

D1 - Report on the review of the EUROCONTROL process for the estimation of the historical annual CO₂ aviation emissions in line with the Directive prescriptions

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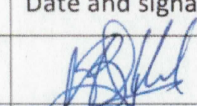

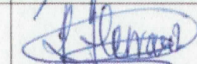
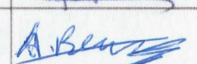
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TABLE OF CONTENTS

1. INTRODUCTION.....	3
1.1 Purpose and scope.....	3
1.2 Structure of the document.....	4
1.3 References.....	4
2. REQUIREMENTS	5
3. EUROCONTROL PROCESS DESCRIPTION	5
4. REVISION OF THE PROCESS	7
4.1 Data validation.....	7
4.1 Validation of the CO ₂ emissions calculation method.....	11
4.1 Gaps estimation.....	13
4.1 Validation of the Directive exemptions application.....	14
5. VALIDATION SUMMARY	18
ANNEX I. SENSIBILITY ANALYSIS.....	19

1 INTRODUCTION

1.1 Purpose and scope

On 19 November 2008 the European Parliament and the Council of the European Union adopted Directive 2008/101/EC (hereafter referred to as "the Directive") amending Directive 2003/87/EC so as to include aviation activities in the 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. One of the tasks for which EUROCONTROL is providing support is the estimation of "historical aviation CO₂ emissions".

Historical aviation CO₂ emissions is to be understood as the average of the annual CO₂ emissions in the calendar years 2004, 2005 and 2006 from aircraft performing an aviation activity included in the EU ETS, and will serve as a basis to set the CO₂ emissions cap for aviation¹. Considering the financial implications of the total quantity of allowances to be allocated to the aviation sector, it is essential to ensure that the estimation of the historical aviation emissions is of the highest possible quality, since:

- a. An under-estimation of the historical CO₂ emissions could lead to an insufficient amount of allowances being made available to be shared amongst the different airlines.
- b. An over-estimation of the historical CO₂ emissions could also lead to a non-desirable scenario, as it would hinder the purpose of the inclusion of the aviation sector in the ETS.

EUROCONTROL has established a process for the estimation of the historical annual CO₂ aviation emissions in the EU-27 that consists of the following steps:

- a. establishment of a process for the estimation of the historical annual CO₂ aviation emissions in the EU-27 relying on the air traffic management information available in EUROCONTROL;
- b. calculation of the 2004, 2005 and 2006 historical annual CO₂ aviation emissions estimates based on the above process;
- c. collection of actual fuel burn information from volunteer aircraft operators;
- d. analysis of the fuel burn information and establishment of a methodology for reconciling the historical annual CO₂ aviation emissions estimates (phase b) relying on this actual fuel burn information;
- e. adjustment of the 2004, 2005 and 2006 historical annual CO₂ aviation estimates based on the above reconciliation methodology for EU-27; and
- f. establishment of a methodology for the reassessment, upon the extension of the EU ETS to other states, of the historical annual CO₂ aviation emissions.

¹ The cap will be 97% of the historical aviation emissions from 1 January 2012 to 31 December 2012. For the five-year period beginning 1 January 2013, and for each subsequent five-year period, the total quantity of allowances may be gradually reduced.

As a part of the above process, EUROCONTROL has awarded a contract to Innaxis and the Polytechnic University of Madrid (UPM) with the following objectives:

- to **validate** the methodology used by EUROCONTROL and, if deemed necessary, to **derive recommendations** for its improvement, with a view to ensure that such methodology makes the most suitable use of the available data in order to fulfil the Directive's prescriptions and come up with the best possible estimation of CO₂ aviation emissions achievable within the given timeframe, and
- to **verify** the implementation of the methodology².

The present document (D1) corresponds to the validation of the process established in phase (a), while deliverable D2 covers the verification of such process. The project team has carefully reviewed the methodology following a requirement-based approach, which aims at ensuring that all the requirements emanating from the Directive are reviewed in a systematic manner and that the impact of any deviation from such requirements is properly quantified.

1.2 Structure of the document

The document is organised as follows:

- Section 2 presents the requirements for the calculation of historical aviation CO₂ emissions as established by the Directive.
- Section 3 describes the process developed by EUROCONTROL.
- Section 4 analyses in detail the different steps of the process and provides a set of recommendations on how to improve the accuracy and reliability of the calculations.
- Section 5 summarizes the compliance with the Directive requirements. A systematic review of each requirement is performed in order to verify whether the process satisfies such requirement and identify the non-compliances.
- Annex I presents a sensibility analysis showing the estimated impact of the data gaps and the inaccuracies of the methodology on the accuracy of the total estimated historical emissions.

1.3 References

- [1] Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community.
- [2] EUROCONTROL Price Enquiry No. 09-110224-E. Technical specification.
- [3] www.eurocontrol.int/prisme
- [4] ECAC. Recommendation ECAC/27-3 Methodology for emissions calculation.
- [5] EUROCONTROL. Calculation of Emissions by Selective Equivalencing (C.A.S.E.). Edition 1.0, 25 November 2003.
- [6] EUROCONTROL. EU ETS aircraft operator allocation by EC Member State-Process description. Edition 1.0, 26 February 2009.

² Validation refers to checking that the methodology is appropriate and actually follows the requirements that are imposed by the Directive. Verification refers to checking that the procedure is correctly implemented.

2. REQUIREMENTS

The table below extracts all the requirements emanating from the Directive that are relevant to the calculation of historical aviation CO₂ emissions.

Id	Requirement	Defined in
R1	"Historical aviation CO ₂ emissions" means the mean average of the annual CO ₂ emissions in the calendar years 2004, 2005 and 2006 from aircraft performing an aviation activity covered by the ETS.	Article 1(3)
R2	The estimation of the historical aviation CO ₂ emissions shall be based on best available data, including estimates based on actual traffic information.	Article 3c(4)
	All flights which arrive at or depart from an aerodrome situated in the territory of a Member State to which the Treaty applies shall be included, with the exemptions (a) to (j) listed below:	Annex I
R3	a) flights performed exclusively for the transport, on official mission, of a reigning Monarch and his immediate family, Heads of State, Heads of Government and Government Ministers, of a country other than a Member State, where this is substantiated by an appropriate status indicator in the flight plan;	Annex I
R4	b) military flights performed by military aircraft and customs and police flights;	Annex I
R5	c) flights related to search and rescue, firefighting flights, humanitarian flights and emergency medical service flights authorised by the appropriate competent authority;	Annex I
R6	d) any flights performed exclusively under visual flight rules as defined in Annex 2 to the Chicago Convention;	Annex I
R7	e) flights terminating at the aerodrome from which the aircraft has taken off and during which no intermediate landing has been made;	Annex I
R8	f) training flights performed exclusively for the purpose of obtaining a licence, or a rating in the case of cockpit flight crew where this is substantiated by an appropriate remark in the flight plan provided that the flight does not serve for the transport of passengers and/or cargo or for the positioning or ferrying of the aircraft;	Annex I
R9	g) flights performed exclusively for the purpose of scientific research or for the purpose of checking, testing or certifying aircraft or equipment whether airborne or ground-based;	Annex I
R10	h) flights performed by aircraft with a certified MTOM of less than 5700 kg;	Annex I
R11	i) flights performed in the framework of public service obligations imposed in accordance with Regulation (EEC) No 2408/92 on routes within outermost regions, as specified in Article 299(2) of the Treaty, or on routes where the capacity offered does not exceed 30 000 seats per year; and	Annex I
R12	j) flights which, but for this point, would fall within this activity, performed by a commercial air transport operator operating either: <ul style="list-style-type: none"> - fewer than 243 flights per period for three consecutive four-month periods; or - flights with total annual emissions lower than 10 000 tonnes per year. Flights performed exclusively for the transport, on official mission, of a reigning Monarch and his immediate family, Heads of State, Heads of Government and Government Ministers, of a Member State may not be excluded under this point.	Annex I
R13	Fuel consumption shall include fuel consumed by the auxiliary power unit.	Annex II

Table 1. Requirements

3. EUROCONTROL PROCESS DESCRIPTION

EUROCONTROL methodology for the estimation of the historical aviation CO₂ emissions comprises the following steps:

1. **Acquisition of data.** EUROCONTROL CRCO data contains air traffic record archives for flights operated in the vast majority of EUROCONTROL states. This data is complemented with data provided by different National Aviation Authorities and CFMU.
2. **Calculation of actual route length.** CFMU provides individual flight actual route length for the 2004-2006 data.
3. **Calculation of emissions.** Using the ANCAT Methodology and the Calculation of Emissions by Selective Equivalence (CASE) (see ref. [5]), CO₂ emissions are calculated on a flight-by-flight basis for those flights for which there are sufficient data to perform such calculation.
4. **Directive exemptions.** EUROCONTROL has developed several functions that extract those flights exempted from the ETS according to the criteria established in Annex I of the Directive, in order to subtract the relevant CO₂ emissions from the grand total.
5. **Gap estimation.** There is a number of flights for which the available air traffic data are not sufficient to calculate the historical CO₂ emissions on a flight-by-flight basis. A statistical estimation based on the best available information is carried out to fill this gap.
6. **De minimis exemption filtering.** Application of the de minimis exemption following the Directive.
7. **Annual historical aviation CO₂ emissions calculation.**

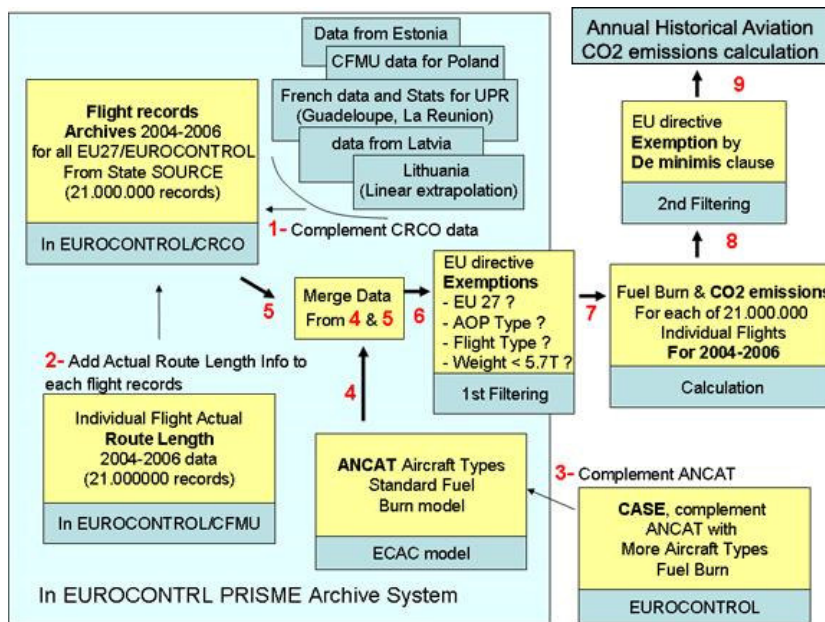


Figure 1. EUROCONTROL methodology for historical aviation CO₂ emissions estimation: flow chart (source: EUROCONTROL)

Each of these sub processes is analysed in the next section so as to identify potential sources of error and provide recommendations on how to improve the accuracy and the reliability of the calculation.

4. REVISION OF THE PROCESS

This section is the core of the validation process developed. The different elements of the methodology chosen by EUROCONTROL are reviewed, its adequacy to the goals is analysed, and some recommendations for improvement are suggested.

4.1 Data validation

4.1.1 Data sources

The methodology developed by EUROCONTROL uses several sources for the air traffic data that will be then used to calculate the ETS historical CO₂ emissions.

These data sources are:

- PRISME Data Warehouse.
- Data provided by National Authorities.

The datasets concerned amount to more than 23 million database records.

PRISME Data Warehouse

PRISME (Pan-European Repository of Information Supporting the Management of EATM) is an integrated ATM data warehouse that gathers data from other data warehouse systems. PRISME provides:

- data storage, and
- applications to analyse the data.

Detailed information on PRISME can be found in ref. [3].

The data stored in PRISME are obtained from several sources, including:

- CRCO (Central Route Charging Office) provides PRISME with air traffic data initially gathered for the purpose of billing route charges. The air traffic data stored in CRCO are the air traffic data that national authorities from the different participating states and from those states having a bilateral agreement with the CRCO send to this office for them to bill and recover the required amount from the airspace users, for further redistribution to each State.
- CFMU (Central Flow Management Unit) provides PRISME with air traffic data initially gathered for the purpose of Air Traffic Flow and Capacity Management (ATFCM).

The legal validity of the CRCO data relies on the submission of the data under precise Service level agreements between the Agency and the States. Final payment by an aircraft operator of the route charges billed by the CRCO shows that the operator accepts the existence of the flight being charged and the correctness of the applicable route charges' data.

Extract from EUROCONTROL documentation:

The EUROCONTROL route charges system is governed by the Multilateral Agreement relating to Route Charges, an international agreement signed in 1981 by which Contracting States decided to adopt a common policy, to create a joint system for the calculation, billing and recovery of their route charges and to use for this purpose the services of EUROCONTROL.

The Member States supply the basic data required for calculating the route charges and are responsible for the accuracy of these data. The State responsible for collecting and sending the flight data is the State on whose territory the aerodrome of departure is situated, or via whose airspace the aircraft enters the EUROCONTROL charging area.

On average only about 0.5% of flights are subject of claims by users. Each claim is investigated by the CRCO. This involves research, correspondence and correction of the database where necessary. Where a claim is accepted, the CRCO issues a credit note for the total amount of the disputed flight, which is then re-billed after correction. Where a claim is rejected, a confirmation note is issued, giving the reasons for the rejection.

Therefore, the route charges information available at EUROCONTROL's CRCO has been used as the main source of data to identify the flights to which the Directive applies. CRCO data are complemented by data from CFMU. CFMU provides information on the latest changes done in the flight plan (Updated Flight Plan), which contains the final flight planned route, necessary for the precise calculation of the flight plan distance.

Extract from EUROCONTROL documentation:

To manage the flow of European air traffic, the CFMU Flow Managers must be able to access a database containing flight plan information on every aircraft that is planning to fly in the airspace.

The Integrated Initial Flight Plan Processing System (IFPS), which became fully operational in March 1996, is the main source for the CFMU demand database and is also the sole source for the distribution of flight plan and associated messages to all relevant ATC units in more than thirty four European States - collectively known as the IFPS Zone.

For flights within the IFPS airspace, AOs send the Flight Plan (FPL) to the IFPS, which acknowledges receipt, processes the data, stores it in the CFMU database and sends the information to the ATC units which will be concerned with the flight.

However, CRCO flight information for 2004-2006 does not cover those flights that have departed or arrived in an aerodrome situated in the following countries or territories AND that have NOT entered the CRCO area during the flight:

- Poland.
- Lithuania.
- Estonia.
- Latvia.
- French overseas departments (French Guiana, Guadeloupe, Martinique, Reunion).

For 2004, 2005 and 2006, the CRCO only holds information for those flights that have operated "From", "To" or "Through" the CRCO area. Therefore, domestic and international flights operating entirely outside CRCO area are not accounted for.

The estimation of the CO₂ emissions for this very limited part of the traffic of Poland, Latvia, Lithuania, Estonia and French overseas department not accounted for in CRCO databases is about 0.2247 % of total EU27 CO₂ emissions.

For Poland and Lithuania, which are integrated in CRCO from 1 January 2008, complete information for 2008 is available.

In the case of Poland, EUROCONTROL has been providing, prior to 1 January 2004, ATFM functions for all flights operating in the Polish airspace, and thus the CFMU has received a flight plan for all flights operated at least in part under IFR rules in Polish airspace. Therefore, CFMU data have been used to complement the CRCO flight data.

To have a complete description of the 2004-2006 traffic, the missing data have been requested to the National Authorities and have been integrated into the PRISME database System.

Data provided by National Authorities

For those flights for which there was not any historical data available through the PRISME archives system, individual States were addressed to provide their records of the air traffic operating in their territory for 2004-2006 period. In particular, EUROCONTROL requested the French (for French overseas departments' traffic only), Lithuanian, Estonian and Latvian authorities to forward information on domestic and international flights operating outside CRCO area.

EUROCONTROL received air traffic information from the following entities:

- The Estonian authorities have provided EUROCONTROL with air traffic information on flights that operated in the Estonian airspace during the 2004-2006 period.
- The French Authorities have provided EUROCONTROL with air traffic information on flights that operated in French Guiana, Guadeloupe and Martinique during the 2004-2006 period. They also provided 2004-2006 fuel consumption estimations for La Reunion.
- The Latvian authorities have provided EUROCONTROL with air traffic information on flights that operated in the Latvian airspace during the 2004-2006 period.

Information from Lithuanian authorities was not made available to EUROCONTROL. This will be addressed in section 4.3 Gaps estimation.

4.1.2 Data completeness

The air traffic data completeness depends on the regions where the different flights operated.

PRISME Data completeness

GAT IFR traffic that during the 2004 to 2006 period operated within a EUROCONTROL Member State's airspace is accounted for in PRISME, which therefore accounts for the majority of the air traffic covered by the ETS.

For such flights, the PRISME Data Warehouse is the source used by EUROCONTROL for the calculation of CO₂ historical emissions. PRISME has been chosen as the most reliable data source for the following reasons:

- The final settlement (payment) by an aircraft operator of the route charges billed by the CRCO shows that the operator accepts the existence of the flight being charged and the legal correctness of the applicable data. The information of each flight includes:
 - identity of the operator (as identified by field 7 of the flight plan);
 - aircraft type;
 - average maximum take-off weight per aircraft type per operator;
 - departure and arrival aerodrome;
 - date of operation;
 - applicability of relevant exemption criteria.
- Due to the commonalities between the Conditions of Application of the Route Charges System and Conditions of Payment (hereafter referred to as the CRCO Conditions) and the Directive, as far as the identification of the operators and the exemption criteria, CRCO data (complemented with CFMU data) are considered the most complete data source in terms of:
 - data quality for the calculation of CO₂ emissions on a flight-by-flight basis, as explained in section 4.2; and
 - data integrity and data quality for the identification of the ETS flights and the application of the exemption criteria, as explained in section 4.3.

National Authorities' data completeness

The data received from the different National Authorities was analysed, in order to ensure that:

- the air traffic data was complete and accurate;
- each flight's information was sufficient to perform CO₂ emissions calculation;
- each flight's information was sufficient to identify whether the Directive exemptions were applicable;
- the data was not accounted for in another source of information.

After completing this task, the following gaps were identified:

- a small portion of the flights did not have an ICAO aircraft type code,
- a small portion of the flights did not have an ICAO airport identification either for departure or arrival.

4.1.3 Data Validation Summary

The data acquisition process established by EUROCONTROL is complete and covers all regions with enough granularity for the CO₂ emissions calculation process. Additionally, no other data sources have been identified as having better depth or precision, so the process can be considered, in regards to data acquisition, as the best achievable by the aviation industry within the given timeframe.

There are some gaps of air traffic data that have not been made available to EUROCONTROL. These gaps refer to the air traffic that operated in Lithuania and did not operate in CRCO airspace, as well as incomplete flight data from the different sources. Section 4.3 describes the methodology to estimate these gaps, while the impact on total CO₂ emissions is shown in the sensibility analysis included in Annex I.

4.2 Validation of the CO₂ emissions calculation method

4.2.1 Process description

The calculation of the CO₂ emissions associated to each flight is performed by EUROCONTROL using the ANCAT 3 methodology.

ANCAT 3 is based on the UNECE CORINAIR/EMEP Emission Inventory Guidebook and is the methodology recommended by the European Civil Aviation Conference through Recommendation ECAC/27-3, 8-9 July 2003 (see ref. [4], available at www.ecac-ceac.org).

The methodology has been implemented by EUROCONTROL, with the following adjustments:

- Type of aircraft assimilation.
- Distance correction factors.

Type of aircraft assimilation

The ANCAT methodology provides estimates of fuel burn and some greenhouse gas emissions as a function of the flown distance and of the aircraft type. Specifically, ANCAT provides information for:

- 19 jet aircraft.
- 25 turboprops.

In addition, some more aircraft types are associated directly to the 19 reference ANCAT jet aircraft.

Whereas the list of aircraft types modelled by ANCAT³ covers in terms of traffic, flown distances and fuel burn (and therefore CO₂ emissions) the vast majority of the overall traffic, this list is far from being complete.

A study was conducted by EUROCONTROL to determine how to ensure that fuel burn and CO₂ emissions could be estimated for all aircraft types that operate in Europe (more than 400 types). The study (see the C.A.S.E. document, ref. [5]) concluded that by separating the jet aircraft types modelled by ANCAT in two categories, namely those having a Maximum Take-Off Mass (MTOM) of less than 80 tonnes and those having a MTOM of more than 80 tonnes, the fuel burn performance of the aircraft in these two categories varied almost linearly with the MTOM of the aircrafts. The study was later expanded to cover also the turboprops, resulting in the same conclusion.

It was thus decided to introduce the following three fictitious aircraft types with specific fuel burn and CO₂ emissions performances:

- EQV_TP, a 20 tonnes MTOM reference aircraft for all turboprop aircraft.
- EQV_40T, a 40 tonnes MTOM reference aircraft for jet aircraft of less than 80 tonnes.
- EQV_200T, a 200 tonnes MTOM reference aircraft for jet aircraft of more than 80 tonnes.

³ ANCAT method does not distinguish emissions from different engines of a given airframe. Calculating emissions on an aircraft type basis implies that for each airframe a typical engine type (or an "average engine") is assumed.

The fuel burn performance of the aircraft types not covered by ANCAT are then derived from the fuel burn performance of the relevant fictitious aircraft, correcting the latter by the ratio between the MTOM of the non covered aircraft type and the MTOM of the relevant fictitious aircraft type.

For each of the three fictitious aircraft types, the fuel performance was determined by:

1. identifying which of the 44 ANCAT reference aircraft types could be modelled by the fictitious aircraft type being considered;
2. estimating with ANCAT the annual (for 2005) fuel consumption of the traffic operated with the ANCAT reference aircraft types identified under step 1;
3. determining the fuel burn performance of each of the fictitious aircraft type being considered such that if this was used in place of the ANCAT reference types identified under step 1, the fuel consumption estimate would be the same than that assessed under step 2.

Distance correction factor

The route length used for the estimation of CO₂ emissions is obtained from 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) or from the data provided by National Authorities.

When actual route information is not available, the orthodromic distance between airports plus 95 km has been used. This was the case for less than 0.00169% of the total cumulative route length.

4.2.2 Validation of the CO₂ emissions calculation method and proposed amendments

ANCAT 3 represents a harmonised and approved methodology for estimating aircraft CO₂ emissions based on air traffic movement. Its application is thus valid for the objective of the Directive. However, the ANCAT methodology does not account for certain factors that may introduce some deviations with respect to the actual fuel consumption, such as:

- actual take-off weight,
- non optimal flying altitude;
- TMA holding,
- meteorological conditions,
- actual taxi times,
- engines derating level;
- fuel consumed by the Auxiliary Power Unit (APU).

With the aim to increase the accuracy of the fuel consumption estimates computed by means of ANCAT-3 and account for the abovementioned factors, the development of an adjustment methodology based on actual fuel consumption data is addressed within deliverable D3.

The methodology of D3 will adjust the fuel coefficients included in ANCAT, as well as the assimilation methodology for aircraft types not included in ANCAT.

Additionally, the project team recommends performing a statistical analysis of the database for medium and long haul flights and comparing Flight Plan distances with orthodromic distances to amend the methodology to estimate distance when it is not available in the air traffic data.

4.3 Gap estimation

4.3.1 Proposed gap estimation process

Lithuanian traffic

For flights that operated to/from aerodromes located in Lithuania, no information was submitted by the Lithuanian authorities. The majority of these flights are accounted for in the data contained in CRCO, since most of the traffic passes through this airspace. Another part of the traffic is accounted for in the data provided by the neighbouring states of Lithuania. Only a small portion of traffic is not accounted for by EUROCONTROL. For this small portion of traffic, an approximation using the available data is deemed necessary.

CRCO data contains all relevant flights for 2008 and flights that operated in the CRCO area for the 2004-2006 period. Latvian and Estonian data contains those flights operating in their airspace for the 2004-2006 period.

Given that we have the information to calculate the CO₂ emissions for Lithuania in 2008, the recommended methodology is based on the assumption that the ratio of emissions for the traffic accounted/not accounted for by CRCO in the previous years is the same as in 2008.

The estimation is performed the following way:

1. Calculation of CO₂ emissions of Lithuanian traffic entering the CRCO area during 2008 by applying ANCAT-3 methodology on a flight-by-flight basis.
2. Calculation of CO₂ emissions of Lithuanian traffic not entering CRCO area during 2008 by applying ANCAT-3 methodology on a flight-by-flight basis.
3. Find the ratio between (1) and (2).
4. Calculation of emissions of the Lithuanian traffic entering the CRCO area for the years 2004, 2005, and 2006 by applying ANCAT-3 methodology on a flight-by-flight basis.
5. Calculation of emissions of the Lithuanian traffic not entering the CRCO area for the 2004, 2005, and 2006 by using the previous results and considering that the ratio (1)/(2) is equal to the ratio (4)/(5)

Incomplete Flight Data

A fraction of the flights did not have an ICAO aircraft type code or an ICAO location indicator either for departure or arrival, making it impossible to apply the ANCAT-3 Methodology. This was the case for flights in the following regions:

- Poland.
- Latvia.
- Estonia.
- French Overseas Departments.

Therefore, it is necessary to estimate these gaps. The proposed approach to estimate these gaps is the same for the different regions where the flights took place:

1. Calculate average fuel consumption per flight on each region (for French Overseas Departments, taking into account only non-CRCO flights, since unknown aircraft types are expected to be light-medium aircraft)
2. Calculate average fuel consumption per nautical mile.
3. For flights where no distance is available, apply (1) for each flight.
4. For flights where the distance is available, multiply (2) times the distance of the relevant flight.

4.3.2 Validation of the gap estimation process

For the Lithuanian air traffic data, the proposed estimation process seems the closest approximation taking into account that no data has been provided by the Lithuanian Authorities.

For the Incomplete Flight Data, the proposed approach seems the closest approximation given the data available.

A sensibility analysis estimating the impact of these estimations is included in Annex I.

4.4 Validation of the Directive exemptions application

4.4.1 Description of the Directive exemptions process

The process developed by EUROCONTROL for the identification of those flights to be exempted according to the criteria laid down in points (a) to (h) of Annex I to the Directive depends on the source from which the flight has been initially identified (see section 4.1).

The commonalities between the exemption criteria stated in the CRCO Conditions (see Table 2 for an overview) and those of Annex I of the Directive allow to exploit the flight type information associated to each CRCO flight for the purpose of applying the exemptions based on criteria (a) to (h) of Annex I to the Directive. In the case of the flights not included in the CRCO, the application of the exemption process relies on the data provided by National Authorities. Whenever the data provided by national authorities cannot be analysed for the exemptions, the recommendation is to apply a percentage of exemptions equal to the CRCO exemptions. This will represent less than 2% of emissions per state; and these states represent 0.22% of total emissions; hence, the total impact amounts to less than 0.0044% of total CO₂ emissions.

CRCO Flight Type	Description
O	Circular flight
T	Training flight
M	Military flight operated by an aircraft operator of a EUROCONTROL Contracting State
X	Military flight operated by an aircraft operator of a non-EUROCONTROL Contracting State
S	State flight
R	Search and rescue flight
E and N	Test flight
V	Flight performed exclusively under visual flight (VFR) rules
P	Customs and police flight
H	Humanitarian flight

Table 2 - CRCO flight type information relevant for ETS purposes.

4.4.2 Validation of the Directive exemptions application

The table below lists the rules that have been applied to identify which flights are exempted from the application of the Directive and the proposed improvements for the relevant requirement.

Req. Id	Text	Identification process	Compliance		Analysis of non-compliances / Proposed improvement
			CRCO	Non-CRCO	
	All flights which arrive at or depart from an aerodrome situated in the territory of a Member State to which the Treaty applies shall be included, with the exemptions (a) to (j) listed below:				
R3	a) flights performed exclusively for the transport, on official mission, of a reigning Monarch and his immediate family, Heads of State, Heads of Government and Government Ministers, of a country other than a Member State, where this is substantiated by an appropriate status indicator in the flight plan;	Due to the lack of information regarding the passengers' information, it is impossible to identify this requirement. Therefore, EUROCONTROL does not execute this criterion.	Not compliant	Not compliant	No potential improvement identified. For the impact of this non-compliance, see Annex I.
R4	b) military flights performed by military aircraft and customs and police flights;	Flights have been exempted when: <ul style="list-style-type: none"> the CRCO exemption code = 'M', 'X' or 'P' 	Compliant	Partially compliant	
R5	c) flights related to search and rescue, fire fighting flights, humanitarian flights and emergency medical service flights authorised by the appropriate competent authority;	Flights have been exempted when: <ul style="list-style-type: none"> the CRCO exemption code = 'H'; or 'R' Note: information on emergency medical service flights is not available in the CRCO. Identification of these flights for their exemption is not yet possible. Note: fire-fighting flights are usually exempted because they are VFR flights or, sometimes, identified as search and rescue flights.	Partially compliant	Partially compliant	No potential improvement identified. For the impact of this non-compliance, see Annex I.
R6	d) any flights performed exclusively under visual flight rules as defined in Annex 2 to the Chicago Convention;	Flights have been exempted when: <ul style="list-style-type: none"> the CRCO exemption code = 'V' 	Compliant	Compliant	

Req. Id	Text	Identification process	Compliance		Analysis of non-compliances / Proposed improvement
			CRCO	Non-CRCO	
R7	e) flights terminating at the aerodrome from which the aircraft has taken off and during which no intermediate landing has been made;	Flights have been exempted when: <ul style="list-style-type: none"> • the CRCO exemption code = '0' 	Compliant	Compliant	
R8	f) training flights performed exclusively for the purpose of obtaining a licence, or a rating in the case of cockpit flight crew where this is substantiated by an appropriate remark in the flight plan provided that the flight does not serve for the transport of passengers and/or cargo or for the positioning or ferrying of the aircraft;	Flights have been exempted when: <ul style="list-style-type: none"> • the CRCO exemption code = 'T' 	Compliant	Partially compliant	
R9	g) flights performed exclusively for the purpose of scientific research or for the purpose of checking, testing or certifying aircraft or equipment whether airborne or ground-based;	Flights have been exempted when: <ul style="list-style-type: none"> • the CRCO exemption code = 'E' or 'N' Note: information on flights performed exclusively for the purpose of scientific research is not available in the CRCO. Identification of these flights for their exemption is not yet possible.	Partially compliant	Partially compliant	Only flights that informed in the flight plan that it was, indeed, a test flight can be exempted. No potential improvement identified. For the impact of this non-compliance, see Annex I.
R10	h) flights performed by aircraft with a certified maximum take-off mass of less than 5 700 kg;	Flights have been exempted when the maximum take-off weight referred to in CRCO Conditions for a flight is < 5.7 tonnes	Mostly Compliant	Mostly Compliant	For a very small part of the traffic, aircraft operators have pointed out that the maximum take-off mass of the aircraft used was slightly below the 5 700 kg threshold, whilst at CRCO the weight was considered slightly above. The reason for this is the rounding process performed by CRCO. A verification of the weight for such aircraft types could be performed, e.g. by asking EASA for the certified MTOW for the a/c types that are on the border of the 5.7 tonnes. For the impact of this non-compliance, see Annex I.

Req. Id	Text	Identification process	Compliance		Analysis of non-compliances / Proposed improvement
			CRCO	Non-CRCO	
R11	i) flights performed in the framework of public service obligations imposed in accordance with Regulation (EEC) No 2408/92 on routes within outermost regions, as specified in Article 299(2) of the Treaty, or on routes where the capacity offered does not exceed 30 000 seats per year;	The information available at present does not make it possible to identify systematically public service obligation flights.	Not Compliant	Not Compliant	No potential improvements identified in the scope of this study. In the future, exemptions codes for ETS purposes could be added.
R12	j) flights which, but for this point, would fall within this activity, performed by a commercial air transport operator operating either: - fewer than 243 flights per period for three consecutive four-month periods; or - flights with total annual emissions lower than 10 000 tonnes per year. Flights performed exclusively for the transport, on official mission, of a reigning Monarch and his immediate family, Heads of State, Heads of Government and Government Ministers, of a Member State may not be excluded under this point.'	This requirement is based on the knowledge of all traffic; however, there is a small part of the traffic that is estimated at macro-level because the data is unavailable, and for this traffic, the De-minimis requirement cannot be applied.	Mostly Compliant	Mostly Compliant	No potential improvement identified. For the impact of this non-compliance, see Annex I.
R13	Fuel consumption shall include fuel consumed by the auxiliary power unit.		Not compliant	Not compliant	Statistical approximation based on real samples including APU consumption will be performed in D3.

Table 3. Validation of the process for Directive exemptions application

Annex I describes the impact of each requirement on the total amount of CO₂ emissions.

5. CONCLUSIONS AND RECOMMENDATIONS

The main conclusion of this study is that the methodology used by EUROCONTROL to calculate the historical CO₂ emissions makes an appropriate use of the best available data and provides a good level of accuracy.

The validation process has been completed successfully by the project team. The accuracy of the estimation can be further increased following the gap estimation process proposed in Section 4.3. The gaps identified have been estimated whenever possible, and their impact has been described in Annex I, showing that such gaps represent a very small percentage of the grand total.

Recommendations

Following the validation activity developed for EUROCONTROL, the project team recommends the following actions:

1. Perform the gaps' estimations proposed in Section 4.3. Due to the lack of information, the proposed approach is considered as the best possible solution to cover these gaps. It is worth noting that such gaps represent a small portion of the CO₂ emissions, so their impact on the accuracy of the total annual historical aviation CO₂ emissions is hardly significant.
2. Of less importance due to the few flights affected, it is recommended to perform the distance correction factor as described in section 4.2.

Finally, although out of the scope of the validation process, two additional areas of potential improvement have been identified. Both are related to the lack of technical documentation for the process put in place by EUROCONTROL:

1. EUROCONTROL has provided very detailed information about the Historical Emission Computation process through technical meetings in Brussels, presentations on the process followed and access to their computing facilities as needed. However, the Project team recommends EUROCONTROL to write and publish (at least internally) a technical document on the process followed to ensure all elements are correctly collected in a single document to be used for future reference.
2. EUROCONTROL has provided very detailed information about the implementation of ANCAT during technical meetings in Brussels and through technical notes registered in this project internal documentation system. However, the Project team recommends EUROCONTROL to write and publish (at least internally) a technical document on the implementation of ANCAT to ensure all elements are correctly collected in a single document to be used for future reference.

ANNEX I. SENSIBILITY ANALYSIS

The following table shows the amount of CO₂ emissions calculated following the EUROCONTROL methodology reviewed in the present document.

Year	Estimated CO ₂ emissions (tonnes)
2004	201.230.517,72
2005	213.110.369,72
2006	221.245.104,72

Table 4. Total estimated CO₂ emissions

Impact of data gaps

The table and the figures below show that the impact of the data gaps is hardly significant, most of the traffic is accounted for by CRCO and the neighboring states.

% CO ₂	SOURCE							Total
	YEAR	CRCO	ESTONIA	LATVIA	POLAND ⁴	UPR_AGM ⁵	UPR_REU ⁶	
2004	99.7753%	0.0090%	0.0129%	0.0552%	0.0651%	0.0752%	0.0074%	100%
2005	99.7734%	0.0092%	0.0251%	0.0541%	0.0621%	0.0669%	0.0091%	100%
2006	99.7858%	0.0103%	0.0271%	0.0567%	0.0541%	0.0560%	0.0099%	100%

Table 5. Distribution of CO₂ per source of data (after exemptions):

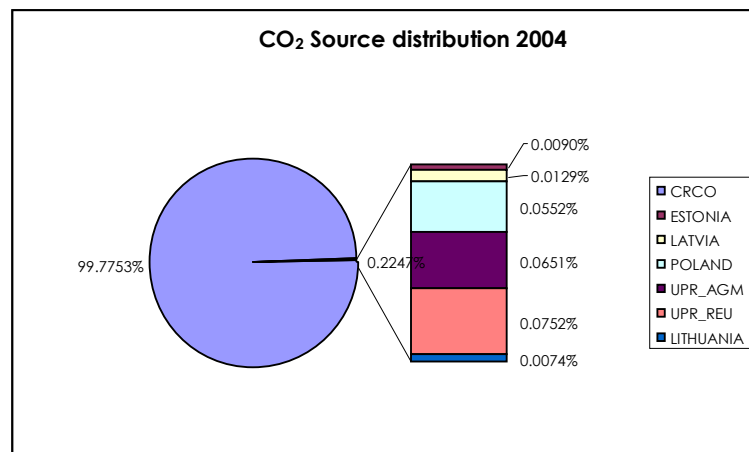


Figure 2. 2004 Source distribution.

⁴ CFMU data

⁵ French Guiana, Guadeloupe and Martinique

⁶ Reunion

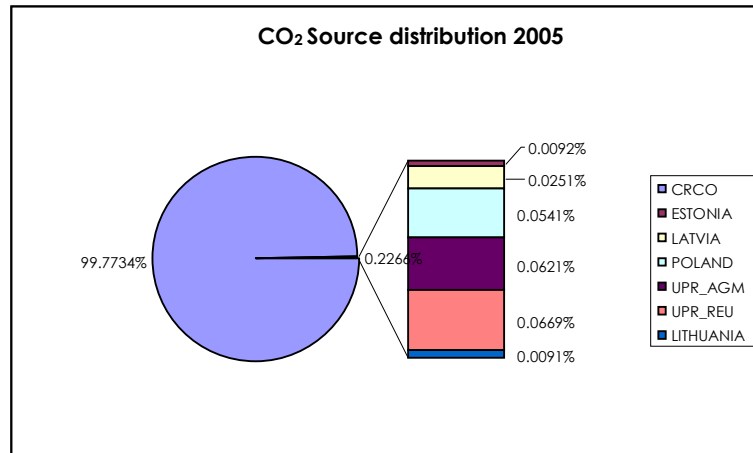


Figure 3. 2005 Source distribution.

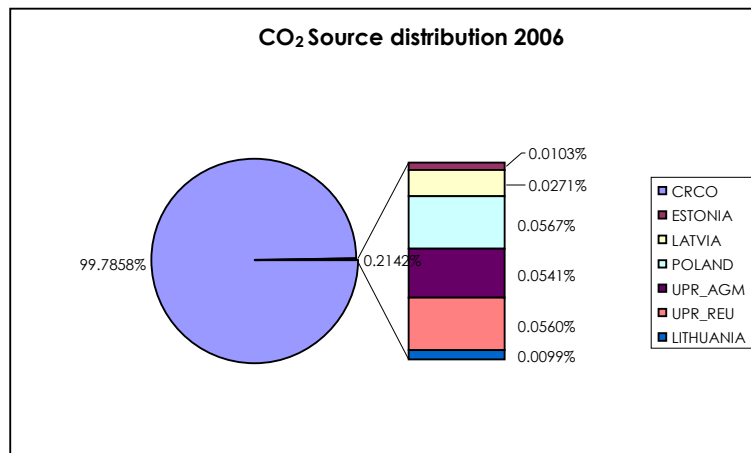


Figure 4. 2006 Source distribution.

Impact of exemptions application

% of CO ₂	Exemption	Included			Exempted								Total
		a	in	s_eu27 ⁷	j	b	c	d	e	f	g	h	
YEAR	2004	0.0289%	96.4159%	0.0339%	1.1493%	2.2798%	0.0004%	0.0052%	0.0388%	0.0078%	0.0038%	0.0363%	100 %
	2005	0.0279%	97.0876%	0.0298%	0.9632%	1.7956%	0.0002%	0.0044%	0.0452%	0.0061%	0.0034%	0.0364%	100 %
	2006	0.0246%	97.5447%	0.0328%	0.7560%	1.5242%	0.0003%	0.0052%	0.0610%	0.0059%	0.0050%	0.0403%	100 %

Table 6. CO₂ emissions distribution.

⁷ State flights operated by an EU27 registered operator

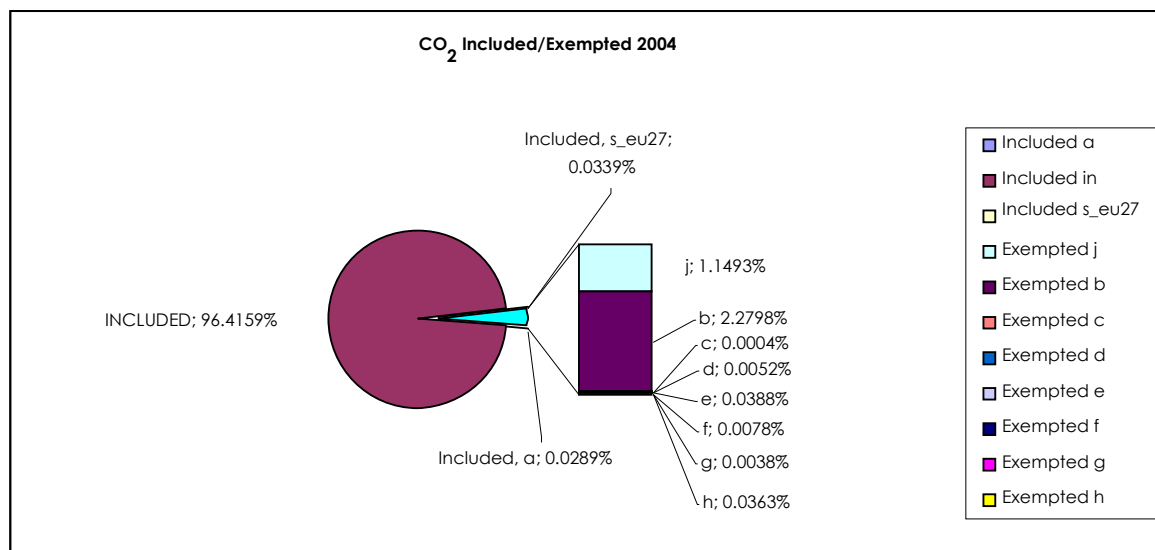


Figure 5. 2004 CO₂ emissions distribution per exemption.

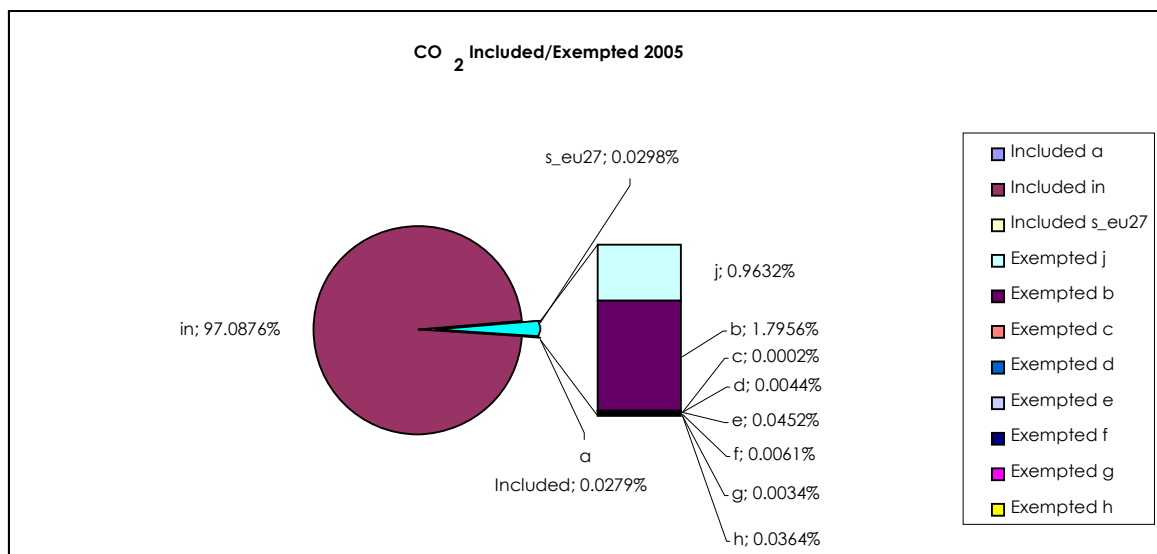


Figure 6. 2005 CO₂ emissions distribution per exemption.

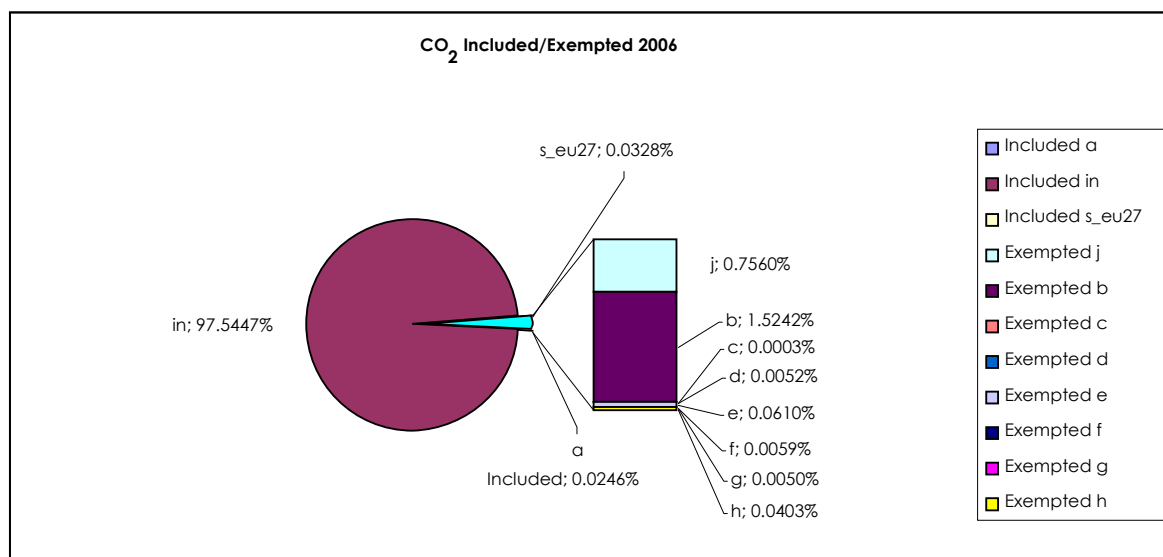


Figure 7. 2006 CO₂ emissions distribution per exemption