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May 5, 2008

Mr. Mike Zais
Chairman, UEF Subcommittee
American Composites Manufacturing Association

Mike:

Attached is the LAGA Petition that was discussed at the Winter ACMA meeting in Dallas. This final version incorporates the comments that I received from several interested members.

Please ask the participating UEF committee members to approve and submit this petition to the ANSI process for adoption as part of the UEF factors.

Best regards

Robert A. Haberlein, Ph.D., QEP

cc:

Larry Cox, UEF/ANSI Secretariat and Associate Director of ACMA Technical Services
Bob Lacovara, Senior Director of ACMA Technical Services
Pete Emrich, Chairman, ACMA Technical Services

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1. Introduction

A new emission factor for the latest class of gelcoat application equipment is urgently needed. At present, fabricators who apply gelcoat must choose between the current UEF factor for atomized gelcoat application or the current UEF factor for non-atomized gelcoat application. The atomized gelcoat factor has been found to significantly over predict gelcoat emissions from the latest class of gelcoat applicators, while the non-atomized gelcoat factor has been shown to significantly under predict gelcoat emissions. A new factor for lesser atomized gelcoat application (LAGA) equipment is proposed in this petition to bridge the gap between the atomized and non-atomized factors by providing a more accurate factor for the latest class of gelcoat equipment

The proposed LAGA equation is derived from test data collected during the recent ACMA Gelcoat Test program. Three gelcoat formulations (white, pigmented, and clear gelcoat formulations) were selected by the ACMA Resin Technical Managers committee as representative of the range of gelcoats commonly applied by the composites industry. Each of the four USA gelcoat applicator manufacturers provided their latest state-of-the-art equipment for gelcoat application. The equipment manufacturers were provided gelcoat samples prior to the test, which were then used by the manufacturers to establish the manufacturers' recommended applicator setups. The equipment manufacturers were asked to determine applicator setups that could produce acceptable parts for their customers. Each equipment manufacturer provided an operator to operate their respective equipment. These operators were instructed by the manufacturer on how to operate the equipment properly. For the abovementioned reasons, the equipment, materials, and gun setup are representative of actual production conditions and should be reproducible in most production settings.

2. LAGA Technology Description

LAGA equipment is designed to apply gelcoat to an open mold with less atomization of the spray plume than older equipment designs, which results in lower styrene emissions from the gelcoat.

The particular details of each applicator design are confidential and proprietary. The reader is asked to contact each manufacturer directly for this information

The LAGA equipment tested during the ACMA Gelcoat Test project at CMTI are listed in **Table 1** below:

Table 1 – LAGA equipment tested during the ACMA Gelcoat Test Project at CMTI

Manufacturer	Spray Gun Model
GlasCraft, Inc.	Formula – External Mix
GS Manufacturing, Inc.	X-Gun
ITW Binks Div.	Century LEL
Magnum Venus Plastech, Inc.	ATG 3500

3. Gelcoat and Applicator Information

The three gelcoat formulations used in the ACMA Gelcoat Test project are detailed in **Table 2** below. The equipment setup and operating data for the four LAGA applicators are listed in **Table 3** on the next page.

Table 2 – Test Data from the ACMA Gelcoat Test Project

Gel Coat Type	White	Black	Clear
Styrene %	30.49%	36.32%	44.00%
Weight per Gallon	11.1	10.05	9.0
Viscosity	RV#4@2 – 23,800 cps	LV#4@6 – 16,500 cps	#3@6 – 11,000 cps
	RV#4@20 – 4,200 cps		#3@60 – 1,900 cps
Thix Index	5.6	5.61	5.8
Gel Time	1.50% HP-90	1.80% HP-90	2.00% HP 90
	12.0 min	11.3 min	10.0 min
Gel to Peak	10.0 min	-	12.0 min
Peak Exotherm	336 ^{0}F	-	406 ^{0}F

Table 3 – Equipment Setup and Operating Data from the ACMA Gelcoat Test Project

Spray Gun Set-Up	Spray Gun Alpha	Spray Gun Beta	Spray Gun Gamma	Spray Gun Delta
White Gel Coat - 30.49% Styrene – 100 F				
Orifice Size (0.001")	0.021	0.021	0.021	0.022
Designated Tip Angle (degrees)	40	40	40	17
Pump Ratio	12:01	20:1	15:01	15:1
Pump Pressure (psi)	85	52	72	60
Tip Pressure (calc)	1020	1040	1080	900
Shaping Air Pressure (psi)	35	40	20	23
Tip to Target Distance (in)	18-24"	18-24"	18-24"	18-24"
Target Gel Coat Weight (g)	2250	2250	2250	2250
Black Gel Coat - 36.32% Styrene – 70 F				
Orifice Size (0.001")	0.021	0.018	0.019	0.022
Designated Tip Angle (degrees)	24	45	40	27
Pump Ratio	12:01	20:1	15:01	15:1
Pump Pressure (psi)	70	60	55	70
Tip Pressure (calc)	840	1200	825	1050
Shaping Air Pressure (psi)	30	30	20	24
Tip to Target Distance (in)	18-24"	18-24"	18-24"	18-24"
Target Gel Coat Weight (g)	2250	2250	2250	2250
Clear Gel Coat - 44.00% Styrene – 70 F				
Orifice Size (0.001")	0.017	0.018	0.019	0.017
Designated Tip Angle (degrees)	24	25	40	22
Pump Ratio	12:1	20:1	15:01	15:1
Pump Pressure (psi)	45	32	50	50
Tip Pressure (calc)	540	640	750	750
Shaping Air Pressure (psi)	25	40	20	25
Tip to Target Distance (in)	18-24"	18-24"	18-24"	18-24"
Target Gel Coat Weight (g)	2250	2250	2250	2250

4. LAGA Test Data

The test data from the ACMA Gelcoat test project is listed in **Table 4** below:

Table 4 – Test Data from the ACMA Gelcoat Test Project

Data Point	Gelcoat Type	Styrene Content	Gelcoat Temperature	Styrene Emission Rate	
		(%wt)	(F)	(% gelcoat wt)	(% styrene wt)
1	Clear	44.00%	70	18.56%	42.18%
2	Clear	44.00%	70	17.56%	39.91%
3	Clear	44.00%	70	18.58%	42.23%
4	Clear	44.00%	70	19.52%	44.36%
5	Clear	44.00%	70	17.22%	39.14%
6	Clear	44.00%	70	16.01%	36.39%
7	Clear	44.00%	70	21.51%	48.89%
8	Clear	44.00%	70	20.15%	45.80%
9	Clear	44.00%	70	18.65%	42.39%
10	Clear	44.00%	70	16.34%	37.14%
11	Clear	44.00%	70	16.03%	36.43%
12	Clear	44.00%	70	16.64%	37.82%
13	Black	36.32%	70	12.80%	35.24%
14	Black	36.32%	70	12.19%	33.56%
15	Black	36.32%	70	12.26%	33.76%
16	Black	36.32%	70	14.26%	39.26%
17	Black	36.32%	70	12.76%	35.13%
18	Black	36.32%	70	12.94%	35.63%
19	Black	36.32%	70	14.32%	39.43%
20	Black	36.32%	70	13.34%	36.73%
21	Black	36.32%	70	13.36%	36.78%
22	Black	36.32%	70	12.78%	35.19%
23	Black	36.32%	70	12.12%	33.37%
24	Black	36.32%	70	12.11%	33.34%
25	White	30.49%	100	9.62%	31.55%
26	White	30.49%	100	9.79%	32.11%
27	White	30.49%	100	10.83%	35.52%
28	White	30.49%	100	10.29%	33.75%
29	White	30.49%	100	10.61%	34.80%
30	White	30.49%	100	10.50%	34.44%
31	White	30.49%	100	10.86%	35.62%
32	White	30.49%	100	10.57%	34.67%
33	White	30.49%	100	11.35%	37.23%
34	White	30.49%	100	9.41%	30.86%
35	White	30.49%	100	9.58%	31.42%
36	White	30.49%	100	9.38%	30.76%

5. LAGA Equation Derivation

The linear regression of the data listed in **Table 4** yields:

Regression Statistics	
Multiple R	0.941349487
R Square	0.886138856
Adjusted R Square	0.882789999
Standard Error	0.011922442
Observations	36

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.037612792	0.037612792	264.6093302	1.30648E-17
Residual	34	0.004832917	0.000142145		
Total	35	0.042445709			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.0783506	0.01341396	-5.840974603	1.38556E-06	-0.105611046	-0.051090153	-0.105611046	-0.051090153
X Variable 1	0.584229883	0.03591544	16.26681684	1.30648E-17	0.511240928	0.657218838	0.511240928	0.657218838

Based upon this regression, the proposed styrene emission factor equation for the LAGA process is given by:

Styrene Emissions (% gel wt) = 0.5842 × [% styrene content (decimal)] - 0.07835

or

Styrene Emissions (lb/ton) = { 0.5842 × [% styrene content (decimal)] - 0.07835} × 2000

This LAGA equation will be linearly extrapolated from the emission rate at the 30% styrene content bounding endpoint through zero emissions at 0% styrene content, which is the current accepted practice for the other UEF emission factor equations.

The regression statistics by process for the LAGA equation and the other UEF emission factor equations are listed in **Table 5** below:

Table 5 – Linear Regression Statistics for the UEF Factor Equations

Open Molding Process	**Number of Data Points**	**Input Data Range (styrene % wt)**	**R^2 Fit**	**Standard Error of Estimate**
Atomized Gelcoat Application	21	35% to 40%	0.654	0.0198
Non-Atomized Gelcoat Application	37	19% to 52%	0.954	0.0103
Manual Resin Application	26	33% to 48%	0.503	0.0128
Atomized Resin Application	26	35% to 44%	0.714	0.0182
Non-Atomized Resin Application	15	33% to 44%	0.733	0.0044
Filament Winding Application	10	33% to 48%	0.740	0.0134
Lesser Atomized Gelcoat Application	**36**	**30% to 44%**	**0.886**	**0.0119**

In comparison to the other UEF equations (and the corresponding HAP factor equations in Table 1 to Subpart WWWW), the "quality" of LAGA equation is as good as or better than the other factor equations, which are commonly accepted and widely used by industry and EPA. From a purely statistical viewpoint, the proposed LAGA equation is actually superior in most respects to most of the existing UEF equations.

6. Proposed UEF Table Entry for LAGA

The proposed entry for the LAGA process in the UEF Emission Factor Table is:

Emission Rate in Pounds of Styrene Emitted per Ton of Resin or Gelcoat Processed																							
Styrene content in resin/gelcoat, % (1)	**<30** (note)	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**>50** (2)
Lesser Atomized Gelcoat Applicatin	0.323 x %styrene x 2000	194	206	217	229	241	252	264	276	287	299	311	322	334	346	357	369	381	392	404	416	428	((0.5842 x %styrene) - 0.07835) x 2000

7. LAGA Equation Plot

A plot showing the LAGA test data and the proposed LAGA equation is attached as page 9 of this petition. This plot is a useful method for visualizing the test data and proposed LAGA equation. The current UEF atomized gelcoat equation and data, and UEF non-atomized gelcoat equation and data are also plotted for comparison purposes.

8. Applicability of the LAGA Emission Factor Equation

The responsibility for determining the applicability of the LAGA equation to a particular LAGA applicator at an individual facility is a compliance issue that rests with the particular equipment manufacturer and individual fabricator. Individual applicability of LAGA is not the responsibility of the ANSI UEF process. Instead, the ANSI UEF process sets a benchmark by which the equipment manufacturer and fabricator can gauge the performance of specific equipment and material combinations in actual use.

The question of future reproducibility of the LAGA factor through site-specific source testing at an individual facility is not a concern in this context. Instead, each equipment manufacturer is directly responsibility for documenting the performance of their equipment, and each fabricator is responsible for verifying the actual performance in their facility. The LAGA equation will provide a benchmark level of performance. In practice, the equipment manufacturer and fabricator must work together to demonstrate that a particular applicator will "measure up" to this benchmark in each specific case. The equipment manufacturer and the fabricator user are the only logical parties that could be responsible for the proper setup and operation of the equipment in the shop for three important reasons:

1. Proper gun setup is too complicated and variable to characterize in a general way, and is better addressed at the field level. Investigating every possible combination of material, temperature, tip geometry, and tip pressure to ascertain proper setup for every possible case is not practical.
2. The equipment manufactures can modify their equipment design at any time – and the fabricators can change materials or equipment setup at any time. There is no conceivable way that every possible combination of equipment design, applicator setup, and material type could be tested or modeled for emissions.
3. Emissions are tied to acceptable finish through the equipment setup. Acceptable finish is determined by each fabricator as needed for each product market, which makes it impossible to predict individual performance in a general way.

Finally, the question of individual equipment performance only becomes an issue if the local EPA requires a source test at a specific facility to demonstrate compliance. Compliance issues are a wholly separate matter, unrelated to the establishment of an emission factor.

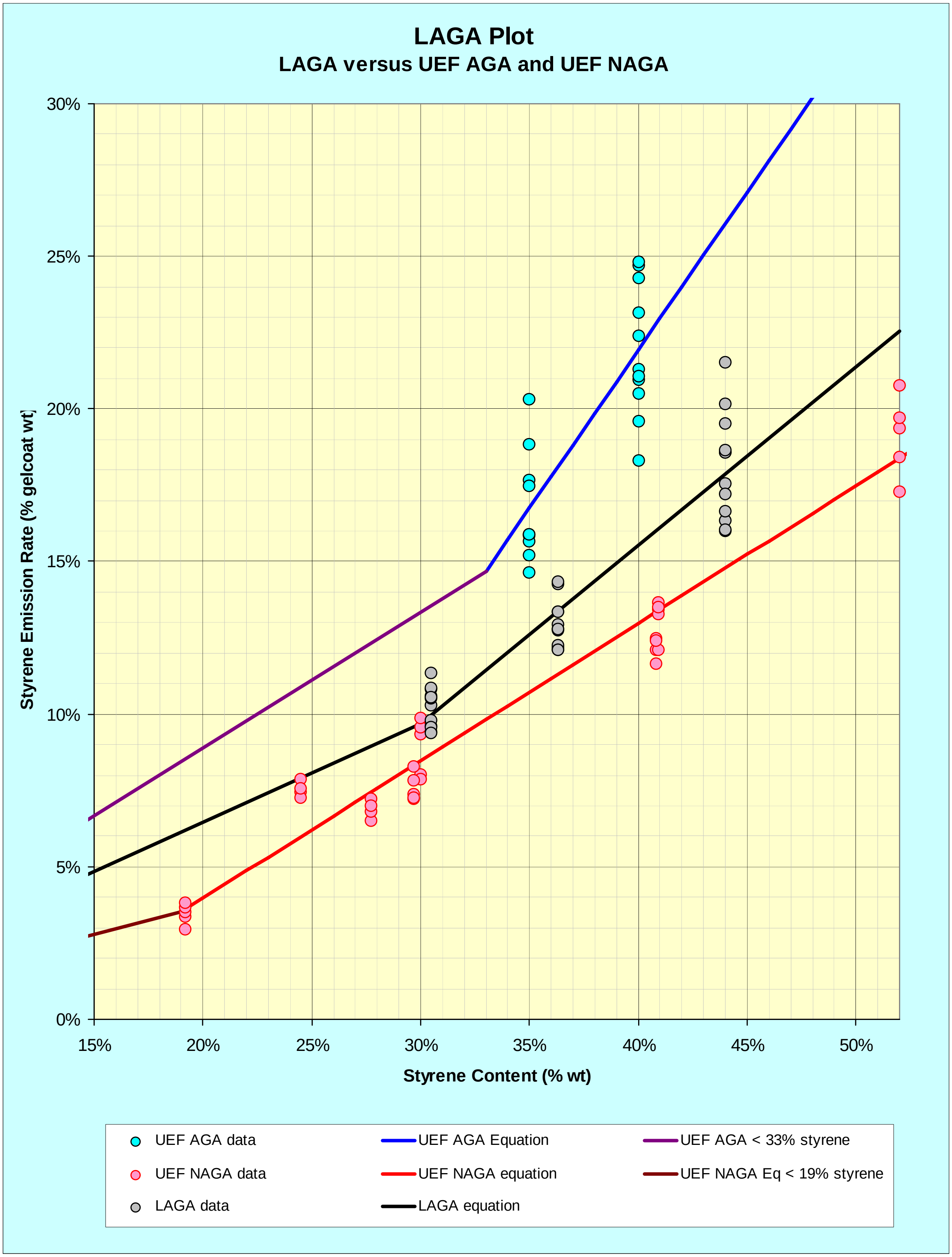
9. Conclusion

I request prompt adoption of the proposed LAGA emission factor equation.

The LAGA factor is urgently needed by fabricators who must now choose between the current UEF factor for atomized gelcoat application or the current UEF factor for non-atomized gelcoat application. The atomized gelcoat factor significantly over predicts emissions for the latest class of gelcoat applicators, while the non-atomized gelcoat factor significantly under predicts emissions. The LAGA factor is needed to bridge this gap by providing a more accurate factor and a more reasonable compliance option.

10. Appendices

ACMA/CFA UEF Test Protocol
2000 and 2004 Inspection Reports for the CMTI Laboratory
ACMA Gelcoat Screening Test Report
Gelcoat Screening Test Data from CMTI


LAGA Plot
LAGA versus UEF AGA and UEF NAGA
Styrene Emission Rate (% gelcoat wt)
0%
5%
10%
15%
20%
25%
30%
15%
20%
25%
30%
35%
40%
45%
50%
Styrene Content (% wt)
UEF AGA data
UEF AGA Equation
UEF AGA < 33% styrene
UEF NAGA data
UEF NAGA equation
UEF NAGA Eq < 19% styrene
LAGA data
LAGA equation