THE PLANE TRUTH

Air Quality Impacts of Airport Operations and Strategies for Sustainability: A Case Study of the Los Angeles World Airports

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OVERVIEW OF THE PROBLEM

The aviation industry emits air pollution

Aircraft and the vehicles, facilities, and operations that support aviation emit many types of "criteria air pollutants,"[i] including nitrogen oxides (NOx), particulate matter (PM), carbon monoxide (CO), and sulfur oxides (SOx) that cause local environmental and health problems. For example, NOx — combined with volatile organic compounds (VOC) in the presence of sunshine — is a key precursor to ground-level ozone. Ozone (smog) is a powerful oxidant that can damage the respiratory tract and induce symptoms such as coughing, chest tightness, shortness of breath, worsening of asthma symptoms, and even death.[13] The majority of our nation's busiest airports fall in ozone non-attainment areas.[14]

Aviation contributes approximately 0.5 percent of the total US inventory of NOx pollution.[15] According to members of the State and Territorial Air Pollution Program Administrators, NOx emissions from major airports are often greater than emissions from large stationary sources such as refineries and electrical generating facilities.[16] Table 1 shows the contributions that the nation's largest airports have on regional NOx inventories. Considering the myriad sources of NOx pollution, even a small percentage in the total NOx inventory represents a large amount of pollution.

Los Angeles International Airport is one of the largest sources of NOx and VOC emissions in the South Coast Air Basin.[17] The staff of the South Coast Air Quality Management District (SCAQMD) estimated that LAX contributes one percent of the Air Basin's annual NOx emissions. To put the airport's emissions in perspective, LAX's 6,522 tons of NOx emissions in 1993 placed it as the top emitter of this pollutant in the South Coast Air Basin, well ahead of second place Mobil Oil Corporation (2,731 tons), and third place Chevron Corporation (1,921

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[i] The U.S. Environmental Protection Agency sets National Ambient Air Quality Standards for six common air pollutants known as "criteria pollutants" because EPA develops human health-based and/or environmentally-based criteria for setting permissible levels for these six pollutants. These pollutants are particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead. Source: U.S. Environmental Protection Agency, http://www.epa.gov/air/urbanair/.

tons). With regard to VOC, LAX's 1993 VOC emissions were almost three times the emissions from the basin's largest oil refinery and more than 10 times the VOC emissions from Santa Ana's John Wayne Airport.[18]

Table 1

Airport Contributions to NOx Inventories

Airport	National Rank (Enplanements)	Ozone Non-Attainment Status	Airport Contribution to Area NOx Inventory	Airport Contribution to Non-Road NOx Inventory
Hartsfield Atlanta International	1	Marginal	2.8%	14.1%
Chicago Nonattainment Area (ORD, MDW)	2 (ORD), 28 (MDW)	Moderate	0.8-2.0%	10.5%
South Coast California (BUR, LAX, LGB, ONT, SNA)	3 (LAX), 44 (SNA), 51 (ONT), 61 (BUR),93 (LGB)	Severe	1.5%	5.7%
Dallas/Fort Worth Air Quality Area (DFW, DAL, AFW)	4 (DFW), 53 (DAL)	Moderate	6.1%	19.9%
Houston Bush Intercontinental	8	Moderate	0.7%	3.3%

Source: Federal Aviation Administration, Office of Energy and Environment. "Aviation and Emissions: A Primer." January, 2005.
http://www.faa.gov/regulations_policies/policy_guidance/envir_policy/media/aeprimer.pdf

Aircraft– just one source of airport-related emissions– is a major source of SOx pollution in the South Coast Air Basin. As illustrated in Table 2, aircraft are the fifth largest source of SOx emissions. The SCAQMD expects this ranking to jump to number three by 2014.[19] It should be noted that the most recent regional and state emission inventories do not address airport emissions cumulatively. Not included in the inventory are other sources of airport related emissions, such as the equipment that services the aircraft and the vehicles going to and from an airport. Therefore, the inventories underestimate the role that the aviation sector plays in emission inventories.

Table 2

Top 10 Sources of SOx Emissions (2002, 2014, and 2023) in the South Coast Air Basin, from Highest to Lowest

	2002	2014	2023
1	Ships & Commercial Boats	Ships & Commercial Boats	Ships & Commercial Boats
2	RECLAIM	RECLAIM	RECLAIM
3	Petroleum Refineries (non-RECLAIM)	Aircraft	Aircraft
4	Heavy-Duty Diesel Trucks	Manufacturing & Industrial Combustion	Manufacturing & Industrial Combustion
5	Aircraft	Light-Duty Passenger Cars	Light-Duty Passenger Cars
6	Trains	Light-Duty Trucks	Light-Duty Trucks
7	Off-Road Equipment	Service & Commercial Combustion	Service & Commercial Combustion
8	Light-Duty Passenger Cars	Petroleum Refineries (non-RECLAIM)	Petroleum Refineries (non-RECLAIM)
9	Manufacturing & Industrial Combustion	Waste Burning & Disposal	Waste Burning & Disposal
10	Light-Duty Trucks	Residential Fuel Combustion	Residential Fuel Combustion

Source: South Coast Air Quality Management District, "2007 Air Quality Management Plan." http://www.aqmd.gov/aqmp/07aqmp/draft/07aqmp.pdf.
A total of 48 airports were identified as having reportable operations within the District boundaries.

Aircraft is currently not one of the top ten emitters of NOx in region, but SCAQMD expects aircraft's contribution to NOx pollution in the South Coast Basin to grow significantly to the fourth top source of NOx pollution by 2023, as indicated in Table 3.[20] This is due to expected growth in air travel and reductions in other sources of emissions.

Table 3

Top Ten Sources of NOx Emissions (2002, 2014, and 2023) in the South Coast Air Basin, from Highest to Lowest

	2002	2014	2023
1	Off-Road Equipment	Heavy-Duty Diesel Trucks	Ships & Commercial Boats
2	Heavy-Duty Diesel Trucks	Off-Road Equipment	Off-Road Equipment
3	Light-Duty Passenger Cars	Ships & Commercial Boats	Heavy-Duty Diesel Trucks
4	Light-Duty Trucks	Light-Duty Trucks	Aircraft
5	Ships & Commercial Boats	Light-Duty Passenger Cars	Trains
6	Medium-Duty Trucks	RECLAIM	RECLAIM
7	Heavy-Duty Gasoline Trucks	Heavy-Duty Gasoline Trucks	Light-Duty Trucks
8	Trains	Trains	Residential Fuel Combustion
9	RECLAIM	Residential Fuel Combustion	Light-Duty Passenger Cars
10	Residential Fuel Combustion	Aircraft	Heavy-Duty Gasoline Trucks

Source: South Coast Air Quality Management District, "2007 Air Quality Management Plan." http://www.aqmd.gov/aqmp/07aqmp/draft/07aqmp.pdf.
A total of 48 airports were identified as having reportable operations within the District boundaries.

Aviation emits greenhouse gases

The Intergovernmental Panel on Climate Change concluded in 1999 that aircraft alone accounted for 13 percent of all carbon dioxide emissions (CO2) from the transportation sector and was responsible for 3.5 percent of global climate change.[21] CO2 is the greenhouse gas with the most significant impact on climate change. Airplanes emit more CO2 per passenger-mile than most other modes of transportation because of their high energy intensity.[22]

While aircraft fuel efficiencies have steadily increased over the past several decades, demand for air travel has grown more rapidly than efficiency improvements, causing CO2 and other greenhouse gases emissions to continue to increase.[23] These trends will continue under a "business-as-usual" scenario where the global economy continues to grow over the long-term and there are no specific policies targeting aviation related greenhouse gas emissions.[24] Table 4 illustrates the growth in US world greenhouse gas emissions.

Table 4

US and World Greenhouse Gas Emissions

	Units: Millions of metric tons of CO2 equivalent	Year: 1990	Year: 2005	% Change from 1990 to 2005
World	Total Aircraft: Domestic and International	—	641.0	—
United States	Commercial, Domestic	136.7	150.4	10% increase
	General Aviation, Domestic	9.4	13.8	47% increase

Source: McCollum, D.; Gould, G.; Greene, D. "Greenhouse Gas Emissions from Aviation and Marine Transportation: Mitigation Potential and Policies." Pew Center on Global Climate Change. Dec 2009.

Air travel is down, but long-term growth will likely occur

The US aviation industry experienced turbulence during the first decade of the twentieth century. Negatively impacted by the September 11, 2001 terrorist attacks, the industry rebounded by 2006. However, unprecedented fuel prices in 2008 followed by a worsening global economic recession constrained the airline industry in 2008 and 2009.[25] In 2008, the US airline industry experienced $5.8 billion in operating losses for the year and multiple bankruptcies. Prior to the fourth quarter of 2007, the industry had experienced six consecutive quarters of operating profits totaling $11.8 billion.[26]

During the first half of the decade, the Los Angeles World Airports announced several airport projects designed to accommodate expected growth in both passenger and cargo air traffic, but since then business at these airports has decreased. Such projects at Los Angeles International Airport (LAX) and LA/Ontario International Airport are still moving forward despite passenger and cargo operations that are lower than forecasted.

LA/Ontario International Airport (ONT) exemplifies the turbulence in the airline industry during this past decade. Until recently, ONT was setting growth records. Airlines flocked to the Inland Empire airfield in what Los Angeles Mayor Antonio Villaraigosa hailed as the "great first steps" to regionalizing air travel in Southern California.[27] However, ONT has been hit harder than any other airport in Southern California by the aviation fuel and economic crisis.[28] In the fall of 2008, flights were down approximately one-third from the previous year, frustrating promises by politicians to shift some service away from LAX.[29] Officials for the Los Angeles World Airports say that ONT and LAX are particularly affected because they are neither hubs nor headquarters for major domestic airlines; when economic times are bad, airlines concentrate flights at their hubs to save money and to take advantage of their established markets.[30]

Despite the recent dip in air traffic nationwide and locally, officials at the Federal Aviation Administration (FAA) continue to forecast long-term aviation growth. Their 2009 forecast for commercial aviation anticipates a sharp decline in activity in the near- term, with a return to growth over the long-term. Specifically, this forecast predicts that the US commercial aviation industry will break a new record and carry one billion passengers by 2016.[31] At a more local level, staff at the Southern California Association of Governments (SCAG) predict that air passenger demand in the region will more than double to 170 million passengers in 2030 and that air cargo will more than triple to 8.7 million tons in 2030.[32]

As aviation traffic increases, so will the environmental impacts

Airport-related air pollution and greenhouse gas emissions are projected to grow as the demand for air travel is expected to increase more than aviation technology, operations, or other advancements over the long-term.[33] In 2005, staff at the US Department of Transportation (DOT) predicted that aircraft greenhouse emissions would increase 60 percent by 2025.[34]

Other projections are even more staggering. In 2007, experts at the US DOT Volpe Center forecasted aviation-related CO_2 globally to rise from 572 million tons in 2000 to 1,228 million by 2025, a 114 percent increase.[35] These experts also predicted that NOx pollution around airports would rise from 2.5 million tons in 2000 to 6.1 in 2025, a 144 percent increase.[36] Finally, computations provided to the US House of Representatives by staff at the Joint Planning Development Office show that aviation noise pollution and air pollution emissions are likely to increase by a whopping 140-200 percent by 2025 under future aviation growth scenarios, unless aggressive actions are taken to control and reduce aviation's environmental footprint.[37]

While these predictions from 2005 and 2007 are likely somewhat inflated based on the recent downturn in air travel, the timeline for reaching these projected numbers has merely shifted. Given what will likely be a long-term increase in air travel, these emission forecasts cannot be ignored. Aviation will be able to count on technology to reduce some emissions per passenger mile, but the long-term growth in air travel— both an enabler and a product of the burgeoning global economy— is likely to outpace technology efficiency gains.[38] This is at a time when other sources of pollution are decreasing. For most states and localities with major airports and seaports, aircraft and international marine vessels are the only two source sectors where emissions are projected to increase in the future.[39]

Air quality regulators and airports managers face challenges— while also missing opportunities— to reduce airport-related air pollution

Airport-related emissions are subject to a complex, multidimensional patchwork of regulations and voluntary programs. Most airport-related emission sources are independently regulated through equipment specific regulations, standards, and operational guidelines, which are established by a variety of agencies. For example, stationary sources at airports, like power boilers and refrigeration chillers, must meet independent state regulations. And the Federal Aviation Administration is responsible for enforcing aircraft emissions standards established by the US Environmental Protection Agency based on the international standards set by International Civil Aviation Organization (ICOA).

The International Civil Aviation Organization (ICAO) is a United Nations intergovernmental body responsible for worldwide planning, implementation, and coordination of civil aviation. The United States is one of 188 participating member States. Under the basic ICAO treaty established in 1944, as long as a participating nation adopts aircraft emission standards that are equal to or more stringent than the ICAO's standards, it satisfies its obligations under ICAO.[40] Therefore, the ICAO sets emission standards for jet engines that are the basis of the FAA's aircraft engine performance certification standards, established through the EPA's regulations. The ICAO has long been the forum for evaluating the environmental performance of aircraft engines.[41]

The ICAO has taken a "technology progressing" approach, raising standards within the capabilities of proven technologies and certified products (engines and aircraft) rather than a "technology forcing" approach, which set standards based on technology that is not yet certified, still in the development process, or may not even exist.[42] The ICAO's approach is based on the premise that the safety of aircraft operations restricts the use of unproven new technologies.

The FAA and the ICOA, in a sense, limit the EPA's jurisdiction over airport related emission sources. The EPA has historically worked with the FAA and the ICAO in the development of international aircraft emission standards. The FAA enforces the aircraft emissions standards established by the EPA in alignment with the ICAO's standards. The ICOA itself does not have much authority to enforce the standards that they set.

AIR POLLUTION

The Clean Air Act requires the EPA to set National Ambient Air Quality Standards for six common air pollutants found all over the US. They are: particulate matter, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead. Airports operations emit all of these pollutants along with toxic air pollutants and greenhouse gases. I have already described some of pollutants and their impacts earlier in this report. The following section provides more detail about key pollutants related to airports in the Los Angeles region.

Lead Pollution

Lead is a metal now banned in the kerosene fuel used in commercial aircraft in the US In fact, due to its toxicity, the Clean Air Act of 1990 originally stated that all leaded fuels would be eliminated by 1996. However, the Clean Air Act of 1990 was later amended to include one exemption— for aviation gas (avgas). Avgas is a leaded fuel used in non-commercial, piston-engine aircraft (private, corporate, and government jets) that frequent general aviation and air taxi airports. Avgas contains four times more lead than leaded gasoline before it was banned from new cars in 1973.[90] Emissions of lead from avgas are the largest single source category for emissions of airborne lead in the US, comprising approximately half of the national inventory.[91]

The tetra-ethyl lead found in leaded avgas and its combustion products are potent neurotoxins. The US Centers for Disease Control and Prevention (CDC) concluded in 2005 that no "safe threshold for blood lead has been identified."[92] Lead can adversely affect the nervous system, kidney function, immune system, reproductive and developmental systems and the cardiovascular system.[93] The lead effects most commonly encountered in current populations are neurological effects in children and cardiovascular effects (e.g. high blood pressure and heart disease) in adults. Infants and young children are especially sensitive to even low levels of lead, which may contribute to behavioral problems, learning deficits and lowered IQ.[94] Lead exposure can occur from breathing or swallowing lead particles/dust, or by eating soil or paint chips containing lead.[95]

Figures 4 and 5 illustrate that lead levels are elevated near airports. The correlation is especially apparent near airports with high levels of general aviation operations (takeoff and landings of private, corporate, and government jets), such as Van Nuys Airports with almost 400,000 general aviation operations in

2008, Long Beach Airport with about 300,000 general aviation operations in 2008, Santa Monica Airport with approximately 150,000 general aviation operations, and Whiteman Airport with about 115,000 general aviation operations.

Figure 4