APPENDIX H

2011 TEXAS RAILROAD EMISSION INVENTORY REPORT

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2011 TEXAS RAILROAD EMISSION INVENTORY REPORT

This appendix provides the detailed documentation of methods and procedures used in developing the 2011 Texas railroad emissions inventory.

2011 Texas Railroad Emission Inventory Report

FINAL REPORT

Prepared for:

Texas Commission on Environmental Quality
Air Quality Division

Prepared by:

Eastern Research Group, Inc.

August 17, 2012

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2011 Texas Railroad Emission Inventory Report

FINAL REPORT

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1.0 INTRODUCTION

The objective of this Texas Commission for Environmental Quality (TCEQ) project was to develop statewide toxics and actual annual and ozone season weekday emission inventories for locomotives and commercial marine vessels (CMVs) for the calendar year 2011. One primary improvement of this inventory over previous efforts is its bottom-up approach based heavily on locally-provided data. While previous efforts have relied heavily on a top-down approach adjusting national inventory data to quantify state and county level activity and emissions, recent trends in inventory development have emphasized increased spatial resolution that is not well served by modifying national-level data. For that reason, the TCEQ sought an inventory effort built on detailed, locally-based activity and emissions data.

The 2011 Texas Locomotive Emissions Inventory includes Class I, II, and III locomotive activity and emissions by rail segment for all counties within Texas. The inventory contains criteria, greenhouse gas, and hazardous air pollutants (HAPs) where emission factors or speciation profiles are available. The following sections describe the inventory approach, including initial collection of local data, emission calculations, and spatial allocations used to develop the statewide locomotive inventory.

2.0 DATA COLLECTION

One primary aim of the 2011 Texas Statewide Locomotive Emissions Inventory was to include rail companies operating in the state of Texas in the inventory effort. ERG solicited line haul and yard data from all Class I, II, and III locomotive companies operating in Texas. All railroad members listed in the American Short Line and Regional Railroad Association (ASLRRA) as operating in Texas were included, as well as Class I rail companies Union Pacific (UP), Burlington Northern – Santa Fe (BNSF), and Kansas City Southern (KCS); the Texas Department of Transportation, and the Texas Transportation Institute (ASLRRA, 2011). Approximately 45 different contacts were identified; and ERG used phone, email, and United States (U.S.) mail to solicit quantitative and/or qualitative data for inclusion in this inventory effort. The data received from this outreach effort is summarized below.

2.1 Union Pacific

Union Pacific (UP) is one of the largest Class I rail companies operating in Texas, with over 6,300 miles of track and more than 7,700 employees in Texas alone. In response to our data solicitation, UP provided a 12-page PDF document that contained line haul and yard data for all activities in Texas for the year 2011. Line haul mileage, annual average million gross tons (MGT) per mile, fuel usage, train counts, and emission estimates for HC, CO, NO_x, and PM were provided by county and track segment. The emission estimates provided were calculated using current U.S. Environmental Protection Agency (EPA) emission factors, and the fuel usage was calculated based on the system-wide average fuel consumption rate for 2011. Yard data were provided by county for 107 “yard job equivalents” which is equal to one switch locomotive operating 24 hours a day. The activity data were then provided in terms of estimated annual fuel use in gallons, based on an EPA factor of 226 gallons/day of operation.

2.2 Burlington Northern Santa Fe Railway

Burlington Northern Santa Fe Railway (BNSF), headquartered in Fort Worth, is the second most significant Class I railway company operating in Texas. In response to our data solicitation, BNSF sent 92 rich text format (rtf) files that included 91 county-specific line haul and yard data. The files included segment-level mileage, gross tonnage, and fuel use for line haul data as well as county-level emission estimates for HC, CO, NO_x, PM, and SO_2 using EPA emission factors. Each file also included county-level yard locomotive count and emission estimates. BNSF also sent one rtf file that included data for all of the 91 counties in the individual reports; however, discrepancies existed between the individual and aggregated files for some counties. Discussions with BNSF indicated that the individual files had been manually edited to include revised emissions for Genset locomotives and therefore should be used instead of the aggregated report.

2.3 Texas South-Eastern Railroad Company

Texas South-Eastern Railroad Company responded to our data request with an email stating they are a “small short-line switching railroad with two engines and basically operate on about 1 mile of track.” This information, while helpful, was insufficiently detailed for inclusion in this inventory effort.

3.0 LOCAL DATA PROCESSING

3.1 Union Pacific Railroad Data Processing

UP's PDF data were converted to text using Adobe Acrobat and then imported into MSExcel. As the original PDF was a scanned image file, this process resulted in numerous incorrectly converted characters that required substantial manual revision and quality assurance (QA) to restore the file's utility. The resulting spreadsheets were summed and compared to the original to confirm successful processing, and the totals derived from the converted worksheet did not match the totals present in the original PDF. Upon closer examination, it was discovered that summing the individual rows in the original PDF did not equal the totals listed in the PDF, likely due to compounding rounding errors resulting from displaying the values in each row as whole numbers. The discrepancy between the values was less than 0.02%, leading ERG to conclude the conversion and subsequent clean-up was suitably accurate. Note that clean-up focused on fields that were used in later processing steps and that other fields may not have received the same level of QA due to time constraints. Tables 3-1 and 3-2 summarize the line haul and yard data received from UP, respectively.

**Table 3-1. Union Pacific Railroad 2011
Line Haul Data Summary**

UP Line Haul Data Summary	
Counties with Data	139
Miles of Track	6,747
Total Gross Tons	205,042,561,500
Total Fuel (gallons)	231,865,331
Train Counts	5,781
Tons HC Emissions	1,967
Tons CO Emissions	6,998
Tons NOx Emissions	38,055
Tons PM Emissions	1,124

**Table 3-2. Union Pacific Railroad 2011
Yard Data Summary**

UP Yard Data Summary	
Counties with Data	18
Number of Locomotives	322
Hours of Operation per Year	501,923
Annual Fuel Use (gallons)	8,187,154

While the line haul data was provided at the segment level, railroad track identification information was limited to mile markers and segment IDs that are specific to UP's network and do not relate to any publically available railway networks to allow for accurate spatial mapping of the rail activities. Furthermore, segment-level data could be considered confidential business information. Given these limitations, the line haul data were summarized at the county level.

UP yard data were provided by yard and by "yard job." Activity data in the form of estimated annual fuel use in gallons were summed to the yard level, and yards were then mapped to specific points found in EIS, based on city location whenever possible. When a clear match was not available, a new Yard ID was created with best-available coordinates derived from the location/city or county centroid.

3.2 BNSF Railroad Data Processing

BNSF's data were copied and pasted from the rich text files and organized within MSExcel. Line haul mileage and fuel usage was provided by line segment whereas emissions and switch locomotive counts were provided at the county level. Given the same limitations as with UP's line haul data, BNSF's line haul mileage and fuel usage were summarized to the county level as well.

BNSF's yard data were provided at the county level, so efforts were made to identify BNSF's yard point locations already present in the EIS database. Given only a county location and a train count, this matching process was difficult; so most of the yard data were assigned to a new Yard ID with county centroid coordinates. Please note that this approach maximizes the use of locally-provided data but may introduce some duplicate yards in the final dataset. A general summary of the BNSF data received is found in Tables 3-3 and 3-4.

Table 3-3. BNSF 2011 Line Haul Data Summary

Counties with Data*	91
Mileage	2,596
MGTM	1,256,522
Fuel Use	127,641,662
Tons HC Emissions	1,054
Tons CO Emissions	3,692
Tons NOx Emissions	20,708
Tons PM Emissions	611
Tons SO2 Emissions	111

*Includes counties with 0 reported emissions.

Table 3-4. BNSF 2011 Yard Data Summary

Counties with Data*	91
Train Count	208
Tons HC Emissions	120
Tons CO Emissions	189
Tons NOx Emissions	1,951
Tons PM Emissions	44
Tons SO2 Emissions	10

*Includes counties with 0 reported emissions.

3.3 Class II and Class III Line Haul Data

Since no Class II/III railroad companies responded to our request for local line haul data, ERG sought other locally-based sources to estimate 2011 activity levels. The Eastern Regional Technical Advisory Committee (ERTAC) recently collaborated with the Federal Railroad Administration, the ASLRRA, and members of the Class II and III Railroad communities to develop activity and emissions profiles for Class II and Class III railroads for 2008 (Bergin et. al, 2009). The ASLRRA compiles data from the Class II and III railroads every few years, including total industry fuel use for locomotives and total Class II/III route miles. These values were used to calculate an average fuel use factor for the industry using the following equation:

$$\text{Fuel Use Factor} = \frac{\text{Total Industry Fuel Use}}{\text{Total Class II/III Route Miles}} = \frac{157{,}800{,}800 \text{ gal}}{56{,}985 \text{ miles}} = 2{,}797.74 \frac{\text{gal}}{\text{mile}}$$

This fuel use factor was multiplied with the route miles listed for each Class II and III railroad in the FRA database, resulting in an estimate of gallons of fuel used in 2008 for each railroad. The annual gallons of fuel used were then multiplied with pollutant emission factors for a mass of pollutant emitted for the year as described in the next section (Bergin et. al, 2011). The U.S. Energy Information Administration's (EIA) latest Annual Energy Outlook (AEO) 2012 indicates an annual growth rate of 0.8% billion ton miles via rail for 2010-2035 (U.S. EIA, 2012). Hence, 2008 fuel usage values were grown by 0.8% for three years to estimate 2011 emissions.

4.0 EMISSION CALCULATIONS

4.1 Class I Line Haul Emissions Calculations

BNSF provided county-level emission estimates for HC, CO, PM, NO_x, and SO_2. The emission factor referenced indicated emissions for PM_{10}, so $PM_{2.5}$ was calculated as 0.97 times the PM_{10} emissions (US EPA 2009). HC was multiplied by 1.053 to convert it to VOC (US EPA 2009). CO_2 was calculated using the county-level fuel usage and emission factors listed in Table 4-1.

UP's segment-level emissions estimates were summed to the county level, and HC was multiplied by 1.053 to convert it to VOC (US EPA 2009). PM was determined to be PM_{10}, so $PM_{2.5}$ was calculated as 0.97 of PM_{10} emissions (US EPA 2009). CO2 and SO2 were calculated using the fuel usage and emission factors listed in Table 4-1. Black carbon emissions were also calculated for the draft report; however, as it is not a HAP, and will not be included in the final inventory.

Table 4-1. Class I Line Haul Criteria Emission Factors

Pollutant Code	Pollutant Name	BNSF (g/gal)	UP (g/gal)	EF (g/gal)	Reference
CH4	Methane			0.80	US EPA, 2007
CO	Carbon monoxide	26.6	27.4	26.624	US EPA, 2009
CO2	Carbon dioxide			10,217	US EPA, 2009
HC	Hydrocarbons	7.7	7.7		--
N2O	Nitrous oxide			0.26	US EPA, 2007
NH3	Ammonia			0.08327	EIIP, 2004
NOx	Nitrogen oxides	149	149	149.00	US EPA, 2009
PM10	PM10 Primary (Filt + Cond)	4.4	4.4	4.4	US EPA, 2009
PM2.5	PM2.5 Primary (Filt + Cond)			4.268	US EPA, 2009
SO2	Sulfur dioxide	0.8		1.88	US EPA, 2009
VOC	Volatile Organic Compounds	8.1081	8.1081		--

Once criteria emissions were calculated, HAP speciation profiles from Table 4-2 were applied to VOC or PM10 emission estimates as noted in the equations and example calculations provided below.

Table 4-2. Hazardous Air Pollutant Rail Speciation Profiles

Pollutant	Speciation Profile	Reference
2,2, 4 Trimethylpentane	0.00224 ton/ton VOC	US EPA, 2005
Ethylbenzene	0.0020 ton/ton VOC	US EPA, 2005
n-Hexane	0.0055 ton/ton VOC	US EPA, 2005
Propionaldehyde	0.0061 ton/ton VOC	US EPA, 2005
Styrene	0.0021 ton/ton VOC	US EPA, 2005
Toluene	0.0032 ton/ton VOC	US EPA, 2005
Xylene	0.0048 ton/ton VOC	US EPA, 2005
Manganese	0.00000204 ton/ton PM10	US EPA, 2005
Nickel	0.00000655 ton/ton PM10	US EPA, 2005
Benzo(a)anthracene	0.0000160 ton/ton PM10	US EPA, 2005
Benzo(a)pyrene	0.0000027 ton/ton PM10	US EPA, 2005
Benzo(b)fluoranthene	0.0000064 ton/ton PM10	US EPA, 2005
Benzo(k)fluoranthene	0.0000052 ton/ton PM10	US EPA, 2005
Chrysene	0.0000119 ton/ton PM10	US EPA, 2005
Dibenz(a,h)anthracene	0.0000000 ton/ton PM10	US EPA, 2005
Indeno(1,2,3-cd)pyrene	0.0000027 ton/ton PM10	US EPA, 2005
Acenaphthene	0.0000306 ton/ton PM10	US EPA, 2005
Acenaphthalene	0.0004275 ton/ton PM10	US EPA, 2005
Anthracene	0.0001009 ton/ton PM10	US EPA, 2005
Benzo(ghi)perylene	0.0000031 ton/ton PM10	US EPA, 2005
Fluoranthene	0.0000746 ton/ton PM10	US EPA, 2005
Fluorene	0.0001407 ton/ton PM10	US EPA, 2005
Napthalene	0.0025756 ton/ton PM10	US EPA, 2005
Phenanthrene	0.0005671 ton/ton PM10	US EPA, 2005
Pyrene	0.0001054 ton/ton PM10	US EPA, 2005

For other HAPs, speciation profiles from Table 4-2 were applied to VOC or PM_{10} emission estimates as noted in the equations and example calculations provided below.

HAP/VOC Speciation

HAP = VOC estimate (tons/year) × speciation profile (tons HAP/tons VOC)

Example: Palestine Yard Locomotive styrene emissions.

0.3996 tons/yr VOC × 0.0021 tons Styrene/VOC = 8.3916E-04 tons Styrene/yr

HAP/PM Speciation

HAP = PM10 estimate (tons/yr) ×speciation profile (tons HAP/tons PM_{10})

Example: Palestine Yard Locomotive chrysene emissions for all U.S. States.

$$0.14983 \text{ tons } PM_{10}/\text{yr} * 0.0000119 \text{ tons chrysene/ton } PM_{10} = 1.78\text{ E-06 tons chrysene/yr}$$

UP and BNSF's emissions were summed together to create a county-level Class I line haul inventory. One limitation of this inventory is that it does not include activity from KCS. KCS is a Class I railroad serving the ports of Beaumont, Brownsville, Corpus Christi, Dallas, and Houston while also offering transportation in and out of Mexico via Laredo and was the only Class I rail company that did not respond to our data request.

4.2 Class II Line Haul Emissions Calculations

Through guidance from the Class II/III railroad community, ERTAC determined the EPA non-regulated (pre-1973) emission factors best represent most operating Class II and III locomotives (Bergin et.al, 2011). In addition, although the fuel use and track miles data obtained represent both switching and line-haul activities by the Class II and III railroads, the US EPA line-haul duty cycle was selected as most representative along with the "Small Line-Haul" adjustment factor to obtain emission factors for HC, NO_x, PM, and CO, as listed in Table 4-3. Non-engine-specific emission factors are presented without the adjustment factor.

Table 4-3. Class II/III Rail Line Haul Emission Factors

Pollutant Code	Pollutant	Emission Factor (g/gal)
CO*	Carbon monoxide	23.296
HC*	Hydrocarbons	8.736
NH3	Ammonia	0.8327
NOx*	Nitrogen oxides	236.6
PM10*	PM10 Primary (Filt + Cond)	5.824
PM2.5	PM2.5 Primary (Filt + Cond)	5.64928
SO2	Sulfur dioxide	1.88
VOC	Volatile Organic Compounds	1.97964

*Adjusted using a small line haul conversion factor of 18.2 bhp-hr/gal

4.3 Yard Emissions Calculations

Yard emissions, when not provided directly from the railroad companies, were calculated using the same emission factors and speciation profiles used for line haul. BNSF provided county-level emission estimates for HC, CO, PM, NO_x, and SO_2. The remaining criteria pollutants' emissions were calculated, and these county-level estimates were split between BNSF-identified yards when possible; otherwise, a new yard ID was generated for the entirety of the county's emissions. Since UP's yard data did not include emissions, criteria emissions were calculated directly from activity data.

Fuel usage estimates were summed to the yard level, and emissions were calculated using the emission factors in Table 4-4.

Table 4-4. Rail Yard Criteria Emission Factors

Pollutant Code	Pollutant Name	BNSF (g/gal)	EF (g/gal)	Reference
CH4	Methane		0.80	US EPA, 2007
CO*	Carbon monoxide	19.5	27.816	US EPA, 2009
CO2	Carbon dioxide		10,217	US EPA, 2009
HC*	Hydrocarbons	14.0	15.352	US EPA, 2009
N2O	Nitrous oxide		0.26	US EPA, 2007
NH3	Ammonia		0.08327	EIIP, 2004
NOx	Nitrogen oxides	235	264.48	US EPA, 2009
PM10*	PM10 Primary (Filt + Cond)	5.3	6.688	US EPA, 2009
PM2.5*	PM2.5 Primary (Filt + Cond)		6.48736	US EPA, 2009
SO2	Sulfur dioxide	0.8	1.88	US EPA, 2009
VOC*	Volatile Organic Compounds		16.166	US EPA, 2009

*Adjusted using a switching conversion factor of 15.2 bhp-hr/gal

Once criteria emissions were calculated for all yards, HAP speciation profiles from Table 4-4 were applied to VOC or PM_{10} emission estimates as noted in the equations and example calculations provided above. Yards present in the EIS system that did not appear represented in UP and BNSF's datasets were identified; activity and emissions for these yards were obtained from ERTAC's inventory and were grown by 0.8% annually to estimate 2011 levels.

5.0 CLASS I LINE HAUL EMISSIONS ALLOCATION

Since the yard emissions were calculated at the yard level, no further spatial allocation was needed. However, aggregation of the line haul rail activity and emissions to the county level was necessary to facilitate processing and to protect Confidential Business Information (CBI); therefore, the emissions needed to be reallocated back to rail segments and switch yards to meet format requirements of the NEI. Class I line haul emissions were allocated to rail segments based on segment-specific railroad traffic data (ton miles) obtained from the Department of Transportation (BTS, 2009). This dataset categorizes the segments' level of activity into ranges of MGTM and is populated by FRA. Emissions were divided between all mainline segments using these activity ranges as a proxy to allocate more emissions to segments with higher activity.

Since the activity data were provided as ranges, a single "allocation value", typically the midpoint of the range, was selected for use in the emissions allocation. Table 5-1 lists the activity categories along with their ranges in MGTM/mi and the allocation value used in the emissions spatial allocation.

Table 5-1. Line Haul Segment Activity (MGTM/Mi) Categories

Category	Range Minimum	Range Maximum	Allocation Value Used
0*	0.0003	0.09	0.01233
1	0.1	4.9	2.5
2	5	9.9	7.45
3	10	19.9	14.95
4	20	39.9	29.95
5	40	59.9	49.95
6	60	99.9	79.95
7	100	1,000,000	100

* The "0" category has "unknown" activity in the publically available segment data. As a result, this table lists the minimum, maximum, and average of the confidential activity data greater than zero that were categorized as "unknown" in the public data.

The county emission sums were reallocated to the segments by multiplying the county emissions by the segment's allocation value divided by the sum of the allocation values for all links within the county.

$$E_{iL} = E_{iC} * \frac{A_L}{\sum_{C=1}^{N} A_{LC}}$$

Where:

E_{iL}	=	Emissions of pollutant i per link L (tons/year).
E_{iC}	=	Emissions of pollutant i per county C (tons/year).
A_L	=	Allocation value for link L per activity category from public BTS dataset.
A_{LC}	=	Sum of allocation values for all links in county C from public BTS dataset.

The spatial inventory was developed from confidential data from FRA very similar to the publically-available BTS rail dataset, so segment IDs were generally consistent with those used in EIS, thus facilitating later data processing.

5.1 Class II/III Line Haul Emissions Allocation

ERTAC Rail extracted links identified as owned or operated by specific Shortline or Regional Railroads from their FRA-provided proprietary shapefile to create a shapefile of Class II/III mainline rail segments. Because Class II/III railroads are less likely to use rail segments that are heavily traveled by Class I railroads, the activity-based approach used for Class I lines was not appropriate. Instead, Class II/III line haul emissions were allocated to rail segments using segment length as a proxy.

The county emission sums were reallocated to the segments by multiplying the county emissions by the segment’s length divided by the sum of the length for all links within the county.

$$E_{iL} = E_{iC} * \frac{l_L}{\sum_{C=1}^{N} l_{LC}}$$

Where:

E_{iL}	=	Emissions of pollutant i per link L (tons/year).
E_{iC}	=	Emissions of pollutant i per county C (tons/year).
l_L	=	Allocation value for link L per activity category from public BTS dataset.
l_{LC}	=	Sum of allocation values for all links in county C from public BTS dataset.

Since ERTAC Rail used proprietary data to develop the shapefile, some segment IDs were not found in the EIS data set. These segments were manually identified, and their emissions were allocated to the nearest segment within the EIS data set.

6.0 RESULTS

Table 6-1 summarizes the 2011 locomotive mobile source emission estimates for Texas.

Table 6-1. 2011 Locomotive Annual Emissions Data

2011 Texas Locomotive Criteria Emissions (Tons)				
Pollutant Name	**Class I Line Haul**	**Class II/III Line Haul**	**Rail Yard**	**TOTAL**
Ammonia	33	0.81	3	37
Carbon Dioxide	4,048,881	--	92,206	4,141,087
Carbon Monoxide	10,690	259	1,227	12,177
Methane	317	--	7	324
Nitrogen Oxides	58,762	2,633	10,638	72,033
Nitrous Oxide	103	--	2	105
PM10 Primary (Filt + Cond)	1,735	65	279	2,078
PM2.5 Primary (Filt + Cond)	1,683	60	271	2,013
Sulfur Dioxide	592	18	80	690
Volatile Organic Compounds	3,181	97	677	3,955
2011 Locomotive Hazardous Air Pollutant Emissions				
1,3-Butadiene	8.2802	0.3094	1.3318	9.9215
2,2,4-Trimethylpentane	7.1334	0.2180	1.5183	8.8697
Acenaphthene	0.0531	0.0020	0.0085	0.0636
Acenaphthylene	0.7415	0.0277	0.1193	0.8885
Acetaldehyde	47.9230	1.7907	7.7081	57.4218
Acrolein	7.9693	0.2978	1.2818	9.5489
Anthracene	0.1751	0.0065	0.0282	0.2098
Arsenic	0.0006	0.0000	0.0001	0.0007
Benz[a]Anthracene	0.0278	0.0010	0.0045	0.0333
Benzene	6.5951	0.2464	1.0608	7.9023
Benzo[a]Pyrene	0.0048	0.0002	0.0008	0.0057
Benzo[b]Fluoranthene	0.0111	0.0004	0.0018	0.0133
Benzo[g,h,i,]Perylene	0.0053	0.0002	0.0009	0.0064
Benzo[k]Fluoranthene	0.0090	0.0003	0.0014	0.0108
Beryllium	0.0486	0.0018	0.0078	0.0582
Cadmium	0.0486	0.0018	0.0078	0.0582
Chromium (VI)	0.0036	0.0001	0.0006	0.0043

Table 6-1. 2011 Locomotive Annual Emissions Data (Cont.)

2011 Locomotive Hazardous Air Pollutant Emissions				
Pollutant Name	**Class I Line Haul**	**Class II/III Line Haul**	**Rail Yard**	**TOTAL**
Chromium III	0.0070	0.0003	0.0011	0.0084
Chrysene	0.0206	0.0008	0.0033	0.0247
Ethyl Benzene	6.3619	0.1944	1.3541	7.9104
Fluoranthene	0.1295	0.0048	0.0208	0.1551
Fluorene	0.2441	0.0091	0.0393	0.2924
Formaldehyde	110.4227	4.1261	17.7607	132.3095
Hexane	17.4953	0.5347	3.7237	21.7537
Indeno[1,2,3-c,d]Pyrene	0.0046	0.0002	0.0007	0.0055
Lead	0.1458	0.0054	0.0234	0.1747
Manganese	0.0035	0.0001	0.0006	0.0042
Mercury	0.0486	0.0018	0.0078	0.0582
Naphthalene	4.4676	0.1669	0.7186	5.3531
Nickel	0.0114	0.0004	0.0018	0.0136
Phenanthrene	0.9836	0.0368	0.1582	1.1786
Propionaldehyde	19.4039	0.5931	4.1299	24.1268
Pyrene	0.1828	0.0068	0.0294	0.2191
Styrene	6.6800	0.2042	1.4218	8.3060
Toluene	10.1791	0.3111	2.1665	12.6567
Xylenes (Mixed Isomers)	15.2686	0.4667	3.2497	18.9850

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