# ERTAC Rail: A Collaborative Effort in Building a Railroad-Related Emissions Inventory between Eastern States' Air Protection Agencies and Participation with the Railroad Industry

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Air protection agencies from twenty-seven states, coordinated through the Eastern Regional Technical Advisory Committee (ERTAC), identified a need to better quantify and characterize rail-related emissions inventories. Traditional locomotives largely utilize diesel combustion engines, resulting in emissions of $NO_x$, diesel PM, hydrocarbons, and greenhouse gases (e.g. $CO_2$). These emissions are sometimes concentrated in areas exceeding National Ambient Air Quality Standards. Inventory development methods for locomotive emissions estimates vary dramatically from state to state and, in general, lack the spatial or temporal resolution needed to support air quality modeling. The ERTAC Rail Subcommittee was established with active representatives from twelve member states, three regional planning offices, and the US EPA. The committee's goals are to (1) standardize agencies' inventory development methods through a collaborative effort, (2) improve the quality of data received and the resulting emission inventories, and (3) reduce the administrative burden on railroad companies of providing data. The ERTAC Rail Subcommittee has identified five major rail-related source categories of interest and is working with the railroad industry to establish the methodology, collect the supporting data for a 2008 regional or nationwide emissions inventory, and to prepare a protocol for future inventory development. The Association of American Railroads has been coordinating participation by its seven member Class I Railroads and Amtrak, and efforts are being made to contact Class II and III Railroads through their member associations. This paper discusses the progress ERTAC is making toward these goals.

## Introduction

The Eastern Regional Technical Advisory Committee (ERTAC) was convened by a group of state agencies to identify and address significant gaps in our representation of air pollutant emissions in order to support effective air quality planning. Five priority areas were identified: (1) Agricultural Ammonia, (2) Area Source Comparability, (3) Rail, (4) Marine, and (5) Primary Organic Carbon from On-road Mobile Sources. Railroad-related sources, while only 1 to 2% of total emissions, were identified as a high-priority due to the extent and level of emissions in many populated areas in the eastern US, the high level of uncertainty associated with their representation in current emission inventories, and their rapid projected growth due to increased shipping demand, better fuel-efficiency, and generally lower emissions compared with alternative modes of freight transportation. The ERTAC Rail Subcommittee (ERTAC Rail) was formed to improve emissions estimates from this sector.

ERTAC Rail is comprised of active representatives from 12 state air quality protection agencies, three regional air quality management groups, and the EPA (Table 1). The group initially became familiarized with each other's backgrounds and skill sets, established overriding principles of transparency, documentation, and collaboration, and set goals of producing a 2008 inventory and projection techniques, as well as establishing a foundation to better facilitate railroad inventory development in the future. The state agencies contribute in-kind resources with the understanding that a cohesive regional or national approach, rather than independent state-by-state approaches, will both produce more reliable results as well as benefit both the railroad community and the air protection agencies by requiring less effort and resources in the long-term. The railroads will benefit from a consistent approach that uses publicly available information to the degree it exists, and are hopeful that this one consistent approach will be nationally adopted.

**Table 1.** Names, organizations, and contact information of ERTAC Rail Subcommittee members.

| Name | Organization | E-mail |
|---|---|---|
| 1 Allan Ostrander | MI Dept. of Environ. Quality | OstranderA2@michigan.gov |
| 2 Amanda Carter | AL Dept. of Environ. Manag. | AKCarter@adem.state.al.us |
| 3 Ashley Mixon | SC Dept. of Health and Environ.Control | mixonar@dhec.sc.gov |
| 4 Bob Wooten | NC Dept. of Environ. and Natural Resources | Bob.Wooten@ncmail.net |
| 5 Carla Bedenbaugh | SC Dept. of Health and Environ. Control | bedenbcw@dhec.sc.gov |
| 6 Chad Wilbanks | SC Dept. of Health and Environ. Control | wilbanmc@dhec.sc.gov |
| 7 Dennis McGeen | MI Dept. of Environ. Quality | mcgeend1@michigan.gov |
| 8 Douglas Malchenson | PA Dept. of Environ. Protection | dmalchenso@state.pa.us |
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| 11 Jim Boylan | GA Environ. Protection Div. | james.boylan@dnr.state.ga.us |
| 12 Julie McDill | Mid-Atlantic Regional Air Management Assoc. (MARAMA) | jmcdill@marama.org |
| 13 Kelley Matty | PA Dept. of Environ. Protection | kmatty@state.pa.us |
| 14 Kevin McGarry | NY Dept. of Environ. Conserv. | kpmcgarr@gw.dec.state.ny.us |
| 15 Laurel Driver | US EPA OAQPS | Driver.Laurel@epa.gov |
| 16 Lisa Higgins | ME Dept. of Environ. Protection | Lisa.Higgins@maine.gov |
| 17 Mark Janssen | ERTAC/ Lake Michigan Air Directors Consortium (LADCO) | janssen@ladco.org |
| 18 Matthew Harrell | IL Environ. Protection Agency | Matthew.Harrell@illinois.gov |
| 19 Michelle Bergin | GA Environ. Protection Division | michelle.bergin@dnr.state.ga.us |
| 20 Mike Koerber | LADCO | koerber@ladco.org |
| 21 Pat Brewer | Visibility Improvement State and Tribal Association of the Southeast (VISTAS) /ASIP | Pat.Brewer@ncmail.net |
| 22 Richard Dalebout | MI Dept. of Environ. Quality | daleboutr@michigan.gov |

| | | |
|---|---|---|
| 23 Sam Long | IL Environ. Protection Agency | Sam.Long@Illinois.gov |
| 24 Stacy Allen | MO Dept. of Natural Resources | stacy.allen@dnr.mo.gov |
| 25 Tracy Anderson | AL Dept. of Environ. Manag. | tanderson@adem.state.al.us |
| 26 William Nichols | OH Environ. Protection Agency | william.nichols@epa.state.oh.us |

After evaluating existing methodologies and results of past railroad emission inventory studies [1-5], the subcommittee contacted different sectors of the railroad community to request participation, input, and guidance on potential methodologies and data sources. Participation in this effort by the rail community is critical, largely because much of the data required to design and build a representative inventory is not publicly available and must be voluntarily supplied by the railroads. While the railroad industry has no legal requirements to cooperate, many of the railroads independently pursue clean air programs to reduce their environmental footprint - some have made commitments as partners of programs such as EPA SmartWay[6], and one is a partner in the US EPA Climate Leader Program[7]. In addition, a more accurate estimation of emissions will enable current emission reduction actions, such as improving the overall Tier level of a fleet and increasing fuel efficiency, to be fully recognized. This may result in and help identify promising opportunities for collaborative funding for emissions reduction activities.

## The Importance of Rail Emissions in Air Quality Analysis and Management

Railroad activity releases a variety of emissions, primarily from diesel combustion during train operations, and occurs throughout the United States (Figure 1). Emissions are often concentrated in densely populated, urban areas (e.g. Figure 2). Emissions of $NO_x$ and primary $PM_{2.5}$ from diesel combustion contribute to ambient concentrations of ozone and $PM_{2.5}$, pollutants for which many states have areas out of attainment with the National Ambient Air Quality Standards (Figure 3). Ozone and some components of $PM_{2.5}$ are 'secondary' pollutants, meaning they are formed in the atmosphere rather than directly emitted, making them difficult to manage. Some control strategies can be inefficient or even counter productive if pursued in areas with a poorly characterized chemical composition, particularly in urban areas [e.g.8-10]. Diesel combustion also releases air toxics and greenhouse gases, pollutants for which many states have established reduction programs.

**Figure 1.** National Rail Freight Network and Primary Rail Freight Corridors.[11]

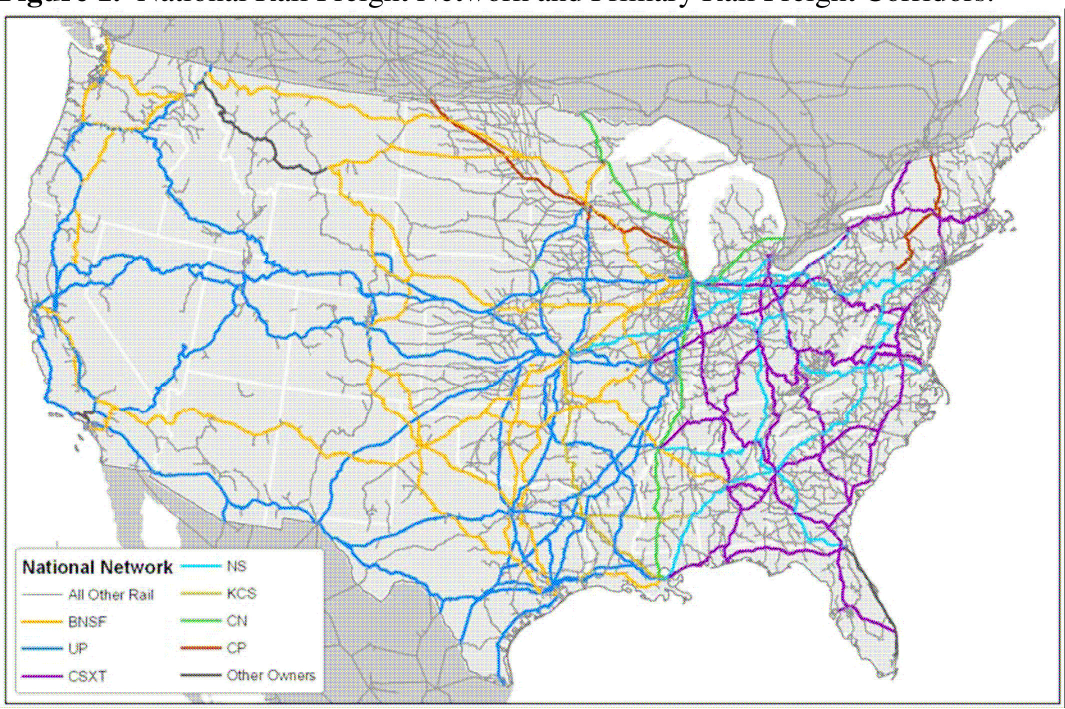


**Figure 2.** Georgia counties exceeding the National Ambient Air Quality Standards for both ozone and $PM_{2.5}$ are outlined in red. Five "urban core" nonattainment counties are outlined in green. Population density is shown with blue squares, and blue lines are railroad tracks.

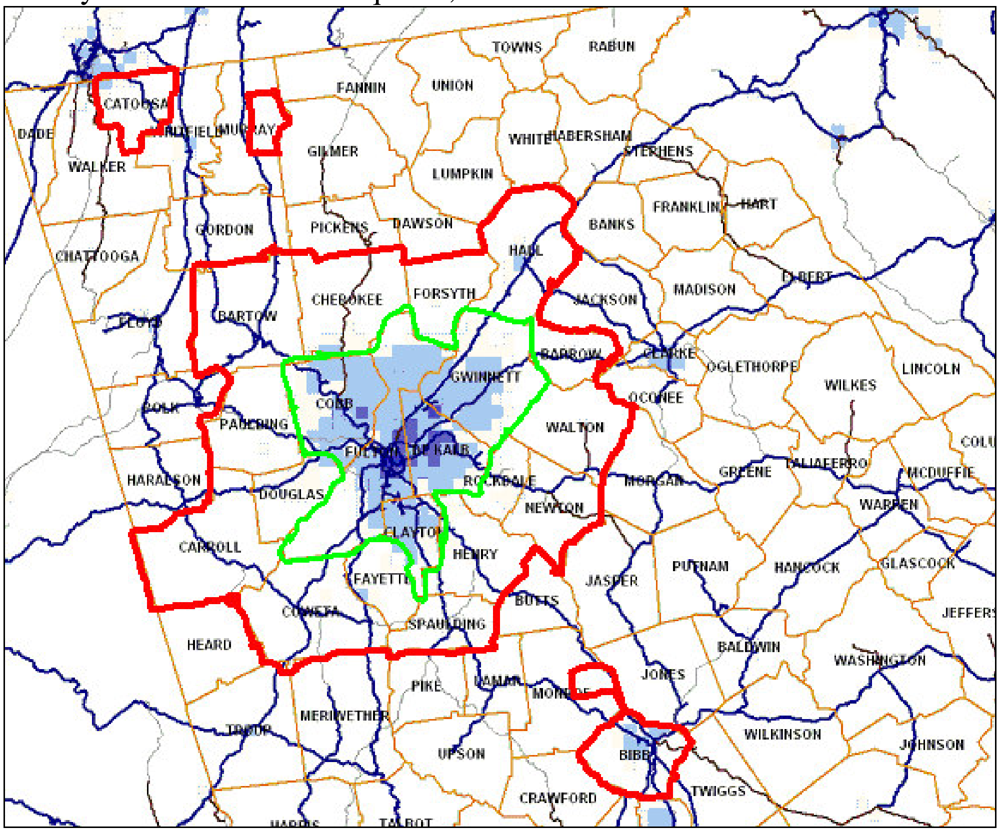
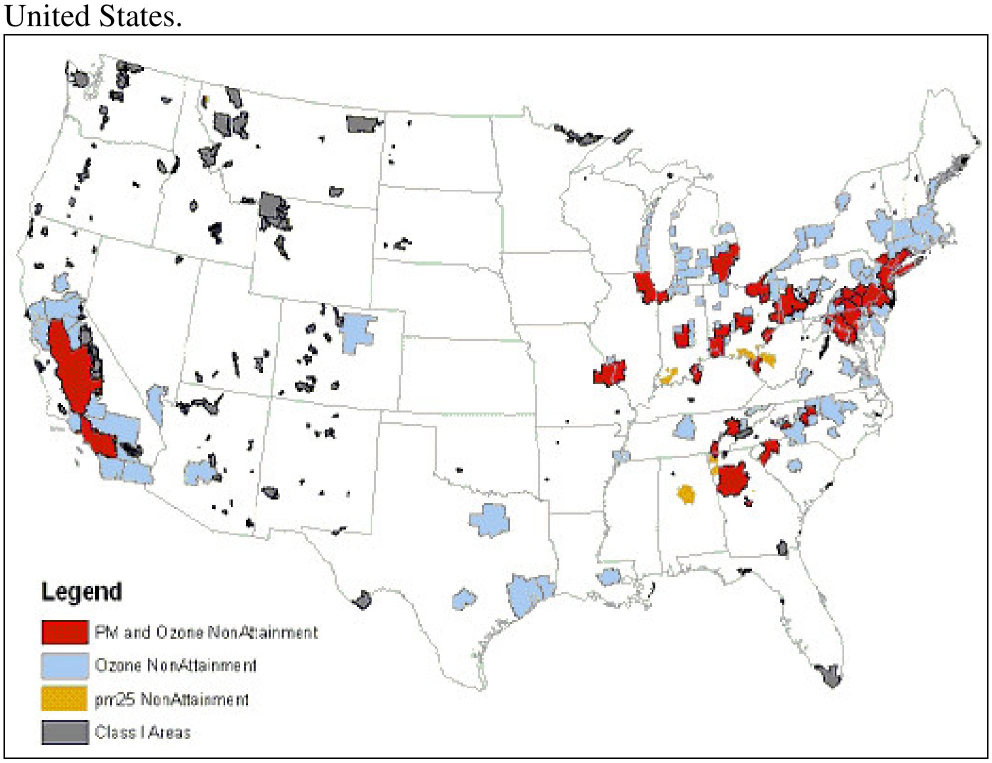
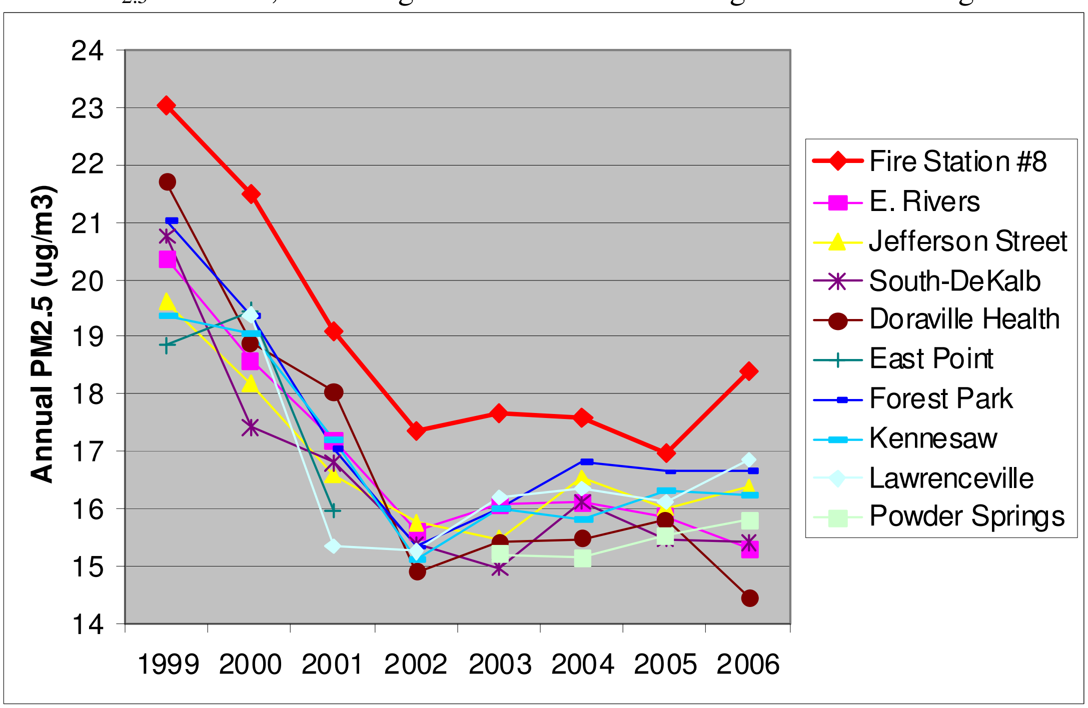



**Figure 3.** Counties not attaining the ozone and PM National Ambient Air Quality Standards in the United States.



In some nonattainment areas, it is possible that emissions from rail yards and associated sources may contribute to the high monitored levels of pollutants. For example, the highest annual $PM_{2.5}$ concentrations in Atlanta, GA are measured at a monitor located in close proximity to two large, active railyards. Similar nearby urban monitors measure consistently lower concentrations (Figure 4a, b, and c). Emissions in and around railyards can be due to locomotive engines, cargo handling equipment, and/or other associated modes of transportation such as trucking or marine shipping, as well as from large or small industrial sources often located nearby[12]. Better understanding and characterization of the emissions contributing to high measured concentrations would help identify important sources and aid in the development of efficient air quality management strategies. It is important to note that the use of locomotives has a lower overall air quality and climate change impact than moving equivalent amounts of cargo by trucks, and uses lower amounts of fuel. The expanded use of railroads can be a powerful tool in efforts for environmental protection and energy independence, particularly when available emissions control practices and technologies are implemented.

**Figure 4.** (a) The Fire Station #8 $PM_{2.5}$ monitor consistently measures higher annual $PM_{2.5}$ concentrations than all of the other Atlanta nonattainment area monitors. (The NAAQS for annual $PM_{2.5}$ is 15 $\mu g/m^3$)[13]. (b) This monitor is located very near 2 large classification and intermodal railyards. (c) Other nearby urban monitors (e.g. E. Rivers and Jefferson Street) show better agreement with the larger set of $PM_{2.5}$ monitors, indicating the influence of more regional contributing sources.



(a)

(b)

(c)

**Current Status of Rail-related Sources, Data Availability, and Emissions Inventories**

Railroad companies are classified by the Surface Transportation Board (STB) by levels of revenue, with Class I Railroads having operating revenues of $346.8M and higher, Class II Railroads having revenues between $28M and $346.8M, and Class III Railroads with revenues of $28M or less, including all 'switching and terminal' companies. There are eight Class I Railroads operating in the US and approximately 550 Class II ('Regional Railroads') and Class III Railroads ('Shortlines') combined. Class II/III Railroads account for approximately 33% of the industry's national mileage[14]. As with Class II/III Railroads, passenger and commuter rail activity is a small fraction of total rail for most states, although can be significant for some areas, especially the Northeast, Chicago, and Southern California. There appears to be little or no data available on the 'industrial' (non-railroad company) locomotive fleet size, locations, or activity level.

Locomotives are divided into two main categories: 'line-haul', which are locomotives that move freight trains between cities over relatively long distances, and 'switchers', which operate in railyards to classify rail cars and assemble them into trains. In general, line-haul locomotives are larger and newer than switchers. While the majority of locomotive activity is long-distance movement by line-hauls, locomotive activity is often concentrated in railyards, including switching, maintenance, and inspection activity, along with rail-associated equipment used to load and unload rail cars, intermodal truck or ship idling, and movement to and from the yards. Because state air quality agencies may be concerned with both regional and more detailed local scale air quality issues, ERTAC Rail is addressing both line-haul and railyard inventories.

The US EPA has defined duty cycles for both line-haul and switcher locomotives, with emission factor estimates based on fuel usage (or brake-hp hr). EPA locomotive emissions regulations are equipment based and depend on the year the locomotive was built or remanufactured (Table 2). Locomotives can last up to 30 – 40 years in line-haul service through proper maintenance and possibly power assembly rebuilds, before being transferred to switching service or sold to Class II/III Railroads.

**Table 2.** Emission factors over standard operating Switch and Line-Haul duty cycles [15]

| | Gaseous and Particulate Emissions (g/bhp-hr) | | | | | |
|---|---|---|---|---|---|---|
| | Switch | | | Line-Haul | | |
| | HC | NOx | PM | HC | NOx | PM |
| Non-regulated (pre 1973)* | - | - | - | - | - | - |
| Tier 0 (1973-2001) | 2.10 | 11.8 | 0.26 | 0.55 - 1.00 | 7.4 - 8.0 | 0.22 |
| Tier 1 (2002-2004) | 1.20 | 11.0 | 0.26 | 0.55 | 7.4 | 0.22 |
| Tier 2 (2005 +) | 0.60 | 8.1 | 0.13 | 0.30 | 5.5 | 0.10 |
| Tier 3 (2011 or 2012) | 0.60 | 5.0 | 0.10 | 0.30 | 5.5 | 0.10 |
| Tier 4 (2015) | 0.14 | 1.3 | 0.03 | 0.14 | 1.3 | 0.03 |

*Engines earlier than 1973 are not regulated

While treated as a non-road mobile source in emissions inventories, locomotives are not addressed in the US EPA NONROAD model or any other standardized model, so states each currently estimate their own emissions, often with the assistance of railroad companies. Emissions inventory preparation guidance from the U.S. EPA describes locomotive activity as relatively constant throughout the year (e.g. no daily, weekly, or seasonal variability) and calculations are based on nationwide estimates of locomotive fleet mix, emissions factors, and average annual fuel consumption (i.e. for switcher locomotives). Class I Railroads submit annual 'R-1' reports to the STB, which contains annual system-wide (multi-state) fuel use data and annual Gross Ton Miles (GTM). In addition, some link-level (single lengths of track) data is compiled by the railroads and is submitted to the Federal Railroad Administration. However, due to business confidentiality requirements and a lack of common formats and transfer methods, this data has not been publicly released and is difficult to aggregate into a usable database. Class II and III Railroads do not report any fuel use, fleet, or activity data in a cohesive manner, although the American Shortline and Regional Railroad Association (ASLRRA) compiles some industry-wide fleet estimates. Unfortunately, this information is often not available in electronic format and does not provide the variables needed for emissions calculations.

Historically, each state has either requested voluntary data submissions individually or has estimated emissions using surrogates for the calculation of emissions from railroad activities. Much of the information that would support emissions inventory development at the state or county level is not routinely collected or maintained by the railroads in a form that would be useful for inventory calculations and would take additional effort on the part of the companies to provide. Therefore, acquiring this data at a state or county level has been difficult and generally not successful. Many states have had difficulty with even rudimentary tasks such as locating all of their railyards and estimating the number of switchers in each yard. When additional effort is undertaken, emissions estimates are often found to be inaccurate (e.g. Table 3). The potential level of error in current inventories can impact the effectiveness of controls applied by other sources in the airshed, the efficiency of selected control strategies, and can obscure valuable opportunities for reducing emissions.

**Table 3.** Comparison of 2002 New York State (NYS) National Emissions Inventory (NEI) with NYS Survey-Based NOx Emissions (in tons/yr). [5]

| Description | NEI | Survey | Difference | Percent Difference |
|---|---|---|---|---|
| Class I Line Haul | 10,520 | 17,939 | 7,419 | 70.5% |
| Class II/III Line Haul | 9 | 1,046 | 1,037 | 11522.2% |
| Line Haul Passenger (Amtrak) | 521 | 1,914 | 1,393 | 267.4% |
| Line Haul Commuter | 85 | 4,055 | 3,970 | 4670.6% |
| Yard Locomotive[a] | 2,979 | 102 | (2,877) | (96.6%) |
| *Total* | 14,115 | 25,055 | 10,942 | 77.5% |

[a]In many cases data was not provided on yard locomotives especially for Class I Line Haul rail lines, and as a result these emissions are included in the estimate of total class I line Haul emissions

ERTAC Rail initially established six workgroups, or teams, to address different components of the rail inventory, including Class I Line-Haul, Railyards, Class II/III Railroads, Commuter and Passenger Rail, Emission Factors and Fuel Usage, and Website Development and Management. Later, at the request of Class I Railroad representatives, a National Inventory Coordination team was added, and, to support the actual compilation of the inventory, a GIS and Data Workgroup was established collaboratively with the Association of American Railroads (AAR) and representatives from the Class I railroads (Table 4).

**Table 4.** ERTAC Rail Subcommittee Positions and Contacts

| | |
|---|---|
| **ERTAC Lead** | Mark Janssen, LADCO |
| **Co-Chairs** | Michelle Bergin, GA EPD<br>Julie McDill, MARAMA |
| **Workgroups** | **Leads** |
| Class I Line-Haul | Matt Harrell, IL EPA<br>Mark Janssen LADCO |
| Railyards | Michelle Bergin, GA EPD<br>Julie McDill, MARAMA |
| Class II/III | Dennis McGeen, MI DEQ<br>Lisa Higgins, ME DEP |
| Passenger and Commuter Rail | None currently |
| Emission Factors and Fuel Use | Richard Dalebout, MI DEQ<br>Kelley Matty, PA DEP |
| Website Design and Management | William Nichols, OH EPA |
| National Inventory Coordination | Stacy Allen, MO DNR<br>Laurel Driver, US EPA OAQPS |

| | |
|---|---|
| GIS and Data* | Matt Harrell, IL EPA<br>Michelle Bergin, GA EPD<br>Mark Janssen, LADCO<br>Julie McDill and Patrick Davis, MARAMA<br>Laurel Driver, US EPA OAQPS<br>Robert Fronczak, AAR<br>Rick Nath, Abby Clark, and Kelley Slettebo, CSX Transportation<br>David Seep and William Watson, BNSF<br>Ken Roberge, Canadian Pacific Railway<br>Carl Akins, Kansas City Southern<br>Erika Akkerman, CN Railway<br>M. John Germer, Lanny Schmid, and Paul Steege, Union Pacific Railroad<br>Brent Mason, Norfolk Southern Corp.<br>Joanne Maxwell, Amtrak |

* This is currently a joint workgroup with the AAR and representatives from each Class I Railroad. Class II/III or other industry representatives may later join.

## Methodology

### Objectives and Approach

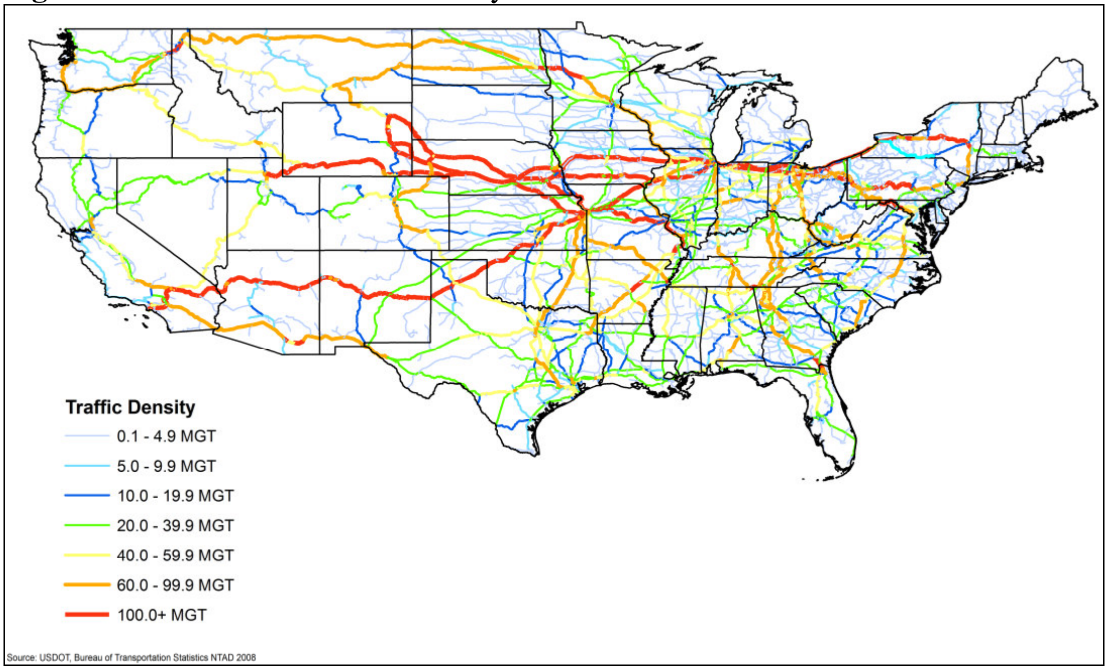
ERTAC Rail's primary goal is to build a link-level, spatially and temporally allocated consolidated emissions inventory of railroad related sources for the year 2008, and developing a projection methodology to estimate future year emissions. A secondary objective is to develop a longer-term methodology in cooperation with the railroad community so that future inventories will require less effort and will be more accurate where needed. Discussions and analysis are aimed at identifying variables and activities that are most critical and can be incorporated in the 2008 inventory, and what may be important to target for future characterization.

### Class I Line-Haul

Class I line-haul activities have been shown to be the predominant source of rail-related emissions in numerous rail emission studies, with estimates of Class I line-haul fuel consumption totals to be from 74 to 84% of all rail sources combined [4, 5]. For this reason, Class I line-haul activities are a focal point of ERTAC Rail's current efforts.

Earlier inventory efforts generally apportioned annual system-wide (i.e. aggregated over each Class I's total rail network, see Figure 1) fuel use reported to the STB equally across all route miles operated by a Class I railroad within a given state or county. However, the majority of freight tonnage carried by Class I railroads, generally measured in Millions of Gross Tons (MGT), is concentrated on a disproportionately small number of route miles (Figure 5). For example, in 2006 only 37% of rail route miles were classified carrying a minimum of 20 MGT[16]. Out of this total, only 5.4% carried at least 100 MGT. In addition, for states trying to better allocate Class I MGT, only highly aggregated data is publically available (e.g. Figure 5).

**Figure 5.** US Railroad Traffic Density in 2006.[16]




Fortunately, the US DOT Federal Railroad Administration (FRA) has recently compiled a nationwide 1:100,000 scale Rail Lines GIS layer based on confidential link-level industry annual MGT data. The Class I Railroads will likely release this data to ERTAC Rail to be combined with more representative fleet information for use in inventory development. ERTAC Rail will largely follow the line-haul inventory methodology recommended by Sierra Research[2, 3]. This methodology recommends calculating a Railroad Fuel Consumption Index (RFCI) for each railroad using their system-wide line-haul fuel consumption and gross ton mile data contained in each Class I's annual STB R-1 report (Equation 1). This index value represents the average number of GTM produced per gallon of diesel fuel over their system in a year, and varies between railroad carriers depending on factors such as fleet mix, system terrain, speeds, loading/weight of cargo, percent of unit trains (aggregate cargo such as coal vs. smaller individual shipments), and operating practices such as idle control.

Equation (1) $$RFCI_i = \frac{GTM_i}{FC_i}$$

Where *RFCI* = Railroad Fuel Consumption Index (GTM/gal), annual system-wide fuel use per railroad carrier *i*.

*GTM* = Gross Ton Miles (GTM), annual system-wide gross ton miles of freight transported per carrier.

FC = Annual system-wide fuel consumption per carrier, excluding fuel used for passenger and work trains (gal).

The number of gallons of diesel fuel consumed per link ($FC_L$) will be calculated by first multiplying the link's gross tonnage from the FRA database ($MGT_{FRA\ L}$) by the link's length in miles ($L_L$), resulting in each link's gross ton miles (GTM) per year (Equation 2), which is then divided by the average RFCI of the railroads operating on link L (Equation 3). Approximately 36% of track in the United States supports traffic by more than one railroad carrier, a fraction that drops to 26% when neglecting track only shared between one freight railroad and Amtrak. Accurately apportioning the specific fractions per carrier of tonnage per link was considered, but, after comparing likely worst-case areas (where multiple railroads with the largest differences in RFCI share track usage), the difficultly of merging carrier-specific usage with the aggregated FRA tonnage dataset was considered too great considering the potential gain in accuracy. Instead, carrier-specific emissions factors and RFCIs will simply be averaged and applied to links known to support specific multiple carriers. Where warranted, usage may be apportioned more accurately.

Equation (2) $$GTM_L = MGT_{FRAL} * L_L$$

Where $GTM_L$ = Gross Ton Miles per link.
$MGT_{FRAL}$ = Million Gross Tons per link from the FRA database ($10^6$ tons).
$L_L$ = Link length (miles)

Equation (3) $$FC_L = GTM_L \Big/ \frac{\sum_{i=1}^{7} RFCI_{iL}}{n}$$

Where $FC_L$ = Total fuel consumed over link L per year (gal/yr).
$GTM_L$ = Gross Ton Miles per link.
$RFCI_{iL}$ = RFCI for each carrier *i* operating on link *L* (if not operating on *L*, RFCI = 0).
$n$ = number of carriers operating on link L

Emission factors per pollutant (gm or tons/gal) will be calculated for each railroad carrier depending on its system-wide fleet mix (line-haul and switchers will be treated separately), likely based on Tier level certification, and will be multiplied with link-level fuel use to obtain emissions for each compound of concern over link L (Equation 4). The FRA Rail Lines dataset is constructed with breaks (nodes) in the line segments at state and county boundaries, allowing these emission estimates to be easily aggregated to county or state levels.

Equation (4) $$E_{jL} = FC_L * \frac{\sum_{i=1}^{7} EF_{ji}}{n}$$

Where $E_{jL}$ = Emissions of pollutant j per link L (gm).
$EF_{ji}$ = Emission Factor for pollutant j per railroad fleet i (gm/gal)

Early ERTAC Rail discussions concluded that link-level tonnage was the most important data to incorporate, while other variables such as track grade, speed, alternative duty-cycles, or link-level emission factors or fuel use could be neglected at this time. However, fleet mix can be highly variable throughout regions of the country, and emissions vary considerably with engine year and type. Activity levels may seasonally vary, particularly in some yards, and annual averaging may dilute or exaggerate concentrations during pollution episodes. ERTAC Rail and the Class I railroad community are evaluating if incorporating more specific fleet mix or monthly or seasonal variation may be worthwhile.

It is important to note that the link-level MGT data maintained by the FRA is proprietary and can only be released to agencies/ groups outside the FRA with the express permission of each Class I railroad. It is possible that one or more Class I railroads will withhold permission for access.

## Rail Yards

A number of reasons make the development of accurate railyard emission inventories advantageous for both air quality agencies and railroad companies. Locomotive activity is highly concentrated in many railyards, which are often located in densely populated areas, and switcher locomotives are often older, higher emitting engines. Information on yard location, equipment, and activity levels within railyards can be critical for supporting air quality management decisions. In addition, significant cooperative federal funding opportunities exist for the implementation of emissions reduction technologies in these types of areas (e.g. the Congestion Mitigation and Air Quality program for nonattainment areas and the Diesel Emissions Reduction Act program).

To characterize rail yard emissions, optimal information would include the

- location and extent of the yard,
- number, fleet mix (e.g. engine type, year, and/or Tier level), and fuel consumption of the normal operating switcher fleet,
- normal/average schedule of operation,
- GTM throughput, and
- main yard activities such as classification, intermodal transfers, maintenance, and repair.

However, it is understood that yard operating characteristics and equipment are often variable and information may be difficult to assemble, therefore simplifying methodologies are being explored. A first priority is to obtain a dataset of location of existing railyards and some estimate of usual number of operating switchers. Some states have maps of yards available for some areas, and the FRA recently compiled a first draft dataset of approximately 1000 railyards through the use of digitized aerial photography (Figure 6). While a useful start, this dataset is found to be lacking (Chicago example, Figure 7). Since compiling detailed information on all railyards would be an onerous task, railyards within nonattainment areas and with some threshold number dedicated switchers (e.g. more than 3 or 10) will first be characterized. ERTAC Rail and the GIS/Data Workgroup are also exploring the possible need to address monthly or seasonal activity variability in some railyards.

**Figure 6.** FRA Draft dataset of railyard locations derived from digitized aerial photography.

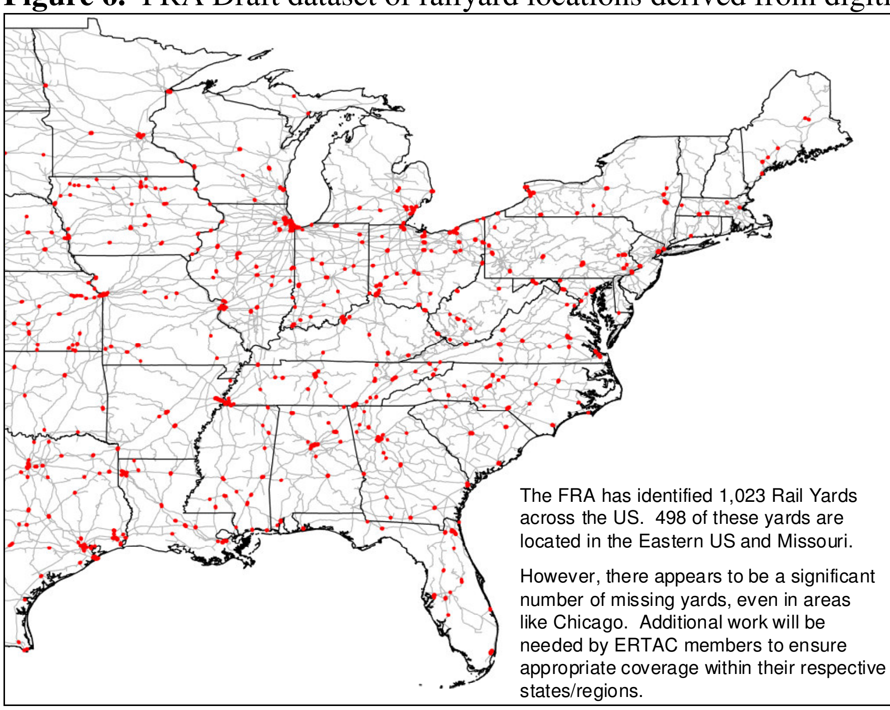
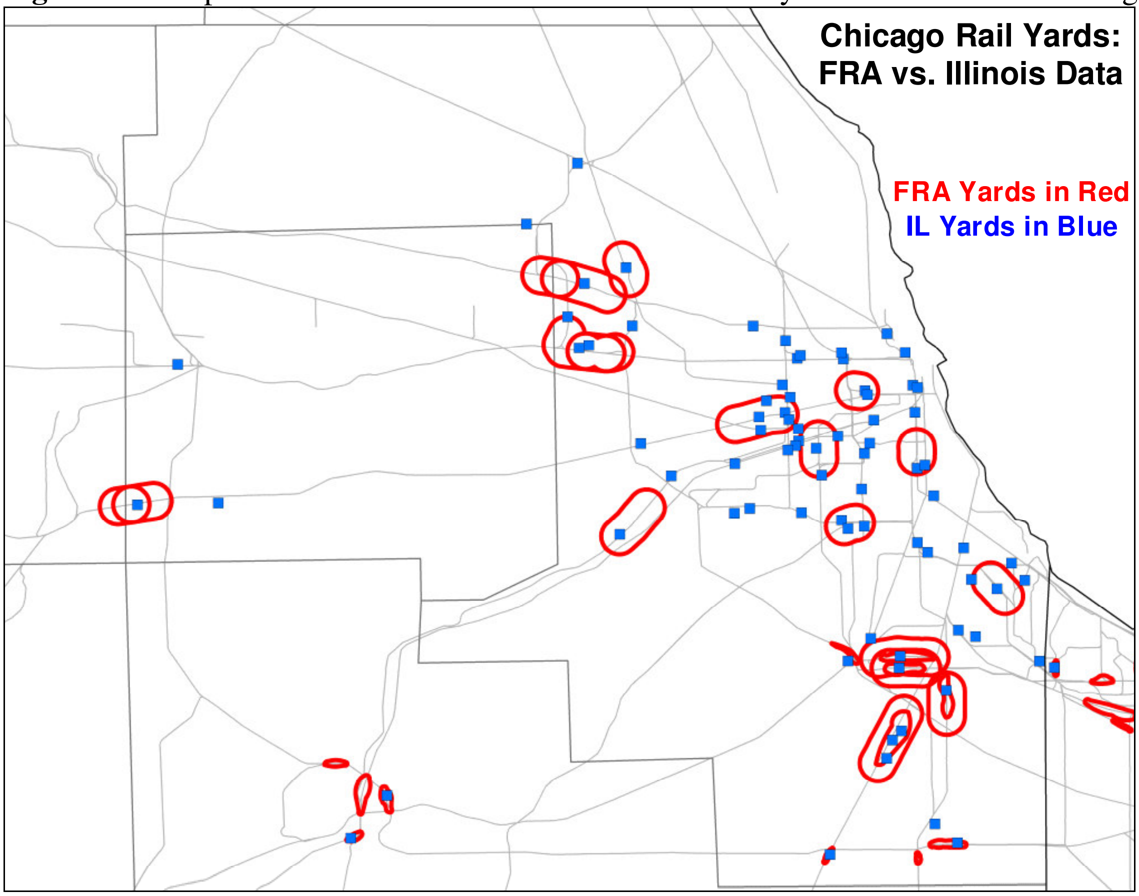


**Figure 7.** Comparison of draft FRA dataset with known railyard locations in the Chicago area[17].




The current practice of using a single nationwide set of emission factors and a single estimate of fuel use per year per switcher (assuming a known yard and usual number of switchers operating) leads to high uncertainties in resulting inventories. Railroad-specific switcher fleet mix data will be used to calculate a system-wide emission factor per carrier, and railroad-specific annual fuel use per switcher will be estimated. ERTAC Rail is considering how yard design or the spatial extent of yards may impact duty cycle estimates, possibly leading to the use of an addition set of emission factors for yards with specific dominant characteristics.

## Class II and III Railroads

To calculate the Class II/III emissions inventory, information on annual fuel use, track miles and location, yard locations, number and fleet mix of road and switcher locomotives, tonnage, and temporal information is desired. There are approximately 550 Class II and III Railroads operating in the United States, around 440 of which are members of ASLRRA. In general, while information on Class II/III link locations and many fleet characteristics are available online, a significant effort would be required to compile this data into a usable format and check the data for reliability. The most recent publically available compiled data found is for 1995 and is not seemingly available in a spreadsheet or database format[18]. However, the Class II and III sectors of the railroad industry have been in considerable flux since partial deregulation from the 1980 Staggers Act, so more recent data in electronic format is still being sought.

ERTAC Rail is seeking guidance on methodology and potential data sources from the ASLRRA, and will also contact the larger Class II/III North American Railroads (e.g. Genesee & Wyoming, RailAmerica, Omnitrax) and the STB for potential data sources. If fuel use and fleet mix data can only be obtained for a subset of Class II/III Railroads, generic RFCI or fuel use per carload relationships will be derived, dependent on a characteristic such as total track miles owned or operated, and applied to Class II/III links for which no fleet or activity data is obtained. In addition, states may be requested to contact railroads operating in their state or submit their best estimates for these sectors.

The FRA link-level dataset described in the Class I Line-Haul discussion above includes definitions of Class II and III links; however, tonnage is not included. Class II and III railroads occasionally share track with Class I railroads, so, if the FRA dataset is obtained, care will be taken to ensure the sectors are treated independently. It is unknown how accurate the Class II/III link descriptions are, so each state may be requested to check and/or submit their own statewide GIS shape file of Class II/III links and possibly assumed fleet and activity estimates.

**Passenger and Commuter Rail**

Passenger and commuter rail activity is a small fraction of total rail for most states, although can be significant for some areas, especially the Northeast, Chicago, and Southern California. ERTAC Rail does not have plans to address this inventory sector at this time, but may recommend a guiding methodology if enough states show an interest and can support the effort.

## Conclusions

Rail-related emissions can be important components of emissions inventories used to support effective air quality management practices, both at the state and national level. The ERTAC Rail Subcommittee was established by air quality agencies in the eastern United States to (1) standardize agencies' inventory development methods through a collaborative effort, (2) improve the quality of data received and the resulting emission inventories, and (3) reduce the administrative burden on railroad companies of providing data. In particular, ERTAC Rail will produce a 2008 and projected future years locomotive emissions inventories for the eastern United States, and will offer national coordination to assist western states in producing a cohesive inventory. The Association of American Railroads and the Class I North American Railroads are participating in this effort by providing information and guidance for the Class I line-haul and railyard calculations. Communications with Class II/III Railroads are still in early stages.

Due to recent federal programs/regulations, Class I rail companies are currently collaborating on a national dataset of track location, ownership and usage. In addition, the Federal Railroad Administration is continually improving their datasets describing the national rail network. ERTAC Rail is tracking these upcoming improvements, communicating data needs for modeling-focused emissions inventories, and working with the railroad community to ease the process of producing railroad emissions inventories in the future.

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## Key Words

Transportation emissions, freight movement, railroad emissions, locomotive emissions, emissions inventory, emission factors, photochemical modeling, dispersion modeling, air quality modeling.