Zurich Airport

Airport Emission Inventory

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Airport Emission Inventory

1. Introduction
2. Emission Species
3. Emission Sources at the Airport and Boundaries
4. Emission Inventory Calculation
5. Results
6. Guidance and Tools

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Introduction

Why do we need an airport emission inventory?

- Knowledge on airport local air quality
- Potentially legal compliance
- Trend-analysis
- Benchmarking
- Basis for mitigation planning

Who compiles an emission inventory?

- Airport operator or assigned consultant

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Steps to Develop Emission Inventory

1. Definition of overall parameters: purpose of the inventory (inventory only or also dispersion modelling); system perimeter (spatial and functional boundaries), updates (frequency to to the inventroy, e.g. annually), level of accuracy and complexity (simple, advanced, sophisticated).
2. Choice of emission species
3. Determination of emission sources (principle: as complete as possible, even if not all data are available);
4. Quantification of the emissions from those sources.
5. Interpretation and presentation of results, also in the context of macroscale approach (regional emission inventory).
6. Implement proper quality assurance and control measures.

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Emission Species

Emissions are substances that are directly emitted from a source (e.g. engine exhaust, storage container, open air application).

Common primary emission species relevant to airports are:

NOx	Nitrogen oxides (incl. NO_2 and NO)
VOC	Volatile organic compounds (incl. non-methane hydrocarbons, NMHC)
CO	Carbon monoxide
PM	Particulate matter (fraction size PM2.5 and PM10)
SOx	Sulfur oxides
CO_2	Carbon dioxide (being of global rather than local concern)

Additional species include hazardous air pollutants (HAP): benzene, formaldehyde, naphthalene, toluene, xylene, acrolein, lead, 1,2-butadiene, etc.

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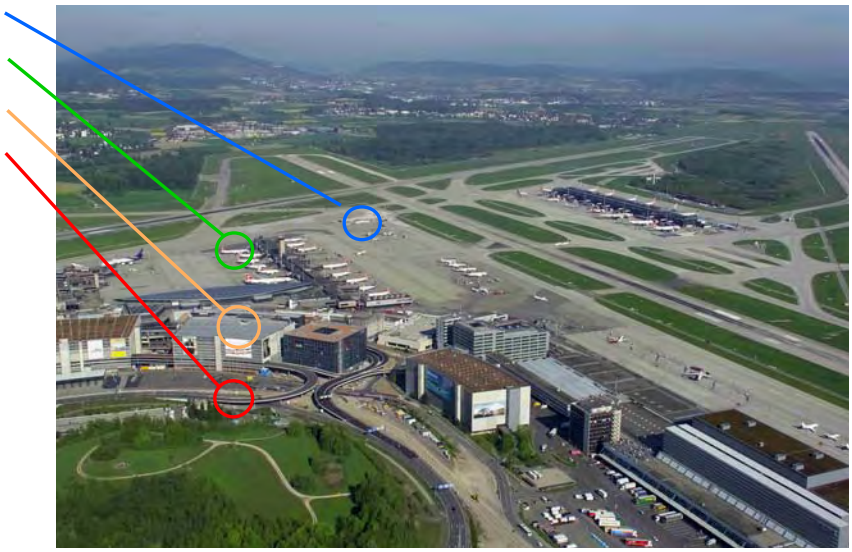
Overview: Airport Emission Source Groups

Aircraft
Aircraft Handling
Airport Infrastructure
Landside Road Traffic



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Aircraft Emission Sources

1. Aircraft engines: Landing and take-off cycle (movements below 3,000 ft) plus engine start-up.
2. Aircraft auxiliary power unit (APU): electricity and pre-conditioned air for aircraft.
3. Aircraft frame: brake and tire wear.

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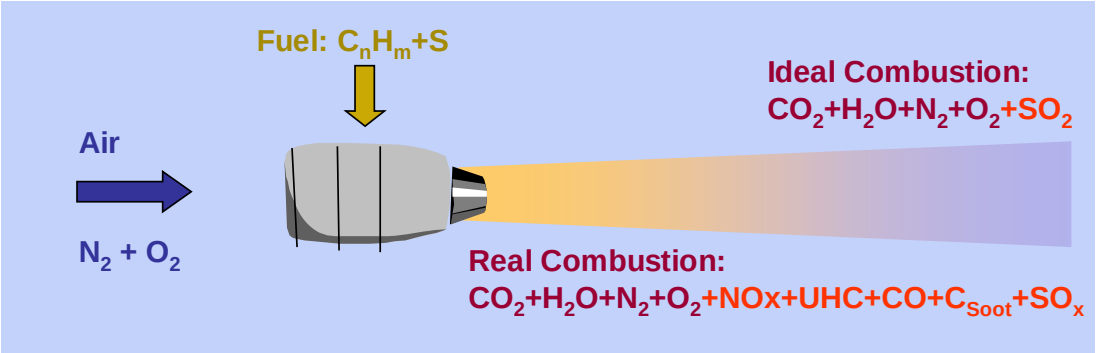
Emissions of Jet Engines



Exhaust Gas:

8.5%	Combustion products
16.3%	Oxygen
75.2%	Nitrogen

Combustion Products:

0.4%	Pollutants
27.6%	Water Vapor
72.0%	Carbon Dioxid

Pollutants:

0.1%	Soot
4.0%	VOC
11.8%	CO
84.0%	NOx

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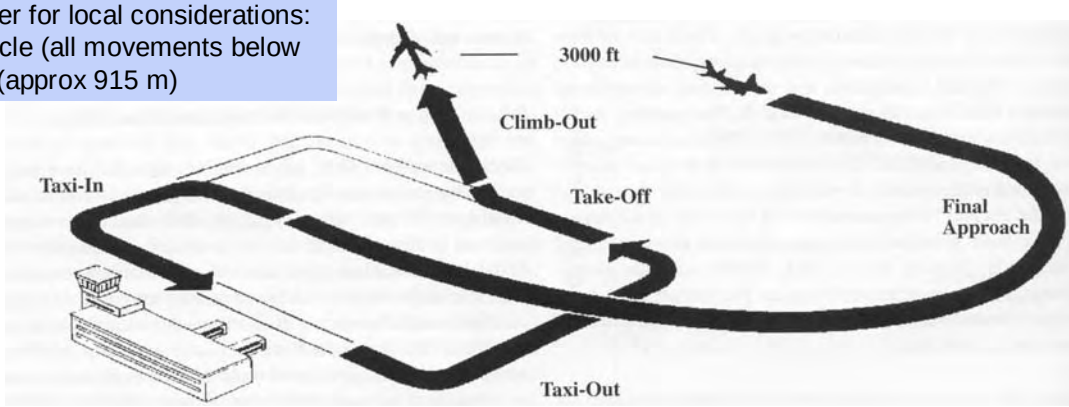
Air Traffic Emissions

Perimeter for local considerations: LTO-Cycle (all movements below 3000 ft (approx 915 m)



Operating Mode	Thrust setting	Time in operating mode, minutes
Take-off	100 % F_{oo}	0.7
Climb-out	85 % F_{oo}	2.2
Approach	30 % F_{oo}	4.0
Taxi/ground idle	7 % F_{oo}	26.0

Source: IPCC, 1999

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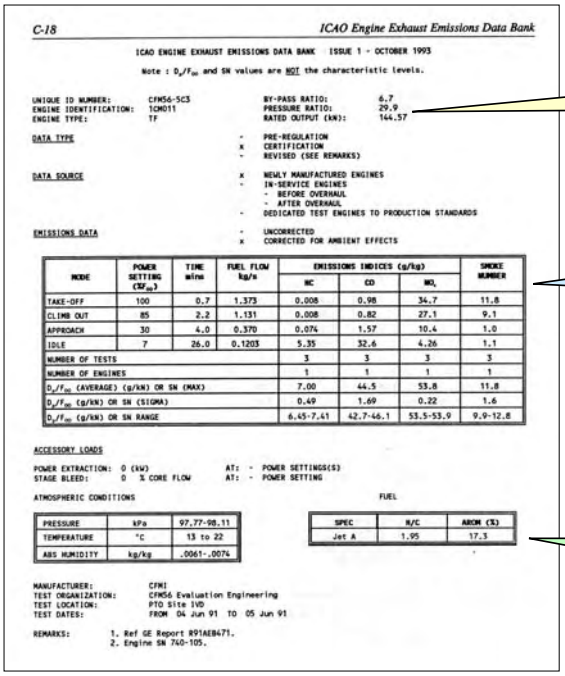
ICAO Engine Emission Data Sheet



C-18 ICAO Engine Exhaust Emissions Data Bank

ICAO ENGINE EXHAUST EMISSIONS DATA BANK ISSUE 1 - OCTOBER 1993

Note : D_p/F_{oo} and SN values are NOT the characteristic levels.

UNIQUE ID NUMBER: CFM56-5C3
ENGINE IDENTIFICATION: 1CM011
ENGINE TYPE: TF

BY-PASS RATIO: 6.7
PRESSURE RATIO: 29.9
RATED OUTPUT (kN): 144.57

DATA TYPE
- PRE-REGULATION
x CERTIFICATION
- REVISED (SEE REMARKS)

DATA SOURCE
x NEWLY MANUFACTURED ENGINES
- IN-SERVICE ENGINES
- BEFORE OVERHAUL
- AFTER OVERHAUL
- DEDICATED TEST ENGINES TO PRODUCTION STANDARDS

EMISSIONS DATA
- UNCORRECTED
x CORRECTED FOR AMBIENT EFFECTS

MODE	POWER SETTING ($\%F_{oo}$)	TIME min	FUEL FLOW kg/s	EMISSIONS INDICES (g/kg)			SMOKE NUMBER
				HC	CO	NO_x	
TAKE-OFF	100	0.7	1.373	0.008	0.98	34.7	11.8
CLIMB OUT	85	2.2	1.131	0.008	0.82	27.1	9.1
APPROACH	30	4.0	0.370	0.074	1.57	10.4	1.0
IDLE	7	26.0	0.1203	5.35	32.6	4.26	1.1
NUMBER OF TESTS				3	3	3	3
NUMBER OF ENGINES				1	1	1	1
D_p/F_{oo} (AVERAGE) (g/kN) OR SN (MAX)				7.00	44.5	53.8	11.8
D_p/F_{oo} (g/kN) OR SN (SIGMA)				0.49	1.69	0.22	1.6
D_p/F_{oo} (g/kN) OR SN RANGE				6.45-7.41	42.7-46.1	53.5-53.9	9.9-12.8

ACCESSORY LOADS

POWER EXTRACTION: 0 (kW) AT: - POWER SETTINGS(S)
STAGE BLEED: 0 % CORE FLOW AT: - POWER SETTING

ATMOSPHERIC CONDITIONS

PRESSURE	kPa	97.77-98.11
TEMPERATURE	°C	13 to 22
ABS HUMIDITY	kg/kg	.0061-.0074

FUEL

SPEC	H/C	AROM (%)
Jet A	1.95	17.3

MANUFACTURER: CFMI
TEST ORGANIZATION: CFM56 Evaluation Engineering
TEST LOCATION: PTO Site IVD
TEST DATES: FROM 04 Jun 91 TO 05 Jun 91

REMARKS: 1. Ref GE Report R91AEB471.
2. Engine SN 740-105.

Engine Identification

Fuel Flow and Emissions

Test Environment

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Aircraft Handling Emission Sources

1. Ground support equipment: tugs, tractors, stairs, loaders, ground power units, etc on aircraft stands.
2. Airside traffic: service vehicles and machinery (sweepers, trucks, busses, vans, cars) on the airside roads.
3. Aircraft refuelling: evaporation losses during aircraft refuelling on aircraft stands.
4. Aircraft de-icing: application of de-icing and anti-acing substances.

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Stationary/Infrastructure Emission Sources

1. Power/heat generation plant: on-site power station.
2. Emergency power generation: diesel generators.
3. Aircraft Maintenance: cleaning, painting, engine run-ups.
4. Airport Maintenance: cleaning agents, painting, vehicle and greenery maintenace.
5. Fuel farm: storage and distribution of fuel, vehicle fuel stations.
6. Construction activities.
7. Fire training activities.
8. Airport surface de-icing: substances applied to runways, taxiways, apron.

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Landside Traffic Emission Sources

1. Vehicle traffic: motor bikes, cars, shuttles, vans, busses, trucks within a defined boundary that includes access roads, curbside, parking lots.
2. Rail traffic: diesel locomotives, also within a definded boundary specific to each airport.

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Emission Inventory Calculations

General Approach: **Activity x Emission Factor**

Depending on the available information and data, a simple, advanced or sophisticated method can be used.

Activity (examples):
- Movements of a specific aircraft/engine combination;
- Operating hours of a baggage tractor
- Kilometers driven of a passenger bus
- Amount of solvents used for cleaning

Emission Factors:
- Obtainable from aviation industry (ICAO, others)
- National emission factor tables (e.g. vehicle mix)

In many cases, intermediate steps are required to bring the data in the format necessary to perform the calculations.

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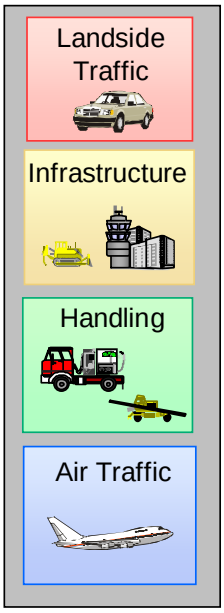
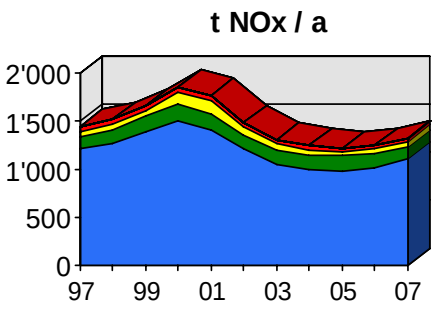
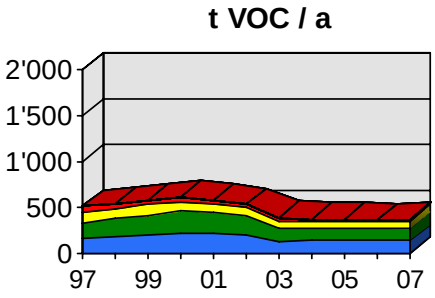
Emission Inventory Zurich Airport







Air Traffic is the largest single source of NOx-Emissions at the Airport

- Landside Traffic (Airport Area)
- Infrastructure
- Handling
- Air Traffic (modified LTO-Cycle)

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Guidance and Tools

ICAO Doc 9889 (2007)

(www.icao.int)

<u>Models for Airport Emission Inventory Calculations:</u>

Europe: - LASPORT
- ADMS Airport

North America: - AEDT-EDMS

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