

(R) Mobile Air Conditioning System Refrigerant Emission Charts for R-134a and R-1234yf

RATIONALE

Industry standards did not exist for measuring, or estimating, refrigerant emissions from mobile air conditioning systems when the original version of SAE J2727 was created in 2005. The 2005 version provided a method of rating emissions from A/C systems, based solely on component technologies used in the system, combined with expert input regarding relative emission rates of components. The 2007 revision was based on the 2005 version, enhanced with laboratory measurements and vehicle field test correlations, and replaced the rating system with an estimate of system emissions in grams per year. While the 2008 revision provided clearer definitions of sealing technologies and how to apply them to the SAE J2727 System Emissions Chart, even greater clarity is needed to accommodate the wide variety of system components and their possible connections to the A/C system. The current revision encompasses additional components, a consideration for the emission reduction value of effective Helium leak detection of components prior to vehicle assembly, and requires the use of SAE J2064 A/C hose permeation data to provide proper credit based on the actual emissions of the hose used. In addition, although the original refrigerant emission chart was based on R-134a, the current revision has been enhanced to allow the estimation of R-1234yf emissions as well as those of the R-134a.

The revisions in this document allow for more detailed component emission ratings for existing production manufacturing processes, including leak checking components using helium. Although some sectors of the international MAC industry have developed other emission measurement approaches, this standard has had a comprehensive ongoing relationship of vehicle and laboratory SAE testing procedures that has resulted in correlation of MAC system refrigerant emissions used in this document.

1. SCOPE

The "System Emissions Chart" contained herein is intended to serve as a means of estimating the annual refrigerant emission rate (grams per year) from new production A/C systems equipped with specified component technologies. It provides emission values for various component technologies that are currently available, and can be expanded as new technologies are commercialized. This document provides the information to develop an Excel file template "System Emissions Chart" for system emission analysis. The chart includes automotive compressor technologies for conventional mobile air conditioning systems as well as those using semi-hermetic compressors. This standard can be considered a companion document to SAE J2763 Test Procedure for Determining Refrigerant Emissions from Mobile Air Conditioning Systems. SAE J2727 estimates system emissions, taking into account production assembly variation and accounts for components that are 100% helium leak tested prior to vehicle final assembly. The results from SAE J2064 are used to better represent permeation emissions from different hose material and coupling configurations in this version. SAE J2763 may be used to quantify emissions from properly assembled systems.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2012 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: <http://www.sae.org>

**SAE values your input. To provide feedback
on this Technical Report, please visit
http://www.sae.org/technical/standards/J2727_201202**

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J2064 R-134a Refrigerant Automotive Air-Conditioned Hose

SAE J2763 Test Procedure for Determining Refrigerant Emissions from Mobile Air Conditioning Systems 2006 SAE Alternate Refrigerants Symposium June 28, 2006, "Revising SAE J2727"

3. ASSUMPTIONS FOR THE EMISSIONS CHART SPREADSHEET

3.1 General Assumptions

3.1.1 Real-world refrigerant emission rates will not be universally consistent for any given system design due to assembly variations, and customer climate and usage patterns.

3.1.2 The values in this standard apply to systems assembled in new production vehicles and include an allowance for the expected normal variation for most OEM vehicle and component assembly plants except in the case where the components are 100% helium leak tested to assure proper assembly prior to assembly in the vehicle.

3.1.2.1 Fitting technologies vary in their ability to contain refrigerant and in their inherent ability to be properly assembled. Emission rates were assigned to each technology based on laboratory testing and field repair experience.

3.1.3 This standard accounts for normal design assembly of refrigerant system connections. The assigned value for each fitting technology reflects its potential for miss-assembly.

3.1.3.1 The correlation to field test results is based on vehicles properly assembled in the typical vehicle assembly plant. The laboratory correlations are based on properly assembled components in a laboratory environment.

3.1.4 The chart can be modified as new components and leak testing technologies are developed and evaluated for their robustness and ability to assure reduced system emissions.

3.2 System Joints (Connections)

All connections (a.k.a., joints, fittings) of all components attached to the A/C system, in sub-assemblies or in the vehicle assembly plant, must be listed under the appropriate heading in the System Joints Section. Connections must be accounted for in one of two ways:

1. Those connections (with higher emissions than seal washers) made and subsequently leak tested by Helium mass spectrometry should be totaled and listed in the special (stippled) box under the Seal Washer category on Line 9.

NOTE: To use the credit for Helium leak testing after assembly, 100% of all joints for which the credit is claimed must be Helium leak tested. Audit sampling, or any other form of non -continuous sampling, shall not be used in place of 100% component leak testing with Helium.

2. All other connections made must be separately accounted for under the specific connection type on Line 8. All system joints (connections) made on the vehicle production line shall be listed under the specific connection type on line 8.
- 3.2.1 Emission values for fittings relate to their potential for production miss-assembly. O-rings are significantly more difficult to properly assemble than, for example, seal washers. Accordingly, O-ring fitting technologies have been assigned higher emission default values.
 - 3.2.1.1 A single, radially sealed O-ring has the inherent potential for twisting the O-ring during initial assembly, and then twisting (or cutting) it again when the mating surfaces slide over one another to close the joint and consummate the seal.
 - 3.2.1.2 An axially sealed O-ring is similar to a captured O-ring, in that the seal is first placed into position and then the mating surface compresses the seal axially without the opportunity for further seal movement. (Figure 15) These seal technologies present only one opportunity for miss-assembly, i.e., when the seal is first placed into position prior to joint closure. Thus, axially sealed O-rings and molded seals are considered equivalent to a captured O-ring.
- 3.2.2 It is assumed that properly designed and assembled O-ring fittings will have emission rates comparable to properly designed and assembled seal washers, hence the special consideration given to those O-ring fittings that have been verified as properly assembled via Helium mass spectrometry. Given the above, SAE J2727 may overestimate O-ring fitting emissions not helium leak tested after assembly for those vehicle manufacturers capable of exceptionally reliable production A/C system O-ring assembly. This may be taken into consideration when interpreting the emission values calculated in the spreadsheet.

3.3 Devices with Other (Non-Joint) Emission Paths

The assumption is that all of these devices are helium leak tested prior to assembly in the vehicle.

3.3.1 Service Ports

Service fittings are assumed to have sealing caps in place. Non-connection emissions are those that occur through the valve core assembly and, ultimately, through the service port valve cap seal. Assigned emission rates are based on the cap with seals properly assembled and torqued, and system location, i.e., high pressure or low pressure side of the system. Connection emissions from a service port must be accounted for if the service port requires a seal for attachment purposes (e.g., O-ring), and that seal must be included in the System Joints Section. Such a port is often referred to as a "two-piece" service port.

3.3.2 Line-Mounted and Compressor-Mounted Devices (e.g., PRV, Switches, Transducers)

These devices may include different internal sealing technologies (e.g., O-rings, seal washers, diaphragms, and gaskets) Assigned values in the spreadsheet account for emissions from these internal seals and the location of the device in the system, i.e., high pressure or low pressure side of the system. Assigned values account for emissions exclusive of fitting connections. Connections/fittings used to install the device onto the system plumbing are to be accounted for in the System Joints Section

3.3.3 Refrigerant Flow Devices

These devices, e.g., Thermal Expansion Valves, may include different internal sealing technologies (as noted in Section 3.3.2) that create non-joint emission paths. Assigned values account for these emissions, exclusive of fitting connections. All joints used to connect the refrigerant flow device to the system are to be included in the System Joints Section.

NOTE: Orifice tube flow devices mounted inside flexible hose assemblies or rigid pipes have zero emissions. Connection(s) to install/service such devices are to be included in the System Joints Section.

3.4 Flexible Hose

- 3.4.1 Hoses technologies differ in refrigerant permeation rate due to different hose materials used and construction methods employed in their manufacture. Hose permeation rate is a function of the refrigerant, internal refrigerant temperature and pressure, hose material, hose construction, hose inner surface area and location on the system. Hose permeation rates ($\text{kg/m}^2/\text{year}$) measured at 80°C per the requirements of SAE J2064 shall be entered in the spreadsheet for each system hose type. The permeation rate multiplied by the internal surface area of the hose and the conversion factor yields the annual emission rate for the specific hose. Relative emission rates of system high-side hoses are greater than low-side hoses. In addition, permeation rates are based on the assumption that the A/C system 'on' time usage is 5 to 7%, i.e., 440 to 620 hours per year.
- 3.4.2 Flexible hose assemblies include tube, hose and coupling. Emissions occur through the hose and at the couplings, which are accounted for in this section. Emissions from the tube fitting connections at either end of the hose are to be included in the System Joints Section.
- 3.4.3 High-side, and low-side, pressure hose inner diameter, hose construction type, and exposed hose length must be identified in the Flexible Hose Section of the emissions chart.

3.5 Heat Exchangers, Mufflers, Receiver/Driers and Accumulators

- 3.5.1 Heat Exchangers (HX) are considered to be robust and the Emissions Chart assigns each a relative emission rate. Internal Heat Exchangers are to be included in this category. Emissions from fittings to connect HX components to the system are to be included in the System Joints Section. Mufflers, Receiver/Driers, and Accumulators are considered to be emission-free except for the emissions from the fittings to connect them to the system. Such fittings are to be included in the System Joints Section. Any serviceable connections on any of the above components, such as fittings for servicing desiccant, are also to be included in the System Joints Section.

3.6 Compressor

- 3.6.1 It is assumed that multiple lip shaft seals are better than single lip seals. It is assumed that gasket-housing seals are better than O-rings. Dust lips in the shaft seal shall not count as secondary refrigerant seals unless shown to reduce emission levels.
- 3.6.2 The major refrigerant emission paths of a belt-driven compressor are the shaft seal and housing (body) seals.
- 3.6.2.1 Compressor shaft seal(s). The number of lips on the shaft seal is defined by the number of individual sealing elements in contact with the compressor shaft. Common seal materials are PTFE and HNBR.
- 3.6.3 Semi-Hermetic compressors are expected to emit less refrigerant than belt-driven compressors and are so accounted for. The shaft is fully enclosed within the compressor body. Semi-hermetic compressors contain one, or more, housing seals. All connections that are not hermetic are to be included in the System Joints Section.
- 3.6.4 Compressor emission is a function of the number of housing sealing joints that are used, the number of lips on the shaft seal (if non-hermetic), and number and type of non-hermetic connections. The type of design shall be identified in the Compressor Section of the spreadsheet.
- 3.6.5 Some compressors use fitting adaptor plates between the compressor body and the rigid pipe fittings. Adaptor plates are sealed to the housing by a captured O-ring or molded-in-place seal. Adaptor plate seals are assumed to perform similar to single axial O-ring joints. Those not Helium leak tested must be accounted for in the System Joints section as equivalent to an axial O-ring joint. Those leak tested by Helium-mass spectrometry following assembly are to be listed in the Compressor Body Section.

3.6.6 Compressor sealing surfaces to be accounted for in this section are:

3.6.6.1 Number of Lips on the Shaft Seal

3.6.6.2 Number of O-Ring Housing Seals

3.6.6.3 Number of Molded Housing Seals - O-ring material molded into a specific shape

3.6.6.4 Number of Gasket Housing Seals Fitting

3.6.6.5 Adaptor Plate (e.g., European style) unless not Helium leak tested and listed in the System Joints Section

3.6.7 To use the spreadsheet for emissions estimation, 100% of compressors shall have been Helium leak tested prior to assembly onto the vehicle. For compressors that are Helium leak tested as above, replace the "2" in Cell D40 with "1"

3.6.7.1 For compressors that are not Helium leak tested:

3.6.7.1.1 All compressor seal types used shall be entered on Line 38 of the table and the number "2" in Cell D40 shall remain unchanged.

$$\text{Line H38} = (\text{B39/B38} + \text{C39} \cdot \text{C38} + \text{D39} \cdot \text{D38} + \text{E39} \cdot \text{E38} + \text{F39} \cdot \text{F38}) \cdot 0.522 \cdot \text{D40}$$

3.6.7.1.2 No entries shall be made on Line 9 for any Compressor Mounted Devices. Such devices shall be accounted for on Line 8.

3.6.8 Compressor Mounted Devices, specifically the Compressor Control Valve [just the last seal to the atmosphere], Pressure Relief Valve (PRV), and Switches are to be accounted for in both the System Joints Section and the Devices with Other Emission Paths Section, as noted in Section 3.3. If such devices are Helium leak tested after assembly to the compressor, their connection should be accounted for on Line 9 as equivalent to a seal washer connection.

3.6.9 See Section 9 Notes for additional compressor definitions.

4. CORRELATING SYSTEM EMISSION RATINGS (SPREADSHEET) WITH FIELD TEST AND MINI-SHED TEST RESULTS

4.1 Mini-shed testing of systems, with and without the compressor, was performed per SAE J2763 to establish the emission rate of properly assembled A/C systems and the relative contribution of the compressor and hoses. Fleet tests were also conducted in Japan and Europe by JAMA and ACEA, respectively. The spreadsheet has been correlated to the field test results and bench testing done per SAE J2763.

4.2 The customer usage profile assumed herein combines 5 months of usage under SAE J2763 mini-shed test conditions (weighted average ambient of 31 °C) with a 7-month non-use period at an average ambient of 5 °C, during which emissions are 0.18 times those in the mini-shed test based upon pressure squared. This combination results in a correction factor 0.522 that is applied to all components' emission formulas.

5. CORRELATING SYSTEM EMISSIONS WITH RANDOMLY CHOSEN PRODUCTION VEHICLES

- 5.1 The "Systems Emissions Chart" spreadsheet directly calculates the estimated annual emissions from production assembled systems using the component technologies comprising the system
- 5.2 The emission estimates provided by this spreadsheet correlated well with the measured refrigerant losses from field test vehicles in Japan and Europe. [See presentation made at the 2006 SAE Alternate Refrigerants Symposium June 28, 2006. "Revising SAE J2727"] [Note: the changes made to this standard [2011] do not significantly affect this correlation.]
- 5.3 This procedure can be used to predict annual grams per year emission rates for new vehicle systems and may be used as a basis for compliance with governmental requirements. Estimates are conservative, include an accounting for potential miss-assembly of fittings, and may slightly overestimate actual measured emission values.

6. BASIS FOR ESTIMATING R-1234YF EMISSIONS

- 6.1 While the original spreadsheet was, and is, intended to estimate R-134a mass-based emissions, it has been modified to estimate emissions of R-1234yf. With the exception of hose permeation, leakage is a volume flow and is dependent upon vapor pressure and inversely dependent upon the viscosity of the escaping vapor (see Table below). Volume flow can be converted to mass flow using molecular weight. Given the equivalence of R-134a and R-1234yf vapor pressures, R-134a emissions can be corrected to estimate those of R-1234yf by multiplying R-134a leakage by the ratio of molecular weights ($114/102$) and the inverse ratio of gas viscosities ($11.1 \times 10^{-6} / 12.0 \times 10^{-6}$). The contribution of hose assembly emissions is directly accounted for by requiring the measurement of refrigerant permeation per SAE J2064 for the specific refrigerant. Hence, applying the conversion factor of 1.03 to all emissions except hose emissions, followed by adding R-1234yf hose emissions, will convert the R-134a chart emissions to R-1234yf emissions.

TABLE: VISCOSITY AND MOLAR MASS OF SELECTED GASES AND REFRIGERANTS (FROM SAE J2842)

Gas /Refrigerant	Dynamic Viscosity at 15°C η in Pa x s	Molar mass M in kg/kmol
Nitrogen	17.4×10^{-6}	28
Helium	19.3×10^{-6}	4
Air	18.0×10^{-6}	29
R-744	14.5×10^{-6}	44
R-134a	11.1×10^{-6}	102
HFO-1234yf	12.0×10^{-6}	114

7. SPREADSHEET FORMULAS

A working spreadsheet template cannot be included in this document. Accordingly, the spreadsheet template is shown in Figure 1 and the formulas for developing the system spreadsheet, (Excel or similar), including assigned values and assumptions, are identified below in this section.

Four different emission chart templates are required, one for belt-driven and one for semi-hermetic compressors and one each for R134a and R1234yf. These four templates are shown in section 8.

7.0 Spreadsheet Information and Formulas For R-134a Refrigerant Systems

NOTE: Each line in the chart is separately accounted for below. Wording to be included in each cell is shown in quotation marks after the cell coordinates, e.g. B6 "Single O-ring".

	A	B	C	D	E	F	G	H	I
4	Enter data only in cells of this color							Calculated Emissions	
5	System Joints (a.k.a. Fittings & Connections)								
6	EACH & EVERY JOINT Used to Attach Components to the A/C System <u>MUST</u> be Accounted for in either Row 8 or Row 9	Single Radial O-ring	Single Captured O-ring / Single Axial O-ring / Molded Seal	Multiple ring	O- Seal Washer	Dual Seal Washer / Seal Washer with O-ring	Metal Gasket		Joints are those sealing technologies separating the refrigerant from the atmosphere
7	Relative Emission Value	1.250	0.750	0.500	0.100	0.050	0.010		
8	Insert Total Number of Joint Types E6, F6, and G6. Also enter the Total Number of Joints B6, C6, and D6 NOT Helium Leak Checked After Component Sub-Assembly							0.00	Joints NOT Helium Leak Tested After Assembly
9	Joint Types B6, C6, and D6 That Are Helium Leak Checked After Component Sub-Assembly Are Considered Equivalent to Seal Washers. List The Total Number of Such Seals only in E9							0.00	Joints that ARE Helium Leak Tested After Component Sub-Assembly. <u>Note:</u> To use this cell, 100% of all joints must be so tested.
10							Connections Total	0.00	

7.1 Fittings and Connections

7.1.1 Line 6, A6 "**EACH & EVERY JOINT** Used to Attach Components to the A/C System MUST be accounted for in either Row 8 or Row 9"

7.1.2 Line 6 lists different sealing technologies, i.e.

	B	C	D	E	F	G
6	Single Radial O-ring	Single Captured O-ring / Single Axial O-ring / Molded seal	Multiple O-ring	Seal Washer	Dual Seal Washer / Seal Washer with O-ring	Metal Gasket

Line 6, I6 "Joints are those sealing technologies separating the refrigerant from the atmosphere"

7.1.3 Line 7, A7 "Relative Emission Value" Columns 7B to 7G contain the values, i.e.

	B	C	D	E	F	G
7	1.250	0.750	0.500	0.100	0.050	0.010

- 7.1.4 Line 8, A8 "Insert Total Number of Joint Types E6, F6, and G6. Also enter the Total Number of Joints B6, C6, and D6 *NOT* Helium Leak Checked After Component Sub-Assembly"

List appropriate number in cells 8B through 8G

$$\text{Equation for H8} = (B7*B8+C7*C8+D7*D8+E7*E8+F7*F8 +G7* G8)*0.522$$

I8 "Joints NOT Helium Leak Tested After Assembly"

- 7.1.5 Line 9, A9 "Joint Types B6, C6, and D6 That Are Helium Leak Checked After Component Sub-Assembly Are Considered Equivalent to Seal Washers. List The Total Number of Such Seals only in E9"

E9 is a stippled cell to denote Helium leak tested connections

$$\text{Equation for H9} = (E7*E9)*0.522$$

I9 "Joints Helium Leak Tested After Assembly. Note: To use this cell for Helium leak testing after assembly, 100% of all joints for which the credit is claimed must be so tested."

- 7.1.6 Line 10, F10-G10 "Connections Total"

$$\text{Equation for H10} = \text{SUM}(H8,H9)$$

- 7.2 Line 11, A11-G11 "Devices with Other Emission Paths" I11 "Devices with emission paths other than at the connecting joint, e.g. thru the valve core and cap of a service port"

	A	B	C	D	E	F	G	H	I
11	Devices with Other Emission Paths								Devices with emission paths other than at the connecting joint, e.g. thru the valve core and cap of a service port
12	Service Ports (non-joint emissions)		High Side		Low-Side				Note: List all sealing connections to the atmosphere in Line 8 or 9
13		Insert number of service valves		Insert number of service valves				0.00	Note: If a two piece core is used with an internal o-ring, this o-ring must be included in row 8 or 9 above.
14	Line-mounted PRV, Switches, Transducers (non-joint emissions)		Located on High Side		Located on Low-Side				
15		number of devices						0.00	Note: List all sealing connections to the atmosphere in Line 8 or 9
16	Thermal Expansion Device Refrigerant Control (non-joint emissions)								Note: ALL four connections for a block style thermal expansion valve [TXV] need to be accounted for in rows 8 and 9 above!
17		number of devices						0.00	Note: List all sealing connections to the atmosphere in Line 8 or 9
18	Compressor Mounted Devices (non-joint emissions)		PRV, Control Valve, Switches						
19		number of devices						0.00	Note: List all sealing connections to the atmosphere in Line 8 or 9
20								Other Emission Paths Total	0.00

- 7.2.1 Line 12, A12 "Service Ports (non-joint emissions)"; C12 "High Side"; E12 "Low Side"; I12 "Note: List all sealing connections to the atmosphere in Line 8 or 9"

- 7.2.2 Line 13, B13 "Insert number of service valves"; D13 "Insert number of service valves"

$$\text{Equation for H13} = (\text{SUM}(C13*0.3)+\text{SUM}(E13*0.2))*0.522$$

I13 "Note: If a two piece core is used with an internal o-ring, this o-ring must be included in row 8 or 9 above"

- 7.2.3 Line 14, A14 "Line-mounted PRV, Switches, Transducers (non-joint emissions)"; C14 "Located on High Side"

E14 "Located on Low Side"

7.2.4 Line 15, B15 "number of devices"

$$\text{Equation for H15} = (\text{SUM}(\text{C15} \times 0.3) + \text{SUM}(\text{E15} \times 0.2)) \times 0.522$$

I15 "Note: List all sealing connections to the atmosphere in Line 8 or 9"

7.2.5 Line 16, A16 "Thermal Expansion Device Refrigerant Control (non-joint emissions)"; I16 "Note: ALL four connections for a block style thermal expansion valve [TXV] need to be accounted for in rows 8 and 9 above!"

7.2.6 Line 17, B17 "number of devices"

$$\text{Equation for H17} = \text{SUM}(\text{C17} \times 0.2) \times 0.522$$

I17 "Note: List all sealing connections to the atmosphere in Line 8 or 9"

7.2.7 Line 18, A18 "Compressor Mounted Devices (non-joint emissions); C18 "PRV, Control Valve, Switches"

7.2.8 Line 19, B19 "number of devices"

$$\text{Equation for H19} = \text{SUM}(\text{C19} \times 0.2) \times 0.522$$

C19 "Insert number of devices"

7.2.9 Line 20, F20-G20 "Other Emission Paths Total"

$$\text{Equation for H20} = \text{SUM}(\text{H13}, \text{H15}, \text{H17}, \text{H19})$$

7.3 Flexible Hoses SAE J2064 Permeation rate in $\text{kg/m}^2/\text{year}$ at 80C

Line 23, Cells E23-G23 shall read "Enter SAE J2064 R-134a Permeation Rate at 80C in Column F for Each System Hose"

The appropriate Hose Permeation Rates shall be listed in Column F and lines (24-31) for each hose type used.

	A	B	C	D	E	F	G	H	I
21	Flexible Hoses								
22	Includes Hose and Hose Coupling Crimps [End Connections Included in Component Connection]	Hose	Hose	Calculated	Enter SAE J2064 Refrigerant Permeation Rate at 80C in Column F For Each System Hose			Do Not Enter Data	Permeation Rate Unit = $\text{Kg/m}^2/\text{year}$
		Exposed Length (Between Crimps) [mm]	Diameter Inner [mm]	Surface Area Do Not Enter Data [mm ²]					Use Only Exposed Length of Hose Between Crimps. Coupling emission is accounted for in this calculation
23									
24	High pressure line 1	0	0.0	0		0.00		0.000	Enter length to the nearest millimeter
25	High pressure line 2	0	0.0	0		0.00		0.000	Enter diameter to the nearest tenth of mm.
26	High pressure line 3	0	0.0	0		0.00		0.000	
27	High pressure line 4	0	0.0	0		0.00		0.000	
28	Low pressure line 1	0	0.0	0		0.00		0.000	
29	Low pressure line 2	0	0.0	0		0.00		0.000	
30	Low pressure line 3	0	0.0	0		0.00		0.000	
31	Low pressure line 4	0	0.0	0		0.00		0.000	
32							Hose Total	0.00	

7.3.1 High pressure line 1

Cell A24 = "High pressure line 1"

$$\text{Cell D24} = 3.14159 \times \text{C24} \times \text{B24}$$

$$\text{Cell H24} = (\text{F24} \times 0.0000268 \times \text{D24}) \times 0.522$$

7.3.2 High pressure line 2

Cell A25 = "High pressure line 2"

Cell D25 = $3.14159 * C25 * B25$

Cell H25 = $(F25 * 0.0000268 * D25) * 0.522$

7.3.3 High pressure line 3

Cell A26 = "High pressure line 3"

Cell D26 = $3.14159 * C26 * B26$

Cell H26 = $(F26 * 0.0000268 * D26) * 0.522$

7.3.4 High pressure line 4

Cell A27 = "High pressure line 4"

Cell D27 = $3.14159 * C27 * B27$

Cell H27 = $(F27 * 0.0000268 * D27) * 0.522$

7.3.5 Low pressure line 1

Cell A28 = "Low pressure line 1"

Cell D28 = $3.14159 * C28 * B28$

Cell H28 = $(F28 * 0.0000179 * D28) * 0.522$

7.3.6 Low pressure line 2

Cell A29 = "Low pressure line 2"

Cell D29 = $3.14159 * C29 * B29$

Cell H29 = $(F29 * 0.0000179 * D29) * 0.522$

7.3.7 Low pressure line 3

Cell A30 = "Low pressure line 3"

Cell H30 = $3.14159 * C30 * B30$

Cell H30 = $(F30 * 0.0000179 * D30) * 0.522$

7.3.8 Low pressure line 4

Cell A31 = "Low pressure line 4"

Cell D31 = $3.14159 * C31 * B31$

Cell H31 = $(F31 * 0.0000179 * D31) * 0.522$

7.3.9 Line 32, G32 "Hose TOTAL"

Equation for H32 =SUM(H24:H31)

7.4 Heat Exchangers (HX's)

7.4.1 Line 33, "Heat Exchangers (HX's)"

	A	B	C	D	E	F	G	H	I
33	Heat Exchangers (HX's)								
34				Number of Heat Exchangers			HX Total	0.00	Include all Condensers, Evaporators and Internal Heat Exchangers Note: 100% of such components must be Helium leak tested.

7.4.2 Line 34, D34 "Number of Heat Exchangers"; G34 "HX Total"

E34 is a stippled cell to denote Helium leak tested HX's

Equation for H34 =E34*0.25*0.522

I34 "Include all Condensers, Evaporators and Internal Heat Exchangers Note: 100% of such components must be Helium leak tested"

7.5 Compressor Tables are applied to all compressor designs.

Belt driven compressor

	A	B	C	D	E	F	G	H	I
35	Compressor Body								
36	Exclusive of Attached Devices	Type of Seal						Do Not Enter Data	Account for All Attached Devices (e.g., HPRV, HPCO, Drain Plug) on Lines 8 or 9
37		Number of lips on shaft seal	Number of O-Ring Housing Seals	Number of Molded Housing Seals	Number of Gasket Housing Seals	Fitting Adaptor Plate Seal			
38	Insert Number of Each Type of Seal in Compressor	1					Compressor Total	16.13	Note: 100% of compressors must be Helium Leak Tested: If NOT, emissions are doubled
39	Relative Emission Value	15	3	2	1	0.4			
40	IF Compressors ARE Helium Leak Tested, change the number in Cell D40 from 2 to 1								

Electric Compressor

	A	B	C	D	E	F	G	H	I
35	Compressor Body								
36	Exclusive of Attached Devices	Type of Seal						Do Not Enter Data	Account for All Attached Devices (e.g., HPRV, HPCO, Drain Plug) on Lines 8 or 9
37		Number of lips on shaft seal	Number of O-Ring Housing Seals	Number of Molded Housing Seals	Number of Gasket Housing Seals	Fitting Adaptor Plate Seal			
38	Insert Number of Each Type of Seal in Compressor	N/A					Compressor Total	0.00	Note: 100% of compressors must be Helium Leak Tested: If NOT, emissions are doubled
39	Relative Emission Value	15	3	2	1	0.4			
40	IF Compressors ARE Helium Leak Tested, change the number in Cell D40 from 2 to 1								

7.5.1 Line 35, A35-G35 "Compressor Body"

7.5.2 Line 36, A36 "Exclusive of Attached Devices" ; B36-G36 "Type of Seal"

7.5.3 Line 37, B37 "Number of lips on shaft seal"; C37 "Number of O-Ring Housing Seals" ; D37 "Number of Molded Housing Seals" ; E37 "Number of Gasket Housing Seals"; F37 "Fitting Adaptor Plate Seal"; H37 "Do Not Enter Data";

I37 "Account for All Attached Devices (e.g., HPRV, HPCO, Drain Plug) on Lines 8 or 9"

7.5.4 Line 38, A38 "Insert Number of Each Type of Seal in Compressor"; G38 "Compressor Total";

7.5.4.1 Equation for H38 = $(B39/B38+C39*C38+D39*D38+E39*E38+F39*F38)*0.522*D40$ for Belt-Driven Compressors

7.5.4.2 Equation for H38 = $(C39*C38+D39*D38+E39*E38+F39*F38)*0.522*D40$ for Electric Compressors

7.5.5 Line 39, A39 "Relative Emission Value" columns B to F are the values

	B	C	D	E	F
Relative Emission Value	15	3	2	1	0.4

Belt driven compressor - insert number in line 38 columns B through F

Electric compressor - insert number in line 38 columns C through F

7.5.6 Line 40, A40 "If Compressors ARE Helium Leak Tested, change the number in Cell D40 from "2" to "1" Cell D40 "2"

7.6 Summary and Pie Chart

A	B	C	D	E	F	G
42	Summary	% Contribution				
43	System Joints (Connections)	=H10/B51	=SUM(H10)			% System Component Contribution
44	Non-Joint Related Emissions	=H20/B51	=SUM(H20)			
45	Flexible Hoses	=H32/B51	=SUM(H32)			
46	Heat Exchangers	=H34/B51	=SUM(H34)			
47	Compressor Body	=H38/B51	=SUM(H38)			
48	Total	=SUM(B43:B47)	=SUM(C43:C47)			
49						
50						
51	Approximate Total System Refrigerant Emission Grams/Year	=SUM(H10, H20, H32, H34, H38)				

TABLE 1 - SUMMARY OF SPREADSHEET VALUES FOR PIE CHART

Line/Column	A	B	C
42	Summary	% Contribution	Grams/yr
43	System Joints (Connections)	=H10/B51	=SUM(H10)
44	Non-Joint Related Emissions	=H20/B51	=SUM(H20)
45	Flexible Hoses	=H32/B51	=SUM(H32)
46	Heat Exchangers	=H34/B51	=SUM(H34)
47	Compressor Body	=H38/B51	=SUM(H38)
48	Total	=SUM(B43:B47)	=SUM(C43:C47)

7.6.1 Cell C43 = SUM(H10); Cell C44 = SUM(H20); Cell C45 = SUM(H32); Cell C46 = SUM(H34); Cell C47 = SUM(H38); Cell C48 = SUM(C43:C47)

7.6.2 Line 51, A51 "Approximate Total System Refrigerant Emission Grams/Year"

Equation for B51 = SUM(H10, H20, H32, H34, H38)

7.7 Spreadsheet for R-1234yf Refrigerant Systems

The spreadsheet for R-1234yf systems is identical to that of R-134a systems with the exception of the wording for cells E22-G22 and the equations in Cells H8, H9, H13, H15, H17, H19, H34 and H38. The equation in each of these cells has the additional multiplier of 1.03 to account for the combined effect of the gas viscosity difference and the molecular weight difference between R-1234yf and R-134a. See Section 6.1.

7.7.1 To create an R-1234yf spreadsheet from the R-134a spreadsheet, make the changes noted in 7.7.1.1 and 7.7.1.2.

7.7.1.1 Replace the R-134a equations with the R-1234yf equations listed below. Note the only change is the addition of the correction factor multiplier, 1.03.

Equations for R-1234yf spreadsheet

Equation for Cell H8 = $(B7*B8+C7*C8+D7*D8+E7*E8+F7*F8+G7*G8)*0.522*1.03$

Equation for Cell H9 = $(E7*E9)*0.522*1.03$

Equation for Cell H13 = $(SUM(C13*0.3)+SUM(E13*0.2))*0.522*1.03$

Equation for Cell H15 = $(SUM(C15*0.3)+SUM(E15*0.2))*0.522*1.03$

Equation for Cell H17 = $SUM(C17*0.2)*0.522*1.03$

Equation for Cell H19 = $SUM(C19*0.2)*0.522*1.03$

Equation for Cell H32 = SUM(H24:H31)

Equation for Cell H34 = $E34*0.25*0.522*1.03$

Equation for Cell H38 = $(B39/B38+C39*C38+D39*D38+E39*E38+F39*F38)*0.522*D40*1.03$ for Belt-Driven Compressors

Equation for Cell H38 = $(C39*C38+D39*D38+E39*E38+F39*F38)*0.522*D40*1.03$ for Electric Compressors

7.7.1.2 CHANGE THE WORDING IN LINE 23 AS FOLLOWS:

Cells E23-G23 shall read "Enter SAE J2064 R-1234yf Permeation Rate at 80C" (kg/m² /yr) in column F for each system hose

8. SPREADSHEET

Samples SAMPLE SHEETS FOR R-134a and R-1234yf Belt driven and electric compressor Emission Chart SPREADSHEETS FIGURES 1 TO 4.

8.1 Sample R-134a Belt-Driven Compressor, Figure 1

	A	B	C	D	E	F	G	H	I
1	SAE J2727 TEMPLATE for R-134a Systems								
2	Revised September 30, 2011								
3	Leakage Chart for Systems with Belt-Driven Compressors (Template)								
4	Enter data only in cells of this color							Calculated Emissions	
5	System Joints (a.k.a. Fittings & Connections)								
6	EACH & EVERY JOINT Used to Attach Components to the A/C System MUST be Accounted for in either Row 8 or Row 9	Single O-ring	Radial O-ring	Single Captured O-ring / Single Axial O-ring / Molded Seal	Multiple ring	O-ring	Seal Washer	Dual Seal Washer / Seal Washer with O-ring	Metal Gasket
7	Relative Emission Value	1.250	0.750	0.500			0.100	0.050	0.010
8	Insert Total Number of Joint Types E6, F6, and G6. Also enter the Total Number of Joints B6, C6, and D6 NOT Helium Leak Checked After Component Sub-Assembly		5	3			5	1	
9	Joint Types B6, C6, and D6 That Are Helium Leak Checked After Component Sub-Assembly Are Considered Equivalent to Seal Washers. List The Total Number of Such Seals only in E9						1		
10								Connections Total	3.08
11	Devices with Other Emission Paths								
12	Service Ports (non-joint emissions)			High Side		Low-Side			
13		Insert number of service valves	1	Insert number of service valves		1			0.26
14	Line-mounted PRV, Switches, Transducers (non-joint emissions)			Located on High Side		Located on Low-Side			
15		number of devices	2			1			0.42
16	Thermal Expansion Device (non-joint emissions)								
17		number of devices	1						0.10
18	Compressor Mounted Devices (non-joint emissions)			PRV, Control Valve, Switches					
19		number of devices	1						0.10
20									
21								Other Emission Paths Total	0.89
22	Flexible Hoses								
23	Includes Hose and Hose Coupling Crimps [End Connections included in Component Connection]	Exposed Length (Between Crimps) [mm]	Diameter Inner [mm]	Surface Area [mm ²]	Do Not Enter Data	Enter SAE J2064 R-134a Permeation Rate at 80C For Each System Hose	In Column F	Do Not Enter Data	Permeation Rate Unit = Kg/m ³ /2year
24	High pressure line 1	300	10.0	9425		0.60		0.079	Enter length to the nearest millimeter
25	High pressure line 2	80	10.0	1885		0.60		0.021	Enter diameter to the nearest tenth of mm.
26	High pressure line 3	100	10.0	3142		1.00		0.044	
27	High pressure line 4	0	0.0	0		0.00		0.000	
28	Low pressure line 1	480	16.0	24127		4.00		0.902	
29	Low pressure line 2	0	0.0	0		0.00		0.000	
30	Low pressure line 3	0	0.0	0		0.00		0.000	
31	Low pressure line 4	80	0.0	0		0.00		0.000	
32								Hose Total	1.05
33	Heat Exchangers (HX's)								
34				Number of Heat Exchangers	2			HX Total	0.26
35	Compressor Body								
36	Exclusive of Attached Devices	Number of lips on shaft seal	Number of O-Ring Housing Seals	Number of Molded Housing Seals	Number of Gasket Housing Seals	Fitting Adaptor Plate Seal		Do Not Enter Data	Account for All Attached Devices (e.g., HPRV, HPCO, Drain Plug) on Lines 8 or 9
37	Insert Number of Each Type of Seal In Compressor	2	1	1	1			Compressor Total	14.09
38	Relative Emission Value	15	3	2	1	0.4			Note: 100% of compressors must be Helium Leak Tested: If NOT, emissions are doubled
39	IF Compressors ARE Helium Leak Tested, change the number in Cell D40 from 2 to 1			2					
40									
41									
42	Summary	% Contribution	grams/year						
43	System Joints (Connections)	15.9%	3.1						
44	Non-Joint Related Emissions	4.6%	0.9						
45	Flexible Hoses	5.4%	1.0						
46	Heat Exchangers	1.3%	0.3						
47	Compressor Body	72.8%	14.1						
48	Total	100.0%	19.4						
49									
50									
51	Approximate Total System Refrigerant Emission Grams/Year		19.4						
52									
53									
54	NOTE: Entries made in stippled boxes represent components/connections Helium Leak tested for leak tightness after assembly								

% System Component Contribution

Component	Percentage
Compressor Body	73%
System Joints (Connections)	16%
Heat Exchangers	5%
Non-Joint Related Emissions	5%

8.2 Sample R-1234yf Belt-Driven Compressor Figure 2

	A	B	C	D	E	F	G	H	I
1	SAE J2727 TEMPLATE for R-1234yf Systems								
2	Revised September 30, 2011								
3	Leakage Chart for Systems with Belt-Driven Compressors (Template)								
4	Enter data only in cells of this color							Calculated Emissions	
5	System Joints (a.k.a. Fittings & Connections)								
6	EACH & EVERY JOINT Used to Attach Components to the A/C System MUST be Accounted for in either Row 8 or Row 9	Single O-ring	Radial O-ring	Single Captured O-ring / Single Axial O-ring / Molded Seal	Multiple ring	O-ring	Seal Washer	Dual Seal Washer / Seal Washer with O-ring	Metal Gasket
7	Relative Emission Value	1.250	0.750	0.500	0.100	0.050	0.010		
8	Insert Total Number of Joint Types E6, F6, and G6. Also enter the Total Number of Joints B6, C6, and D6 NOT Helium Leak Checked After Component Sub-Assembly		5	3	5	1		3.12	Joints are those sealing technologies separating the refrigerant from the atmosphere
9	Joint Types B6, C6, and D6 That Are Helium Leak Checked After Component Sub-Assembly Are Considered Equivalent to Seal Washers. List The Total Number of Such Seals only in E9				1			0.05	Joints NOT Helium Leak Tested After Assembly
10							Connections Total	3.17	Joints that ARE Helium Leak Tested After Component Sub-Assembly. Note: To use this cell, 100% of all joints must be so tested.
11	Devices with Other Emission Paths								
12	Service Ports (non-joint emissions)		High Side		Low-Side				Devices with emission paths other than at the connecting joint, e.g. thru the valve core and cap of a service port
13		Insert number of service valves	1	Insert number of service valves	1			0.27	Note: List all sealing connections to the atmosphere in Line 8 or 9
14	Line-mounted PRV, Switches, Transducers (non-joint emissions)		Located on High Side		Located on Low-Side				Note: If a two piece core is used with an internal o-ring, this o-ring must be included in row 8 or 9 above.
15		number of devices	2		1			0.43	Note: List all sealing connections to the atmosphere in Line 8 or 9
16	Thermal Expansion Device (non-joint emissions)								Note: ALL four connections for a block style thermal expansion valve [TXV] need to be accounted for in rows 8 and 9 above!
17		number of devices	1					0.11	Note: List all sealing connections to the atmosphere in Line 8 or 9
18	Compressor Mounted Devices (non-joint emissions)		PRV, Control Valve, Switches						Note: List all sealing connections to the atmosphere in Line 8 or 9
19		number of devices	1					0.11	Note: List all sealing connections to the atmosphere in Line 8 or 9
20							Other Emission Paths Total	0.91	
21	Flexible Hoses								
22	Includes Hose and Hose Coupling Crimps [End Connections Included in Component Connection]	Hose Exposed Length (Between Crimps) [mm]	Hose Diameter Inner [mm]	Hose Surface Area [mm ²]	Do Not Enter Data	Enter SAE J2064 R-1234yf Permeation Rate at 80°C For Each System Hose	Do Not Enter Data		Permeation Rate Unit = Kg/m ² /2year
23									Use Only Exposed Length of Hose Between Crimps. Coupling emission is accounted for in this calculation
24	High pressure line 1	300	10.0	9425		0.50		0.066	Enter length to the nearest millimeter
25	High pressure line 2	80	10.0	1885		0.70		0.018	Enter diameter to the nearest tenth of mm.
26	High pressure line 3	100	10.0	3142		0.90		0.040	
27	High pressure line 4	0	0.0	0		0.00		0.000	
28	Low pressure line 1	480	16.0	24127		5.00		1.127	
29	Low pressure line 2	0	0.0	0		0.00		0.000	
30	Low pressure line 3	0	0.0	0		0.00		0.000	
31	Low pressure line 4	50	0.0	0		0.00		0.000	
32							Hose Total	1.25	
33	Heat Exchangers (HX's)								
34				Number of Heat Exchangers	2			HX Total	0.27
35	Compressor Body								
36	Exclusive of Attached Devices	Number of lips on shaft seal	Number of O-Ring Housing Seals	Number of Molded Housing Seals	Number of Gasket Housing Seals	Fitting Adaptor Plate Seal		Do Not Enter Data	Account for All Attached Devices (e.g., HPRV, HPCO, Drain Plug) on Lines 8 or 9
37	Insert Number of Each Type of Seal In Compressor	2	1	1	1		Compressor Total	14.52	Note: 100% of compressors must be Helium Leak Tested: If NOT, emissions are doubled
38	Relative Emission Value	15	3	2	1	0.4			
39	IF Compressors ARE Helium Leak Tested, change the number in Cell D40 from 2 to 1			2					
40									
41	Summary								
42		% Contribution	grams/year						
43	System Joints (Connections)	15.8%	3.2						
44	Non-Joint Related Emissions	4.5%	0.9						
45	Flexible Hoses	6.2%	1.3						
46	Heat Exchangers	1.3%	0.3						
47	Compressor Body	72.1%	14.5						
48	Total	100.0%	20.1						
49									
50									
51	Approximate Total System Refrigerant Emission Grams/Year		20.1						
52									
53	NOTE: Entries made in stippled boxes represent components/connections Helium Leak tested for leak tightness after assembly								

% System Component Contribution

Compressor Body 72.1%
System Joints (Connections) 16%
Flexible Hoses 6%
Heat Exchangers 1%
Non-Joint Related Emissions 5%

8.3 Sample R-134a Electric Compressor, Figure 3

	A	B	C	D	E	F	G	H	I
1	SAE J2727 TEMPLATE for R-134a Systems								
2	Revised September 30, 2011								
3	Leakage Chart for Systems with Electrically-Driven Compressors (Template)								
4	Enter data only in cells of this color								Calculated Emissions
5	System Joints (a.k.a. Fittings & Connections)								
6	EACH & EVERY JOINT Used to Attach Components to the A/C System MUST be Accounted for in either Row 8 or Row 9	Single O-ring	Radial O-ring	Single Captured O-ring / Single Axial O-ring / Molded Seal	Multiple ring	O-ring	Seal Washer	Dual Seal Washer / Seal Washer with O-ring	Metal Gasket
7	Relative Emission Value	1.250	0.750	0.500	0.100	0.050	0.010		
8	Insert Total Number of Joint Types E6, F6, and G6. Also enter the Total Number of Joints B6, C6, and D6 NOT Helium Leak Checked After Component Sub-Assembly		5	3	5	1		3.03	Joints NOT Helium Leak Tested After Assembly
9	Joint Types B6, C6, and D6 That Are Helium Leak Checked After Component Sub-Assembly Are Considered Equivalent to Seal Washers. List The Total Number of Such Seals only in E9				1			0.05	Joints that ARE Helium Leak Tested After Component Sub-Assembly. Note: To use this cell, 100% of all joints must be so tested.
10							Connections Total	3.08	
11	Devices with Other Emission Paths								
12	Service Ports (non-joint emissions)		High Side		Low-Side				
13		Insert number of service valves	1	Insert number of service valves	1			0.26	Note: List all sealing connections to the atmosphere in Line 8 or 9
14	Line-mounted PRV, Switches, Transducers (non-joint emissions)		Located on High Side		Located on Low-Side				Note: If a two piece core is used with an internal o-ring, this o-ring must be included in row 8 or 9 above.
15		number of devices	2		1			0.42	Note: List all sealing connections to the atmosphere in Line 8 or 9
16	Thermal Expansion Device (non-joint emissions)								Note: ALL four connections for a block style thermal expansion valve [TXV] need to be accounted for in rows 8 and 9 above!
17		number of devices	1					0.10	Note: List all sealing connections to the atmosphere in Line 8 or 9
18	Compressor Mounted Devices (non-joint emissions)		PRV, Control Valve, Switches						
19		number of devices	1					0.10	Note: List all sealing connections to the atmosphere in Line 8 or 9
20							Other Emission Paths Total	0.89	
21	Flexible Hoses								
22	Includes Hose and Hose Coupling Crimps [End Connections Included in Component Connection]	Hose Exposed Length (Between Crimps) [mm]	Hose Diameter Inner [mm]	Calculated Surface Area Do Not Enter Data [mm ²]	Enter SAE J2064 R-134a Permeation Rate at 80C For Each System Hose	In Column F	Do Not Enter Data		Permeation Rate Unit = Kg/m ² /year
23									Use Only Exposed Length of Hose Between Crimps. Coupling emission is accounted for in this calculation
24	High pressure line 1	300	10.0	9426	0.60		0.079		Enter length to the nearest millimeter
25	High pressure line 2	60	10.0	1885	0.60		0.021		Enter diameter to the nearest tenth of mm.
26	High pressure line 3	100	10.0	3142	1.00		0.044		
27	High pressure line 4	0	0.0	0	0.00		0.000		
28	Low pressure line 1	480	16.0	24127	4.00		0.902		
29	Low pressure line 2	0	0.0	0	0.00		0.000		
30	Low pressure line 3	0	0.0	0	0.00		0.000		
31	Low pressure line 4	0	0.0	0	0.00		0.000		
32						Hose Total	1.05		
33	Heat Exchangers (HX's)								
34				Number of Heat Exchangers	2		HX Total	0.26	Include all Condensers, Evaporators and Internal Heat Exchangers. Note: 100% of such components must be Helium leak tested.
35	Compressor Body								
36	Exclusive of Attached Devices	Number of lips on shaft seal	Number of O-Ring Housing Seals	Number of Molded Housing Seals	Number of Gasket Housing Seals	Fitting Adaptor Plate Seal		Do Not Enter Data	Account for All Attached Devices (e.g., HPRV, HPCO, Drain Plug) on Lines 8 or 9
37	Insert Number of Each Type of Seal in Compressor	N/A	1	1	1		Compressor Total	6.26	Note: 100% of compressors must be Helium Leak Tested: If NOT, emissions are doubled
38	Relative Emission Value		3	2	1	0.4			
39	IF Compressors ARE Helium Leak Tested, change the number in Cell D40 from 2 to 1								
40				2					
41									
42	Summary	% Contribution	grams/year						
43	System Joints (Connections)	26.7%	3.1						
44	Non-Joint Related Emissions	7.7%	0.9						
45	Flexible Hoses	9.1%	1.0						
46	Heat Exchangers	2.3%	0.3						
47	Compressor Body	54.3%	6.3						
48	Total	100.0%	11.5						
49									
50									
51	Approximate Total System Refrigerant Emission Grams/Year	11.5							
52									
53									
54	NOTE: Entries made in stippled boxes represent components/connections Helium Leak tested for leak tightness after assembly								

% System Component Contribution

Component	% Contribution
Compressor Body	54.3%
System Joints (Connections)	26.7%
Non-Joint Related Emissions	7.7%
Flexible Hoses	9.1%
Heat Exchangers	2.3%

8.4 Sample R-1234yf Electric Compressor, Figure 4

	A	B	C	D	E	F	G	H	I
1	SAE J2727 TEMPLATE for R-1234yf Systems								
2	Revised September 30, 2011								
3	Leakage Chart for Systems with Electrically-Driven Compressors (Template)								
4	Enter data only in cells of this color							Calculated Emissions	
5	System Joints (a.k.a. Fittings & Connections)								
6	EACH & EVERY JOINT Used to Attach Components to the A/C System MUST be Accounted for in either Row 8 or Row 9	Single O-ring	Radial O-ring	Single Captured O-ring / Single Axial O-ring / Molded Seal	Multiple ring	O-ring	Seal Washer	Dual Seal Washer / Seal Washer with O-ring	Metal Gasket
7	Relative Emission Value	1.250	0.750	0.500	0.100	0.050	0.010		
8	Insert Total Number of Joint Types E6, F6, and G6. Also enter the Total Number of Joints B6, C6, and D6 NOT Helium Leak Checked After Component Sub-Assembly		5	3	5	1		3.12	Joints NOT Helium Leak Tested After Assembly
9	Joint Types B6, C6, and D6 That Are Helium Leak Checked After Component Sub-Assembly Are Considered Equivalent to Seal Washers. List The Total Number of Such Seals only in E9				1			0.05	Joints that ARE Helium Leak Tested After Component Sub-Assembly. Note: To use this cell, 100% of all joints must be so tested.
10							Connections Total	3.17	
11	Devices with Other Emission Paths								
12	Service Ports (non-joint emissions)		High Side		Low-Side				
13		Insert number of service valves	1	Insert number of service valves	1			0.27	Note: List all sealing connections to the atmosphere in Line 8 or 9
14	Line-mounted PRV, Switches, Transducers (non-joint emissions)		Located on High Side		Located on Low-Side				Note: If a two piece core is used with an internal o-ring, this o-ring must be included in row 8 or 9 above.
15		number of devices	2		1			0.43	Note: List all sealing connections to the atmosphere in Line 8 or 9
16	Thermal Expansion Device (non-joint emissions)								Note: ALL four connections for a block style thermal expansion valve [TXV] need to be accounted for in rows 8 and 9 above!
17		number of devices	1					0.11	Note: List all sealing connections to the atmosphere in Line 8 or 9
18	Compressor Mounted Devices (non-joint emissions)		PRV, Control Valve, Switches						
19		number of devices	1					0.11	Note: List all sealing connections to the atmosphere in Line 8 or 9
20							Other Emission Paths Total	0.91	
21	Flexible Hoses								
22	Includes Hose and Hose Coupling Crimps [End Connections Included in Component Connection]	Hose Exposed Length (Between Crimps) [mm]	Hose Diameter Inner [mm]	Do Not Enter Data	Calculated Surface Area [mm ²]	Enter SAE J2064 R-1234yf Permeation Rate at 80°C For Each System Hose	Do Not Enter Data		Permeation Rate Unit = Kg/m ² /year
23									Use Only Exposed Length of Hose Between Crimps. Coupling emission is accounted for in this calculation
24	High pressure line 1	300	10.0		9426	0.50	0.066		Enter length to the nearest millimeter
25	High pressure line 2	60	10.0		1885	0.70	0.018		Enter diameter to the nearest tenth of mm.
26	High pressure line 3	100	10.0		3142	0.90	0.040		
27	High pressure line 4	0	0.0		0	0.00	0.000		
28	Low pressure line 1	480	16.0		24127	5.00	1.127		
29	Low pressure line 2	0	0.0		0	0.00	0.000		
30	Low pressure line 3	0	0.0		0	0.00	0.000		
31	Low pressure line 4	60	0.0		0	0.00	0.000		
32						Hose Total	1.25		
33	Heat Exchangers (HX's)								
34				Number of Heat Exchangers	2		HX Total	0.27	Include all Condensers, Evaporators and Internal Heat Exchangers. Note: 100% of such components must be Helium leak tested.
35	Compressor Body								
36	Exclusive of Attached Devices	Number of lips on shaft seal	Number of O-Ring Housing Seals	Number of Molded Housing Seals	Number of Gasket Housing Seals	Fitting Adaptor Plate Seal		Do Not Enter Data	Account for All Attached Devices (e.g., HPRV, HPCO, Drain Plug) on Lines 8 or 9
37	Insert Number of Each Type of Seal in Compressor	N/A	1	1	1		Compressor Total	6.45	Note: 100% of compressors must be Helium Leak Tested: If NOT, emissions are doubled
38	Relative Emission Value		3	2	1	0.4			
39	IF Compressors ARE Helium Leak Tested, change the number in Cell D40 from 2 to 1								
40				2					
41									
42	Summary		% Contribution	grams/year					
43	System Joints (Connections)		26.3%	3.2					
44	Non-Joint Related Emissions		7.6%	0.9					
45	Flexible Hoses		10.4%	1.3					
46	Heat Exchangers		2.2%	0.3					
47	Compressor Body		53.5%	6.6					
48	Total		100.0%	12.1					
49									
50									
51	Approximate Total System Refrigerant Emission Grams/Year		12.1						
52									
53									
54	NOTE: Entries made in stippled boxes represent components/connections Helium Leak tested for leak tightness after assembly								

% System Component Contribution

Component	% Contribution
System Joints (Connections)	26%
Compressor Body	54%
Flexible Hoses	10%
Non-Joint Related Emissions	8%
Heat Exchangers	2%

Reference Component Illustrations Hose Construction

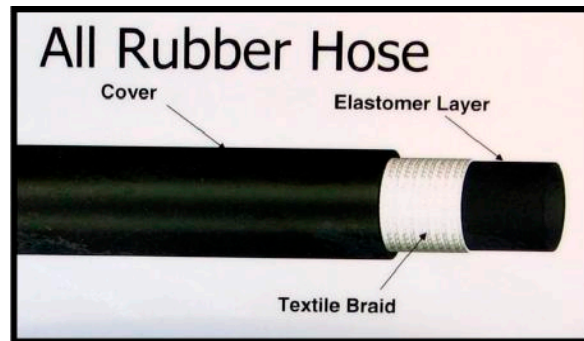


FIGURE 5

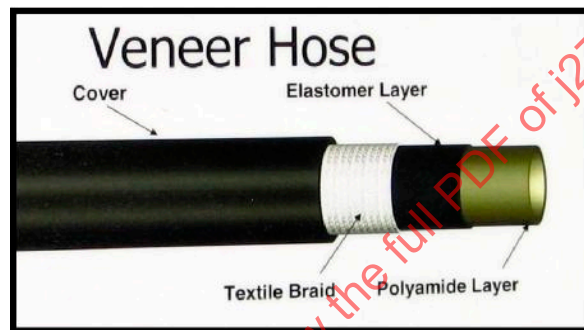


FIGURE 6



FIGURE 7

Fittings

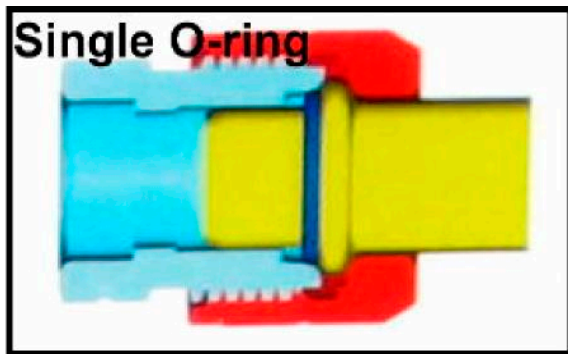


FIGURE 8

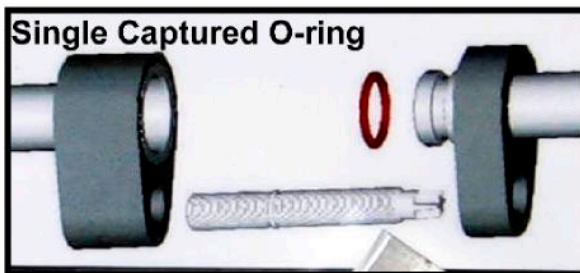


FIGURE 9



FIGURE 10



Figure 11



FIGURE 12



Figure 13 Seal Washer