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SURFACE VEHICLE STANDARD

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(R) HFC-134a Mobile Air Conditioning System Refrigerant Emission Chart

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. The current revision is intended to provide clearer definitions of sealing technologies and how to apply them to the SAE J2727 System Emissions Chart.

1. SCOPE

The original SAE J2727 “Emission Chart” provided a rating system for comparing mobile A/C systems and was not intended to define mobile A/C system refrigerant emission. It had been developed from industry experience of expected system refrigerant emission based upon currently available technologies.

The “System Emissions Chart” contained in this revision is intended to serve as a means of estimating the annual refrigerant emissions 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. SAE J2763 may be used to quantify emissions from properly assembled systems.

2. REFERENCES

2.1 Applicable Publications

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 R134a 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 HFC-134a 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 spreadsheet apply to systems assembled in new production vehicles and include an estimate of the expected normal variation for most OEM assembly plants.

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

3.1.3 This chart allows for normal design assembly of refrigerant system connections. The default value for each fitting technology reflects its potential for mis-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 technologies are developed and evaluated for their robustness and ability to reduce system emissions.

3.2 Fitting Connections

All connections of components to the A/C system must be listed in the Fittings and Section. Tube-hose couplings are excluded and accounted for in the Flexible Hose Section.

3.2.1 Emission default values for fittings relate to their potential for production A/C system O-ring mis-assembly. Fittings such as 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.

It is assumed that properly designed and assembled O-ring fittings will have emission rates comparable to properly designed and assembled seal washers.

Given the above, SAE J2727 may overestimate O-ring fitting emissions 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 Service Ports

Service fittings emissions are assumed to have sealing caps in place. Emission rate is based on the design of the seals in these caps and being properly assembled and torqued.

3.4 PRV, Switches, Transducers Emission

These devices may include different internal sealing technologies (e.g., o-rings, seal washers, and gaskets) Default values in the spreadsheet account for emissions from these internal seals. Default 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 Fittings and Connections Section.

3.5 Flexible Hose

3.5.1 Hose technologies vary principally in refrigerant permeation rate, i.e., different hose materials and construction can affect the permeation rate. Hose permeation rate is a function of location on the system, internal refrigerant temperature and pressure, material, hose construction, and hose inner surface area. Assigned values herein are based on laboratory testing experience. Relative emission rates of high-side hoses are 1.5 times that of 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.

3.5.2 Flexible hose assemblies include tube, hose and coupling. Emissions occur through the hose and at the couplings. Emissions from the tube fitting connections at either end of the hose are to be included in the Fittings and Connections Section.

3.5.3 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.

3.5.4 It is assumed that veneer hoses use an adhesive, or O-rings, or similarly effective sealing technology between the hose and tube in the coupling assembly. All Rubber type and Barrier type hoses are excluded from this assumption. Both Veneer type and Barrier type hoses are constructed to minimize emissions.

3.5.5 Ultra low permeation hoses are herein defined as those hoses having a permeation rate less than 1.5 kg/m^2/year at 80 °C as tested per SAE J2064.

3.6 Refrigerant Flow Devices

3.6.1 Expansion valves, in-line or block type, incorporate various sealing technologies on the fitting connections. Emissions from connections to the refrigerant flow device are to be included in the number of connections in the Fittings and Connections Section. The assigned emission from the TXV body/housing is 0.2 g/yr.

3.6.2 Orifice tube flow device emissions included in flexible hose assemblies or rigid pipe connections and are to be included in the number of connections in the Fittings and Connections Section.

3.7 Heat Exchangers, Mufflers and Receiver/Driers and Accumulators

3.7.1 These components are considered robust and the Emissions Chart assigns a value of 0.50 g/yr for their combined emissions. Emissions from fittings to connect these components to the system are to be included in the Fittings and Connections Section. Any serviceable connections on these components, such as fittings for servicing desiccant, are to be included in the Fittings and Connections Section.

3.8 Compressor

3.8.1 The major refrigerant emission paths of a belt driven compressor are the shaft seal and housing (body) seals.

3.8.2 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.

3.8.2.1 Compressor shaft seal(s). The number of lips on the shaft seal is defined by the number of individual sealing elements, e.g., PTFE, HNBR.

3.8.3 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 Fittings and Connections Section.

3.8.4 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.

3.8.5 Some compressors use fitting adaptor plates between the compressor body and the rigid pipe fitting. Adaptor plates are sealed to the housing by a captured O-ring or molded-in-place seal. Adaptor plate seals some of which are molded in place, are assumed to perform similar to single o-ring joints.

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

3.8.6.1 Number of Lips on the Shaft Seal

3.8.6.2 Number of O-Ring Housing Seals

3.8.6.3 Number of Molded Housing Seals

3.8.6.4 Number of Gasket Housing Seals Fitting

3.8.6.5 Adaptor Plate (e.g., European style)

3.8.7 Compressor Control Valve seals are to be included in the Fittings and Connections Section.

3.8.8 See Section 9 Notes for additional compressor definitions.

3.8.9 All other refrigerant fittings located on the compressor assembly shall be listed in the appropriate Fittings and Connections Section and/or the Service Ports and Refrigerant Devices Section.

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 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"]

5.3 This procedure can be used to predict annual grams per year emission rates for new HFC-134a 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. SAMPLE SHEET FOR HFC-134a EMISSION CHART SPREADSHEET FIGURES 1 TO 4

6.1 This provides examples for two identical refrigerant systems, one containing a belt-driven compressor and the other a Semi-Hermetic electric compressor.

6.2 Fittings and Connections

9 single o-rings - 1 single captured o-ring - 2 seal washers

6.3 Service Ports

1 high side single o-ring -1 low side single o-ring

6.4 PRV, Switches, and Transducers - 2

6.4.1 Refrigerant Control Device - TXV -1

6.5 Flexible Hose

One high-pressure line, 650 mm in length, 10 mm in inner diameter, and standard barrier material
One low-pressure line, 650 mm in length, 16 mm in inner diameter, and all rubber hose material

6.6 Compressor

6.6.1 Belt Driven (Figures 1 and 2) with Single Lip Shaft Seal (1) Number of O-Ring Housing Seals (2) Number of Molded Housing Seals (2) Fitting Adaptor Plate (1)

6.6.2 Electric Semi-Hermetic (Figures 3 and 4) Number of Molded Housing Seals (1) Number of Gasket Housing Seals (1)

7. SPREADSHEET FORMULAS

A working spreadsheet template cannot be included in this document. Accordingly, the spreadsheet template is shown in Figure 1, a typical layout is identified in Figure 2, and the formulas for developing the system, Excel or similar, spreadsheet, including default values and assumptions, are identified below in this section.

Two different emission chart templates are required, one for belt-driven and one for semi-hermetic compressors. Both charts are identical except for the compressor type used and its contribution to overall emission.

7.1 Fittings and Connections

7.1.1 Line H7 =(B6*B7+C6*C7+D6*D7+E6*E7+F6*F7 + G7*G6)/100*0.522

7.1.2 Line H8 =SUM(H7)

7.1.3 Spreadsheet Layout

System Fittings and Connections							Calculated Value
Fittings							
Connections	Single O-ring	Single Captured O-ring	Multiple O-ring	Seal Washer	Seal Washer with O-ring	Metal Gasket	Do Not Enter Data
Emissions Value	125	75	50	10	5	1	
Insert Number of Fittings:							Line H7 =(B6*B7+C6*C7+D6*D7+E6*E7+F6*F7 + G7*G6)/100*0.522
						Fittings Total	Line H8 =SUM(H7)

7.2 Service Ports and Refrigerant Devices

7.2.1 High side service port
Line H12 =SUM(B12*0.3)*0.522

7.2.2 Low side service port
Line H15 =SUM(B15*0.2)*0.522

7.2.3 PRV, Switches, Transducers
Line H18 =SUM(B18*0.2)*0.522

7.2.4 Refrigerant Control Device
Line H 21 =SUM(B21*0.2)*0.522

7.2.5 Total
Line H 22 =SUM(H12+H15+H18+H21)

7.2.6 Spreadsheet Layout

Service Ports - Refrigerant Devices			
High Side Service Port			
	Number of Ports		
Insert number			Line H12 =SUM(B12*0.3)*0.522
Low-Side Service Port			
	Number of Ports		
Insert number			Line H15 =SUM(B15*0.2)*0.522
PRV, Switches, Transducers			
	Number of Devices		
Insert number			Line H18 = SUM(B18*0.2)*0.522
Refrigerant Control Device- (e.g., TXV)			
	Number of Devices		
Insert number			Line 21 =SUM(B21*0.2)*0.522
		Service Ports Refrigerant Devices Total	Line 22 =SUM(H12+H15+H18+H21)

7.3 Flexible Hose

7.3.1 High pressure line 1
Line D27 =3.141 59*C27*B27
Line H27 =(E27*0.021 6*D27+F27*0.0054*D27+G27*0.00225*D27)/1 00*0.522

7.3.2 High pressure line 2
Line D28 =3.141 59*C28*B28
Line H28 =(E28*0.021 6*D28+F28*0.0054*D28+G28*0.00225*D28)/1 00*0.522

7.3.3 High pressure line 3
Line D29 =3.141 59*C29*B29
Line H29 =(E29*0.021 6*D29+F29*0.0054*D29+G29*0.00225*D29)/1 00*0.522

7.3.4 High pressure line 4
Line D30 =3.141 59*C30*B30
Line H30 =(E30*0.021 6*D30+F30*0.0054*D30+G30*0.00225*D30)/1 00*0.522

7.3.5 Low pressure line 1
Line D31 =3.14159*C31*B31
Line H31 =(E31 *0.01 44*D31 +F31 *0.0036*D31 +G31 *0.001 67*D31)/1 00*0.522

7.3.6 Low pressure line 2
Line D32 =3.141 59*C32*B32
Line H32 =(E32*0.01 44*D32+F32*0.0036*D32+G32*0.001 67*D32)/1 00*0.522

7.3.7 Low pressure line 3
Line H33 =3.14159*C33*B33
Line H33 =(E33*0.01 44*D33+F33*0.0036*D33+G33*0.001 67*D33)/1 00*0.522

7.3.8 Low pressure line 4
Line D34 =3.141 59*C34*B34
Line H34 =(E34*0.01 44*D34+F34*0.0036*D34+G34*0.001 67*D34)/1 00*0.522

7.3.9 TOTAL
Line H35 =SUM(H27:H34)

7.3.10 Spreadsheet Layout

Flexible Hoses	Hose	Hose	Calculated Value	Type of Hose			
Includes Hose and Hose Coupling Crimps [End Connections included in Component Connection]	Length [mm]	Diameter Inner [mm]	**Surface Area Do Not Enter Data**	All Rubber Hose	Standard Barrier or Veneer Hose	Ultra-low Perm Barrier or Veneer Hose	**Do Not Enter Data**
High pressure line 1 Insert size type			Line D27 =3.14159 *C27*B27				Line H27 =(E27*0.021 6*D27+F27*0.0054*D27+G27*0.00225*D27)/1 00*0.522
High pressure line 2 Insert size type			Line D28 =3.14159 *C28*B28				Line H28 =(E28*0.021 6*D28+F28*0.0054*D28+G28*0.00225*D28)/1 00*0.522
High pressure line 3 Insert size type			Line D29 =3.14159 *C29*B29				Line H29 =(E29*0.021 6*D29+F29*0.0054*D29+G29*0.00225*D29)/1 00*0.522
High pressure line 4 Insert size type			Line D30 =3.14159 *C30*B30				Line H30 =(E30*0.021 6*D30+F30*0.0054*D30+G30*0.00225*D30)/1 00*0.522
Low pressure line 1 Insert size type			Line D31 =3.14159 *C31*B31				Line H31 =(E31 *0.01 44*D31 +F31 *0.0036*D31 +G31 *0.001 67*D31)/1 00*0.522
Low pressure line 2 Insert size type			Line D32 =3.14159 *C32*B32				Line H32 =(E32*0.01 44*D32+F32*0.0036*D32+G32*0.001 67*D32)/1 00*0.522
Low pressure line 3 Insert size type			Line D33 =3.14159 *C33*B33				Line H33 =(E33*0.01 44*D33+F33*0.0036*D33+G33*0.001 67*D33)/1 00*0.522
Low pressure line 4 Insert size type			Line D34 =3.14159 *C34*B34				Line H34 =(E34*0.01 44*D34+F34*0.0036*D34+G34*0.001 67*D34)/1 00*0.522
	[place hose size in appropriate cell]		[place a "1" in the appropriate cell]	**Hose Total**			Line H35 =SUM(H27:H34)

7.4 Heat Exchangers Mufflers and Receiver/Driers and Accumulators

7.4.1 Assumption = Line H 38 = 0.500*0.522

7.5 Compressor

7.5.1 Belt-Driven Line H44 =(B45/B44+C45*C44+D45*D44+E45*E44+F45*F44)/1 00*0.522 7.5.1.1

7.5.2 Spreadsheet Layout

Compressor							
	Type of Seal						
	Number of Lips on Shaft Seal	Number of O-Ring Housing Seals	Number of Molded Housing Seals	Fitting Adaptor Plate Seal	Number of Gasket Housing Seals		**Do Not Enter Data**
Insert Number and Type of Seals in Compressor						**Belt Driven Comp. Total**	Line H44 =(B45/B44+C45*C44+D45*D44+E45*E44+F45*F44)/1 00*0.522
Belt Driven Compressor	1500	300	200	150	100		
	[place a "##" in the appropriate cell]						

7.5.3 Electric Compressor Line H44 =(C45*C44+D45*D44+E45*E44+F45*F44)/1 00*0.522

7.5.3.1 Spreadsheet Electric Compressor Layout

Compressor							
	Type of Seal						
	Shaft Seal N/A	Number of O-Ring Housing Seals	Number of Molded Housing Seals	Fitting Adaptor Plate Seal	Number of Gasket Housing Seals		**Do Not Enter Data**
Insert Number and Type of Seals in Compressor						**Electric Comp. Total**	Line H44 =(C45*C44+D45*D44+E45*E44+F45*F44)/1 00*0.522
Electric Compressor	1500	300	200	150	100		
	[place a "##" in the appropriate cell]						

7.6 Summary and Pie Chart

TABLE 1 - SUMMARY OF SPREADSHEET VALUES FOR PIE CHART

Line	A	B	C
48	Summary	% Contribution	Grams/year
49	Fittings	=H8/B57	=sum (H8)
50	Refrigerant Control Device	=H22/B57	=sum (H22)
51	Hoses	=H35/B57	=sum (H35)
52	Heat Exchangers	=H38/B57	=sum (H38)
53	Compressor	=H44/B57	=sum (H44)
54	Total	=sum(B49: B53)	=sum(B49: B53)

7.6.1 Line A57 Approximate Total System Refrigerant Emissions in Grams/Year

7.6.2 Line B57 =SUM(H8, H22,H35,H38,H44) 8. SAMPLE

8. SPREADSHEET TEMPLATES

8.1 Template Belt-Driven Compressor, Figure 1

8.2 Sample Belt-Driven Compressor, Figure 2

8.3 Template Electric Compressor, Figure 3

8.4 Sample Electric Compressor, Figure 4

SAE J2727 TEMPLATE — August 2008

Leakage Chart Belt-Driven Compressor "Template"

System Fittings & Connections							Calculated Value
Fittings Connections	Single O-ring	Single Captured O-ring	Multiple O-ring	Seal Washer	Seal Washer with O-ring	Metal Gasket	Do Not Enter Data
Emissions Value	125	75	50	10	5	1	
Insert Number of fittings:							0.000
						Fittings Total	0.000

Service Ports - Refrigerant Devices		
High Side service port		
	Number of Ports	
Insert number		0.000
Low-Side service port		
	Number of Ports	
Insert number		0.000
PRV, Switches, Transducers		
	Number of Devices	
Insert number		0.000
Refrigerant Control Device- (e.g., TXV)		
	Number of Devices	
Insert number		0.000
	Service Ports Refrigerant Devices Total	0.000

Flexible Hoses		Hose Length [mm]	Hose Diameter Inner [mm]	Calculated Value	Type of Hose			
Includes Hose and Hose Coupling Crimps [End Connections included in Component Connection]				Surface Area Do Not Enter Data	All Rubber Hose	Standard Barrier or Veneer Hose	Ultra-low Perm Barrier or Veneer Hose	Do Not Enter Data
High pressure line 1	Insert size type			0				0.000
High pressure line 2	Insert size type			0				0.000
High pressure line 3	Insert size type			0				0.000
High pressure line 4	Insert size type			0				0.000
Low pressure line 1	Insert size type			0				0.000
Low pressure line 2	Insert size type			0				0.000
Low pressure line 3	Insert size type			0				0.000
Low pressure line 4	Insert size type			0				0.000
		[place hose size in appropriate cell]			[place a "1" in the appropriate cell]		Hose Total	0.000

Heat Exchangers	
Assumption = 0.5	Heat Exchange Total 0.261

Compressor							
	Type of seal						
	Number of lips on shaft seal	Number of O-Ring Housing Seals	Number of Molded Housing Seals	Fitting Adaptor Plate Seal	Number of Gasket Housing Seals		Do Not Enter Data
Insert Number and type of seals in compressor						Belt driven comp. total	#DIV/0!
Belt Driven compressor	1500	300	200	150	100		
	[place a "##" in the appropriate cell]						

Summary	% Contribution	grams/year
Fittings	#DIV/0!	0.0
Refrigerant Control Device	#DIV/0!	0.0
Hoses	#DIV/0!	0.0
Heat Exchangers	#DIV/0!	0.3
Compressor	#DIV/0!	#DIV/0!
Total	#DIV/0!	#DIV/0!

Approximate Total System Refrigerant Emission Grams/Year	#DIV/0!

% System Component Contribution

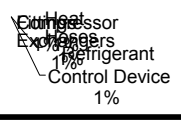

FIGURE 1 - TEMPLATE BELT DRIVEN COMPRESSOR

SAE J2727 TEMPLATE — August 2008

Leakage Chart Belt-Driven Compressor "Sample"

System Fittings & Connections							Calculated Value
Fittings Connections	Single O-ring	Single Captured O-ring	Multiple O-ring	Seal Washer	Seal Washer with O-ring	Metal Gasket	Do Not Enter Data
Emissions Value	125	75	50	10	5	1	
Insert Number of fittings:	9	1		2			6.368
						Fittings Total	6.368

Service Ports - Refrigerant Devices		
High Side service port		
	Number of Ports	
Insert number	1	0.157
Low-Side service port		
	Number of Ports	
Insert number	1	0.104
PRV, Switches, Transducers		
	Number of Devices	
Insert number	2	0.209
Refrigerant Control Device- (e.g., TXV)		
	Number of Devices	
Insert number	1	0.104
		Service Ports Refrigerant Devices Total 0.574

Flexible Hoses Includes Hose and Hose Coupling Crimps [End Connections included in Component Connection]		Hose Length [mm]	Hose Diameter Inner [mm]	Calculated Value Surface Area Do Not Enter Data	Type of Hose: All Rubber Hose	Standard Barrier or Veneer Hose	Ultra-low Perm Barrier or Veneer Hose	Do Not Enter Data
High pressure line 1	Insert size type	650	10	20420		1		0.576
High pressure line 2	Insert size type			0				0.000
High pressure line 3	Insert size type			0				0.000
High pressure line 4	Insert size type			0				0.000
Low pressure line 1	Insert size type	650	16.0	32673	1			2.456
Low pressure line 2	Insert size type			0				0.000
Low pressure line 3	Insert size type			0				0.000
Low pressure line 4	Insert size type			0				0.000
		[place hose size in appropriate cell]			[place a "1" in the appropriate cell]		Hose Total	3.032

Heat Exchangers	
Assumption = 0.5	Heat Exchange Total 0.261

Compressor	Number of lips on shaft seal	Type of seal: Number of O-Ring Housing Seals	Number of Molded Housing Seals	Fitting Adaptor Plate Seal	Number of Gasket Housing Seals		Do Not Enter Data
Insert Number and type of seals in compressor	1	2	2	1		Belt driven comp. total	13.833
Belt Driven compressor	1500	300	200	150	100		
	[place a "##" in the appropriate cell]						

Summary	% Contribution	grams/year
Fittings	26.5%	6.4
Refrigerant Control Device	2.4%	0.6
Hoses	12.6%	3.0
Heat Exchangers	1.1%	0.3
Compressor	57.5%	13.8
Total	100.0%	24.1

Approximate Total System Refrigerant Emission Grams/Year	24.068

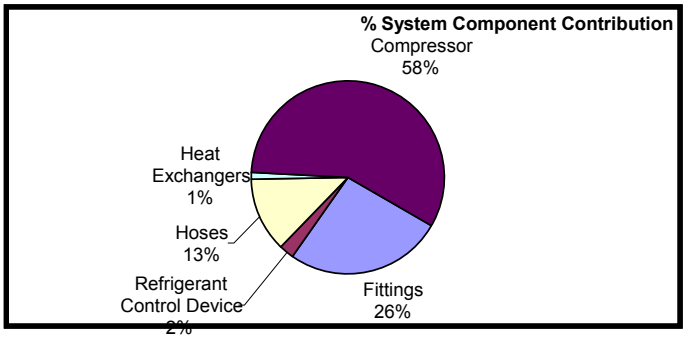

FIGURE 2 - SAMPLE BELT DRIVEN COMPRESSOR

SAE J2727 TEMPLATE — August 2008

Leakage Chart Electric Compressor "Template"

System Fittings & Connections							Calculated Value
Fittings Connections	Single O-ring	Single Captured O-ring	Multiple O-ring	Seal Washer	Seal Washer with O-ring	Metal Gasket	Do Not Enter Data
Emissions Value	125	75	50	10	5	1	
Insert Number of fittings:							0.000
						Fittings Total	0.000

Service Ports - Refrigerant Devices		
High Side service port		
	Number of Ports	
Insert number		0.000
Low-Side service port		
	Number of Ports	
Insert number		0.000
PRV, Switches, Transducers		
	Number of Devices	
Insert number		0.000
Refrigerant Control Device- (e.g., TXV)		
	Number of Devices	
Insert number		0.000
	Service Ports Refrigerant Devices Total	0.000

Flexible Hoses		Hose Length [mm]	Hose Diameter Inner [mm]	Calculated Value Surface Area Do Not Enter Data	Type of Hose: All Rubber Hose	Standard Barrier or Veneer Hose	Ultra-low Perm Barrier or Veneer Hose	Do Not Enter Data
Includes Hose and Hose Coupling Crimps [End Connections included in Component Connection]								
High pressure line 1	Insert size type			0				0.000
High pressure line 2	Insert size type			0				0.000
High pressure line 3	Insert size type			0				0.000
High pressure line 4	Insert size type			0				0.000
Low pressure line 1	Insert size type			0				0.000
Low pressure line 2	Insert size type			0				0.000
Low pressure line 3	Insert size type			0				0.000
Low pressure line 4	Insert size type			0				0.000
		[place hose size in appropriate cell]			[place a "1" in the appropriate cell]		Hose Total	0.000

Heat Exchangers	
Assumption = 0.5	Heat Exchange Total 0.261

Compressor	Shaft Seal N/A	Type of seal: Number of O-Ring Housing Seals	Number of Molded Housing Seals	Fitting Adaptor Plate Seal	Number of Gasket Housing Seals		Do Not Enter Data
Insert Number and type of seals in compressor						Electric comp. total	0.000
Electric compressor	1500	300	200	150	100		
	[place a "##" in the appropriate cell]						

Summary	% Contribution	grams/year
Fittings	0.0%	0.0
Refrigerant Control Device	0.0%	0.0
Hoses	0.0%	0.0
Heat Exchangers	100.0%	0.3
Compressor	0.0%	0.0
Total	100.0%	0.3

Approximate Total System Refrigerant Emission Grams/Year	0.261

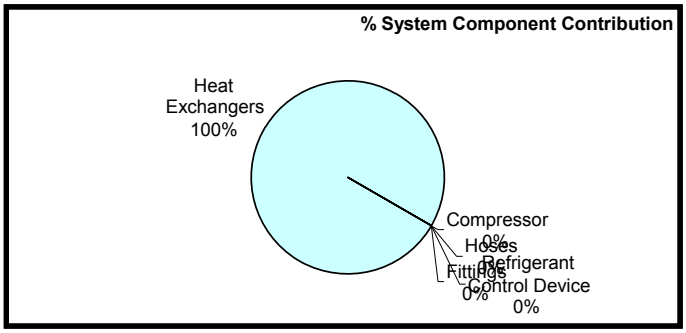

FIGURE 3 - TEMPLATE ELECTRIC COMPRESSOR