Emission Locomotive Emission Factors by Tier

Tier	Large Line-haul (g/bhp-hr)			
	PM_{10}	HC	NO_X	CO
Tier 2	0.18	0.26	4.95	1.28
Tier 2+ and Tier 3	0.08	0.13	4.95	1.28
Tier 4	0.015	0.04	1.00	1.28

Taken from Table 1 of EPA's Technical Highlights: Emission Factors for Locomotives, 2009 (http://www.epa.gov/nonroad/locomotv/420f09025.pdf).
+ indicates that these are the revised standards in 40 CFR 1033.
Large Line-haul is assumed to be representative of the locomotives used in both freight and passenger trains of AAF.

Tier	Switch (g/bhp-hr)			
	PM_{10}	HC	NO_X	CO
Tier 2	0.19	0.51	7.30	1.83
Tier 2+	0.11	0.26	7.30	1.83
Tier 3	0.08	0.26	4.50	1.83
Tier 4	0.015	0.08	1.00	1.83

Taken from Table 2 of EPA's Technical Highlights: Emission Factors for Locomotives, 2009 (http://www.epa.gov/nonroad/locomotv/420f09025.pdf).
+ indicates that these are the revised standards in 40 CFR 1033.

http://en.wikipedia.org/wiki/List_of_GM-EMD_locomotives

From Wikipedia (http://en.wikipedia.org/wiki/List_of_GM-EMD_locomotives), the estimated horsepower ratings for the two specified freight locomotives:

Six-axle roadswitchers or Special Duty Locomotives (SD)

Model designation	Build year	Total produced	AAR wheel arrangement	Prime mover	Power output (hp)	Image
SD70	1993–1999	122	C-C	EMD 16-710G3	4,000 (3.2 MW)	
SD40	1966–1972	1,268	C-C	EMD 16-645E3	3,000 (2.2 MW)	

Cowl units

Model designation	Build year	Total produced	AAR wheel arrangement	Prime mover	Power output (hp)	Image
F40PH-2	1985–1989	90	B-B	EMD 16-645E3	3,200 (2.2 MW)	

FREIGHT: Average Speed and Estimated One-Way Travel Time Along Line (by Year and County)

County	Linear Distance (miles)	Average Speed (mph)			Estimated One-Way Travel Time (hrs)		
		2006	2015	2016	2006	2015	2030
Palm Beach Co	26.31	28.5	30.5	39.5	0.92	0.86	0.67
Broward Co	26.31	22.6	30.5	38.5	1.16	0.86	0.68
Miami-Dade Co	13.16	29.5	31.3	33.2	0.45	0.42	0.40

Total track length = 65.78 miles

(per email correspondence From: Skoropowski, Eugene K. (FECR.BWY) dated Wednesday, June 27, 2012, To: Cumber, Husein (FECR.BWY); Stevens, Robert (FECR.BWY) on Subject: RE: FEC CatEx)
(assumes Palm Beach Co and Broward Co distances are equal, AND are twice the distance as that traveled in Miami-Dade Co)
Average speed provided by engineering.

PASSENGER: Average Speed and Estimated One-Way Travel Time (by County)

County	Linear Distance (miles)	Average Speed (mph)	Estimated One-Way Travel Time (hrs)
Palm Beach Co	26.31	60.1	0.44
Broward Co	26.31	60.1	0.44
Miami-Dade Co	13.16	60.1	0.22
		Total	**1.09**

Total track length = 65.78 miles

(per email correspondence From: Skoropowski, Eugene K. (FECR.BWY) dated Wednesday, June 27, 2012, To: Cumber, Husein (FECR.BWY); Stevens, Robert (FECR.BWY) on Subject: RE: FEC CatEx)
(assumes Palm Beach Co and Broward Co distances are equal, AND are twice the distance as that traveled in Miami-Dade Co)
Average speed provided by engineering.

FREIGHT: Annual Line-Haul Emissions (tons per year)

County	2006				2015				2030			
	PM_{10}	HC	NO_X	CO	PM_{10}	HC	NO_X	CO	PM_{10}	HC	NO_X	CO
Palm Beach Co	4	6	111	29	0	0	11	14	0	1	13	17
Broward Co	5	7	140	36	0	0	11	14	0	1	14	17
Miami-Dade Co	2	3	54	14	0	0	5	7	0	0	8	10
Total	**11**	**16**	**305**	**79**	**0**	**1**	**27**	**35**	**1**	**1**	**35**	**44**

Notes:

1) Assumed Freight train frequency =

Year	Frequency (trains per day)	
2006	27	
2015	14	(as provided by project proponent)
2030	22	(as provided by project proponent)

County	Passenger Train Emissions Per County			
	PM10	HC	NOx	CO
Palm Beach Co	0.08	0.23	5.64	7.22
Broward Co	0.08	0.23	5.64	7.22
Miami-Dade Co	0.04	0.11	2.82	3.61

2) Emissions estimated for two(2)

3) Emissions beginning 2015 and thereafter are based on sole use of Tier 4 locomotives for BOTH freight and the new passenger services; prior locomotives assumed to be Tier 2.

4) Includes 28% load factor for line-hauling (Source: Port of Long Beach, 2007 Air Emissions Inventory).

SUMMARY: Annual Emissions (tons per year)

Calendar Year	Assumed Tier	ESTIMATED ANNUAL Emissions (tons/yr)															
		Freight				Passenger				Switching				TOTAL			
		PM_{10}	HC	NO_X	CO	PM_{10}	HC	NO_X	CO	PM_{10}	HC	NO_X	CO	PM_{10}	HC	NO_X	CO
2006	2	11	16	305	79	--	--	--	--	0.06	0.16	2.35	0.59	11	16	308	79
2015	4	0	1	27	35	0	1	14	18	0.01	0.05	0.64	1.18	1	2	42	54
2030	4	1	1	35	44	0	1	14	18	0.01	0.08	0.97	1.77	1	2	50	64

Notes:

1) Maximum passenger train frequency = 28 trains per day (based on 1 train per hour, per direction) Daily operating hours = 14 hrs/day
(obtained from project proponent)

2) Freight emissions estimated for two (2) SD70 locomotives, each rated at 4,000 bhp (both operating at full horsepower rating). Passenger emissions estimated for two (2) 3,500 bhp locomotives. These assumptions were provided by project proponent. 3500

3) Emissions beginning 2015 and thereafter are based on sole use of Tier 4 locomotives for freight, new passenger services and switching; all prior locomotives assumed to be Tier 2.

4) Assumed following operational details for switching:
Number of switching locomotives: 1
Assumed horsepower of switching locomotive: 4000 hp

Year	Hours
2006	2
2015	4
2030	6

5) Includes 28% load factor for line-hauling and 10% load factor for switching (Source: Locomotive Emission Standards Regulatory Support Document, EPA 1998)

MOVES2010b Modeling Summary Output

							Emissions (grams)										
Year	State	County		Run	CO	NOx	Exhaust_PM10	Exhaust_PM25	Brake_PM10	Tire_PM10	Brake_PM25	Tire_PM25	PM10	PM25	SO2	VOC	VMT (miles)
2006	12	12011	Broward County	1	1.55801E+11	33648480256	943859520	907282240	338754272	99972408	88679248	23974210	1382586200	1019935698	529945696	9.052E+09	14425907200
2006	12	12086	Miami-Dade County	1	1.74331E+11	36756299776	1010983168	971415424	396851808	113998256	103887976	27337656	1521833232	1102641056	581009664	1.014E+10	16259600384
2006	12	12099	Palm Beach County	1	1.00914E+11	21607188480	615719296	591726656	226522704	67289264	59299080	16136523	909531264	667162259	344922336	6.031E+09	9718648832
2015	12	12011	Broward County	1	86181273600	15937259520	423905472	405485184	364711168	106128720	95474352	25450498	894745360	526410034	111390208	4.563E+09	15237732352
2015	12	12086	Miami-Dade County	1	98673696768	17312602112	456761504	436670368	427247264	121014664	111844704	29020296	1005023432	577535368	125313408	5.106E+09	17173040128
2015	12	12099	Palm Beach County	1	55870087168	10248407040	277492320	265360112	243944144	71456320	63859780	17135800	592892784	346355692	73467520	3.044E+09	10267296768
2030	12	12011	Broward County	1	76388352000	6958206976	168279984	157421984	463493088	138574352	121333216	33231286	770347424	311986486	119706520	2.526E+09	19881754624
2030	12	12086	Miami-Dade County	1	87714742272	7256811008	185674368	173573472	542862400	158033872	142110256	37897856	886570640	353581584	134506256	2.787E+09	22408611840
2030	12	12099	Palm Beach County	1	49376010240	4456889856	111638496	104404440	310058208	93309280	81167088	22376310	515005984	207947838	78884776	1.682E+09	13394728960

Emission Factor (grams/mile)					
CO	NOx	PM10	PM25	SO2	VOC
10.8000488	2.332503585	0.0958405	0.070702	0.036736	0.627474
10.7217113	2.260590599	0.09359598	0.067815	0.035733	0.623632
10.3835257	2.223270833	0.09358618	0.068648	0.035491	0.620611
5.65578077	1.045907564	0.05871906	0.034546	0.00731	0.299458
5.74584908	1.008126807	0.05852333	0.03363	0.007297	0.297349
5.44155764	0.998160204	0.05774575	0.033734	0.007155	0.296454
3.84213332	0.349979522	0.03874645	0.015692	0.006021	0.127055
3.91433182	0.323840274	0.03956384	0.015779	0.006002	0.124367
3.6862269	0.332734605	0.03844841	0.015525	0.005889	0.125602

Weighted Average Emission Factor (grams/mile)					
CO	NOx	PM10	PM25	SO2	VOC
10.6351	2.272122	0.094341	0.069055	0.035987	0.623906
5.614396	1.017398	0.058329	0.03397	0.007254	0.297754
3.814231	0.335518	0.03892	0.015665	0.005971	0.125675

Station Pair VMT Reduction Emissions (tons per year)

	2015							2030						
Station Pair	Reduction in VMT	CO	NOx	PM10	PM25	SO2	VOC	Reduction in VMT	CO	NOx	PM10	PM25	SO2	VOC
Miami / Fort Lauderdale	7,283,318	45.03	8.16	0.47	0.27		2.39	8,455,176	35.52	3.12	0.36	0.15		1.17
Miami / West Palm Beach	35,747,716	221.04	40.05	2.30	1.34		11.72	41,499,385	174.33	15.33	1.78	0.72		5.74
Fort Lauderdale / West Palm Beach	1,198,307	7.41	1.34	0.08	0.04		0.39	1,391,110	5.84	0.51	0.06	0.02		0.19
Total	44,229,342	273.48	49.56	2.84	1.65		14.50	51,345,672	215.69	18.97	2.20	0.89		7.11

Passenger Train Emissions (tons per year)

	2015						2030					
County	PM10	PM2.5	VOC	NOX	CO	SO2	PM10	PM2.5	VOC	NOx	CO	SO2
Palm Beach County	0.08	0.08	0.24	5.64	7.22		0.08	0.08	0.24	5.64	7.22	
Broward County	0.08	0.08	0.24	5.64	7.22		0.08	0.08	0.24	5.64	7.22	
Miami-Dade County	0.04	0.04	0.12	2.82	3.61		0.04	0.04	0.12	2.82	3.61	
Total	0.21	0.21	0.59	14.10	18.04		0.21	0.21	0.59	14.10	18.04	

Difference between VMT Reduction emissions and Passenger Train Emissions (tons per year)

	2015						2030					
	CO	NOx	PM10	PM25	SO2	VOC	CO	NOx	PM10	PM25	SO2	VOC
Regional Total	255.44	35.46	2.63	1.45		13.91	197.64	4.88	1.99	0.68		6.51

COFL2004 Example Input/Output

```
Input==============================================================================
FEC Commuter Rail Service from WPB to Miami
Fort Lauderdale Worst Intersection - Avenue of the Arts/Broward Blvd - Design
Chris Fatogoma
          6
1,2035,3
         20
       2044
       2590
       1421
       3727
         45
         45
10,0
Default Rec 1,20,150,6
Default Rec 2,20,50,6
Default Rec 3,50,20,6
Default Rec 4,150,20,6
Default Rec 5,50,50,6
Default Rec 6,20,-150,6
Default Rec 7,20,-50,6
Default Rec 8,50,-20,6
Default Rec 9,150,-20,6
Default Rec 10,50,-50,6
```

```
Output==============================================================================
                                    07-26-2012

                        CO Florida 2004

Project:        FEC Commuter Rail Service from WPB to Miami
Facility:  Fort Lauderdale Worst Intersection - Avenue of the Arts/Broward Blvd - Design
Analyst:  Chris Fatogoma

Environmental Data:
   Temperature:                58 F
   Reid Vapor Pressure:          11.5 psi
   Land Use:                   Urban
   Stability Class:             D
   Surface Roughness:            175
   Background Concentration:     1-hr = 5.0 ppm      8-hr = 3.0 ppm

Project Data:
   Region:                    6: Palm Beach / Broward / Dade
   Year:                      2035
   Intersection Type:           6 x 4 Intersection
   Max 4-Lane Traffic:          2044  veh/hour
   Max 6-Lane Traffic:          3727  veh/hour
   4-Lane Speed:               45
   6-Lane Speed:               45

Receptor Data (all distances are in feet):
                East-West Distance  North-South Distance  Receptor
   Receptor Name       from Intersection    from Intersection    Height
   -------------       -------------------  --------------------  --------
   Default Rec 1            20                150                6
   Default Rec 2            20                 50                6
   Default Rec 3            50                 20                6
   Default Rec 4           150                 20                6
   Default Rec 5            50                 50                6
   Default Rec 6            20               -150                6
   Default Rec 7            20                -50                6
   Default Rec 8            50                -20                6
   Default Rec 9           150                -20                6
   Default Rec 10           50                -50                6

RESULTS (including background CO):
                          Max 1-Hr      Max 8-Hr
          Receptor Name        Conc (ppm)    Conc (ppm)
          -------------        ----------    ----------
          Default Rec 1           8.7           5.2
          Default Rec 2           9.8           5.9
          Default Rec 3          10.5           6.3
          Default Rec 4          10.2           6.1
          Default Rec 5           9.3           5.6
          Default Rec 6           9.1           5.5
          Default Rec 7          10.2           6.1
          Default Rec 8          10.6           6.4
          Default Rec 9           9.6           5.8
          Default Rec 10          9.7           5.8

   ***********************************************************************
    PROJECT PASSES - NO EXCEEDANCES OF NAAQ CO STANDARDS ARE PREDICTED
   ***********************************************************************
```