Appendix G All Other Emission Calculations

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Particulate

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Owens Corning Guelph Glass Plant
Data for the Calculation of Particulate Emissions

Material Transfer Particulate Emission Rate Data

Source ID	Source Description	Batch transfer rate (kg/min)	Emission Factor (g PM/kg Transferred)	Flexibility Factor	Dust Collector Efficiency	Comments
G39	Batch House D/C Exhaust	167	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13
G40	Batch House D/C Exhaust	467	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13
G52	Batch Ingredient Dust Collector	250	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13
G45	Batch House D/C Exhaust, Mixed Batch Silo	208	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13
G46	Bad Batch D/C Exhaust #1	208	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13
G47	Bad Batch D/C Exhaust #2	175	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13
G48	Batch Ingredient Dust Collector	175	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13
G65	Batch Ingredient Dust Collector	335	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13
G50	Batch Ingredient Dust Collector (Silos 5, 10, 11)	167	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13
G68	Batch Ingredient D/C Exhaust (Silo # 1, 3, 9)	167	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13
G61	Batch Ingredient D/C Exhaust (Silo #18)	200	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13
G62	Batch Ingredient D/C Exhaust (Silo #19)	200	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13
G63	Batch Ingredient D/C Exhaust (Silo #20)	200	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13
G64	Batch Ingredient D/C Exhaust (Silo #21)	200	1.50	1.25	99.9%	Emission Factor reference :AP42 Chap 11-13

Furnace Particulate Emission Rate Data

Source ID	Source Description	Current / Max Operating Capacity kg/h	Emission Factor (gPM/kg glass pulled)	Flexibility Factor	Conversion Factor (hr to second)	Comments
B01	107 Furnace	4991	0.068	1.25	0.0002778	Source Testing - report 96127

Cooling Tower Particulate Emission Rate Data

Source ID	Source Description	Flowrate (usgpm)	Emission Factor (lbPM/1000gal)	Conversion Factors	Dissolved solids (ppm)	Comments
A06/A07/ A08/A58	Each cooling tower	1440	1.7	0.000205808	800	Emission Factor reference :AP42 Chap 13.4-1

Source ID	Source Description	air flow (m3/s)	Inlet Loading (grains/ft3)	Control Efficiency	Conversion Factors	Comments
C73	CFM Cyclone Exhaust	2.1	1	97.0%	18.823	Engineering calculation

Source ID	Source Description	air flow (m3/s)	Inlet Loading (grains/ft3)	Control Efficiency	Conversion Factor & Flex Factor	Comments
C51	**CSM Line PM Emissions**	9.44	0.00526	50.0%	2.86	CofA Application 1985 (to amend CofA 8-2096-85-866)

Source ID	Source Description	Emission Factor (g/s)	Flexibility Factor			Comments
C48/C50	source C48 - Charge Stack, C49, and C50 - discharge Hood	0.01	1.25			Source Emission Survey, Nov. 1987, Fiberglass Canada, report #87-13 &March 1990, Fiberglass Canada, report #90-4

Source ID	Source Description	Emission Factor (g/s)	Flexibility Factor			Comments
C49	main oven stack	0.11	1.25			Source Emission Survey, Nov. 1987, Fiberglass Canada, report #87-13

Source ID	Source Description	Inlet Loading (kg/hr)	Control Efficiency Baler	Control Efficiency PRD	Control Efficiency Filter Box	Comments
C63/C64	Baler PRD and Filter Box System	132	93%	90%	60%	Appln to amend 8-2250-92-006. Appln Attach #1 Oct 5, 1994 Also applied conversion factor fo 1000/3600.

Metals (Zinc and Di-Trivalent Chromium)

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Owens Corning Guelph Glass Plant
Calculation of Di-Trivalent Chromium

107 Furnace West (B1)		**Total Chromium**	**Hex Chromium**		**Di Tri Metallic chromium**
		ug/s	ug/s	% Hex	ug/s
Project No.:	13-Oct-11	226	37	17%	189
113922	14-Oct-11	259	33	13%	226
	14-Oct-11	246	42	17%	205
Project No.:	6-Aug-13	271	46	17%	225
134401	7-Aug-13	291	24	8%	268
	7-Aug-13	200	25	13%	174
					215

confidence interval = 0.05 95%
number of samples (n) = 6
test statistic (t-value) = 2.571 from t-tables.xls
sample mean (x) = 214.5 (arithmetic mean)
standard deviation (s) = 33.059 (standard deviation of a sample using STDEV.S function)

sample uncertainty is equal to the mean +/- [t-value x standard deviation (s) / Square root of # of samples (n)]

sample uncertainty = 214.5 +/- 34.70

Uncertainty as a percentag 16%

B01 **0.000249** (g/s) ER Di,Tri Chromium

105 Forehearth (B38)		**Chromium**	**Hex Chromium**		**Di Tri Metallic chromium**
		ug/s	ug/s	% Hex	ug/s
Project No.:	6-Aug-13	78	12	16%	66
134401	7-Aug-13	2,927	12	0%	2915
	7-Aug-13	193	12	6%	181
					123

* test #2 not included in the assessment as it was determined anomalous - see source testing report.
confidence interval = 0.05 95%
number of samples (n) = 2
test statistic (t-value) = 4.303 from t-tables.xls
sample mean (x) = 123.1 (arithmetic mean)
standard deviation (s) = 81.175 (standard deviation of a sample using STDEV.S function)

sample uncertainty is equal to the mean +/- [t-value x standard deviation (s) / Square root of # of samples (n)]

sample uncertainty = 123.1 +/- 246.99

Uncertainty as a percentag 201%

B38 **0.000370** (g/s) ER Di,Tri Chromium

107 Forehearth (B11)		**Chromium**	**Hex Chromium**		**Di Tri Metallic chromium**
		ug/s	ug/s	% Hex	ug/s
Project No.:	13-Oct-11	175	188	107%	0
113922	13-Oct-11	183	174	95%	9
	14-Oct-11	149	144	97%	4
Project No.:	6-Aug-13	181	155	86%	26
134401	7-Aug-13	197	154	78%	42
	7-Aug-13	256	178	70%	78

confidence interval = 0.05 95%
number of samples (n) = 6
test statistic (t-value) = 2.571 from t-tables.xls
sample mean (x) = 26.6 (arithmetic mean)
standard deviation (s) = 29.704 (standard deviation of a sample using STDEV.S function)

sample uncertainty is equal to the mean +/- [t-value x standard deviation (s) / Square root of # of samples (n)]

sample uncertainty = 26.6 +/- 31.18

Uncertainty as a percentag 117%

B11 **0.000058** (g/s) ER Di,Tri Chromium

Zinc

107 Furnace (B01)

ZnO ER, g/s = Emission Factor, g/kg glass pull x glass pull rate, kg/hr x Uncertainty Factor x conversion factor

ZnO ER, g/s = 0.0578 g/kg x 4991 kg glass/hr x uncertainty factor of 1.25 x (1hr/3600s)

ZnO ER, g/s = 0.10021

Glass pull rate used is 4991 kg/hr

Compound	Emission factor (g/kg glass)
ZnO	0.0578

These emission factor was developed based on source testing results from 1996 (project 96127) at the pull rate during testing.

Silica

See Appendix Q for Silica Calculations

Nitrogen Dioxides (NOx)

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Owens Corning Guelph Glass Plant
Emission Calculation Data for NOx from 107 furnace

Furnace NOx Emission Estimates

107

Scenario	Base Emission	Base Pull	New Pull	Gas Required to heat furnace	Incremental Gas per ton of batch	Oxidizer Factor	Uncertainty Factor	Gas Consumption w eboost	Gas Consumption wo eboost	Projected emission
	g/s	kg/hr	kg/hr	scfh	ft3/ton	3.5	1.25	sfch	sfch	g/s
All	0.32	2852	4991	11400	1500	3.5	1.25	17562	22230	2.16

Background

	Term
Emission Rate of NOx = f{fuel required to melt glass = heat of melting x Pull rate}	1
+ f{pull rate (tramp N, entrained air)}	2
+ f{fuel required to heat furnace}	3
+ f{furnace temperature}	4
+ f{leakage into furnace}	5

Term 1 Will increase with pull rate - affected by oxidizer purity and N content of fuel
Term 2 Will increase with pull rate
Term 3 Constant - affected by oxidizer purity and N content of fuel
Term 4 Essentially constant
Term 5 Constant

Discussion Based on the above it is anticipated that a formula to predict the NOx emissions will take the form of:
NOx = m(pull rate) + b
where
m is affected by Term 1 and 2
b is a constant defined by Terms 3, 4 and 5
both m and b are dependant upon the oxidizer concentration

If we agree that the actual emission can be expressed as above then we also need to recognize that we do not have sufficient data points to determine m and b. To generate these factors, more testing under specific operating conditions will be required. To date we have essentially one data point per operating condition

So, how do we predict the effect of increased pull and oxidizer changes for the Guelph operation.

The suggested method to predict the effect of increasing pull on 105 or 107 is to ratio based on gas consumption - in other words use an emission factor (g NOx/ft3 gas) based on source testing.

General Formula:
=Base_Emission*((Gas_Required_to_heat_furnace+New_Pull*Incremental*0.0011)/(Gas_Required_to_heat_furnace+Base_Pull*Incremental*0.0011))*Oxidizer_Factor*Uncertainty_Factor*(Gas_Consumption__wo_eboost/Gas_Consumption__w_eboost)

Notes:
This approach is anticipated to provide conservative estimated unless NOx generation is largely driven by batch materials.

The Oxidizer Factor is an engineering factor that reflects the nitrogen level in the furnace during the trial tests. For 107 it reflects the nitrogen levels in the oxygen during the testing compared to the level of nitrogen in the VSA oxygen. For 105, it reflects the improved furnace construction after the rebuild to eliminate air leakage into the furnace.

Uncertainty factor of 1.25 used to reflect limited data and to ensure conservatism

Nitrogen Dioxide (NOx)

107B forehearth stack (B11)

NOx ER, g/s = (Natural gas usage, m3/s) x (AP42 Emission Factor, lb/million scf) x conversion factors

NOx ER, g/s = 0.025 m3/s x 100 lb/ million scf x (3.28^3)*(454)/1000000

NOx ER, g/s = 0.040

Source ID	Operation	Natural Gas Consumption m3/s
C72	CFM Forming Tunnel	0.02
C99	CFM Forming Tunnel	0.02
C100	CFM Forming Tunnel	0.02
C101	CFM Forming Tunnel	0.02
B01	107 Furnace Stack (West)	0.138
B11	107B Forehearth Stack	0.025
B38	105 Forehearth Stack	0.09

AP 42 1.4.1 EF = 100 lb/ million scf

Nitrogen Dioxide (NOx)

Burner exhaust (C65)

NOx ER, g/s = (nameplate capacity, MMBTU/hr) x (AP42 Emission Factor, lb/million scf) x conversion factors

NOx ER, g/s = 2.33 m3/s x 100 lb/ million scf x (1/1020)*454*(1/3600)

NOx ER, g/s = 0.029

Source ID	Operation	Natural Gas Consumption MMBtu/hr
C65	No. 12 Oven Burner Exhaust	2.33
C66	No. 13 Oven Burner Exhaust	2.33
C67	No. 14 Oven Burner Exhaust	2.33
C68	No. 15 Oven Burner Exhaust	2.33
C69	No. 16 Oven Burner Exhaust	2.33
C70	No. 17 Oven Burner Exhaust	2.33
C75	CFM RTO - Oven	31.00
C48	Mat Line Oven Charge Stack	1.04
C49	Mat Line Main Oven Stack	9.00
C50	Mat Line Oven Discharge Stack	1.04
G13	NGF Tire Cord Line #1 RTO	12.00

AP 42 1.4.1 EF = 100 lb/ million scf

Conversion factor = =(1/1020)*454*(1/3600)

comfort heating sources calculated in the same manner

Carbon Monoxide (CO)

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Carbon Monoxide (CO)
107 Furnace (B01)

CO ER, g/s = Emission Rate durng testing, g/s x Uncertainty Factor

CO ER, g/s = 0.029 g/s x 2

CO ER, g/s = 0.058

Compound	Emission Rate from Testing (g/s)
CO	0.029

This emission data is based on source testing results from December 1998 (project 99429)

Volatile Organic Compounds (VOC)

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Summary of Emission Rates for Size / Binder Losses

								for curing - pull rate for 107 furnace only applies			
		Binder Preparation 3			Forming 3			1	Curing		
		Pre-Mix Level Exhaust #1	Pre-Mix Level Exhaust #2	Binder Circ. Tank Exhaust	107C Forming Scrap Tunnel Exhaus	107B Forming Scrap Tunnel Exhaus	107A Forming Scrap Tunnel Exhaus	105 Forming Scrap Tunnel Exhaust	No.11 Oven, Lane 13 Exhaust	No.11 Oven, Lane 14 Exhaust	No.11 Oven, Lane 13 Burner	No.11 Oven, Lane 14 Burner	No.11 Oven Exit Hood
		A12	A13	C60	B15	B16	B39	B40	C26	C27	C28	C29	C30
Contaminant	CAS #	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s
METHANOL (METHYL ALCOHOL,	67-56-1	0.0341	0.0341	0.0341	0.0683	0.0683	0.0000	0.0683					
ETHANOL (ETHYL ALCOHOL)	64-17-5	0.0315	0.0315	0.0315	0.0630	0.0630	0.0000	0.0630					
TOLUENE	108-88-3	0.0020	0.0020	0.0020	0.0030	0.0030	0.0000	0.0030					
ACETIC ACID	64-19-7	0.0338	0.0338	0.0338	0.0675	0.0675	0.0000	0.0675					
Dibromoacetonitrile	3252-43-5	8.07E-05	8.07E-05	8.07E-05	8.07E-05	8.07E-05	0.00E+00	8.07E-05					

								used application allocation only ~ 40%						
							5	CFM Line			4			
		No. 12 Oven Burner Exhaust	No. 13 Oven Burner Exhaust	No. 14 Oven Burner Exhaust	No. 15 Oven Burner Exhaust	No. 16 Oven Burner Exhaust	No. 17 Oven Burner Exhaust	CFM Forming Tunnel	CFM Forming Tunnel	CFM Forming Tunnel	CFM Forming Tunnel	CFM Binder Cyclone	CFM RTO - Oven	Total Facility Emission Rate (g/s)
		C65	C66	C67	C68	C69	C70	C72	C99	C100	C101	C73	C75	
Contaminant	CAS #	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s
METHANOL (METHYL ALCOHOL,	67-56-1	0.0324		0.0324	0.0324	0.0324	0.0324	0.0107	0.0107	0.0107	0.0107	0.026766	0.00080	0.5396
ETHANOL (ETHYL ALCOHOL)	64-17-5	0.0299		0.0299	0.0299	0.0299	0.0299	0.0099	0.0099	0.0099	0.0099	0.024691	0.00074	0.4978
TOLUENE	108-88-3	0.0008		0.0008	0.0008	0.0008	0.0008	0.0005	0.0005	0.0005	0.0005	0.000628	0.00002	0.0215
ACETIC ACID	64-19-7	0.0321		0.0321	0.0321	0.0321	0.0321	0.0106	0.0106	0.0106	0.0106	0.02648	0.00079	0.5339
Dibromoacetonitrile	3252-43-5	3.95E-05		3.95E-05	3.95E-05	3.95E-05	3.95E-05	1.34228E-05	1.34228E-05	1.34228E-05	1.34228E-05	3.07E-05	9.2E-07	0.000767

Emission Factor Development:

The emission factors for the binder components are developed using the following methdology:

$$Emission\ \ Factor\ ,\frac{g\ binder}{kg\ glass\ \ pull}=\left(Max\ Fraction\ \ of\ Component\ \ \right)\times\left(Applicatio\ n\ Efficiency\ \ \%\right)$$

$$\times\left(Flexibilit\ y\ \ Factor\ \right)\times\left(Applicatio\ n\ \ Rate\ ,\frac{g\ binder}{kg\ glass\ \ pull}\right)$$

The maximum fraction of each component in the binder is proprietary information. The detailed information for the development of the emission factor is located in Appendix Q (Confidential).

The following table summarizes the emission factors and % loss assigned to each section of the process:

			Allocation of Losses-Main			Allocation of Losses-CFM			
Contaminant	CAS #	MAX Emission Factor (g/kg)	Binder Room	Application	Curing	Binder Room	Application	Binder Application	Curing
Methanol	67-56-1	3.7E-01	20%	40%	40%	20%	40%	25%	15%
Ethanol	64-17-5	3.4E-01	20%	40%	40%	20%	40%	25%	15%
Toluene	108-88-3	1.4E-02	30%	45%	25%	30%	45%	15%	10%
Acetic Acid	64-19-7	3.7E-01	20%	40%	40%	20%	40%	25%	15%
dibromoacetonitrile	3252-43-5	2.6E-04	33%	33%	34%	35%	35%	20%	10%

Example Calculation for Methanol from Source A12

Source A12 is one of three exhausters from the Binder Preparation Area. So the total emissions from the Binder Preparation Area are calculated and allocated evenly to each of the exhausters.

ER Acetic Acid, g/s (A12) = ['Emission Factor Acetic Acid (g/kg glass pull)] x [Facility Glass Pull rate (kg/hr)] x [Total % loss for Binder Preparation] x (1/3 stacks) x Flexibility Factor x Conversion Factors

ER Acetic Acid, g/s (A12) = 0.3654 (g/kg) x 4990.9 kg glass pulled/hr x 0.2 x (1/3) x 1 x 1hr/3600s

ER Acetic Acid, g/s (A12) = 0.0338

Acid Gases

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Hydrogen Fluoride (HF) and Hydrogen Chloride (HCl)

107 Furnace (B01) HF

HF ER, g/s = Emission Factor, g/kg glass pull x glass pull rate, kg/hr x Uncertainty Factor x conversion factor

HF ER, g/s = 0.01 g/kg x 4991 kg glass/hr x uncertainty factor of 1.25 x (1hr/3600s)

HF ER, g/s = 0.01733

Glass pull rate used is 4991 kg/hr

Compound	Emission factor (g/kg glass)
HF	0.01
HCl	0.006

These emission factors are developed based on source testing results from December 1998 (project 99429) at the pull rate during testing.