



IPCC – National Greenhouse Gas Inventory Process (NGGIP) Methods for Assessing Aviation Emissions

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IPCC NGGIP Process



➤ 1996 IPCC Guidelines and Good Practice Guidance (GPG 2000)

- Outline methods to estimate GHG emissions from aircrafts for country specific domestic and international flights.
- Designate Tier 1 (very simple), Tier 2 (simple) and Tier 3 (detailed) emission estimation methods.
- Tier 1 only recommended for small aircraft, Tier 3 method very demanding.



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➤ Background for ICAO contribution

- The IPCC has recently completed a project to revise and update the *1996 IPCC Guidelines*.
- In this context, it was considered highly desirable for IPCC to seek advice/input from ICAO to update data on emission factors and other parameters that are currently provided in the reports and tools.
- WG3 of ICAO formed a small group to update Emissions Factors Database (EFDB) Table Z1, Z2, Z3, primarily used for Tier 2, to account for aircraft fleet developments and understanding of aircraft emissions.



Tier 1 Method



➤ Tier 1: Very simple

- Purely fuel based
- Emissions = Fuel Consumption * Average Emission Factor
- Default Emissions Factors from Table 3.6.4 and Table 3.6.5, or country specific Emissions Factors if available.
- Table 3.6.4 and Table 3.6.5 not updated for this exercise



Tier 2 Methods



➤ Tier 2: Simple

- Tier 2 is based on the number of landing/take-off cycles (LTOs) and fuel use.
- Distinction is made between emissions below and above 914 m (3000 feet); that is emissions generated during the LTO and cruise phases of the flight.
- Input data are included in Emissions Factors Database (EFDB) Table Z1, Z2, Z3 which have been updated by ICAO.



Tier 2 Methods



EQUATION 2.8

$$\text{Emissions} = \text{LTO Emissions} + \text{Cruise Emissions}$$

Where

EQUATION 2.9

$$\text{LTO Emissions} = \text{Number of LTOs} \bullet \text{Emission Factor}_{\text{LTO}}$$

EQUATION 2.10

$$\text{LTO Fuel Consumption} = \text{Number of LTOs} \bullet \text{Fuel Consumption per LTO}$$

EQUATION 2.11

$$\text{Cruise Emissions} = (\text{Total Fuel Consumption} - \text{LTO Fuel Consumption}) \bullet \text{Emission Factor}_{\text{CRUISE}}$$



Tier 2 – Table Z1 data



➤ Sample from EFDB Table Z1

AVIATION EFDB Table Z1			
	737-300/400/500	737-600	737-700
Average sector distance in nautical miles (nm)			
Total Flight	523	462	726
Climb	8.91	8.15	8.58
Cruise	496	437	700
Descent	17.77	17.40	18.02
Fuel use (kg)			
Total Flight	3629	3185	4750
LTO (flight < 3000 ft)	436	439	508
Flight minus LTO (flight >3000 ft)	3193	2746	4242
Fuel use (kg per nm)			
Flight minus LTO (flight > 3000 ft)	6.44	6.29	6.06



Tier 2 – Table Z2 data



➤ Sample from EFDB Table Z2

Table AVIATION EFDB Z2		LTO emissions factors/airplane (kg/LTO/airplane)								LTO Fuel consumption (kg/LTO/airplane)
	Airplane	CO ₂	CH ₄	N ₂ O	NO _x	CO	NM VOC	SO ₂		
Source: ICAO (2004)	Large Commercial Aircraft	A300	5450	0.12	0.2	25.86	14.80	1.12	1.72	1720
		A310	4760	0.63	0.2	19.46	28.30	5.67	1.51	1510
		A319	2310	0.06	0.1	8.73	6.35	0.54	0.73	730
		A320	2440	0.06	0.1	9.01	6.19	0.51	0.77	770
		A321	3020	0.14	0.1	16.72	7.55	1.27	0.96	960
		A330-200/300	7050	0.13	0.2	35.57	16.20	1.15	2.23	2230
		A340-200	5890	0.42	0.2	28.31	26.19	3.78	1.86	1860
		A340-300	6380	0.39	0.2	34.81	25.23	3.51	2.02	2020
		A340-500/600	10660	0.01	0.3	64.45	15.31	0.13	3.37	3370
		707	5890	9.75	0.2	10.96	92.37	87.71	1.86	1860
		717	2140	0.01	0.1	6.68	6.78	0.05	0.68	680



Tier 2 – Table Z3 data



➤ Sample from EFDB Table Z3

<i>Aviation EFDB Table Z-3</i>		
Emission Factors of NO_x for Various Aircraft at Cruise		
	Aircraft	NO_x Emission Factor (g/kg)
Large Commercial Aircraft	DC-10	13.9
	DC-8-50/60/70	10.8
	DC-9	9.1
	L-1011	15.7
	MD-11	13.2
	MD-80	12.4
	MD-90	14.2
	TU-134	8.5
	TU-154-M	9.1
	TU-154-B	9.1



Tier 3 Methods



➤ Tier 3: Detailed

- Method is based on actual individual aircraft and flight movement data
- Modelling primarily based on ICAO engine emission certification data
- Tier 3A: Origin and Destination (OD) by aircraft type and actual engines
- Tier 3B: Modelling of full flight trajectory



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➤ Summary

- 1996 IPCC Guidelines and Good Practice Guidance outline methods to estimate GHG emissions from aircrafts for country specific domestic and international flights.
- Three methods: Tier 1 (very simple), Tier 2 (simple) and Tier 3 (detailed) emissions estimation methods.
- Emissions factors table for Tier 2 method updated in 2006 by ICAO to account for aircraft fleet developments and understanding of aircraft emissions.



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THANK YOU