

**EU Emissions Trading Scheme
Historical Aviation CO₂
Emissions
for
2004, 2005 & 2006**

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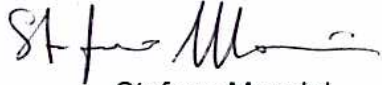

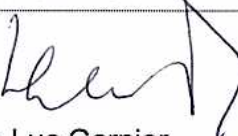

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Abstract		
<p>On 30 December 2008, the European Community and the European Organisation for the Safety of Air Navigation (“EUROCONTROL”) concluded a cooperation agreement for the provision of support by EUROCONTROL to the European Commission for the inclusion of aviation in the scheme for greenhouse gas emission allowances trading within the Community (European Union Emissions Trading Scheme, EU ETS).</p> <p>As part of this support, EUROCONTROL has calculated, using best available data, the historical average aviation Carbon Dioxide (CO₂) emissions for the years 2004, 2005 and 2006, i.e. the mean of the annual CO₂ emissions in each of those years from aircraft performing an aviation activity included in the EU ETS. These calculations will be used by the European Commission to determine the total number of CO₂ allowances that will be allocated to the aviation sector under the EU ETS.</p> <p>The present report provides the results of this calculation.</p>		
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The following table identifies all management authorities who have successively approved the present issue of this document.

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CHAPTER 1 – MAIN REPORT

1 Introduction

On 19 November 2008 the European Parliament and the Council of the European Union adopted Directive 2008/101/EC amending Directive 2003/87/EC (hereafter referred to in its amended version as “the Directive”) so as to include aviation activities in the scheme for greenhouse gas emission allowances trading within the Community (European Union Emissions Trading Scheme, EU ETS).

On 30 December 2008, the European Community and the European Organisation for the Safety of Air Navigation (“EUROCONTROL”) concluded a cooperation agreement for the provision of support by EUROCONTROL to the European Commission for the inclusion of aviation in the EU ETS.

As part of this support, EUROCONTROL has estimated, using best available data, the average aviation CO₂ emissions for the years 2004, 2005 and 2006, i.e. the mean of the annual CO₂ emissions in each of those years from aircraft performing an aviation activity included in the EU ETS. These estimates will be used by the European Commission to determine the total number of CO₂ allowances that will be allocated to the aviation sector under the EU ETS.

Considering the financial implications of the total quantity of allowances to be allocated to the aviation sector, it is essential to ensure that these estimates are of the highest possible quality to minimise the risk of an insufficient amount of allowances being made available for allocation to the different aircraft operators.

It is also essential to ensure the highest possible quality of these estimates in order to preserve the environmental purpose of the scheme upon the inclusion of the aviation sector within it. The following process has thus been followed:

- an independent external company has been awarded a contract by EUROCONTROL to:
 - validate the methodology used by EUROCONTROL to estimate aviation CO₂ emissions;
 - propose, if necessary, recommendations to improve the methodology such that the most appropriate use is made of the data available to

EUROCONTROL in order to ensure that the Directive's prescriptions are correctly implemented, thereby generating the best possible estimation of aviation CO₂ emissions achievable within the given timeframe of the study;

- verify that the methodology is correctly implemented in the EUROCONTROL systems;
 - define a reconciliation methodology to adjust the annual historical aviation CO₂ emissions estimates based on the actual fuel burn information provided on a voluntary basis by aircraft operators;
 - verify that the reconciliation methodology is correctly implemented.
- the support of the airspace users' associations was sought in order to encourage aircraft operators to work in partnership with EUROCONTROL to improve the emissions estimates through the voluntary supply of sample fuel burn data.

The findings of the work performed by the independent external company on validation, verification, reconciliation methodology development and final verification are available in, respectively:

- D1 – Report on the review of the EUROCONTROL process for the estimation of the historical annual CO₂ aviation emissions in line with the Directive's prescriptions;
- D2 – Report on the verification of the calculation of the 2004, 2005 and 2006 historical annual CO₂ aviation emissions estimates based on the process reviewed in D1;
- D3 – Methodology for reconciling the historical annual CO₂ aviation emissions estimates based on the actual fuel burn information as provided to EUROCONTROL by volunteer aircraft operators;
- D4 – Report on the verification of the implementation of the reconciliation methodology defined in D3.

The results of the estimation of the historical aviation CO₂ emissions for the years 2004, 2005 and 2006 are provided in section 3.

Annex 1 provides additional information which should help readers of this report to understand further the quality of the results.

2 CO₂ Calculation Process Overview

The process that has been followed to calculate the CO₂ emissions has been designed to make use of the best available data and of the best fuel burn estimation methodology that could be used within the challenging timeframe of the study. The process comprises three main steps:

1. identification of the aviation activities (flights) that in 2004, 2005 and 2006 would have been included in the ETS;
2. calculation of the CO₂ emissions produced by these flights;
3. calculation of the confidence interval of the final results.

2.1 Identification of the 2004, 2005 & 2006 aviation activities

EUROCONTROL has been operating the Central Route Charges Office (CRCO) since 1971, billing and collecting route charges for any flight performed at least in part under Instrument Flight Rules (IFR) within the airspace of the States that have signed the *Multilateral Agreement relating to Route Charges*¹ (hereafter referred to as the EUROCONTROL

¹ See http://www.eurocontrol.int/crco/gallery/content/public/docs/other/multilateral_agreement_en.pdf.

Contracting States) and that have been technically integrated in the CRCO system². The list of States that were technically integrated in the CRCO system in the period 2004-2006 is provided in Annex 2.

Considering:

- the commonalities between the *Conditions of Application of the Route Charges System and Conditions of Payment*³ (hereafter referred to as the CRCO Conditions) and the Directive as far as the identification of the operator of a flight and the exemption criteria are concerned;
- the significant overlap between the territorial area of application of the Directive and the area for which the CRCO is billing and collecting route charges;
- the CRCO's excellent application of the CRCO Conditions and track record of the recovery rate of route charges (in 2007, 99% within 30 days after the due date; 99.75% within one year after the due date); and
- that final settlement (payment) by an aircraft operator of the route charges billed by the CRCO confirms that the operator accepts the existence of the flight being charged and the legal correctness of the applicable route charges' data, namely the:
 - identity of the operator;
 - aircraft type;
 - average maximum take-off weight per aircraft type per operator;
 - departure and arrival aerodrome;
 - date of operation;
 - applicability of relevant exemption criteria;

it was decided that the route charges information available at EUROCONTROL's CRCO represents the most comprehensive source of information to identify the flights to which the Directive applies.

For the years 2004 to 2006 that are to be considered for establishing the historical aviation emissions, the CRCO information covers all flights which departed from or arrived at an aerodrome situated in the majority of the territories of the States to which the EC Treaty applies.

CRCO flight information does not however cover all flights that have departed or arrived at an aerodrome situated in the following countries or territories:

- Estonia;
- the French overseas departments (French Guiana, Guadeloupe, Martinique, La Réunion);
- Latvia;
- Lithuania (integrated in the CRCO system as from 1 January 2008);
- Poland (integrated in the CRCO system as from 1 January 2008).

Flight information for Estonia, the French overseas departments and Latvia has been completed thanks to the information that has been kindly provided by the relevant national authorities for the years concerned. For Lithuania, the traffic has been completed based on an analysis of the information that CRCO holds for 2008. For Poland, the traffic has been completed by relying on the information available through EUROCONTROL's Central Flow

² More information on the CRCO is available at http://www.eurocontrol.int/crco/public/subsite_homepage/homepage.html

³ See http://www.eurocontrol.int/crco/gallery/content/public/docs/circulars/cond_app_doc_07_60_02_en_oct2007.pdf.

Management Unit (CFMU) which has received flight plans for all flights operated at least in part under IFR rules in Polish airspace.

2.2 Calculation of the CO₂ emissions

The estimation of the CO₂ emissions associated with each flight has been calculated using the ANCAT method number three (ANCAT-3), as recommended by the European Civil Aviation Conference (ECAC) in its recommendation 27/3 on 8 July 2003⁴. The ANCAT methodology has been expanded by EUROCONTROL to cater for the wider range of aircraft types that fly in European airspace.

The ANCAT methodology does not cater for the usage of the Auxiliary Power Unit (APU) or for other factors that influence fuel consumption, e.g. meteorological conditions, actual taxi times, holdings, or actual take-off weight. In order to mitigate the possible impact of the limitations of the ANCAT methodology, actual fuel burn data samples provided on a voluntary basis by a number of aircraft operators⁵ have also been used to review the fuel performance models of the aircraft.

The fuel burn data samples provided by volunteer aircraft operators indicate for an individual flight the amount of fuel actually burnt for the period covered from departure from the airport gate or stand (off-blocks) to its arrival at the destination airport gate or stand (on-blocks). The actual fuel burn thus caters for the factors mentioned above that influence fuel consumption. APU fuel usage is only partially covered since the fuel burnt by the APU after on-blocks of the arriving flight but prior to off-blocks of the departing flight is not included in the sample data.

The flight information available in the CFMU has also been used to improve the accuracy of the CO₂ estimations. In particular, the route length used in the calculation is determined on the bases of the route flown by an aircraft. This is the route defined in the flight plan available at the CFMU, updated with actual surveillance data i.e. radar-derived data provided by the air navigation service providers and position report data provided by the aircraft operators.

2.3 Calculation of the overall confidence interval

The confidence interval associated to the CO₂ emissions calculated for each year has been computed based on the estimation error that has been calculated for each individual flight. The method of calculation of the individual flight estimation error and of the overall confidence interval is explained in D3 (see section 1).

3 *Historical Aviation CO₂ Emissions and Confidence Intervals for 2004, 2005 & 2006*

The estimated historical aviation CO₂ emissions for each of the three years 2004, 2005 and 2006 have been grouped according to the source of the traffic data used, as explained in the following sections.

3.1 CRCO covered traffic

The “CRCO covered traffic” group covers the estimates of the aviation CO₂ emissions from aircraft performing an aviation activity within the airspace of the States covered by the CRCO (see Annex 2 for the list of these States) and that would have been included in the EU ETS if the scheme had been applicable to aviation in the years 2004, 2005 and 2006.

⁴ Recommendation available at www.ecac-ceac.org.

⁵ CO₂ emissions are linearly proportional to fuel burn, thus the provision of fuel burn data samples on a voluntary basis by a number of aircraft operators does allow to assess directly the volume of CO₂ emissions.

The “CRCO covered traffic” group also includes the estimates for ETS covered flights operating to or from States or areas that were not covered by the CRCO in those years but which either landed in or flew through the airspace of a State covered by the CRCO.

The “CRCO covered traffic” group does not, however, cover:

- those flights operating to or from States or areas that were not covered by the CRCO in those years and that did not land in or flew through the airspace of a State covered by the CRCO (these are covered by the groups described in sections 3.2, 3.3, 3.4, 3.5, and 3.6); nor
- flights for which data was incomplete (these are covered by the group described in section 3.7).

3.2 Additional emissions for Estonia

Estonia is not a EUROCONTROL Contracting State. The CRCO thus holds information only for those flights that have departed from or arrived at an aerodrome in Estonia and have also flown through the airspace of at least one of the EUROCONTROL Contracting States.

The “Additional emissions for Estonia” group thus covers estimates that relate to the CO₂ emissions from aircraft performing aviation activities in 2004, 2005 and 2006 that were not covered in the traffic information available from the CRCO for those years. This additional traffic has been identified from the air traffic information kindly provided to EUROCONTROL by the Estonian authorities for the period concerned.

3.3 Additional emissions for French Overseas Departments

The Directive applies to all flights departing from or arriving at an aerodrome situated in any of the French overseas departments, i.e. French Guiana, Guadeloupe, Martinique, and La Réunion.

Whereas France is a EUROCONTROL Contracting State, CRCO’s billing and charging covers only flights which have operated in continental Europe. The CRCO thus holds information only for those flights that have departed from or arrived at an aerodrome in the French overseas departments as long as those flights have flown through the airspace of at least one of the EUROCONTROL Contracting States (e.g. flights between Belgium and any of the French overseas departments).

The “Additional emissions for French Overseas Departments” group thus covers estimates that relate to the CO₂ emissions from aircraft performing aviation activities in 2004, 2005 and 2006 that were not covered in the traffic information available from the CRCO for those years. This additional traffic has been identified from the air traffic information kindly provided to EUROCONTROL by the French authorities for the period concerned.

3.4 Additional emissions for Latvia

Latvia is not a EUROCONTROL Contracting State. The CRCO thus holds information only for those flights that have departed from or arrived at an aerodrome in Latvia and have also flown through the airspace of at least one of the EUROCONTROL Contracting States.

The “Additional emissions for Latvia” group thus covers estimates that relate to the aviation CO₂ emissions from aircraft performing aviation activities in 2004, 2005 and 2006 that were not covered in the traffic information available from the CRCO for those years. This additional traffic has been identified from the air traffic information kindly provided to EUROCONTROL by the Latvian authorities for the period concerned.

3.5 Additional emissions for Lithuania

Lithuania became a EUROCONTROL Contracting State on 1 September 2006 and has been technically integrated in the CRCO system from 1 January 2008.

Whereas the CRCO holds information for all flights that operated to or from an aerodrome situated in Lithuania in 2008, for the years 2004, 2005 and 2006 the CRCO holds information only for those flights that have departed from or arrived at an aerodrome situated in Lithuania and which have also flown through the airspace of at least one of the EUROCONTROL Contracting States.

Domestic flights in Lithuania as well as flights that have departed from or arrived at an aerodrome situated in Lithuania and which have not flown through the airspace of at least one of the EUROCONTROL Contracting States (e.g. flights from Vilnius to Moscow) have thus not been covered. Information for these flights has been requested from the Lithuanian authorities to complement the CRCO available information. At the time of completing the historical aviation CO₂ emissions estimation, this additional information had not been made available to EUROCONTROL.

The CRCO however holds information for all flights that operated to or from an aerodrome situated in Lithuania in 2008. This has been used to determine the ratio between the emissions for the traffic that would have been covered by the CRCO in 2008 if Lithuania had not integrated the CRCO system and the overall emissions for all the traffic that has operated to or from Lithuania in 2008.

The estimates that relate to the CO₂ emissions from aircraft performing ETS aviation activities in 2004, 2005 and 2006 that were not covered in the traffic information available from the CRCO have then been calculated assuming that this ratio has not changed since 2004. These additional estimates are covered in the “Additional emissions for Lithuania” group.

3.6 Additional emissions for Poland

Poland became a EUROCONTROL Contracting State on 1 September 2004 and has been technically integrated in the CRCO system from 1 January 2008.

For 2004, 2005 and 2006, the CRCO thus holds information only for those flights that have departed from or arrived at an aerodrome situated in Poland and which have also flown through the airspace of at least one of the EUROCONTROL Contracting States.

Prior to 1st January 2004, EUROCONTROL, through its Central Flow Management Unit, provided some air traffic flow management functions for all flights operating in the Polish airspace. In particular flight plans have been received for all flights operated at least in part under IFR rules in Polish airspace.

This information has been used to complement the CRCO flight data for flights that have departed from or arrived at an aerodrome situated in Poland for the years 2004, 2005 and 2006.

The “Additional emissions for Poland” group thus covers estimates that relate to the CO₂ emissions from aircraft performing an aviation activity in 2004, 2005 and 2006 but not covered in the traffic information available from the CRCO for those years.

3.7 Additional emissions for flights with incomplete data

A very small proportion of the flights did not have an ICAO aircraft type code defined or an ICAO location indicator specified for the departure or arrival aerodrome, making it therefore impossible to apply the ANCAT-3 Methodology.

The emissions for the flights in the “Additional emissions for flights with incomplete data” group have been estimated based on either the average emissions per nautical mile or per flight of similar flights.

3.8 Historical aviation CO₂ emissions and confidence intervals

Table 1 indicates the estimated historical aviation CO₂ emissions for each of the three years 2004, 2005 and 2006.

Table 1 – Historic aviation CO₂ emissions (in tonnes)

Source	2004	2005	2006
CRCO covered traffic (see section 3.1)	205,768,287	217,293,873	225,161,413
Additional emissions for Estonia (see section 3.2)	21,094	22,965	26,398
Additional emissions for French Overseas Departments (see section 3.3)	309,594	303,058	269,224
Additional emissions for Latvia (see section 3.4)	29,803	59,471	68,491
Additional emissions for Lithuania (see section 3.5)	11,514	16,226	17,421
Additional emissions for Poland (see section 3.6)	137,342	140,823	153,947
Additional emissions for flights with incomplete data (see section 3.7)	5,705	7,956	2,177
Total	206,283,339	217,844,372	225,699,071

Table 2 indicates the confidence interval associated to the CO₂ emissions calculated for the aviation activities identified for all the above source groups, with the exception of the groups “Additional emissions for Lithuania” and “Additional emissions for flights with incomplete data”.

Table 2 – Confidence interval determined for a confidence level of 99.5%⁶

	2004	2005	2006
CO ₂ (in tonnes) ⁷	206,266,120	217,820,190	225,679,473
Confidence Interval	0.41%	0.34%	0.27%

⁶ For the convenience of readers not familiar with the theory and concept of confidence levels and intervals, a confidence level of 99.5% with a confidence interval of 1.5% means that by estimating the CO₂ emissions using another data sample of the same size, there is a probability of 99.5% that the newly estimated CO₂ emissions are within $\pm 1.5\%$ of the previously calculated CO₂ emissions.

⁷ The CO₂ reference for the calculation of the confidence interval does not include the CO₂ emissions from the groups “Additional emissions for Lithuania” and “Additional emissions for flights with incomplete data”.

ANNEX 1

ADDITIONAL INFORMATION

Annex 1 provides additional information to help understand further the quality of the results.

A1.1 Fuel Burn Sample Data Coverage

Fuel burn sample data has been provided on a voluntary basis by several aircraft operators. The following sections provide information relating to the representativeness of such information.

A1.1.1 Air Transport Industry Sectors

The fuel burn sample data has been provided on a confidential basis by aircraft operators from the following air transport industry sectors:

- European business aviation;
- European legacy carriers;
- European leisure carriers;
- European low fares carriers;
- European regional carriers;
- Non-European legacy carriers from the following continents: Africa, Asia, and North America).

A1.1.2 Period

Fuel burn sample data has been provided by each aircraft operator for one or more months for 2004, 2005 and/or 2006. Some aircraft operators provided data for periods relating to 2007 or 2008.

A1.1.3 Aircraft types

According to the ICAO aircraft designator taxonomy, more than 400 aircraft types would have fallen under the EU ETS prescriptions in the years 2004, 2005 and 2006.

Fuel burn sample data has been received for 59 of these aircraft types, covering both jet and turbo-prop aircraft. For 54 of them, the sample data has been deemed valid. The remaining 5 aircraft types were discarded because of insufficient sample data.

Table 3 indicates which is the share of the CO₂ emissions for which the retained 54 aircraft types are accountable compared to the total amount of CO₂ emissions stated in Table 1.

Table 3 – Share of the historical aviation CO₂ emissions covered by the 54 aircraft types for which valid sample data has been received

2004	2005	2006
92.2%	92.6%	93.0%

A1.2 Confidence Intervals

The reconciliation methodology described in D3 (Methodology for reconciling the historical annual CO₂ aviation emissions estimates based on the actual fuel burn information as provided to EUROCONTROL by volunteer aircraft operators) explains that the overall confidence interval has been calculated on the basis of the individual confidence intervals computed for each flight.

During the reconciliation, the aircraft types have been grouped in the following 4 clusters:

- SAMPLE, comprising all aircraft types for which sufficient fuel burn sample data has been received;
- EQV, comprising those aircraft types for which sufficient fuel burn sample data was not received but which, due to their characteristics, have been made equivalent, through a correction factor, to one of the aircraft types of the AO SAMPLE cluster (e.g. an A319 can be made equivalent through a correction factor to an A320);
- ANCAT, comprising those aircraft types which although covered by the ANCAT-3 methodology, were not included in either the AO SAMPLE or the AO EQV clusters;
- REGRESSION, comprising all remaining aircraft types.

For each of these 4 clusters, Table 4 indicates the share of the historical aviation CO₂ emissions covered by the aircraft within each cluster and the confidence interval with respect to the emissions of the same cluster.

Table 4 – Share of the historical aviation CO₂ emissions covered by the aircraft of each cluster and confidence intervals with respect to the emissions of the same cluster

Cluster	2004		2005		2006	
	CO ₂ share ⁸	Confidence Interval	CO ₂ share ⁸	Confidence Interval	CO ₂ share ⁸	Confidence Interval
SAMPLE	92.2%	0.02%	92.6%	0.02%	93.0%	0.02%
EQV	4.6%	0.10%	4.6%	0.10%	4.8%	0.10%
ANCAT	1.6%	0.29%	1.5%	0.30%	1.0%	0.33%
REGRESSION	1.5%	26.49%	1.3%	25.36%	1.2%	21.87%

⁸ The CO₂ reference for the calculation of the confidence interval does not include the CO₂ emissions from the groups "Additional emissions for Lithuania" and "Additional emissions for flights with incomplete data".

A1.3 Effects of the Reconciliation

The reconciliation of the ANCAT methodology on the basis of the fuel burn sample data provided by voluntary aircraft operators has resulted in an upward adjustment of 2% or above to the calculated historical aviation CO₂ emissions with respect to the results obtained with the initial implementation of the ANCAT methodology. This is shown in Table 5, below.

Table 5 – Variation of the calculated CO₂ emissions following the reconciliation of the ANCAT methodology on the basis of the fuel burn sample data provided by voluntary aircraft operators

2004	2005	2006
2.50%	2.2%	2.0%

ANNEX 2 LIST OF STATES TECHNICALLY INTEGRATED IN THE CRCO SYSTEM

Table 6 provides the list of States that are integrated in the CRCO system, the current charging zone to which each State is associated and the date at which integration took place.

Table 6 – States integrated in the CRCO system

State	Current Charging Zone	Date of integration
Belgium	Belgium	01/11/71
Luxemburg		01/11/71
Germany	Germany	15/12/71
France	France	01/05/72
Monaco		
United Kingdom	United Kingdom	01/11/71
Netherlands	Netherlands	15/12/71
Ireland	Ireland	01/11/71
Switzerland	Switzerland	01/11/71
Portugal	Portugal	01/11/71
	Santa Maria	01/07/72
Austria	Austria	01/11/71
Spain	Spain Cont.	02/07/72
	Spain Can.	
Greece	Greece	01/01/89
Turkey	Turkey	01/04/89
Malta	Malta	01/01/90
Italy	Italy	01/01/97
Cyprus	Cyprus	01/01/91
Hungary	Hungary	01/01/93
Norway	Norway	01/01/95
Denmark	Denmark	01/01/95
Slovenia	Slovenia	01/10/96
Romania	Romania	01/01/98
Czech Rep.	Czech Rep.	01/01/96
Sweden	Sweden	01/01/97
Slovakia	Slovakia	01/01/97
Croatia	Croatia	01/01/98
Bulgaria	Bulgaria	01/01/98
FYROM	FYROM	01/01/99
Moldova	Moldova	01/01/01
Finland	Finland	01/01/02
Albania	Albania	01/07/03
Bosnia-Herz.	Bosnia-Herz.	01/01/05
Armenia	Armenia	01/03/09
Serbia	Serbia-Mtn	01/07/07
Montenegro		
Poland	Poland	01/01/08
Lithuania	Lithuania	01/01/08