Reports

Flying Off Course

Environmental Impacts of America's Airports

Executive Summary

In January 1995, the Natural Resources Defense Council (NRDC) undertook a study to determine: (1) the most important environmental issues connected with airports, and (2) the best management techniques airports were using to mitigate them.

The bulk of our data came from a nationwide survey that we conducted in the spring and summer of 1995. We mailed a seven-page questionnaire to 125 of the nation's busiest airports, as defined by the Federal Aviation Administration (FAA) in terms of numbers of passengers, or enplanements. The questionnaire dealt with noise and land use, deicing and water quality, air pollution, expansion plans, and basic geographical information.

Forty-six of the 125 airports responded to our survey. In addition, we conducted in-depth research at government agencies on the country's 50 busiest airports.

We found that, while airports vary in terms of size and geographical characteristics, significant environmental impacts were common to most of the airports in our survey. We also found that the regulatory framework currently in place to address these impacts is inadequate. Because aviation is the fastest growing mode of transportation in the United States, increasing nearly twice as fast as motor-vehicle travel, these failings must be addressed. This report focuses on the issues we found to be most significant: noise and land use, ground-level air emissions, water pollution, and, on a more global scale, climate change and energy efficiency.

NRDC recognizes and supports the critical safety concerns and requirements of the FAA, the airports, and the flying public. These concerns and requirements have been taken into account in the recommendations of this report. Nothing recommended herein would compromise the safety of flying.

NOISE AND LAND USE

Aircraft noise -- like many environmental problems -- affects millions of people every day in myriad ways both short-term and long-term, both obvious and difficult to gauge. Studies indicate that noise affects one's ability to concentrate and can cause sleep deprivation, resulting in potentially deleterious effects on health and well-being. Some studies have also shown that continuous exposure to high levels of aircraft noise is associated with hypertension, cardiovascular and gastrointestinal problems, and other disorders.

Despite the phasing-in of newer, quieter aircraft, noise near airports will, in all likelihood, increase in the next century. U.S. passenger air travel is expected to continue its current strong growth trends: the FAA predicts international enplanements to increase at a rate of 5.3% annually for the next 12 years, and domestic enplanements to increase at a rate of 3.7%. Aircraft operations, of course, will likewise increase: according to the FAA, there will be 36% more flights in 2007 than there are today.

Airport communities often find themselves with little recourse in addressing noise impacts under the FAA's current noise policies. In particular, the noise threshold that the FAA has set as compatible with residential use ("65 dB DNL") is problematic because: (1) it is based on an **averaging** of noise, rather than the loud "single event" noise that specifically characterizes aircraft noise, and (2) the threshold of 65 dB significantly underestimates the level at which many people are annoyed or impacted by aircraft noise.

As typically happens, FAA's estimates failed badly. A 36% increase by he year 2007 would mean 2007 ops hitting 719,000. Here is what happened at Denver:
...in the year of this article (2000): 529K ops
...in the year cited by FAA (2007): 620K ops
...in the PEAK YEAR (2010): 635K ops
...and steadily downward since 2010, falling to 575K ops in 2014.

Findings

- NRDC's Airport Survey demonstrates that the aircraft noise problem in the United States will probably worsen: at least 32 of the 50 busiest airports in the country have plans for expansion. The FAA reports that 60 of the 100 largest airports in this country are currently proposing to build new runways or runway extensions.
- The FAA's threshold of 65 dB DNL does not accurately assess how many people are disturbed by aircraft noise. NRDC's Airport Survey found that, despite the relatively few people living within its 65 dB DNL noise contour, Denver International Airport received the highest number of noise complaints per month.
- The most recent studies on noise and health have been conducted mostly in Europe rather than the United States. This is due, at least in part, to the current limited role of the U.S. Environmental Protection Agency (EPA) in the field of aircraft noise.
- While most airports have some type of program in place to lessen noise for their neighbors (such as using flight paths farther away from residential areas at night), NRDC believes that a fundamental key to good aircraft noise policy lies in setting appropriate land uses adjacent to airports.

Recommendations

1. **The sole use of DNL for measuring aircraft noise is inadequate.** DNL as a mechanism for determining funds for noise mitigation measures and land use planning should be reevaluated with full public review. Specifically, NRDC recommends that:
    - Rather than DNL, CNEL (community noise equivalent level) should be used to adequately account for the importance of communication and relaxation during evening hours. The CNEL, used in California and many European countries, includes a 5 decibel penalty during the hours of 7:00 p.m. to 10:00 p.m. in addition to the DNL's 10 dB nighttime penalty.
    - The FAA should use 55 dB CNEL, rather than 65 dB DNL, as the threshold for planning and funding decisions.
    - Single event noise must be taken into account when assessing the impacts of aircraft noise. Single events interrupt school lectures, wake people up, and interfere with speech intelligibility. The "single exposure level" (SEL), which measures the intensity of sound during a single noise event, should be used in conjunction with CNEL.
    - Noise mitigation plans should be site-specific. Many factors need to be considered, including seven key issues identified by EPA over 20 years ago, which remain relevant:
        1. Duration of intruding noises and frequency of occurrence
        2. Time of year (windows open or closed)
        3. Time of day of exposure
        4. Outdoor noise level in community when intruding noises are not present
        5. History of prior exposure to noise source
        6. Attitude toward the noise source
        7. Presence of pure tones or impulses.
2. **Airports and municipalities should be required to provide full disclosure to potential airport neighbors regarding levels of noise they can expect.** Disclosure statements should include an airport's current noise levels, flight paths, and future expansion plans. A state or local "Community Right to Know Noise" Act (similar to the act that requires industries to divulge information on toxic releases to a community) should be developed and implemented. This act would require municipalities and realtors to disclose information about current and expected noise levels to potential residents within the 55+ dB CNEL.
3. **The Office of Noise Abatement and Control should be reinstated within EPA, and funds allotted for research on noise and health.** The EPA, more than any other federal agency, should lead study of the impact of aircraft noise on health and well-being. EPA is the agency most directly responsible for the protection and regulation of public health and welfare, while the FAA has other unrelated, and sometimes conflicting responsibilities.

GROUND-LEVEL AIR EMISSIONS

Noise tends to dominate debates over airport pollution, often to the exclusion of another important topic: ground-level ozone pollution, the primary component of smog. Smog is normally associated with motor vehicles and industrial sources such as factories, power plants, and incinerators. However, air pollution totals from automobiles and many major industries have stabilized or decreased with time while aircraft continue to emit more and more ground-level ozone precursors--volatile organic compounds (VOCs) and nitrogen oxides (NO_x)--with each passing year. For example, in 1993, airplanes at U.S. airports produced 350 million pounds of these pollutants during their landing and takeoff cycles (LTOs), more than twice their 1970 total. This total is likely to climb even higher as the aviation industry grows.

In order to better understand the relationship between aircraft emissions and local air pollution problems, NRDC calculated the amount of aircraft-generated VOCs and NO_x at nine U.S. airports. The airports selected for study were Chicago O'Hare, John F. Kennedy International, LaGuardia International, and Westchester County in New York, Newark International (NJ), Bradley International (CT), Jacksonville International (FL), El Paso International (TX), and Fairbanks International (AK).

These airports were selected because they span a wide range in terms of the types and numbers of planes they handle. The list includes not only the nation's largest international airports but also smaller, yet busy, regional airports.

Findings

The results of NRDC's air carrier emissions inventories are as follows:

TABLE 1: Ground-Level Air Carrier Emissions at Nine Airports in 1993[a]

AIRPORT & STATE	LANDING & TAKEOFF CYCLES (LTOs) per year[b]	VOC (tons/yr)	NO_x (tons/yr)
Chicago O'Hare (IL)	383,362	1,428	4,650
Newark (NJ)	140,109	914	1,916
LaGuardia (NY)	135,800	677	1,476
John F. Kennedy (NY)	80,337	1,027	1,879

Bradley (CT)	36,506	128	342
El Paso (TX)	29,752	48	258
Jacksonville (FL)	19,838	42	201
Westchester (NY)	9,145	18	42
Fairbanks (AK)	7,075	15	64

[a] Raw data generated using FAA software and data as well as airport-specific idle/taxi times. Actual VOC totals may be 10-15% less than reported due to fuel conservation measures voluntarily practiced by the airlines which also result in emissions reduction.

[b] Landing and takeoff cycles (LTOs) are the basis for ground-level aircraft emissions calculations. The components of an LTO are approach and landing, taxi/idle-in, taxi/idle-out, takeoff, and climbout. LTO cycle calculations include only the emissions planes create within 3,000 feet of the earth's surface, all of which affect ground-level air quality.

- Airports are significant sources of ground-level VOC and NO_x emissions. Locally, an airport's arriving and departing planes can create as much, if not more, ground-level VOCs and NO_x as many of its largest industrial neighbors (see table below).

TABLE 2: 1993 VOC and NO_x Emissions in 3 States: Airports[a] and Comparable Sources

STATE	POLLUTANT	EMISSIONS SOURCE	RANK IN STATE[b]	TONS/YR
IL	VOC	Deere & Co. (Harvester Plant)	17	1,471
IL	VOC	Chicago O'Hare Airport	--	1,428
IL	VOC	All Steel, Inc.	18	1,367
IL	NO_x	Granite Steel Company	21	4,819

IL	NO_x	Chicago O'Hare Airport	--	4,650
IL	NO_x	CPC Int'l (corn products)	22	4,439
UT	VOC	Geneva Steel	6	590
UT	VOC	Salt Lake City Int'l Airport	--	485
UT	VOC	Magnesium Corp. of America	7	438
UT	NO_x	Questar Pipeline Company	8	1,152
UT	NO_x	Salt Lake City Int'l Airport	--	955
UT	NO_x	Chevron USA Salt Lake Refinery	9	743
CT	VOC	Quality Rolling (metal painting company)[(c)]	10	129
CT	VOC	Bradley Int'l Airport	--	128
CT	VOC	Northeast Petroleum (storage facilities)[(c)]	11	112
CT	NO_x	AES Thames (power plant)[(c)]	17	370
CT	NO_x	Bradley Int'l Airport	--	342

CT	NO_x	Dexter (paper mill)[c]	18	290

(a) Airport totals reflect ground-level emissions from air carrier flights. NRDC calculated the emissions for O'Hare and Bradley airports. The state of Utah provided the emissions data for Salt Lake City International Airport. Ground-level VOC totals from aircraft may be 10-15% less than reported due to fuel conservation measures voluntarily practiced by airlines which also result in emissions reduction.

[b] Ranking is based on stationary source emissions inventories provided by the states of Illinois, Utah, and Connecticut.

[c] Refers to 1994 rather than 1993 data.

- Airports are not regulated in the same manner as other significant air pollution sources. Neither airports nor airlines are held accountable for the aggregate impacts of their ground-level aircraft emissions. State and local regulators remain nearly powerless to address the problem in meaningful ways, while other major industrial sources are accordingly forced to compensate on airports' behalf as states scramble to meet mandatory emissions reductions deadlines. The number of commercial flights (which burn the most fuel and cause the most pollution per operation) meanwhile grows higher and higher each year.
- A1993 EPA-sponsored study of toxic emissions at Chicago's Midway Airport (a much smaller airport than Chicago's O'Hare, with about 3 million enplanements per year, compared with O'Hare's 30 million) suggests that toxic air pollution from aircraft deserves more attention. The study, conducted in response to community concerns, evaluated cancer risks attributable to all air pollution sources in southwestern Chicago. It indicated that Midway's arriving and departing planes constitute a considerable source of particulate matter as well as toxic compounds such as benzene, 1,3-butadiene, and formaldehyde, releasing far more of these pollutants than other industrial pollution sources within the 16-square mile study area. In fact, few of all of Chicago's industrial sources release as much benzene or formaldehyde as Midway Airport. Nevertheless, airports are exempt from the federal law that requires other toxic sources to report their toxic emissions totals (the Toxic Release Inventory, or TRI).

Recommendations

1. **Treat airport-generated emissions in the same manner as emissions from other large sources and include them in state air pollution plans.** Although airplane emissions at airports are comparable to those from industrial sources, they escape inclusion in State Implementation Plans (or SIPs), the EPA's principal means of achieving cleaner air in nonattainment areas. As states scramble to meet mandatory emissions reductions deadlines, other major industrial sources are forced to compensate for this omission. Allowing states to include control

strategies for ground-level aircraft emissions in their SIPs would help them meet air quality goals.

2. **Minimize aircraft engine use while idling and taxiing.** VOC emissions (both toxic and non-toxic) at airports would be significantly reduced if all airlines instructed their pilots to shut down as many engines as possible during the idle and taxi period. This simple procedure would decrease emissions, as well as fuel costs. The FAA should issue an Advisory Circular on reduced-engine idling and taxiing, encouraging airlines to employ the practice as often as possible.
3. **Adopt more stringent NO_x standards.** Ground-level NO_x emissions from aircraft can be curbed by tightening engine emissions standards. The UN-affiliated International Civil Aviation Organization (ICAO) tightened NO_x standards by 20% on January 1, 1996 and is currently considering tightening the standard an addition 16%. The European Union is supporting the tighter NO_x standard. However, the new standard is unlikely to be approved without U.S. support, which has, to date, been withheld. The United States needs to join its European counterparts in actively supporting the additional tightening of this standard. Regardless of ICAO's ultimate decision, the United States should adopt the proposed standard as its own.
4. **Address toxic aircraft emissions.** EPA should carry out a nationwide investigation and risk assessment of aircraft emissions. If findings similar to its southwest Chicago study are reached elsewhere, then airports should be placed on EPA's list of major hazardous pollution sources. Whatever the outcome, airports -- just as similarly-sized toxic air pollution sources -- should be required to report their toxic emissions to the Toxic Release Inventory (TRI).
5. **Investigate differential landing fees.** Until local authorities can implement SIP control strategies for aircraft, they can address the problem of aircraft pollution indirectly. Airports can establish a revenue-neutral set of differential landing fees to encourage airlines to use their least-polluting planes.
6. **Discourage auxiliary power unit use.** Jets parked at airport gates often use generators (auxiliary power units or APUs) to power their electrical and climate control systems. Both emissions and fuel consumption could be reduced if planes shut off their APUs and relied on airport-provided power and air to the fullest extent possible. Southern California's airports are already electrifying their gates; airports in other nonattainment areas should follow their lead.
7. **Convert airport vehicle fleets and ground service equipment to alternative fuels.** Alternative-fuels programs already exist at many airports. Los Angeles International Airport (LAX), for example, operates 14 liquid national gas (LNG) buses, and is ordering more. Boston's Logan Airport is converting its vehicles from diesel to natural gas and electric power. Centrally fueled and maintained airport-based fleets are excellent niches for alternative fuel vehicles; states and airports should create incentives for or require their conversion.
8. **Encourage mass transit.** Private vehicles at airports can produce as much VOC and NO_x as planes. Our survey shows that the overwhelming majority of airline passengers reach the airport in their own cars. Airport emissions totals could be considerably reduced if these people left their cars at home; mass transit use to and from airports should be promoted and developed at every opportunity.

DEICING AND WATER QUALITY

The presence of snow, ice, or slush on runways or aircraft frequently causes hazardous conditions that can contribute to aircraft accidents, delays, diversions, and flight cancellations. Consequently, deicing or anti-icing (preventing the formation of ice) of aircraft and runways is a necessary part of operations at most airports in winter months. The most common method of controlling ice is through the use of chemicals, particularly ethylene- or propylene-based glycol mixtures with additives.

Most airports were built long before environmental regulations governing polluted water "runoff" were in place, and many airports lack the infrastructure to control large quantities of deicing fluids. Deicing generally takes place directly on the tarmac; deicing chemicals then enter the runoff from this procedure and flow into nearby waterways. In 1987, under Clean Water Act revisions, stormwater runoff was finally recognized under federal law as a serious water pollution problem, and the national stormwater permit system was adopted to attempt to control polluted runoff from urban areas, including industrial sites.

Findings

- Given that many, if not most, of the country's largest airports are sited along waterways, the control and disposal of deicing chemicals constitutes a significant water pollution issue. Our survey found that 45 of the 50 busiest airports in the country were within three miles of an ocean, bay, lake, wetland, reservoir, river, or stream.
- The runoff management systems that airports are required to implement under the national stormwater system is problematic, with gaps in the areas of effluent standards, enforcement, and monitoring.
- The use of deicing chemicals (particularly ethylene glycol) and other toxic substances at airports may present threats to human health, particularly to airport workers.
- In addition to ethylene glycol, numerous hazardous substances such as solvents and metals are used at aircraft maintenance facilities. However, airports are exempt from reporting under the Toxic Release Inventory.

Recommendations

1. **Aircraft deicing should be subject to a traditional effluent guideline permitting process.** EPA could accomplish this by reinstating aircraft deicing in its Transportation Cleaning effluent guideline. Currently, aircraft deicing is covered inadequately under the more open-ended national stormwater program.

2. **Ethylene glycol and the issue of worker health and safety needs to be further addressed.** Given the toxic properties of ethylene glycol, the Occupational Safety and Health Administration (OSHA) should set appropriate exposure limits for ethylene glycol in deicing applications.
3. **Stormwater pollution prevention plans should be public documents and should be available for public review directly from every airport.** Incomplete, inadequate, or unimplemented plans should be subject to enforcement action on the same basis as other NPDES violations.
4. **Under the national stormwater program, the threshold that requires airports to monitor and sample outflows should be lowered to include smaller airports.** While larger airports that use over 100,000 gallons of deicing fluids are required to monitor their outflows, sensitive receiving waters near smaller airports are left at risk.
5. **More research should be conducted and information made available on alternatives to chemicals for deicing.** FAA should revise its Advisory Circular on Airport Winter Safety and Operations (AC 150/5200-30A) to include information on the latest, least environmentally-damaging deicing procedures that also meet safety requirements.
6. **Airports should be required to report releases of hazardous substances under the Toxic Release Inventory (TRI).** (See also Ground-Level Air Emissions). Ethylene glycol, widely used by airports, is a TRI-reportable substance, yet airports are exempt from TRI reporting.

CLIMATE CHANGE AND ENERGY EFFICIENCY

Though the primary environmental issues associated with airports are local, the aircraft themselves are responsible for global impacts. Transporting one person one mile by air requires more energy than by car, personal truck, bus, or train (at similar load factors). Though larger aircraft traveling longer distances can improve those efficiencies, it has been estimated that, currently, half of all airline flights are less than 500 miles. The emissions from aircraft engines, particularly carbon dioxide, nitrogen oxides, and water vapor, also play an increasingly significant role in global climate change and in ozone depletion. In addition, air travel is expected to grow at a faster rate over the coming decades than all other modes, further intensifying its environmental impacts.

A transportation system using airplanes with more efficient engines, supplemented by improved rail service, would likely result in less fuel use and fewer pollutants released into the environment. Newer, more efficient engines are generally quieter as well, since continuing public pressure to reduce airport noise helps prompt the redesign of engines.

Findings

- Studies show that, currently, aircraft are responsible for between 2-3% of total anthropogenic carbon dioxide (CO_2) emissions globally. This represents a modest, but increasing contribution to anthropogenic global warming effects.
- Aircraft also emit significant quantities of nitrogen oxides (NO_x). Although there are some scientific uncertainties, studies show that about 4% of anthropogenic, atmospheric NO_x may be attributed to aircraft.
- Forecasts reveal that aircraft CO_2 and NO_x emissions could be responsible for 10% of all anthropogenic global warming effects by 2050.
- In addition to requiring more energy per passenger-mile than most other forms of transportation, airplanes also emit more CO_2 per passenger-mile than most other modes of transportation, because of their high energy intensity.
- Air travel is especially inefficient over short distances. Aircraft are most efficient for truly long distance travel, because they "amortize" the tremendous energy consumption associated with high speed takeoff over a greater number of miles and passengers (larger aircraft tend to carry more passengers and offer greater range).
- Much could be done to reduce energy consumption per passenger mile in aircraft, including improving the energy efficiency of the engines, improving aerodynamics, increasing average aircraft occupancy rates, increasing average trip length, and reducing idle time.

Recommendations

1. **The United States should adopt more stringent NO_x standards.** (See Ground-Level Air Emissions Recommendations).
2. **Airlines should invest in newer, more efficient aircraft.** The federal government should provide financial incentives to airlines to accelerate acquisition of newer, safer, quieter, more efficient aircraft and provide greater disincentives for airlines to retain older, less efficient aircraft. Currently, there is an opportunity to incorporate incentives for conserving fuel in the reinstatement of funding of the Aviation Trust Fund. Revenue that was collected through a 10% domestic ticket tax could instead be collected through an aviation fuel tax, thus providing an incentive to increase airline operational efficiency and to modernize the aging commercial fleet with more efficient airframes/engines. Unless a clear message is sent to aircraft manufacturers and airlines, efficiency improvements may fall by the wayside. Financial mechanisms that would funnel a tax on fuel back into the aviation industry are necessary to ensure that aircraft efficiency improvements are accomplished.
3. **Supplement air travel with high-speed rail.** National transportation planners and the Department of Transportation should further examine proposed plans for high-speed rail "pockets" throughout the country, such as the Boston-New York-Washington; Houston-Austin-Dallas; San Diego-Los Angeles-Sacramento; Portland-Seattle-Vancouver routes. Supplementing the aviation system with high-speed rail would greatly reduce the "short hops," for which air travel makes the least environmental sense.
4. **Improve intermodal links, so that intercity rail connects to airports.** For example, someone traveling from Paris to Philadelphia, landing in New York, should not have to get on another plane from New York to Philadelphia.
