ARKEMA
INNOVATIVE CHEMISTRY
900 First Ave. King of Prussia, PA 19406 / 215.610.878.6500

October 25, 2017

Mr. Jason Holloman
Air Program Investigator
TCEQ Region 12-Houston
5425 Polk Street, Suite H
Houston, Texas 77023-1452

Re: Emissions Event Final Report – Revised Event Emissions
Arkema Crosby Plant, 18000 Crosby Eastgate Road, Crosby, Texas 77532
CN600124044, RN100210301
Incident Nos: 267578, 267679,266756,266771, 266778

Dear Mr. Holloman:
Pursuant to direction from Karen Lewis-Holmes, TCEQ Region 12 Environmental Investigator, to Carolyn Hervey at the Arkema Inc. Crosby, Texas facility (Arkema), Arkema is submitting revised emission summaries and calculations for the above referenced incidents (Attachment 1), which are based upon updated information and more accurately reflect the emissions related to the respective incidents. These improvements and corrections became apparent during the recent work associated with the Department's request for air dispersion modeling of the incident emissions. Arkema also requests your advice on how it can best update the emission estimates in STEERS. Specifically, for Incident 267578, the organic material release from the wastewater tanks, Arkema has updated the emissions estimates in order to refine emissions associated with a relatively small organic release into a very large volume of flood waters. Emissions of the tank overflows were modeled using Toxchem™ Version 4.3 from Hydromantis Environmental Software Solutions, Inc. Toxchem utilizes fate and transport mechanisms for specific air contaminants into process-specific mass balance equations. Emissions from the tank overflow are modeled based on the previously-reported quantity of organic material released to the flood waters. The rate of volatilization is related to the contaminant concentration, vapor pressure, solubility, dimensions of wastewater process vessel, and environmental factors such as wind speed and temperature.
For the remaining Incidents, the product storage trailer decompositions and fires, the following revisions have been made in order to refine the emissions estimates:

- The impact of combustion of the lead acid batteries on each trailer (lead and SO2 emissions) has been added to each fire event.
- The impact of combustion of the HFC refrigerant in each trailer's cooling system (hydrofluoric acid emissions) has been added to each fire event.
- A calculation error has been corrected, which had underestimated the amount of the organic peroxide products combusted in the fires.
- Product diluent has been properly categorized as organic mineral spirits (OMS), rather than dividing it among several unclassified and non-specific VOCs.

These revised emission estimates were prepared to the best of Arkema's current knowledge and understanding under the available time constraints. The incidents remain under investigation, and Arkema may supplement this response if new or additional data becomes available.
If you have any questions concerning this response, please do not hesitate to contact me at (610) 878-6632.

Sincerely,

Jean-Marie Cencetti
Director of Environment and Sustainable Development

Attachment

cc: all with attachments
Mr. Roberto Bernier, EPA Region 6
United States Environmental Protection Agency Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Mr. Ramiro Garcia, Jr., Deputy Director
Office of Compliance and Enforcement – MC-172
Texas Commission on Environmental Quality
P. O. Box 13087
Austin, Texas 78711-3087

Ms. Guadalupe Quiroz
TCEQ Region 12
5425 Polk Avenue, Suite H
Houston, Texas 77023

Mr. Craig Hill
Harris County Pollution Control Services Department
101 South Richey, Suite H
Pasadena, Texas 77506

Attachment 1

Emission Estimate of Waste Water Tank Overflow

There are two waste water tanks (2A and 2B) used to treat wastewater containing mineral spirits. Tanks were almost full (98%-99%) and an organic layer was on the top of each tank when heavy rains caused the tanks to overflow. When organic layer is spilled on the ground, it spreads out, vaporizes, and results in air emissions.

Tank 2A: The tank was measured with a 6 inch organic layer prior to the overflow and 1/4 inch after the overflow. The tank has a diameter of 35 ft. the volume of overflow is based on the net volume of the organic layer before and after the overflow.

Tank 2B: Measurements are not available for the organic layer, however, an estimate of the volume of organics was based on typical waste water organics generation. After reviewing the past four 90-day disposals of waste water organics, the daily average waste water organics generation from the process units is 45 gal/day. For conservatism, it is assumed that 2 days-worth of production organics (90 gallons) were in tank 2B at the time of the overflow.

Density of Mineral Spirits [1]	6.67	lb/gal
Tank 2A Diameter [2]	35	ft
Thickness of Organic Layer [2]	0.48	ft
Organics Overflow from Tank 2A [2]	3,448.37	gal
	23,007.54	lb
Organics Overflow from Tank 2B [3]	90.00	gal
	600.48	lb

Component [4]	Min wt% [4]	Max wt% [4]	Normalized wt% [4]	Total Organic Spilled from Tank 2A	Total Organic Spilled from Tank 2B	Total Organic Spilled from Tanks	Total Organic Spilled from Tanks Normalized
				lb/event	lb/event	lb/event	wt%
T-Amyl Alcohol	0%	20%	8.58%	1,974.90	51.54	2,026.44	5.13E-06
T-Butyl Alcohol	0%	20%	8.58%	1,974.90	51.54	2,026.44	5.13E-06
Di-T-Butyl Peroxide	0%	5%	2.15%	493.72	12.89	506.61	1.28E-06
Di-T-Amyl Peroxide	0%	5%	2.15%	493.72	12.89	506.61	1.28E-06
2,5 Dimethyl-2,5 Di (T-Butyl Peroxy) Hexane	0%	5%	2.15%	493.72	12.89	506.61	1.28E-06
Ethyl Benzene	0%	4%	1.72%	394.98	10.31	405.29	1.03E-06
Naphthalene (Crude Or Refined)	0%	4%	1.72%	394.98	10.31	405.29	1.03E-06
1, 2, 4 - Trimethylbenzene	4%	22%	9.44%	2,172.39	56.70	2,229.08	5.64E-06
Hydrotreated Heavy Naphtha	0%	4%	1.72%	394.98	10.31	405.29	1.03E-06
Water [5]	0%	0%	--	--	--	395,234,134.55	1.00E+00
Mineral Spirits	0%	80%	34.33%	7,899.58	206.17	8,105.76	2.05E-05
Naphtha, light aromatic	28%	60%	25.75%	5,924.69	154.63	6,079.32	1.54E-05
Xylene, mixed isomers	0%	4%	1.72%	394.98	10.31	405.29	1.03E-06
Total Active Oxygen from Organic Peroxides [6]	0%	0%	--	--	--		--

Notes:

[1] According to "Waste Water Organics (with OMS Diluent) In House Profile.pdf" provided by Arkema, specific gravity is 0.7-0.9. Average specific gravity 0.8 is used in the calculation.

[2] Provided by Arkema based on tank diameter and measurement of organic layer prior to and after overflow.

[3] Provided by Arkema based on the best estimate assuming typical daily production and two days of production.

[4] Per "Waste Water Organics (with OMS Diluent) In House Profile.pdf" and "Waste Profile for Wastewater Organics with Mineral Spirits (Signed 11-18-14).pdf" provided by Arkema, wt% of components are normalized based on the maximum wt% of each possible component in wastewater.

[5] Weight percentage of water is changed from maximum 10% to 0% to be conservative. For total event normalized concentrations, the volume of water includes the estimated volume of stormwater flow through the spill area over the event period (i.e., Estimated 1 mph stormwater flow across area of 1.55 m x 100 m over 6 hours).

[6] Weight percentage of total active oxygen from organic peroxides is changed from 1% to 0% to be conservative.

Tank Overflow Emissions Based on Toxchem Modeled Results

Compound [1]	CAS No.	Maximum Wastewater Tank Concentration [2] (ppm)	Total Emissions [3] (lb/event)	Emissions from Flooded Area [4] (lb/hr)
T-Amyl Alcohol	75-85-4	5.13	42.85	7.14
T-Butyl Alcohol	75-65-0	5.13	8.85	1.48
Di-T-Butyl Peroxide	110-05-4	1.28	37.30	6.22
Di-T-Amyl Peroxide	10508-09-5	1.28	22.51	3.75
2,5 Dimethyl-2,5 Di (T-Butyl Peroxy) Hexane	78-63-7	1.28	2.18	0.36
Ethyl Benzene	100-41-4	1.03	35.92	5.99
Naphthalene (Crude Or Refined)	91-20-3	1.03	31.27	5.21
1, 2, 4 - Trimethylbenzene	95-63-6	5.64	165.37	27.56
Hydrotreated Heavy Naphtha	64742-48-9	1.03	31.27	5.21
Mineral Spirits	--	20.51	231.84	38.64
Naphtha, light aromatic	64742-95-6	15.38	514.98	85.83
Xylene, mixed isomers	1330-20-7	1.03	37.44	6.24
		VOC Totals (lbs/event):	1,161.79	--
		VOC Totals (tons/event):	0.58	--

[1] Hydrotreated heavy naphtha was modeled as naphthalene, mineral spirits was modeled as decane, and light naphtha was modeled as pentane.

[2] Wastewater tank concentrations based on normalized wastewater organics composition.

[3] The emission event occurred from noon to 6 PM on August 29, 2017; therefore, multiplied the hourly emissions by six (6) to determine the overall emissions for the event for each chemical compound.

[4] Hourly Emissions (lb/hr) = Toxchem Modeled Results (g/day) * 1/24 (day/hours) * 1/453.59 (lb/g)

Tank Overflow Unit Parameters

Influent Stream

Flow Rate [1]	1,097,872.60	gpm(US)	
Suspended Solids	200	ppm	Toxchem Default
VSS to SS Ratio	100	%	Conservative assumption
Wastewater DOC	0	ppm	Toxchem Default
Oil/Grease Concentration	0	ppm	Toxchem Default
Temperature [2]	71.8	deg F	
	22	deg C	Unit Conversion

Lagoon (Polishing Pond)

Liquid Depth [3]	1.55	m	
Surface Area [4]	40,000.00	m^2	
Effluent SS Concentration	200	ppm	Assume no change

Site Parameters

Elevation [5]	14.00	m	
Wind Speed [2]	17.13	mph	
Site Wide pH	7		Toxchem Default

[1] Flow based on estimated quantity of wastewater organics overflowing the tank divided by the estimated duration of the event.

[2] Temperature and wind speed from the Wallisville Road C617 (EPA Site No. 48-201-0617) monitoring site (https://www.tceq.texas.gov/cgi-bin/compliance/monops/yearly_summary.pl), accessed October 17, 2017. Maximum temperature was calculated from 12:00 PM to 6:00 PM on August 29, 2017.

[3] Liquid depth based on difference in elevation between tanks and property line at drainage point.

[4] Surface area of lagoon represented to be 100 meters by 400 meters based on flow path from tank overflows to property line.

[5] Elevation was determined using National Elevation Data (NED) obtained from the United States Geological Survey (USGS).

Arkema Inc. - Crosby
Trailer No. 1 Emissions
August 31, 2017

Emissions Summary

Emission Source	Emissions (lb/event)								
	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2	VOC	HF	Lead
Products in Trailer No. 1 Consumed in Fire	511.17	59.62	176.71	176.71	176.71	--	4,751.74	--	--
Trailer Consumed in Fire	484.38	15.50	387.50	387.50	387.50	--	124.00	--	--
Pallets Consumed in Fire	133.50	4.27	106.80	106.80	106.80	--	34.18	--	--
Containers Consumed in Fire	342.90	10.97	274.32	274.32	274.32	--	87.78	--	--
Refrigeration Unit Consumed in Fire	61.72	1.98	49.38	49.38	49.38	--	15.80	--	--
Refrigerant Consumed in Fire	--	--	--	--	--	--	--	3.28	--
Battery Consumed in Fire	--	--	5.37	5.37	5.37	9.79	--	--	1.82
Diesel Fuel Comsumed in Fire	0.13	0.60	0.08	0.08	0.08	1.78	0.01	--	--
Total Emissions	**1,533.79**	**92.94**	**1,000.16**	**1,000.16**	**1,000.16**	**11.56**	**5,013.50**	**3.28**	**1.82**

Summary of Speciated Emissions

Compound	CAS#	Contaminant Code	Total
			lb/event
Nonane	111-84-2	56703	**1,297.43**
Nonene	124-11-8	56704	**427.13**
OMS	68551-17-7	59275	**1,069.31**
Acetophenone	98-86-2	59861	**805.93**
2-Ethyl hexanol	104-76-7	51521	**869.00**
2-Ethyl hexanal	123-05-7	51601	**282.94**
Acetone	67-64-1	54020	**393.76**
Ethane	74-84-0	56550	**38.32**
Hydrofluoric Acid	7664-39-3	11162	**3.28**
Lead	7439-92-1	14319	**1.82**
CO	630-08-0	90300	**1,533.79**
NO_X	10102-44-0	70402	**92.94**
PM	--	10000	**1,000.16**
PM_{10}	--	20000	**1,000.16**
$PM_{2.5}$	--	39999	**1,000.16**
SO_2	7446-09-5	70510	**11.56**
Unclassified VOC [1]	--	500001	**261.76**

Note:
[1] Unclassified VOC includes VOC emissions from combustion products.

Summary of Emissions from Trailer 1

Emission Source	Emissions (lb/event)					
	VOC	CO	NO_X	PM	PM_{10}	$PM_{2.5}$
Decomposition to Vapor - Unburned	1,008.37	--	--	--	--	--
Decomposition Products - Burned	3,743.37	511.17	59.62	176.71	176.71	176.71
Total	**4,751.74**	**511.17**	**59.62**	**176.71**	**176.71**	**176.71**

1. Emissions from Decomposition to Vapor - Unburned

Product	Decomp Composition [1]	Vapor wt% [2]	Decomp to Vapor, Unburned - Total lbs	Decomp to Vapor, Unburned - Speciated lbs	Speciated VOC Emissions to Air lbs
Lup 188M75	Nonane	23.44%	1,181.25	276.93	276.93
	Nonene	7.74%		91.48	91.48
	Carbon Dioxide	10.73%		126.70	
	OMS	24.89%		294.06	294.06
	Acetophenone	29.28%		345.89	345.89
	Methane	3.91%		46.19	
Total VOC from Vapor (Unburned) to Air					**1,008.37**

2. Emissions from Decomposition Products - Burned

VOC Emissions

Destruction Efficiency 93% [3]

Product	Original Composition [4]	Original wt% [4]	Decomposed Composition [1]	Decomposed wt% [2]	Product Unburned - Total [5] lbs	Speciated Emissions to Air lbs	Product Burned - Total [5] lbs	Product Burned - speciated lbs	Heating Value [6] btu/lb	Heat Input MMbtu	Speciated VOC Emissions to Air lbs
Lup 10	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	>=95%	Nonane	37%	551	205.62	7324	2,731.81	19,000	51.90	205.62
	Hydroperoxide, 1,1-dimethylethyl	<1%	Nonene	12%		67.46		896.29	18,800	16.85	67.46
			Carbon Dioxide	22%		119.73		1,590.73	0	0.00	
			OMS	0%		0.00		0.00	15,000	0.00	0.00
			Acetone	23%		124.14		1,649.32	12,281	20.25	
			Methane	6%		34.29		455.60	21,509	9.80	
Lup 10M75	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	>= 74- <=76%	Nonane	29%	1,103	323.98	14,648	4,304.26	19,000	81.78	323.98
	Naphtha (petroleum), hydrotreated heavy	<26%	Nonene	10%		106.29		1,412.20	18,800	26.55	106.29
	Naphtha (petroleum), heavy alkylate	<26%	Carbon Dioxide	13%		148.22		1,969.25	0	0.00	
	Hydroperoxide, 1,1-dimethylethyl	<0.2%	OMS	25%		274.37		3,645.26	15,000	54.68	274.37
			Acetone	18%		195.60		2,598.68	12,281	31.91	
			Methane	5%		54.03		717.85	21,509	15.44	
Lup 188M75	Nedodecaneperoxoic acid, 1-methyl-1-phenylethyl ester	>=74- <75%	Nonane	23%	1,571	368.32	20,873	4,893.34	19,000	92.97	368.32
	Benzenemethanol, .alpha.,.alpha.-dimethyl-	>=5- <=11%	Nonene	8%		121.67		1,616.46	18,800	30.39	121.67
	Benzene, (1-methylethyl)-	>=5 -<=7%	Carbon Dioxide	11%		168.51		2,238.76	0	0.00	
	Ethanone, 1-phenyl-	<=5%	OMS	25%		391.10		5,196.08	15,000	77.94	391.10
	Naphtha (petroleum), hydrotreated	>=1 - <25%	Acetophenone	29%		460.04		6,111.95	14,257	87.14	460.04
	Naphtha (petroleum), heavy alkylate	>=1 - <25%	Methane	4%		61.43		816.10	21,509	17.55	
Lup 223M75S	Peroxydicarbonic acid, bis(2-ethylhexyl)	>= 75 - <= 77 %	2-Ethyl hexanol	56%	1,544	869.00	20,507	11,545.23	15,000	173.18	869.00
	Naphtha (petroleum), hydrotreated heavy	<25%	2-Ethyl hexanal	18%		282.94		3,759.05	15,000	56.39	282.94
	Naphtha (petroleum), heavy alkylate	<25%	Carbon Dioxide	25%		391.56		5,202.22	0	0.00	
	Proprietary component	<0.2%									
Lup 546M75	Neodecaneperoxoic acid, 1,1-dimethylpropyl ester	>= 74 - <= 75 %	Nonane	28%	441	122.59	5,859	1628.69	19,000	30.95	122.59
	Naphtha (petroleum), hydrotreated heavy	>= 0 - <= 25 %	Nonene	9%		40.22		534.36	18,800	10.05	40.22
	Naphtha (petroleum), heavy alkylate	>= 0 - <= 25 %	Carbon Dioxide	13%		56.09		745.15	0	0.00	
	Hydroperoxide, 1,1-dimethylpropyl	<= 0.1 %	OMS	25%		109.77		1458.36	15,000	21.88	109.77
			Acetone	17%		74.01		983.32	12,281	12.08	
			Ethane	9%		38.32		509.12	20,426	10.40	
Totals:										**930.07**	**3,743.37**

NOx, CO, and PM Emissions

Pollutants	Emission Factors lb/MMbtu	Emissions lbs/event
NOx [7]	0.0641	59.62
CO [7]	0.5496	511.17
PM [8]	0.19	176.71

Notes

[1] Decomposition ("Decomp") products provided by Arkema in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx". "OMS" stands for

[2]Calculated based on 1000 pounds of Lup 188M75 product decomposed, provided by Arkema in the file "in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx".

[3] Per *TCEQ publication RG-360A/11, Revised February 2012, TECHNICAL SUPPLEMENT 4: FLARES,* based on EPA test data, for combustions that do not satisfy 40 CFR 60.18, a 93 percent destruction efficiency (DRE) is assumed.

[4] Product composition provided by Arkema via email on 9/5 /2017 in the file "Crosby Inventory 082817 Trailers Stg Bldg.xlsx".

[5] According to Arkema, 5% as Lup 188M75 was emitted as vapor prior to combustion. The remaining product decomposed except diluent (e.g., OMS) and burned with a 93% DRE (i.e., 7% of decomposition products and diluent emitted to atmosphere and the remainder converted to combustion products).

[6] Yaws' Handbook of Thermodynamic and Physical Properties of Chemical Compounds/Enthalpy of Combustion

[7]*TCEQ publication RG-360A/11, Revised January 2017, TECHNICAL SUPPLEMENT 4: FLARES, Table A-7, air or unassisted flare, low Btu.*

[8] Based on AP 42 Table 13.5-1, heavily smoking flares 274 µg/L in exhaust, calculated from concentration using F-factor method on a dry basis, assuming 3% O_2 in exhaust gas stream (*Emission Estimation Protocol for Petroleum Refinerie:*, RTI International, May 2011, Table 6-4).

Summary of Emissions from Trailer Components Combustion

Emission Source	Emissions (lb/event)					
	VOC	CO	NO_X	PM	PM_{10}	$PM_{2.5}$
Combustion Emissions	261.76	1,022.49	32.72	818.00	818.00	818.00

Trailers		
Weight of Trailer [1]	15,500	pounds
Burned [2]	50%	
Weight of Trailer Burned	7,750	pounds
Pallets		
Weight of Each Pallet [3]	44.5	pounds
# of Pallets in a Trailer [4]	48	
Burned	100%	
Weight of Pallets Burned	2,136	pounds
Containers		
Weight of a 5 Gal Container [5]	1,153	grams
Weight of a 5 Gal Container	2.54	pounds
Trailer Capacity	3,500	ft^3
Number of 5 Gal Containers Impacted [5]	2,160	
Burned	100%	
Weight of Containers in a Trailer	5,486	pounds
Refrigeration Unit		
Weight of Refrigeration Unit [6]	1,975	pounds
Burned	50%	
Weight of Refrigeration Unit Burned	988	pounds
Total Weight of Solid Combustibles Per Trailer	**8.18**	**tons**

Refrigerant

Weight of Refrigerant [6] 16 pounds

Compositions [7]	CAS #	M. Wt.	Wt%	Emissions
		lb/lb-mol		lbs
1,1,1-Trifluoroethane [7]	420-46-2	84.04	52%	8.32
Pentafluoroethane [7]	354-33-6	120.02	44%	7.04
1,1,1,2-Tetrafluoroethane [7]	811-97-2	102.03	4%	0.64
Emissions as Hydrofluoric Acid (HF)	7664-39-3	20.01		**3.28**

Battery

Weight of Battery [8] 50 pounds

Compositions [9]	CAS #	M. Wt.	Wt%	Weight
		lb/lb-mol		lbs
Lead	7439-92-1	207.2	70%	35
Sulfuric acid	7664-93-9	98.08	30%	15

Emissions from Battery Burned

Pollutant	Emission Factor [10]	Emissions from Lead Burned	Emissions from Sulfuric Acid Burned [11]
	lb of pollutant/ton of metal produced	lbs	lbs
PM	307	5.37	--
Lead	104	1.82	--
SO_2	--	--	9.79

NOx, CO, and PM Emissions from Trailer Components Combustion

Pollutants	Emission Factors [12]	Emissions From Trailer Burning	Emissions From Pallets Burning	Emissions From Containers Burning	Emissions From Refrigeration Unit Burning	Total Emissions From Solids Burning
	lb/ton	lbs	lbs	lbs	lbs	lbs
VOC	32	124.00	34.18	87.78	15.80	**261.76**
NOx	4	15.50	4.27	10.97	1.98	**32.72**
CO	125	484.38	133.50	342.90	61.72	**1,022.49**
PM	100	387.50	106.80	274.32	49.38	**818.00**

Notes:
[1] Per information provided by Arkema, the trailer is a 53' refrigerated trailer, based on vendor information, typical weight of refrigerated trailer is 15,500 lb.
[2] Based on phone communication between Arkema and Trinity Consultants on September 6, 2017, 50% of weight of trailer estimated to be combusted.
[3] According to dimensions of trailer provided by Arkema, typical pallet used in this type of trailer is 40"x 48" and weight is 44.5 lb.
[4] Provided by Arkema based on trailer inventory and products information.
[5] Provided by Arkema based on trailer inventory and products information, typical 35 lbs products per container. Typical empty container weight based on vendor information.
[6] Weight of refrigeration unit and refrigerant based on vendor information for typical unit.
[7] Per R-404A Refrigerant safety data sheet (SDS)
[8] Per KLLM Trailer Specifications
[9] Per Lead-acid Battery SDS normalized to total weight of battery for conservatism.
[10] The battery in engine of trailer burned in the fire and is represented as second lead processing in blast furnaces. Particulate and lead emission factors are selected based on AP-42 Chapter 12.11.2, Table 12.11-2, Emission Factors for Secondary Lead Processing.
[11] Sulfur dioxide (SO_2) emissions estimated assuming all sulfur from sulfuric acid converted to SO_2.
[12] Emission factors from AP-42 Chapter 2.5, Table 2.5-1 "Emission Factors for Open Burning of Municipal Refuse," factors for Automobile Components

Products in Trailer No. 1

Product Name	Composition [1]	CAS#	wt% [1]	Quantity in 1st Trailer [2] lbs
Lup 10	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>=95%	7,875
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<1%	
Lup 10M75	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>= 74- <=76%	15,750
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<0.2%	
Lup 11M45	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1- dimethlethyl ester	927-07-1	>=44- <46%	--
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<56%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<56%	
Lup 11M75	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1- dimethlethyl ester	927-07-1	>=74- <76%	--
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
Lup 188M75	Nedodecaneperoxoic acid, 1-methyl-1-phenylethyl ester	26748-47-0	>=74- <75%	23,625
	Benzenemethanol, .alpha.,.alpha.-dimethyl-	617-94-7	>=5- <=11%	
	Benzene, (1-methylethyl)-	98-82-8	>=5 -<=7%	
	Ethanone, 1-phenyl-	98-86-2	<=5%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>=1 - <25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>=1 - <25%	
Lup 221	Peroxydicarbonic acid, dipropyl ester	16066-38-9	>= 99 %	--
Lup 223M75S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 75 - <= 77 %	22,050
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<25%	
	Proprietary component	NJTSN# 03365400	<0.2%	
Lup 223S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 97 - <= 100 %	--
	Proprietary component	NJTSN# 03365400	<0.3%	
Lup 223V75	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	75%	--
	Proprietary component	NJTSN# 03365400	25%	
Lup 225M60	Peroxydicarbonic acid, bis(1-methylpropyl) ester	19910-65-7	>= 59 - <= 61 %	--
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<41%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<41%	
Lup 546M75	Neodecaneperoxoic acid, 1,1- dimethylpropyl ester	68299-16-1	>= 74 - <= 75 %	6,300
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>= 0 - <= 25 %	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>= 0 - <= 25 %	
	Hydroperoxide, 1,1-dimethylpropyl	3425-61-4	<= 0.1 %	
			Total (lbs)	**75,600**

Estimate Pounds of Material Lost in Fire
Destruction Efficiency [4] 93%

Products in Trailers	Quantity [1]	% Fast Decomp - to Vapor [3]	% Decomp to Fire - Unburned [4]	% Decomp to Fire - Burned [4]	% Burned from Original Product [5]	lb Decomp to Vapor	lb Decomp to Fire, Unburned	lb Decomp to Fire, Burned
	lbs					lbs	lbs	lbs
Lup 10	7,875.00	--	7%	93%	0%	--	551	7,323.75
Lup 10M75	15,750	--	7%	93%	0%	--	1,102.50	14,647.50
Lup 11M45	--	--	7%	93%	0%	--	--	--
Lup 11M75	--	--	7%	93%	0%	--	--	--
Lup 188M75	23,625	5%	6.65%	88.35%	0%	1,181.25	1,571.06	20,872.69
Lup 221	--	--	7%	93%	0%	--	--	--
Lup 223M75S	22,050	--	7%	93%	0%	--	1,543.50	20,506.50
Lup 223S	--	--	7%	93%	0%	--	--	--
Lup 223V75	--	--	7%	93%	0%	--	--	--
Lup 225M60	--	--	7%	93%	0%	--	--	--
Lup 546M75	6,300	--	7%	93%	0%	--	441.00	5,859.00
Total	**75,600**					**1,181.25**	**5,209.31**	**69,209.44**

Notes:
[1] Product composition provided by Arkema via email on 9/5/2017 in the file "Crosby Inventory 082817 Trailers Stg Bldg.xlsx".
[2] Provided by Arkema via email on 9/8/2017 in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx".
[3] Based on the information provided by Arkema, 5% of Lup 188M75 is used to represent the decomposition products to vapor phase.
[4] Per *TCEQ publication RG-360A/11, Revised February 2012, TECHNICAL SUPPLEMENT 4: FLARES,* based on EPA test data, for combustions that do not satisfy 40 CFR 60.18, a 93 percent destruction efficiency is assumed. Therefore, for decomposed product Lup 188M75 remaining after vapor release, 7% unburned, and 93% of decomposed part is burned.
[5] Value excludes diluent (e.g., naphtha).

Input

Parameter	Value	Units
Diesel Oil Burned [1]	25	gal/event

[1] Volume combusted based on email from Arkema, September 7, 2017.

Emission Factors and Emissions of Criteria Pollutants

Pollutant	Emission Factor [1] [2] (lb/Mgal)	Emissions (lb/event)	(short tons/event)
CO	5	0.13	6.3E-05
NO_X	24	0.60	3.0E-04
PM	3.3	0.08	4.1E-05
PM_{10}	3.3	0.08	4.1E-05
$PM_{2.5}$	3.3	0.08	4.1E-05
SO_2	71	1.78	8.9E-04
VOC	0.2	0.01	2.5E-06

Note:

[1] U.S. EPA AP-42, Section 1.3 - Fuel Oil Combustion, May 2010, Tables 1.3-1 and 1.3-2 - No. 2 oil fired (1-01-005-01), (1-02-005-01), (1-03-005-01) for CO, NO_X, PM, PM_{10}, $PM_{2.5}$, and SO_2.

[2] U.S. EPA AP-42, Section 1.3 - Fuel Oil Combustion, May 2010, Table 1.3-3 - Industrial boilers, Distillate oil fired (1-02-005-01/02/03) for VOC.

Arkema Inc. - Crosby
Trailer Nos. 2 and 3 Emissions
September 1, 2017

Emissions Summary

Emission Source	Emissions (lb/event)								
	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2	VOC	HF	Lead
Products in Trailer No. 2 and 3 Consumed in Fire	479.95	55.98	165.92	165.92	165.92	--	3,977.20	--	--
Trailer Consumed in Fire	968.75	31.00	775.00	775.00	775.00	--	248.00	--	--
Pallets Consumed in Fire	122.38	3.92	97.90	97.90	97.90	--	31.33	--	--
Containers Consumed in Fire	314.33	10.06	251.46	251.46	251.46	--	80.47	--	--
Refrigeration Unit in Fire	123.44	3.95	98.75	98.75	98.75	--	31.60	--	--
Refrigerant Consumed in Fire	--	--	--	--	--	--	--	6.56	--
Battery Consumed in Fire	--	--	10.75	10.75	10.75	19.58	--	--	3.64
Diesel Fuel Combusted in Fire	0.25	1.20	0.17	0.17	0.17	3.55	0.01	--	--
Total Emissions	**2,009.09**	**106.10**	**1,399.94**	**1,399.94**	**1,399.94**	**23.13**	**4,368.61**	**6.56**	**3.64**

Summary of Speciated Emissions

Compound	CAS#	Contaminant Code	Total
			lb/event
Nonane	111-84-2	56703	**1,424.49**
Nonene	124-11-8	56704	**1,226.90**
OMS	68551-17-7	59275	**527.99**
Acetophenone	98-86-2	59861	**249.37**
2-Ethyl hexanol	104-76-7	51521	**89.87**
2-Ethyl hexanal	123-05-7	51601	**89.87**
Acetone	67-64-1	54020	**430.36**
Ethane	74-84-0	56550	**223.75**
Hydrofluoric Acid	7664-39-3	11162	**6.56**
Lead	7439-92-1	14319	**3.64**
CO	630-08-0	90300	**2,009.09**
NO_X	10102-44-0	70402	**106.10**
PM	--	10000	**1,399.94**
PM_{10}	--	20000	**1,399.94**
$PM_{2.5}$	--	39999	**1,399.94**
SO_2	7446-09-5	70510	**23.13**
Unclassified VOC [1]	--	500001	**391.41**

Note:
[1] Unclassified VOC includes VOC emissions from combustion products.

Summary of Emissions from Trailer 2 and Trailer 3

Emission Source	Emissions (lb/event)					
	VOC	CO	NO_X	PM	PM_{10}	$PM_{2.5}$
Decomposition to Vapor - Unburned	732.85	--	--	--	--	--
Decomposition Products - Burned	3,244.35	479.95	55.98	165.92	165.92	165.92
Total	**3,977.20**	**479.95**	**55.98**	**165.92**	**165.92**	**165.92**

1. Emissions from Decomposition to Vapor - Unburned

Product	Decomp Composition [1]	Vapor wt% [2]	Decomp to Vapor, Unburned - Total lbs	Decomp to Vapor, Unburned - Speciated lbs	Speciated VOC Emissions to Air lbs
Lup 10	Nonane	37.30%	393.75	146.87	146.87
	Nonene	12.24%		48.19	48.19
	Carbon Dioxide	21.72%		85.52	
	OMS	0.00%		0	0
	Acetone	22.52%		88.67	
	Methane	6.22%		24.49	
Lup 188M75	Nonane	23.44%	630.00	147.70	147.70
	Nonene	7.74%		48.79	48.79
	Carbon Dioxide	10.73%		67.57	
	OMS	24.89%		156.83	156.83
	Acetophenone	29.28%		184.48	184.48
	Methane	3.91%		24.63	
Total VOC from Vapor (Unburned) to Air					**732.85**

2. Emissions from Decomposition Products - Burned

VOC Emissions

Destruction Efficiency 93% [3]

Product	Original Composition [4]	Original wt% [4]	Decomposed Composition [1]	Decomposed wt% [2]	Product Unburned - Total [5] lbs	Speciated Emissions to Air lbs	Product Burned - Total [5] lbs	Product Burned - speciated lbs	Heating Value [6] btu/lb	Heat Input MMbtu	Speciated VOC Emissions to Air lbs
Lup 10	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	>=95%	Nonane	37%	524	195.34	6,958	2,595.22	19,000	49.31	195.34
	Hydroperoxide, 1,1-dimethylethyl	<1%	Nonene	12%		64.09		851.47	18,800	16.01	64.09
			Carbon Dioxide	22%		113.75		1,511.20	0	0.00	
			OMS	0%		0.00		0.00	15,000	0.00	0.00
			Acetone	23%		117.94		1,566.85	12,281	19.24	
			Methane	6%		32.58		432.82	21,509	9.31	
Lup 10M75	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	>= 74- <=76%	Nonane	29%	2,095	615.55	27,830	8,178.09	19,000	155.38	615.55
	Naphtha (petroleum), hydrotreated heavy	<26%	Nonene	10%		201.96		2,683.18	18,800	50.44	201.96
	Naphtha (petroleum), heavy alkylate	<26%	Carbon Dioxide	13%		281.62		3,741.57	0	0.00	
	Hydroperoxide, 1,1-dimethylethyl	<0.2%	OMS	25%		521.31		6,926.00	15,000	103.89	521.31
			Acetone	18%		371.64		4,937.50	12,281	60.64	
			Methane	5%		102.66		1,363.92	21,509	29.34	
Lup 188M75	Nedodecaneperoxoic acid, 1-methyl-1-phenylethyl ester	>=74- <75%	Nonane	23%	838	196.44	11,132	2,609.78	19,000	49.59	196.44
	Benzenemethanol, .alpha.,.alpha.-dimethyl-	>=5- <=11%	Nonene	8%		64.89		862.11	18,800	16.21	64.89
	Benzene, (1-methylethyl)-	>=5 -<=7%	Carbon Dioxide	11%		89.87		1,194.00	0	0.00	
	Ethanone, 1-phenyl-	<=5%	OMS	25%		208.59		2,771.24	15,000	41.57	208.59
	Naphtha (petroleum), hydrotreated	>=1 - <25%	Acetophenone	29%		245.35		3,259.71	14,257	46.47	245.35
	Naphtha (petroleum), heavy alkylate	>=1 - <25%	Methane	4%		32.76		435.25	21,509	9.36	
Lup 223M75S	Peroxydicarbonic acid, bis(2-ethylhexyl)	>= 75 - <= 77 %	2-Ethyl hexanol	56%	882	496.57	11,718	6,597.28	15,000	98.96	496.57
	Naphtha (petroleum), hydrotreated heavy	<25%	2-Ethyl hexanal	18%		161.68		2,148.03	15,000	32.22	161.68
	Naphtha (petroleum), heavy alkylate	<25%	Carbon Dioxide	25%		223.75		2,972.70	0	0.00	
	Proprietary component	<0.2%									
Lup 546M75	Neodecaneperoxoic acid, 1,1-dimethylpropyl ester	>= 74 - <= 75 %	Nonane	28%	441	122.59	5,859	1628.69	19,000	30.95	122.59
	Naphtha (petroleum), hydrotreated heavy	>= 0 - <= 25 %	Nonene	9%		40.22		534.36	18,800	10.05	40.22
	Naphtha (petroleum), heavy alkylate	>= 0 - <= 25 %	Carbon Dioxide	13%		56.09		745.15	0	0.00	
	Hydroperoxide, 1,1-dimethylpropyl	<= 0.1 %	OMS	25%		109.77		1458.36	15,000	21.88	109.77
			Acetone	17%		74.01		983.32	12,281	12.08	
			Ethane	9%		38.32		509.12	20,426	10.40	
				Totals:						**873.28**	**3,244.35**

NOx, CO, and PM Emissions

Pollutants	Emission Factors lb/MMbtu	Emissions lbs/event
NOx [7]	0.0641	55.98
CO [7]	0.5496	479.95
PM [8]	0.19	165.92

Notes
[1] Decomposition ("Decomp") products provided by Arkema in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx". "OMS" stands for
[2]Calculated based on 1000 pounds of Lup 188M75 product decomposed, provided by Arkema in the file "in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx".
[3] Per *TCEQ publication RG-360A/11, Revised February 2012, TECHNICAL SUPPLEMENT 4: FLARES*, based on EPA test data, for combustions that do not satisfy 40 CFR 60.18, a 93 percent destruction efficiency (DRE) is assumed.
[4] Product composition provided by Arkema via email on 9/5/2017 in the file "Crosby Inventory 082817 Trailers Stg Bldg.xlsx".
[5] According to Arkema, 5% as Lup 10 and LUP 188M75 was emitted as vapor prior to combustion. The remaining product decomposed except diluent (e.g., OMS) and burned with a 93% DRE (i.e., 7% of decomposition products and diluent emitted to atmosphere and the remainder converted to combustion products).
[6] Yaws' Handbook of Thermodynamic and Physical Properties of Chemical Compounds/Enthalpy of Combustion
[7]*TCEQ publication RG-360A/11, Revised January 2017, TECHNICAL SUPPLEMENT 4: FLARES, Table A-7, air or unassisted flare, low Btu.*
[8] Based on AP 42 Table 13.5-1, heavily smoking flares 274 µg/L in exhaust, calculated from concentration using F-factor method on a dry basis, assuming 3% O_2 in exhaust gas stream (*Emission Estimation Protocol for Petroleum Refineries*, RTI International, May 2011, Table 6-4).

Summary of Emissions from Trailer No. 2 and No.3 Components Combustion

Emission Source	Emissions (lb/event)					
	VOC	CO	NO_X	PM	PM_{10}	$PM_{2.5}$
Combustion Emissions	391.40	1,528.89	48.92	1,223.11	1,223.11	1,223.11

Trailers		
Weight of a Trailer [1]	15,500	pounds
Number of Trailers Burned	2	
Burned [2]	50%	
Weight of Trailer Burned	15,500	pounds
Pallets		
Weight of Each Pallet [3]	44.5	pounds
# of Pallets in a Trailer [4]	22	
Burned	100%	
Weight of Pallets Burned	1,958	pounds
Containers		
Weight of a 5 Gal Container [5]	1,153	grams
Weight of a 5 Gal Container	2.54	pounds
Trailer Capacity	3,500	ft^3
Number of 5 Gal Containers Impacted [5]	1,980	
Burned	100%	
Weight of Containers in a Trailer	5,029	pounds
Refrigeration Unit		
Weight of a Refrigeration Unit [6]	1,975	pounds
Burned	50%	
Weight of Refrigeration Unit Burned	1,975	pounds
Total Weight of Solid Combustibles Per Trailer	**12.23**	**tons**

Refrigerant

Weight of Refrigerant [6] 16 pounds/trailer

Compositions [7]	CAS #	M. Wt.	Wt%	Emissions
		lb/lb-mol		lbs
1,1,1-Trifluoroethane [7]	420-46-2	84.04	52%	16.64
Pentafluoroethane [7]	354-33-6	120.02	44%	14.08
1,1,1,2-Tetrafluoroethane [7]	811-97-2	102.03	4%	1.28
Emissions as Hydrogen Fluoride	7664-39-3	20.01		**6.56**

Battery

Weight of Battery [8] 50 pounds/trailer

Compositions [9]	CAS #	M. Wt.	Wt%	Weight
		lb/lb-mol		lbs
Lead	7439-92-1	207.2	70%	70
Sulfuric acid	7664-93-9	98.08	30%	30

Emissions from Battery Burned

Pollutant	Emission Factor [10]	Emissions from Lead Burned	Emissions from Sulfuric Acid Burned [11]
	lb of pollutant/ton of metal produced	lbs	lbs
PM	307	10.75	--
Lead	104	3.64	--
SO_2	--	--	19.58

NOx, CO, and PM Emissions from Trailer Components Combustion

Pollutants	Emission Factors [12]	Emissions From Trailer Burning	Emissions From Pallets Burning	Emissions From Containers Burning	Emissions From Refrigeration Unit Burning	Total Emissions From Solids Burning
	lb/ton	lbs	lbs	lbs	lbs	lbs
VOC	32	248.00	31.33	80.47	31.60	**391.40**
NOx	4	31.00	3.92	10.06	3.95	**48.92**
CO	125	968.75	122.38	314.33	123.44	**1,528.89**
PM	100	775.00	97.90	251.46	98.75	**1,223.11**

Notes:
[1] Per information provided by Arkema, the trailer is a 53' refrigerated trailer, based on vendor information, typical weight of refrigerated trailer is 15,500 lb.
[2] Based on phone communication between Arkema and Trinity Consultants on September 6, 2017, 50% of weight of trailer estimated to be combusted.
[3] According to dimensions of trailer provided by Arkema, typical pallet used in this type of trailer is 40"x 48" and weight is 44.5 lb.
[4] Provided by Arkema based on trailer inventory and products information.
[5] Provided by Arkema based on trailer inventory and products information, typical 35 lbs products per container. Typical empty container weight based on vendor information.
[6] Weight of refrigeration unit and refrigerant based on vendor information for typical unit.
[7] Per R-404A Refrigerant safety data sheet (SDS)
[8] Per KLLM Trailer Specifications
[9] Per Lead-acid Battery SDS normalized to total weight of battery for conservatism.
[10] The battery in engine of trailer burned in the fire and is represented as second lead processing in blast furnaces. Particulate and lead emission factors are selected based on AP-42 Chapter 12.11.2, Table 12.11-2, Emission Factors for Secondary Lead Processing.
[11] Sulfur dioxide (SO_2) emissions estimated assuming all sulfur from sulfuric acid converted to SO_2.
[12] Emission factors from AP-42 Chapter 2.5, Table 2.5-1 "Emission Factors for Open Burning of Municipal Refuse," factors for Automobile Components

Products in Trailer No. 2 and No.3

Product Name	Composition [1]	CAS#	wt% [1]	Quantity in Trailers [2] lbs
Lup 10	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>=95%	7,875
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<1%	
Lup 10M75	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>= 74- <=76%	29,925
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<0.2%	
Lup 11M45	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1- dimethlethyl ester	927-07-1	>=44- <46%	--
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<56%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<56%	
Lup 11M75	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1- dimethlethyl ester	927-07-1	>=74- <76%	--
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
Lup 188M75	Nedodecaneperoxoic acid, 1-methyl-1-phenylethyl ester	26748-47-0	>=74- <75%	12,600
	Benzenemethanol, .alpha.,.alpha.-dimethyl-	617-94-7	>=5- <=11%	
	Benzene, (1-methylethyl)-	98-82-8	>=5 -<=7%	
	Ethanone, 1-phenyl-	98-86-2	<=5%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>=1 - <25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>=1 - <25%	
Lup 221	Peroxydicarbonic acid, dipropyl ester	16066-38-9	>= 99 %	--
Lup 223M75S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 75 - <= 77 %	12,600
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<25%	
	Proprietary component	NJTSN# 03365400	<0.2%	
Lup 223S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 97 - <= 100 %	--
	Proprietary component	NJTSN# 03365400	<0.3%	
Lup 223V75	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	75%	--
	Proprietary component	NJTSN# 03365400	25%	
Lup 225M60	Peroxydicarbonic acid, bis(1-methylpropyl) ester	19910-65-7	>= 59 - <= 61 %	--
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<41%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<41%	
Lup 546M75	Neodecaneperoxoic acid, 1,1- dimethylpropyl ester	68299-16-1	>= 74 - <= 75 %	6,300
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>= 0 - <= 25 %	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>= 0 - <= 25 %	
	Hydroperoxide, 1,1-dimethylpropyl	3425-61-4	<= 0.1 %	
			Total (lbs)	**69,300**

ARK_ TCEQ_0000248

Estimate Pounds of Material Lost in Fire

Destruction Efficiency [4] 93%

Products in Trailers	Quantity [1]	% Fast Decomp - to Vapor [3]	% Decomp to Fire - Unburned [4]	% Decomp to Fire - Burned [4]	% Burned from Original Product [5]	lb Decomp to Vapor	lb Decomp to Fire, Unburned	lb Decomp to Fire, Burned
	lbs					lbs	lbs	lbs
Lup 10	7,875	5%	6.65%	88.35%	0%	393.75	524	6,957.56
Lup 10M75	29,925	--	7%	93%	0%	--	2,094.75	27,830.25
Lup 11M45	--	--	7%	93%	0%	--	--	--
Lup 11M75	--	--	7%	93%	0%	--	--	--
Lup 188M75	12,600	5%	6.65%	88.35%	0%	630.00	837.90	11,132.10
Lup 221	--	--	7%	93%	0%	--	--	--
Lup 223M75S	12,600	--	7%	93%	0%	--	882.00	11,718.00
Lup 223S	--	--	7%	93%	0%	--	--	--
Lup 223V75	--	--	7%	93%	0%	--	--	--
Lup 225M60	--	--	7%	93%	0%	--	--	--
Lup 546M75	6,300	--	7%	93%	0%	--	441.00	5,859.00
Total	**69,300**					**1,023.75**	**4,779.34**	**63,496.91**

Notes:
[1] Product composition provided by Arkema via email on 9/5/2017 in the file "Crosby Inventory 082817 Trailers Stg Bldg.xlsx".
[2] Provided by Arkema via email on 9/8/2017 in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx".
[3] According to Arkema, 5% as Lup 10 and LUP 188M75 was emitted as vapor prior to combustion. The remaining product decomposed except diluent (e.g., OMS) and burned with a 93% DRE (i.e., 7% of decomposition products and diluent emitted to atmosphere and the remainder converted to combustion products).
[4] Per *TCEQ publication RG-360A/11, Revised February 2012, TECHNICAL SUPPLEMENT 4: FLARES,* based on EPA test data, for combustions that do not satisfy 40 CFR 60.18, a 93 percent destruction efficiency is assumed. Therefore, for decomposed product Lup 188M75 remaining after vapor release, 7% unburned, and 93% of decomposed part is burned.
[5] Value excludes diluent (e.g., naphtha).

Input

Parameter	Value	Units
Diesel Oil Burned [1]	50	gal/event

[1] Total volume combusted (25 gallons from each trailer) based on email from Arkema, September 7, 2017.

Emission Factors and Emissions of Criteria Pollutants

Pollutant	Emission Factor [1] [2] (lb/Mgal)	Emissions (lb/event)	(short tons/event)
CO	5	0.25	1.3E-04
NO_X	24	1.20	6.0E-04
PM	3.3	0.17	8.3E-05
PM_{10}	3.3	0.17	8.3E-05
$PM_{2.5}$	3.3	0.17	8.3E-05
SO_2	71	3.55	1.8E-03
VOC	0.2	0.01	5.0E-06

Notes:

[1] U.S. EPA AP-42, Section 1.3 - Fuel Oil Combustion, May 2010, Tables 1.3-1 and 1.3-2 - No. 2 oil fired (1-01-005-01), (1-02-005-01), (1-03-005-01) for CO, NO_X, PM, PM_{10}, $PM_{2.5}$, and SO_2.

[2] U.S. EPA AP-42, Section 1.3 - Fuel Oil Combustion, May 2010, Table 1.3-3 - Industrial boilers, Distillate oil fired (1-02-005-01/02/03) for VOC.

Arkema Inc. - Crosby
Trailer No. 4-9 Products Decomposition Emissions
September 2, 2017

Trailer No. 4-9 Products Decomposition Emissions Summary

Emission Source	VOC Emissions (lb/event)
Products in Trailer No. 4 - 9 Decomposed to Air	1,329.46
Total Emissions	**1,329.46**

Summary of Speciated Emissions

Compound	CAS#	Contaminant Code	Total lb/event
Isobutane	75-28-5	56703	**376.93**
Isobutene	115-11-7	56704	**121.29**
OMS	68551-17-7	59275	**831.24**
Acetone	67-64-1	54020	**502.17**

Summary of Emissions from Trailer No. 4-9 Products Decomposition [1]

Emission Source	Emissions (lb/event)					
	VOC	CO	NO_X	PM	PM_{10}	$PM_{2.5}$
Decomposition to Vapor - Unburned	1,329.46	--	--	--	--	--
Total	**1,329.46**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

1. Emissions from Decomposition to Vapor - Unburned

Product	Decomp Composition [2]	Vapor wt% [3]	Decomp to Vapor, Unburned - Total lbs	Decomp to Vapor, Unburned - Speciated lbs	Speciated VOC Emissions to Air lbs
Lup 11M45	Isobutane	12.46%	991.50	123.50	123.50
	Isobutene	4.01%		39.74	39.74
	Carbon Dioxide	12.57%		124.68	
	OMS	50%		494	493.60
	Acetone	16.59%		164.53	
	Methane	4.58%		45.45	
Lup 11M75	Isobutane	18.64%	1,359.39	253.43	253.43
	Isobutene	6.00%		81.55	81.55
	Carbon Dioxide	18.82%		255.86	
	OMS	24.84%		337.64	337.64
	Acetone	24.84%		337.64	
	Methane	6.86%		93.27	
Total VOC from Vapor (Unburned) to Air					**1,329.46**

Notes

[1] Based on information provided by Arkema, from Trailers 4-6, two trailers (5 and 8) had decomposition of products released to atmosphere on September 2, 2017 prior to the controlled combustion on September 3, 2017. The quantity decomposed is estimated to be 5% of the weight of Lup 11M45 and 11M75 which are used to represent the decomposition products to the vapor phase and emissions from the trailers to atmosphere on September 2, 2017. Emissions associated with the remaining product are represented in a separate emission event for the controlled combustion on September 3, 2017.

[2] Decomposition ("Decomp") products provided by Arkema in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx". "OMS" stands for Organic Mineral Spirits.

[3] Calculated based on Lup 11M75 and 11M45 product decomposed, provided by Arkema in the file "in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx".

Products in Trailer No. 4-9

Product Name	Composition [1]	CAS#	wt% [1]	Quantity in Trailers [2] lbs
Lup 10	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>=95%	40,550
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<1%	
Lup 10M75	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>= 74- <=76%	17,282
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<0.2%	
Lup 11M45	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1- dimethlethyl ester	927-07-1	>=44- <46%	19,830
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<56%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<56%	
Lup 11M75	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1- dimethlethyl ester	927-07-1	>=74- <76%	27,188
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
Lup 188M75	Nedodecaneperoxoic acid, 1-methyl-1-phenylethyl ester	26748-47-0	>=74- <75%	47,291
	Benzenemethanol, .alpha.,.alpha.-dimethyl-	617-94-7	>=5- <=11%	
	Benzene, (1-methylethyl)-	98-82-8	>=5 -<=7%	
	Ethanone, 1-phenyl-	98-86-2	<=5%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>=1 - <25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>=1 - <25%	
Lup 221	Peroxydicarbonic acid, dipropyl ester	16066-38-9	>= 99 %	2,112
Lup 223M75S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 75 - <= 77 %	39,165
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<25%	
	Proprietary component	NJTSN# 03365400	<0.2%	
Lup 223S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 97 - <= 100 %	9,216
	Proprietary component	NJTSN# 03365400	<0.3%	
Lup 223V75	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	75%	4,032
	Proprietary component	NJTSN# 03365400	25%	
Lup 225M60	Peroxydicarbonic acid, bis(1-methylpropyl) ester	19910-65-7	>= 59 - <= 61 %	11,025
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<41%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<41%	
Lup 546M75	Neodecaneperoxoic acid, 1,1- dimethylpropyl ester	68299-16-1	>= 74 - <= 75 %	4,025
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>= 0 - <= 25 %	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>= 0 - <= 25 %	
	Hydroperoxide, 1,1-dimethylpropyl	3425-61-4	<= 0.1 %	
			Total (lbs)	**221,716**

Estimate Pounds of Material Lost to Atmosphere

Products in Trailers	Quantity [1]	% Fast Decomp - to Vapor [3]	lb Decomp to Vapor
	lbs		lbs
Lup 10	40,550.00	--	--
Lup 10M75	17,282	--	--
Lup 11M45	19,830	5.00%	991.50
Lup 11M75	27,188	5.00%	1,359.39
Lup 188M75	47,291	--	--
Lup 221	2,112	--	--
Lup 223M75S	39,165	--	--
Lup 223S	9,216	--	--
Lup 223V75	4,032	--	--
Lup 225M60	11,025	--	--
Lup 546M75	4,025	--	--
Total	**221,716**		**2,350.89**

Notes:
[1] Product composition provided by Arkema via email on 9/5/2017 in the file "Crosby Inventory 082817 Trailers Stg Bldg.xlsx".
[2] Provided by Arkema via email on 9/8/2017 in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx".
[3] Based on information provided by Arkema, from Trailers 4-6, two trailers (5 and 8) had decomposition of products released to atmosphere on September 2, 2017 prior to the controlled combustion on September 3, 2017. The quantity decomposed is estimated to be 5% of the weight of Lup 11M45 and 11M75 which are used to represent the decomposition products to the vapor phase and emissions from the trailers to atmosphere on September 2, 2017. Emissions associated with the remaining product are represented in a separate emission event for the controlled combustion on September 3, 2017.

Arkema Inc. - Crosby
Trailer No. 4-9 Combustion Emissions
September 3, 2017

Emissions Summary

Emission Source	Emissions (lb/event)								
	CO	NO_X	PM	PM_{10}	$PM_{2.5}$	SO_2	VOC	HF	Lead
Products in Trailer Nos. 4-9 Consumed in Fire	1,458.11	170.06	504.08	504.08	504.08	--	10,368.95	--	--
Trailer Consumed in Fire	2,906.25	93.00	2,325.00	2,325.00	2,325.00	--	744.00	--	--
Pallets Consumed in Fire	367.13	11.75	293.70	293.70	293.70	--	93.98	--	--
Containers Consumed in Fire	1,005.64	32.18	804.51	804.51	804.51	--	257.44	--	--
Refrigeration Unit in Fire	370.31	11.85	296.25	296.25	296.25	--	94.80	--	--
Refrigerant Consumed in Fire	--	--	--	--	--	--	--	19.68	--
Battery Consumed in Fire	--	--	32.24	32.24	32.24	58.73	--	--	10.92
Total Emissions	**6,107.44**	**318.84**	**4,255.77**	**4,255.77**	**4,255.77**	**58.73**	**11,559.17**	**19.68**	**10.92**

Summary of Speciated Emissions

Compound	CAS#	Contaminant Code	Total
			lb/event
Nonane	111-84-2	56703	**2,268.66**
Nonene	124-11-8	56704	**746.08**
Isobutane	75-28-5	55178	**501.32**
Isobutene	115-11-7	90100	**161.31**
n-propanol	71-23-8	51570	**64.32**
n-propanal	123-38-6	51721	**20.72**
sec-butanol	78-92-2	51580	**219.22**
sec-butanone	78-93-3	54065	**71.09**
OMS	68551-17-7	59275	**2,608.73**
Acetophenone	98-86-2	59861	**969.34**
2-Ethyl hexanol	104-76-7	51521	**2,065.61**
2-Ethyl hexanal	123-05-7	51601	**672.55**
Acetone	67-64-1	54020	**1,569.03**
Ethane	74-84-0	56550	**24.48**
Hydrofluoric Acid	7664-39-3	11162	**19.68**
Lead	7439-92-1	14319	**10.92**
CO	630-08-0	90300	**6,107.44**
NO_X	10102-44-0	70402	**318.84**
PM	--	10000	**4,255.77**
PM_{10}	--	20000	**4,255.77**
$PM_{2.5}$	--	39999	**4,255.77**
Unclassified VOC [1]	--	500001	**1,190.23**

Note:
[1] Unclassified VOC includes VOC emissions from combustion products.

Summary of Emissions from Trailer No. 4 - No. 9

Emission Source	Emissions (lb/event)					
	VOC	CO	NO_x	PM	PM_{10}	$PM_{2.5}$
Decomposition Products - Burned	10,368.95	1,458.11	170.06	504.08	504.08	504.08
Total	**10,368.95**	**1,458.11**	**170.06**	**504.08**	**504.08**	**504.08**

2. Emissions from Decomposition Products - Burned

VOC Emissions

Destruction Efficiency 93% [3]

Product	Original Composition [4]	Original wt% [4]	Decomposed Composition [1]	Decomposed wt% [2]	Decomp Products Release to Air - Total [5] lbs	Speciated Emissions to Air lbs	Product Burned - Total [5] lbs	Product Burned - speciated lbs	Heating Value [6] btu/lb	Heat Input MMbtu	Speciated VOC Emissions to Air lbs
Lup 10	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	>=95%	Nonane	37%	2,839	1,058.78	37,712	14,066.63	19,000	267.27	1,058.78
	Hydroperoxide, 1,1-dimethylethyl	< 1%	Nonene	12%		347.38		4,615.18	18,800	86.77	347.38
			Carbon Dioxide	22%		616.53		8,191.01	0	0.00	
			OMS	0%		0.00		0.00	15,000	0.00	0.00
			Acetone	23%		639.23		8,492.69	12,281	104.30	
			Methane	6%		176.58		2,345.99	21,509	50.46	
Lup 10M75	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	>= 74- <=76%	Nonane	29%	1,210	355.49	16,072	4,722.93	19,000	89.74	355.49
	Naphtha (petroleum), hydrotreated heavy	<26%	Nonene	10%		116.63		1,549.56	18,800	29.13	116.63
	Naphtha (petroleum), heavy alkylate	<26%	Carbon Dioxide	13%		162.64		2,160.80	0	0.00	
	Hydroperoxide, 1,1-dimethylethyl	<0.2%	OMS	25%		301.06		3,999.84	15,000	60.00	301.06
			Acetone	18%		214.63		2,851.46	12,281	35.02	
			Methane	5%		59.29		787.68	21,509	16.94	
Lup 11M45	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1- dimethlethyl ester	>=44- <46%	Isobutane	12%	1,319	164.25	18,442	2,297.09	19,587	44.99	164.25
	Naphtha (petroleum), hydrotreated heavy	<56%	Isobutene	4%		52.85		739.14	19,341	14.30	52.85
	Naphtha (petroleum), heavy alkylate	<56%	Carbon Dioxide	13%		165.83		2,319.06	0	0.00	
			OMS	50%		656.49		9,180.93	15,000	137.71	656.49
			Acetone	17%		218.83		3,060.31	12,281	37.58	
			Methane	5%		60.45		845.37	21,509	18.18	
Lup 11M75	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1- dimethlethyl ester	59%	Isobutane	19%	1,808	337.07	21,848	4,073.18	19,587	79.78	337.07
	Naphtha (petroleum), hydrotreated heavy	20%	Isobutene	6%		108.46		1,310.64	19,341	25.35	108.46
	Naphtha (petroleum), heavy alkylate	20%	Carbon Dioxide	19%		340.29		4,112.14	0	0.00	
			OMS	25%		449.06		5,426.52	15,000	81.40	449.06
			Acetone	25%		449.06		5,426.52	12,281	66.64	
			Methane	7%		124.05		1,499.00	21,509	32.24	
Lup 188M75	Nedodecaneperoxoic acid, 1-methyl-1-phenylethyl ester	>=74- <75%	Nonane	23%	3,310	776.07	43,981	10,310.70	19,000	195.90	776.07
	Benzenemethanol, .alpha.,.alpha.-dimethyl-	>=5- <=11%	Nonene	8%		256.37		3,406.03	18,800	64.03	256.37
	Benzene, (1-methylethyl)-	>=5 -<=7%	Carbon Dioxide	11%		355.06		4,717.27	0	0.00	
	Ethanone, 1-phenyl-	<=5%	OMS	25%		824.09		10,948.61	15,000	164.23	824.09
	Naphtha (petroleum), hydrotreated	>=1 - <25%	Acetophenone	29%		969.34		12,878.43	14,257	183.61	969.34
	Naphtha (petroleum), heavy alkylate	>=1 - <25%	Methane	4%		129.43		1,719.59	21,509	36.99	
Lup 221	Peroxydicarbonic acid, dipropyl ester	100%	n-propanol	44%	148	64.32	1,964	854.49	13,243	11.32	64.32
			n-propanal	14%		20.72		275.27	12,519	3.45	20.72
			Carbon Dioxide	42%		62.80		834.40	0	0.00	
Lup 223M75S	Peroxydicarbonic acid, bis(2-ethylhexyl)	>= 75 - <= 77 %	2-Ethyl hexanol	56%	2,742	1,543.50	36,423	20,506.54	15,000	307.60	1,543.50
	Naphtha (petroleum), hydrotreated heavy	<25%	2-Ethyl hexanal	18%		502.55		6,676.79	15,000	100.15	502.55
	Naphtha (petroleum), heavy alkylate	<25%	Carbon Dioxide	25%		695.49		9,240.13	0	0.00	
	Proprietary component	<0.2%									
Lup 223S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	>= 97 - <= 100 %	2-Ethyl hexanol	56%	645	363.20	8,571	4,825.44	15,000	72.38	363.20
	Proprietary component	<0.3%	2-Ethyl hexanal	18%		118.26		1,571.13	15,000	23.57	118.26
			Carbon Dioxide	25%		163.66		2,174.31	0	0.00	
Lup 223V75	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	75.0%	2-Ethyl hexanol	56%	282	158.90	3,750	2,111.13	15,000	31.67	158.90
	Proprietary component	25.0%	2-Ethyl hexanal	18%		51.74		687.37	15,000	10.31	51.74
			Carbon Dioxide	25%		71.60		951.26	0	0.00	
Lup 225M60	Peroxydicarbonic acid, bis(1-methylpropyl) ester	>= 59 - <= 61 %	sec-butanol	28%	772	219.22	10,253	2,912.44	14,206	41.37	219.22
	Naphtha (petroleum), hydrotreated heavy	<41%	sec-butanone	9%		71.09		944.42	13,543	12.79	71.09
	Naphtha (petroleum), heavy alkylate	<41%	Carbon Dioxide	22%		173.54		2,305.65	0	0.00	
			OMS	40%		307.90		4,090.73	15,000	61.36	307.90
Lup 546M75	Neodecaneperoxoic acid, 1,1-dimethylpropyl ester	>= 74 - <= 75 %	Nonane	28%	282	78.32	3,743	1040.55	19,000	19.77	78.32
	Naphtha (petroleum), hydrotreated heavy	>= 0 - <= 25 %	Nonene	9%		25.70		341.40	18,800	6.42	25.70
	Naphtha (petroleum), heavy alkylate	>= 0 - <= 25 %	Carbon Dioxide	13%		35.83		476.07	0	0.00	
	Hydroperoxide, 1,1-dimethylpropyl	<= 0.1 %	OMS	25%		70.13		931.73	15,000	13.98	70.13
			Acetone	17%		47.29		628.23	12,281	7.72	
			Ethane	9%		24.48		325.27	20,426	6.64	
					Totals:					**2,653.04**	**10,368.95**

NOx, CO, and PM Emissions

Pollutants	Emission Factors	Emissions
	lb/MMbtu	lbs/event
NOx [7]	0.0641	170.06
CO [7]	0.5496	1,458.11
PM [8]	0.19	504.08

Notes
[1] Decomposition ("Decomp") products provided by Arkema in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx". "OMS" stands fo
[2] Calculated based on Lup 11M45 and 11M75 product decomposed, provided by Arkema in the file "in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx
[3] Per *TCEQ publication RG-360A/11, Revised February 2012, TECHNICAL SUPPLEMENT 4: FLARES*, based on EPA test data, for combustions that do not satisfy 40 CFR 60.18, a 93 percent destruction efficiency (DRE) is assumed
[4] Product composition provided by Arkema via email on 9/5/2017 in the file "Crosby Inventory 082817 Trailers Stg Bldg.xlsx".
[7] Based on information provided by Arkema, 5% of Lup 11M45 and 11M75 vapor to atmosphere in the September 2, 2017 emission event prior to combustion. Emissions from the September 2, 2017 event are not included in the emissions associated with the controlled combustion of the September 4, 2017 event. For the September 4, 2017 combustion, the remaining product decomposed except diluent (e.g., OMS) and burned with a 93% DRE (i.e., 7% of decomposition products and diluent emitted to atmosphere and the remainder converted to combustion products).
[6] Yaws' Handbook of Thermodynamic and Physical Properties of Chemical Compounds/Enthalpy of Combustio
[7] *TCEQ publication RG-360A/11, Revised January 2017, TECHNICAL SUPPLEMENT 4: FLARES, Table A-7, air or unassisted flare, low Btu*
[8] Based on AP 42 Table 13.5-1, heavily smoking flares 274 µg/L in exhaust, calculated from concentration using F-factor method on a dry basis, assuming 3% $_2$ in exhaust gas stream (*Emission Estimation Protocol for Petroleum Refineries*, RTI International, May 2011, Table 6-4).

ARK_ TCEQ_0000256

Summary of Emissions from Trailer Components Combustion

Emission Source	Emissions (lb/event)					
	VOC	CO	NO_X	PM	PM_{10}	$PM_{2.5}$
Combustion Emissions	1,190.23	4,649.33	148.78	3,719.46	3,719.46	3,719.46

Trailers		
Weight of Trailer [1]	15,500	pounds
# of Trailers	6	
Burned [2]	50%	
Weight of Trailer Burned	46,500	pounds
Pallets		
Weight of Each Pallet [3]	44.5	pounds
# of Pallets in a Trailer [4]	22	
Burned	100%	
Weight of Pallets Burned	5,874	pounds
Containers		
Weight of a 5 Gal Container [5]	1,153	grams
Weight of a 5 Gal Container	2.54	pounds
Capacity of a Trailer	3,500	ft^3
Number of 5 Gal Containers Impacted [5]	6,335	
Burned	100%	
Weight of Containers in a Trailer	16,090	pounds
Refrigeration Unit		
Weight of a Refrigeration Unit [6]	1,975	pounds
Burned	50%	
Weight of Refrigeration Unit Burned	5,925	pounds
Total Weight of Solid Combustibles	**37.19**	**tons**

Refrigerant

Weight of Refrigerant [6] 16 pounds/trailer

Compositions [7]	CAS #	M. Wt.	Wt%	Emissions
		lb/lb-mol		lbs
1,1,1-Trifluoroethane [7]	420-46-2	84.04	52%	49.92
Pentafluoroethane [7]	354-33-6	120.02	44%	42.24
1,1,1,2-Tetrafluoroethane [7]	811-97-2	102.03	4%	3.84
Emissions as Hydrogen Fluoride	7664-39-3	20.01		**19.68**

Battery

Weight of Battery [8] 50 pounds/trailer

Compositions [9]	CAS #	M. Wt.	Wt%	Weight
		lb/lb-mol		lbs
Lead	7439-92-1	207.2	70%	210
Sulfuric acid	7664-93-9	98.08	30%	90

Emissions from Battery Burned

Pollutant	Emission Factor [10]	Emissions from Lead Burned	Emissions from Sulfuric Acid Burned [11]
	lb of pollutant/ton of metal produced	lbs	lbs
PM	307	32.24	--
Lead	104	10.92	--
SO_2	--	--	58.73

NOx, CO, and PM Emissions from Trailer Components Combustion

Pollutants	Emission Factors [12]	Emissions From Trailer Burning	Emissions From Pallets Burning	Emissions From Containers Burning	Emissions From Refrigeration Unit Burning	Total Emissions From Solids Burning
	lb/ton	lbs	lbs	lbs	lbs	lbs
VOC	32	744.00	93.98	257.44	94.80	**1,190.23**
NOx	4	93.00	11.75	32.18	11.85	**148.78**
CO	125	2,906.25	367.13	1,005.64	370.31	**4,649.33**
PM	100	2,325.00	293.70	804.51	296.25	**3,719.46**

Notes:
[1] Per information provided by Arkema, the trailer is a 53' refrigerated trailer, based on vendor information, typical weight of refrigerated trailer is 15,500 lb
[2] Based on phone communication between Arkema and Trinity Consultants on September 6, 2017, 50% of weight of trailer estimated to be combustec
[3] According to dimensions of trailer provided by Arkema, typical pallet used in this type of trailer is 40"x 48" and weight is 44.51t
[4] Provided by Arkema based on trailer inventory and products information.
[5] Provided by Arkema based on trailer inventory and products information, typical 35 lbs products per container. Typical empty container weight based on vendor informatio
[6] Weight of refrigeration unit and refrigerant based on vendor information for typical unit
[7] Per R-404A Refrigerant safety data sheet (SDS)
[8] Per KLLM Trailer Specifications
[9] Per Lead-acid Battery SDS normalized to total weight of battery for conservatism
[10] The battery in engine of trailer burned in the fire and is represented as second lead processing in blast furnaces. Particulate and leaemission factors are selected based on AP-42 Chapter 12.11.2, Table 12.11-2, Emission Factors for Secondary Lead Processing.
[11] Sulfur dioxide (SO_2) emissions estimated assuming all sulfur from sulfuric acid converted to SO_2.
[12] Emission factors from AP-42 Chapter 2.5, Table 2.5-1 "Emission Factors for Open Burning of Municipal Refuse," factors for Automobile Component

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Products in Trailer No. 4 to No.9

Product Name	Composition [1]	CAS#	wt% [1]	Quantity in Trailers 4-9 [2] lbs
Lup 10	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>=95%	40,550
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<1%	
Lup 10M75	Neodecaneperoxoic acid, 1,1-dimethylethyl ester	26748-41-4	>= 74- <=76%	17,282
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
	Hydroperoxide, 1,1-dimethylethyl	75-91-2	<0.2%	
Lup 11M45	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1- dimethlethyl ester	927-07-1	>=44- <46%	19,830
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<56%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<56%	
Lup 11M75	Propaneoperoxoic acid, 2,2-dimethyl-, 1,1- dimethlethyl ester	927-07-1	>=74- <76%	27,188
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<26%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<26%	
Lup 188M75	Nedodecaneperoxoic acid, 1-methyl-1-phenylethyl ester	26748-47-0	>=74- <75%	47,291
	Benzenemethanol, .alpha.,.alpha.-dimethyl-	617-94-7	>=5- <=11%	
	Benzene, (1-methylethyl)-	98-82-8	>=5 -<=7%	
	Ethanone, 1-phenyl-	98-86-2	<=5%	
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>=1 - <25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>=1 - <25%	
Lup 221	Peroxydicarbonic acid, dipropyl ester	16066-38-9	>= 99 %	2,112
Lup 223M75S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 75 - <= 77 %	39,165
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<25%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<25%	
	Proprietary component	NJTSN# 03365400	<0.2%	
Lup 223S	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	>= 97 - <= 100 %	9,216
	Proprietary component	NJTSN# 03365400	<0.3%	
Lup 223V75	Peroxydicarbonic acid, bis(2-ethylhexyl) ester	16111-62-9	75%	4,032
	Proprietary component	NJTSN# 03365400	25%	
Lup 225M60	Peroxydicarbonic acid, bis(1-methylpropyl) ester	19910-65-7	>= 59 - <= 61 %	11,025
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	<41%	
	Naphtha (petroleum), heavy alkylate	64741-65-7	<41%	
Lup 546M75	Neodecaneperoxoic acid, 1,1- dimethylpropyl ester	68299-16-1	>= 74 - <= 75 %	4,025
	Naphtha (petroleum), hydrotreated heavy	64742-48-9	>= 0 - <= 25 %	
	Naphtha (petroleum), heavy alkylate	64741-65-7	>= 0 - <= 25 %	
	Hydroperoxide, 1,1-dimethylpropyl	3425-61-4	<= 0.1 %	
			Total (lbs)	**221,716**

Estimate Pounds of Material Lost in Fire
Destruction Efficiency [4] 93%

Products in Trailers	Quantity [1]	% Fast Decomp - to Vapor [3]	% Decomp to Fire - Unburned [4]	% Decomp to Fire - Burned [4]	% Burned from Original Product [5]	lb Decomp to Vapor	lb Decomp to Fire, Unburned	lb Decomp to Fire, Burned
	lbs					lbs	lbs	lbs
Lup 10	40,550	--	7%	93%	0%	--	2,839	37,712
Lup 10M75	17,282	--	7%	93%	0%	--	1,209.74	16,072
Lup 11M45	19,830	5.00%	6.65%	88.35%	0%	991.50	1,318.70	17,520
Lup 11M75	27,188	5.00%	6.65%	88.35%	0%	1,359.39	1,807.98	24,020
Lup 188M75	47,291	--	7%	93%	0%	--	3,310.37	43,981
Lup 221	2,112	--	7%	93%	0%	--	147.84	1,964
Lup 223M75S	39,165	--	7%	93%	0%	--	2,741.55	36,423
Lup 223S	9,216	--	7%	93%	0%	--	645.12	8,571
Lup 223V75	4,032	--	7%	93%	0%	--	282.24	3,750
Lup 225M60	11,025	--	7%	93%	0%	--	771.75	10,253
Lup 546M75	4,025	--	7%	93%	0%	--	281.75	3,743
Total	**221,716**					**2,350.89**	**15,355.54**	**204,009**

Notes:
[1] Product composition provided by Arkema via email on 9/5/2017 in the file "Crosby Inventory 082817 Trailers Stg Bldg.xlsx".
[2] Provided by Arkema via email on 9/8/2017 in the file "Crosby Inv 082817 Trailers Stg Bldg.xlsx".
[3]Based on information provided by Arkema, 5% of Lup 11M45 and 11M75 vapor to atmosphere in the September 2, 2017 emission event prior to combustion. Emissions from the September 2, 2017 event are not included in the emissions associated with the controlled combustion of the September 3, 2017 event. For the September 3, 2017 combustion, the remaining product decomposed except diluent (e.g., OMS) and burned with a 93% DRE (i.e., 7% of decomposition products and diluent emitted to atmosphere and the remainder converted to combustion products).
[4] Per *TCEQ publication RG-360A/11, Revised February 2012, TECHNICAL SUPPLEMENT 4: FLARES,* based on EPA test data, for combustions that do not satisfy 40 CFR 60.18, a 93 percent destruction efficiency is assumed. Therefore, for decomposed product Lup 11M45 remaining after vapor release, 7% unburned, and 93% of decomposed part is burned.
[5] Value excludes diluent (e.g., naphtha).

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