AIR POLLUTION MITIGATION MEASURES FOR AIRPORT-RELATED ACTIVITY

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Over the past three decades, all aspects of the transportation industry have been subjected to regulations, emission standards, and mitigation measures designed to reduce air pollution. Traditionally, on-road cars, trucks, and buses have borne the brunt of these controls. More recently, however, additional sources such as off-road vehicles, mobile equipment, and aircraft and airport-related sources have been targeted for control.

Presented here is a discussion of the nature of airport-related air pollution sources and mitigation measures. While these measures can be applied at airports throughout the United States, the illustrations are drawn from airports in Southern California, which seems to be everyone's favorite laboratory for trying out new cures for air pollution.

Three areas of activity at an airport are important from an emissions standpoint: aircraft operations, ground support equipment (GSE) for servicing aircraft, and other activities that relate directly or indirectly to the operation of the airport. Aircraft operations and GSE operations, which are considered part of the airside operations are discussed here. Airport landside operations, such as passenger pickup and dropoff, and activities of airport tenants such as rental car agencies, commercial services, parking facilities, etc., are covered in a separate presentation that follows

TRENDS

Growth in air travel in the United States has averaged more than 5 percent per year for the past decade. The growth in California has been even higher since it is the U.S. gateway for travel to Asia, the fastest growing segment of international air travel. The growth rate of California air travel, measured by millions of annual passengers (MAP) or landings and takeoffs (LTO), is not expected to diminish through the first half of the next decade. (Figures 1 and 2) To accommodate this growth, many airports have plans to expand their runways, their passenger facilities, or both. As many as six California airports have major construction projects either under way or in design.

Robust growth of this sort can lead to congestion on both the airport airside and landside. Aircraft may wait in line to take off, and upon arrival, wait for an empty gate. During peak periods, passenger traffic to the airport can overload access roads and parking facilities. Construction, congestion, and general increase in airport activity all result from this growth, with the net effect that emissions of hydrocarbons (HC) , carbon monoxide (CO), and oxides of nitrogen (NO_x) from activities on and adjacent to airports are a growing part of the emission inventory. (Figure 2)

SOURCES

Table 1 is an inventory of the sources of aircraft and ground support equipment emissions. Emission inventories for aircraft are based on a landing and takeoff (LTO) cycle, which begins at the time an aircraft starts its engines and continues through taxi to the runway, takeoff, and climb to cruise altitude, and concludes with approach, landing, and taxi to the gate where the engines are shut down. HC and CO emissions are very high during taxi and idle operations when aircraft engines are at low power and operate at less then optimum efficiency. These emissions decline, on a per-pound-of-fuel basis, as the aircraft moves into the higher-power operating modes of the LTO cycle. Thus, operation in the taxi and idle modes, when aircraft are on the ground at low power, is a significant source of HC and CO emissions. When considering mitigation methods for HC and CO, the objective is to minimize the aircraft operation at idle and low-power taxi.

NO_x emissions, on the other hand, are low when engine power and combustion temperatures are low, but

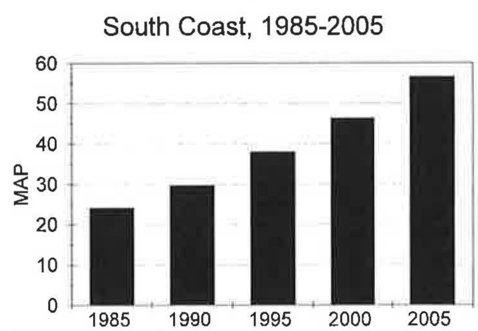

FIGURE 1 Millions of annual passengers (MAP), South Coast 1985-2005.

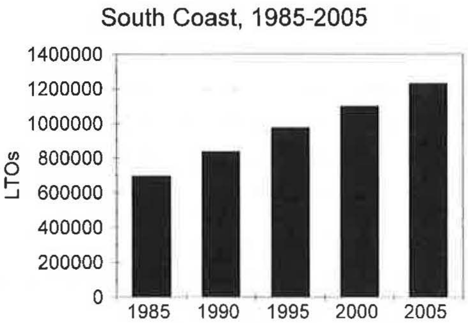

FIGURE 2 Aircraft landings and takeoffs (LTO), South Coast 1985-2005.

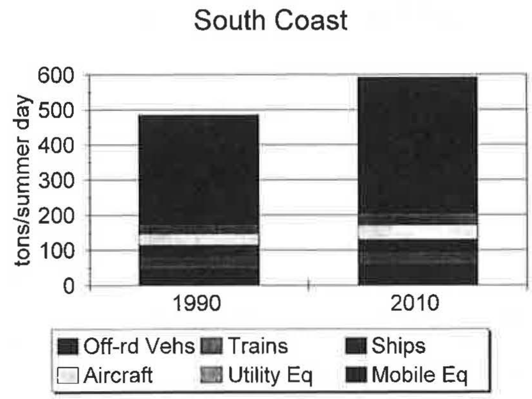

FIGURE 3 Sources of nonroad mobile hydrocarbon and nitrogen oxide emission, South Coast.

rise as the power level is increased and higher combustion temperatures are reached. Thus, the takeoff and climbout modes have the highest NO_x emission rates, and the most effective NO_x mitigation measures target reducing the number of LTO cycles.

A second source of emissions is the wide variety of equipment used in ground support of aircraft operations (GSE). The three distinct categories of GSE included in the emission inventory are: mobile equipment with engines certified to on-road emissions standards, other mobile equipment, and transportable equipment. The latter two are currently unregulated. This equipment produces tailpipe HC, CO, and NO_x emissions, plus evaporative, refueling, and crankcase HC emissions. Table 1 lists the GSE typically in use.

AIRCRAFT MITIGATION MEASURES

The most desirable aircraft mitigation measures are those that reduce emissions without disrupting the safe transport of passengers and freight. Table 2 lists examples of mitigation measures: decreasing engine operation, decreasing aircraft time in inefficient modes such as taxiing and idling, decreasing fleet average engine emission factors, and decreasing the number of LTOs.

As an example, consider one of these mitigation measures, single or reduced engine taxiing. Large commercial aircraft have two, three, or four engines. Since low thrust is needed to taxi an aircraft, one or more engines can be shut down during taxi. Not only does this eliminate emissions from the engines shut down, the remaining engines operate at higher RPM. The result is more efficient operation and lower the HC and CO emissions per pound of fuel consumed. The longer the taxi time, the greater the emission benefit from single or reduced engine taxiing. As a consequence, this mitigation measure is most useful at crowded airports where aircraft cannot proceed directly from the gate to the runway. Since all engines must run for at least two minutes prior to takeoff to achieve thermal stability, this measure may not be as useful at uncrowded airports. However, at a busy airport like Los Angeles International, single or reduced engine taxiing can reduce HC and CO taxi and idle emissions by almost 15 percent.

Table 3 illustrates additional mitigation measures, all of which have the potential to dramatically reduce all emissions from aircraft operations. Measures such as modernizing the aircraft fleet and establishing new engine emission factors are either expensive to implement, or can take years to fully implement, or both. Discussion of these is beyond the scope of this brief overview.

GSE MITIGATION MEASURES

GSE emissions range from 2 to 6 percent of total emissions at commercial airports. When parked at a terminal gate, today's large commercial aircraft require an electrical power source and, during warm weather, air conditioning. The electricity operates the avionics, on-board lighting, etc. Air conditioning keeps the passenger compartment comfortable and sensitive electronic equipment within its design operating temperature range. There are two commonly used ways to provide for these needs. In the absence of other support, the aircraft's Auxiliary Power Unit (APU) provides the electricity and air-conditioning. Alternatively, ground support equipment can provide electricity from a mobile ground power unit (GPU) and air-conditioning from a mobile air conditioning cart. Both types of GSE use

TABLE 1 AIRPORT EMISSION SOURCES

Aircraft
• Idling at gates and on taxi/runway; • Taxiing to/from runway; • Take off/landing; and • Auxiliary power for air conditioning, electrical, and engine starting needs.
Ground Support Equipment
• Ground units for air conditioning, electrical power, and engine starting needs; • Service tractors for baggage, push-back, and towing; and • Others (baggage belts, fuel service, lavatory carts).

TABLE 2 AIRCRAFT MITIGATION MEASURES

Objective	Measure
Decrease Engine Operation	• Single/reduced engine taxiing; and • Lengthen runways to reduce need for reverse thrust.
Decrease Times in Mode	• Tow aircraft to runway; • Take passengers to aircraft near runway; and • Reduce airport congestion.

TABLE 3 ADDITIONAL AIRCRAFT MITIGATION MEASURES

Objective	Measure
Decrease Fleet Average Engine Emission Factors	• Modernize fleet; • Establish new engine emission standards; and • Derate takeoff power.
Decrease LTOs	• Use larger aircraft; • Increase load factor; • Limit number of operations; and • Manage fleet.

TABLE 4 GSE MITIGATION MEASURES

Objective	Measure
Reduce Aircraft Engine Idle Time	• Provide central ground power and air conditioning.
Reduce GSE Emissions	• Alternative fuels or electric power for GSE.

TABLE 5 RESPONSIBLE PARTIES

Measure	Responsible Party
• Single/reduced engine taxiing; • Modernize fleet; • Derate takeoff power; • Use larger aircraft; • Increase load factor; • Manage fleet; and • Alternate fuels for GSE.	Airlines
• Lengthen runways; • Tow aircraft to runway; and • Take passengers to aircraft near runway.	Airports
• Provide central power and air conditioning.	Airports/Airlines
• Reduce airport airside congestion.	FAA/Airports
• Limit number of LTO.	FAA/EPA
• Establish new engine emission standards.	EPA/FAA

either gasoline or diesel fuel and emit HC, CO, and NO_x.

Table 4 lists two major mitigation measures. The first consists of replacing APUs or GPUs with fixed power and air conditioning systems. Fixed or central power systems draw electricity from the main power grid and convert it to the electrical current used by aircraft. Fixed air conditioning systems supply chilled air from a central unit. Fixed systems provide all of the services needed by an aircraft parked at the gate with none of the on-site emissions that come from the GSE and APUs. Several air carriers currently require the captain to hook up to fixed power and air conditioning systems whenever it is available.

The second GSE mitigation measure listed allows for the continued use of GSE in essentially the same way as it is currently used, but it requires modernizing the GSE fleet with either engines powered by alternative fuels or, ideally, electrically powered equipment.

RESPONSIBILITY

Table 5 shows who is currently responsible for implementing these mitigation measures. In general, it is up to the airlines to implement those measures that require changes in the way aircraft and support equipment are used, while airport authorities (sometimes with airlines' assistance) are responsible for physical and operational changes at the airport. Finally, Federal agencies take responsibility for imposing and enforcing the various control measures.