW16151, shall be performed followed by a Leak Rate test according to 3.6.2 in this standard. The tube bending test is not required for the in-process quality assurance burst testing.
- b. The burst pressure values are defined as follows:
 - Beginning of life (BoL): Two (2) times the maximum refrigerant operating low side pressure. The burst pressure value is set to 3000 kPaA. The maximum low side pressure value for a system using R1234yf is the saturation pressure of HFO1234yf at $56\text{ }^{\circ}\text{C}$. For a system using R134a, the maximum low side pressure value is the saturation pressure of R134a at $54\text{ }^{\circ}\text{C}$. Refer to SAE J639 for more information.
 - End of life (EoL): 75% of BoL pressure.
- c. The chiller assembly which includes mating block simulating a TXV (e.g., dummy TXV) and pipes shall be connected per design intent on a burst test bench and pressurized. Test fluid can be oil or water and its

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