



Revising J-2727

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Current J-2727

- Based upon
 - technology level of system components
 - existing experience with the emission characteristics of components
- Intended to account for
 - relative emission characteristics of components
 - assembly & quality variations
- Ratings
 - represent 1/10th of expected annual emissions
 - deemed sufficient as a rating system pending confirmation by laboratory and/or fleet test results



Revision Rationale

- Mini-shed and vehicle test results have shown today's A/C systems to be less emissive than previously believed
- Desire to convert the rating system to a means of estimating actual emissions experienced by vehicle owners (grams/year)
- Revised Standard J-2727 would provide a basis for A/C system improvement incentives (voluntary or regulatory)



Revision Rationale

- Revised spreadsheet should be **capable** (as is, or with minor modifications) of reasonably accurate prediction of
 - emissions from randomly chosen production A/C systems (**ultimate goal**)
 - emissions from systems assembled to spec in a mini-shed
 - emissions from controlled fleet test vehicles



Revision Rationale

- Had emission measurement capability existed when we developed J-2727, we would have
 - measured system emissions (mini-shed or fleet)
 - developed the spreadsheet specifically to predict the measured emissions
 - modified the spreadsheet to account for component leak tightness and probability of improper assembly
 - further modified the spreadsheet to account for customer usage and climatic conditions during use



J-2727 Revisions

- Hose emissions vs. type and application
 - Hoses should behave in the fleet as they do in laboratory permeation testing (exclusive of fittings)
 - Relative permeation rate of high side vs. low side hoses changed from **2:1 to 1.5:1**
 - in accord with weighted average use temperatures
 - Relative permeation rate of rubber hose vs. barrier/veneer hose changed from **8:1 to 4:1**
 - more in accord with laboratory findings



J-2727 Revisions

- Permeation rates modified
 - Based on mini-shed testing of “W” car system without compressor
 - actual system emission was 2.9 grams/year
 - J-2727 predicted 8.3 grams/year
 - assumed all 2.9 grams came from the barrier hoses
 - fittings and HX’s assumed to be leak-free
 - modified base barrier hose permeation rate such that, when combined with new hose permeation ratios, the revised J-2727 predicted 2.9 grams
 - **Adjusted spreadsheet formulas accordingly**



Permeation Rate Modifications

Hose permeation rates (g/mm²-year)

	J 2727		J 2727r (revised)	
	<u>Rubber</u>	<u>Barrier</u>	<u>Rubber</u>	<u>Barrier</u>
High-side	0.090	0.0113	0.0216_d	0.0054_c
Low-side	0.045	0.0056	0.0144_b	0.0036_a

Subscripts refer to steps in the correlation process

a - Permeation rate reduced by 35% for low side barrier hose
– all others modified relative to this

a-c - Rate for Barrier decreased to 1.5x for high side use

a-b - Rate for Rubber hose decreased to 4x Barrier for low side use

c-d - Rate for Rubber hose decreased to 4x Barrier for high side use



J-2727r Mini-Shed Predictions versus IMAC SHED Data

	Original J-2727 Rating	J-2727r Rating	J-2727r SHED Rating	J-2727r SHED Emissions Estimate g /yr	Actual SHED Emissions Measured g /yr
W-Car	2.3	1.8	1.23	12.3	9.5
Camry	2.6	2.0	1.62	16.2	17.8
DC-Van	2.6	2.5	1.57	15.7	15.3
Ford F-150	2.3	2.1	1.33	13.3	tbd



J-2727r Correlation to Fleet

- Assumed customer usage / climate profile
 - 5 months use under mini-shed I-MAC test conditions
 - modified CARB cycle between 27C and 36C (31C weighted average)
 - 7 months non-use at an average temperature of 5C
 - where emission rate is ~ 0.18 that of mini-shed emissions, based on P^2
 - Comparison to real world temperatures is reasonable
 - U.S. average annual temperature is 12.4C
 - average temperature for assumed profile above is 15.2C
 - expect system temperatures to exceed ambient due to solar loads and residual engine heating



J-2727r Correlation to Fleet

- Correlation equation for customer usage emissions

$$\begin{aligned} &5/12 (\text{annualized shed emissions}) + 7/12 (0.18)(\text{annualized shed emissions}) \\ &= 0.522 (\text{annualized shed emissions}) \end{aligned}$$

therefore

$$\begin{aligned} &5/12 (\text{J-2727r rating}) + 7/12 (0.18)(\text{J-2727r rating}) \\ &= 0.522 (\text{J-2727 rating}) \end{aligned}$$

- Correlation to convert J-2727r rating to random customer usage emissions

$$\text{J-2727r rating} \times 10 \times 0.522 = \text{grams/year}$$



J-2727r Modifications for Controlled Testing

- Mini-shed system emission testing
 - modification should account for proper fitting assembly & fully leak tested components
 - seals of lesser technology than seal washers were moved to the category of High-Side Service Port Multiple O-Ring (0.4 grams / year / fitting)
 - compressor rating set at lowest emission (7 g/y)
 - in accord with Ecole des Mines laboratory testing of compressors



J-2727r Modifications for Controlled Testing

- Controlled vehicle emission testing
 - modification should account for proper fitting assembly & Fleet leak tested components
 - seals of lesser technology than seal washers were moved to the category of Rigid Pipe Multiple O-Ring (0.5 grams / year / fitting)
 - Compressor ratings unmodified



- Comparison of J-2727r to real-world data



J-2727r Fleet Prediction versus JAMA Data

Vehicle Type	a	b	c	d	e	f	g
J-2727 rating	3.1	3.2	3.1	3.1	2.6	2.8	2.7
J-2727r rating rev.	2.2	2.4	2.4	2.4	2.0	2.1	2.1
J-2727r Fleet rating	2.0	2.1	2.0	2.2	1.7	1.8	1.8
J-2727r Fleet estimate	10.6	10.8	10.6	11.6	8.9	9.4	9.2
Fleet average	9.4	10.6	7.3	9.9	6.7	7.1	7.8
Fleet range	6.8- 13.0	6.4- 20.4	5.5- 9.1	8.5- 11.3	4.2- 10.2	3.6- 12.0	6.6- 9.0
J-2727r random estimate	11.7	12.3	12.7	12.7	10.5	11.0	10.7

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Refrigerants Symposium

June 28, 2006



J-2727r Fleet Prediction versus JAMA Data

Vehicle Type	h	i	j	k	l	m	n
J-2727 rating	3.0	2.8	2.8	3.4	3.3	4.0	3.3
J-2727r rating rev.	2.2	2.1	2.1	2.7	2.6	2.7	3.2
J-2727r Fleet rating	1.9	1.8	1.8	2.4	2.3	2.5	2.2
J-2727r Fleet estimate	9.8	9.3	9.5	12.6	12.2	12.9	11.6
Fleet average	8.1	9.8	4.5	13.7	9.2	8.7	7.7
Fleet range	7.8- 8.4	9.6- 10.2	3.6- 5.4	11.0- 16.5	4.9- 12.0	7.9- 9.1	6.2- 10.4
J-2727r random estimate	11.3	10.9	11.1	14.2	13.8	13.9	16.9

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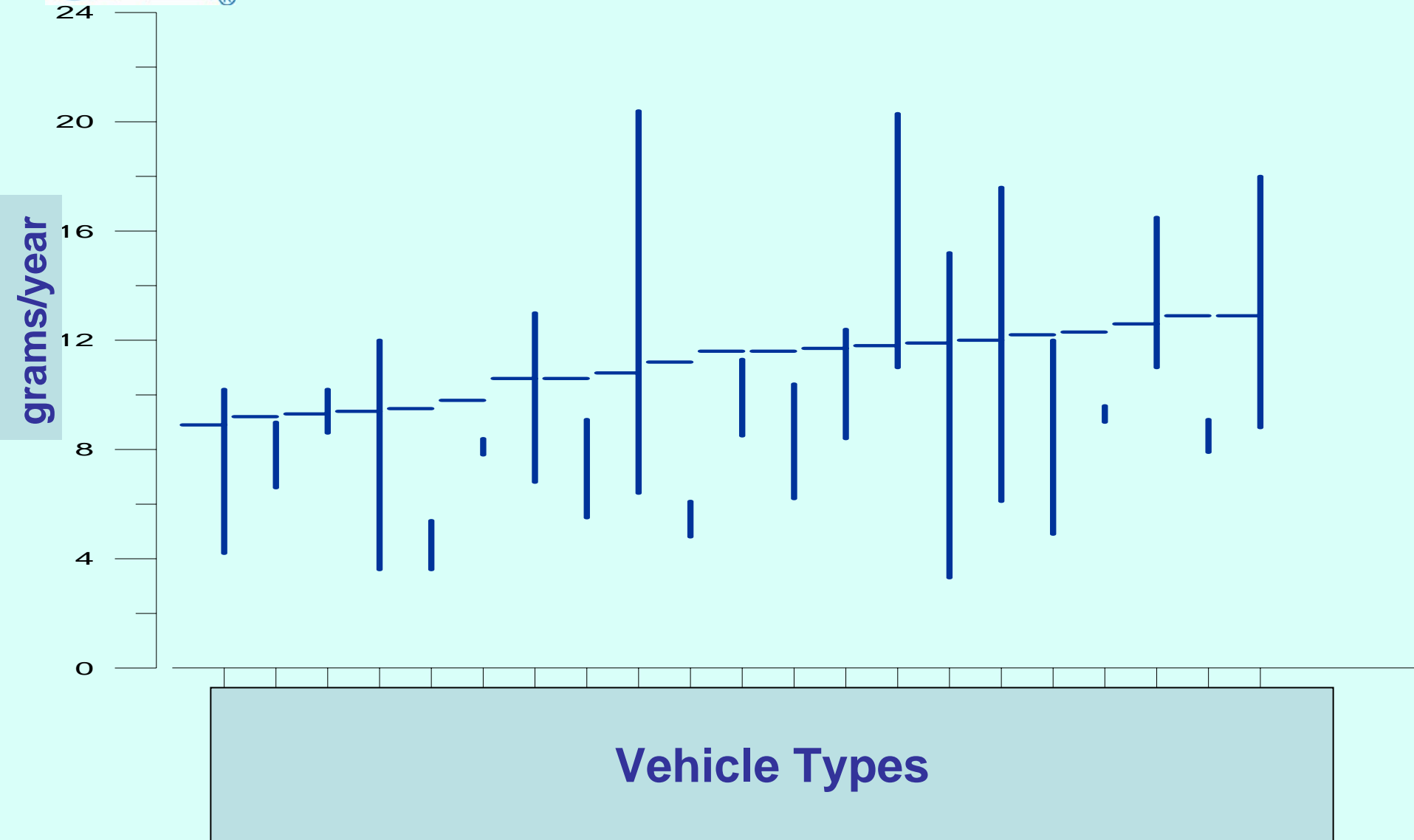


J-2727r Fleet Prediction versus JAMA Data

Vehicle Type	o	p	q	r	s	t	u	v
J-2727 rating	3.7	3.1	4.3	4.2	3..5	3.6	3.5	4.5
J-2727r rating rev.	2.9	3.0	2.9	3.3	2.6	2.6	2.9	3.6
J-2727r Fleet rating	2.3	2.2	2.3	2.5	2.2	2.3	2.4	3.0
J-2727r Fleet estimate	11.9	11.2	12.0	12.9	11.7	11.8	12.3	15.6
Fleet average	8.2	5.5	12.3	14.7	10.3	15.7	9.3	17.9
Fleet range	3.3-15.2	4.8-6.1	6.1-17.6	8.8-18.0	8.4-12.4	11.0-20.3	9.0-9.6	15.4-20.1
J-2727r random estimate	15.1	15.7	15.1	17.2	13.8	13.9	15.1	18.7



Comparison of Revised J-2727 (Fleet Test Modified) to JAMA Data





J-2727r Fleet Prediction vs JAMA Data

- J-2727r Fleet estimates
 - over-predicted 16/23 times
 - average over-prediction 2.7 grams/year
 - under-predicted 7/23 times
 - average under-prediction 1.4 grams/year
- J-2727r Fleet estimates
 - average over-prediction of 1.5 grams/year



Summary

- J-2727 imbedded equations modified to conform to laboratory data
- J-2727r further modified for field correlation
- J-2727r appears to reasonably predict test results from controlled mini-shed and vehicle fleet testing
- J-2727r is expected to reasonably predict emissions from random vehicle fleets
- Recommend SAE ICCSC review, modify if desired, and ballot J-2727r