CHAPTER II

PORT AND GOODS MOVEMENT EMISSIONS INVENTORY

A. INTRODUCTION

This chapter focuses on the movement of *internationally destined import and export* goods. ARB staff chose to distinguish that subset of emissions from all other domestic truck and rail operations when defining the "goods movement" sector. We are soliciting comments on whether that delineation is appropriate or, on the contrary, whether a broader definition should be applied.

Before describing the inventory, it is useful to understand how imported goods move into and through California. Imported goods enter California through the Ports of Los Angeles, Long Beach, Oakland, and others. These goods arrive on ocean-going ships which emit during transit. While berthed at harbor, additional "hoteling" emissions are generated by on-board power plants. Once shore-side, a number of different activities occur. Goods may be packaged into large metal boxes called containers, transferred in bulk, or, in the case of vehicles, driven off of a ship. Each one of these steps has its own emissions profile. Smaller boats within ports, called commercial harbor craft, support ocean-going ships. For example, tugboats help move ocean-going ships into berths. Cargo handling equipment like cranes and forklifts move goods around the port so that they can be staged for land-side transportation. Goods may be moved onto trains directly for long distance transport across the country or put on trucks. Trucks may move goods to distant destinations, local destinations, distribution centers (where goods are warehoused, repackaged and transferred to other trucks) or intermodal rail yards (where goods are transferred to trains).

This report also includes all emissions generated at California's ports, whether related to international trade or not. For example, some commercial harbor craft provide support functions at a port by moving crew or supplies to offshore oil rigs, by towing barges, providing coast guard services, and many other functions. Ferries move people across the San Francisco Bay for their daily commutes, and fishing boats leave the Ports of Los Angeles and Long Beach to work in California's fisheries. These emissions affect local air quality around ports even if they are not related to goods movement. The large mass of emissions at the ports, coupled with potential localized health impacts in communities surrounding ports, is the reason we consider all emissions generated at ports in this plan.

This plan considers the following emission categories: ocean-going ships out to 24 nautical miles from shore, all commercial harbor craft, all port dredging equipment; and cargo handling equipment, truck, locomotive, and transportation refrigeration unit (TRU) emissions associated with international (import and export) goods movement. This port and international goods movement inventory provides specific estimates for each category by county and air basin, and for each rail yard and port in California.

Emissions are generated at each stage of the goods moving process, predominantly by diesel or residual fueled-engines. These engines release a variety of pollutants including reactive organic gases (ROG), carbon monoxide (CO), oxides of nitrogen (NOx), oxides of sulfur (SOx), and particulate matter (PM). ROG, NOx and SOx all contribute to the formation of ozone and fine particulate matter in the atmosphere. Ozone and particulate matter are a major concern in California due to their association with asthma, premature deaths and other health effects. Diesel particulate is an identified toxic air contaminant and contributes approximately 70 percent of the known ambient air toxics risk in the State.

The location where air pollutant emissions are released is very important when assessing exposure and health effects. In general, pollutant concentrations are highest by the source because emissions disperse with distance. For example, concentrations of vehicle exhaust are highest within 200 feet of a freeway and decrease dramatically between 300 and 1000 feet.[1] Goods movement sources that operate on land like trucks, locomotives, and cargo handling equipment, generate more near-source impacts than sources that operate over water. That is because the emissions from ocean-going ships and harbor craft have a longer distance to disperse before impacting a community. However, water-based sources still contribute significantly to regional air pollution and overall pollutant loading in the atmosphere.

California is experiencing a major increase in the amount of goods imported to our ports. Between 2000 and 2004, the number of containers measured as twenty-foot equivalent units (TEU) increased by 40 percent at the Ports of Los Angeles and Long Beach.[2] Between 1990 and 2004 traffic doubled from one to two million containers per year at the Port of Oakland.[2] The Southern California Association of Governments (SCAG) believes freight volumes will double or triple in the Los Angeles region over the next two decades[3]. The Bay Area Metropolitan Transportation Commission believes total cargo tonnage will double at the Port of Oakland between 2002 and 2020.[4]

The statewide air pollution impact of this growth is substantial. Figure II-1 shows the 2005 NOx emissions in the South Coast Air Basin for five major emissions categories. Figure II-2 displays those same emissions categories in 2020. ARB staff has updated its estimates since these charts were generated for the *Phase I Goods Movement Action Plan*[5] but the overall conclusion has not changed. Port-related emissions will increase between 2005 and 2020 and become a dominant source of emissions in future years if no action is taken.

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[1] California Air Resources Board (2005). Air Quality and Land Use Handbook: A Community Health Perspective. Available at: http://www.arb.ca.gov/ch/landuse.htm

[2] American Association of Port Authorities (2005). US / Canada Container Traffic in TEUs. Available at: http://www.aapa-ports.org/industryinfo/statistics.htm

[3] Southern California Association of Government (2004), Southern California Regional Strategy for Goods Movement, A Plan for Action. At: http://www.scag.ca.gov/goodsmove/pdf/GoodsmovePaper0305.pdf

[4] San Francisco Bay Conservation and Development Commission and Metropolitan Transportation Commission (2003), San Francisco Bay Area Seaport Plan

[5] California Air Resources Board (2005). Goods Movement Action Plan Phase I: Foundations. Available at: http://www.arb.ca.gov/gmp/docs/finalgmpplan090205.pdf.

Figure II-1
2005 NOx Emissions in the South Coast Air Basin

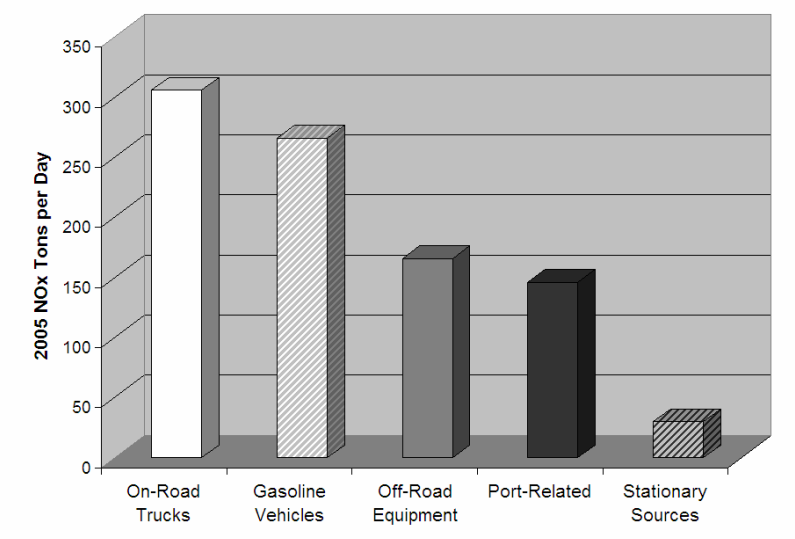


Figure Taken from Goods Movement Action Plan Phase I: Foundations (Page VI-8)

Figure II-2
2020 NOx Emissions in the South Coast Air Basin

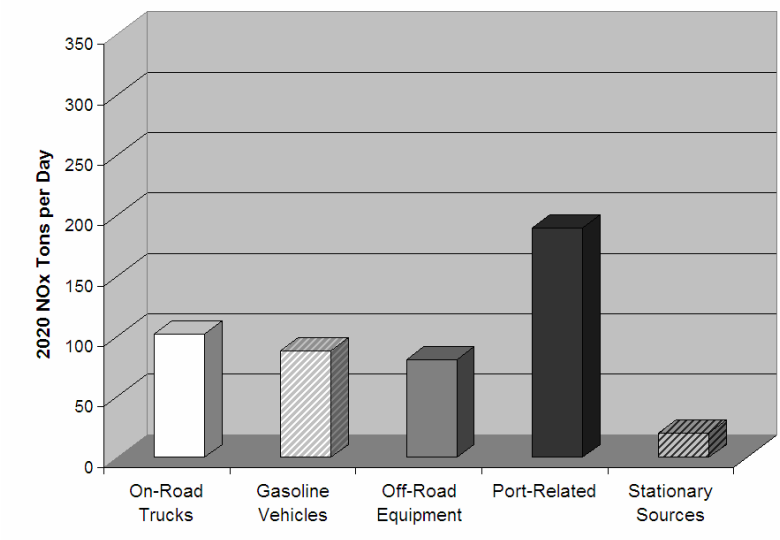


Figure Taken from Goods Movement Action Plan Phase I: Foundations (Page VI-9)

B. EMISSIONS SUMMARY

Table II-1 presents estimated goods movement emissions for 2001, the base year for this plan. On a typical day, more than 400 tons per day of NOx are emitted from ports and goods movement activities in California, representing about 10 percent of the statewide NOx inventory. Sixty tons per day of SOx were generated by ports and international goods movement in 2001. Diesel particulate emissions generated by goods movement were estimated to be about 18 tons per day of PM in 2001, representing about 20 percent of the statewide inventory.

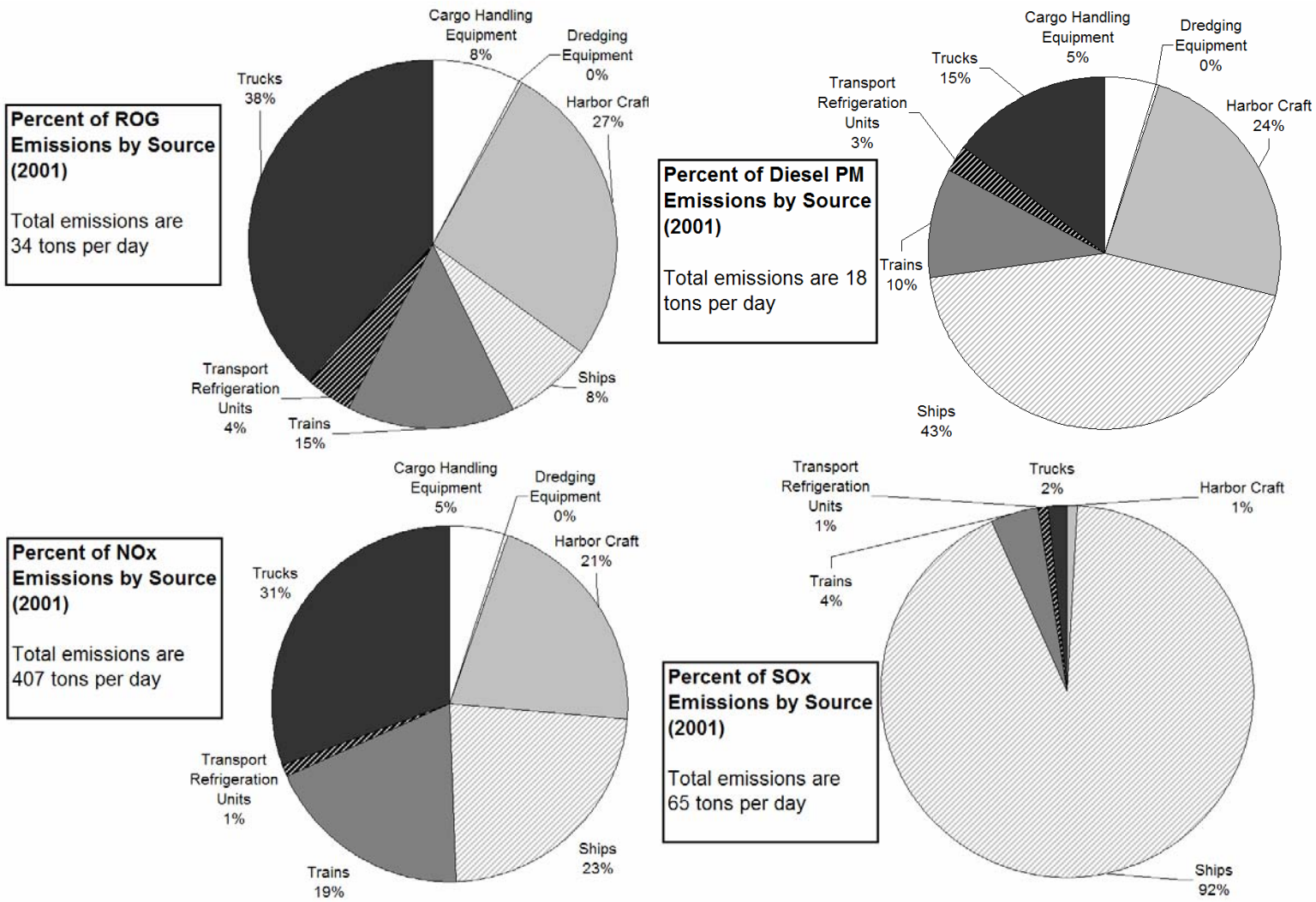
Table II-1
2001 Statewide Pollutant Emissions
from Ports and International Goods Movement
(tons per day)

Pollutant	Ships	Harbor Craft	Cargo Handling Equipment	Trucks and TRU	Trains	Total
Diesel PM	8	4	1	3	22	**18**
NOx	94	86	21	129	77	**407**
ROG	3	9	3	14	5	**34**
SOx	59	1	<1	2	3	**65**

The pie charts below in Figure II-3 depict the proportion of each source category's contribution to total goods movement emissions in 2001. Ocean-going ships are the largest contributor of SOx; while trucks are the largest single contributor of ROG and NOx. Taken together, ocean-going ships and harbor craft account for 65 percent of the diesel particulate goods movement inventory; the majority of these emissions are generated over the open ocean. Diesel particulate emission sources over land contribute around 40 percent of goods movement diesel particulate emissions; however, because these emissions occur over land their health impact is proportionally greater.

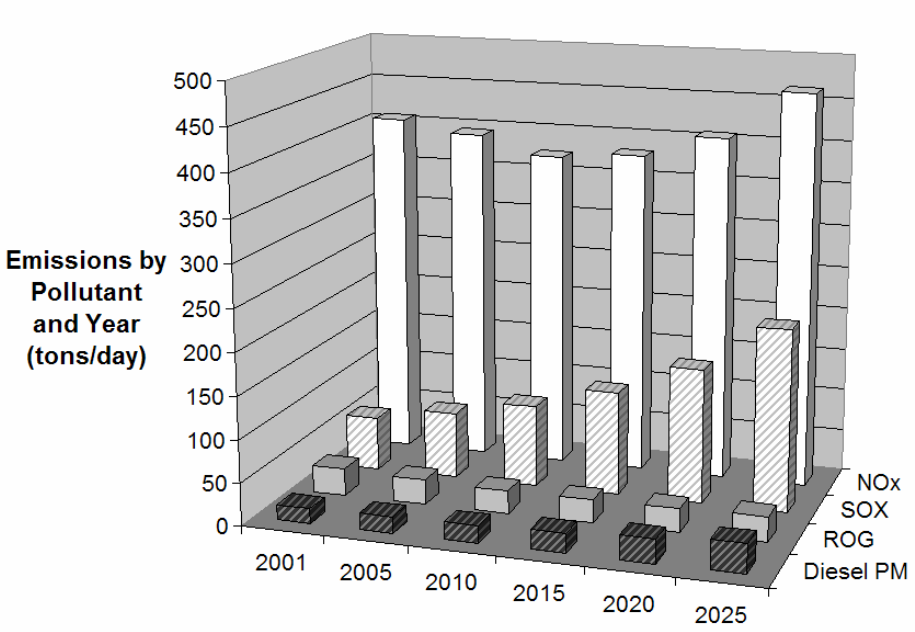
Over the past decade ARB and U.S. EPA have both taken steps to enact new engine standards and require the use of cleaner fuels. These regulations are working to reduce emissions now and into the future from trucks, locomotives, harbor craft, and cargo handling equipment. In the past these regulations have not applied to ocean-going ships; only recently have the first steps been taken to reduce their emissions. As a result, ocean-going ship emissions are currently increasing, while emissions in other goods movement categories are decreasing. This rate of decrease varies substantially by source category, and additional controls will be required of all categories to accelerate emission reductions to meet air quality goals.

Figure II-3. 2001 Ports and International Goods Movement Emissions



As imports increase, more ships will enter the ports, more cargo handling equipment will move goods, and more trucks and trains will transport those goods to their final destinations. This growth will have a major impact on southern California and the State as a whole. Figure II-4 provides growth estimates by pollutant and by year for 2001-2025. By 2025 diesel particulate emissions are projected to double and SOx emissions are projected to triple. NOx emissions are projected to increase more than 10 percent by 2025, primarily in areas that are currently not in attainment with air quality standards.

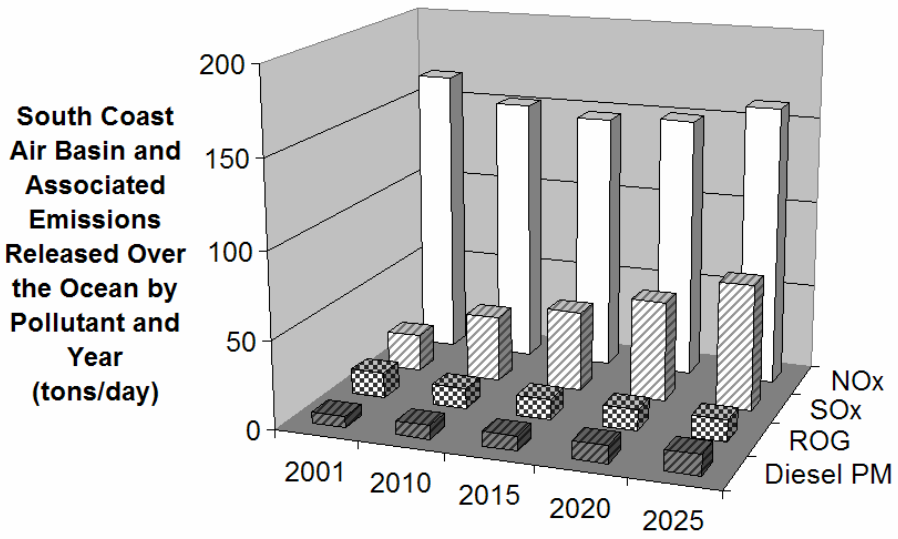
Figure II-4
Statewide Ports and International Goods Movement Emissions



These trends are also apparent in the greater Los Angeles region. Figure II-5 presents emissions in the South Coast Air Basin and emissions released over the ocean up to 24 miles off the coast of Los Angeles and Orange counties. Roughly one-third of all goods movement emissions statewide are generated in the Los Angeles region.

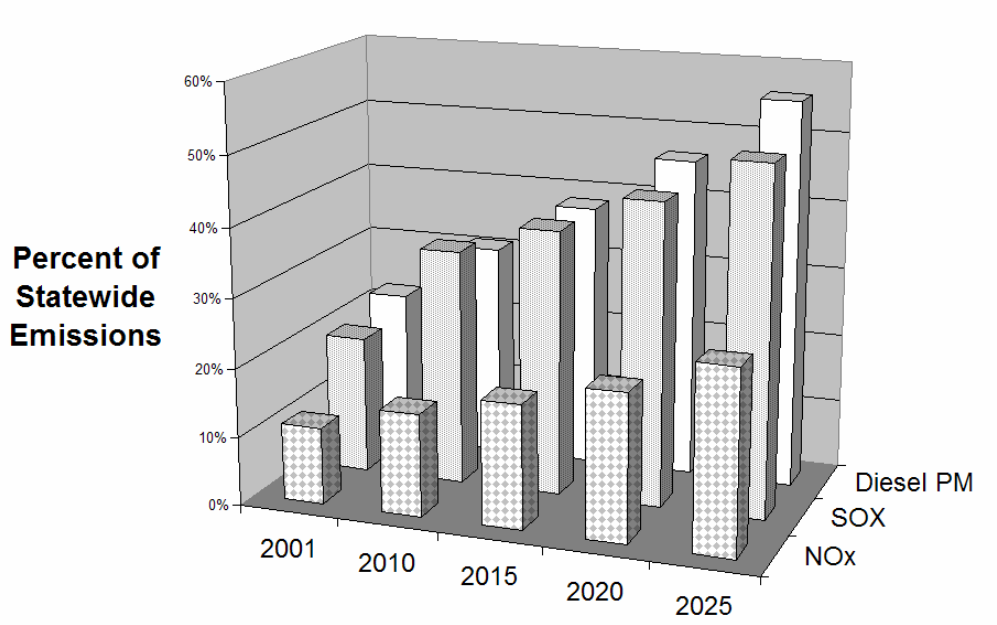
The increasing contribution of ports and international goods movement emissions to the statewide inventory is important. Figure II-6 compares goods movement and statewide emissions by pollutant for the years 2001-2025. By 2025, we estimate SOx from goods movement sources will represent more than 40 percent of the statewide SOx inventory. We estimate by 2025 diesel particulate emissions from goods movement sources will increase from 20 percent to more than 50 percent of the statewide inventory. NOx emissions will grow from 10 percent to 30 percent of the statewide inventory. Impacts will be at least as great in southern California as for the State as a whole given the expected increase in imports through the Ports of Los Angeles and Long Beach. These two ports together are the largest and most important port in the United States, and the third largest container port in the world.

Figure II-5
Ports and International Goods Movement Emissions in the South Coast Air Basin



As goods movement activity increases with growth in imported goods and our economy as a whole, the relative contribution of different source types to the emissions inventory will change. Figure II-7 displays the 2020 emissions inventory by pollutant and source category. Figure II-8 compares 2001 and 2020 goods movement emissions by pollutant and source category. Emissions generated by heavy-duty trucks, locomotives, and cargo handling equipment are projected to decrease between 2001 and 2020 due to existing control measures that have been adopted for these categories. At the same time, emissions from ocean-going ships are projected to increase substantially. As Figure II-7 shows, by 2020 ships and harbor craft will be responsible for at least 75 percent of all diesel particulates and NOx generated by goods movement activities statewide, and nearly all of the SOx.

Figure II-6
Ports and International Goods Movement Emissions as a Percentage of Statewide Emissions



C. EMISSIONS BY REGION

Ocean-going ships and harbor craft are a major source of goods movement related emissions. Most emissions from these categories are generated in shipping lanes off the coast of California in the outer continental shelf, as ships move from one port to another. Figure II-9 presents the percentage of goods movement emissions released by ships and harbor craft over the open ocean relative to total goods movement emissions. As the figure shows, a relatively large percentage of total goods movement emissions are generated over the open ocean. Emissions released over the ocean do impact air quality over land. Emissions of ROG, NOx, and SOx, which react in the atmosphere to form ozone and fine particulate matter, have a potentially strong impact on air quality. Direct emissions of diesel particulates will impact air quality, but their impacts on air quality may be less important than emissions which occur over land, because emissions disperse with distance. These issues are discussed in Appendix A.

California has four major goods movement corridors: (1) the Los Angeles-Inland Empire Region, (2) the Bay Area Region, (3) the San Diego/Border Region, and (4), the Central Valley Region. Regions like Los Angeles and the Bay Area are major centers of goods movement because they contain the largest ports in California. In particular, the Los Angeles region contains the largest ports in the United States and Southern California's economy and transportation infrastructure has developed around these ports. The Central Valley is a major corridor for transport of goods by truck and rail, and also contains the Ports of Stockton and Sacramento. Table II-2 provides 2001 emissions estimates for each of these four regions.

Figure II-7. 2020 Statewide Ports and International Goods Movement Emissions

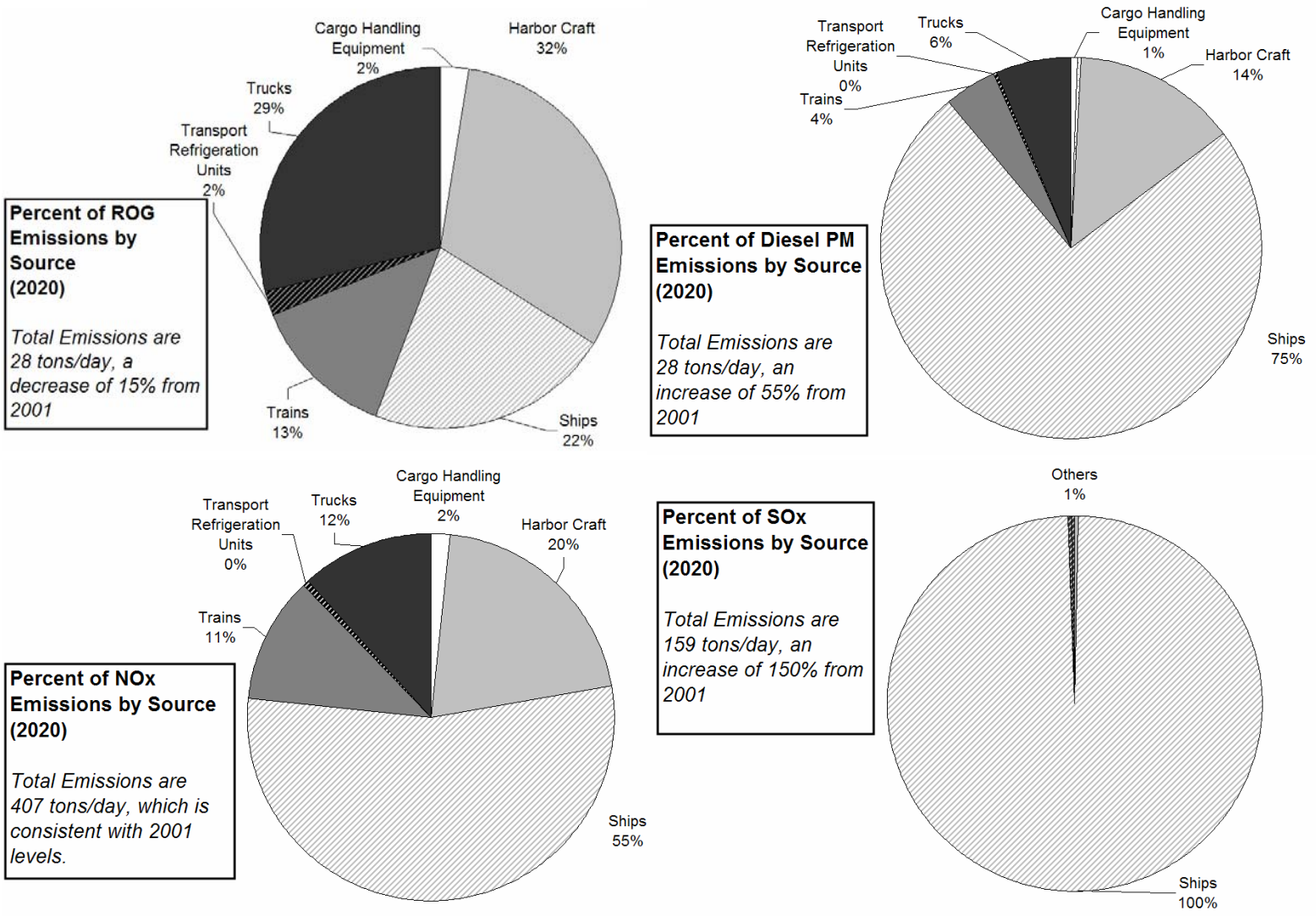


Figure II-8
Statewide Ports and International Goods Movement Emissions:
2001 v. 2020

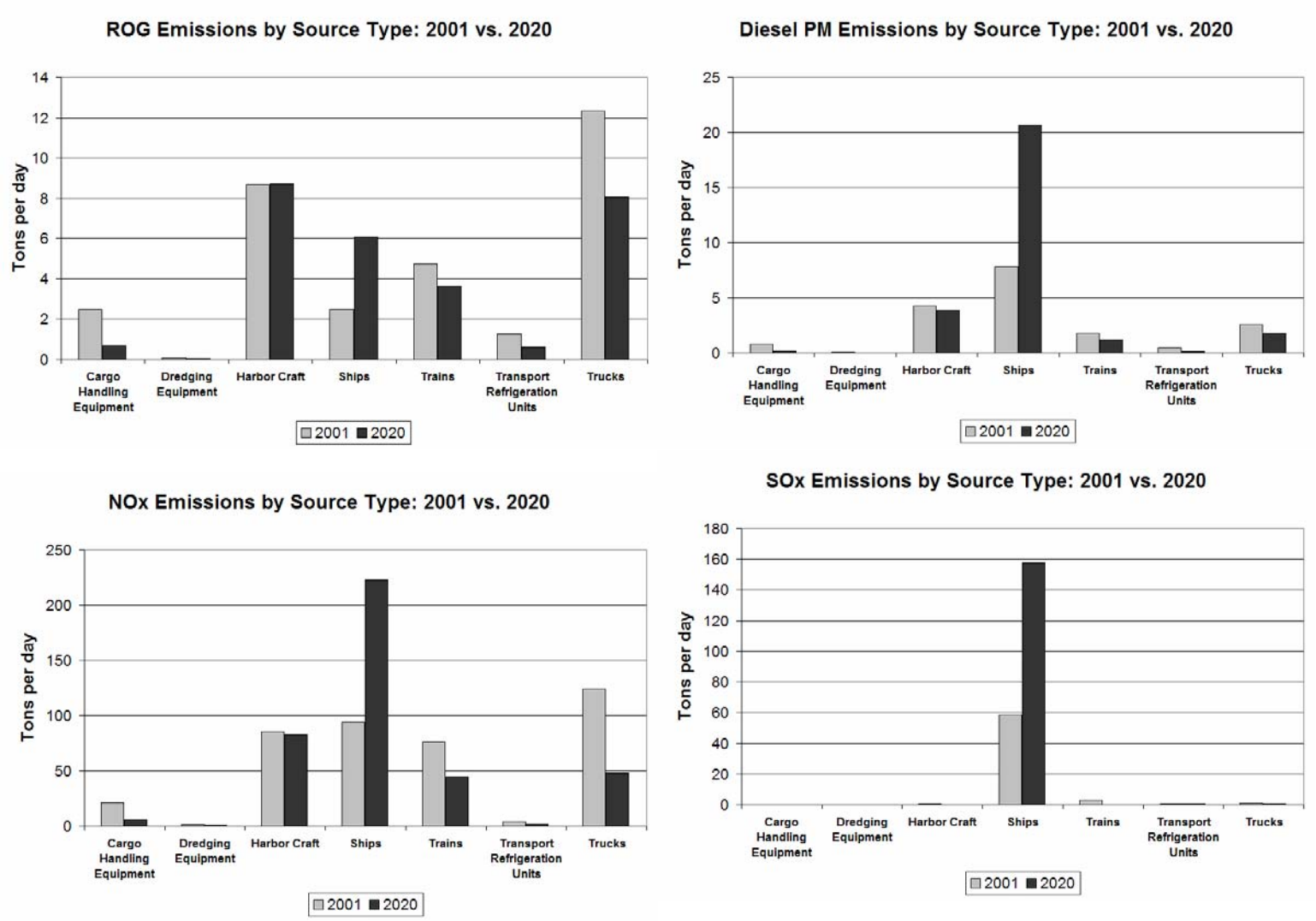


Figure II-9
Percent of Total Port and International Goods Movement Emissions in the Outer Continental Shelf

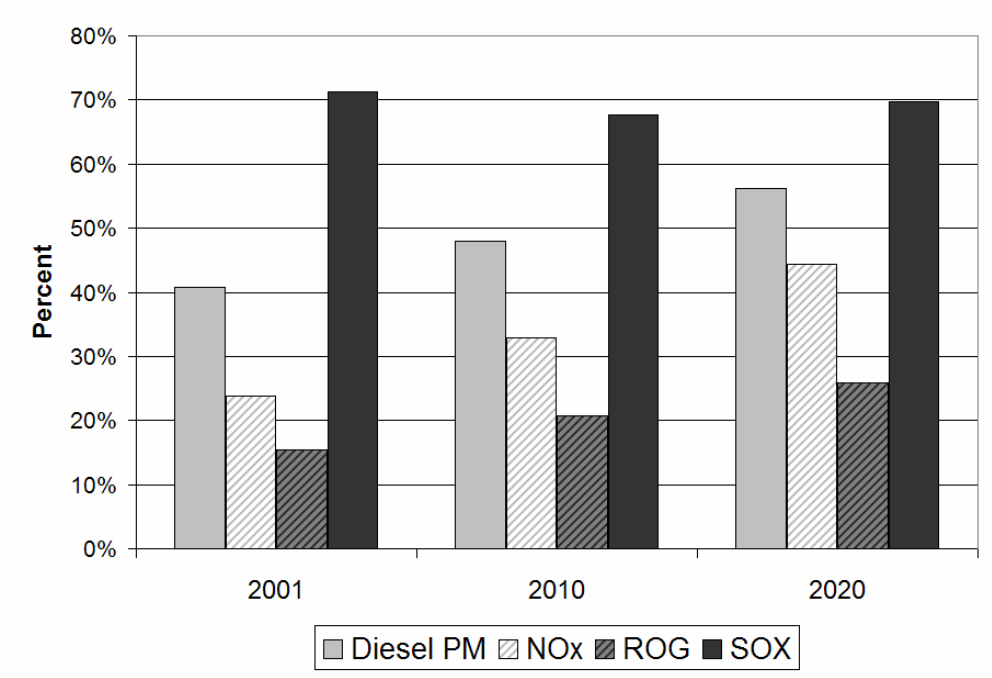


Table II-2
2001 Ports and International Goods Movement Related Emissions Released Over Land by Corridor Region
(tons per day)

Region	Diesel PM	NOx	ROG	SOx
South Coast	4	130	13	8
San Francisco	2	50	4	3
Central Valley	2	60	4	1
San Diego/Imperial	1	20	2	1

D. DEVELOPMENT OF EMISSIONS INVENTORIES

ARB staff used statewide emission inventories as a starting point and benchmark for estimating emissions related to goods movement. Other data sources were added to improve our understanding of specific goods movement sources such as ocean-going ships, harbor craft, cargo handling equipment, heavy-duty trucks, and trains. The following sections are intended to provide a brief overview of how these inventories were calculated. Details are provided in Appendix B to this report.

Several efforts are underway to improve this emissions inventory. New information will be incorporated in as it becomes available. Aspects of the inventory such as the number, location, age, activity patterns, growth, and control of the engines used in various source categories will continue to be reviewed and improved in future revisions to the goods movement inventory and this document.

1. Ocean-going Ships

Ocean-going ships can be classified into many different categories, including container ships that move goods in containers, tankers that move liquids like oil, roll-on/roll-off vessels that move imported automobiles from Asia, and others. Some vessel types, like container ships, directly move imported goods into the State. Other vessel types, like passenger vessels, are not engaged in goods movement, but do contribute emissions to the overall port-wide total. All types of ocean-going vessels are included in this analysis.

The ocean-going ship category is defined by size; the category includes all ships exceeding 400 feet in length or 10,000 gross tons in weight. These ships are typically powered by diesel and residual oil fueled marine engines. Ocean-going ships have two types of engines. The main engine is a very large engine used mainly to propel the vessel at sea. Auxiliary engines are engines that in general provide power for uses other than propulsion, such as electrical power for ship navigation and crew support. Passenger vessels use diesel electric engines, where a diesel or residual oil fueled engine acts as a power plant, providing power both for propulsion and general ship operations. For this reason, ARB considers engines on passenger vessels to be part of the auxiliary engine category.

ARB has recently developed an improved emissions inventory that accounts for emissions based on a variety of factors including type of vessel, transit locations, various ship engine sizes and loads, and other factors. The inventory covers three modes of ship operation: in-transit emissions generated as a ship travels at cruising speeds, generally in between ports of call; maneuvering emissions generated as a ship slows down in anticipation of arriving, moving within or departing a port; and hotelling emissions generated by auxiliary engines as a ship is docked at port.

For this analysis, emissions were calculated on a statewide basis for each port in California. Emissions are calculated for hotelling and maneuvering operating modes that occur within ports, and transit emissions as ships move up and down the California coastline. Emissions calculated within 24 nautical miles of the shore are included in this report. For emissions inventory tracking purposes, emissions are allocated to a port when they occur within three miles of shore. Emissions outside of three miles are allocated to the outer continental shelf air basin.

Growth of ocean-going vessel emissions are a major concern for developing a credible emissions inventory for this category. For this inventory, ARB staff worked with experts at the University of Delaware to compile data on the size of main engines visiting each

port in California over time. These data account for any increase in the number of ships visiting each port over time as well as the increasing size of these ships. Using data collected representing the years 1997-2003, we developed growth rate estimates for each port. For emissions at the Ports of Los Angeles and Long Beach, we used the growth rates developed for the Port of Los Angeles' No Net Increase Report,[6] which agree with ARB growth projections based on main engine size. As a result, growth rate estimates for 2025 used in this plan are consistent with the No Net Increase report.[6]

As with all emissions inventories, the ocean-going ship inventory provided in this report is a snapshot of a larger inventory effort which is evolving over time. Emission estimates are always somewhat speculative. This is especially true for categories such as ships where information is limited.

2. Commercial Harbor Craft

Harbor craft are commercial boats that operate generally within harbors, or are smaller ships that support a commercial or public purpose. The harbor craft category includes many vessels operated by the U.S. Coast Guard, fishing vessels, tug boats and other types of ships. Vessel types in the goods movement inventory include:

- Crew and Supply - Ships used for carrying personnel and supplies to and from off-shore and in-harbor locations.
- Pilot Vessels - Ships used to guide ocean-going vessels into and out of a port or harbor.
- Towboat/Pushboat - Ships used to tow/push barges and pontoons. The hull of these vessels is usually rectangular in plan and has little freeboard.
- Tug Boats - Ships used for the towing and pushing of ocean-going ships or other floating structures such as barges.
- Other - Ships used in various commercial operations that do not fit into any other category.
- Work Boat - Ships used to perform duties such as fire/rescue, law enforcement, hydrographic surveys, spill/response research, training, and construction.
- Ferry/Excursion Vessel - Vessels used for public use in the transportation of persons or property.
- Commercial Charter Fishing Vessel - Vessels available for hire by the general public and used for the search and collection of fish for the purpose of personal consumption.
- Commercial Fishing Vessel - Vessels used in the search and collection of fish for the purpose of sale at market.

ARB staff have recently developed an improved emissions inventory for the harbor craft category. The emission methodology uses the statewide population of ships, in conjunction with information about the size and activity of propulsion engines by ship

[6] Report to Mayor Hahn and Councilwoman Hahn by the No Net Increase Task Force: June 24, 2005. Available at: http://www.portoflosangeles.org/DOC/NNI_Final_Report.pdf

type obtained by survey to estimate emissions. Harbor craft have both propulsion and auxiliary engines; both are generally powered by diesel fuel. For most commercial harbor craft, the propulsion engines are the primary engines and move the vessel through the water. The auxiliary engines generally provide power to the vessels electrical systems and can also provide additional power to unique, essential vessel equipment (e.g. refrigeration units) during the normal day-to-day operation of the vessel.

Growth in harbor craft emissions was assessed by vessel category. Growth in tug boat emissions were assumed proportional to growth in the number of visits to each port by ocean-going ships in each year. No growth was assumed in other harbor craft ship types unless location specific information was provided by local authorities.

The commercial harbor craft inventory in this report, like the ocean-going ship inventory, is a snapshot of a larger inventory effort which is evolving over time. ARB staff are continuing to evaluate inventory assumptions in this category.

3. Cargo Handling Equipment

The cargo handling equipment category includes many different types of off-road vehicles that are used to move goods through California's ports and intermodal facilities. ARB staff recently developed a new emissions inventory representing cargo handling equipment that covers the following types of machines:

- Cranes – Because most large container handling cranes at ports are electrified, this category generally covers mobile cranes, often referred to as rubber tire gantry cranes, that are used to move, stack, and unstack containers at ports.
- Forklifts – Forklifts are used to move cargo and other equipment for short distances.
- Container Handling Equipment – Containers are handled using specific types of vehicles similar to forklifts called side picks, top picks, and reach stackers.
- General Industrial Equipment – This category covers various types of equipment including rail-car movers and heavy-duty off-highway trucks.
- Sweepers/Scrubbers – These vehicles are used to clean-up areas after bulk materials have been moved.
- Excavators – Excavators are a specific type of equipment designed for handling heavy dry bulk materials.
- Bulk Handling Equipment – This category covers tractors, loaders, and backhoes that are used to handle bulk materials.
- Yard Trucks – Yard trucks or "hostlers" are used to move containers within or between terminals.

The goods movement inventory provides emissions by equipment type and for each port and major intermodal facility in California. The inventory reflects updated population and activity data for cargo handling equipment statewide by equipment type based on a survey conducted by ARB in early 2004 and recent emission inventories prepared for the ports of Los Angeles and Long Beach. Growth rates were developed by equipment type from survey responses.

4. Heavy-Duty Trucks

Heavy-duty trucks are an integral and important component of California's goods movement transportation system. Nearly all goods, whether imported into California from overseas, imported into California from Canada, Mexico, or other states in America, generated and consumed within California, or generated and exported from California are moved by a truck at some time during their transport. Emissions generated by the movement of imported goods is only a fraction of the total emissions generated by heavy-duty trucks in California.

Emissions from heavy-duty trucks are estimated in California by a complex model, called EMFAC, which is designed to take into account many factors that affect emissions, from driving patterns and vehicle miles traveled (VMT), to engine age, technology, and controls. However, the EMFAC model provides emission estimates by vehicle class and by county. It does not provide emission estimates for a specific industry or sector of the economy, such as goods movement.

We used additional data sources and assumptions to estimate truck emissions generated during goods movement. First we estimated total truck emissions within each port and rail yard in California, and second, we estimated the fraction of heavy-duty truck emissions by air basin that can be attributed to goods movement. Inventory estimates representing trucks associated with goods movement should be considered draft in this document. These estimates represent the best information currently available to ARB staff.

To estimate truck emissions at ports and rail yards we used emissions data representing the Ports of Los Angeles and Long Beach that were published in 2004. These estimates included both idling and movement emissions within port boundaries and within individual marine terminals. We used combined emissions from the Ports of Los Angeles and Long Beach, and scaled these emissions to develop estimates for other ports based on total annual tonnage throughput at each port.[7]

We used combined emissions from the Ports of Los Angeles[8] and Long Beach,[9] and scaled these emissions to develop estimates for each intermodal rail yard in California using the total number of on-site dedicated yard trucks. The number of yard trucks was estimated by ARB staff at each rail yard in California based on a survey of cargo handling equipment that was part of the basis of the cargo handling equipment inventory described above. Overall, heavy-duty truck emissions at intermodal rail yards were a small fraction of emissions at major ports in California.

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[7] American Association of Port Authorities, (2005). Port Industry Statistics: 2003 US Port Cargo Tonnage Rankings. http://www.aapa-ports.org/industryinfo/statistics.htm

[8] Port of Los Angeles (2004). Port of Los Angeles Baseline Air Emissions Inventory – 2001. Available at: http://www.portoflosangeles.org/DOC/POLA_Final_BAEI.pdf

[9] Port of Long Beach (2004). 2002 Baseline Emissions Inventory. Available at: http://www.polb.com/civica/filebank/blobdload.asp?BlobID=2159

These estimates represent the best data currently available to ARB. We expect that by working with port and rail yard operators in the future, more refined emissions estimates can be generated.

We estimated the fraction of goods movement truck emissions in each air basin based upon data and reports generated by SCAG and other local transportation agencies in Southern California. In Southern California, SCAG generates estimates of total miles traveled by heavy-duty trucks within their jurisdiction (the Los Angeles and Inland Empire regions). SCAG maintains a heavy-duty truck travel demand model that estimates VMT as well as the number of trips that are generated by the Ports of Los Angeles and Long Beach, as shown in Table II-3.

Table II-3
Heavy-Duty Trucks Involved in International Goods Movement: Daily Trips, Vehicle Miles Traveled, and Estimated Trip Length Generated by the Ports of Los Angeles and Long Beach by Year

Year	Trips	VMT	Average Trip Length
2000	39500	1463670	37.1
2010	50800	1866550	36.7
2025	105540	3459040	32.8

These data were used to estimate the fraction of heavy-duty truck emissions in the SCAG regions that are related to direct trips to and from the Ports of Los Angeles and Long Beach.

Using technical reports generated by local transit agencies in the Los Angeles region, we estimated an additional amount of heavy-duty truck miles traveled as a result of secondary truck trips generated by a fraction of trucks that are expected to travel to a distribution center for either local or long-haul additional truck trips.[10] We assumed 38 percent of local primary truck trips result in three additional secondary trips by smaller trucks. These additional local trips were assumed to have the same length as primary truck trips. We assumed 21 percent of local primary truck trips terminate in a distribution center, where the contents of a 40 foot container are transloaded to a 53 foot container. Because a 40 foot container is about two-thirds the size of a 53 foot container, we assumed two-thirds additional transload long-haul trips are generated. Of these secondary, transload, long-haul trips, we assumed 27 percent terminated outside of the South Coast Air Basin in other areas of California, 20 percent terminated in Arizona, 6 percent terminated in Canada or Illinois, with the rest terminating in other national destinations.[11] We assumed a trip length associated with each termination point to estimate VMT by termination point. All primary trips, and all long-haul trips were assumed to be performed by heavy-heavy-duty trucks. VMT was summarized by year

[10] (ACTA, 2004), as cited in Jones and Stokes (2004), Port of Los Angeles, Portwide Rail Synopsis
[11] Metropolitan Transportation Authority (2004). DRAFT Compendium of Freight Information for the Greater Los Angeles Metropolitan Area

and compared to total VMT by vehicle class for the South Coast Air Basin in the EMFAC model. This ratio was then applied to emissions to estimate emissions related to trucks engaged in goods movement.

To estimate the fraction of goods movement emissions outside of the South Coast Air Basin, we scaled primary and secondary local VMT in the South Coast Air Basin to other air basins based on total tonnage throughput at each port. If no port was located in an air basin, no VMT was assigned. For the Port of Oakland, scaled primary trips estimated using SCAG trip estimates scaled by tonnage throughput at the Port of Oakland were used to estimate secondary truck trips based on the same transload long-haul percentage (21 percent) as assumed for the South Coast Air Basin. Thirty percent of trips were assumed to travel north, and 70 percent were assumed to travel east. A trip length was assumed for each of these trips.

Secondary trips generated by the Ports of Oakland, Los Angeles, and Long Beach were tracked for both expected destinations in a given air basin in California, and through traffic as long-haul trips travel to their final destination. A trip length was assumed for each of these trips to estimate secondary VMT. Total goods movement VMT by vehicle class was divided by the air basin VMT total by vehicle class. This ratio was then applied to estimate emissions related to trucks engaged in goods movement.

Table II-4 presents the fraction of truck emissions related to international import and export goods movement assumed for selected air basins in California. As is shown, a significant fraction of total emissions in the South Coast Air Basin are assumed related to ports and international goods movement. Because the Port of Oakland is smaller than the Ports of Los Angeles and Long Beach, the fraction of goods-movement related truck emissions is lower than in the South Coast Air Basin. Heavy-duty truck fractions are high in the Central Valley (Sacramento and San Joaquin Valleys) because of through traffic VMT generated by the Ports of Los Angeles, Long Beach, and Oakland.

Table II-4
Percentage of Truck Emissions Generated by International Goods Movement by Year, Air Basin, and Truck Type

Air Basin	2001 Light-Heavy and Medium-Heavy Duty Trucks	2001 Heavy-Heavy Duty Trucks	2025 Light-Heavy and Medium-Heavy Duty Trucks	2025 Heavy-Heavy Duty Trucks
South Coast	15	20	30	40
San Francisco Bay Area	1	7	2	15
San Diego	0	4	1	7
San Joaquin Valley	0	25	0	35
Sacramento Valley	0	20	0	40

5. Locomotives

Trains, and the diesel-fueled locomotives that power them, travel throughout California. The vast majority of trains in California move freight; a fraction of this freight represents freight that is imported into and through California from overseas, while the balance represents freight generated in California that is bound for export, and freight generated and consumed within California.

ARB's inventory of emissions from locomotives was first developed in 1987 and has been updated periodically since that time. The inventory uses a relatively simple methodology that accounts for generalized locomotive activity patterns over broad geographical regions. The inventory covers two types of train locomotives. Line-haul locomotives are large locomotives that are used to move trains over long distances. Switchers are locomotives used to transport smaller trains within a rail yard or over short distances. Switching engines are much smaller, and often older, than locomotives used for line-hauls. Line-haul locomotives operate in rail yards as they travel through to their final destination.

ARB staff started with our standard statewide locomotive inventory in order to develop an inventory of emissions from locomotives engaged in the movement of internationally imported and exported goods. To develop a goods movement inventory, we first reviewed available literature and information to estimate a percentage of overall train activity in each region of California that is related to imported and exported goods. This fraction ranged from 25 percent in most regions of California to 40 percent in the Los Angeles Region and about 35 percent in the Bay Area and Central Valley.

Next, we developed emission estimates for locomotive activity specifically within ports and rail yards. For ports, we used locomotive emission estimates developed by the Ports of Los Angeles and Long Beach, and scaled these emissions to develop estimates for other ports based on port-specific total tonnage of freight throughput. All port emissions were assumed related to internationally imported and exported goods. For off-port rail yards, we used locomotive emissions estimates for the Roseville Rail Yard that were developed previously by ARB, and scaled these emissions to develop estimates for other rail yards based on our best estimate of the number of locomotives and railcars passing through each rail yard on an annual basis. These emission estimates are based upon the best data currently available to ARB staff. As the State's major rail carriers submit additional data required through the Statewide Rail Memorandum of Understanding with major rail carriers, these estimates will improve.

E. FUTURE REFINEMENTS

ARB constantly improves emission inventories as new data are received. In the future, we hope to improve inventories by integrating comprehensive emission estimates for all categories of emissions at ports and rail yards throughout California. Improving the spatial accuracy and detail of emission estimates at key facilities like ports and rail

yards in California is one of ARB's long-term goals. Some of these data will be collected through discussions with ports, especially through ongoing discussions with the Ports of Los Angeles and Long Beach. Improved emissions data for rail yards, and locomotive inventories more generally will become available through the Statewide Locomotive Memorandum of Understanding with rail companies which operate in California. In addition, through the EMFAC model, ARB is constantly improving inventory estimates representing diesel powered trucks that operate throughout the State. Over time, we are working to improve the detail and accuracy of emission estimates on fine spatial scales such as regions around the Ports of Los Angeles and Long Beach, as well as specific freeway segments in key regions throughout the State.