Assessing the Effects of Freight Movement on Emissions

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Emission Reduction Strategies & Challenges:
A Multi-Modal Workshop Focused on the Goods Movement Sector

TRB Annual Meeting

January 22, 2006

ICF CONSULTING

Background

- Growing concern about the future performance of our freight system
  - Increasing urban highway congestion
  - Limited rail system capacity and frequent bottlenecks
  - Globalization is stressing a constrained port system
  - Rapid growth in air freight
- Demand across all modes expected to increase
- Strong linkage between the economy and an efficient and reliable freight system
- Numerous efforts to expand freight capacity and improve efficiency

We need to improve our understanding of freight emissions

- Air quality is a regional issue
  - Most previous studies of freight transportation emissions have looked only at the national level or at individual facilities
  - Little research comparing freight emissions across regions and modes
- Emission inventories done for SIP purposes are not sufficient
  - No distinction between freight and non-freight activity (e.g., passenger rail vs. freight rail)
  - No distinction of non-road equipment used for freight at ports and airports
  - May not estimate emissions by operational mode

FHWA's study

- *Assessing the Effects of Freight Movement on Air Quality at the National and Regional Level*, April 2005
  - Fill a void in the current understanding of the emissions impacts of freight transportation
  - Evaluate current methods, current and future regulations, and likely demand trends
  - Assess the contribution of freight movement (by mode) to emissions in six metropolitan regions
  - Investigate emission reduction strategies that state and local practitioners can implement
  - Recommend needed progressions in methods given likely trends

Freight Contribution to Total Emissions (National Level)

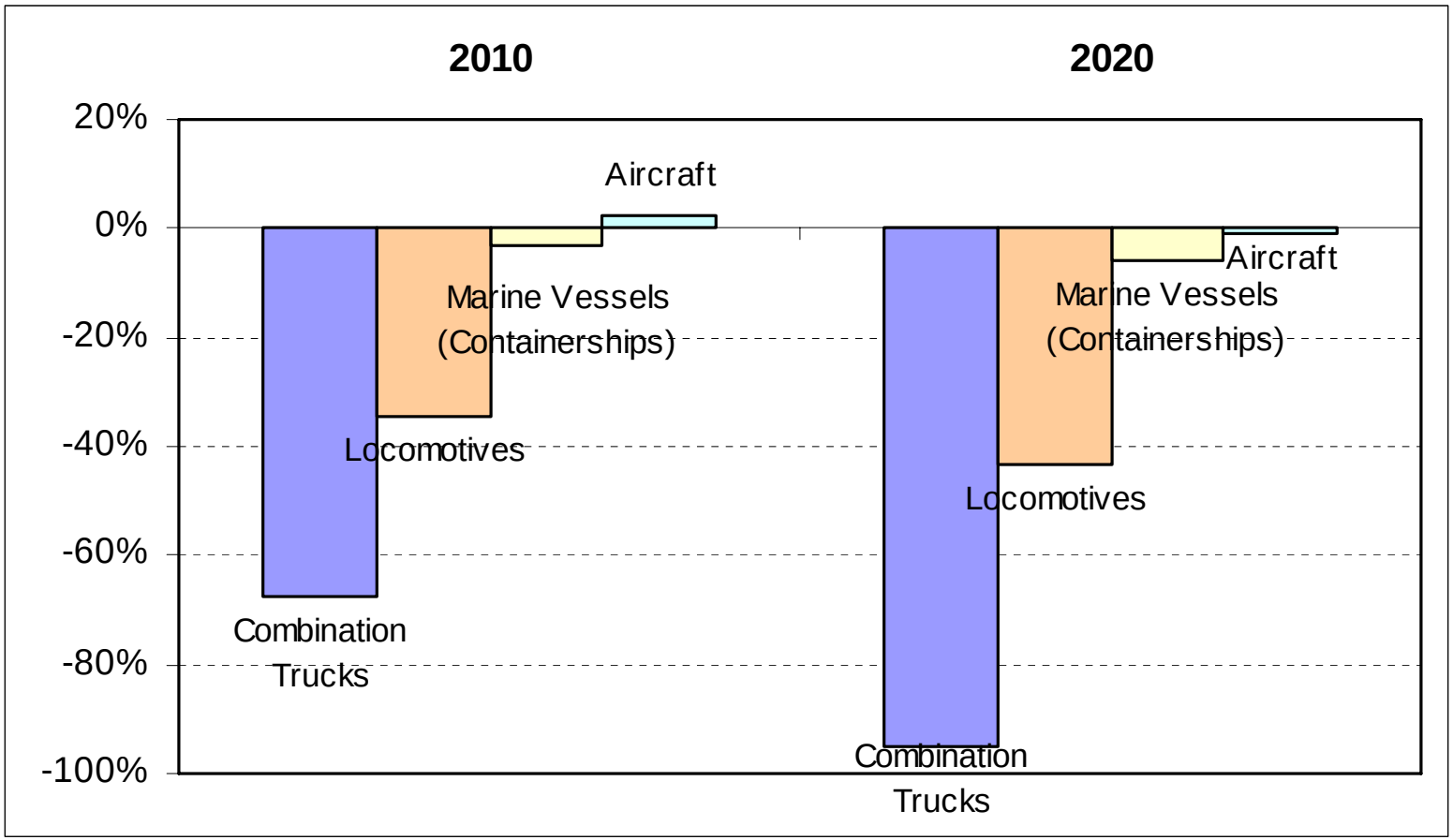
Mode	NOx Emissions, 2002				PM-10 Emissions, 2002			
			As percent of:				As percent of:	
	Tons	Percent	All Mobile Sources	All Sources	Tons	Percent	All Mobile Sources	All Sources
Heavy-duty Vehicles	3,782,000	66.8%	33.0%	17.9%	120,000	64.7%	23.3%	0.5%
Freight Railroads	857,200	15.1%	7.5%	4.1%	21,300	11.5%	4.1%	0.1%
Marine Vessels	1,011,000	17.9%	8.8%	4.8%	44,000	23.7%	8.5%	0.2%
Air Freight	8,200	0.1%	0.1%	0.0%	300	0.2%	0.1%	0.0%
Total	5,658,400	100%	49.4%	26.8%	185,600	100%	36.0%	0.8%

New Emission Standards Affecting Freight

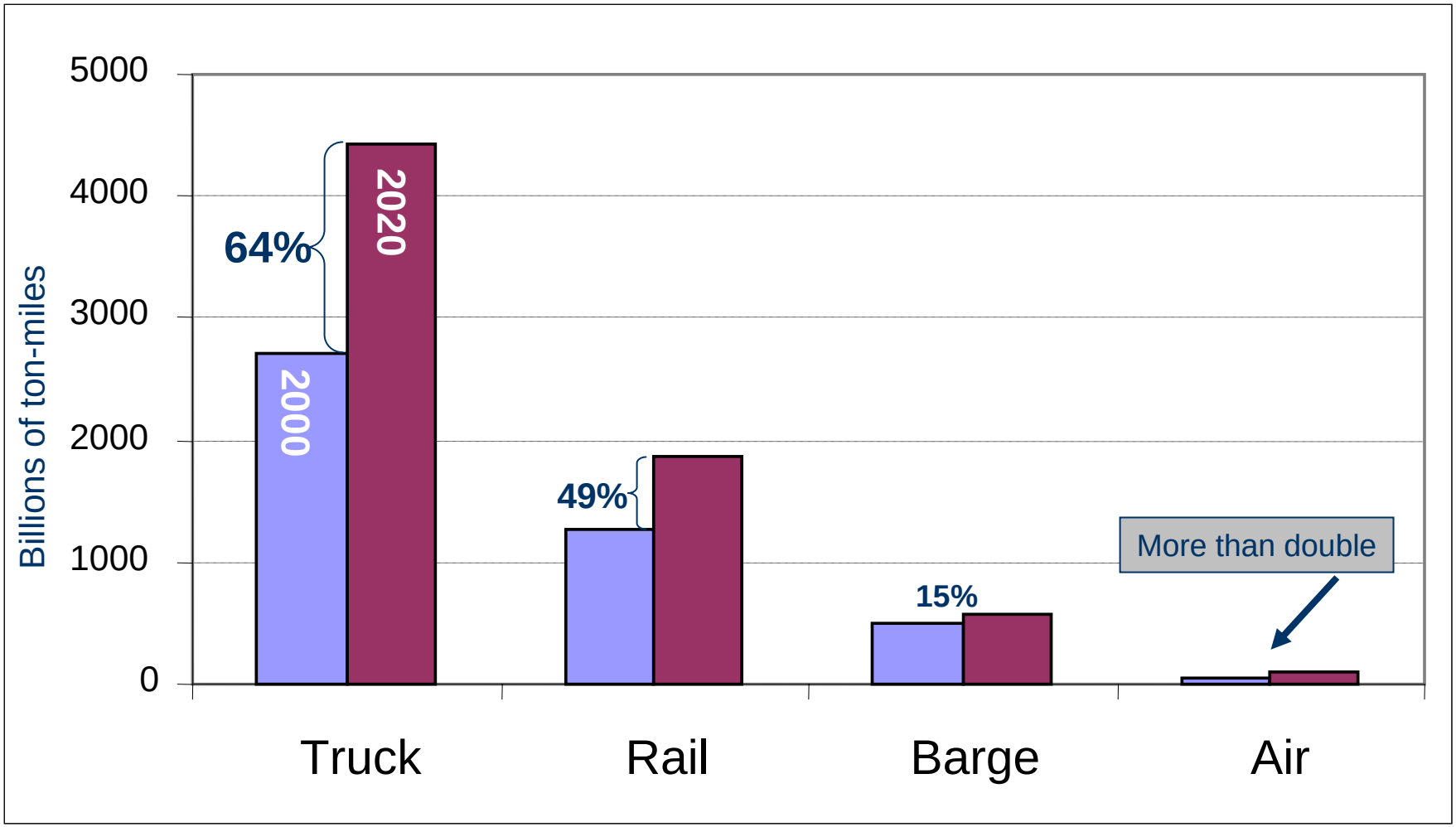
- Trucks
  - Very stringent NOx and PM standards for trucks take effect in 2007
  - By 2020, NOx and PM emission factors will be 5 - 15 times lower than current levels
- Rail
  - First locomotive standards took effect in 2002; EPA has announced plans for stringent standards (similar to those for trucks)
  - Very slow fleet turnover (some locomotives > 40 yrs old)
- Marine Vessels
  - First standards took effect in 2004; EPA has announced plans for stringent standards (similar to those for trucks)
  - Slow fleet turnover
  - No EPA authority to regulate foreign-flagged vessels (IMO standards only)
- Aircraft
  - EPA adopted ICAO NOx standards affecting 2004+ new aircraft
  - Difficult tradeoff between NOx and noise

Estimated Effects of New Standards

Change in Fleet-Average NOx Emissions Rates Compared to 2002

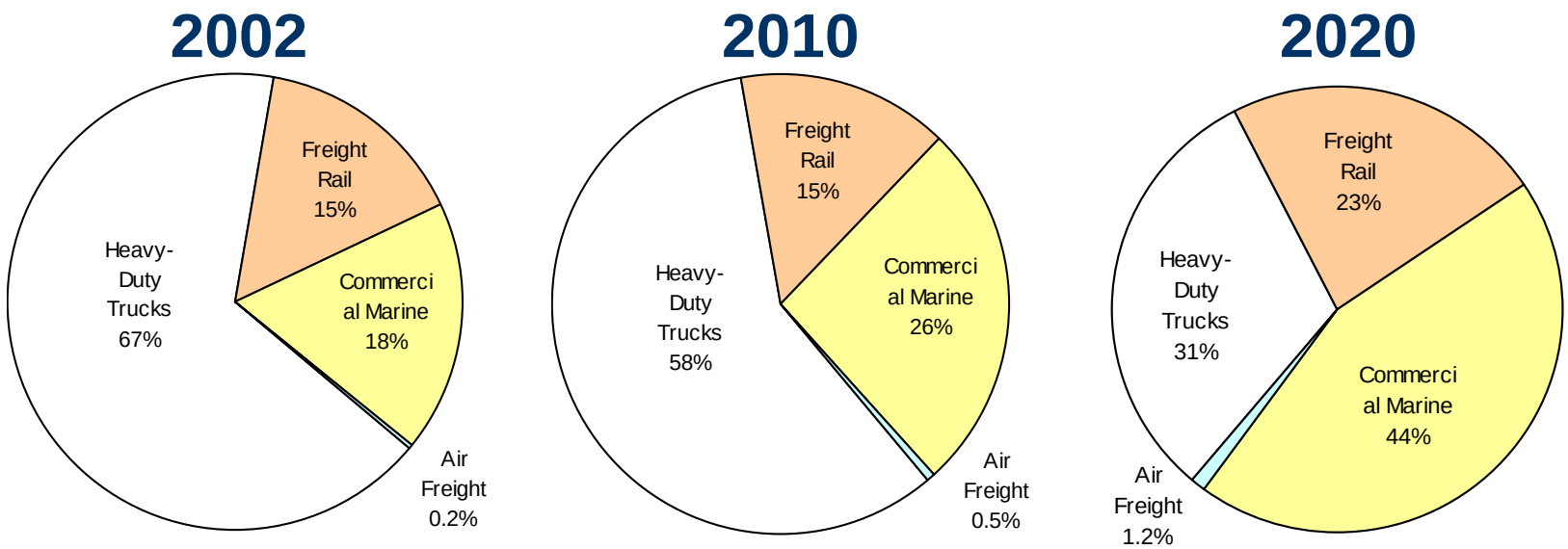


But, demand is expected to grow significantly…



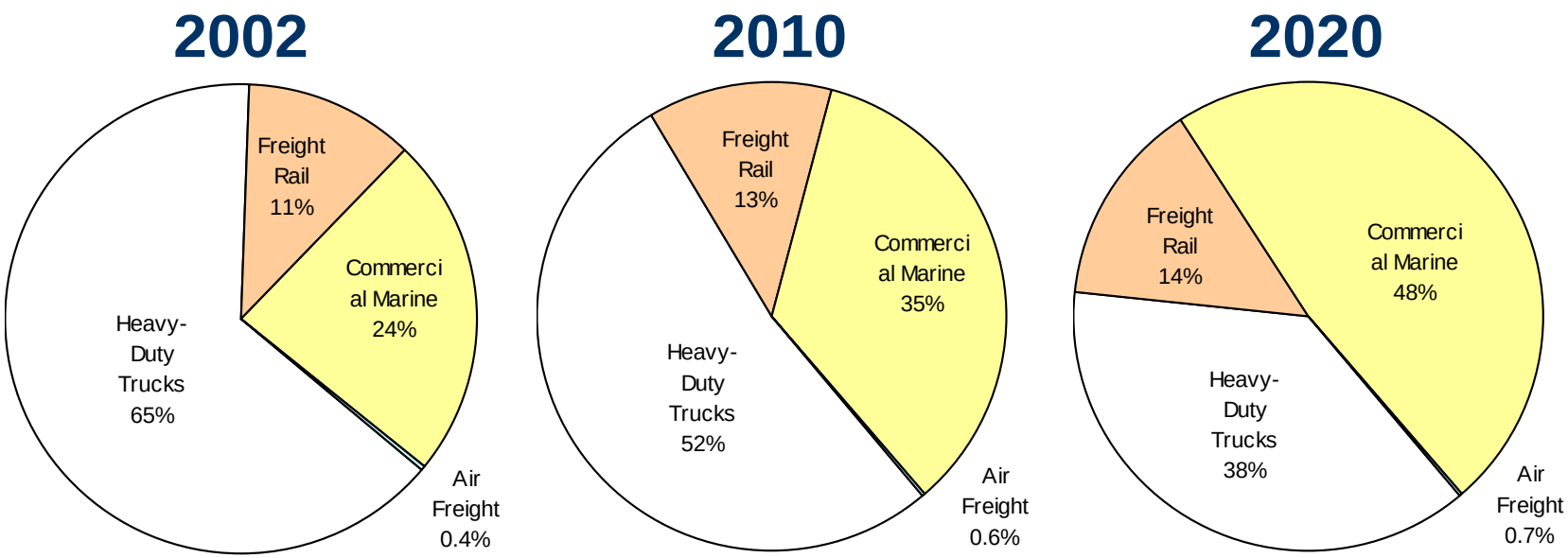
Future Freight NOx Emissions at the National Level

	Heavy-Duty Trucks		Freight Rail		Commercial Marine		Air Freight		Freight Total	
Year	tons	chnge	tons	chnge	tons	chnge	tons	chnge	tons	chnge
2002	3,782,000		857,200		1,011,000		8,200		5,658,400	
2010	2,186,900	-42%	563,200	-34%	987,200	-2%	10,000	22%	3,747,300	-34%
2020	662,600	-82%	486,400	-43%	938,600	-7%	12,400	51%	2,100,000	-63%



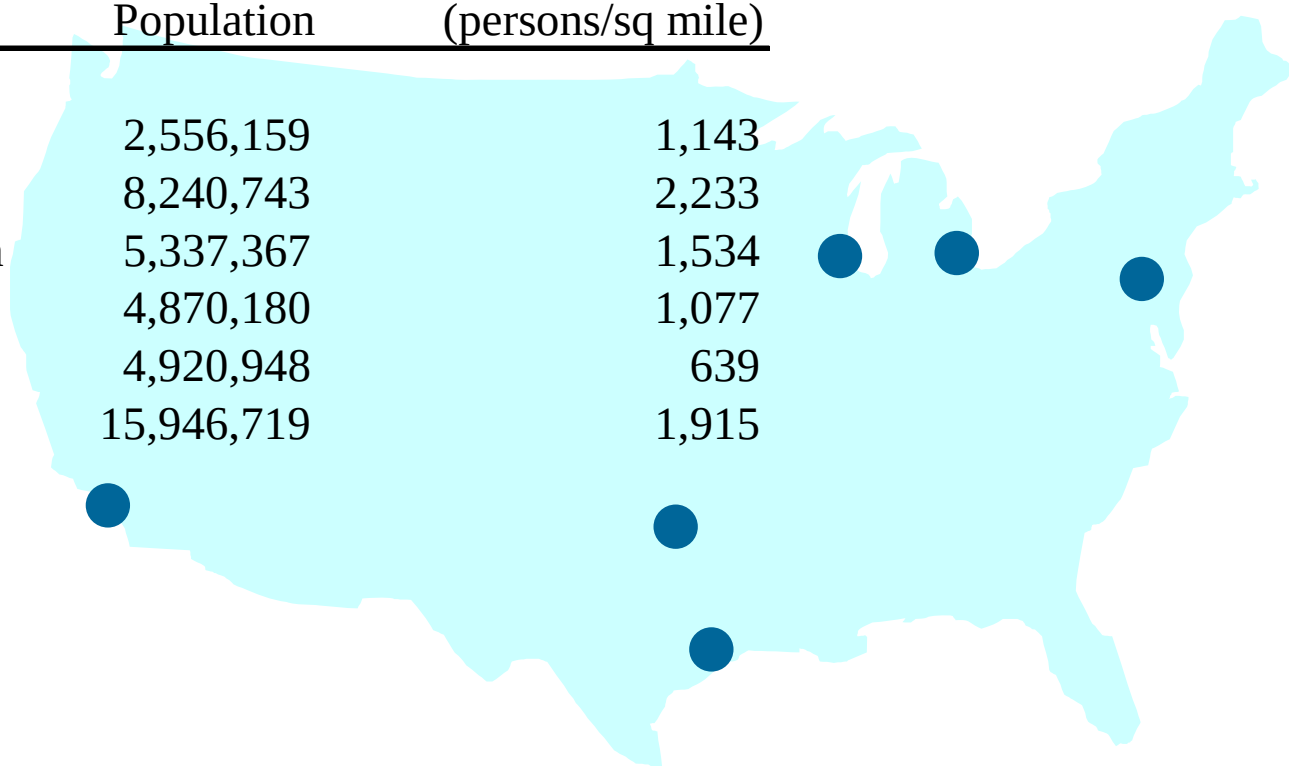
Future Freight PM-10 Emissions at the National Level

	Heavy-Duty Trucks		Freight Rail		Commercial Marine		Air Freight		Freight Total	
Year	tons	chnge	tons	chnge	tons	chnge	tons	chnge	tons	chnge
2002	120,000		21,300		44,000		300		185,600	
2010	65,380	-46%	15,730	-26%	42,930	-2%	290	-3%	124,300	-33%
2020	34,760	-71%	12,990	-39%	44,080	0%	270	-10%	92,100	-50%



Regional-level Estimation of Freight Emissions

Region	2002 Population	Population Density (persons/sq mile)
Baltimore	2,556,159	1,143
Chicago	8,240,743	2,233
Dallas-Ft. Worth	5,337,367	1,534
Detroit	4,870,180	1,077
Houston	4,920,948	639
Los Angeles	15,946,719	1,915



Sources Contributing to Regional Freight Emissions

- Trucking (heavy-duty single-unit and combination trucks)
- Line-haul freight rail
- Switch yard freight rail
- Marine vessels (freight vessels and related harbor craft)
- Port cargo handling equipment (yard tractors, cranes, container handlers, etc.)
- Aircraft (air cargo planes and freight portion of passenger planes)
- Airport ground support equipment (associated with freight)

Regional-level Freight Activity Parameters

Trucking	VMT; fleet characteristics
Line-haul rail	Ton-miles or fuel use
Switch yard rail	Hours of operation or number of locomotives
Marine vessels	Trips and operational data by vessel type
Port CHE	# of pieces; hours of operation
Aircraft	Landings and take-offs; freight vs. passenger tonnage
Airport GSE	# of pieces; hours of operation

Regional Heavy-Duty Truck Emissions (2002)

	NOx (tons)	as % of total on-road NOx	PM-10 (tons)	as % of total on-road PM-10
Baltimore	29,081	50%	734	56%
Chicago	96,291	57%	2,641	**63%**
Dallas-Ft. Worth	53,718	50%	884	38%
Detroit	98,195	**63%**	2,382	**63%**
Houston	64,590	55%	1,256	48%
Los Angeles	130,341	49%	2,210	31%

Regional Freight Rail Emissions (2002)

	NOx (tons)	% switch yard	PM-10 (tons)	% switch yard
Baltimore	2,655	54%	71	52%
Chicago	**23,212**	18%	**792**	32%
Dallas-Ft Worth	4,157	27%	113	26%
Detroit	2,106	25%	58	23%
Houston	5,163	31%	141	29%
Los Angeles	12,744	10%	346	8%

Regional Port Emissions (2002)

	Marine Freight Vessel Emissions (tons)		Port CHE Emissions (tons)		Port Total Freight Emissions (tons)	
	NOx	PM-10	NOx	PM-10	NOx	PM-10
Baltimore	2,399	141	916	50	3,315	190
Chicago	1,901	160	298	13	2,199	173
Detroit	247	18	221	9	468	27
Houston	12,734	808	1,618	106	14,351	915
Los Angeles	**18,347**	1,261	**4,263**	260	**22,610**	1,521

Summary of Freight NOx Emissions at the Regional Level (2002)

	Trucking	Freight Rail	Marine Freight	Air Freight	Freight Total (tons)		Freight as % of all emissions
Baltimore	83%	8%	9%	0.1%	35,078	100%	N/A
Chicago	79%	**19%**	2%	0.4%	122,164	100%	34%
Dallas-Ft. Worth	93%	7%	0%	0.3%	58,030	100%	35%
Detroit	**97%**	2%	0%	0.0%	100,809	100%	31%
Houston	77%	6%	**17%**	0.1%	84,189	100%	29%
Los Angeles	78%	8%	14%	**0.5%**	166,564	100%	**39%**

Summary of Freight PM-10 Emissions at the Regional Level (2002)

	Trucking	Freight Rail	Marine Freight	Air Freight	Freight Total (tons)		Freight as % of all emissions
Baltimore	74%	7%	19%	0.1%	996	100%	N/A
Chicago	73%	**22%**	5%	0.3%	3,616	100%	**6%**
Dallas-Ft. Worth	88%	11%	0%	**0.4%**	1,002	100%	1%
Detroit	**96%**	2%	1%	0.1%	2,469	100%	2%
Houston	54%	6%	**40%**	0.1%	2,314	100%	2%
Los Angeles	54%	8%	37%	0.3%	4,091	100%	2%

Emissions Estimation Challenges

- Trucking
  - Typical process does not account for extended truck idling (overnight, loading docks, long queues)
  - Difficult to accurately assess impacts of changes in congestion
- Rail
  - Reliance on activity data provided private railroads
  - Limited information on switch yard locomotive operations
- Marine
  - Many regions use simplistic approach; more accurate approach is time-consuming and expensive
  - Port cargo handling equipment often ignored, lumped in with all non-road

Summary

- Freight transportation is a major source of national and regional NOx and PM-10 emissions
  - National level – 50% of mobile source NOx emissions
  - Regional level – 40%-52% of mobile source NOx emissions (six study regions)
  - National level – 36% of mobile source PM-10 emissions
  - Regional level – 22%-47% of mobile source PM-10 emissions
- Modal contribution can vary significantly across regions
  - Freight rail contributes 19% of freight NOx in Chicago; only 2% in Detroit
  - Marine freight contributes 40% of freight PM in Houston and 37% in Los Angeles; only 5% in Chicago and 1% in Detroit
  - Trucking is the major source of freight NOx emissions at both the national and regional levels (67% and 77%-97%)

Summary, cont.

- Nationally, total freight emissions will decline significantly over the next 15 years
  - Emissions rates dropping faster than growth in activity, particularly for trucking
- Modal contribution to freight emissions total will change
  - Commercial marine sector will surpass trucking by 2020
- Current emissions estimation methodologies have shortcomings
  - Rail and marine inventories often suffer from poor quality data and/or simplistic methods
  - Difficult to estimate the impacts of operational strategies
- Report can be found at:
  - http://www.fhwa.dot.gov/environment/freightaq/index.htm