ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT)

— Design, Development and Validation —

August 2018

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1. INTRODUCTION

In order to facilitate the implementation of the Standards and Recommended Practices relating to the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), the ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT) was developed. The ICAO document entitled "ICAO CORSIA CO_2 Estimation and Reporting Tool" is referenced in Annex 16, Volume IV, Appendix 3, and is referred to as an ICAO CORSIA Implementation Element.

The CERT tool supports aeroplane operators in:

a) assessing whether or not an aeroplane operator is within the applicability scope of the Monitoring, Reporting and Verification (MRV) requirements (Annex 16, Volume IV, Part II, Chapter 2, 2.1);

b) assessing their eligibility to use fuel use monitoring methods in support of their Emissions Monitoring Plan (Annex 16, Volume IV, Part II, Chapter 2, 2.2);

c) filling any CO_2 emissions data gaps (Annex 16, Volume IV, Part II, Chapter 2, 2.5); and

d) fulfilling their monitoring and reporting requirements by supporting the development of the standardized Emissions Monitoring Plan and Emissions Report templates (Appendix 1 of the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*).

ICAO's Committee on Aviation Environmental Protection (CAEP) will develop and recommend updates to the CERT information that will be captured in some form of ICAO document and, following approval by the ICAO Council, the ICAO CORSIA Implementation Element will be published on the ICAO CORSIA website (www.icao.int/corsia).

2. HIGH LEVEL ARCHITECTURE AND EVOLUTION OF THE ICAO CORSIA CERT

The CORSIA CO_2 Estimation and Reporting Tool (CERT) is expected to be updated and enhanced over time to reflect: (1) evolving requirements from the implementation of CORSIA (i.e., Annex 16, Volume IV) such as the phased implementation of CORSIA reflected in the ICAO document entitled "CORSIA States for Chapter 3 State Pairs" that is available on the ICAO CORSIA website, (2) increasing data coverage in terms of aeroplane types and geographic distribution; and (3) improvements in fuel efficiency observable from input data and resulting from technology and operations. A version/release of the tool is expected to be only valid for a given reporting year.

Starting with the 2018 version of the ICAO CORSIA CERT, an aeroplane operator, that uses the CO_2 estimation functionality of the ICAO CORSIA CERT, is able to estimate for each year if its annual CO_2 emissions are above the thresholds as described in Annex 16, Volume IV [1].

An aeroplane operator is also able to determine its eligibility to use simplified compliance procedures (as per Annex 16, Volume IV, Part II, Chapter 2, 2.2)[2]. The ICAO CORSIA CERT is based on the CO_2

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[1] The Standards and Recommended Practices of Annex 16, Volume IV, Part II, Chapter 2 shall be applicable to an aeroplane operator that produces annual CO_2 emissions greater than 10 000 tonnes from the use of an aeroplane(s) with a maximum certificated take-off mass greater than 5 700 kg conducting international flights, as defined in Annex 16, Volume IV, Part II, Chapter 1, 1.1.2, on or after 1 January 2019, with the exception of humanitarian, medical and firefighting flights.
The Standards and Recommended Practices of Annex 16, Volume IV, Part II, Chapter 2 shall not be applicable to international flights, as defined in Annex 16, Volume IV, Part II, Chapter 1, 1.1.2, preceding or following a humanitarian, medical or firefighting flight provided such flights were conducted with the same aeroplane, and were required to accomplish the related humanitarian, medical or firefighting activities or to reposition thereafter the aeroplane for its next activity. The aeroplane operator shall provide supporting evidence of such activities to the verification body or, upon request, to the State.

Estimation Models (CEMs) that capture the set of equations that allow to estimate for a given aircraft type the CO_2 emissions as a function of Great Circle Distance.

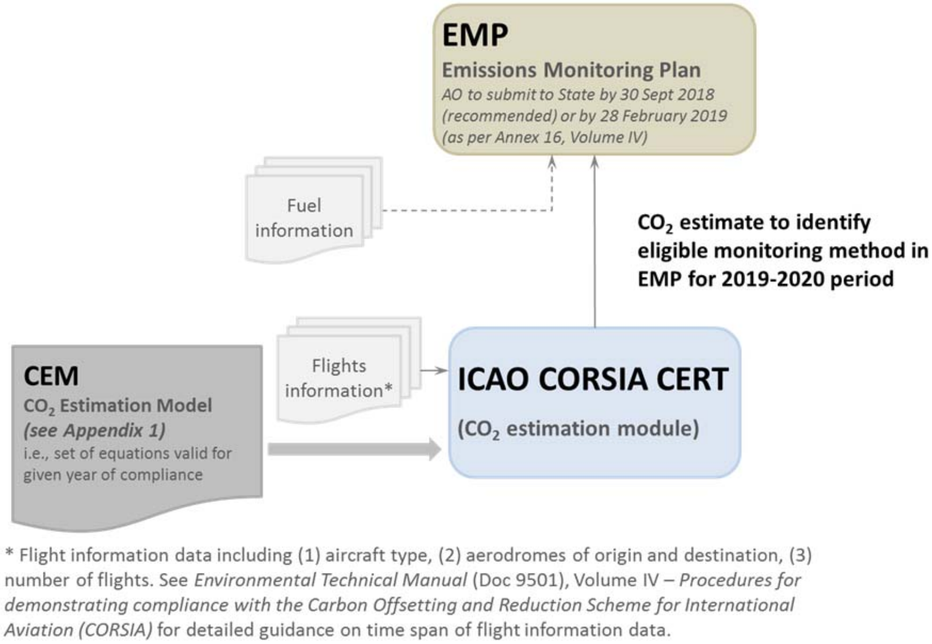

Figure 1: Architecture of CORSIA Emissions Monitoring Plan and reporting system (2018 or aeroplane operator year of entry into CORSIA)

Starting with the 2019 version of the ICAO CORSIA CERT, aeroplane operators will be able to comply with simplified monitoring and reporting requirements from Annex 16, Volume IV, Part II, Chapter 2. The ICAO CORSIA CERT will allow aeroplane operators to import or manually input the required information: (1) individual or aggregated information at the individual flight, or aerodrome, or State pair level, (2) flights for which there are data gaps in order to generate emissions estimations.

Aeroplane operators eligible to use simplified compliance procedures (as per Annex 16, Volume IV, Chapter 2, 2.2) will be able to manually input information at individual flight level to estimate their CO_2 emissions for the compliance year and generate the Emissions Report.

Figure 3 summarizes the evolution of the functionalities of the ICAO CORSIA CERT, where the 2018 version will only include the CO_2 estimation functionality to determine the applicability of CORSIA and eligibility to the use of the ICAO CORSIA CERT. The 2019 and 2020 versions will include the

[2] For the 2019-2020 period: the aeroplane operator with annual CO_2 emissions from international flights, as defined in Annex 16, Volume IV, Part II, Chapter 1, 1.1.2, and Chapter 2, 2.1, greater than or equal to 500 000 tonnes shall use a Fuel Use Monitoring Method as described in Appendix 2. The aeroplane operator with annual CO_2 emissions from international flights, as defined in Annex 16, Volume IV, Part II, Chapter 1, 1.1.2, and Chapter 2, 2.1 of less than 500 000 tonnes shall use either a Fuel Use Monitoring Method or the ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT), as described in Annex 16, Volume IV, Appendices 2 and 3 respectively.
For the 2021-2035 period: the aeroplane operator, with annual CO_2 emissions from international flights subject to offsetting requirements, as defined in Annex 16, Volume IV, Part II, Chapter 1, 1.1.2, and Chapter 3, 3.1, of greater than or equal to 50 000 tonnes, shall use a Fuel Use Monitoring Method as described in Annex 16, Volume IV, Appendix 2 for these flights. For international flights, as defined in Annex 16, Volume IV, Part II, Chapter 1, 1.1.2, and Chapter 2, 2.1, not subject to offsetting requirements, as defined in Annex 16, Volume IV, Part II, Chapter 3, 3.1, the aeroplane operator shall use either a Fuel Use Monitoring Method, as described in Annex 16, Volume IV, Appendix 2, or the ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT), as described in Annex 16, Volume IV, Appendix 3. The aeroplane operator, with annual CO_2 emissions from international flights subject to offsetting requirements, as defined in Annex 16, Volume IV, Part II, Chapter 1, 1.1.2, and Chapter 3, 3.1, of less than 50 000 tonnes, shall use either a Fuel Use Monitoring Method or the ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT) as described in Annex 16, Volume IV, Appendices 2 and 3 respectively.

monitoring and report generation functionality. The 2021-2035 versions will include the list of States between which State pairs will be subject to offsetting requirements.

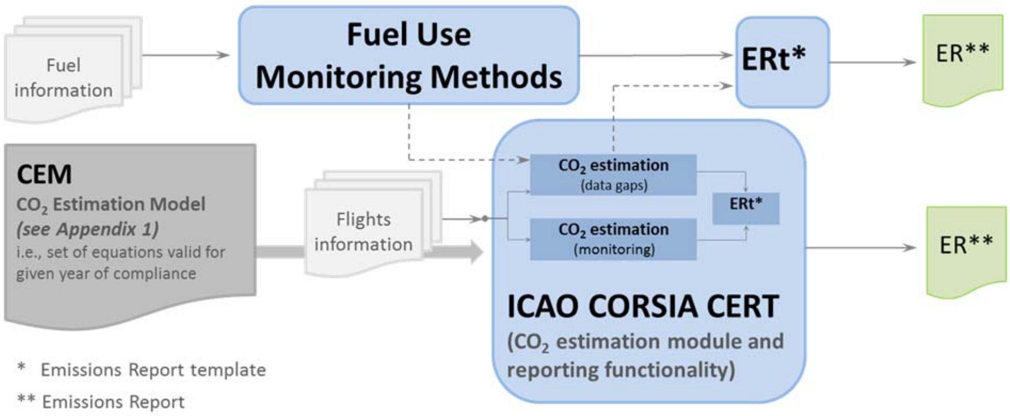

Figure 2: Architecture of CORSIA reporting system (2019 onward for compliance purposes)

	CERT CO_2 Estimation and Reporting Tool		
Year of validity	2018	2019-2020	2021-2035
Estimation of CO_2 for determination of simplified compliance procedures eligibility	Yes	Yes	Yes
Monitoring (estimating CO_2)	No	Yes	Yes
Report generation functionality	No	Yes	Yes
States for Chapter 3 State pairs	No	No	Yes

Figure 3: Phased development and implementation of the ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT)

3. DESIGN AND DEVELOPMENT OF THE ICAO CORSIA CERT

Based on assessment conducted by the ICAO-CAEP of the potential candidate methods that could be used as a basis for a CO_2 estimation tool, it was recommended that a modeling approach and tool based on a statistical method was most appropriate and fit for purpose for developing the CO_2 Estimation Models (CEMs) underlying the ICAO CORSIA CERT. The statistical method is based on actual historic fuel burn data, provided by aeroplane operators, that are used to establish statistical models to estimate fuel burn for a particular distance or time and aircraft type. Similar to the Fuel Use Monitoring Methods as described in Annex 16, Volume IV, Appendix 2, a menu of CO_2 Estimation Models (CEMs) based on

Great Circle Distance input or Block Time input could provide flexibility to aircraft operators to meet the monitoring and reporting requirements from the CORSIA.

3.1 Functionality of the ICAO CORSIA CERT

The ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT) comprises a three-step process as described in Figure 4. This includes:

(1) Entering aeroplane operator's information (to meet the requirements of the Emissions Report template per the *Environmental Technical Manual* (Doc 9501), Volume IV);

(2) Entering flight data either manually or using a file upload, to estimate CO_2 emissions using either the Block Time or Great Circle Distance (GCD). The user enters a) Aircraft type and b) airport designator for origin-destination based on Doc 7910 — *Location Indicators* (i.e., Great Circle Distance GCD) or flight operating time (i.e., Block Time) as input to estimate an aeroplane operator's CO_2 emissions; and

(3) Generating the Emissions Report, reviewing and submitting it.

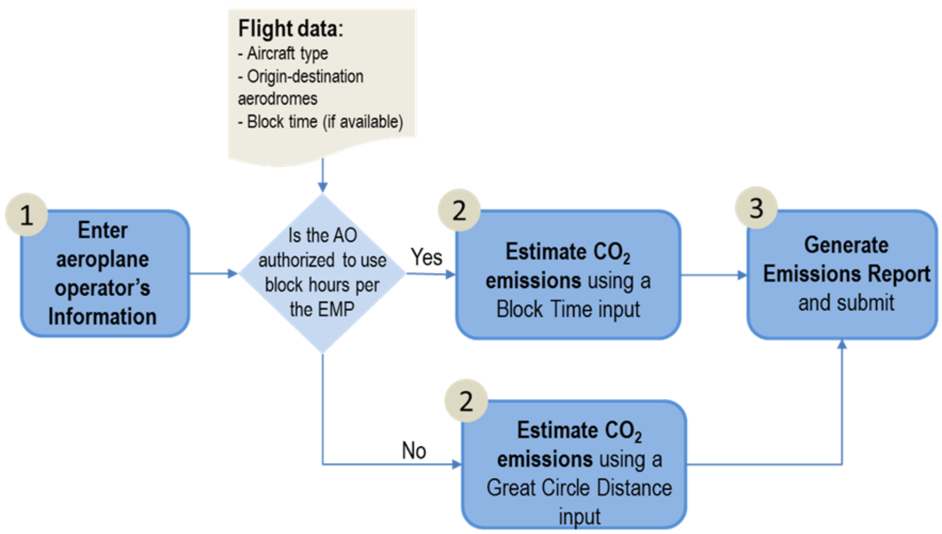

Figure 4: Overview of the high-level functions of the potential CORSIA CO_2 Estimation and Reporting Tool

Note. - The 2018 version of the ICAO CORSIA CERT only includes the functionality of estimation of CO_2 emissions using Great Circle Distance (GCD). The Block Time estimation functionality and the generation of the Emissions Report will be included in the 2019 onward versions.

3.2 Development of the CO_2 Estimation Models (CEMs)

Underlying the ICAO CORSIA CERT CO_2 estimation functionality (i.e., step 2 in Figure 4), the CO_2 Estimation Models (CEMs) allow to convert the users input (i.e., aircraft types, aerodromes of origin and destination, Block Time if available) into estimated CO_2 emissions.

3.2.1 Overview of the Process for Developing CEMs

Figure 5 shows an overview of the process for developing the CEMs. First, the list of aircraft types, by ICAO Type Designator, for which a CEM needs to be established were scoped and identified. Doc 8643 — *Aircraft Type Designators* [3] was analyzed to identify those aircraft types that are within the scope of applicability of Annex 16, Volume IV, i.e., Maximum Take Off Mass (MTOM) greater than 5 700 kg. Because Doc 8643 does not include MTOM information, several information sources, including: the EASA Certification Database, the ICAO Noise Certification database, and complementary information such as the US FAA Type Certificate Data Sheets (TCDS) were used and mapped to each aircraft type designators in Doc 8643. The identified aircraft types form the basis for the ICAO CORSIA CERT aircraft database. For the 2018 version of the ICAO CORSIA CERT, 239 aircraft types were identified. Section 3.2.2 provides additional information about the process for scoping the ICAO CORSIA CERT aircraft database.

For each of the aircraft types identified in the scoping process described above, a CO_2 Estimation Model (CEM) was developed. As shown in Figure 5, a four-tier approach was developed and implemented:

(1) First, if the aircraft type can be mapped to an aircraft type available in the validated CCG Operations and Fuel database (COFdb), a CEM is developed using the methodology described in section 3.2.2;

(2) Second, if the aircraft type is not available in the COFdb but there is an equivalent aircraft type which is modeled using (1) within the same family (and same manufacturer), a CEM is developed through scaling of the CEM of the equivalent aircraft type, using the method described in 3.2.3;

(3) Third, if the aircraft type is not mapped to the COFdb via steps 1 or 2, then the ICAO Fuel Formula is used, (see section 3.2.4 for background on the ICAO Fuel Formula); and

(4) Finally, if an aircraft type is missing a CEM after steps 1 to 3, a generic equation can be developed using the methodology described in section 3.2.5. This approach is used for aircraft types identified in Appendix A-1 (Table A-1.2.d) as well as aircraft types that can be entered into the ICAO CORSIA CERT as Custom Aircraft.

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[3] *ICAO Document* Aircraft Type Designators *(Doc 8643)*, available for query at: https://www.icao.int/publications/DOC8643/Pages/Search.aspx

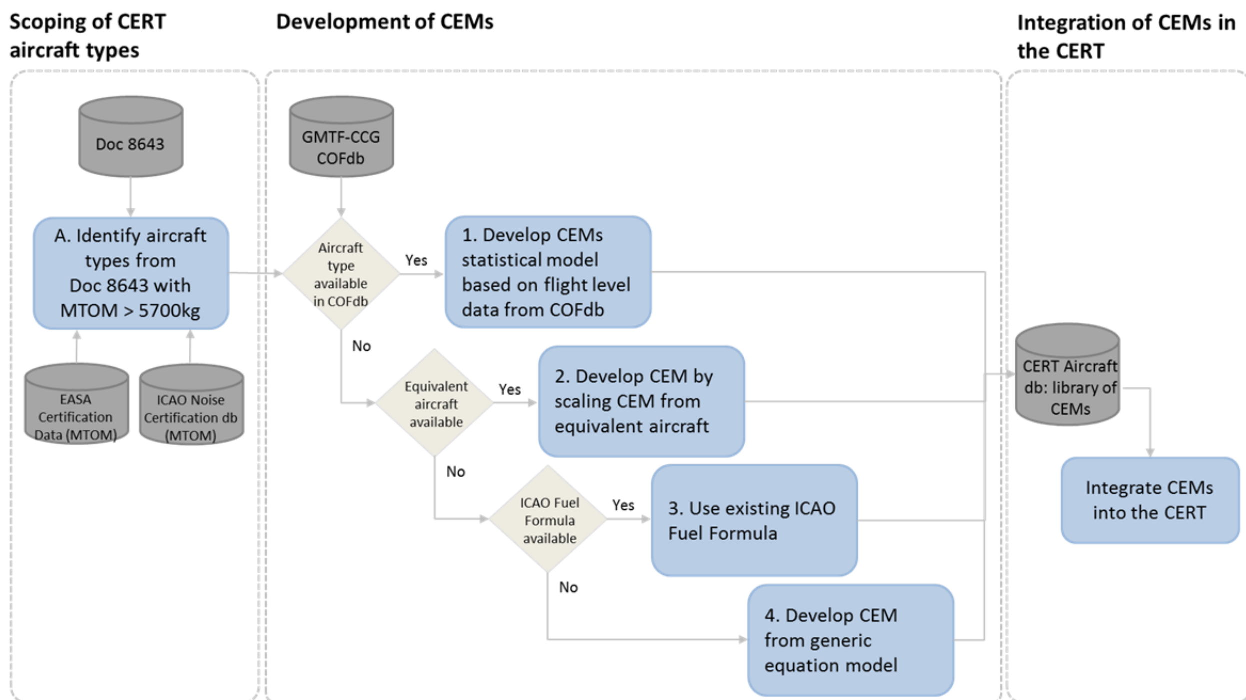

Figure 5: Summary of process for developing CO_2 Emissions Estimation Models (CEMs)

3.2.2 Scoping of ICAO CORSIA CERT aircraft database

Users of the ICAO CORSIA CERT can enter aircraft type by ICAO Type Designator (e.g., B738 for a Boeing B737-800 or A321 for an Airbus A321). The Type Designators are consistent with Doc 8643 — *Aircraft Type Designators* which is filtered to only include aircraft types that are under the scope of applicability of Annex 16, Volume IV (i.e., Maximum Take Off Mass (MTOM) greater than 5 700 kg).

Data sources

- Doc 8643:
  - The 2018 version of the ICAO CORSIA CERT is based on the version of Doc 8643 that was last updated on 9 November 2017.
- Maximum Take Off Mass (MTOM):
  - The following version of the EASA Noise Certification Databases (www.easa.europa.eu/document-library/noise-type-certificates-approved-noise-levels) were used to obtain MTOM data by aircraft type.
    - EASA approved noise levels (Heavy propeller driven aeroplanes), Issue 26, last updated: 27 June 2017
    - EASA approved noise levels (Jet aeroplanes), Issue 28, last updated: 27 June 2017
    - EASA approved noise levels (Light propeller driven aeroplanes), Issue 28, last updated: 10 July 2017
  - In addition, the ICAO Noise Certification Database, version 2.24 that was validated by the CAEP Working Group 1 (WG/1) on the 8th November 2017 was used. The Noise Certification database is available at: http://noisedb.stac.aviation-civile.gouv.fr

- o Complementary data sources were also used when needed, including the U.S. Federal Aviation Administration (FAA) Type Certificate Data Sheet (TCDS), available at: http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgMakeModel.nsf/Frameset?OpenPage

Methodology

In order to ensure that aircraft types (by Type Designator) with a variant greater than 5 700 kg Maximum Take-Off Mass (MTOM) is available in the ICAO CORSIA CERT, the Maximum MTOM was derived from across aircraft variants and the multiple available MTOM databases.

Figure 6 illustrates the process for filtering aircraft types with MTOM greater than 5 700 kg. Aircraft types from the MTOM databases were mapped to Doc 8643 — *Aircraft Type Designators*. The Maximum MTOMs were then used to filter and identify Type Designators with MTOM greater than 5700 kg.

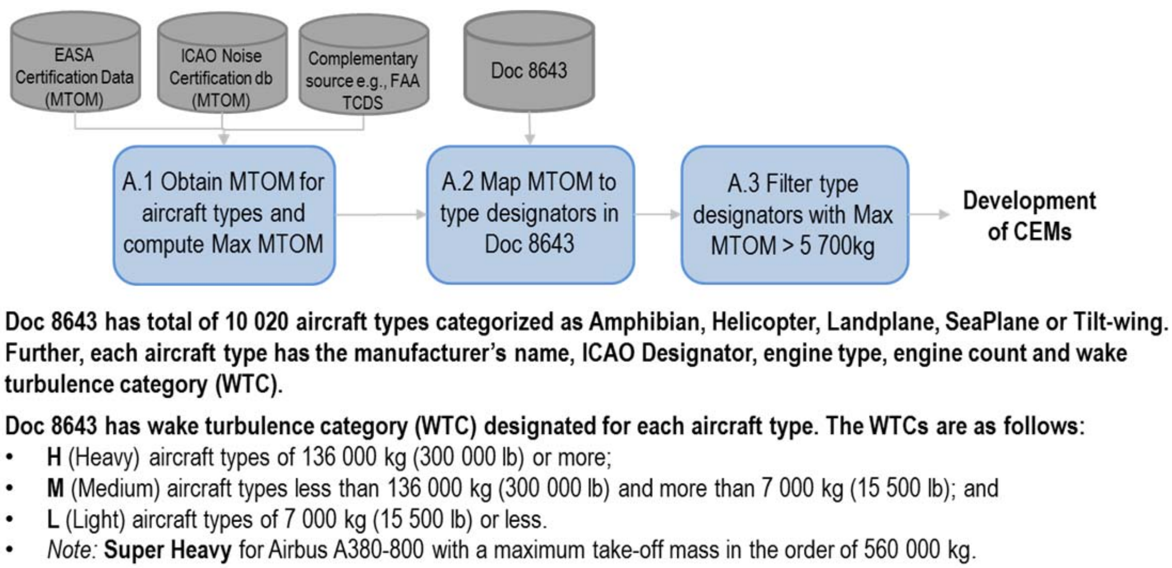

Figure 6: Development of list of aircraft types with MTOM>5 700kg for CORSIA CO_2 emissions estimation tool development process

3.2.3 Development of CEMs based on aeroplane operator data (COFdb)

As described in the first step of the four-tier approach in Figure 5, if the aircraft type can be mapped to an aircraft type available from the CCG Operations and Fuel database (COFdb), a CEM is developed using statistical models.

Overview of the CCG Operations and Fuel database (COFdb)

The GMTF CCG Operations and Fuel database (COFdb) is a database of actual flights that includes: aircraft type, great circle distance (based on aerodrome of origin and destination), fuel burn, block time, and operation year for each flight.

Data contained in the COFdb comes from aeroplane operators who have voluntarily agreed to provide data for the development of the ICAO CORSIA CERT as per recommendation from Annex 16, Volume IV, Appendix 3. Given the commercial sensitivity of flight level fuel burn information, the COFdb is the result of a multi-step process used to ensure that data in the COFdb is anonymized i.e., that neither the aeroplane operator nor the individual flight can be identified from the COFdb data. Aeroplane operators provide relevant flight level data to Organizations Providing Data (OPDs) who process the flight level data anonymizing it to remove references to the actual aeroplane operators and flight, assigning to it a unique code to allow traceability if needed, and provide it to the GMTF-CCG co-leads for it to be integrated in the COFdb replacing the OPD unique code with a COFdb specific unique code. Once validated by the CCG co-leads, the resulting COFdb is shared only with GMTF CCG members and governed by a Use Agreement and for the sole purpose of supporting and facilitating the work of developing, validating and maintaining the ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT) and the underlying CO_2 Estimation Models (CEMs).

Data collection and validation processes

When providing data to CAEP, OPDs are responsible for:

- validating, to the extent possible to the Organization, the correctness of the departure and arrival aerodrome as well as of the correct use of the ICAO aircraft type designator as per Doc 8643 for each flight having indeed been operated between those aerodromes, coordinating with the aircraft operator as necessary;
- computing the Great Circle Distance, rounded to the kilometer, between the departure and arrival aerodrome, using the latitude and longitude of the aerodromes as provided in the applicable version of Doc 7910 (applicability determined on the basis of the date of flight and the date of issue of the ICAO Document) or applicable AIP information and with the Earth modelled according to the WGS84 reference system and geodetic datum; the Great Circle Distance field is to be left empty if either the departure or the arrival aerodrome is not available in Doc 7910;
- computing whether the flight is international or domestic on the basis of the departure and arrival aerodrome and in accordance with the prescriptions of Annex 16, Volume IV, Part II, Chapter 1, 1.1.2;
- including for each flight record a unique identifier per aircraft type, identifier which allows the OPD to identify the related flight data supplier in order to coordinate with the latter as and if required;
- ensuring that, when available, the block time is provided in minutes without decimals, leaving the field empty if not available;
- excluding from the provided data records for which:
    - the validation of the first point is unsuccessful; or
    - the aircraft type is not in the applicable version of Doc 8643 (applicability determined on the basis of the date of the flight and the date of issue of the ICAO Document); or
    - both the Great Circle Distance and the block time are unknown.

Integration of data into the COFdb (pre-verification)

Prior to integrating data received from an OPD into the COFdb, CAEP conducts a parallel and redundant process that includes (1) pre-verification of the COFdb in order to ensure the quality of the data as well as (2) accurate and appropriate data integration in the COFdb.

Verification and distribution of the COFdb

CAEP also conducts verification of the integrated COFdb, including checks that the data available in the received version of the COFdb is complete. The COFdb is then made available to each CAEP expert contributing to the development of the CERT and that have executed a Use Agreement at the time of the distribution of the COFdb.

Version of the COFdb used for the 2018 version of the ICAO CORSIA CERT

For the 2018 version of the ICAO CORSIA CERT, the COFdb version 1.2b as of November 29, 2017 was used. This 2018 version of the COFdb includes data from over 3,040,000 flights for 78 aircraft types by ICAO type designator. Data ranged from 2010 to 2017 with over 80% of the data coming from 2013 to 2017.

Identifying and removing outliers from aircraft operator's raw data

Before final regression models were developed for each of the aircraft type, outliers were identified and removed. To identify outliers, a first regression on the entire dataset is developed. This allows the calculation of the standardized residual absolute value for all data points. As an initial step, data points with a standardized residual absolute value greater than 3σ were identified as outliers and were examined. For each aircraft type and regressions, CCG evaluated the fitness of the 3σ criterion for the given dataset. If deemed appropriate, the default 3σ criterion was used. For a few aircraft types, 4σ or 5σ were used to better capture the distribution of flights across the dataset. Once outliers were removed, single or multi-segment regressions were developed.

Regression model selection and development

The CEMs are based on piece-wise linear fuel burn vs. GCD or block time functions. The dependent variable is fuel burn. There are two potential explanatory variables in the model: (1) block time or (2) Great Circle Distance (GCD) of the flight. For the 2018 version of the ICAO CORSIA CERT, only CEMs based on Great Circle Distance were developed. The 2019 version of the ICAO CORSIA CERT and subsequent versions are expected to include both Great Circle Distance and Block Time.

Figure 7 shows an illustration for a sample aircraft type with the COFdb data split into data retained for the development of the regression i.e., CEM (in green) and outliers (in red).

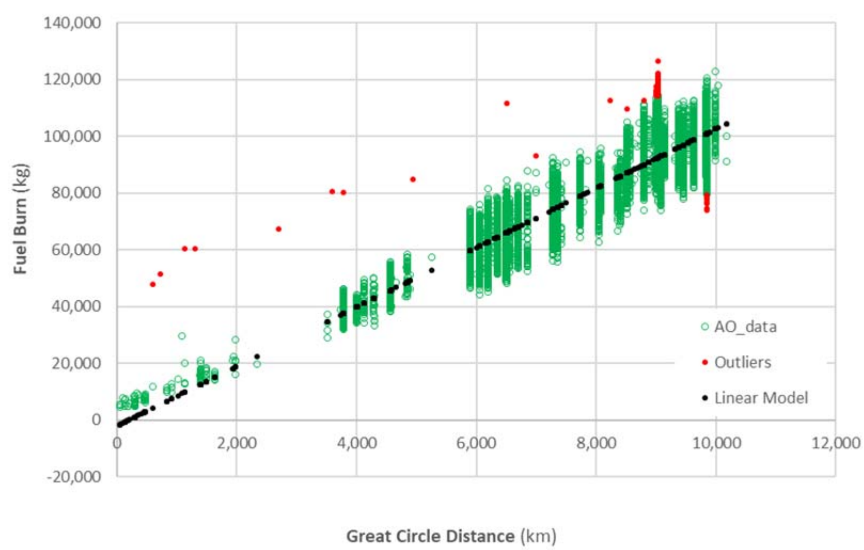

Figure 7: Illustration of sample data used to generate CEMs, including outlier data removed from the process of generating the CEM

To generate a CEM, the CCG followed the following steps:

- Import an aircraft type database;
- Generate a regression on entire dataset (i.e., linear OLS model);
- Identify outliers and remove them; and
- Run a second single-segment regression or a piece-wise regression (up to three segments with breakpoints).

If breakpoints are not used on some aircraft types, uncorrected linear regression CEMs may result in negative intercept. Piecewise linear equations are used to address this and better represent the dataset. The need for breakpoints was determined using the following rules:

- If there is a negative intercept -> introduce a breakpoint;
- If there is a cluster consistently above or below -> introduce a breakpoint; and
- If there is a Great Circle Distance (GCD) gap -> potentially introduce breakpoints.

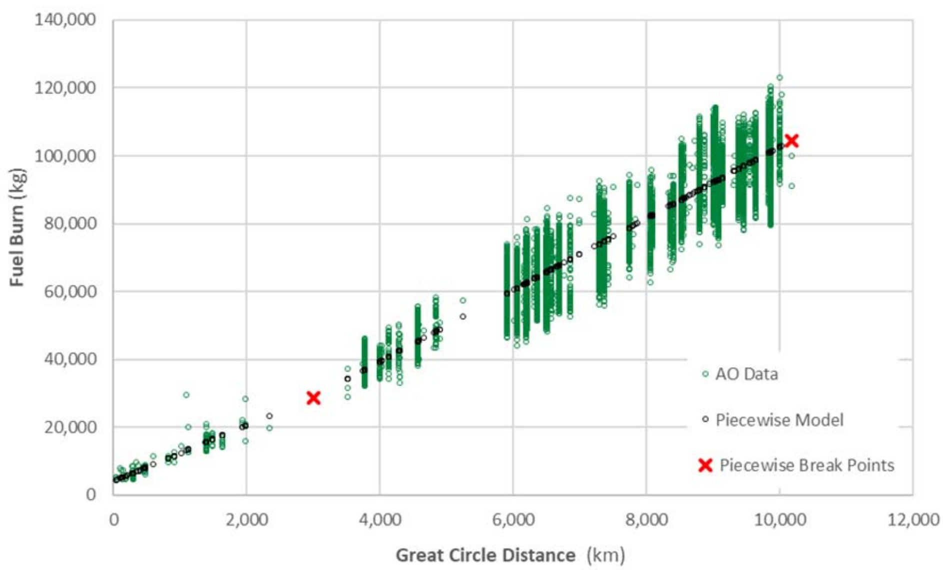

Figure 8: Illustration of fuel burn statistical method model formulation (GCD Model)

3.2.4 Development of CEMs based on equivalent aircraft types

If the aircraft type is not available in the COFdb but can be mapped to an equivalent aircraft type within the same family (and same manufacturer), a CEM is developed through scaling of the CEM of the equivalent aircraft type.

The development of equivalent aircraft type model was only allowed for aircraft within the same family (and same aeroplane manufacturer) if deemed appropriate. For example, an Airbus A342 was deemed equivalent to an Airbus A343 for which a CEM based on data from the COFdb was available.

Once equivalent aircraft are identified, the CEM was adjusted by scaling (multiplying) it using a Mass ratio of the Average Operating MTOM of both aircraft types:

$$\text{MTOM ratio factor} = \frac{\text{Avg. MTOM}_{\text{aircraft not in COFdb}}}{\text{Avg. MTOM}_{\text{equivalent aircraft in the COFdb}}}$$

Data from a global registration database was used to develop Average MTOM values for each aircraft types in the CERT aircraft database.

3.2.5 CEMs based on ICAO Fuel Formula

If the aircraft type is not mapped to the COFdb or equivalent aircraft type, then the ICAO Fuel Formula is re-used.

Additional information on the ICAO Fuel Formula used in the ICAO Carbon Calculator is available at ICAO Carbon Emissions Calculator Methodology Version 10, https://www.icao.int/environmental-protection/CarbonOffset/Documents/Methodology%20ICAO%20Carbon%20Calculator_v10-2017.pdf

3.2.6 Development of CEMs based on generic equation model

Finally, to allow the estimation of fuel burn and CO_2 emissions for an aircraft type that is missing a CEM after applying the steps in 3.2.3 to 3.2.5, a set of generic equation models are developed from which a CEM for such aircraft type can then be derived. This step forms the basis for the ICAO CORSIA CERT functionality of entering custom aircraft that can either be (1) one of the aircraft types identified in Appendix A-1, Table A-1.2.d or (2) an aircraft type not included in Doc 7910 that a user may need to enter and use towards the estimation of its emissions. For each linear regression-based model the fuel is calculated on specific distances. Those are determined to ensure a sufficient level of granularity and account for the possible variation of the piecewise breakpoints.

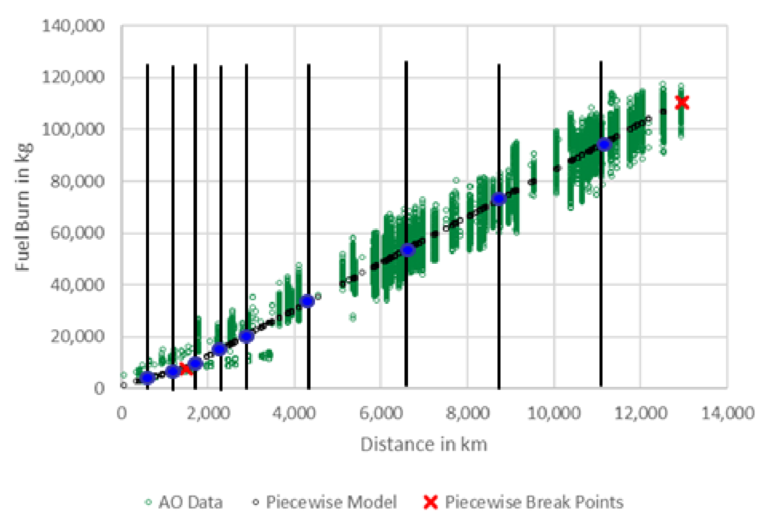

Figure 9: Illustration of process for binning data for developing generic equation

For each distance band value the calculated fuel are reported versus the aircraft average Maximum Take-off Mass (MTOM). To develop generic equation models most representative, aircraft types are grouped by category including:

- Heavy Jets[4];
- Medium Jets with Certified MTOM greater than 60 000 kg[5];
- Medium Jets with Certified MTOM lower or equal to 60 000 kg; and
- Turboprops and Turboshaft aircraft.

Figure 10 illustrates the development of generic aircraft (fuel burn) values (in orange) for a given distance within the category of Medium Jets with Certified MTOM greater than 60 000 kg based on values from the CEMs (in blue) for aircraft in the same category. Distances of 0 km and 1 000 km are shown for illustration.

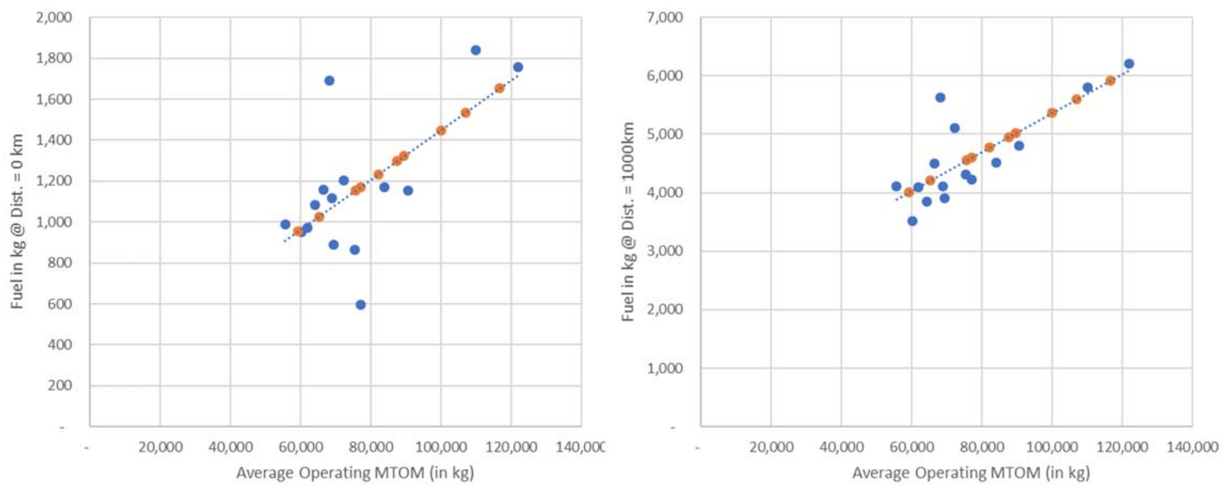

Figure 10: Illustration of generic aircraft fuel burn-MTOM based regressions for a given distance

Similarly to aeroplane operator fuel burn data, a linear regression is then calculated. The result is a set of equations (per aircraft category and distance band) returning a fuel as a function of the aircraft maximum take-off mass. As based on that set of equations, a fuel estimation model (equation) can be derived for any aircraft type (Figure 11).

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[4] Heavy Jets, Medium Jets, Turboprops and Turboshaft powered aircraft based on categorization included in Doc 8643.

[5] The Medium Jets category was split into two subcategories to capture different trends across the broad MTOM range from approximately 10 tonnes to approximately 120 tonnes. A breakpoint at 60 tonnes was established as it captures trends appropriately. In addition, the 60 tonnes thresholds leverages and is consistent with the ICAO CO_2 emissions standard (governed by Annex 16, Volume III) that includes a breakpoint at 60 tonnes certified MTOM.

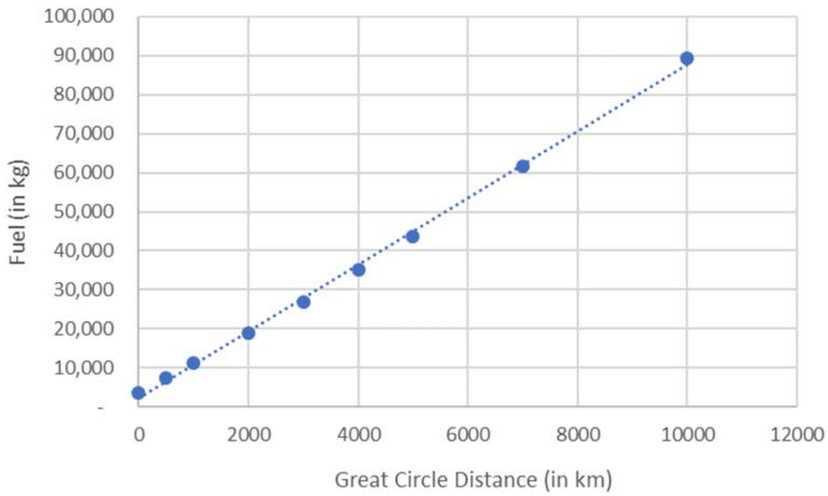

Figure 11: Illustration of generic aircraft CEM

4. IMPLEMENTATION OF THE ICAO CORSIA CERT

The ICAO CORSIA CERT version 2018 was developed to take the user through a simple three steps process where the user:

(1) Enters aeroplane operator information relevant for assessing the applicability of CORSIA and eligibility to use the ICAO CORSIA CERT for monitoring and reporting of CO_2 emissions;

(2) Estimates its CO_2 emissions from international flights; and

(3) Generates a summary assessment of applicability of CORSIA and eligibility of the aeroplane operator to use the ICAO CORSIA CERT, with the possibility to generate documents to save them for record keeping.

4.1 Aeroplane operator identification

To allow for the identification of the aeroplane operator on the summary documents, the user can enter key information on the aeroplane operator. The format of the required information is consistent with the identification page of the Emissions Monitoring Plan. This information is then used in the summary assessment and saved documents.

4.2 Calculation of CO_2 emissions

The core functionality of the ICAO CORSIA CERT is the estimation of CO_2 emissions based on user input data.

4.2.1 Loading and entering data into the ICAO CORSIA CERT

The user can enter aircraft type and flight information data into the ICAO CORSIA CERT using two key paths:

a) Manual entry by selecting an aircraft type designator from the list of types available in the ICAO CORSIA CERT aircraft database. If needed, the user can also enter codes that are not included in the ICAO CORSIA CERT aircraft database which become 'custom aircraft code'. See section

4.2.2 for details on the custom aircraft and airport functionality in the ICAO CORSIA CERT; and

b) Direct upload into the ICAO CORSIA CERT by loading a file containing aircraft types, origin and destination airports as well as number of flights. This file in csv format can be used as the interface between an aeroplane operator's Operations and Flight Management System and the ICAO CORSIA CERT.

4.2.2 Comparison of the operations input data against the ICAO CORSIA CERT aircraft and airport databases

When loading operations data into the ICAO CORSIA CERT or calculating CO_2 emissions, the user can choose to compare the input aircraft type and airports entries against the internal ICAO CORSIA CERT aircraft and airports databases. This comparison checks for consistency and returns any aircraft type code and airport code that does not match the internal ICAO CORSIA CERT aircraft and airports databases. The user can then choose to enter custom aircraft and airports information for these codes or return to the input data and correct the codes if an error was made in the data entry.

Entering custom aircraft codes

If the user chooses to use custom aircraft type codes, he/she is prompted to select an aircraft category from the following list:

a) Jet (Heavy) with certified MTOM ≥136 000 kg;

b) Jet with certified MTOM ≥60,000kg and < 136 000kg;

c) Jet with certified MTOM < 60 000 kg; and

d) Turboprop.

The user is also prompted to enter the Average Maximum Take Off Mass (MTOM) in the aeroplane operator fleet. The Average MTOM is calculated using the arithmetical average of individual MTOMs of aircraft in the fleet of a given aircraft type code. The individual MTOMs are the individual maximum permissible take-off mass of each individual aeroplane according to the certificate of airworthiness, the flight manual or other official documents as defined by ICAO Annex 16, Volume IV.

Based on the aircraft category selected and the Average Maximum Take Off Mass (MTOM) in the aeroplane operator fleet, the ICAO CORSIA CERT derives a tailored CEM from the relevant generic equation model according to the approach described in section 3.2.6. The custom aircraft functionality displays information on the fuel burn rate (kg/km) and intercept value (fuel at great circle distance of 0 km) depending on the underlying regression model associated with a manually selected aircraft category and average MTOM. The indicated fuel burn rate and interception value are used within ICAO CORSIA CERT to calculate the estimated fuel and emissions for all flights with this Custom Aircraft Code.

The following coefficients are used in the 2018 version of the ICAO CORSIA CERT to generate generic equations (as a function of entered Average MTOM) for aircraft types entered as custom aircraft, by aircraft type category.

Aircraft Type Category	Coefficients for Linear Function to Derive the Intercept of the Generic Equation		Coefficients for Linear Function to Derive the Slope of the Generic Equation	
	Intercept	Slope	Intercept	Slope
Jet (Heavy) with certified MTOM >= 136 000 kg	381.1155955	0.006168482	1.542988157	2.31557E-05
Jet with certified MTOM >= 60,000kg and < 136,000kg	233.6879644	0.012166564	1.470494926	2.53049E-05
Jet with certified MTOM < 60,000 kg	256.6681218	0.011457408	0.11797668	5.35191E-05
Turboprop	30.63415761	0.007941834	0.407538326	4.52448E-05

Figure 12: Coefficients used in the 2018 version of the ICAO CORSIA CERT to generate generic equations (as a function of entered Average MTOM) for aircraft types entered as custom aircraft

Note. - If custom aircraft types are entered but already exist in the ICAO CORSIA CERT aircraft database, the information in the ICAO CORSIA CERT aircraft database will anyhow be used as default for calculating CO_2 *emissions.*

Entering custom airport codes

If needed, the user can enter custom airport codes in order to allow for the calculation of CO_2 emissions for each flight entered. The user is prompted to enter airport latitude using WGS84 coordinates in the following formats:

Degree and decimal:

For North Latitude + dd.dddddd

For South Latitude - dd.dddddd

Degree/Minutes/Seconds:

For North Latitude dd° mm' ss"" N

For South Latitude dd° mm' ss"" S

The user is prompted to enter airport longitude using WGS84 coordinates in the following formats:

Degree and decimal:

For East Longitude + dd.dddddd

For West Longitude - dd.dddddd

Degree/Minutes/Seconds:

For East Latitude dd° mm' ss"" E

For West Latitude dd° mm' ss"" W

In addition, the user is prompted to enter an ICAO Member State attributed to the aerodrome by selecting from the list of 192 ICAO Member States as of July 2018. In order to help with the attribution of airports to ICAO Member States, the ICAO CORSIA CERT provide a suggestion on a potential ICAO Member State based on the first two letters of the Custom Airport Code (for codes with four letters only).

Note. - If custom airports are entered but already exist in the ICAO CORSIA CERT aircraft database, the information for the custom airports will be used as default for the purpose of calculating CO_2 *emissions.*

Note. – In order to help the user search the ICAO CORSIA CERT aircraft and airport databases, a search functionality was developed. Additional information on the underlying Doc 8643 can be found at: https://www.icao.int/publications/DOC8643/Pages/default.aspx. In addition, additional information on Doc 7910 can be found at https://gis.icao.int/7910FLEX/.

4.2.3 Computation of Great Circle Distance

For each aerodrome pair entered as input into the tool, the ICAO CORSIA CERT calculates a Great Circle Distance (GCD).

Doc 7910 was used as the basis for the aerodrome latitudes and longitudes. The input latitude and longitude is based on WGS84. In order to compute Great Circle Distance used as input to the ICAO CORSIA CERT CEMs, the Vincenty's Method was used and implemented in the ICAO CORSIA CERT. The Vincenty's method is an iterative process used in geodesy to calculate the distance between two points on the surface of a spheroid, developed by Thaddeus Vincenty (1975a). It is based on the assumption that the figure of the Earth is an oblate spheroid, and hence are more accurate than methods that assume a spherical Earth, such as Great Circle Distance. The method is widely used in geodesy because they are accurate to within 0.5 mm (0.020″) on the Earth ellipsoid.

4.3 Generation of a summary assessment of CO_2 emissions

After ensuring that the entered information is complete and calculating CO_2 emissions, the user can generate a summary assessment of applicability of Annex 16, Volume IV, Chapter 2 and eligibility to use the ICAO CORSIA CERT in 2019.

The summary assessment includes:

a) **Aeroplane operator information** based on input from the user;

b) **Estimated CO_2 emissions and status of aeroplane operator.** This comprises:

- Total annual estimated CO_2 emissions (international). It should be noted that emissions are for all international State pairs. For the 2021 version of the ICAO CORSIA CERT, this total will be split between State pairs with offsetting requirements and State pairs not subject to offsetting requirements (see Annex 16, Volume IV, Chapter 3 for details).
- Total annual estimated CO_2 emissions (domestic). Domestic aviation is outside the scope of applicability of Annex 16, Volume IV. Information is provided for awareness of tool user in the event domestic flights are entered in the input tables.
- Status of aeroplane operator as to whether the aeroplane operator falls under the scope of applicability of CORSIA as per Annex 16, Volume IV, Chapter 2 and whether the aeroplane operator is eligible to use the ICAO CORSIA CERT or required to use one of the five Fuel Use Monitoring Methods. For details on Fuel Use Monitoring Methods refer to Annex 16, Volume IV, Chapter 2 and Appendix 2 and the *Environmental Technical Manual* (Doc 9501), Volume IV.

c) **Detailed estimated CO_2 emissions by State pairs.**

4.4 Generation of report on summary assessment

To support the Emissions Monitoring Plan (EMP) in 2018, the aeroplane operator can use the ICAO CORSIA CERT to estimate its emissions. The ICAO CORSIA CERT can produce a copy summary assessment along with a copy of the Appendix to the summary assessment containing the custom aircraft and airports information (if entered in the tool).

The user can save a copy for its records. In accordance with Annex 16, Volume IV, Appendix 4, 2.3.1.1 a) on the supporting information on methods and means for calculating emissions from international flights, the aeroplane operator can submit a copy of the summary assessment to its State along with the Emissions Monitoring Plan.

5. VALIDATION AND REVIEW OF THE CORSIA CO_2 ESTIMATION MODELS (CEMS)

The work on the CO_2 Estimation Models (CEMs), ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT) and the associated development/maintenance documentation was led by the CAEP Global Market-Based Measures Task Force (GMTF). The CAEP Modeling and Database Group (MDG) subsequently conducted a validation exercise to ensure the ICAO CORSIA CERT was fit for purpose in terms of its use within CORSIA. The MDG also provided recommendations on improvements to the ICAO CORSIA CERT CO_2 Estimation Models.

6. PHASED DEVELOPMENT OF THE ICAO CORSIA CERT AND FEEDBACK

The ICAO CORSIA CO_2 Estimation and Reporting Tool (CERT) can be used by an aeroplane operator to support the monitoring and reporting of their CO_2 emissions, in accordance with the requirements from ICAO Annex 16, Volume IV, Part II, Chapter 2, 2.2 and Appendix 3.

The ICAO CORSIA CERT supports aeroplane operators in fulfilling their monitoring and reporting requirements by populating the standardized Emissions Monitoring Plan and Emissions Report templates in Appendix 1 of the *Environmental Technical Manual* (Doc 9501), Volume IV – *Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*. This support includes:

(i) assessing its eligibility to use Fuel Use Monitoring Methods in support of their Emissions Monitoring Plan (e.g. CO_2 emissions threshold requirements);

(ii) assessing whether or not it is within the applicability scope of Annex 16, Volume IV, Chapter 2 (MRV requirements); and

(iii) filling any CO_2 emissions data gaps.

6.1 Phased development of the ICAO CORSIA CERT and expected 2019 version

As described in section 2, the ICAO CORSIA CERT is expected to be valid for a given year to address the evolution of the required functionality of the ICAO CORSIA CERT in accordance with Annex 16, Volume IV.

This version 2018 of the tool is valid for assessing aeroplane operators' eligibility to use Fuel Use Monitoring Methods in support of their Emissions Monitoring Plan (e.g. CO_2 emissions threshold requirements) and assessing whether or not it is within the applicability scope of the Chapter 2 MRV requirements towards the submission of the Emissions Monitoring Plan. This version shall not be used for monitoring CO_2 emissions towards the Emissions Report in 2019. A new (2019) version of the ICAO CORSIA CERT is expected to be available in the second half of 2019.

In support of the recommendations from Annex 16, Volume IV, Appendix 3 on the collection of data to further develop and maintain the ICAO CO_2 Estimation Models (CEMs) used within the ICAO CORSIA CERT, Appendix A-2 shows the list of aircraft that will be the focus of further and targeted data collection towards the 2019 version of the ICAO CORSIA CERT. Any operator and/or State willing to contribute to the development of the ICAO CORSIA CERT and provide data is encouraged to contact

ICAO-CAEP.

6.2 Process for providing feedback and input towards the future versions of the ICAO CORSIA CERT

Feedback on the CERT functionalities or questions can be directed to CERT@icao.int

APPENDIX A-1: ICAO CORSIA CO_2 Estimation Model (CEM) in version 2018 of the ICAO CORSIA CERT

Table A-1.1.a. Aircraft types (by ICAO type designator) modelled with CEM based on aeroplane operator data from the COFdb

Type Designator	Example of Model*	CEM based on AO data (from COFdb)	CEM based on Equivalent Aircraft Type		CEM based on ICAO Fuel Formula		CEM based on Generic/Representative Aircraft Type
		Source of CEM	Source of CEM	Type Designator of Equivalent Aircraft	Source of CEM	ICAO Aircraft Code	Source of CEM
A388	A-380-800	Yes					
A346	A-340-600	Yes					
A343	A-340-300	Yes					
A333	A-330-300	Yes					
A332	A-330-200	Yes					
A306	A-300B4-600	Yes					
A310	A-310	Yes					
B748	747-8	Yes					
B744	747-400 (international, winglets)	Yes					
B77W	777-300ER	Yes					
B77L	777-200LR	Yes					
B772	777-200	Yes					
MD11	MD-11	Yes					
B789	787-9 Dreamliner	Yes					
B788	787-8 Dreamliner	Yes					
B764	767-400	Yes					
B763	767-300	Yes					
B762	767-200	Yes					
A321	A-321	Yes					
A320	A-320	Yes					
A319	A-319	Yes					
A318	A-318	Yes					
B752	757-200	Yes					
B753	757-300	Yes					
B739	737-900	Yes					
B738	737-800	Yes					
B737	737-700	Yes					
MD90	MD-90	Yes					
MD88	MD-88	Yes					
B734	737-400	Yes					
B736	737-600	Yes					
B733	737-300	Yes					
B735	737-500	Yes					
RJ85	RJ-85 Avroliner	Yes					
GLEX	Global Express	Yes					
GL5T	Global 5000	Yes					
CL60	CL-600 Challenger 650	Yes					
CRJX	Regional Jet CRJ-1000	Yes					
CL35	BD-100 Challenger 350	Yes					
CL30	BD-100 Challenger 300	Yes					
B463	BAe-146-300	Yes					
B462	BAe-146-200	Yes					
H25B	Hawker 800	Yes					
CRJ9	Challenger 890	Yes					
CRJ7	Challenger 870	Yes					
CRJ1	Regional Jet CRJ-100	Yes					
C68A	680A Citation Latitude	Yes					
C56X	560XL Citation Excel	Yes					
C550	550 Citation 2	Yes					
FA7X	Falcon 7X	Yes					
F900	Falcon 900	Yes					
F2TH	Falcon 2000	Yes					
FA50	Falcon 50	Yes					
E190	ERJ-190 Lineage 1000	Yes					
E170	ERJ-170-100	Yes					
E135	ERJ-135	Yes					
E145	ERJ-145EP	Yes					
E35L	EMB-135BJ Legacy	Yes					
E55P	EMB-505 Phenom 300	Yes					
F100	100	Yes					

* Example of model: Doc 8643 includes one or more model for a given type designator. Sample/example of model is provided in this table. For additional details of other applicable models for a given type designator see: https://www.icao.int/publications/DOC8643/Pages/Search.aspx

Table A-1.1.a (cont.). Aircraft types (by ICAO type designator) modelled with CEM based on aeroplane operator data from the COFdb

Type Designator	Example of Model*	CEM based on AO data (from COFdb)	CEM based on Equivalent Aircraft Type		CEM based on ICAO Fuel Formula		CEM based on Generic/Representative Aircraft Type
		Source of CEM	Source of CEM	Type Designator of Equivalent Aircraft	Source of CEM	ICAO Aircraft Code	Source of CEM
F70	70	Yes					
LJ31	31	Yes					
GLF6	Gulfstream G650	Yes					
GLF5	Gulfstream 5	Yes					
GLF4	Gulfstream 4	Yes					
G280	Gulfstream G280	Yes					
LJ60	60	Yes					
LJ45	45	Yes					
LJ40	40	Yes					
AT72	ATR-72-201	Yes					
AT76	ATR-72-600	Yes					
AT45	ATR-42-500	Yes					
AT46	ATR-42-600	Yes					
B190	1900	Yes					
DH8D	Dash 8 (400)	Yes					
D328	328	Yes					
F50	50 Maritime Enforcer	Yes					
SF34	SF-340	Yes					

* Example of model: Doc 8643 includes one or more model for a given type designator. Sample/example of model is provided in this table. For additional details of other applicable models for a given type designator see: https://www.icao.int/publications/DOC8643/Pages/Search.aspx

Table A-1.1.b. Aircraft types (by ICAO type designator) modelled with equivalent aircraft types

Type Designator	Example of Model*	CEM based on AO data (from COFdb)	CEM based on Equivalent Aircraft Type		CEM based on ICAO Fuel Formula		CEM based on Generic/Representative Aircraft Type
		Source of CEM	Source of CEM	Type Designator of Equivalent Aircraft	Source of CEM	ICAO Aircraft Code	Source of CEM
A345	A-340-500		Yes	A346			
A342	A-340-200		Yes	A343			
A30B	A-300B2		Yes	A306			
B74D	747-400 (domestic, no winglets)		Yes	B744			
B742	747-200		Yes	B744			
B743	747-300		Yes	B744			
B741	747-100		Yes	B744			
B74R	747SR		Yes	B744			
B74S	747SP		Yes	B744			
B773	777-300		Yes	B772			
B78X	787-10 Dreamliner		Yes	B789			
MD83	MD-83		Yes	MD88			
MD82	MD-82		Yes	MD88			
MD87	MD-87		Yes	MD88			
MD81	MD-81		Yes	MD88			
RJ70	RJ-70 Avroliner		Yes	RJ85			
B732	737-200		Yes	B733			
B712	717-200		Yes	MD88			
B461	BAe-146-100		Yes	B462			
H25C	Hawker 1000		Yes	H25B			
CRJ2	Challenger 800		Yes	CRJ1			
C560	560 Citation 5		Yes	C550			
C525	525 Citation CJ1		Yes	C550			
C25C	525C Citation CJ4		Yes	C550			
C55B	550B Citation Bravo		Yes	C550			
FA8X	Falcon 8X		Yes	FA7X			
H25A	HS-125-1		Yes	H25B			
E195	ERJ-190-200		Yes	E190			
E75L	ERJ-170-200 (long wing)		Yes	E170			
E75S	ERJ-170-200 (short wing)		Yes	E170			
LJ55	55		Yes	LJ45			
LJ35	35		Yes	LJ40			
LJ25	25		Yes	LJ40			
LJ75	75		Yes	LJ45			
LJ70	70		Yes	LJ45			
RJ1H	RJ-100 Avroliner		Yes	B463			
AT73	ATR-72-211		Yes	AT72			
AT75	ATR-72-500		Yes	AT76			
AT43	ATR-42-300		Yes	AT45			
DHC7	DHC-7 Dash 7		Yes	DH8D			
DH8C	Dash 8 (300)		Yes	DH8D			
DH8B	Dash 8 (200)		Yes	DH8D			
DH8A	Dash 8 (100)		Yes	DH8D			

* Example of model: Doc 8643 includes one or more model for a given type designator. Sample/example of model is provided in this table. For additional details of other applicable models for a given type designator see: https://www.icao.int/publications/DOC8643/Pages/Search.aspx

Table A-1.1.c. Aircraft types (by ICAO type designator) modelled with ICAO Fuel Formula

Type Designator	Example of Model*	CEM based on AO data (from COFdb)	CEM based on Equivalent Aircraft Type		CEM based on ICAO Fuel Formula		CEM based on Generic/Representative Aircraft Type
		Source of CEM	Source of CEM	Type Designator of Equivalent Aircraft	Source of CEM	ICAO Aircraft Code	Source of CEM
A124	An-124 Ruslan				Yes	A4F	
DC10	DC-10				Yes	D10	
DC87	DC-8-70				Yes	DC8	
DC85	DC-8-50				Yes	DC8	
IL96	Il-96				Yes	IL9	
IL86	Il-86				Yes	ILW	
IL76	Il-76				Yes	IL7	
IL62	Il-62				Yes	IL6	
L101	L-1011 TriStar				Yes	L10	
B701	707-100				Yes	70M	
B722	727-200				Yes	72A	
B721	727-100				Yes	721	
T204	Tu-204				Yes	T20	
T154	Tu-154				Yes	TU5	
T134	Tu-134				Yes	TU3	
J328	Dornier 328JET				Yes	FRJ	
S601	SN-601 Corvette				Yes	NDC	
A148	An-148				Yes	A81	
AN72	An-72				Yes	AN7	
BA11	BAC-111 One-Eleven				Yes	B11	
FA10	Falcon 10				Yes	DF2	
DC95	DC-9-50				Yes	D95	
DC94	DC-9-40				Yes	D94	
DC93	DC-9-30				Yes	D93	
DC92	DC-9-20				Yes	D92	
DC91	DC-9-10				Yes	D91	
F28	F-28 Fellowship				Yes	F28	
WW24	1124 Westwind				Yes	WWP	
YK42	Yak-42				Yes	YK2	
YK40	Yak-40				Yes	YK4	
N262	N-262 Frégate				Yes	ND2	
JS41	BAe-4100 Jetstream 41				Yes	J41	
A748	748				Yes	HS7	
CN35	CN-235				Yes	CS5	
C212	C-212 Aviocar				Yes	CS2	
L410	L-410 Turbolet				Yes	L4T	
AN12	An-12				Yes	ANF	
AN24	An-24				Yes	AN4	
A140	IRAN-140 Faraz				Yes	A40	
AN28	An-28				Yes	A28	
BE20	Super King Air (200)				Yes	BE2	
ATP	ATP				Yes	ATP	
JS32	BAe-3200 Jetstream Super 31				Yes	J32	
JS31	BAe-3100 Jetstream 31				Yes	J31	
CVLT	Cosmopolitan				Yes	CVR	
F27	F-27				Yes	F27	
DHC6	DHC-6 Twin Otter				Yes	DHT	
D228	Dornier 228				Yes	D28	
E120	EMB-120 Brasilia				Yes	EM2	
E110	EMB-110 Bandeirante				Yes	EMB	
G159	G-159 Gulfstream 1				Yes	GRS	
IL18	Il-18				Yes	IL8	
I114	Il-114				Yes	I14	
C130	L-100 Hercules				Yes	LOH	
L188	Electra (L-188)				Yes	LOE	
YS11	YS-11				Yes	YS1	
SB20	2000				Yes	S20	
BELF	SC-5 Belfast				Yes	SHB	
SH36	360				Yes	SH6	
SH33	SD3-30				Yes	SH3	
SC7	SC-7 Skyliner				Yes	SHS	
SW2	SA-26 Merlin 2				Yes	SWM	
CVLP	Convairliner				Yes	CVR	
DC6	DC-6				Yes	DC6	
DC3	DC-3				Yes	DC3	

* Example of model: Doc 8643 includes one or more model for a given type designator. Sample/example of model is provided in this table. For additional details of other applicable models for a given type designator see: https://www.icao.int/publications/DOC8643/Pages/Search.aspx

Table format of CO_2 Estimation Models (CEMs) in the 2018 version of the ICAO CORSIA CERT

*Note: Tables provide fuel in kg. CO_2 emissions can be calculated using CO_2 (in kg) = 3.16 * Fuel (in kg).*

Table A-1.2.a. Aircraft types (by ICAO type designator) modelled with CEM based on aeroplane operators data from the COFdb

	Fuel (in kg) for given Great Circle Distance (in km)																
Type Designator	0	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	7000	8000	9000	10000
A388	7,718	14,130	20,541	26,953	33,364	39,776	46,187	52,599	59,010	65,422	71,834	79,988	88,141	104,448	120,755	137,062	153,369
A346	3,944	8,069	12,193	16,318	20,442	24,567	28,690	33,960	39,230	44,500	49,770	55,040	60,310	70,850	81,390	91,930	102,470
A343	2,491	6,562	10,633	14,204	17,776	21,347	24,919	28,490	32,062	35,633	39,204	43,521	47,838	56,472	65,106	73,740	82,374
A333	2,404	5,747	9,090	12,433	15,775	19,118	22,461	25,804	29,147	32,490	35,833	39,176	42,518	49,204	55,890	62,576	69,261
A332	2,388	5,167	7,946	10,725	13,503	16,885	20,267	23,649	27,031	30,413	33,795	37,177	40,559	47,323	54,087	60,851	67,615
A306	2,721	5,593	8,465	11,337	14,209	17,081	19,953	22,825	25,697	28,569	31,441	34,313	37,185	42,929			
A310	1,579	4,434	7,289	10,144	12,999	15,854	18,709	21,564	24,419	27,274	30,129	32,984	35,839	41,549	47,259	52,969	
B748	6,008	11,304	16,599	21,895	27,190	32,486	37,781	43,077	48,372	53,668	58,963	64,259	69,549	82,335	95,121	107,907	120,693
B744	5,104	9,845	14,587	19,329	25,132	30,934	36,737	42,539	48,342	54,144	59,947	65,749	71,552	84,435	98,602	112,769	126,936
B77W	4,529	8,446	12,363	16,280	20,197	24,114	28,031	31,945	37,256	42,568	47,879	53,191	58,502	69,125	79,748	90,371	100,994
B77L	3,309	7,275	11,240	15,206	19,171	23,137	27,102	31,068	35,034	40,416	45,797	51,179	56,560	67,323	78,089	86,071	94,053
B772	2,801	6,498	10,195	13,892	17,589	21,286	24,982	28,910	32,838	36,766	40,694	44,622	48,550	56,406	64,262	74,231	84,200
MD11	2,082	6,796	11,509	16,223	20,936	25,650	30,363	35,077	39,790	44,504	49,217	53,931	58,644	68,071	77,498	86,925	96,352
B789	2,508	5,099	7,689	10,280	12,871	16,095	19,319	22,543	25,767	28,991	32,215	35,439	38,663	45,111	51,559	58,007	64,455
B788	2,622	5,304	7,986	10,668	13,350	16,032	18,714	21,396	24,078	26,760	29,441	32,432	35,423	41,405	47,387	53,369	59,351
B764	1,851	4,865	7,878	10,892	13,905	16,919	19,932	22,946	25,959	28,973	31,986	35,000	38,013	44,040	50,067	56,094	62,121
B763	2,840	5,264	7,688	10,112	12,536	14,960	17,387	20,617	23,847	27,077	30,307	33,537	36,767	43,227	49,687	56,147	62,607
B762	2,886	4,856	6,826	9,706	12,585	15,465	18,344	21,224	24,103	26,983	29,862	32,742	35,621	41,380	47,139	52,898	
A321	1,156	2,983	4,810	6,637	8,464	10,291	12,118	13,945	15,772	17,599	19,426	21,253					
A320	778	2,752	4,306	5,859	7,413	8,966	10,637	12,309	13,980	15,652	17,323	18,995					
A319	804	2,713	4,106	5,500	6,919	8,354	9,790	11,225	12,661	14,096	15,532	16,967	18,403				
A318	695	2,453	3,842	5,139	6,436	7,733	9,030	10,327	11,624	12,921	14,218	15,515	16,812				
B752	1,839	3,818	5,798	7,777	9,757	11,736	13,716	15,695	17,675	19,654	21,634	23,613	25,593	29,552	33,511		
B753	2,700	4,154	6,211	8,670	11,129	13,588	16,047	18,506	20,965	23,424	25,883	28,342	30,801	35,719	40,637		
B739	1,169	2,844	4,518	6,193	7,867	9,542	11,216	12,891	14,565	16,240	17,914						
B738	583	2,633	4,227	5,820	7,414	9,007	10,601	12,194	13,790	15,551	17,312						
B737	888	2,398	3,908	5,418	6,928	8,438	9,948	11,458	12,968	14,478	15,988	17,498					
MD90	1,205	3,157	5,110	7,062	9,015	10,967	12,920	14,872									
MD88	1,693	3,658	5,624	7,589	9,555	11,520	13,486	15,451									
B734	1,157	2,831	4,506	6,180	7,855	9,529	11,204	12,878	14,553	16,227	17,902	19,576	21,251	24,600	27,949	31,298	34,647
B736	951	2,236	3,521	4,806	6,091	7,376	8,661	9,946	11,231	12,516	13,801	15,086	16,371	18,941			
B733	971	2,535	4,099	5,663	7,227	8,791	10,355	11,919	13,483	15,047	16,611	18,175	19,739				
B735	990	2,548	4,106	5,664	7,222	8,780	10,338	11,896	13,454	15,012	16,570	18,128	19,686	22,802	25,918	29,034	
RJ85	545	2,364	4,183	6,002	7,821	9,640	11,459	13,278									
GLEX	771	1,852	2,739	3,627	4,514	5,402	6,289	7,177	8,064	8,952	9,839	10,727	11,614	13,389	15,164	16,939	18,714
GL5T	806	1,910	2,772	3,634	4,496	5,358	6,220	7,082	7,944	8,806	9,668	10,530	11,392	13,116	14,840	16,564	
CL60	252	1,104	1,704	2,304	2,904	3,504	4,104	4,704	5,304	5,904	6,504	7,104	7,704	8,904			
CRJX	509	1,856	2,906	3,956	5,006												
CL35	308	1,030	1,482	1,934	2,386	2,900	3,415	3,929	4,444	4,958	5,473	5,987					
CL30	321	993	1,566	2,041	2,516	2,991	3,466	3,941	4,416	4,891	5,366	5,841					
B463	667	2,544	4,420	6,297	8,173	10,050											
B462	746	2,400	4,053	5,707	7,360	9,014											
H25B	267	811	1,238	1,665	2,092	2,519	2,946	3,373	3,800	4,227							
CRJ9	526	1,762	2,700	3,639	4,577	5,516											
CRJ7	509	1,642	2,537	3,433	4,328	5,224											
CRJ1	468	1,226	1,984	2,742	3,500	4,258	5,016	5,774	6,532	7,290	8,048	8,806	9,564				
C68A	374	983	1,423	1,864	2,304	2,745	3,185	3,626	4,066	4,507	4,947	5,388	5,828				
C56X	233	769	1,107	1,445	1,783	2,121	2,459	2,797									
C550	188	619	945	1,272	1,598	1,925	2,251	2,578									
FA7X	398	1,335	2,001	2,668	3,334	4,001	4,667	5,334	6,000	6,667	7,333	8,000	8,666	9,999	11,332	12,665	13,998
F900	314	1,046	1,648	2,250	2,852	3,454	4,056	4,658	5,260	5,862	6,464	7,066	7,668	8,872	10,076		
F2TH	391	1,020	1,535	2,050	2,565	3,080	3,595	4,111	4,566	5,021	5,476	5,931	6,386	7,296			
FA50	303	1,070	1,631	2,140	2,649	3,158	3,667	4,176	4,685	5,194	5,703	6,212	6,721				
E190	609	2,135	3,387	4,638	6,121	7,603	9,086	10,568	12,051	13,533	15,016	16,498	17,981	20,946	23,911		
E170	627	1,695	2,763	3,831	5,097	6,362	7,628										
E135	388	1,219	1,893	2,567	3,241	3,915	4,591	5,103	5,615								
E145	248	1,241	1,959	2,600	3,241	3,882	4,523	5,164	5,805								
E35L	414	1,298	1,917	2,536	3,155	3,774	4,393	5,012	5,631	6,250	6,869	7,488	8,107	9,345			
E55P	203	668	932	1,197	1,461	1,726	1,990	2,255									
F100	543	2,170	3,532	4,893	6,255	7,616	8,978	10,339	11,701								

Table A-1.2.a (cont.). Aircraft types (by ICAO type designator) modelled with CEM based on aeroplane operators data from the COFdb

	Fuel (in kg) for given Great Circle Distance (in km)																
Type Designator	0	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	7000	8000	9000	10000
F70	594	1,954	3,126	4,299	5,471	6,644	7,816										
LJ31	118	595	889	1,183	1,477	1,771											
GLF6	550	1,781	2,574	3,368	4,161	4,955	5,748	6,542	7,335	8,129	8,922	9,716	10,509	12,096	13,683	15,270	16,857
GLF5	705	1,677	2,491	3,305	4,119	4,933	5,747	6,561	7,375	8,189	9,003	9,817	10,626	12,116	13,606	15,096	16,586
GLF4	468	1,715	2,513	3,310	4,108	4,905	5,703	6,500	7,298	8,095	8,893	9,690	10,488	12,083			
G280	293	859	1,425	1,991	2,558	2,931	3,305	3,678	4,052	4,425	4,799	5,172	5,546				
LJ60	222	651	1,028	1,405	1,782	2,159	2,536	2,913	3,290	3,667	4,044						
LJ45	68	655	1,010	1,365	1,720	2,075	2,430	2,785	3,140								
LJ40	124	610	994	1,378	1,762	2,146	2,530										
AT72	185	863	1,541	2,219	2,897												
AT76	170	922	1,674														
AT45	155	854	1,553	2,252	2,951	3,650	4,349										
AT46	203	863	1,523														
B190	97	446	794	1,143	1,491	1,840											
DH8D	303	1,117	1,932	2,746	3,561												
D328	141	674	1,208	1,741													
F50	190	849	1,507	2,166	2,824	3,483	4,141	4,800	5,458	6,117	6,775	7,434	8,092				
SF34	154	612	1,069	1,527	1,984	2,442											

Table A-1.2.b. Aircraft types (by ICAO type designator) modelled with equivalent aircraft types

	Fuel (in kg) for given Great Circle Distance (in km)																
Type Designator	0	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	7000	8000	9000	10000
A345	3,965	8,112	12,259	16,405	20,552	24,698	28,844	34,142	39,441	44,739	50,037	55,335	60,634	71,230	81,827	92,423	103,020
A342	2,430	6,401	10,371	13,855	17,339	20,823	24,306	27,790	31,274	34,758	38,241	42,452	46,663	55,085	63,507	71,929	80,351
A30B	2,638	5,423	8,207	10,992	13,776	16,561	19,346	22,130	24,915	27,700	30,484	33,269	36,054	41,623	47,192		
B74D	4,908	9,467	14,027	18,587	24,167	29,747	35,327	40,907	46,486	52,066	57,646	63,226	68,806	81,194	94,818	108,441	122,064
B742	4,818	9,295	13,771	18,249	23,727	29,205	34,683	40,161	45,639	51,118	56,596	62,074	67,552	79,715	93,090	106,465	119,840
B743	4,828	9,313	13,798	18,284	23,773	29,261	34,750	40,239	45,727	51,216	56,705	62,193	67,682	79,869	93,269	106,670	120,071
B741	4,410	8,507	12,604	16,703	21,717	26,731	31,745	36,759	41,773	46,787	51,801	56,815	61,829	72,962	85,204		
B74R	4,207	8,115	12,023	15,932	20,715	25,497	30,280	35,063	39,846	44,628	49,411	54,194	58,976	69,595	81,272	92,950	104,627
B74S	4,108	7,925	11,742	15,560	20,231	24,902	29,573	34,244	38,915	43,586	48,257	52,928	57,599	67,970	79,375	90,779	102,183
B773	2,702	6,269	9,835	13,402	16,968	20,535	24,099	27,889	31,678	35,467	39,257	43,046	46,835	54,414	61,993	71,610	81,226
B78X	2,413	4,904	7,396	9,888	12,380	15,481	18,582	21,683	24,784	27,885	30,987	34,088	37,189	43,391	49,593	55,795	61,998
MD83	1,797	3,883	5,970	8,056	10,143	12,229	14,315	16,402	18,488	20,574	22,661	24,747	26,833	31,006			
MD82	1,653	3,571	5,489	7,408	9,326	11,245	13,163	15,082	17,000	18,919							
MD87	1,537	3,321	5,105	6,889	8,673	10,457	12,241	14,026	15,810	17,594	19,378	21,162	22,946				
MD81	1,580	3,414	5,248	7,083	8,917	10,751	12,585	14,419	16,254	18,088	19,922						
RJ70	547	2,374	4,201	6,028	7,855												
B732	855	2,232	3,609	4,986	6,363	7,740	9,117	10,495	11,872	13,249	14,626						
B712	1,330	2,875	4,419	5,964	7,508	9,053	10,598	12,142									
B461	674	2,169	3,663	5,158													
H25C	297	904	1,380	1,857	2,333	2,809											
CRJ2	479	1,257	2,034	2,811	3,588	4,365	5,142	5,920	6,697	7,474	8,251	9,028	9,805				
C560	228	750	1,145	1,541	1,937	2,332	2,728	3,124									
C525	154	506	774	1,041	1,308	1,576											
C25C	194	638	975	1,312	1,649	1,986	2,322	2,659	2,996								
C55B	201	663	1,013	1,362	1,712	2,062	2,412	2,761									
FA8X	396	1,328	1,991	2,654	3,317	3,980	4,643	5,306	5,969	6,632	7,295	7,958	8,621	9,947	11,273	12,598	13,924
H25A	325	988	1,508	2,028	2,548	3,068	3,588	4,109	4,629	5,149	5,669						
E195	619	2,169	3,441	4,713	6,219	7,725	9,231	10,737	12,244	13,750	15,256	16,762	18,268	21,281	24,293		
E75L	664	1,796	2,927	4,059	5,400	6,740	8,081										
E75S	641	1,733	2,826	3,918	5,212	6,507	7,801										
LJ55	67	646	996	1,346	1,697	2,047	2,397										
LJ35	108	532	867	1,202	1,537	1,872	2,207	2,542	2,877	3,212							
LJ25	89	436	710	985	1,260	1,534	1,809										
LJ75	70	673	1,037	1,401	1,766	2,130	2,494	2,859									
LJ70	68	657	1,013	1,369	1,725	2,081	2,436	2,792									
RJ1H	696	2,655	4,613	6,572	8,530	10,489	12,447										
AT73	190	888	1,586	2,284	2,981												
AT75	167	906	1,644	2,383													
AT43	141	774	1,407	2,041	2,674	3,307	3,941	4,574	5,207	5,840	6,474						
DHC7	213	785	1,357														
DH8C	201	742	1,283	1,824	2,365												
DH8B	171	631	1,091	1,552													
DH8A	164	606	1,049	1,491	1,933												

Table A-1.2.c. Aircraft types (by ICAO type designator) modelled with an ICAO Fuel Formula

	Fuel (in kg) for given Great Circle Distance (in km)																
Type Designator	**0**	**500**	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**	**4500**	**5000**	**5500**	**6000**	**7000**	**8000**	**9000**	**10000**
A124	5	21,665	33,067	44,469	53,971	62,912	71,854	80,795	89,737	98,678	107,620						
DC10	0	8,597	14,175	19,752	25,212	30,074	34,936	39,798	44,659	49,521	54,383	59,245	64,107	73,830	83,554		
DC87	3	6,839	10,595	14,350	17,708	20,502	23,295	26,088	28,881	31,675	34,468	37,261	40,054	45,641	51,227	56,814	
DC85	3	6,843	10,579	14,314	17,760	20,548	23,335	26,122	28,909	31,697	34,484	37,271	40,059	45,633	51,208	56,782	
IL96	4	9,866	14,433	19,000	23,567	28,135	32,702	37,269	41,836	46,404	50,971	55,538	60,106	69,240	78,375	87,004	92,504
IL86	7	15,054	21,568	28,082	34,597	40,173	45,449	50,725	56,001	61,277							
IL76	6	13,987	19,162	24,337	29,512	34,687	39,863	45,038	49,615	54,091							
IL62	21	10,938	14,857	18,776	22,695	26,615	30,534	34,453	38,372	42,352	46,392	50,432	54,471	62,551	70,631		
L101	2	8,688	14,100	19,513	24,925	30,337	35,525	40,394	45,264	50,133	55,003	59,872	64,742	74,481	84,220	93,959	103,698
B701	1	7,892	11,213	14,535	17,856	21,177	24,498	27,820	31,141	34,462	37,715	40,366	43,017	48,319	53,621	58,924	
B722	0	5,072	8,167	11,263	14,139	16,765	19,391	22,017	24,642	27,268	29,894	32,520					
B721	2	4,372	6,800	9,212	11,108	13,004	14,901	16,797	18,693	20,589							
T204	46	7,054	10,474	13,894	16,976	19,736	22,496	25,255	28,015	30,775	33,535	36,294	39,054				
T154	49	7,054	10,474	13,894	16,998	19,744	22,490	25,235	27,981	30,727	33,473						
T134	0	4,507	6,096	7,684	9,273	10,861	12,450	14,038									
J328	0	1,221	1,840	2,406													
S601	0	527	794	1,035	1,267	1,499											
A148	1	2,244	3,362	4,459	5,381	6,303	7,224	8,146									
AN72	1	2,246	3,358	4,471	5,398	6,298	7,197	8,097	8,996								
BA11	1	3,088	4,890	6,514	8,139	9,763	11,387	13,012	14,636	16,260							
FA10	0	1,067	1,594	2,120	2,573	2,994	3,416										
DC95	1	3,474	5,656	7,700													
DC94	1	3,365	5,479	7,458	9,253	11,048	12,842										
DC93	1	3,134	5,104	6,947	8,619	10,291	11,963	13,635	15,306	16,978	18,650						
DC92	1	2,931	4,773	6,498	8,061	9,625											
DC91	1	2,896	4,716	6,419													
F28	1	2,801	4,222	5,506	6,747	7,989	9,230	10,471	11,712								
WW24	0	815	1,226	1,604	1,954	2,305	2,656	3,007	3,357								
YK42	1	4,473	6,165	7,856	9,547	11,115	12,624	14,132	15,641								
YK40	0	1,142	1,723	2,250													
N262	0	448	737														
JS41	0	602	983	1,336	1,656	1,975	2,294	2,614									
A748	0	1,089	1,774	2,418													
CN35	0	712	1,165	1,579	1,950	2,320	2,690	3,061	3,431								
C212	0	468	771	1,032													
L410	0	474	773	1,053													
AN12	40	3,753	5,813	7,872	9,683	11,376	13,068	14,761	16,453	18,146	19,838	21,531					
AN24	0	1,280	1,977	2,674	3,371												
A140	0	1,068	1,747	2,369	2,925	3,480	4,036										
AN28	0	534	878														
BE20	0	174	275	369	456	542	629	715									
ATP	0	959	1,572	2,120	2,625	3,130	3,635	4,140	4,645								
JS32	0	436	718														
JS31	0	409	673														
CVLT	0	1,471	2,412	3,251	4,030	4,809	5,588	6,367									
F27	0	1,145	1,877	2,534	3,134	3,734	4,334	4,934	5,535	6,135							
DHC6	0	399	652														
D228	0	390	637	869	1,101	1,332											
E120	1	602	961	1,293													
E110	0	373	615	823													
G159	0	1,068	1,750	2,363	2,923	3,483	4,042	4,602	5,162								
IL18	0	3,033	4,926	6,819	8,353	9,846	11,340										
I114	0	1,307	2,132														
C130	0	2,965	4,803	6,641	8,204	9,637	11,070	12,504									
L188	0	3,446	5,610	7,729	9,456	11,184	12,912	14,640									
YS11	0	1,045	1,725	2,303	2,879												
SB20	3	1,316	2,044	2,730	3,223	3,715											
BELF	0	4,291	6,934	9,577	12,027	14,033	16,040	18,046	20,053	22,059	24,066	26,072	28,079	32,091	36,104		
SH36	0	602	983	1,335													
SH33	0	563	919	1,249													
SC7	0	296	484														
SW2	0	421	693	928	1,155	1,383	1,610	1,838									
CVLP	0	1,471															
DC6	0	1,779	2,792	3,784	4,772	5,555	6,338	7,121	7,905	8,688	9,471	10,254	11,037	12,604			
DC3	0	500	789	1,060	1,307												

Table A-1.2.d. Guidance on aircraft types (by ICAO type designator) that can be used as custom aircraft modelled with a generic equation

Type Designator	Example of Model*	Aircraft Type Category	Average MTOM (kg) (For information only - not for use as input to the CERT)
A35K	A-350-1000 XWB	Jet (Heavy) with certified MTOM >= 136 000 kg	296,651
A359	A-350-900 XWB	Jet (Heavy) with certified MTOM >= 136 000 kg	274,204
A3ST	A-300ST Beluga	Jet (Heavy) with certified MTOM >= 136 000 kg	147,848
A225	An-225 Mriya	Jet (Heavy) with certified MTOM >= 136 000 kg	600,000
BLCF	747-400LCF Dreamlifter	Jet (Heavy) with certified MTOM >= 136 000 kg	347,429
B703	707-300	Jet (Heavy) with certified MTOM >= 136 000 kg	144,510
A21N	A-321neo	Jet with certified MTOM >= 60,000kg and < 136,000kg	89,186
A20N	A-320neo	Jet with certified MTOM >= 60,000kg and < 136,000kg	77,005
B38M	737 MAX 8	Jet with certified MTOM >= 60,000kg and < 136,000kg	82,001
BCS3	BD-500 CSeries CS300	Jet with certified MTOM >= 60,000kg and < 136,000kg	65,190
BCS1	BD-500 CSeries CS100	Jet with certified MTOM >= 60,000kg and < 136,000kg	59,192
MG15	MiG-15	Jet with certified MTOM < 60,000 kg	5,824
A158	An-158	Jet with certified MTOM < 60,000 kg	41,975
A743	An-74-300	Jet with certified MTOM < 60,000 kg	34,816
AJET	Alpha Jet	Jet with certified MTOM < 60,000 kg	7,154
BE40	400 Beechjet	Jet with certified MTOM < 60,000 kg	7,322
C700	700 Citation Longitude	Jet with certified MTOM < 60,000 kg	17,090
C750	750 Citation 10	Jet with certified MTOM < 60,000 kg	16,324
C680	680 Citation Sovereign	Jet with certified MTOM < 60,000 kg	13,715
C650	650 Citation 3	Jet with certified MTOM < 60,000 kg	9,949
C25B	525B Citation CJ3	Jet with certified MTOM < 60,000 kg	5,630
FA20	Falcon 20	Jet with certified MTOM < 60,000 kg	13,352
E550	EMB-550 Legacy 500	Jet with certified MTOM < 60,000 kg	17,200
E545	EMB-545 Legacy 450	Jet with certified MTOM < 60,000 kg	16,000
LJ24	24	Jet with certified MTOM < 60,000 kg	5,840
GLF2	Gulfstream 2	Jet with certified MTOM < 60,000 kg	30,079
GA5C	Gulfstream G500 (G-7)	Jet with certified MTOM < 60,000 kg	33,251
GLF3	Gulfstream 3	Jet with certified MTOM < 60,000 kg	31,701
GALX	Gulfstream G200	Jet with certified MTOM < 60,000 kg	16,079
G150	Gulfstream G150	Jet with certified MTOM < 60,000 kg	12,873
ASTR	1125 Astra	Jet with certified MTOM < 60,000 kg	11,331
HA4T	Hawker 4000	Jet with certified MTOM < 60,000 kg	17,013
L29B	L-1329 Jetstar 2	Jet with certified MTOM < 60,000 kg	19,857
MRJ9	MRJ-90	Jet with certified MTOM < 60,000 kg	40,825
MU30	MU-300 Diamond	Jet with certified MTOM < 60,000 kg	7,256
SBR1	Sabreliner	Jet with certified MTOM < 60,000 kg	10,072
PC24	PC-24	Jet with certified MTOM < 60,000 kg	7,636
SU95	Superjet 100-95	Jet with certified MTOM < 60,000 kg	46,999
T334	Tu-334	Jet with certified MTOM < 60,000 kg	45,690
AT3	AT-3 Tzu-Chung	Jet with certified MTOM < 60,000 kg	7,574
C295	C-295	Turboprop	21,234
C27J	Spartan (C-27J)	Turboprop	29,093
AN70	An-70	Turboprop	145,000
AN32	An-32	Turboprop	27,066
AN26	An-26	Turboprop	24,000
AN30	An-30	Turboprop	23,000
AN38	An-38	Turboprop	9,500
AT44	ATR-42-400	Turboprop	17,900
BE30	300 Super King Air	Turboprop	6,122
B350	King Air 350	Turboprop	6,804
SW4	Merlin 4	Turboprop	6,745
SW3	Merlin 3	Turboprop	5,735
M28	M-28 Skytruck	Turboprop	7,500

APPENDIX A-2: Aircraft types (by type designator) that will be the focus of further and targeted data collection towards the 2019 version of the ICAO CORSIA CERT

Type Designator	Manufacturer	Example of Model*
A124	ANTONOV	An-124 Ruslan
A140	ANTONOV	IRAN-140 Faraz
A148	ANTONOV	An-148
A158	ANTONOV	An-158
A20N	AIRBUS	A-320neo
A21N	AIRBUS	A-321neo
A225	ANTONOV	An-225 Mriya
A30B	AIRBUS	A-300B2
A342	AIRBUS	A-340-200
A345	AIRBUS	A-340-500
A359	AIRBUS	A-350-900 XWB
A35K	AIRBUS	A-350-1000 XWB
A3ST	AIRBUS	A-300ST Beluga
A743	ANTONOV	An-74-300
A748	AIL	748
AJET	AOI	Alpha Jet
AN12	ANTONOV	An-12
AN24	ANTONOV	An-24
AN26	ANTONOV	An-26
AN28	ANTONOV	An-28
AN30	ANTONOV	An-30
AN32	ANTONOV	An-32
AN38	ANTONOV	An-38
AN70	ANTONOV	An-70
AN72	ANTONOV	An-72
ASTR	GULFSTREAM AEROSPACE	1125 Astra
AT3	AIDC	AT-3 Tzu-Chung
AT43	ATR	ATR-42-300
AT44	ATR	ATR-42-400
AT73	ATR	ATR-72-211
AT75	ATR	ATR-72-500
ATP	BRITISH AEROSPACE	ATP
B350	BEECH	King Air 350
B38M	BOEING	737 MAX 8
B461	BRITISH AEROSPACE	BAe-146-100
B701	BOEING	707-100
B703	BOEING	707-300
B712	BOEING	717-200
B721	BOEING	727-100
B722	BOEING	727-200
B732	BOEING	737-200
B741	BOEING	747-100
B742	BOEING	747-200
B743	BOEING	747-300
B74D	BOEING	747-400 (domestic, no winglets)
B74R	BOEING	747SR
B74S	BOEING	747SP
B773	BOEING	777-300
B78X	BOEING	787-10 Dreamliner
BA11	BAC	BAC-111 One-Eleven
BCS1	BOMBARDIER	BD-500 CSeries CS100
BCS3	BOMBARDIER	BD-500 CSeries CS300
BE20	BEECH	Super King Air (200)
BE30	BEECH	300 Super King Air
BE40	BEECH	400 Beechjet
BELF	SHORT	SC-5 Belfast
BLCF	BOEING	747-400LCF Dreamlifter
C130	LOCKHEED	L-100 Hercules
C212	AIRBUS	C-212 Aviocar
C25B	CESSNA	525B Citation CJ3
C25C	CESSNA	525C Citation CJ4
C27J	ALENIA	Spartan (C-27J)
C295	AIRBUS	C-295
C525	CESSNA	525 Citation CJ1
C55B	CESSNA	550B Citation Bravo
C560	CESSNA	560 Citation 5
C650	CESSNA	650 Citation 3
C680	CESSNA	680 Citation Sovereign
C700	CESSNA	700 Citation Longitude
C750	CESSNA	750 Citation 10
CN35	AIRBUS	CN-235
CRJ2	CANADAIR	Challenger 800
CVLP	CONVAIR	Convairliner
CVLT	CANADAIR	Cosmopolitan
D228	DORNIER	Dornier 228
DC10	BOEING	DC-10
DC3	DOUGLAS	DC-3
DC6	DOUGLAS	DC-6
DC85	DOUGLAS	DC-8-50
DC87	DOUGLAS	DC-8-70
DC91	DOUGLAS	DC-9-10
DC92	DOUGLAS	DC-9-20
DC93	DOUGLAS	DC-9-30
DC94	DOUGLAS	DC-9-40
DC95	DOUGLAS	DC-9-50
DH8A	DE HAVILLAND CANADA	Dash 8 (100)
DH8B	DE HAVILLAND CANADA	Dash 8 (200)
DH8C	DE HAVILLAND CANADA	Dash 8 (300)
DHC6	DE HAVILLAND CANADA	DHC-6 Twin Otter
DHC7	DE HAVILLAND CANADA	DHC-7 Dash 7
E110	EMBRAER	EMB-110 Bandeirante
E120	EMBRAER	EMB-120 Brasilia
E195	EMBRAER	ERJ-190-200
E545	EMBRAER	EMB-545 Legacy 450
E550	EMBRAER	EMB-550 Legacy 500
E75L	EMBRAER	ERJ-170-200 (long wing)
E75S	EMBRAER	ERJ-170-200 (short wing)
F27	CONAIR	F-27
F28	FOKKER	F-28 Fellowship
FA10	DASSAULT	Falcon 10
FA20	DASSAULT	Falcon 20
FA8X	DASSAULT	Falcon 8X
G150	GULFSTREAM AEROSPACE	Gulfstream G150
G159	GRUMMAN	G-159 Gulfstream 1
GA5C	GULFSTREAM AEROSPACE	Gulfstream G500 (G-7)
GALX	GULFSTREAM AEROSPACE	Gulfstream G200
GLF2	GRUMMAN	Gulfstream 2
GLF3	GULFSTREAM AEROSPACE	Gulfstream 3
H25A	DE HAVILLAND	HS-125-1
H25C	BRITISH AEROSPACE	Hawker 1000
HA4T	HAWKER BEECHCRAFT	Hawker 4000
I114	ILYUSHIN	Il-114
IL18	ILYUSHIN	Il-18
IL62	ILYUSHIN	Il-62
IL76	ILYUSHIN	Il-76
IL86	ILYUSHIN	Il-86
IL96	ILYUSHIN	Il-96
J328	328 SUPPORT SERVICES	Dornier 328JET
JS31	BRITISH AEROSPACE	BAe-3100 Jetstream 31
JS32	BRITISH AEROSPACE	BAe-3200 Jetstream Super 31
JS41	AI(R)	BAe-4100 Jetstream 41
L101	LOCKHEED	L-1011 TriStar
L188	LOCKHEED	Electra (L-188)
L29B	LOCKHEED	L-1329 Jetstar 2
L410	AIRCRAFT INDUSTRIES	L-410 Turbolet
LJ24	GATES LEARJET	24
LJ25	GATES LEARJET	25
LJ35	GATES LEARJET	35
LJ55	GATES LEARJET	55
LJ70	LEARJET	70
LJ75	LEARJET	75
M28	PZL-MIELEC	M-28 Skytruck
MD81	BOEING	MD-81
MD82	BOEING	MD-82
MD83	BOEING	MD-83
MD87	BOEING	MD-87
MG15	AERO (2)	MiG-15
MRJ9	MITSUBISHI	MRJ-90
MU30	MITSUBISHI	MU-300 Diamond
N262	AEROSPATIALE	N-262 Frégate
PC24	PILATUS	PC-24
RJ1H	AI(R)	RJ-100 Avroliner
RJ70	AI(R)	RJ-70 Avroliner
S601	AEROSPATIALE	SN-601 Corvette
SB20	SAAB	2000
SBR1	NORTH AMERICAN	Sabreliner
SC7	SHORT	SC-7 Skyliner
SH33	SHORT	SD3-30
SH36	SHORT	360
SU95	SUKHOI	Superjet 100-95
SW2	SWEARINGEN	SA-26 Merlin 2
SW3	FAIRCHILD (1)	Merlin 3
SW4	FAIRCHILD (1)	Merlin 4
T134	TUPOLEV	Tu-134
T154	TUPOLEV	Tu-154
T204	TUPOLEV	Tu-204
T334	TUPOLEV	Tu-334
WW24	IAI	1124 Westwind
YK40	YAKOVLEV	Yak-40
YK42	YAKOVLEV	Yak-42
YS11	MITSUBISHI	YS-11

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