Air Quality: An Emerging Issue in the Airport Industry

By: Patti J. Clark, PhD
Assistant Professor, College of Aeronautics
Embry-Riddle Aeronautical University – Worldwide

Abstract

Today one of the emerging issues in aviation is the assessment, control and reduction of air emissions. In particular airports are increasingly scrutinized for accountability of air emissions contributions to the local and regional air quality. The tasks associated with quantifying air emissions contributions are difficult due to the inconsistency of airport sizes, geographic locations, variables in airport processes and air quality monitoring capabilities. Additionally, many airport executives or local officials do not comprehend air emissions and are reluctant to engage resources to address the related issues.

This practice paper examines air quality from the airport perspective by briefly examining the overarching federal and state regulations, exploring the contributing air emissions sources located at most airports, and best management practices for air emissions reductions. Lastly, the paper discusses the public interest in air quality as an escalating health issue.

Keywords: air quality, airports, pollutants, public health hazards, emissions

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Introduction

Today, airport leaders face increased scrutiny by federal, state, and local authorities to monitor and reduce air emissions from airport sources. The challenges are numerous and, for airports, understanding those sources that contribute to air quality the regulations governing emission sources is critical. Regulatory authorities may require that airports obtain operating permits, keep inventories, and file interval reports.

Air transport accounts for 2% of global man-made carbon dioxide (CO_2), which is considered a component of greenhouse gas (GHG) emissions; this percentage has not increased in the past 20 years (International Air Transport Association [IATA], 2013). Compared to the operational characteristics of older aircraft, new technologies allow today's aircraft to operate more efficiently in terms of regulated gaseous emissions. At a glance, the problem of air quality concerns at airports seems minimal. However, one third of all CO_2 emissions in the United States is produced by transportation (National Academy of Sciences, Transportation Research Board [NAS-TRB], 2013) and is only one component of a much larger air quality watershed. Air quality today is not so much a problem of compliance with regulations as it is a growing global health concern.

Regulations

An examination of the regulatory framework provides a perspective of how the science of air quality has evolved as researchers have gained a better understanding of air emissions components and the effects of air quality. The U.S. government enacted the first measures taken to control air pollution in 1970 with the passage of the Clean Air Act (CAA). Further revisions were made to the Act in 1977 and 1990 in the form of the Clean Air Act Amendments (CAAA) (Airport Cooperative Research Program [ACRP], 2008). The Environmental Protection Agency (EPA) was also created in the late 1970s and is responsible for the CAA and CAAA established standards of air quality for certain pollutants. The original focus of the CAA was to restrict emissions from industrial sites and control vehicle emissions in large cities. The CAAA targeted other areas discovered by scientists such as acid rain and damage to the ozone layer surrounding the earth.

As with many federal regulations, the responsibility of enforcing and validating compliance was pushed down to the states in the form of State Implementation Plans (SIP). Each state maintains a department that is responsible for the oversight of air quality and activities related to air quality. Some states, such as California, also house regional air quality boards to provide specialized expertise in states with varied climates and industrial operations.

Some states have areas where air pollution levels regularly exceed the National Ambient Air Quality Standards (NAAQS), as established by the EPA. These out-of-compliance regions are considered non-attainment areas and are subject to more stringent guidelines. Industries within these areas are encumbered with additional demonstrations of compliance measures that must be incorporated into daily operations. For airports located within non-attainment areas, scrutiny is also increased for compliance with regulations and emissions reductions from pollution emitting sources. For example, in California, the Air Resources Board (ARB) oversees the federal non-attainment areas and state designated areas. State area designations are often more strict such as the California 1-hour ozone standard, which was eliminated from the national designation in 2005 (California Environmental Protection Agency Air Resources Board [CEPAARB], 2013).

What is not clearly defined, even today, is the actual contribution of airport-related emissions to local and regional air quality. This issue is further clouded by attempts to delineate emissions from aircraft and airport infrastructures (Daley, 2010). Several European studies have investigated the allocations attributed to airport sources at airports such as Zurich, Lyon, and Munich (Carslaw, Williams, & Barratt, 2012; Eurocontrol Experimental Centre [EEC], 2006) to the surrounding communities. In the United States, research has been confined to very large airports and to those in areas with overall poor air quality (Choi et al., 2013; South Coast Air Quality Management District [SCAQMD], 2010; Unal, Hu, Chang, Tlat, & Russell, 2005).

As airport operations grow and change, concern for climate changes facing the entire planet also are also evolving. What a few years ago was apprehension over global warming has now transformed into an understanding that the global climate is changing. Regulations resulting from the Kyoto and Montreal Protocol, as well as others, have targeted ozone-depleting substances or Hazardous Air Pollutants (HAPs) reductions (need citation). More recently, GHG and particulate matter (PM) emissions are believed to pose bigger threats to the climate and ultimately to human health. Not surprisingly, airports are under scrutiny by communities and state to reduce emissions from sources located on site.

With the myriad of regulations in place, a good understanding of the pollutants of concern is necessary. For some airports, understanding and navigating the issues for solutions is often problematic. Many regional and small airports do not have environmental specialists on staff and must rely on consulting engineers or develop a layman's understanding of the requirements. Since 2006, the NAS-TRB has produced many products for airports regarding air quality assessment and reduction measures. Funded by the Federal Aviation Administration (FAA, 2013), the ACRP conducts applied research to develop practical solutions for problems encountered by airport operators. For the sake of this practice paper, the section below briefly discusses the air pollutants attributed to airport emission sources.

Air Quality Pollutants of Concern

Air quality is measured in terms of the absence of air pollutants and the presence of needed gases in proper combinations for the environment. Pollutants are chemicals or unwanted materials in the air (Daley, 2010). Possible pollutants are numerous and, for simplicity, the general pollutants of concern in this paper are criteria air pollutants (ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead) and GHG (water vapor, carbon dioxide, methane, nitrous oxide, and ozone) emissions from man-made sources. These criteria air pollutants are monitored and measured through the NAAQS

Criteria air pollutants and hazardous air pollutants generated from industrial activities were the first contaminants regulated by the EPA. Carbon monoxide (CO) is a colorless, odorless gas emitted from combustion sources such as automobile engines and can be lethal at very high concentrations. Sulfur dioxide (SO_2) is a byproduct emission from fossil fuel combustion at power plants and other industrial facilities. In recent years, fuels containing high sulfur levels have been reduced to allow for less emphasis on the adverse effects of SO_2 on the human respiratory system. Lead (Pb) is a metal that is historically found in transportation fuels. As with $SO_{2,}$ Pb has been removed from most fossil fuels with the exception of leaded aviation gas, which is used in piston-powered aircraft. (EPA, 2012).

While the pollutants listed above are of decreasing concern in most areas, the following contaminants are gaining global attention and regulatory oversight. Ozone created at the ground level is a product of chemical reactions between nitrogen oxides gases and volatile organic compounds (VOCs). The ozone, as a protective layer over the earth, is needed; however, ground-level ozone is harmful to breathe (EPAa, 2013). Additionally, nitrogen oxides are formed from combustion emissions from all modes of transportation, power plants, and off-road equipment. These gases contribute predominantly to the formation of ground-level ozone and contain fine particulate matter, both of which are respiratory health concerns.

The remaining criteria air pollutant of concern is particulate matter (PM), specifically, particles smaller than 10 micrometers in diameter that are found in dusty industries and around roadways. Recent health studies have identified PM of 2.5 microns in size to be particularly dangerous to human health because, once inhaled, the body cannot expel these small particles from the lungs. PM 2.5 emissions arise from forest fires and gases emitted from power plants, industries, and combustion engines.

GHG emissions are created from man-made sources and, as the name denotes, create a greenhouse effect on the earth. Based on air transport growth projections, by 2050, aircraft emissions are expected to contribute significantly to global GHG emissions (Daley, 2010; IATA, 2013). Even with gains in fuel efficiency and shifts to low-carbon energy worldwide, the goal of stabilizing atmospheric concentrations of GHG by mid-century remains a distinct challenge (NAS-TRB, 2013). Aviation emissions create a radiative force in the atmosphere, which produces both positive and negative changes. Non-CO_2 climate effects are also an area of current research; however, no standardized approach currently exists to quantify their effects on the climate. Once the science is better defined, perhaps aviation contributions to GHG will be more definitive and distributed (Howitt, Carruthers, Smith, & Rodger, 2011).

In reviewing the air pollutants of concern, what should be obvious is that most pollutants are generated from combustion sources such as aircraft, automobiles, other types of engines, and industrial sources (EPA, 2012). Airports contain numerous types of operations and many involve combustion-related sources. Some of these sources are obvious while others may not be apparent at first glance.

Airport Sources

Airports are often compared to cities in the depth and breadth of their operations as they include industries, roadways, facilities, shopping, and even hotels. Much like cities, airports own the property and infrastructure, but lease or subcontract many of the operations, which can create span of control issues. The airport industry is particularly vulnerable and at a disadvantage to controlling the largest source of air emissions on airport property, which are aircraft operations. While this paper touches on the topic of aircraft emissions, it is not addressed in depth. So, what are airport sources and how do airport officials account for them or lessen their effects? This practice-based paper is devoted to understanding source-reduction measures under the direct control of airport officials.

In terms of air quality, a source is largely defined as stationary or mobile. Stationary sources are places or objects from which pollutants are released and that does not move (EPA, 2012). Mobile sources emit pollutants, but do so from any operating location. A vehicle is an example of a mobile source, while an emergency generator for a building is an example of a stationary source. Both sources emit pollutants from the engines; however, one engine is permanently mounted while the other is mobile or travels from point A to B.

From the definitions above, it is evident that an airport contains both types of sources, which can be controlled. Mobile sources are primarily vehicles used by airport personnel and customers traveling to and from the airport (Choi et al., 2013). Stationary sources, such as generators, boilers, incinerators, power production activities, and aircraft repair activities, are also present at many airports. What may not be readily apparent are the secondary sources that airports use such as wastewater treatment plants, energy production facilities (e.g., coal-fired electrical plants), and even landfills that emit many of the pollutants of concern.

Numerous opportunities exist for airports to lessen their emissions from primary and secondary sources. Examples of best management practices, new technologies, and organizational cultural changes all present opportunities for airports to reduce air emissions. For example, changing interior lights to fluorescents may seem like an oversimplified best management practice, but even small changes add up in the big picture.

Opportunities and Best Management Practices

Small changes make a difference. The best way to begin improving air quality on and surrounding an airport is to establish a baseline of sources and their associated emissions. An air emissions inventory assists airport management in delineating airport-owned sources from those owned by other entities. Creating an inventory simply requires management to locate the sources of emissions, assess the type and amount of pollutants emitted, determine whether the source is mobile or stationary, and document the information. Once an air emissions inventory is completed, the baseline for identification of reductions can be established.

Another administrative measurement that airport officials can implement is an Environmental Management System (EMS). Much like a Safety Management System (SMS), an EMS identifies areas to be changed or improved and sets objectives to reach target goals. Within an EMS, aspects or elements of airport activities and products or services that can interact with the environment are identified. Once these aspects are known, airport management can implement objectives or goals and performance requirements in the form of targets. Implementation of an EMS is an excellent way for airports to not only identify and manage aspects, but also to mitigate measures if an adverse trend is identified.

Aside from direct emission sources, a myriad of other opportunities can be found in energy reduction measures that can lower GHG emissions. High-efficiency lighting and occupancy lighting controls, efficient HVAC systems, building insulation, and solar control glass are all examples of energy efficiency demand measures. High-efficiency lighting, such as compact fluorescent bulbs used with occupancy controls, can reduce energy usage. Couple the occupancy lighting controls with HVAC systems that have timed controls could result in significant energy reductions. In an airport, holding areas and gates not used at night are also good opportunities to increase energy efficiency. Less energy usage, whether generated on or off site, produce fewer emissions. As many electricity production facilities are coal fired and are target areas for reduction by the EPA, these measures may generate short-term emissions benefits and long-term cost reductions (Milford & Pienciak, 2009).

For vehicle-related emissions, simple measures such as particulate matter filters and airport roadway routing are good practices for airport-owned vehicles. Cell phone lots for passenger pick up, employee commuting incentives, warm mix asphalt for construction activities, and construction vehicle operation procedures are also examples of low-cost and easily implementable vehicle emissions reductions at most airports (ACRP, 2008).

At this juncture, it should be emphasized that many of the measures noted in this section are established actions in other industries and government entities. Additionally, large commercial service airports and airports located in high profile areas for air quality have likely instituted most, if not all, of these measures. However, because of the variability of airport ownership models, many reduction measures have not been implemented or even considered by some airports, especially smaller general aviation or regional commercial service airports.

Larger measures. Regarding larger measures, the actions described in this section are not only larger in scope, but also more expensive to implement. Airports, as with any business units, are expected to be revenue centers rather than cost centers to the governing authority. As such, undertaking the initiatives listed below requires significant financial investment and are listed based on expected capital required.

Airport vehicles are used for daily operations activities and, based on the size and activity of the airport, can be a considerable source of emissions. Hybrid vehicles are available in all types of models and can be easily substituted for airside or landside operations vehicles. For activities near main terminals or hangar areas where slow speeds are necessary, electric carts or cars can be used. As with hybrid vehicles, the range in types of electric vehicles is expansive and can be used by and for many airport functions.

An airport is a part of a transportation system; however, each airport requires an extensive airport transportation services footprint (ACRP, 2008). On-site transportation can be in the form of bus, rail, and or ferry. An excellent example of an emission reduction opportunity is the consolidation of rental car facilities present at many major airports. Emissions reductions can occur by establishing common use facilities. Specifically, by merging all rental car companies into one facility or location, efficiency can be gained by constructing the single facility to filter emissions from vehicles. A best practice of fuel conservation can also be realized by the simple measure of busing passengers to rental car counters and back to airport terminals (ACRP, 2011).

On the airfield, several opportunities in the form of reduced energy use are available for incorporation by airports. For example, replacing motorized gates with electrified gates and substituting fossil fuel-powered support equipment with electric ground support equipment are two initiatives for consideration. Lighting costs can also be reduced by implementing daylight harvesting in terminal and hangar buildings. Newer airfield lighting incorporates LED technology, which is more energy efficient than older filament bulb technology. Of course, newer LED lighting is also brighter, which makes this opportunity not only an energy reduction initiative but also a safety consideration. Opportunities and BMPs take time, money, manpower, and resources to implement and maintain. Therefore, airport management must consider whether such measures are worth the investment if the airport is not subject to permit conditions or non-attainment area rules.

Increased Public Interest

As stated in the beginning of this paper, interest in air quality has shifted from a regulatory stance to a health perspective. As scientists have verified the effects of air pollutants on human health, the issue is no longer only about environmental effects (Fleuti, 2008; Yim, Stettler, & Barrett, 2013). Particulate matter from fossil fuels smaller than 2.5 microns is a current high visibility topic in air quality research, and airports are or have been the focus of several projects (Choi et al., 2013; SCAQMD, 2010).

Globally, climate change is an issue that nations are tackling individually and collectively. Without a doubt, the issue of climate change and aviation accountability will be subjected to international regulation in the future. As the science matures regarding the effects of air quality on human health and the environment, public interest will also increase. Airports are members of their local communities and must be ready to respond to inquiries about air quality and be able to demonstrate stewardship by reducing or mitigating air quality effects from airport operations. Airport management may use simple, practical measures such as lighting efficiencies to validate the commitment to being good neighbors.

The Way Forward

The focus of air quality information presented here was on the airport-controlled sources. Aircraft operations generate the largest share of emissions at airport, especially the bulk of CO_2 emissions (IATA, 2013). Airport management cannot regulate airline activities; however, they can certainly form partnerships to reduce air emissions. Continuous descent procedures, electrified green taxiing systems, and electrified support equipment and gates, are examples of airline and airport measures that can be implemented to create significant reductions in air emissions and improve air quality (Turgut, Usanmaz, & Rosen, 2013). While airlines have historically been resisitent to airport involvement in operations, a cost share approach to implementing measures such as those ones listed in this paper may assist in connecting the two entities on an issue with high public visibility.

Generally, airports in the United States are owned and operated either by port authorities, airport authorities, or local governments. As such, the operations, management, and fiscal obligations should always be transparent to the owning public. Airports are integral parts of the community, regional transportation systems, and economic engines to local economies (Clark, 2008). Therefore, airport officials should always look for opportunities to partner with the communities they serve. Furthermore, by gaining knowledge on the issues discussed here, airport managers can implement measures that confirm commitment of airport management to serving the community as a transportation hub with the best interests of their communities in mind.

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