"Miljøforeningen"
for bevarelse af miljøet omkring Københavns Lufthavn
Nyvangsvej 10
2791 Dragør
☎ 32538665
Fax: 32948665
Postgiro: 424-5881
SE: 20452986
E-mail: beck@idt.net
Homepage: http://www.pollution.dk

"The Environmental Organisation Copenhagen"
for protection of the environment around Copenhagen Airport

March 1

Emission report

Introduction

The Kyoto Protocol was signed by 159 countries. An overall reduction of greenhouse gasses by 5.2% was agreed. Europe has pledged to reduce it's emission by 8%.

The purpose of this report is to recommend possible solutions to reduce greenhouse gases and other damaging and health dangerous emissions coming from airports and aviation.

Aviation has so far been a sacred and untouchable cow which has not taken it's fair share of the efforts to reduce greenhouse gasses. It is obvious that our politicians so far have turned the blind eye to the fact that airports and aviation are the single largest polluter, and that airports and aviation cause growing and tremendous environmental damage to the local area around an airport (dangerous emissions), to the region and world-wide (greenhouse gases).

This report is sent to more than 2000 environmental organisations, "green organisations", environmental research centres, politicians, EPAs, etc. in Europe, USA, Australia, Japan etc. In addition every single member of the Danish Parliament has received a Danish version of this report.

The report is based on a database (*Microsoft Excel*) made by *"The Environmental Organisation, Copenhagen"* based on the emission data from *"Federal Aviation Administration (FAA) Aircraft Engine Emission Database (FAEED)"* (for CO, CO_2, HC and NO_x).

The report and database are distributed free of any charge and can be used by any organisation and individual on a non-commercial basis (by mentioning the source).

We ask the question:
How many countries can document plans to reduce greenhouse gases in accordance with the Kyoto Protocol?

CONTENT

1. The Purpose of this Report

The purpose of this report is to compare emissions from different aircraft/jet engine combinations and to investigate which aircraft/engine contributes most to pollution.

When it is clear what kind of aircraft and jet engines that are causing unnecessary environmental and health damages, then our politicians will have a tool to regulate these emissions by putting a ban on these aircraft or to reduce the use of the most polluting aircraft.

Furthermore our politicians has an obligation to reduce the greenhouse gasses (CO_2) and it is obviously that aviation must also take it's fair share of this reduction.

2. Legislation is Necessary

It could be expected that new aircraft and jet engines are more economical and by that less polluting than older aircraft.
However, new aircraft demand more comfort, which makes the planes heavier and some of the technical advantages could be lost on that account. This is very often the case with large aircraft with "two-classes" and "three classes" cabins and for aircraft with a small passenger capacity, for example such as "executive jets".

It could therefor be necessary to also make legislation in these areas to avoid unnecessary waste of passenger capacity and to improve the fuel efficiency per transported passenger. There are many legislation affecting our daily life in the cause of reducing the environmental impact. But aviation seems again to be a sacred cow and excluded all legislation to minimise the environmental impact and damage.

Aviation is the only transport form, which is not regulated in any significant way in order to reduce the environmental impact.

Old aircraft are allowed to pollute without any regulations. There are no limitation of the use of polluting aircraft or in the air traffic routes. Passenger jets and cargo jets can fly nearly empty on some destinations. And this is in despite of that aircraft are the most polluting transport form we have to day.

Aircraft can not benefit of environmental progress, such as the catalytic converter, particle filters, etc. - and still there is no regulation in the aviation sector to reduce the environmental impact from aviation and airports.

This report investigates what type of aircraft and jet engines most contributing to pollution in the form of greenhouse gasses and hazardous emissions. Furthermore the report makes some recommendations on how to reduce the emissions from aircraft.

3. The Kyoto Protocol

It is obvious that many countries do not have any intention in fulfilling the Kyoto Protocol. We could be picking on any country, but in this case we will take Denmark as an example of a country who doesn't have any plans or intention to commit to the Kyoto Protocol.
Denmark's commitment in accordance with the Kyoto Protocol is to reduce it's emission of greenhouse gasses by 8%.

April 30th 1997 Denmark granted permission to Copenhagen Airport to increase emission of Carbon dioxide (CO_2) by 104.000 tons per year (from 203.000 tons/year in 1994 to 307.000 tons/year in 2005). This is an increase of greenhouse gasses of 51,2%[1].

In other words: To comply with the Kyoto Protocol, Denmark has to reduce the emission of greenhouse gasses in other areas.
Denmark has not been able to put forward any plans to fulfil it's commitment to reduce

[1] The Environmental Assessment Report for Copenhagen Airport, page 48, fig. 4.B.3.

greenhouse gasses and it is not likely that Denmark in the near future can compensate for an increase of 104.000 tons of greenhouse gasses.

Unfortunately Denmark is not the only country with the intention of not to commit to reduce it's greenhouse gasses. Ask your country the same question!

An increase of greenhouse gasses (CO_2) of 104.000 tons (the increase of greenhouse gasses caused by the increase of expansion of Copenhagen Airport to year 2005) is comparable to the annual heating of 16.560 houses (annual fuel consumption of 2000 kg[1]). Or 72.800 cars driving 20.000 kilometres on the streets[2]!

4. The Aircraft Emissions

This investigation is using emission data for 85% power setting for "climb out" and 7% power setting for idle.
These power settings are chosen because emission data for these power setting were available and for the reason that a "normal cruise power setting" cannot be defined because "cruise power setting" is depending on the type of air craft, payload, altitude, cruising speed, atmospherics and weather conditions, etc.

The data used in this investigation are from the ***"Federal Aviation Administration (FAA) Aircraft Engine Emission Database (FAEED)"***.

This database can be download from the internettet on the address:
http://www.epa.gov/omswww/aviation.htm

Power settings for "idle" and "climb out" are also the most common used power settings in airport operations. Therefore the emission data is also useful to estimate the local and regional pollution from emissions of the jet engines. Despite 100% power setting is used during "take-of", this power setting is only used for a short time of duration. After "take-off" the pilots go to 85% power setting during the "climb out" to the required altitude.

4.1 Emission Data is not Complete

Emission data varies a lot for different engine types and for various power settings. Furthermore not all emission data seems reliable. This is because of a small statistical material and the various conditions applying to the tests, i.e. atmospheric conditions, age and condition of the testing engine, and the fact that tests very often are performed at the engine plant of the factory test facilities. By that there is no guaranty that the emission data is directly comparable.

For that reason we will not target a single engine, but prefer to categorise an aircraft or a jet engine by type, age and size.

The report also includes emission data for air freighters with the purpose of comparing the amount of emission with the transported air freight.

Unfortunately emission data for the latest jet engines are not available, for example for the B737-600/700/800 with the "CFM56-7B jet engine". Boeing was very reluctant to provide emission data for this engine. Neither is emission data available for B777-300 with the Pratt & Whitney 4077, General Electric 90-77B or the Rolls-Royce Trent 877 engines, while only the data for the older configuration with the PW4074 engines are available.

Not only Boeing seemed reluctant to provide the emission data. We have requested additional emission data from both Boeing/MD and European Airbus, but didn't receive an answer. We can only regret that some aircraft/engine configurations are missing and we shall urge our politicians and environmental authorities to support and

[1] 1 kilo fuel = 3,14 kg CO_2
[2] Fuel consumption of 14 km/kg fuel

enforce much more disclosure for the damaging and dangerous emissions.

It must be our politicians and not the polluting industry who set the boundaries for the disclosure of environmental data and hazardous emissions.

4.2 Aircraft/Engine Configuration

For the same aircraft there will often be a choice of engines. A choice of up to 3-4 engine types are not unusual for the same aircraft. The choice of engines for a specific aircraft is often a decision of the airliners requirements of cost, country of origin, maintenance policy, standardisation, fuel economy, etc. (USA: Pratt & Whitney/General Electric; England: Rolls Royce; and multinational companies: Internationale Aero Engines (IAE) and CFM International).

We have chosen several engine combinations for the same aircraft with the purpose of comparing the fuel consumption and emission from different combinations.

Appendix 1 is an overview of the aircraft in this study. For most aircraft are a choice of different engines for the same aircraft.

4.3 Seat Capacity

Seat capacity varies from airliner to airliner. To avoid any unfair combinations for a specific aircraft with many individual seat configurations, we have chosen the seat numbers given from the aircraft factory.

Seat capacity is playing a key role in the determination of the emission per passenger. Therefore there is significant difference in emission per passenger for an "all tourist class" aircraft compared to the same aircraft, but with two or three classes cabins such as " first class", "business-class" and "tourist class/economy class".

In this report the emission data is based on a 100% occupancy, which is not realistic. Many routes is only able to carry 30-50% passengers or even less. For the purpose of comparable data we have chosen to select 100% seat occupancy, but if these emission data are used to compare with emissions from other transport vehicles a correction should be made to adjust for this factor.

In 1996 the average occupied seats for European flight was 70%. In 1997 the occupied seats counted for 72,4%.

4.4 Fuel Consumption and Size of Aircraft

It will of course not be fair just to compare fuel consumption for each individual aircraft or engine type without respect to the number of seats in the aircraft. Large aircraft with powerful engines of course consumes more fuel than smaller aircraft, but also carries more passengers compared to the smaller aircraft.

The most comparable and fair judgement on fuel consumption must therefor be based on the fuel consumption per transported passenger, in this report for 100% occupancy.

Based on a 100% occupancy and the seat capacity given from the aircraft producer, this report does not take into account that some routes (overseas, intercontinental routes) often require aircraft build for this purpose (and often with less seats than domestic flights).

Furthermore this report does not take into account that short flown distances are far more fuel consuming than longer routes. For example up to 1/3 of the total fuel consumption is used during "take off" and "climb out" for shorter domestic routes (about ½ hour flight). The fuel consumption during "take off" and "climb out" for medium and long distance routes is approximately up to 1/8 of the total fuel consumption for the flight.

5. Fuel Consumption per Seat

Fuel consumption per seat for 100% seat occupancy is shown in appendix 2. From the appendix it is clear that aircraft types such as executive jets (Gulfstream and Cessna), B707, MD11 (mixed class), Russian Turbolev, DC10 (Pratt & Whitney), DC9-10/20, older B737, Airbus A310, B727-200, and B747-400 (General Electric) are using much more fuel than the average fuel consumption per passenger. The same trend can also be found for the "idle power" setting.

Executive jets (Gulfstream and Cessna) obviously have a totally unacceptable fuel consumption per transported passenger. Their fuel consumption are 5 - 10 times bigger than for other passenger jets.

The most fuel economical aircraft is the new large B777 only configured as an "all economic class" (with 550 seats), the Airbus A321, the new MD90, and the present generation of the B737s.

A much better fuel efficiency could be expected from the new aircraft, including the relative newer B767. But the configuration with two or three classes cabins has a price tag with increased fuel consumption. Also the three class version of the 777-200/300 has a significant increase in fuel consumption. A B777-300 with only one class (economical class) can accommodate 550 seats, but a three class B777 can only carry 328 passengers.
As a consequence of the reduced number of seats (seats reduced to 67% of the maximal capacity) the fuel consumption per seat is increased by 33%.

Larger aircraft could be expected to have a better fuel economy than medium and small size aircraft. However, this seems not always to be the case. For example the fuel consumption per seat for the B747 varies lot depending the seat configuration (total number of seats). Furthermore the B747 with the old Rolls Royce mixed turbofan RB211-524G engines is very fuel consuming. However, some of the B747s are also older aircraft, which in general pollutes more than a new aircraft.

Airbus' small and medium size aircraft has a better fuel efficiency than larger aircraft such as the B767, B747 and B777 in a three class cabin configuration.

The old "mixed flow turbofan" engine is using significantly more fuel than the newer "turbofan" and "high bypass turbofan" engines.

The fuel consumption for 85% power setting and for 7% power setting is nearly showing the same conclusions.

Appendix 2 also shows the fuel consumption for a car with three passenger driving the same distance as a jet travels in one hour (770 kilometres). The car[1] uses only half the fuel per passenger compared to the most fuel economical passenger jet.

5.1 Conclusion for Fuel Consumption per Seat

"Ineffectual waste" with seat capacity by having two or three classes in an aircraft has it's price tag: up to 33% more fuel per seat. This element is the most contributing factor to increased fuel consumption.

Q: is it acceptable to increase fuel consumption by up to 33% by "poor seat economy" taking into account that most flights only are of a very limited time (1-7 hours)?

The next single largest factor for an increased fuel consumption is the age of the aircraft/engine. It is obvious, that an

[1] 14 km/kg fuel

old aircraft are using more fuel than a new aircraft and by that pollute more.

A MD90-30 with a capacity of 155 seats is using 25% less fuel than a similar (but much older) B727 with nearly the same seat capacity (148 seats). Both aircraft are with “mixed class” cabins. This trend can be seen for all categories and sizes of aircraft. We will therefore encourage our politicians to legislate against the use of old polluting aircraft - ***or at least that these old aircraft are taxed after the principle: the polluter pays after his proportion of the pollution.***

Large aircraft are not as fuel efficient as expected. Despite an “all economy class” B777 is the most fuel economical aircraft compared to the number of seats, the smaller or medium size aircraft such as Airbus A321, A 320, the medium A340, and the B737s aircraft are in general more fuel economical than larger aircraft, such as the B767, B747 and B777 in a two or three class cabins configuration.
Executive Jets such as Gulfstream and Cessna have a totally unacceptable fuel consumption. They are using 5-10 times more fuel per passenger than other passenger airline jets.

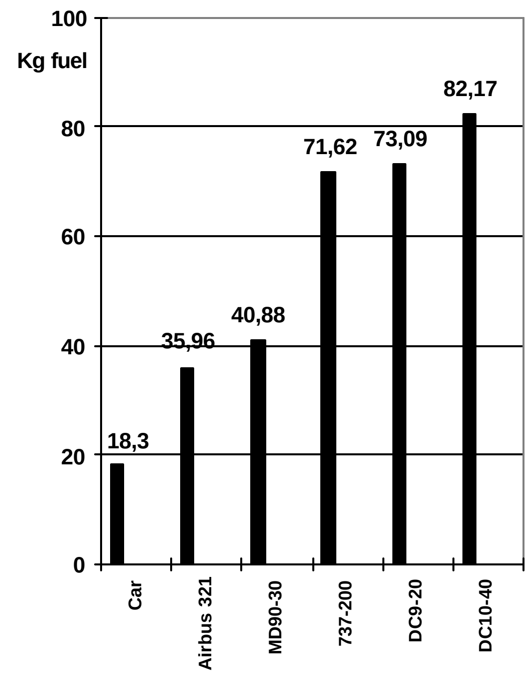
5.2 Jet Engines Fuel Efficiency

Appendix 3 shows that new, big and powerful engines are the most economical when output (thrust) is compared with fuel consumption. The Pratt & Whitney 4077/4084 and General Electric CF6-80C2 engines with thrust of 52.000 - 77.000 lb. are the most economical.

The least economical engine is the old Pratt & Whitney JT8D (ca. 15.000 lb.), which is used in the old DC9 and some B737, B727 and MD88.
The CMF56 engines for B737-300/400/500 (ca. 20.000 lb.) is in the middle of the scale and by that not as fuel economical as expected compared to the bigger engines. The Russian engines and the small jet engines for the executive jets are the most fuel consuming engines.

5.3 Conclusion for Fuel Consumption

New jet engines are obviously (and as expected) the most fuel economical. For example a new MD90 22% consumes less fuel than a similar sized MD82 and is 51% more economical that a DC9-10.
This figure shows the fuel consumption per passenger per hour for a car and some common used aircraft.



It is clear that the fuel savings are significant if an old aircraft is replaced my a new and more fuel economical aircraft.

The figure also shows that a car with three passengers only use half of the fuel per passenger compared to the most economical passenger jet for the same distance (1 hour flight = 700 kilometres driving).

It was expected that the large jets were the most fuel economical because of their capacity to carry a large number of passengers. However, this is not necessary the case because the smaller Airbus aircraft, B737 and MD90 are all using less fuel per seat than larger aircraft such as the

B777 (two or three classes cabins), B767 and B747. Obvious large and heavy aircraft also use more fuel. In addition the large long distance aircraft are equipped with fewer seats and increased comfort equipment such as larger and heavier seats, individual video, telephone, entertainment, etc.
In addition a large selection of food and duty free shopping goods all adds to an increased weight.
An "all economical" B777-300 with 550 tourist class seats is the most fuel economical aircraft. This shows that it is possible to increase fuel efficiency per seat by not wasting seats for the motive of comfort.

Two and three class cabin aircraft are consuming 20 - 30% more fuel.

6. CO_2-emission

Carbon dioxide (CO_2) is the most significant contributor to greenhouse gasses. CO_2-emission is directly related to fuel consumption and 1 kilo combusted fuel is proportional to 3,14 kg CO_2.

Appendix 4 shows the CO_2-emission for different aircraft.

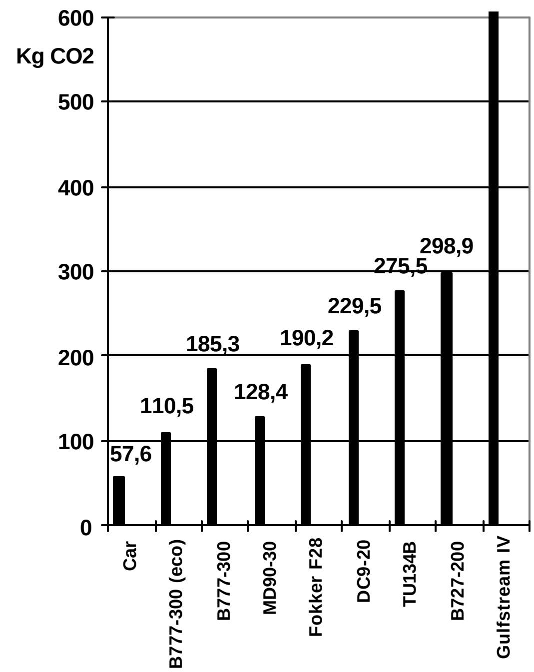
Because CO_2-emission is proportional to the fuel consumption, the same conclusion for Carbon dioxide can be made as for the fuel consumption, i.e. to replace old aircraft with new aircraft and to maximise the seat capacity. By these simple precautions the emission of the greenhouse gasses from aviation can be reduced in the order of 20-50%.

6.1 CO_2-emission from an Aircraft and a Car

The next figure shows the emission of CO_2 per passenger per hour for some popular aircraft and for a car. Basically the figure is comparable with the figure showing the fuel consumption because 1 kilo combusted fuel equal 3,14 kilo CO_2.

The figure also shows, that the CO_2-emission for a passenger transported one hour - or a distance of 700 km - is 110,5 kg in an "all class" B777-300 with 550 seats[1], 185,3 kg for the same B777 but now as a three class cabin aircraft with only 328 seats and 1095,6 kg CO_2 per passenger if a Gulfstream executive jet is used (out of scale in the figure).

The same figure also shows that a car[2] only contributes with half the amount of CO_2 compared with the most environmental friendly aircraft (B777-300 eco) for the same distance.



If a family of four people travel 4 hours in a B727, this trip will cause emissions of 4,7 tons CO_2 to the environment.

If a more economical B777 ("all economical class") is used, the amount of CO_2 is then 1,9 tons. If a car is used for the same distance the emission of Carbon dioxide to the environment is only 692 kg[3].

[1] Under the assumption that the occupancy 100% and "power setting" is 85% during "cruise speed"
[2] Based on 3 passengers in the car
[3] Regardless the numbers of passengers and with a fuel consumption of 14 km/kg fuel

6.2 Environmental Damaging low Rate Pleasure Flights

Low-priced air tickets for weekend pleasure and one day trips are often offered by the airliners. How much damaging pollution is acceptable for such unnecessary travel?

It can be argued that the need, justification and benefit for such short pleasure trips are limited and should be avoided.

By enforcing environmental tax on all air tickets in the order of 50- 100 UK£, the incitement to such unnecessary and environmental damaging trips can be avoided. In a long term perspective the total number of air travelling seats can be reduced if the airliners no longer can expect to “fill up the cabin” with “last minute deals”. The airliners statement that it is better to “fill up the cabin” than fly half empty is not satisfying, because the passenger foundation for an air line route must be calculated on the required and natural passenger numbers and not on a calculated surplus of seats.

6.3 Conclusion for CO_2-emission

CO_2 is the largest contributor of greenhouse gasses. In accordance with the Kyoto Protocol the CO_2-emissions shall be reduced by 6-8%.

If aviation is to take it’s fair share of the reduction of Carbon dioxide, drastically cuts must be made. A reduction of CO_2-emission from aviation can only take place if old and fuel consuming aircraft are replaced with new and more fuel efficient aircraft; a general reduction in passengers and routes are made; a better exploitation of the aircraft and seat capacity is enforced and by introducing environmental taxes of a significant order.

Q. Does it make sense to remove seats in the cabins to improve comfort and space for first class passengers when fuel consumption and CO_2-emission are increasing with up to 33%?

Airliners will without doubt complain against any attempt to regulate air traffic, because first class tickets and business class tickets are very profitable for the airliners.

Is legislation necessary to regulate and direct passenger capacity to avoid unnecessary environmental damage?

Should air travel not pay for the pollution this transport form inflicts on the environment after the principle: the polluter pays for his proportion of pollution?

7. Other Dangerous and Damaging Emission from Aviation

Besides aviation contributes significantly to the greenhouse effect, aviation is also responsible for a long list of other dangerous missions such as Carbon monoxide (CO), NitrogenOxide (NO_x), Hydrocarbons, SulphurDioxid (SO_2) and dust particles.

This report also includes emissions for CO, NO_x and HC. Unfortunately there are no accessible data for SO_2 and dust particles.

7.1 Of what Consist the Emission from Aviation and how Dangerous is this Emission:

Carbon monoxides (CO) is a colourless, odourless gas formed when carbon is oxidised in a limited supply of air. It is a poisonous constituent of combustion engine exhaust fumes, forming a stable compound with haemoglobin in the blood, thus preventing the haemoglobin from transporting oxygen to the body tissues. By adding an oxide (O) Carbon dioxide (CO_2)is formed.

<u>NitrogenOxide (NO_x)</u> is any chemical compound that contains only nitrogen and oxygen. all nitrogen oxides are gasses. Nitrogen monoxide and nitrogen dioxide contribute to air pollution. Nitrogen monoxide (NO), or nitric oxide), is a colourless gas released when metallic copper reacts with concentrated nitric acid. It is also produced when nitrogen and oxygen combine at high temperature. On contact with air it is oxidised to nitrogen dioxide.
Nitrogen dioxide (NO_2) is a brown acid and pungent gas that is harmful if inhaled and contributes to the formation of acid rain, as it dissolves in water to form nitric acid.

<u>Hydrocarbons (HC)</u> is any class of chemical compounds containing only hydrogen and carbon. Hydrocarbons re obtained industrially principally from petroleum and coal tar. Hydrocarbons and especially benzene are cancerously . Furthermore, a number of radical hydrocarbons contribute to the formation of ozone.

<u>SulphurDioxid (SO_2)</u> is colourless gas which contributes to the formation of acid rain and acid soil. , SulphurDioxid is dangerous if inhaled.
Furthermore emissions from jet engines contain soot and dust particles which are dangerous if inhaled. Dust particles is carriers for dangerous particles and causes irritation of eyes and lungs. Soot can also cause cancer.

8. CO-emission

Appendix 5 shows the CO-emission. The same trend as described for CO_2-emission can be made: large new aircraft such as B777, the present generation Airbus and the B767 are the most environmental friendly.

The most damaging polluters are the Russian TU's, Gulfstream, Cessna, DC9/10, B707, B727, first generation B737 and the MD80.

There is a significant difference in the degree of pollution with Carbon monoxides from different aircraft. The least polluting aircraft is the B777-300 "all eco" and the most polluting aircraft is the TU135B. The difference is 88 times!
A DC9-20 pollutes more than 5½ times with Carbon monoxides than it's successor, the MD90.

Fokker is listed to zero pollution with Carbon monoxides in the database. This is obviously not the case but rather lack of test data.

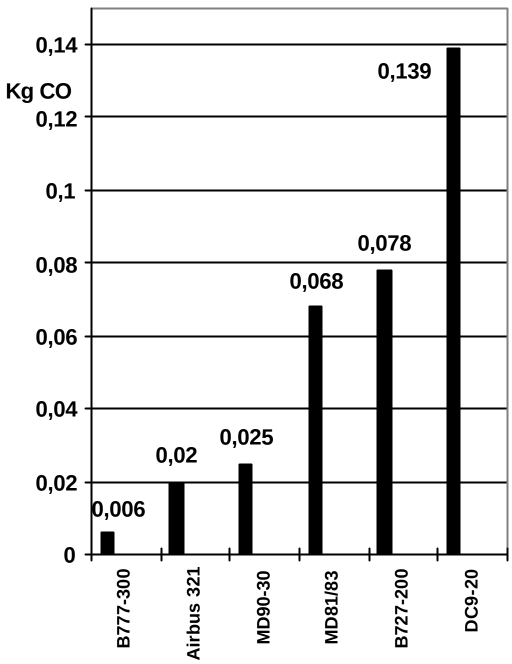
The same trend for "idle" can be seen except that the jet engines in idle are polluting significantly more. Typical the pollution in "idle" power setting is 10 times the pollution for 85 % power setting. This large amount of pollution in idle with Carbon monoxides is very dangerous for the local residents and for airport employees, because Carbon monoxides is poising, causes headache, faintness and heart diseases.

8.1 Conclusion for CO-emission

Carbon monoxides are very dangerous to the human being and damaging to the environment: This should be more than a reason to legislate and regulate for the amount of emission of this poisoning and damaging gas.
By putting a ban on the most pollution aircraft a significant reduction of Carbon monoxides can be achieved.

Most of the pollution with Carbon monoxide takes place in idle during engine test, at runways and in waiting positions at the runways (often for 20-40 minutes). It is therefor important that this CO-emission is regulated.

A regulation in this area is obviously not in the interest of the airports and airliners as the operators often have “traffic jam” problems at congested runways during peak hours. However stacking up 10-20 aircraft in idle in a queue for “take off” contributes to an totally unacceptable pollution in the local area with Carbon monoxides.



This figure above shows the CO-emission per passenger per hour. It is obvious that a significant reduction of carbon monoxides easily can be achieved by replace old polluting aircraft with new and more environmental friendly aircraft.

Airports should not be allowed to taxi aircraft to waiting positions at runways for 20-40 minutes, where the aircraft pollute with large amounts of the damaging and hazardous carbon monoxides.

9. HC-emission

Appendix 6 shows the emission of the cancerously Hydrocarbons. It is apparent that the old mixed flow turbofan/mixed turbofan engines pollute much more than newer high bypass turbofan/turbofan jet engines.

For example a DC9-50 (Pratt & Whitney JT8D-17 mixed flow turbofan) pollutes more than 23 times with hydrocarbons than the new MD90-30 (IAE V2525-D5 turbofan).

Aircraft such as Cessna, B707/B727, Gulfstream, B747 (with RB211-524G engines), first generation B737, DC9 and MD80 also contributes with totally unacceptable mounts of Hydrocarbons.

(The DC10-40 is listed to zero pollution with Hydrocarbon in the database. This is obviously not the case but rather lack of test data).

The same increasing trend as for CO-emission for idle power setting - compared with 85% power setting - can also be seen for emission of HC, except that the jet engines in idle are polluting significantly more - in some cases hundreds of times more pollution with Hydrocarbons than for idle power setting.

Likewise can the same consideration to ground handling of the aircraft be applied for Hydrocarbon as for with Carbon monoxides: most of the HC-emission is released inside the airport and is inflicting great damage to the local area and residents.

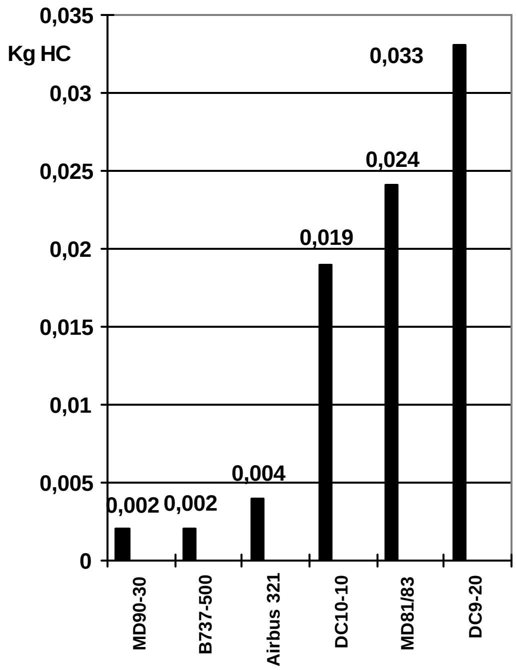
Taken into account that Hydrocarbons are cancerous, this emission is of course not acceptable.

9.1 Conclusion for HC-emission

Like the emission of Carbon monoxide, the emission of Hydrocarbons is neither acceptable. Hydrocarbons are dangerous for the human being and for the environment and must be regulated.

By replacing old polluting aircraft with new and more environmental friendly aircraft, the emission of Carbon monoxide can be reduced in the order of 20 times.

This next figure shows the emission of Carbon monoxide per passenger per hour. Significantly reductions in HC-emissions can be achieved by replacing old aircraft with new aircraft



A significant part of the Hydrocarbon emission takes place at the runways and often close to residential areas. It is therefore important to regulate the aircraft ground traffic to avoid unnecessary, dangerous and damaging emission of Hydrocarbons.

Aircraft in idle pollute several hundreds times more with Hydrocarbons than during normal operations.

Airports should not be allowed to taxi aircraft to waiting positions at runways for 20-40 minutes, where the aircraft pollute with large amounts of the damaging and hazardous Hydrocarbons.

10. NO_x-emission

No significant judgement can be made for the emission of NitrogenOxide (NO_x) (Appendix 7). By that it is not said that significant reductions in the emission of NitrogenOxide can not be made.

The difference between a 747-400RR polluting with 2,891 kg/passenger/hour compared to B737-300 polluting with “only” 0,691 kg/passenger/hour is in the order of 4 times the pollution. However, it can not be stated that new aircraft pollute less than old aircraft and or if there is any significant changes in the type of engine (mixed flow turbofan/turbofan/high bypass turbofan).

Furthermore, the NO_x-emission varies significantly depending on power setting.

In contrast to the emission of CO and HC, the aircraft pollute more in 85% power setting compared to idle (7%), typically in the order of 30-50 times more.

NitrogenOxide is harmful if inhaled and contributes to the formation of acid rain.

10.1 Conclusion for NO_x-emission

NitrogenOxide is very poisoning for the human being and contributes to acid rain and should in anyway be avoided. However, technical jet engine improvements doesn’t seem to have any significantly impact on the reduction of NOx which of cause is an undesired situation.

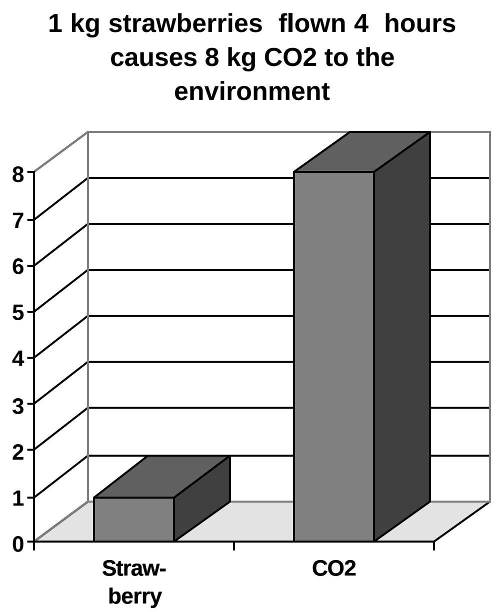
Only a reduction of air traffic is a solution to reduce the amount of NitrogenOxide.

11. Air Cargo

Appendix 8 shows the emission of CO_2 per hour per transported kilo air freight . By transporting one kilo freight by air the CO_2-emission per hour is 0,6 - 2,0 kg CO_2.

One kilo strawberries flown from Israel to Denmark (a four hours flight) causes the emission of 2,4 - 8 kg CO_2 into the environment.
Is this acceptable?

The above mention example presumes, that the air freighter is 100% loaded which is far from the reality. If the air freighter is less than full the emission of CO_2 increases.



12. Conclusion

New aircraft pollute significantly less than old. Aircraft with the old “mixed flow turbofan” engines and the “mixed turbofan” engines pollute more than the later “turbofan” and “high bypass turbofan” engines.

If 15-30 years old aircraft are replaced by new generation aircraft, the fuel consumption can be reduced by 25%. However, weighty “comfort equipment” such as heavier chairs, individual TV, telephone, entertainment equipment, etc. can reduce the fuel efficiency of new aircraft.

By only having “one class cabins” instead of “two or three class cabins” the fuel consumption per passenger can be improved with up to 33%. Aircraft with “first class” and “business class” pay the penalty in a significantly increased fuel consumption.

Because the emission of Carbon dioxide is proportional with the fuel consumption, the same conclusion as for the fuel consumption can be made for the emission of greenhouse gasses (CO_2).
Significantly reductions in greenhouse gasses can be achieved by replacing old aircraft with new aircraft and to maximise the passenger capacity in the cabins. However, air traffic must be regulated to take benefit of these savings as airliners see no incitement to replace old aircraft with new and expensive aircraft.
Furthermore the airline routes are based on a profitable foundation rather than to protect the environment.

The replacement of older aircraft with new and more environmental aircraft will also benefit in the area of less dangerous and damaging emissions. Especially the emission of Carbon monoxide (CO) and Hydrocarbons (HC) can be reduced significantly by introducing new and more environmental friendly aircraft.

A significant part of the emission of Carbon monoxide and Hydrocarbons takes place inside the airport, on the runways and on waiting position on runways.
The emission of these dangerous gasses increases many folds when the jet engines are in “idle mode”. It is therefore necessary to control the ground operations for aircraft by legislation and regulations.

No final conclusion can be made for the emission of NitrogenOxide (NO_x). Both new and old aircraft pollute with NitrogenOxide and technical improvement doesn’t seem to have much effect on the NO_x-emissions.

13. Recommendation

Airport and aviation are the most single polluting industry. Despite this fact aviation is virtually excluded from any control and legislation to reduce the environmental impact and to protect the residents around an airport. There are basically no limits for the amount of deadly gasses an airport or aircraft can poison into the environment and inflict on people with such gasses as Carbon monoxide, Hydrocarbons, NitrogenOxide, SulphurDioxid, dust particles, etc.

Aviation is causing damaging effect on the environment. This both locally, regionally and global.
Despite this tragic fact there is still no regulation of significance for reducing the damaging impact to the environment or people living close to an airport. Moreover, only very little effort - or none - are done in the area of monitoring the pollution from aviation and airport.

Despite that airports are ”environmental bombs” no restrictions seem to apply to airports. For example has Denmark just approved an expansion of Copenhagen Airport with up to 50%, causing an increase of all the damaging, harmful and injuring emissions by up to 50%.

The local pollution from Copenhagen Airport (for landing and take off, inclusive aircraft, air side traffic and total ground traffic) will then be[1] (tons per year):

	1994 level	2005 level
CO	2710 tons	2625 tons
HC	284 tons	213 tons
NOx	1210 tons	1695 tons
SOx	4,34 tons	4,46 tons
CO_2	226100 tons	337600 tons

If these figured are compared to the annual numbers of passengers, ***the local pollution*** will them be per passenger[2] (kg per year):

	1994 level	2005 level
CO	0,2 kg	0,11 kg
HC	0,02 kg	0,01 kg
NOx	0.09 kg	0.07 kg
SOx	0,0003 kg	0,0002 kg
CO_2	16,5 kg	14,0 kg

(1994: 13,7 million passenger)
(2005: 24,1 million passenger)

Obviously these figures are based on the assumption that technical improvement can reduce the amount of emissions (but not for fuel consumption and CO_2-emissions!)

Denmark’s commitment to reduce the emission of greenhouse gasses (and CO_2) is obviously a commitment that Denmark does not intend to fulfil. Even Copenhagen Airport calculates that the CO_2-emissions will be increased by 50% or with the amount of 104.000 tons CO_2 per year!
No plans has been presented to compensate for this increase of greenhouse gasses.

- ***Aviation is the only transport form, which is not regulated in any significant way in order to reduce the environmental impact.***
- ***April 30th 1997 Denmark granted permission to Copenhagen Airport to increase emission of Carbon dioxide (CO_2) by 104.000 tons per year (from 203.000 tons/year in 1994 to 307.000 tons/year in 2005). This is an increase of greenhouse gasses of 51,2%.***
- ***An increase of greenhouse gasses (CO_2) of 104.000 tons (the increase of greenhouse gasses caused by the increase of expansion of Copenhagen Airport to year 2005) is comparable to the annual heating of 16.560 houses (annual fuel consumption of 2000***

[1] The Environmental Assessment Report for Copenhagen Airport, page 48, table 4.B.3
[2] The Environmental Assessment Report for Copenhagen Airport, page 48, table 4.B.3

kg[1]). Or 72.800 cars driving 20.000 kilometres on the streets.

- ***Denmark signed the "Kyoto Protocol" in December 1997 and by that is committed to reduce the overall total emission of greenhouse gasses by 6% (and 8% specific for Denmark) from the 1990-niveaue.***
- ***It must be our politicians and not the polluting industry who sets the boundaries for the disclosure of environmental data and hazardous emissions.***
- ***"Ineffectual waste" with seat capacity by having two or three classes in an aircraft has it's price tag: up to 33% more fuel per seat. This element is the most contributing factor to increased fuel consumption.***
- ***The next single largest factor for an increased fuel consumption is the age of the aircraft/engine. It is obvious, that an old aircraft are using more fuel than a new aircraft and by that pollute more.***
- ***The principle: "The polluter pays after his proportion of the pollution" must also be applied to aviation.***
- ***A car with three passengers use only half of the fuel per passenger compared to the most economical passenger jet for the same distance (1 hour flight = 700 kilometres driving).***
- ***Two and three classes aircraft are consuming 20 - 30% more fuel.***
- ***If a family of four people travel 4 hours in a B727, this trip will cause emissions of 4,7 tons CO_2 to the environment.***
- ***There is a significant difference in the degree of pollution with Carbon monoxides from different aircraft. The least polluting aircraft is a (B777-300 "all eco") and the most polluting aircraft is the TU135B. The difference is in order of 88 times!***
- ***A DC9-20 pollutes more than 5½ times with Carbon monoxides than it's successor, the MD90.***
- ***Aircraft in idle pollute several hundreds times more with Hydrocarbons than during normal operations***
- ***Airports should not be allowed to taxi aircraft to waiting positions at runways for 20-40 minutes, where the aircraft pollute with large amounts of the damaging and hazardous Hydrocarbons.***
- ***One kilo strawberries flown from Israel to Denmark (a four hours flight) causes the emission of 2,4 - 8 kg CO_2 into the environment. Is this acceptable?***

13.1 Recommendation for Reducing the Damaging Emissions.

We will encourage our politicians to regulate air traffic by laws and regulations with the purpose of controlling and reducing the amount of emissions from airports and aviation.
However, It can not be expected that the airports and airliners are co-operative in these matters why the politicians must be firm when dealing with legislation to protect environment and people from the damaging environmental impact from aviation.

1. Aircraft must be categorised in classes after the degree of pollution the aircraft inflict (comparable to aircraft categorised in "chapter I, II and III" noise levels).

2. The most polluting aircraft are banned or restricted in operations.

3. Variable environmental taxes are introduced depending on the degree of

[1] 1 kilo fuel = 3,14 kg CO_2

the pollution from different aircraft types.

4. The old and most polluting aircraft are immediately banned from all airports.

5. Airliners concessions must be approved with the purpose of maximising the capacity and to avoid departures with only limited passengers.

6. The calculated numbers on air traffic routes must be based on the “natural” numbers of passengers and “last minute deals” must be limited with the purpose of having fewer departures with more passengers (“but not last minute passengers”).

7. Tax on air tickets are introduced after the principle: “The polluter pays for his/her pollution”. This includes higher taxes on first class tickets and “business class tickets”.

8. Transit must be minimised.

9. Domestic routes must be shut down where other alternatives and more environmental friendly transports are available. Or at least higher taxes must be introduced to promote an environmental friendly local and regional transport.

10. Aircraft in “idle mode” on runways and waiting positions pollute up to hundreds of time more than during normal power settings in the air. Therefore the ground operations in idle must be regulated to avoid unnecessary waiting time at runways, terminals etc.

11. In addition to tax on tickets, air fuel must be taxed liked any other transport forms.

12. Air freight must be heavily taxed after the degree of pollution to avoid unnecessary air transport.

13. “Aviation environmental committees” are established to supervise, control and inspect the implementation of environmental regulations and laws for airport and aviation.

14. All airport must establish air pollution monitoring on a permanent basis.

15. Denmark and other signing participating governments must be obligated to the Kyoto Protocol and must present a layout showing reductions of greenhouse gasses.

14. Remarks

If you have any questions or remarks to ***The Environmental Organisation, Copenhagen*** concerning this report or who we are, please don’t’ hesitate to contact us.

We can best be contacted on e-mail:
beck@idt.net
but we have also provided telephone numbers and fax numbers at the end of this report.

15. Appendix

32 pages of appendixes to follow.

"Miljøforeningen"
for bevarelse af miljøet omkring Københavns Lufthavn

☎ +45 32538665
Fax: +45 32948665
E-mail: beck@idt.net

"The Environmental Organisation, Copenhagen"

for protection of the environment around Copenhagen Airport

US office (Washington DC)
☎ (703) 734 3285
E-mail: beck@idt.net
