SAE International™

SURFACE VEHICLE STANDARD

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(R) HFC-134a Mobile Air Conditioning System 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. This revision is based on actual laboratory measurements and field correlations and supersedes the original, which provided a relative system emission rating based solely on component technology used in the system combined with expert input regarding relative emission rates of components.

1. SCOPE

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

The new "System Emissions Chart" now 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 new chart includes automotive compressor technologies, for conventional mobile air conditioning systems as well as fully hermetic compressors.

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 HFC-134a Refrigerant Automotive Air-Conditioning Hose

SAE J2763 SAE Refrigerant Emissions (Mini-Shed Evaluation Leakage Evaluation Method)

2006 SAE Alternate Refrigerants Symposium June 28, 2006 Revising J2727

3. ASSUMPTIONS FOR HFC-134A LEAKAGE CHART SPREADSHEET

3.1 General Assumptions

3.1.1 Real world emission rates will not be universally consistent 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.

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

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

3.1.3.1 This chart allows for normal design assembly refrigerant system connections. The default value for each fitting technology reflects its potential for misassembly.

3.1.4 The rating system chart can be modified as new technologies are developed and evaluated for their robustness and ability to reduce system emissions.

3.2 Rigid Pipe Connections

3.2.1 Rigid pipe connections are those tube and pipe assemblies that connect components, without the use of hoses and couplings. The assumption is that leakage occurs only at the two fitting connections at either end.

3.3 Service Ports

Service fittings are tested with sealing caps in place. Leakage rate is based on the design quality of the seals in these caps.

3.4 PRV, Switches, Transducers Leakage

The assumption is that these devices may include o-rings, seal washers, gaskets, or other sealing technologies and leakage is based on the sealing technology used.

3.5 Flexible Hose

3.5.1 Hose technologies vary principally in refrigerant permeation rate, i.e., different hose materials and construction can change the permeation rate. Hose permeation rate is a function of location on the system, internal refrigerant temperature and pressure, material, and hose inner surface area. Assigned values herein were based on laboratory testing experience. Relative rates for high-side and low-side permeation are 1.5 to 1, a weighted average based on 5-7% system ‘on’ time usage.

3.5.1.1 High-side and low-side pressure hose inner diameter and hose construction type must be identified in the leakage chart for rating the system.

3.5.2 Hose permeation rates include leakage from the tube and hose crimp joint.

3.5.3 SAE J2064 HFC-134a Refrigerant Automotive Air-Conditioning Hose [published Jan. 2005] identifies current minimum industry standards for production systems measured under controlled laboratory conditions. Field assembled hose assemblies not meeting these requirements will have higher emission rates.

3.5.3.1 It is assumed veneer hoses use an adhesive or O-rings or similar sealing technology in the area of the crimp joints.

3.5.4 Flexible hose assemblies include tube, hose and crimping. Leakage occurs through the hose and at the crimps. The leakage at the tube fitting connections at either end is included in the "System Component Connection" category.

3.6 Refrigerant Flow Devices

3.6.1 Expansion valves, inline or block type incorporate various sealing technologies on the fitting connections. Emissions of flexible hose assemblies or rigid pipe connections to the refrigerant flow device are included in the identification of number of connections in the component connection chart for 3.2 Rigid Pipe and 3.5 Flexible hose. In addition, the expansion valve device may include joints, o-rings, seal washers, gaskets, or other sealing technologies. These connections are also included with the rigid pipe connections table. In addition there is a value of 0.2 g/y assigned to leakage from the TXV.

3.6.2 Orifice tube flow devices emissions are included in flexible hose assemblies or rigid pipe connections and are identified in the number of connections in the component connection chart for 3.2 Rigid Pipe and 3.5 Flexible hose.

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 ~0.5 g/y for their combined emissions. Emissions of flexible hose assemblies or rigid pipe connections to these devices are included in the identification of number of connections in the component connection chart for 3.2 Rigid Pipe and 3.5 Flexible hose.

3.7.1.1 Refrigerant heat exchanger coupling(s) (threaded surfaces) shall meet the OEM requirements and be free of manufacturing process residue.

3.8 Compressor

3.8.1 The compressor major emission paths are shaft seal and housing (body) seals.

3.8.2 Dust lips in the shaft seal shall not count as secondary refrigerant seals unless shown to reduce leakage levels. It is assumed that gasket-housing seals are better than O-rings.

3.8.3 Leakage for new, properly assembled, non-hermetic (e.g., belt-driven) compressors ranges from approximately 7 to 12 grams/year.

3.8.3.1 Hermetic and semi-hermetic compressors would leak less and are so accounted for. Hermetic compressors contain no seals, only joints for suction and discharge fittings. The shaft is fully enclosed within the compressor body. Semi-hermetic compressors are similar to hermetic compressors except they contain one, or more, housing seals.

3.8.4 Compressor leakage is a function of the number of housing sealing joints that are used. 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.

3.8.6 Emissions of flexible hose assemblies or rigid pipe connections to the compressor are included in the identification of number of connections in the component connection chart for 3.2 Rigid Pipe and 3.5 Flexible hose.

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 [draft standard] 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. The spreadsheet was developed using the field test results with guidance from 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 31C) with a 7-month non-use period at an average ambient of 5 degrees C.

5. CORRELATING SYSTEM EMISSIONS WITH RANDOMLY CHOSEN PRODUCTION VEHICLES

5.1 The “Systems Emissions Chart” spreadsheet directly calculates the annual emissions estimate of production assembled the component technology actually used on 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. [A presentation made at the 2006 SAE Alternate Refrigerants Symposium June 28, 2006. Revising SAE J2727]

5.3 The rating of a MAC by this standard is expected to reasonably predict annual system refrigerant emissions from randomly chosen vehicle fleets assuming good practice in the assembly of the vehicle.

5.4 This procedure can be used to predict MAC annual grams per year emission rates for new HFC-134a vehicle systems for compliance with governmental requirements. Estimates are conservative and will slightly overestimate the actual measured leakage values.

6. SYSTEM EMISSION RATINGS

System Ratings were established in the original SAE J2727 standard. A rating system can also be applied to these systems based on annual refrigerant emissions expected from production HFC-134a mobile air conditioning systems as shown in Table 1.

TABLE 1 - SYSTEM EMISSION RATINGS

Rating Value	Approximate Grams/Year
1- Leakage Enhancement Level IV	<10
2- Leakage Enhancement Level III	10-20
3- Leakage Enhancement Level II	20-30
4- Leakage Enhancement Level I	30-40
5- Standard Leakage	40-50

7. SAMPLE SHEET FOR HFC-134A E EMISSION CHART SPREADSHEET FIGURES 1 TO 4

7.1 This provides an example for a refrigerant system with the emissions estimate of 23.6 grams/year

7.1.1 The sample system is the same typical system that was identified in the original SAE J2727 rating system having a rating of 5.6.

7.2 Rigid Pipe Connections and Flexible Hose Connections

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

7.3 Service Ports

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

7.4 PRV, Switches, Transducers

2 single o-ring
1 single captured o-ring

7.5 Flexible Hose

1 high-pressure line 650 mm length 10 mm inner diameter standard barrier material 1 low-pressure line 650 mm length 16 mm inner diameter rubber hose

7.6 Compressor

Single lip shaft seal and two body joints with o-rings

8. SPREADSHEET FORMULAS

Since a spread sheet cannot be include in this document the typical layout is identified in Figure 2 and the formulas for developing the system assumption are identified in this section.

Two different leakage chart templates are required. Both charts are identical except for the compressor values being different for a belt driven compressor or hermetic electric compressor as identified in:

8.1 Fittings

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

8.1.2 Line H8 =SUM(H7)

8.2 Service Ports and Refrigerant Devices

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

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

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

8.2.4 Refrigerant Control Device
Line 21 =SUM(B21*0.2)

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

8.3 Flexible Hose

8.3.1 High pressure line 1
D27 =3.14159*C27*B27
H27 =(E27*0.0216*D27+F27*0.0054*D27+G27*0.00225*D27)/100*0.522

8.3.2 High pressure line 2
D28 =3.14159*C28*B28
H28 =(E28*0.0216*D28+F28*0.0054*D28+G28*0.00225*D28)/100*0.522

8.3.3 High pressure line 3
D29 =3.14159*C29*B29
H29 =(E29*0.0216*D29+F29*0.0054*D29+G29*0.00225*D29)/100*0.522

8.3.4 High pressure line 4
D30 =3.14159*C30*B30
H30 =(E30*0.0216*D30+F30*0.0054*D30+G30*0.00225*D30)/100*0.522=(E30*0.0216*D30+F30*0.0054*D30+G30*0.00225*D30)/100*0.522

8.3.5 Low pressure line 1
D31 =3.14159*C31*B31
H31 =(E31*0.0144*D31+F31*0.0036*D31+G31*0.00167*D31)/100*0.522

8.3.6 Low pressure line 2
D32 =3.14159*C32*B32
H32 =(E32*0.0144*D32+F32*0.0036*D32+G32*0.00167*D32)/100*0.522

8.3.7 Low pressure line 3
H33 =3.14159*C33*B33
H33 =(E33*0.0144*D33+F33*0.0036*D33+G33*0.00167*D33)/100*0.522

8.3.8 Low pressure line 4
D34 =3.14159*C34*B34
H34 =(E34*0.0144*D34+F34*0.0036*D34+G34*0.00167*D34)/100*0.522

8.3.9 TOTAL
H35 =SUM(H27:H34)

8.4 Heat Exchangers Mufflers and Receiver/Driers and Accumulators

8.4.1 Assumption = 0.01 H38 0.01

8.5 Compressor

8.5.1 Belt Driven

8.5.1.1 H44 =(B45/B44+C45*C44+D45*D44+E45*E44+F45*F44)/100*0.522

8.5.2 Electric

8.5.2.1 H44 =(C45*C44+D45*D44+E45*E44+F45*F44)/100*0.522

8.6 Summary and Pie Chart

TABLE 2 - SUMMARY OF SPREAD SHEET 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)

8.6.1 Line A57 Approximate Total System Refrigerant Emissions Grams/Year

8.6.2 Line B57 =SUM(H8, H22,H35,H38,H44)

9. SAMPLE SPREADSHEET TEMPLATES

9.1 Template Belt Driven Compressor, Figure 1

9.2 Sample Belt Driven Compressor, Figure 2

9.3 Template Electric Compressor, Figure 3

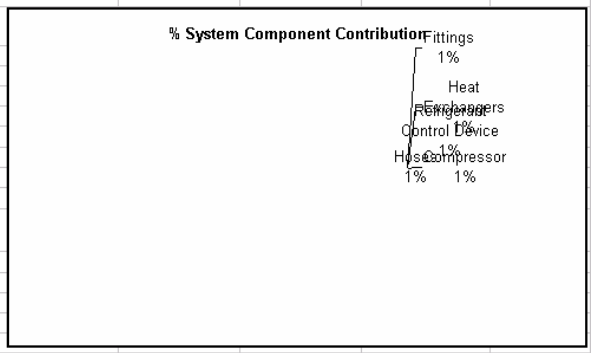
9.4 Sample Electric Compressor, Figure 4

SAE J2727 TEMPLATE — DRAFT FOR SAE BALLOT Revised Sept. 2006 Sample Template Rev#4

Leakage Chart Belt Compressor Drive

System Component Connections							Calculated Value
Fittings							
Rigid Pipe 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	
Number of fittings:							0.000
						Fittings Total	0.000
Service Ports - Refrigerant Devices							
High Side service port							
	Number of Ports						
							0.000
Low Side service port							
	Number of Ports						
							0.000
PRV, Switches, Transducers							
	Number of Devices						
							0.000
Refrigerant Control Device							
	Number of Devices						
TXV							0.000
						Total	0.000
			Calculated Value				
Flexible Hoses				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			0				0.000
High pressure line 2			0				0.000
High pressure line 3			0				0.000
High pressure line 4			0				0.000
Low pressure line 1			0				0.000
Low pressure line 2			0				0.000
Low pressure line 3			0				0.000
Low pressure line 4			0				0.000
TOTAL	[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	0.500
	[heat exchanger value pre-set value 1]				[heat exchanger value pre-set value 1]		
Compressor							
	Type of seal						
	Number of lips on shaft seal	Number of O-Ring Housing Seals	Numbr of Molded Housing Seals	Fitting Adaptor Plate	Number of Gasket Housing Seals		Do Not Enter Data
Number of features 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!	0.5
Compressor	#DIV/0!	#DIV/0!
Total	#DIV/0!	#DIV/0!



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

Rating Value	Approximate Grams/Year
1 - Leakage Enhancement Level IV	<10
2 - Leakage Enhancement Level III	10-20
3 - Leakage Enhancement Level II	20-30
4 - Leakage Enhancement Level I	30-40
5 - Standard leakage	40-50

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FIGURE 1 - TEMPLATE BELT DRIVEN COMPRESSOR

SAE J2727 TEMPLATE — DRAFT FOR SAE BALLOT Revised Sept. 2006 Sample Vehicle Rev#4

Leakage Chart Belt Compressor Drive

System Component Connections							Calculated Value
Fittings							
Rigid Pipe 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	
Number of fittings:	9	1		2			6.368
						Fittings Total	**6.368**
Service Ports - Refrigerant Devices							
High Side service port							
	Number of Ports						
	1						0.300
Low Side service port							
	Number of Ports						
	1						0.200
PRV, Switches, Transducers							
	Number of Devices						
	2						0.400
Refrigerant Control Device							
	Number of Devices						
TXV	1						0.200
						Total	**1.100**
			Calculated Value				
Flexible Hoses				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	650	10	20420		1		0.576
High pressure line 2			0				0.000
High pressure line 3			0				0.000
High pressure line 4			0				0.000
Low pressure line 1	650	16	32673	1			2.456
Low pressure line 2			0				0.000
Low pressure line 3			0				0.000
Low pressure line 4			0				0.000
TOTAL	[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	**0.500**
	[heat exchanger value pre-set value 1]				[heat exchanger value pre-set value 1]		
Compressor							
	Type of seal						
	Number of lips on shaft seal	Number of O-Ring Housing Seals	Numbr of Molded Housing Seals	Fitting Adaptor Plate	Number of Gasket Housing Seals		**Do Not Enter Data**
Number of features 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	25.6%	6.4
Refrigerant Control Device	4.4%	1.1
Hoses	12.2%	3.0
Heat Exchangers	2.0%	0.5
Compressor	55.7%	13.8
Total	100.0%	24.8

Approximate Total System Refrigerant Emission Grams/Year	24.833

Rating Value	Approximate Grams/Year
1 - Leakage Enhancement Level IV	<10
2 - Leakage Enhancement Level III	10-20
3 - Leakage Enhancement Level II	20-30
4 - Leakage Enhancement Level I	30-40
5 - Standard leakage	40-50

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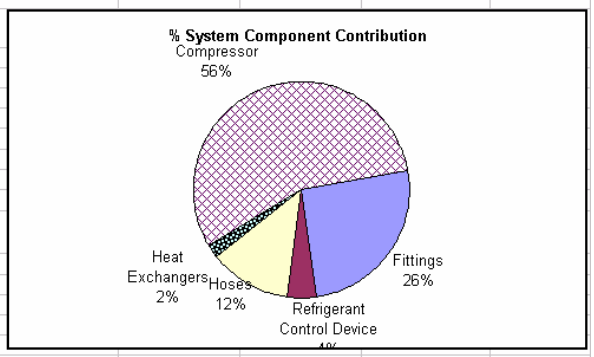


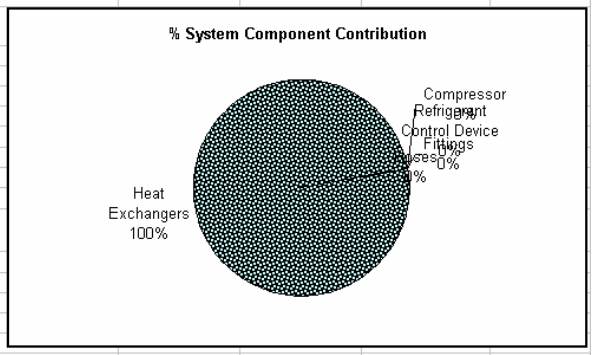
FIGURE 2 - SAMPLE BELT DRIVEN COMPRESSOR

SAE J2727 TEMPLATE DRAFT FOR SAE BALLOT Revised Oct. 2006 Sample Template Rev#5

Leakage Chart Electric Compressor Drive

System Component Connections							Calculated Value
Fittings							
Rigid Pipe 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	
Number of fittings:							0.000
						Fittings Total	0.000
Service Ports - Refrigerant Devices							
High Side service port							
	Number of Ports						
							0.000
Low Side service port							
	Number of Ports						
							0.000
PRV, Switches, Transducers							
	Number of Devices						
							0.000
Refrigerant Control Device							
	Number of Devices						
TXV							0.000
						Total	0.000
			Calculated Value				
Flexible Hoses				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			0				0.000
High pressure line 2			0				0.000
High pressure line 3			0				0.000
High pressure line 4			0				0.000
Low pressure line 1			0				0.000
Low pressure line 2			0				0.000
Low pressure line 3			0				0.000
Low pressure line 4			0				0.000
TOTAL	[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	0.500
	[heat exchanger value pre-set value 1]				[heat exchanger value pre-set value 1]		
Compressor							
	Type of seal						
	Number of lips on shaft seal	Number of O-Ring Housing Seals	Number of Molded Housing Seals	Fitting Adaptor Plate	Number of Gasket Housing Seals		Do Not Enter Data
Number of features in compressor	N/A					Electric comp. total	0.000
Electric driven compressor		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%	0.5
Compressor	0.0%	0.0
Total	100.0%	0.5



Approximate Total System Refrigerant Emission Grams/Year	0.500

Rating Value	Approximate Grams/Year
1 - Leakage Enhancement Level IV	<10
2 - Leakage Enhancement Level III	10-20
3 - Leakage Enhancement Level II	20-30
4 - Leakage Enhancement Level I	30-40
5 - Standard leakage	40-50

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FIGURE 3 - TEMPLATE ELECTRIC COMPRESSOR

SAE J2727 TEMPLATE DRAFT FOR SAE BALLOT Revised Oct. 2006 Sample Vehicle Rev#5

Leakage Chart Electric Compressor Drive

System Component Connections							Calculated Value
Fittings							
Rigid Pipe 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	
Number of fittings:	9	1		2			6.368
						Fittings Total	6.368
Service Ports - Refrigerant Devices							
High Side service port							
	Number of Ports						
	1						0.300
Low Side service port							
	Number of Ports						
	1						0.200
PRV, Switches, Transducers							
	Number of Devices						
	2						0.400
Refrigerant Control Device							
	Number of Devices						
TXV	1						0.200
						Total	1.100
			Calculated Value				
Flexible Hoses				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	650	10	20420		1		0.576
High pressure line 2			0				0.000
High pressure line 3			0				0.000
High pressure line 4			0				0.000
Low pressure line 1	650	16	32673	1			2.456
Low pressure line 2			0				0.000
Low pressure line 3			0				0.000
Low pressure line 4			0				0.000
TOTAL	[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	0.500
	[heat exchanger value pre-set value 1]				[heat exchanger value pre-set value 1]		
Compressor							
	Type of seal						
	Number of lips on shaft seal	Number of O-Ring Housing Seals	Number of Molded Housing Seals	Fitting Adaptor Plate	Number of Gasket Housing Seals		Do Not Enter Data
Number of features in compressor	N/A		1		1	Electric comp. total	1.566
Electric driven compressor		300	200	150	100		
	[place a "##" in the appropriate cell]						

Summary	% Contribution	grams/year
Fittings	50.7%	6.4
Refrigerant Control Device	8.8%	1.1
Hoses	24.1%	3.0
Heat Exchangers	4.0%	0.5
Compressor	12.5%	1.6
Total	100.0%	12.6

Approximate Total System Refrigerant Emission Grams/Year	12.566

Rating Value	Approximate Grams/Year
1 - Leakage Enhancement Level IV	<10
2 - Leakage Enhancement Level III	10-20
3 - Leakage Enhancement Level II	20-30
4 - Leakage Enhancement Level I	30-40
5 - Standard leakage	40-50

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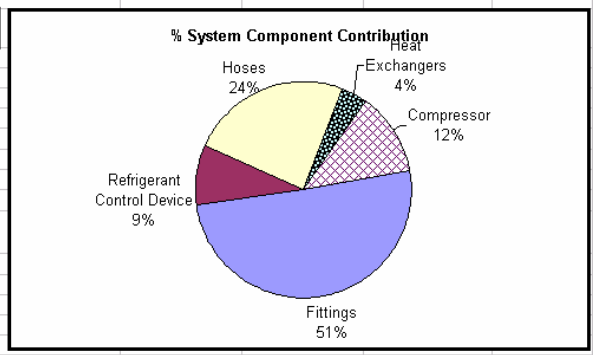

FIGURE 4 - SAMPLE ELECTRIC COMPRESSOR

10. BACKGROUND INFORMATION ON DEVELOPMENT OF DOCUMENT

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. This revision is based on actual laboratory measurements and field correlations and supersedes the original, which provided a relative system emission rating based solely on component technology used in the system combined with expert input regarding relative emission rates of components.

This “System Emissions Chart” has been developed under the auspices of the SAE I-MAC Cooperative Research Program. I-MAC has addressed refrigerant emissions from new production A/C systems and has developed a test procedure (mini-shed) to measure refrigerant emissions from fully assembled production systems (ref). Based upon this mini-shed testing, the system emissions chart was created and correlated to in-use vehicle emissions via international fleet test results.

If emission measurement capability existed when we originally developed SAE J2727, we would have followed these steps:

1. measured system emissions (mini-shed or field) and component contributions
2. developed a spreadsheet specifically to predict the measured emissions
3. modified the spreadsheet to account for relative component leak tightness and probability of improper assembly
4. further modified the spreadsheet to account for customer usage and climatic conditions during use to directly provide emission in grams / year

Because reliable emission measurement capability did not exist, SAE J2727 was developed as a rating system, leaving the correlation to grams / year as an unfinished activity.

SAE J2727 was originally formulated based upon the level of technology of components used and the collective, and current, experience with the emissions characteristics of these component technologies. We rated the relative ability of components (compressors, seals, hoses, and fittings) to contain the refrigerant and their relative ability to be assembled without introducing additional leakage. Therefore, the rating includes emissions resulting from component and system design as well as anticipated assembly errors. The rating system used by SAE J2727 was not intended to rate emissions for a perfectly assembled system - it includes an accounting for the probability of quality problems and improper assembly associated with different technologies.

In developing the rating system, the rating of components was based on estimates of their emissions and, to create a rating system, these emissions were divided by 10. Accordingly, a rating of 2 would correspond to an estimated emission of 20 grams/year.

It was always the intent of SAE to revise SAE J2727 based on actual emission measurements taken from laboratory and field-testing. Emission testing under the I-MAC program was performed to enable such revision.

A review of SAE I-MAC mini-shed system emission testing, coupled with the results of European and Japanese vehicle emission testing, provides strong evidence that actual emissions are lower than previously believed, and that SAE J2727 ratings (when converted to grams per year via multiplication by 10) significantly overestimate actual emissions.

Further review shows that the basis for this overestimate lies in the relative contribution of hoses to overall system emissions within the SAE J2727 spreadsheet. The factors for estimating the relative contribution of hose emissions, both within hose type and hose placement in the system (high vs. low side), are incorrect and need to be revised.