



Air Conditioning Hose and Coupling Assemblies R134a and R1234yf

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.

Note: Unless otherwise stated as gauge, pressures listed within this specification are absolute.

1.1 Purpose. This specification establishes the minimum requirements for the Air Conditioning (A/C) hose and coupling assemblies intended for use in GM automotive air conditioning systems with liquid and gaseous refrigerant:

- Refrigerant: R134a (GM Part Number 9985751 or equivalent).
- Refrigerant: R1234yf (GM Part Number 9986319 or equivalent, see Global Product Description System/Area Parts Manager (GPDS/APM)).
- Polyalkylene Glycol (PAG) compressor oil (Material specification 9986181 for R134a) for R1234yf - PAG oil specification, refer to the following:
 - Mahle (formerly Delphi) - PSD1 - 9986364.
 - Mitsubishi Heavy Industries (MHI), MHI - PAG46 - 9986365.
 - Denso - ND12 - 9986366.
 - Sanden - SP-A2 - 9273590.
- Polyolester (POE) compressor oil (Material specification 9986277).

The functions, performance, reliability, qualification tests and shipping requirements for A/C hose and coupling assemblies are defined in this document.

1.2 Applicability. Not applicable.

1.3 Remarks. PAG and POE compressor oil formulations are unique to each A/C compressor manufacturer. In order to evaluate the entire spectrum of compressor oil formulations and refrigerants (R134a and R1234yf) used in GM vehicles, the A/C hose and coupling assembly supplier shall perform the material compatibility tests with the compressor oil formulations and refrigerant type confirmed by the responsible GM Global Thermal Bill of Materials (BOM) Family Owner (BFO).

2 References

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

2.1 External Standards/Specifications.

ASHRAE 97	ASTM D2240	ISO 188	ISO 7619-1
ASTM D380	ASTM D3182	ISO 815	ISO 11357
ASTM D412	DIN 8905-1	ISO 1431-1	SAE CRP1234-2
ASTM D573	ISO 36	ISO 1817	SAE J639
ASTM D1149	ISO 37	ISO 2393	SAE J2064
ASTM D1415	ISO 48	ISO 7111	

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2.2 GM Standards/Specifications.

9986181	GMW8758	GMW15760	GMW16331
9986277	GMW14573	GMW15786	GMW17010
GMW3059	GMW14872	GMW15862	GMW17223
GMW3116	GMW15272	GMW16317	

2.3 Additional References.

- ADVP&R located in the SOR
- Agilent (www.agilent.com)
- Delphi (www.delphi.com)
- Denso - Part Number 9986366 (www.globaldenso.com)
- Element Analysis Corporation (www.elementanalysis.com)
- EZChrom Elite/Server Software
- GM Design Guidelines
- GM Part Number 88864127
- GM Part Number 52458086
- GM Part Number 52458087
- GM Part Number 52458090
- GM Part Number 9985751
- GM Part Number 9986319
- GM Recyclability Checklist
- GM Recycled Content Report Form
- GM Recycling Design Guidelines
- GM1738 - Intercontinental Packaging Requirements for Production Parts
- Mahle - Part Number 9986364 (www.mahle.com)
- Mitsubishi Heavy Industries - Part Number 9986365 (www.mhi-global.com)
- Respective Drawing
- Sanden - Part Number 9273590 (www.sanden.com)
- Standard Laboratory Safety Precautions
- Vehicle Road Load Data Profile

3 Requirements

All requirements of this standard must be met in order to demonstrate compliance with Design Validation (DV), Product Validation (PV) and In-Process (IP) evaluations.

3.1 System/Subsystem/Component/Part Definitions.

3.1.1 Appearance. When tested per 4.3.26, all exterior and interior surfaces shall be clean and free of weld and/or braze splatter, flash, ridges, sharp edges, flux paste, scratches, roughness, manufacturing lubricants, and other contaminants that are not associated with the function of a coupled hose assembly (for insoluble flux residue allowance contact BFO and Validation Engineer).

3.1.2 Content.

3.1.2.1 Physical Content. An A/C hose and coupling assembly consists of an aluminum line crimped to an A/C hose. See Figure 1.

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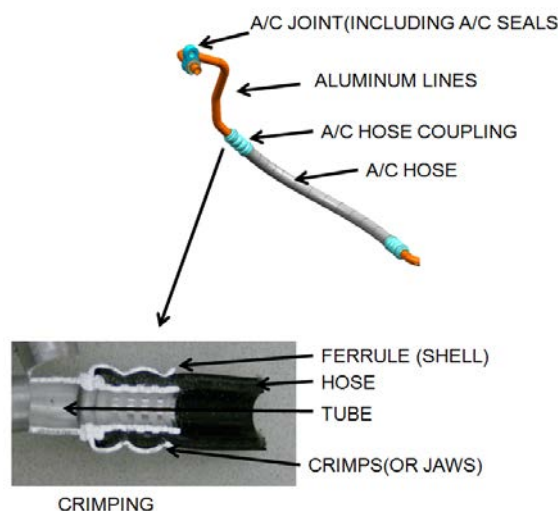


Figure 1: A/C Hose and Coupling Line

3.1.2.2 Functional Content. The A/C hose and coupling assembly must provide a connection interface between A/C plumbing hard lines and A/C flexible hoses.

3.1.3 Ambient Environment. The A/C hose and coupling assembly is expected to be fully functional under ambient conditions of:

- Ambient temperature -40°C to $+135^{\circ}\text{C}$ at continuous and -40°C to $+140^{\circ}\text{C}$ at excursion for high temperature hose.
- Ambient temperature -40°C to $+125^{\circ}\text{C}$ at continuous and -40°C to $+135^{\circ}\text{C}$ at excursion for normal temperature hose.
- Relative Humidity (RH): 5% to 100%.

Supplier shall show compliance with these Hose Ambient Environment temperature validations before Technical Review, the hose type and usage needs to be approved by the Design Release Engineer (DRE) and Validation Engineer.

3.1.4 Interfaces. A/C hose and coupling assemblies interface with A/C hose, end form pipe and in few cases, with sleeve attachments such as plastic straps.

3.1.5 Usage Definition. Not applicable.

3.1.6 Hose. Element used in A/C systems to attenuate the forces resulted of relative movement between two moving components (e.g., engine and chassis). This element can also be used to attenuate some types of noise coming from moving sources (e.g., A/C compressor), and to help manufacturing assembly.

- **Normal Temperature Hose:** Hose used in A/C systems in low side pressure (between Thermostatic Expansion Valve (TXV) or evaporator outlet and compressor inlet) or liquid (condenser to TXV).
- **High Temperature Hose:** Hose used in A/C systems in high side pressure (between compressor outlet and condenser inlet).

There are three types of A/C Hoses covered by this standard as follows:

3.1.6.1 Type A: Rubber (Low Noise Vibration Harshness (NVH)) Hose. Hose having a seamless rubber lining, and a reinforcement consisting of one or more plies of textile yarn adhered to the inner tube and outside cover. The outside rubber cover shall be heat and ozone resistant. See Figure 2. The Type A hose is to be used for suction only.

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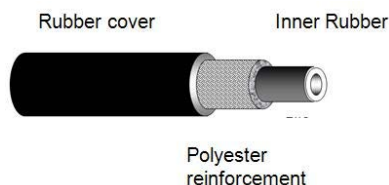


Figure 2: Rubber Type Hose

3.1.6.2 Type B: Standard Permeation (Barrier or Veneer) Hose. Hose having an inner thermoplastic barrier layer (veneer type hose) or an inner layer of rubber adhered to the thermoplastic barrier layer (barrier type hose), a rubber layer, and a reinforcement consisting of one or more plies of textile yarn adhered to the rubber layer underneath and to the outside rubber cover. The outside cover shall be heat and ozone resistant. See Figure 3.

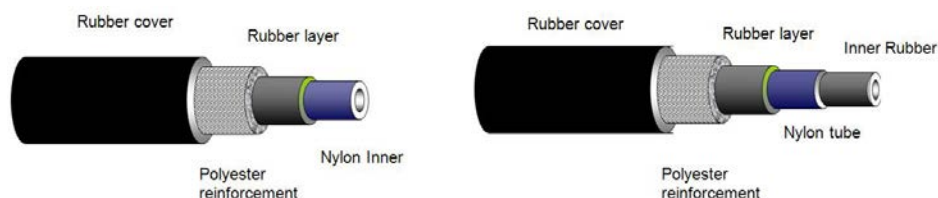


Figure 3: Standard Permeation Type Hose (Left: Veneer Type, Right: Barrier Type)

3.1.6.3 Type C: Low Permeation (Barrier Layer) Hose. Hose having a thermoplastic barrier layer, a rubber layer, and a reinforcement consisting of one or more plies of textile yarn adhered to the rubber layer underneath and to the outside rubber cover. The outside cover shall be heat and ozone resistant. This hose shall have an inner layer of rubber adhered to the thermoplastic barrier layer. See Figure 4.

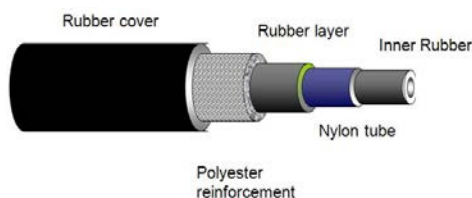


Figure 4: Low Permeation Type Hose

Coupling Assembly (Crimping): An element used in A/C systems to join a rubber hose with an aluminum line to improve flexibility and avoid failures due to stress added by A/C moving components.

Shell: Metal to maintain connection between hose and tube end form fitting.

3.2 Product Characteristics.

3.2.1 Performance Requirements.

3.2.1.1 Dimensional. When evaluated per 4.3.1, minimum internal coupling diameter (B) at the end form fitting must meet Table 1. See Figure 5.

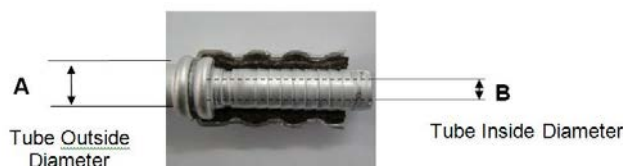


Figure 5: Coupling Construction

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Table 1: Reduction in Cross Sectional Area in Coupled Hose

		A		B	
Hose Nominal Diameter	DIN Specification	Tube Size (millimeters)	Tube Size (inches)	Minimum Internal Crimp Diameter for Type A (Rubber) Hose	Minimum Internal Crimp Diameter for Type B and Type C (Thermoplastic) Hose
8 mm (⁵ / ₁₆ in)	DIN 8905-1	8 × 1.00	³ / ₈ × 0.039	Not applicable	4.2 mm (insert may be required to reach minimum diameter)
		10 × 1.00			
		10 × 1.25	³ / ₈ × 0.049		
10 mm (¹³ / ₃₂ in)	DIN 8905-1	12 × 1.25	¹ / ₂ × 0.049	Not applicable	6.1 mm (insert may be required to reach minimum diameter)
		12 × 1.65	¹ / ₂ × 0.065		
12.7 mm (¹ / ₂ in)	DIN 8905-1	12.7 × 1.25	¹ / ₂ × 0.049	Not applicable	8.6 mm (insert may be required to reach minimum diameter)
		12.7 × 1.65	¹ / ₂ × 0.065		
16 mm (⁵ / ₈ in)	DIN 8905-1	16 × 1.25	⁵ / ₈ × 0.049	11.2 mm (insert may be required to reach minimum diameter)	
		16 × 1.65	⁵ / ₈ × 0.065		
		19 × 1.25	³ / ₄ × 0.049	11.2 mm (insert may be required to reach minimum diameter)	
		19 × 1.65	³ / ₄ × 0.065		
19 mm (³ / ₄ in)	DIN 8905-1	19 × 1.25	³ / ₄ × 0.049	14.0 mm (insert may be required to reach minimum diameter)	
		19 × 1.65	³ / ₄ × 0.065		

3.2.1.2 Material. When tested per 4.3.2; Material requirements for finished parts are summarized in Appendix D, Table D1 and Table D2.

Note: Hose supplier shall analyze the lining sulfur content and free sulfur under GMW16317 Method D (Cooper Plate Test).

Note: Usage of peroxide cured hoses or any other rubber compound cured with peroxide to be used with R1234yf refrigerant is restricted due to debris formation risk, it needs written approval from A/C lines BFO to use it.

3.2.1.3 Leakage. When tested per 4.3.3, the A/C hose and coupling assembly and/or test coupon (including the two crimps) must not exceed a leak rate equivalent to 0.5 g/year of R134a or R1234yf refrigerant.

3.2.1.3.1 Mid checks or required checks during testing with refrigerant in the line set will check to 2 g/year at test pressure.

3.2.1.3.2 In-process will check 100% of all coupled hose assemblies. Check for leak tested at each joint of the assembly using a leak detector indicating sensitivity for leakage equivalent to 4 g/year of HFC134a or R1234yf refrigerant at 1.38 MPag.

3.2.1.4 Bending Rigidity. When tested per 4.3.4, the maximum tensile force shall be the value shown in Table 3.

Note: There is not a Table 2.

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Table 3: Bending Rigidity

Nominal Diameter	Test Value
8 mm ($\frac{5}{16}$ in)	13.0 N (maximum)
10 mm ($\frac{13}{32}$ in)	15.0 N (maximum)
12.7 mm ($\frac{1}{2}$ in)	17.5 N (maximum)
16 mm ($\frac{5}{8}$ in)	20.0 N (maximum)
19 mm ($\frac{3}{4}$ in)	25.0 N (maximum)

3.2.1.5 Kink Resistance. When tested per 4.3.5, the difference between the hose nominal Outside Diameter (OD) and dimensions d_k and d_g shall not exceed the values shown in Table 4.

Table 4: Kink Resistance

Nominal Diameter	OD - d_k and OD - d_g
8 mm ($\frac{5}{16}$ in)	± 0.6 mm
10 mm ($\frac{13}{32}$ in)	± 0.8 mm
12.7 mm ($\frac{1}{2}$ in)	± 0.9 mm
16 mm ($\frac{5}{8}$ in)	± 1.75 mm
19 mm ($\frac{3}{4}$ in)	± 2.0 mm

3.2.1.6 Moisture. When tested per 4.3.6, free moisture must not exceed 0.50 g.

3.2.1.7 Crystallization, Low Temperature Embrittlement and Vacuum Flattening. When tested per 4.3.7, the A/C hose and coupling assembly must meet the following requirements.

3.2.1.7.1 Crystallization. ($W1 - W2$) - ($W1' - W2'$) must be < 0.3 g.

3.2.1.7.2 Low Temperature Embrittlement. ($W2 - W3$) - ($W2' - W3'$) must be < 0.2 g. No visible external degradation, i.e., cracking, delamination, etc., is acceptable.

3.2.1.7.3 Vacuum Flattening.

- The minimum diameter dimension shall not be $< 80\%$ of the minimum hose outside diameter as measured in 4.3.7.3.1 in the U shape prior to the application of the vacuum.
- The maximum permissible pressure increase is 0.8 mmHg/minute.
- Any visible signs cracking or degradation in the hose outer and/or inner surface are not permitted.

3.2.1.8 Tensile. When tested per 4.3.8, the hose samples with fittings shall meet the minimum tensile forces specified in Table 5.

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Table 5: Tensile Test

Nominal Diameter	Hose Type	
	Type A (Rubber Hose)	Type B and Type C (Barrier Layer Hose)
	Minimum Tensile Force	
8 mm ($\frac{5}{16}$ in)	Not applicable	1500 N
10 mm ($\frac{13}{32}$ in)	Not applicable	2500 N
12.7 mm ($\frac{1}{2}$ in)	Not applicable	3000 N
16 mm ($\frac{5}{8}$ in)	2450 N	3250 N
19 mm ($\frac{3}{4}$ in)	4500 N	4000 N

3.2.1.9 Pressure. When tested per 4.3.9, there shall be no evidence of hydraulic fluid leakage from the crimp couplings or the body of the hose. Any signs of leakage constitute a nonconformance.

3.2.1.10 Decompression. Not applicable.

3.2.1.11 Refrigerant Emissions.

3.2.1.11.1 Short Term Loss Rate. When tested per 4.3.11.1, the maximum permissible refrigerant loss must not exceed the values in Table 6.

Table 6: Refrigerant Short Term Loss Rate

Temperature	Hose Type		
	Type A Rubber Hose	Type B Barrier Hose Standard Permeation	Type C Barrier Hose Low Permeation
80 °C (either refrigerant)	10.0 g/m/day	2.0 g/m/day	0.8 g/m/day
90 °C (134a only)	Not applicable	3.0 g/m/day	1.0 g/m/day

3.2.1.11.2 Long Term Loss Rate. When tested per 4.3.11.7, the maximum permissible refrigerant loss must not exceed the values in Table 7.

Table 7: Refrigerant Long Term Loss Rate

Temperature	Hose Type		
	Type A Rubber Hose	Type B Barrier Hose Standard Permeation	Type C Barrier Hose Low Permeation
80 °C (either refrigerant)	17.5 kg/m ² /year ^{Note 1}	4.0 kg/m ² /year	1.5 kg/m ² /year
90 °C (134a only)	Not applicable	10.0 kg/m ² /year	2.0 kg/m ² /year

Note 1: Due to high permeation rates for Type A hoses, Type A hoses need to be limited and approved by Design Release Engineer (DRE) and BFO before it is selected.

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3.2.1.11.3 Long Term Loss Rate (Optional Method for R1234yf). When tested per 4.3.11.9, the maximum permissible refrigerant loss must not exceed the values in Table 8.

Table 8: Refrigerant Long Term Loss Rate

Temperature	Hose Type		
	Type A Rubber Hose	Type B Barrier Hose Standard Permeation	Type C Barrier Hose Low Permeation
80 °C	0.6 kg/m ² /year	0.36 kg/m ² /year	0.36 kg/m ² /year

3.2.1.12 Moisture Vapor Ingression. When tested per 4.3.12, the hose must not ingress moisture at a rate greater than specified in Table 9.

Table 9: Moisture Ingress Rate

Hose Type		
Type A Rubber Hose	Type B Barrier Hose Standard Permeation	Type C Barrier Hose Low Permeation
0.011 g/cm ² /year	0.039 g/cm ² /year	0.039 g/cm ² /year

3.2.1.12.1 The pH of the condensate shall not be < 6.0. The pH shall be measured immediately to prevent CO₂ from dissolving in the collected water.

3.2.1.12.2 No > 50 ppm of chloride is allowed in the condensate.

3.2.1.13 Internal Cleanliness. When tested per 4.3.13, no > 210 mg/m² (internal surface area) of foreign material per assembly shall be retained by the filtration system, after drying to a constant weight. Size of the contaminants shall not exceed 0.3 mm in any dimension for contaminants with a Brinell Hardness < 95 and 0.05 mm in any dimension (maximum) with a Brinell Hardness > 95.

3.2.1.14 Extractables. When tested per 4.3.14:

- The extractable material obtained shall not exceed 12 mg/cm² of tube surface.
- No green/blue flame shall appear when a copper wire and extracts are placed in the Bunsen burner flame.

3.2.1.15 Chemical Compatibility. When tested per 4.3.15, the extractable material shall not cause refrigerant or lubricant decomposition when compared to the control sample containing no extract.

3.2.1.15.1 The visual rating (visual rating for lubricant and metals are additive) shall not exceed a total rating of three (3), and the gas chromatographic analysis shall not show a total decomposition of > 0.5%.

3.2.1.15.2 Visual Ratings.

- Lubricant:
 - 0 = No Change
 - 1 = Slight Darkening
 - 2 = Moderate Darkening
 - 3 = Extreme Darkening
 - 4 = Black, Lubricant Deposits

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- Metals (Iron (Fe), Copper (Cu), Aluminum (Al)):

0 = No Change

1 = Discoloration/Tarnish

2 = Slight Cu Plating/Corrosion

3 = Moderate Cu Plating/Corrosion

4 = Heavy Cu Plating/Corrosion, Pitting

- Gas Chromatography (GC):

Analyze for decomposition products of refrigerant/lubricant (volatiles) (e.g., R134a + PAG = Refrigerant Decomposition (A or B) + Hafnium Element (HF) Measured amount via GC).

Note: An (A) following the numerical rating value indicates a clear solution, while a (B) indicates a cloudy solution.

3.2.1.16 Anion. When tested per 4.3.16, if the concentration of any anion is > 200 ppm, the supplier must demonstrate that it does not contribute to the acidity of the system.

3.2.1.17 Change in Length/Angle. When tested per 4.3.17, the length changes and angle deviations shall not exceed the values specified in Table 10. This is consistent with the SAE J2064 recommended practice. See Table 10.

Table 10: Length Change, Angle Deviation

Change in Length	Deviation of Angle
-4% to +2%	10 degrees/m (maximum)

3.2.1.18 Delamination. When tested per 4.3.18:

- There shall be no evidence of blisters or separation of the inner rubber material from the plastic layer.
- The adhesion between the inner rubber material and the plastic shall not be compromised and should result in a stock tear or failure of one of the layers rather than a separation of these layers.
- Minimum 875 Nm (5 lb/in).

3.2.1.19 Burst Strength. When tested per 4.3.19, the burst strength of the coupled hose assembly shall be a minimum of 8.6 MPa (1250 psi) at room temperature. This pressure exceeds industry recommended safety practices for proper A/C system design, (e.g., SAE J639). In case of a failure, loosening/separation of any parts is not allowed.

3.2.1.20 Pressure Cycling and Vibration.

3.2.1.20.1 Pressure Cycling. When tested per 4.3.20.1:

- After completion of the pressure cycle test, there shall be no evidence of leaks, hose distress or degradation, tube material fatigue, or tube weld fatigue.
- For tensile test, the hose shall retain a minimum of 80% of the required tensile strength.
- For burst test, follow acceptance criteria per 3.2.1.19.
- Pressure cycle test results must demonstrate the required reliability as stated in 3.2.3.2.

3.2.1.20.2 Vibration. When tested per 4.3.20.2:

3.2.1.20.2.1 Allowable leakage:

- When attempting to rotate the hose around the metal tubing by hand, there shall be no such rotation or movement. If a slight movement (slippage) occurs, re-leak test to ensure a leak path was not created.
- If the refrigerant weight (minus variation control sample weight loss) loss after each axis of vibration exceeds the values listed in Table 11, the hose fails. See 1.3 for refrigerant type used.
- There shall be no evidence of hose distress, wrinkles, or degradation, tube material fatigue or tube weld fatigue.

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3.2.1.20.2.2 If any of the acceptance criteria are not met, the supplier must determine the root cause and resolve the nonconformance and rerun the entire test procedure.

Table 11: Maximum Refrigerant Weight Loss

Hose Size, Inside Diameter (ID)	Maximum Weight Loss After Completion of Each Axis of the Vibration Test
8 mm ($\frac{5}{16}$ in)	2.6 g
10 mm ($\frac{13}{32}$ in)	3.4 g
16 mm ($\frac{5}{8}$ in)	5.3 g
19 mm ($\frac{3}{4}$ in)	6.3 g

3.2.1.21 Coupling Integrity (CI). When tested per 4.3.21:

- Weight loss per canister (two couplings) must not exceed the requirements listed in Table 12.
- All post-interval flexing evaluations shall not produce hissing or visible oil loss.
- When attempting to rotate the hose by hand around the metal tubing, there shall be no such rotation.
- If imperfections or cracks exist after the hose is examined externally, the hose fails. If a loose cover exists, the hose fails.
- No imperfections must result from 4.3.21.
- If the shell has any cracks, the hose assembly fails.
- If the assembly leaks, return it to the coupler for Root Cause Analysis (RCA).

3.2.1.21.1 When tested using hose lines assembly:

- Refrigerant weight loss shall not exceed the values shown in Table 12.
- There shall be no visible oil loss and no visible signs of hose material degradation.
- Refrigerant leakage rates shall not exceed 1 g/year anywhere in the connector assemblies during any of the four (4) bending tests following the exposure intervals.
- The two (2) hose assemblies that were subjected to pressure test per 4.3.9 and leakage per 4.3.3, shall meet all requirements of those evaluations.
- The percent (%) of crimp difference must be not > 5% of initial measurement.

Table 12: Refrigerant Weight Loss, Exposure (See 1.3 for Refrigerant Type)

Nominal Diameter	Permissible Refrigerant Loss		
	After 4 th Interval	After 8 th Interval	After 12 th Interval
8 mm ($\frac{5}{16}$ in)	3.0 g (maximum)	4.0 g (maximum)	As recorded (5.0 g maximum)
10 mm ($\frac{13}{32}$ in)	3.0 g (maximum)	4.0 g (maximum)	As recorded 5.0 g (maximum)
12.7 mm ($\frac{1}{2}$ in)	6.0 g (maximum)	6.0 g (maximum)	As recorded 7.0 g (maximum)
16 mm ($\frac{5}{8}$ in)	6.0 g (maximum)	8.0 g (maximum)	As recorded 10.0 g (maximum)
19 mm ($\frac{3}{4}$ in)	8.0 g (maximum)	10.0 g (maximum)	As recorded 12.0 g (maximum)

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3.2.1.22 Noise and Vibration. Not applicable.

3.2.1.23 Thermal Pressure Resistance of Hose Line with Connected Canister. When tested per 4.3.23, all of the following criteria must be met in order to demonstrate compliance:

- a. After performing 4.3.23.10, refrigerant weight loss shall not exceed twice (two times) the value per Table 6.

Note: Adjust refrigerant weight loss with material weight loss of the control sample.

- b. After performing 4.3.23.11, no visible degradation or damage is permitted.
- c. After performing 4.3.23.12, percent of crimp difference must be not > 5% of initial measurement.
- d. After performing 4.3.23.13, leakage shall not exceed limits documented in 3.2.1.3.
- e. After performing 4.3.23.14, no oil leakage or hose material degradation is permitted.

3.2.1.24 Corrosion Resistance. When tested per 4.3.24, the following requirements shall be met:

- a. Underhood cosmetic corrosion and underbody functional corrosion resistance methods 1 and 2 requirements: Table A1 and Table B4 in GMW15272.
- b. For functional corrosion: A/C leak test requirement per 3.2.1.3.

3.2.1.25 Heat Age. When tested per 4.3.25, maximum allowable leakage is listed in Table 13, see 1.3.

Table 13: Allowable Leakage

Hose Type	Leakage Maximum Allowable	
Refrigerant	R134a	HFO-1234YF
A ^{Note 1}	15 g	35 g
B	Reference: Data Only	Reference: Data Only
C	10 g	6 g

Note 1: Due to the high permeation rates the usage of this hose needs to be approved by DRE and global thermal BFO prior to selection.

HFO Hydrofluoro-olefin

3.2.2 Test Requirements.

3.2.2.1 Design Validation (DV). A/C hose and coupling assemblies shall be tested for conformance per the sections listed in Table 14.

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Table 14: Design Validation (DV) and Product Validation (PV) Test Table Note 1, Note 4

Section	Test Procedure	Test	Number of Samples DV	Number of Samples PV
3.2.1.1	4.3.1	Dimensional	10	3
3.2.1.2	4.3.2	Material	1 Batch (hose only)	0
3.2.1.3	4.3.3	Leakage	10	3 (final assembly)
3.2.1.4	4.3.4	Bending Rigidity	3 (hose only)	0
3.2.1.5	4.3.5	Kink Resistance	3 (hose only)	0
3.2.1.6	4.3.6	Moisture	0	3 (final assembly)
3.2.1.7	4.3.7	Crystallization, Low Temperature Embrittlement and Vacuum Flattening	4 (2 each at nominal and minimum) +1 for volatility Note 2	0
3.2.1.8	4.3.8	Tensile Strength	3	3
3.2.1.9	4.3.9	Pressure	3	3
3.2.1.10	4.3.10	Decompression	Not applicable	Not applicable
3.2.1.11	4.3.11	Refrigerant Emissions (Short Loss Rate and Long Loss Rate)	4 (4 samples each) +1 for volatility Note 2	0
3.2.1.12	4.3.12	Moisture Vapor Ingression	4 (hose only)	0
3.2.1.13	4.3.13	Internal Cleanliness	0	4 (final assembly)
3.2.1.14	4.3.14	Extractables	5 (hose only)	0
3.2.1.15	4.3.15	Chemical Compatibility	5 (from 3.2.1.14)	0
3.2.1.16	4.3.16	Anion	5 (from 3.2.1.14)	0
3.2.1.17	4.3.17	Change in Length/Angle	5 (hose only)	0
3.2.1.18	4.3.18	Delamination	4	0
3.2.1.19	4.3.19	Burst Strength	3	3
3.2.1.20	4.3.20	Pressure Cycling and Vibration (Body Mounted Lines)	6 each (6 coupon = 12 couplings or final assemble) at nominal and minimum crimp compression and 3 final assemblies vibration profile only Note 2	3 (final assembly) vibration profile only
	4.3.20	Vibration (engine compressor lines) Note 3	3 (final assembly) Natural Frequency Shaker Test	3 (final assembly) Natural Frequency Shaker Test
3.2.1.21	4.3.21	Coupling Integrity	24 couplings (=12 coupons) +1 for volatility Note 2	6 coupons (= 12 couplings) +1 for volatility
3.2.1.22	4.3.22	Noise and Vibration	Not applicable	Not applicable

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Section	Test Procedure	Test	Number of Samples DV	Number of Samples PV
3.2.1.23	4.3.23	Thermal Pressure Resistance	6 +1 for volatility ^{Note 2}	0
3.2.1.24	4.3.24	Corrosion Resistance	4	0
3.2.1.25	4.3.25	Heat Age	6 +1 for volatility ^{Note 2}	0
3.1.1	4.3.26	Appearance	10	3 (final assembly)

Note 1: Applies for both DV and PV.

Note 2: See 3.2.3.2.

Note 3: See GMW17010, item 3.3.2.5, Natural Frequency Shaker Test.

Note 4: For tests marked "hose only", data may be used from hose supplier with generic couplings.

3.2.2.1.1 Design Validation (DV) Test Samples Requirements. A/C hose and coupling assemblies manufactured for DV tests shall be completely representative of production level dimensions and materials. The exceptions are those assemblies needing to be specially manufactured under extremes of dimensions and/or tolerances to meet the test requirements of the specification. Any exceptions to this requirement must be reviewed beforehand and approved by the GM Global Thermal BFO issuing the approval. All DV Test samples may be made available to the GM Global Thermal BFO for review upon request.

3.2.2.1.2 Design Validation (DV) Approval. DV approval shall be provided by the appropriate Tier 1 A/C line supplier or A/C hose supplier to the appropriate GM Global Thermal BFO and GM Global Thermal BFO and GM Global Thermal Validation Engineer through the Production Part Approval Process (PPAP).

3.2.2.2 Product Validation (PV). A/C hose and coupling assemblies shall be tested for conformance per the sections shown in Table 14. If required, each individual test shall be run with statistically based sample size per GMW15760, such that the reliability requirements stated in 3.2.3.2 are satisfied.

3.2.2.2.1 Product Validation Test Samples Requirement. A/C hose and coupling assemblies manufactured for Product Validation (PV) tests shall have dimensions, materials and manufacturing equipment representative from production level, potential variations from production tooling, process and place of manufacturing are evaluated as well. The test sampling accounts for production variation and forces production tolerances to be determined on the early stages of qualifications.

3.2.2.2.2 PV Approval. PV approval shall be provided by either the appropriate Tier 1 A/C line supplier or A/C hose supplier to the appropriate GM Global Thermal BFO and GM Global Thermal Validation Engineer through the PPAP process.

3.2.2.3 In-Process (IP) Evaluation. These tests shall be completed satisfactorily with parts randomly selected from production process per GMW15760.

Every six (6) month period or defined period in Table 15 the supplier shall run the tests listed in Table 15.

Table 15: In-Process Test Table

Section	Test	Number of Samples
3.2.1.1	Dimensional	Per GMW15760
3.2.1.2	Material Qualification - One (1) Year	^{Note 1}
3.2.1.6	Moisture	Per GMW15760
3.2.1.8	Tensile Strength	Per GMW15760
3.2.1.9	Pressure	Per GMW15760
3.2.1.13	Internal Cleanliness	Per GMW15760
3.2.1.18	Delamination - One (1) Year	Per GMW15760

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Section	Test	Number of Samples
3.2.1.19	Burst Strength	Per GMW15760
3.1.1	Appearance	Per GMW15760

Note 1: See 4.3.2.3.

3.2.2.3.1 In-Process Approval. IP evaluation tests are self-approved by the manufacturer's supplier, subject to audit by GM Supplier Quality Engineering.

3.2.2.3.2 Alternative In-Process Compliance. Supplier may request an exception from IP testing, provided they can demonstrate that sufficient process controls are in place so as to make IP testing unnecessary. Approval to be provided by GM Supplier Quality Engineer (SQE) and/or the GM Global Thermal BFO. The period of testing (six (6) months) may vary, depending on data shown by supplier. GM Supplier Quality Engineering and the GM Global Thermal BFO will determine final IP period.

3.2.2.3.3 Record Retention. All DV, PV, and IP evaluation test data must be retained by the manufacturer for a minimum of 15 years from date of test, and be subject to audit by the GM Global Thermal BFO and/or GM SQE.

3.2.2.3.4 Deviations from this Standard. Deviations from the requirements of this standard shall have prior written approval from the responsible GM Global Thermal BFO. Such requirements shall be specified on component GM drawings/part numbers, test certificates, reports, etc.

3.2.2.3.5 Audit Inspection Testing. If not defined otherwise, the testing required for audit inspection will be as indicated in 3.2.2.3.

3.2.2.4 Physical Characteristics. Physical characteristics must conform to reference GM released drawings/part numbers indicated in 3.3.2.1.

3.2.2.4.1 Dimensions and Capacity. See 3.3.2.1.

3.2.2.4.2 Mass Properties. Not applicable.

3.2.3 Reliability.

3.2.3.1 Reliability Evaluation Point. This standard as written provides a test exposure representing a Reliability Evaluation Point (REP) of R97C50 for final assembly tests and a REP of R99C50 for tests where coupons are required.

The GM Global Thermal BFO will inform the A/C hose and coupling assembly supplier which REP number must be used.

3.2.3.2 Reliability Requirements. The supplier is responsible to demonstrate the required minimum reliability of 97% at a 50% confidence (R97C50). This requirement is applicable for pressure cycling, vibration, coupling and thermal pressure resistance tests, using minimum samples for test lives shown in Analysis/Development/Validation Plan and Report (ADVP&R), see Table 16.

Table 16: Reliability Table

Samples		Duration
For Couplings	For Assemblies	
12 (24 couplings)	23	1.00 test life
9 (18 couplings)	18	1.13 test lives
6 (12 couplings)	12	1.36 test lives
3 (6 couplings)	6	1.86 test lives
-	5	2.00 test lives

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3.2.3.3 Slope. To assess reliability, there is a need for certain parameters: test life, confidence level, sample size, and slope of failure distribution. Slope can be based on actual test data; data from past test results, or expected engineering distribution for the type of failure mechanism. A slope of two (2) (for mechanical systems) is used as default value (value from historical data).

3.2.3.4 Accelerated Test Methods. GM encourages the use of appropriate accelerated test methods, wherever possible; for example, the use of accelerated stress testing to reduce test time (see GMW8758).

GM Global Validation Engineering shall review and accept reliability demonstration test plans prior to the supplier submitting the Analysis/Development/Validation (ADV) test plan for approval.

3.2.4 Serviceability. Not applicable.

3.2.5 User System/Subsystem/Component/Part Interface. Not applicable.

3.3 Design and Construction.

3.3.1 Materials, Processes and Parts Selection Guidelines.

3.3.1.1 Material Guidelines. A/C hose and coupling assemblies materials supplied under this specification must be fabricated as per GM released drawings indicated in 3.3.2.1.

3.3.1.1.1 Recycling Guidelines. No recycling guidelines for rubber parts. Rubber cannot be recycled as material. Materials developed to this specification shall be optimized to provide maximum end-of-life cycle value utilizing the GM Recyclability Checklist and GM Recycling Design Guidelines. Recycled content shall be reported to the approving and procuring Materials Engineering Department utilizing the GM Recycled Content Report Form. Reference the Recyclability/Recoverability Guidelines, GMW3116.

3.3.1.1.2 Restricted and Reportable Substances for Parts. All materials supplied to this specification must comply with the requirements listed in GMW3059.

3.3.1.1.3 Material Compatibility. See 1.3 for details on fluids selected for tests. The acceptance requirements are identical for any combination of refrigerant and compressor oil.

The compatibility test shall perform one (1) time for each combination of refrigerant type and compressor oil formulation.

3.3.1.1.3.1 All A/C hose and coupling assemblies must be compatible with R134a and R1234yf refrigerants; and PAG and POE compressor oils.

3.3.1.1.3.2 Material compatibility tests shall comprehend any of the two refrigerant types R134a and R1234yf, as well as any of the PAG and POE compressor oils. The acceptance requirements are identical for any combination of refrigerant and compressor oil. See 1.3 for details on fluids selected for tests.

3.3.1.2 Processes Guidelines. All production A/C hose and coupling assemblies must be manufactured with the same materials and processes used to manufacture the originally approved samples. No change is permissible without prior written approval from the responsible GM Global Thermal BFO. Suppliers shall use Statistical Process Control (SPC) and industry best practices for all manufacturing activities.

3.3.1.3 Parts Guidelines. Not applicable.

3.3.2 Design Guidelines and Constraints.

3.3.2.1 Drawing/Part Number Requirements. A/C hose and coupling assemblies supplied under this specification must be included in A/C lines assemblies drawings released by GM Design Release Engineer (DRE).

3.3.3 Identification and Marking.

3.3.3.1 Supplier Identification. A/C hose and coupling assemblies supplied under this specification must be visually identified in a manner exclusive and unique to each supplier to permit rapid identification of each respective manufacturer. Identification and markings shall be in accordance with GM Design Guidelines and approved by GM Labeling Engineering. If bar coding is required (only complete A/C line assembly), labeling shall be in accordance with GMW15862 specification for Part Identification and Component Bar-Codes.

Note: Other labeling requirements may include an adhesive type label, which is subject to GMW14573 and shall be applied as indicated on the assembly drawing. Graphics and/or color shall be coordinated through GM Label Engineering for all labels and marking. All labeling requirements must be in accordance with R134a or R1234yf Refrigerant Standards, depending upon the usage. Identification methods must be submitted to and approved by the GM Global Thermal BFO, such that they do not affect the function and/or performance of the part.

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3.3.3.2 Hose Identification. All hose material shall be permanently identified with the type of refrigerant for which the hose was approved (R134a and/or R1234yf), nominal inside diameter in millimeters and inches; e.g., 16 mm ($\frac{5}{8}$ in), manufacturer's identification, Julian date code; e.g., 2560 = 256th day of the year 2000, and shift of hose manufacture. This marking shall appear on the outside of the hose at intervals no > 30 cm (12 in).

3.3.3.3 Coupling Identification. At least one coupling per coupled hose assembly shall be permanently identified with the date of manufacture of the coupled hose assembly, manufacturer's identification, manufacturing location, and assembly part number.

3.3.3.4 Part Number Identification. All coupled hose assemblies shall be marked with the appropriate GM part number per GMW16331.

3.3.4 Workmanship. Key Product Characteristic (KPC) will be defined on the GM approved engineering drawings/part numbers. The A/C hose and coupling assemblies shall have manufacturing capability such that all dimensions are targeted at print nominal. The supplier shall submit a detailed improvement plan which describes how their manufacturing process for each part/operation shall achieve a process distribution of ± 4 sigma, which must be less than or equal to the tolerance spread as specified on the detailed GM drawing/part number. The improvement plan shall be submitted to the GM Global Thermal BFO.

3.3.5 Interchangeability. Not applicable.

3.4 Documentation. Documentation released in DV and PV tests stage shall be approved by the GM Global Thermal BFO and GM Global Thermal Validation Engineer prior to start of delivery of production level parts. IP evaluation tests documentation, see 3.2.2.3. Documentation submitted for A/C hose material and coupling assembly qualification shall include:

- Hose type and code.
- Hose material, outside diameter, thickness and weight, grams per centimeter (g/cm).
- Coupling or crimp type/code, number of fingers and bands, cross sectional view.
- Crimp diameter (minimum, maximum, and nominal).
- Type and manufacturer of refrigerant used for validation performance.
- Type and manufacturer of compressor oil used for validation performance.
- Percent (%) of hose wall compression, as per Appendix A, Figure A8.

3.4.1 Failure Mode and Effects Analysis (FMEA). Detailed design and process FMEAs shall be submitted to the GM Global Thermal BFO and GM Global Thermal Validation Engineer, and will be maintained as part of the records of the Design Validation and Product Validation. The FMEAs shall be updated each time a design change occurs. FMEAs shall be submitted with the GM PPAP documentation.

3.4.2 Design Validation and Product Validation. Documentation of DV and PV test reports shall be through the normal PPAP process. Any non-compliance during Design Validation or Product Validation phases must be documented and resolved before validation is considered complete.

3.4.3 Revalidation Requirements. Any change in design, function, material, manufacturing process, and/or location of manufacture facility from that previously approved for production, requires revalidation, as determined by the GM Global Thermal BFO.

3.4.3.1 If not otherwise agreed to, the entire validation test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product.

3.4.3.2 In some cases, a shorter test can be agreed by the responsible GM Global Thermal BFO.

3.4.3.3 After revalidation tests are completed, a new release approval document shall be issued. Carryover designs may be revalidated for subsequent model year production using the results of tests from previous years' production. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process, and to apply for a new release approval.

3.5 Support of System/Subsystem/Component/Part After Sale. Not applicable.

3.6 System/Subsystem/Component/Part Operator Training. Not applicable.

3.7 System/Subsystem/Component/Part Characteristics.

3.7.1 System/Subsystem/Component/Part Definition. See 3.1.

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4 Validation

4.1 General.

4.1.1 Safety. This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all of the potential safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Caution: This specification refers to the usage of testing pressurized vessels. Tests referred in this specification, shall be performed only by properly trained qualified personnel in using equipment capable of withstanding the pressures, temperatures and exposure of these tests with adequate safety margins. Standard Laboratory Safety Precautions must be followed to prevent accidental bodily injury. All material shall be used in accordance with the manufacturer Material Safety Data Sheet (MSDS).

4.1.2 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

4.1.3 Alternatives. Alternative test facilities and equipment may also be used only if prior approval from GM Global Thermal BFO and GM Global Thermal Validation Engineer has been obtained. However, all measuring variables as specified in this specification shall be determined correctly with respect to its physical definition.

4.1.3.1 Equipment and Facilities. Conforming to the relevant test methods.

4.1.4 Test Fixtures. Four (4) types of fixtures are used to complete the tests in this standard.

- Type 1 = A/C Hose and Coupling (Figure A1).
- Type 2 = A/C Hose and Coupling with Canister (Figure A2).
- Type 3 = Complete A/C Assembly.
- Type 4 = Samples for Material Test.

4.1.4.1 A/C Hose and Coupling (Figure A1). A/C hose and coupling tests, per Figure A1, must have nominal coupling crimp diameters except where noted as requirement of sample size to be crimped to the high and low limits of the dimensions (only DV stage). If using formed hoses, hose samples that are tested shall have a bend which conforms to the minimum radius to be used in the production design (coupling integrity samples shall be formed straight.) The length of hose and metal tube shall be per dimensions provided in Table A1. Each sample shall be capped at one end with a sealing element fitted with a safety guide for longitudinal and transversal movement, while the other end shall be fitted with a charge valve fitting to be able to be connected to a pressure source of gas as per Figure A3. Refer to Table A2 for the respective fasteners and tightening torques. See Figure A7 for setup for sealing A/C hoses.

4.1.4.1.1 Prior to starting any charging operation or testing, all test fixtures must be leak tested per 4.3.3 in order to prevent time lost due to poor welds, O-rings, crimping, fittings, etc.

4.1.4.1.2 After leak test is completed, the samples are now ready to complete the Charging Operation Procedure per 4.1.4.4.

4.1.4.2 A/C Hose and Coupling with Canister (Figure A2).

Note: Test canisters must have minimum burst strength of 8.6 MPa (1247 psi), consistent with SAE J639, with a recommended internal volume of 530 cm³ (minimum). A volume of 1260 cm³ ± 25 cm³ can be used with a wall thickness that can resist high pressures and fatigues due to the durability tests (thermal tests).

4.1.4.2.1 Cleaning Procedures for Canisters and Plugs.

- a. Select a canister that has been dedicated for that system. The canister shall have a charging connection.
- b. The charge port must not have a valve core at this part of the process (for easy cleaning).
- c. Turn canister upside down to allow any residuals to drain.
- d. Rinse the canister thoroughly with the appropriate solvent (Isopropanol at 70%) until all residues are removed. Solvent rinses shall be done with adequate ventilation.
- e. Visually inspect to ensure that all contaminants are removed.
- f. Drain all excess solvent into an approved scrap solvent container.

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- g. The canister shall be flushed thoroughly with water. The flushed water shall be visually inspected to ensure that all contaminants are removed. Drain all excess water. If any contamination is suspected, do not use the canister for testing.
- h. Place canister in an air dry oven at $+121\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ ($+250\text{ }^{\circ}\text{F} \pm 4.5\text{ }^{\circ}\text{F}$), for at least three (3) h of drying time.
- i. Remove canister from the oven and allow it to cool to room temperature $+23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ ($73.4\text{ }^{\circ}\text{F} \pm 3.8\text{ }^{\circ}\text{F}$) before starting assembly of the test system.

A/C hose and coupling assemblies that will be assembled to the canister shall be constructed per example shown in Figure A2 and must have nominal coupling crimp diameters except where noted as requirement of sample size to be crimped to the high and low limits of the dimensions (only DV stage). Each sample shall be capped at one end with a sealing element, while the other end shall be fitted to the canister. Refer to Table A2 for the respective tightening torques.

4.1.4.2.2 Prior to starting any charging operation or testing, all test fixtures must be leak tested per 4.3.3 in order to prevent time lost due to poor welds, O-rings, crimping, fittings, etc.

4.1.4.2.3 After leak test is completed, the samples are now ready to complete the Charging Operation Procedure per 4.1.4.4.

4.1.4.3 Complete A/C Assembly. The purpose of these samples is to test the A/C hose and coupling design using vehicle ambient environment. There will be exceptions when the complete lines are too long and cannot be fit in the chamber test or when this condition will create a costly test setup. GM Global Thermal BFO, GM Global Thermal Validation Engineer and GM DRE for the selected program will indicate to the A/C hose and coupling supplier the design of the A/C line assembly routing to use.

4.1.4.3.1 Prior to the start of any charge operation or any testing, all test fixtures must be leak tested per 4.3.3 in order to prevent loss of test time due to poor welds, O-rings, crimping, fittings etc.

4.1.4.3.2 After leak test is completed, the samples are now ready to complete the Charging Operation Procedure per 4.1.4.4.

4.1.4.4 Charging Operation Procedure. All weights are to be measured at an ambient temperature of $+23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ ($68\text{ }^{\circ}\text{F}$ to $79\text{ }^{\circ}\text{F}$). See 1.3 for refrigerant and compressor oil combination.

4.1.4.4.1 Charging Operation Procedure for A/C Hose and Coupling (Figure A1).

- a. Obtain an initial tare weight to the nearest 0.01 g.
- b. Add the amount of lubricant indicated in each section (where applicable, within $\pm 0.5\text{ g}$ of the specified amount).
- c. Evacuate the assembly to 25 mmHg absolute pressure (vacuum). Avoid removing any lubricant when pulling a vacuum (do not allow the lubricant to enter the Schrader valve or evacuation apparatus). This is required for ease of charging and removal of condensable and oxygen. (See Figure A3.) Sample may be cooled to $+2\text{ }^{\circ}\text{C}$ to $+7\text{ }^{\circ}\text{C}$, ($36\text{ }^{\circ}\text{F}$ to $45\text{ }^{\circ}\text{F}$) for ease of charging. **Caution:** Condensation will lead to erroneous results.
- d. Add the amount of refrigerant indicated in each section of this specification. See 1.3 for proper refrigerant type.
- e. Weigh the assembly. All charges shall be within 1.0 g of the specified values.
- f. Invert the assembly several times to ensure mixing of the refrigerant and lubricant and wetting of all internal surfaces.
- g. A/C hose and coupling assemblies are ready for tests.
- h. At the completion of the tests, discharge refrigerant into an appropriate reclamation system.

4.1.4.4.2 Charging Operation Procedure for A/C Hose and Coupling with Canister (Figure A2).

- a. Evacuate each test canister to 3.3 kPa and charge each canister with the following fluids:
- b. Compressor Oil: Per each. If no compressor oil is indicated, use a default of $17\text{ cc} \pm 5\text{ cc}$.
- c. Fluorescent Dye: (GM Part Number 88864127, GMW17223 Fluorescent Dye for Refrigeration Leakage Detection or equivalent): 0.25 mL optional.
- d. Charge the test fixtures with refrigerant $\pm 1.0\text{ g}$ to the levels in Table 17.

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