

ICAO CORSIA CO₂ Estimation and Reporting Tool (CERT): 2023 Version

- Design, Development and Validation -

C SIA

October 2023

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1. **INTRODUCTION**

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 ICAO CORSIA 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 CO₂ 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 ICAO CORSIA 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

2.1 General Overview

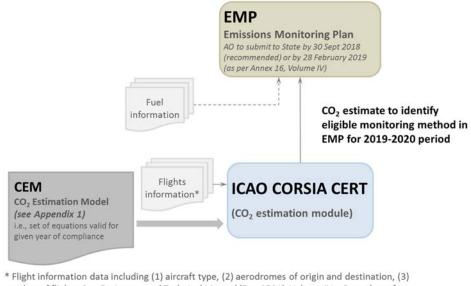
The ICAO CORSIA CO₂ Estimation and Reporting Tool (CERT) is expected to be updated and enhanced over time to reflect: (1) evolving requirements from the implementation of CORSIA (i.e., Annex 16, Volume IV) such as the phased implementation of CORSIA reflected in the ICAO document entitled "CORSIA States for Chapter 3 State Pairs" that will be available on the ICAO CORSIA website from 2020, (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.

With the 2018 version of the ICAO CORSIA CERT, an aeroplane operator, that uses the CO_2 estimation functionality of the ICAO CORSIA CERT, was able to estimate for each year if its annual CO_2 emissions are above the thresholds as described in Annex 16, Volume IV¹.

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 CO₂ 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.

An aeroplane operator was 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 was based on the ICAO CO₂ Estimation Models (CEMs) that capture the set of equations that allow to estimate for a given aeroplane type the CO₂ emissions as a function of Great Circle Distance.



* Flight information data including (1) aircraft type, (2) aerodromes of origin and destination, (3) number of flights. See Environmental Technical Manual (Doc 9501), Volume IV – Procedures for demonstrating compliance with the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) for detailed guidance on time span of flight information data.

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 can 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-pair level, (2) flights for which there are data gaps 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 and/or automatically 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 only included the CO₂ estimation functionality to determine the applicability of CORSIA and

² For the 2019-2020 period: the aeroplane operator with annual CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ Estimation and Reporting Tool (CERT), as described in Annex 16, Volume IV, Appendix 3. The aeroplane operator, with annual CO₂ emissions from international flights subject to offsetting requirements, as defined in Annex 16, Volume IV, Appendix 3. The aeroplane operator, with annual CO₂ emissions from international flights subject to offsetting requirements, as defined in Annex 16, Volume IV, Appendix 3. The aeroplane operator, with annual CO₂ emissions from international flights subject to offsetting requirements, as defined in Annex 16, Volume IV, Appendix 3. The aeroplane operator, with annual CO₂ 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 CO₂ Estimation and Reporting Tool (CERT) as described in Annex 16, Volume IV, Appendices 2 and 3 respectively.

eligibility to the use of the ICAO CORSIA CERT. The 2019 and 2020 versions include the monitoring and report generation functionality. The 2021-2035 versions will then include splitting of the emissions between those subject to offsetting requirements, as they belong to routes between pairs of participating States, and those that have only to be reported but that are not subject to offsetting requirements.

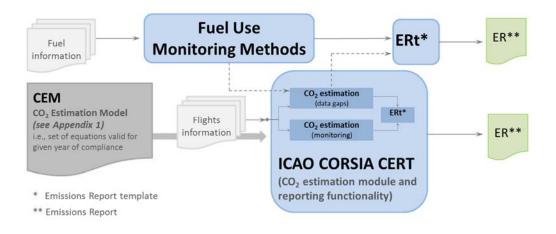


Figure 2: Architecture of CORSIA reporting system (2019 onward for compliance purposes)

	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 CO₂ Estimation and Reporting Tool (CERT)

2.2 Architecture of the 2023 Version of the ICAO CORSIA CERT

Based on requirements from Annex 16 Volume IV, a more detailed architecture of the 2023 version of the ICAO CORSIA CERT was developed. First, potential and expected users of the CERT were identified. Through an iterative process of mapping processes/tasks by different users required functionalities were identified.

2.2.1 Potential Users of the ICAO CORSIA CERT 2023

Figure 4 shows the list of potential users of the ICAO CORSIA CERT along with whether they have a submitted/approved EMP, their primary monitoring method, description of the use of the CERT and needed functionalities.

Users	Submitted/Approved EMP	Primary Monitoring Method (PMM)	Description of Use of the CERT	Needed Functionalities
Aeroplane Operators	Yes	Eligible to use the CERT as PMM	Estimating emissions and filling ER using the CERT (only)	 CO₂ Estimation ER generation
Aeroplane Operators	Yes	Required to use a Fuel Use Monitoring Method as PMM	Using the CERT to fill data gaps and generate ER	 CO₂ Estimation ER generation
Aeroplane Operators	Yes	Required to use a Fuel Use Monitoring Method as PMM	Using the CERT to fill data gaps	 CO₂ Estimation Summary Assessment
Aeroplane Operators	No	n/a	Evaluating applicability of CORSIA and eligibility to use the CERT	 CO₂ Estimation Summary Assessment
States	n/a	n/a	Order of Magnitude checks and Data gap filling	 CO₂ Estimation Summary Assessment
ICAO	n/a	n/a	Data gap filling	 CO₂ Estimation Summary Assessment
Verifiers	n/a	n/a	Order of Magnitude checks	 CO₂ Estimation Summary Assessment

Figure 4: Potential Users of the ICAO CORSIA CERT 2019+ versions

2.2.2 ICAO CORSIA CERT 2019+ High-Level Architecture

The ICAO CORSIA CERT 2023 version was built on the 2022 version with regard to the input of aeroplane operator information, the CO_2 estimation and the generation of a summary assessment functionalities. To meet the additional requirements from monitoring of emissions according to Annex 16 Volume IV, additional functionalities will be added in the 2019+ versions, including;

• <u>ICAO CEMs:</u> The 2023 version of the ICAO CORSIA CERT contains an updated set of ICAO CEMs based on the 2023 version of the COFdb.

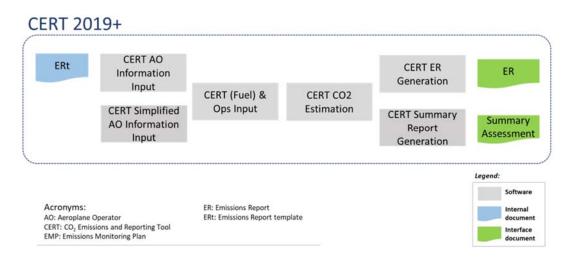


Figure 5: High Level Architecture of the 2019+ versions of the ICAO CORSIA CERT

In accordance with the requirements from Annex 16 Volume IV and the ETM Volume IV, the 2018 version of the ICAO CORSIA CERT only required the CO_2 estimation functionality and no reporting capabilities. The reporting functionality was added to the 2019 version which will be used by aeroplane operators to monitor (via estimation) and report their 2019 CO_2 emissions as well as to fill data gaps if needed. The template of the Emissions Report based on the Second Edition of the Environmental Technical Manual (ICAO Doc 9501) was integrated into the CERT 2023. The ICAO CORSIA CERT allows operators to automatically fill and export the Emissions Report.

2.2.3 Detailed Use Cases for the ICAO CORSIA CERT 2019+

Figure 6 shows the processes expected to be followed by an aeroplane operator for which the State has approved the submitted EMP and the right to use the ICAO CORSIA CERT as a primary monitoring method. This (aeroplane operator) user would also use the ICAO CORSIA CERT to generate its Emissions Report.

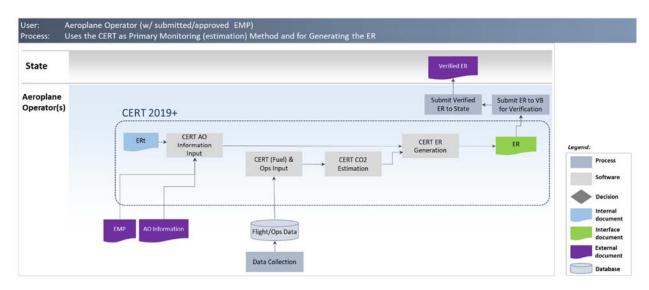


Figure 6: Mapping of processes supported by the 2019+ versions of the ICAO CORSIA CERT for an aeroplane operator with an approved EMP and using the ICAO CORSIA CERT as primary monitoring method and to generate its ER

Figure 7 shows the processes expected to be followed by an aeroplane operator for which the State has approved the submitted EMP and that uses the ICAO CORSIA CERT to fill data gaps (i.e., flights with no data from the approved Fuel Use Monitoring Method). This (aeroplane operator) user would also use the ICAO CORSIA CERT to generate its Emissions Report.

itate	Verified ER	
eroplane perator(s)	CERT 2019+	Legend: Process Softwa Decisio
	EMP AO Information Full List of Flights (some with Fuel some with missing Fuel Data)	Interna docum Interfa docum

Figure 7: Mapping of processes supported by the 2019+ versions of the ICAO CORSIA CERT for an aeroplane operator with an approved EMP and using the ICAO CORSIA CERT to fill data gaps and generate its ER

Figure 8 shows the processes expected to be followed by an aeroplane operator that uses the ICAO CORSIA CERT only to estimate the fuel and emissions for data gaps (i.e., flights with no data from the approved Fuel Use Monitoring Method). This (aeroplane operator) user would not use the ICAO CORSIA CERT to generate its Emissions Report.

	ane Operator (w/ submitted/approved ne CERT to Fill Data Gaps (uses a Fuel U		
State			
Aeroplane Operator(s)	CERT 2019+		
			Legend:
		CERT (Fuel) & CERT CO2 Ops Input Estimation	Process Software
			Decision
		Flight/Ops Data* ER	document Interface document
* Either List with some or List of flights with mi	flight with fuel some with missing fuel data ssing fuel data	T Data Collection	External document Database

Figure 8: Mapping of processes supported by the 2019+ versions of the ICAO CORSIA CERT for an aeroplane operator using the ICAO CORSIA CERT only to fill data gaps

Figure 9 shows the processes expected to be followed by an aeroplane operator to determine the applicability of CORSIA and eligibility to user the ICAO CORSIA CERT. Note: this process is similar to the use of the 2018 version of the ICAO CORSIA CERT.

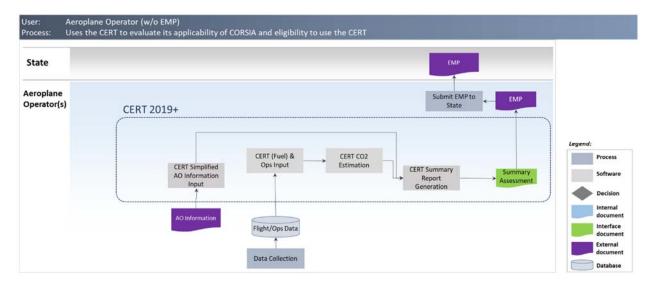


Figure 9: Mapping of processes supported by the 2019+ versions of the ICAO CORSIA CERT for an aeroplane operator to determine the applicability of CORSIA and eligibility to user the ICAO CORSIA CERT

State Process Uses the CERT to Fill Data Gaps and for Generating Draft ER (for submission and co ordination with the AO) ICAO State CERT 2019+ CERT AO ERt CERT ER (Draft) ER Information Generation Input CERT (Fuel) & CERT CO2 Legend Est Aggregation Process with other ERs and submission by State Flight/Ops Data AO Informatic Draft ER to AO Verified ER for R Interface Data Collection Submits an ER External Aeroplane Draft (ER) fo Review No reply Review by AO Operator Database Not acceptable to the AO - observations on used data Acceptable to the AO

Figure 10 shows the processes expected to be followed by a State to fill data gaps.

Figure 10: Mapping of processes supported by the 2019+ versions of the ICAO CORSIA CERT for a State to fill data gaps

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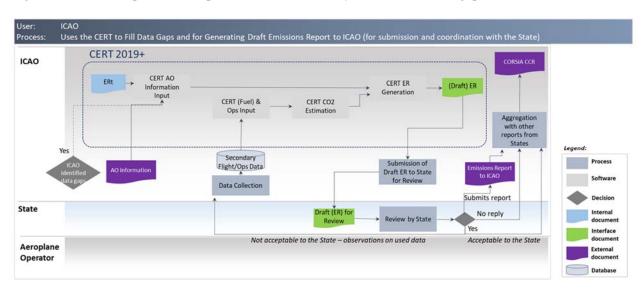


Figure 11 shows the processes expected to be followed by ICAO to fill data gaps.

Figure 11: Mapping of processes supported by the 2019+ versions of the ICAO CORSIA CERT for ICAO to fill data gaps

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 CO₂ 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 ICAO 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 ICAO CEMs based on Great Circle Distance input or Block Time input could provide flexibility to aeroplane 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 12. 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 CO₂ emissions using either the Block Time or Great Circle Distance (GCD). The user enters a) Aircraft type and b) aerodrome 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 CO₂ emissions; and
- (3) Generating the Emissions Report, reviewing and submitting it.

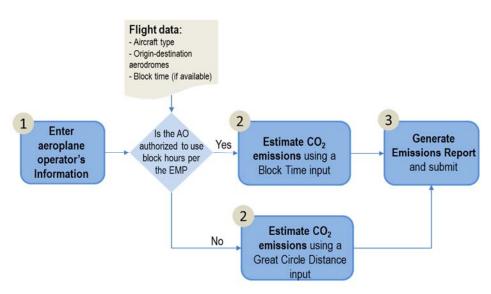


Figure 12: Overview of the high-level functions of the potential CORSIA CO₂ Estimation and Reporting Tool

3.2 **Development of the ICAO CO₂ Estimation Models (CEMs)**

Underlying the ICAO CORSIA CERT CO_2 estimation functionality (i.e., step 2 in Figure 12), the ICAO 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 ICAO CEMs

Figure 13 shows an overview of the process for developing the ICAO CEMs. First, the list of aircraft types, by ICAO Type Designator, for which an ICAO 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 aeroplane database. Section 3.2.2 provides additional information about the process for scoping the ICAO CORSIA CERT aeroplane database.

For each of the aircraft types identified in the scoping process described above, an ICAO CEM was developed. As shown in Figure 13, 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), an ICAO CEM is developed using the methodology described in section 3.2.3;
- (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), an ICAO CEM is developed through scaling of the ICAO CEM of the equivalent aircraft type, using the method described in 3.2.4;

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

- (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 3.2.5 for background on the ICAO Fuel Formula); and
- (4) Finally, if an aircraft type is missing an ICAO CEM after steps 1 to 3, a generic equation can be developed using the methodology described in section 3.2.6. 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 Aeroplane.

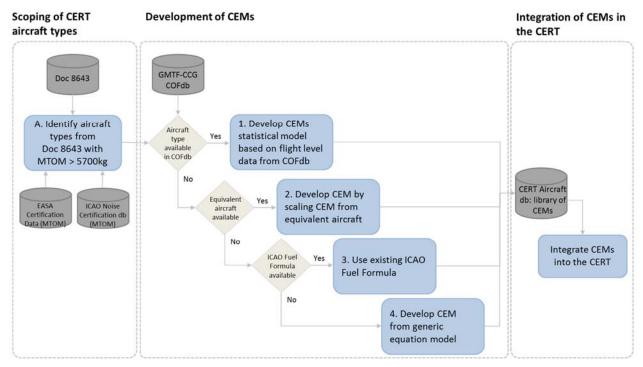


Figure 13: Summary of process for developing ICAO CO₂ Emissions Estimation Models (CEMs)

3.2.2 Scoping of ICAO CORSIA CERT aeroplane 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 2023 version of the ICAO CORSIA CERT is based on the version of Doc 8643 that was last updated on 03 May 2023.
- Maximum Take Off Mass (MTOM):
 - The following version of the EASA Noise Certification Databases (<u>www.easa.europa.eu/document-library/noise-type-certificates-approved-noise-levels</u>) were used to obtain MTOM data by aircraft type.
 - EASA approved noise levels (Heavy propeller driven aeroplanes), Issue 35, last updated: 28 October 2021
 - EASA approved noise levels (Jet aeroplanes), Issue 37, last updated: 28

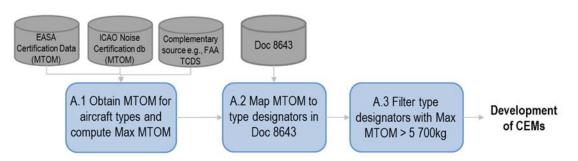
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- EASA approved noise levels (Light propeller driven aeroplanes), Issue 37, last updated: 28 October 2021
- In addition, the ICAO Noise Certification Database, version 2.24 that was validated by the CAEP Working Group 1 (WG1) on the 8th November 2017 was used. The Noise Certification database is available at: <u>http://noisedb.stac.aviation-civile.gouv.fr</u>
- Complementary data sources were also used when needed, including the U.S. Federal Aviation Administration (FAA) Type Certificate Data Sheet (TCDS), available at: <u>http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgMakeModel.nsf/Frameset?Ope</u> <u>nPage</u>

Methodology

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 aeroplane variants and the multiple available MTOM databases.

Figure 14 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.



Doc 8643 has total of 10 020 aircraft types categorized as Amphibian, Helicopter, Landplane, SeaPlane or Tilt-wing. Further, each aircraft type has the manufacturer's name, ICAO Designator, engine type, engine count and wake turbulence category (WTC).

Doc 8643 has wake turbulence category (WTC) designated for each aircraft type. The WTCs are as follows:

- H (Heavy) aircraft types of 136 000 kg (300 000 lb) or more;
- M (Medium) aircraft types less than 136 000 kg (300 000 lb) and more than 7 000 kg (15 500 lb); and
- L (Light) aircraft types of 7 000 kg (15 500 lb) or less.
- Note: Super Heavy for Airbus A380-800 with a maximum take-off mass in the order of 560 000 kg.

Figure 14: Development of list of aircraft types with MTOM>5 700kg for CORSIA CO₂ emissions estimation tool development process

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

As described in the first step of the four-tier approach in Figure 13, if the aircraft type can be mapped to an aircraft type available from the CCG Operations and Fuel database (COFdb), an ICAO CEM is developed using statistical models.

Overview of the CCG Operations and Fuel database (COFdb)

The CAEP Working Group 4 (WG4) 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 DPO Data Providing Organizations (DPOs) 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 WG4-CCG co-leads for it to be integrated in the COFdb replacing the DPO unique code with a COFdb specific unique code. Once validated by the CCG co-leads, the resulting COFdb is shared only with WG4 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 CO₂ Estimation and Reporting Tool (CERT) and the underlying ICAO CO₂ Estimation Models (CEMs).

Data collection and validation processes

When providing data to CAEP, DPOs 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 aeroplane 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 DPO 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
 - o 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 a DPO 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 ICAO CORSIA CERT and that have executed a Use Agreement at the time of the distribution of the COFdb.

Version of the COFdb used for the 2023 version of the ICAO CORSIA CERT

For the 2023 version of the ICAO CORSIA CERT, the COFdb version 2023_3.0 as of March 23, 2023 was used. This 2023 version 3.0 of the COFdb includes data from approximately 6.3 million flights (after removal of older data) for 116 aircraft types by ICAO Type Designator. Data ranged from 2006 to 2022 with about 75% of the data coming from 2017 to 2022.

Identifying and removing outliers from aeroplane 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 ICAO 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. The 2019 version of the ICAO CORSIA CERT and subsequent versions include both Great Circle Distance and Block Time input.

Figure 15 shows an illustration for a sample aircraft type with the COFdb data split into data retained for the development of the regression i.e., ICAO CEM (in green) and outliers (in red).

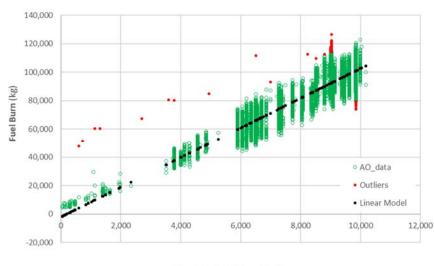




Figure 15: Illustration of sample data used to generate ICAO CEMs, including outlier data removed from the process of generating the ICAO CEM

To generate an ICAO 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 ICAO 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.

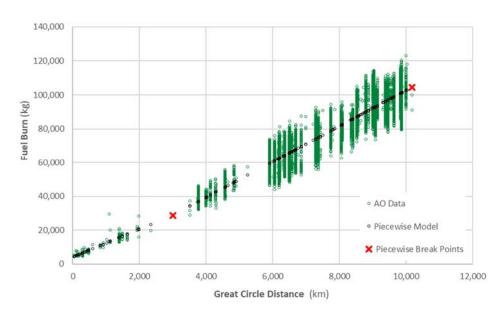


Figure 16: Illustration of fuel burn statistical method model formulation (GCD Model)

3.2.4 Development of ICAO 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), an ICAO CEM is developed through scaling of the ICAO 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 an ICAO CEM based on data from the COFdb was available.

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

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

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

3.2.5 ICAO 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, <u>https://www.icao.int/environmental-protection/CarbonOffset/Documents/Methodology%20ICAO%20Carbon%20Calculator_v10-2017.pdf</u>

3.2.6 Development of ICAO CEMs based on generic equation model

Finally, to allow the estimation of fuel burn and CO₂ emissions for an aircraft type that is missing an ICAO CEM after applying the steps in 3.2.3 to 3.2.5, a set of generic equation models are developed from which an ICAO CEM for such aircraft type can then be derived. This step forms the basis for the ICAO CORSIA CERT functionality of entering custom aeroplane 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 8643 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.

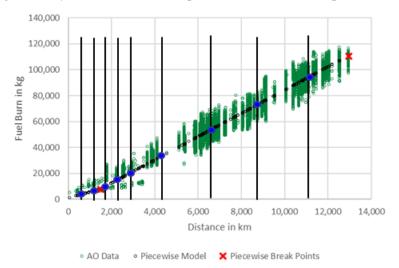


Figure 17: Illustration of process for binning data for developing generic equation

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

- Heavy Jets⁴;
- Medium Jets with Certified MTOM greater than 60 000 kg⁵;
- Medium Jets with Certified MTOM lower or equal to 60 000 kg; and
- Turboprops and Turboshaft aeroplane.

Figure 18 illustrates the development of generic aeroplane (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 ICAO CEMs (in blue) for aeroplane in the same category. Distances of 0 km and 1 000 km are shown for illustration.

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 CO₂ emissions standard (governed by Annex 16, Volume III) that includes a breakpoint at 60 tonnes certified MTOM.

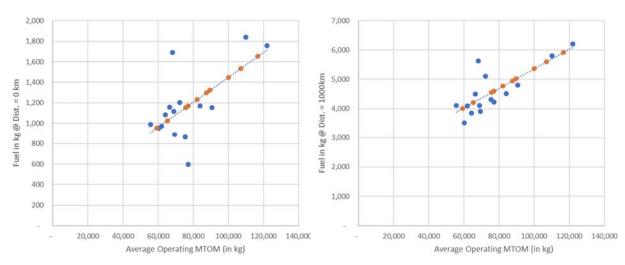


Figure 4: Illustration of generic aeroplane fuel burn-MTOM based regressions for a given distance

Similarly to aeroplane operator fuel burn data, a linear regression is then calculated. The result is a set of equations (per aeroplane category and distance band) returning a fuel as a function of the aeroplane 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).

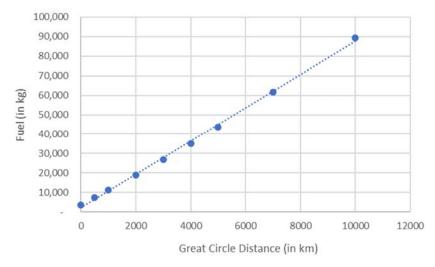


Figure 5: Illustration of generic aeroplane ICAO CEM

4. IMPLEMENTATION OF THE ICAO CORSIA CERT: VERSION 2023

ICAO CORSIA CERT has been developed, tested, and validated on Microsoft Excel 2013 and Windows 11 as Operating System. This should not be considered the minimum possible configuration. However, due to possible compatibility issues with older Excel versions and/or operating systems other than those tested, it is recommended to use Windows 7 or higher and Excel version 2010 or later. ICAO CORSIA CERT has not been tested on any MAC OS.

The ICAO CORSIA CERT version 2023 -includes two key functionalities:

a) Summary of assessment of applicability of CORSIA and eligibility to use the ICAO CORSIA CERT in 2023,

b) CO₂ Estimation and Reporting for 2023.

4.1 Summary of assessment of applicability of CORSIA and eligibility to use the ICAO CORSIA CERT in 2023

The ICAO CORSIA CERT version 2023 takes 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 CO₂ emissions;
- (2) Estimates its CO₂ 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.
- 4.1.1 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.

4.1.2 Calculation of CO₂ emissions

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

4.1.3 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 aeroplane database. If needed, the user can also enter codes that are not included in the ICAO CORSIA CERT aeroplane database which become 'custom aeroplane code'. See below for details on the custom aeroplane and aerodrome 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 aerodromes 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.

4.1.4 Comparison of the operations input data against the ICAO CORSIA CERT aeroplane and aerodrome 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 aerodromes entries against the internal ICAO CORSIA CERT aeroplane and aerodromes databases. This comparison checks for consistency and returns any aircraft type code and aerodrome code that does not match the internal ICAO CORSIA CERT aeroplane and aerodromes databases. The user can then choose to enter custom aeroplane and aerodromes information for these codes or return to the input data and correct the codes if an error was - 21 -

made in the data entry.

Entering custom aeroplane codes

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

- a) Jet (Heavy) with certified MTOM \geq 136 000 kg;
- b) Jet with certified MTOM \geq 60 000 kg and < 136 000 kg;
- 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 aeroplane 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 aeroplane category selected and the Average Maximum Take Off Mass (MTOM) in the aeroplane operator fleet, the ICAO CORSIA CERT derives a tailored ICAO CEM from the relevant generic equation model according to the approach described in section 3.2.6. The custom aeroplane 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 aeroplane 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 Aeroplane Code.

The following coefficients are used in the 2023 version of the ICAO CORSIA CERT to generate generic equations (as a function of entered Average MTOM) for aircraft types entered as custom aeroplane, by aircraft type category.

Aircraft Type Category	Coefficients for L Derive the <u>Interce</u> Equa		Coefficients for Linear Function Derive the <u>Slope</u> of the Generi Equation		
Coefficients for Generic Equation based on Great C	ircle Distance (i.e., l	Fuel = slope * GCD +	+ intercept)		
	Intercept	Slope	Intercept	Slope	
Jet (Heavy) with certified MTOM >= 136 000 kg	-1738.323789	0.015494476	0.851400944	2.58006E-05	
Jet with certified MTOM >= 60 000 kg and < 136 000 k	102.5191681	0.011587369	1.035425787	2.94163E-05	
Jet (Heavy) with certified MTOM < 60 000 kg	186.6981954	0.014121257	0.172655568	5.10469E-05	
Turboprop	-21.96949515	0.013831192	0.33173559	4.80238E-05	
Coefficients for Generic Equation based on Block T	i me (i.e., Fuel = slop	e * Block_Time + in	itercept)		
	Intercept	Slope	Intercept	Slope	
Jet (Heavy) with certified MTOM >= 136 000 kg	4810.166517	-0.03674015	-4.778898921	0.000455796	
Jet with certified MTOM >= 60 000 kg and < 136 000 k	750.9498712	-0.01224546	4.683460687	0.000484168	
Jet (Heavy) with certified MTOM < 60 000 kg	23.53124626	0.002441058	4.135109741	0.000532874	
Turboprop	-19.78366888	0.005858582	0.723039936	0.00043942	

Figure 20: Coefficients used in the 2023 version of the ICAO CORSIA CERT to generate generic equations (as a function of entered Average MTOM) for aircraft types entered as custom aeroplane

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

CERT Aerodrome Database

The CERT Aerodrome database contained in the 2023 version of the CERT is based on the Edition 189 of the ICAO eDoc7910. Some aerodromes contained in ICAO eDoc 7910 with latitude and longitude in erroneous formats were addressed for the purpose of the development of the CERT Aerodrome database. The CERT aerodrome database also includes a short list of aerodromes that complement the subset of aerodromes from ICAO eDoc7910. Appendix C contains the short list of aerodromes to be added to the CERT Aerodrome database underlying the CERT 2023.

These aerodromes or any aerodromes contained in the CERT aerodrome database can be overwritten by users following the procedure described in the next section.

Entering custom aerodrome codes

If needed, the user can enter custom aerodrome codes in order to allow for the calculation of CO_2 emissions for each flight entered. The user is prompted to enter aerodrome latitude using WGS84 coordinates. In the 2023 version of the ICAO CORSIA CERT, the user has greater flexibility for entering aerodrome coordinates. The separation symbols can be defined by the user.

Latitude and longitude pairs for aerodromes or Aerodrome Reference Points (ARP) within the ICAO CORSIA CERT shall be used with the following Latitude & Longitude sign convention.

A negative latitude (-) means South of the Equator. A negative longitude (-) means West of the Prime Meridian.

In addition, the user is prompted to enter an ICAO Member State attributed to the aerodrome by selecting from the list of 193 ICAO Member States as of April 2020. In order to help with the attribution of aerodromes 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 Aerodrome Code (for codes with four letters only).

Note. - If custom aerodromes are entered but already exist in the ICAO CORSIA CERT aeroplane database, the information for the custom aerodromes 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 aeroplane and aerodrome databases, a search functionality was developed. Additional information on the underlying Doc 8643 can be found at: <u>https://www.icao.int/publications/DOC8643/Pages/default.aspx</u>. In addition, additional information on Doc 7910 can be found at <u>https://gis.icao.int/7910FLEX/</u>.

4.1.5 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 underlying ICAO 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 is 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.

4.1.6 Generation of a summary assessment of CO₂ 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 2023.

The summary assessment includes:

- *a*) Aeroplane operator information based on input from the user;
- b) Estimated CO₂ emissions and status of aeroplane operator. This comprises:
 - Total annual estimated CO₂ emissions (international). It should be noted that emissions are for all international State pairs. For the 2023 version of the ICAO CORSIA CERT, this total splits 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 CO₂ 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 CO₂ emissions by State pairs.

4.1.7 Generation of report on summary assessment

To support the Emissions Monitoring Plan (EMP) in 2023, 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 aeroplane and aerodromes 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.

4.2 CO₂ Estimation and Reporting for 2023

The CO₂ Estimation and Reporting functionality of the ICAO CORSIA CERT version 2023 takes the user through each step of the Emissions Report generation process where the user:

- a. Enters aeroplane operator identification and description of activities,
- b. Enters underlying basic information of the Emissions Report,
- c. Enters aeroplane fleet and fuel types
- d. Select Fuel density
- e. Selected the level of aggregation of the information reported,
- f. Load its operations (and fuel) data to estimation CO₂ emissions,

- g. Completes the prefilled "Reporting State pairs" report, or
- h. Completes the prefilled "Reporting Aerodrome pairs", and
- i. Completes the prefilled "Data gaps" information.
- j. Review the Emissions Report and Export the Emissions Report in various formats to meet the need of the aeroplane operator.

The following section provides additional information on each of the steps and the associated underlying methodologies and assumptions.

4.2.1 Starting to Fill the Emissions Report

If the ICAO CORSIA CERT is used to fill an Emissions Report, the user will be prompted to enter information on (1) Aeroplane operator identification and description of activities, (2) Underlying basic information of the Emissions Report, (3) Aeroplane fleet and fuel types, (4) Fuel density and (5) Level of aggregation of the information reported.

The ICAO CORSIA CERT replicates the same process and format as the ICAO Emissions Report template.

4.2.2 Loading and entering data into the ICAO CORSIA CERT

In order to estimate fill the relevant portions of the Emission Report, the ICAO CORSIA CERT will estimate CO_2 emissions and fill data gaps (as needed). The first step is to load or enter data into the ICAO CORSIA CERT. An aeroplane operator 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 aeroplane database. If needed, the user can also enter codes that are not included in the ICAO CORSIA CERT aeroplane database which become 'custom aeroplane code'. See section 4.2.3 for details on the custom aeroplane and aerodrome 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 aerodromes 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.

4.2.3 Comparison of the operations input data against the ICAO CORSIA CERT aeroplane and aerodrome databases

When loading operations data into the ICAO CORSIA CERT or calculating CO₂ emissions, the user can choose to compare the input aircraft type and aerodromes entries against the internal ICAO CORSIA CERT aeroplane and aerodromes databases. This comparison checks for consistency and returns any aircraft type code and aerodrome code that does not match the internal ICAO CORSIA CERT aeroplane and aerodromes databases. The user can then choose to enter custom aeroplane and aerodromes 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 aeroplane codes

If the user chooses to use custom aircraft type codes, he/she is prompted to select an aeroplane category

from the following list:

- a) Jet (Heavy) with certified MTOM \geq 136 000 kg;
- b) Jet with certified MTOM \geq 60 000 kg and < 136 000 kg;
- 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 aeroplane in the fleet of a given aeroplane 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 aeroplane category selected and the Average Maximum Take Off Mass (MTOM) in the aeroplane operator fleet, the ICAO CORSIA CERT derives a tailored ICAO CEM from the relevant generic equation model according to the approach described in section 3.2.6. The custom aeroplane 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 aeroplane 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 Aeroplane Code.

The following coefficients are used in the 2023 version of the ICAO CORSIA CERT to generate generic equations (as a function of entered Average MTOM) for aircraft types entered as custom aeroplane, by aircraft type category.

Aircraft Type Category	Coefficients for L Derive the Interce		Coefficients for Linear Function to Derive the <u>Slope</u> of the Generic		
	Equa	tion	Equa	ition	
Coefficients for Generic Equation based on Great C	ircle Distance (i.e., l	Fuel = slope * GCD +	intercept)		
	Intercept	Slope	Intercept	Slope	
Jet (Heavy) with certified MTOM >= 136 000 kg	-1738.323789	0.015494476	0.851400944	2.58006E-05	
Jet with certified MTOM >= 60 000 kg and < 136 000 k	102.5191681	0.011587369	1.035425787	2.94163E-05	
Jet (Heavy) with certified MTOM < 60 000 kg	186.6981954	0.014121257	0.172655568	5.10469E-05	
Turboprop	-21.96949515	0.013831192	0.33173559	4.80238E-05	
Coefficients for Generic Equation based on Block T	i me (i.e., Fuel = slop	e * Block_Time + in	tercept)		
	Intercept	Slope	Intercept	Slope	
Jet (Heavy) with certified MTOM >= 136 000 kg	4810.166517	-0.03674015	-4.778898921	0.000455796	
Jet with certified MTOM >= 60 000 kg and < 136 000 k	750.9498712	-0.01224546	4.683460687	0.000484168	
Jet (Heavy) with certified MTOM < 60 000 kg	23.53124626	0.002441058	4.135109741	0.000532874	
Turboprop	-19.78366888	0.005858582	0.723039936	0.00043942	

Figure 21: Coefficients used in the 2023 version of the ICAO CORSIA CERT to generate generic equations (as a function of entered Average MTOM) for aircraft types entered as custom aeroplane

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

Entering custom aerodrome codes

Note. – The Custom Aerodrome functionality for the " CO_2 Estimation and Reporting for 2023" functionality is identical to the Custom Aerodrome functionality for the "Summary of assessment of applicability of CORSIA and eligibility to use the ICAO CORSIA CERT in 2023". See section 4.1.4 for details.

4.3 Data entry error and plausibility of input data

The ICAO CORSIA CERT 2023 version also includes a number of functionality that allows the user to identify potential data entry errors and confirm the accuracy of the input data, including;

- **Date**; Date is an Optional Field. When importing an Input File and/or Calculating CO₂ Emissions, the ICAO CORSIA CERT checks that the year of the entered date matches the Reporting Year (as described in "2 Underlying basic information of the Emissions Report" section a) of the Emissions Report). Warning messages are displayed as "Date" in the last column (i.e., "Warnings") of the input/output table.
- ICAO Aircraft Type Designator availability; The tool will prompt the user to check the aircraft type designator against the underlying ICAO CORSIA CERT Aeroplane database and the Custom Aeroplane entered by the user. If any discrepancies are found, the user will be prompted to update/edit existing Custom Aircraft Types or enter new ones,
- Origin Aerodrome and Destination Aerodrome availability; Similar to the aircraft type input, the tool will prompt the user to check the origin and destination aerodromes against the underlying ICAO CORSIA CERT Aerodrome database and the Custom Aerodromes entered by the user. If any discrepancies are found, the user will be prompted to update/edit existing Custom Aerodromes or enter new ones.
- **"Total Number of Flights" valid input checks**; The tool will check that input values of total number of flights for flight entries are; (1) greater or equal to 0, (2) integer values (i.e., not fractions of flights). If errors are identified, a pop up message will appear and flight entries will be highlighted.
- **Type of Fuel valid input checks;** The tool will check that a correct Type of Fuels (i.e., Jet-A, Jet-A1, Jet-B, AvGas) are entered. It should be noted that the Type of Fuel selected can include equivalent fuels. If discrepancies between input data and acceptable Type of Fuels are identified, the tool will return an error message and the flight entries with errors will be highlighted.
- Great Circle Distance comparison with Aeroplane Type's Potential Max Range; For each of the flight entries for which Great Circle Distance (GCD) was computed, the tool will also compare the GCD to a Maximum Range for the associated aircraft type. If the GCD exceeds this maximum range, a warning will be return. It should be noted that this comparison and possible warning are for information only. The intent is to identify potential input errors (e.g., order of magnitude error such as 0 added to input data). The warning can also result from normal operations if longer range versions of the aeroplane are operated.
- Estimated and/or Reported Fuel comparison with Aeroplanes Maximum Fuel Tank Capacity; For each of the flight entries, the tool will identify cases where average reported and/or estimated fuel (and resulting CO₂ emissions) per flight exceed the ICAO CORSIA CERT default maximum fuel tank capacity value for that ICAO Aircraft Type and/or Custom aeroplane code. In order to avoid a possible overestimation of CO₂ emissions, the user is prompted to check the following flight entries flagged with "Fuel Cap". It should be noted that this warning message may be ignored since individual maximum fuel tank capacity and fuel tank configuration can differ from the ICAO CORSIA CERT default values (e.g., some

aeroplanes can have additional fuel tanks which could be one explanation). It should be noted that this comparison and possible warning are for information only. The intent is to identify potential input errors (e.g., order of magnitude error such as 0 added to input data).

4.4 Calculation of CO₂ emissions

4.4.1 The ICAO CORSIA CERT 2023 version builds on the 2022 version with regard to the input of aeroplane operator information, the CO_2 estimation and the generation of a summary assessment functionalities. To meet requirements from Annex 16 Volume IV Chapters 2 and 3, the CERT 2023 embeds the CORSIA Implementation Element titled as "CORSIA States for Chapter 3 State Pairs" that will be used to determine the CO_2 emissions subject to offsetting requirements in 2023. The second edition (revision 1) version (September 2021) of CORSIA Implementation Element titled as "CORSIA States for Chapter 3 State Pairs" is available on the CORSIA website6. This document includes the list of 115 States that participate in CORSIA from 1 January 2023. The CCG developed functionality to embed this list in the CERT 2023 and scripts to calculate and report CO_2 emissions subject to offsetting requirements into the Emissions Report (ER) template.

4.4.2 Generation of Emissions Report (5.1 Reporting - State Pairs and 5.2 Reporting - Aerodrome Pairs, 6 Data Gaps)

After ensuring that the entered information is complete and calculating CO_2 emissions and based on the selection in "5 Reporting" (i.e., reporting on a State pair level or reporting on an aerodrome pair level), the user can fill the portion of the Emissions Report template with statistics on number of flights, emissions, data gaps, etc.

The sections of the Emissions Report automatically and partially filled by the ICAO CORSIA CERT include:

- *a*) **5.1 Reporting at State Pair Level.** This comprises:
 - Total annual measured and/or estimated CO₂ emissions (international). It should be noted that emissions are for all international State pairs. For the 2023 version of the ICAO CORSIA CERT, this total splits 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 number of flights during the reporting period (international). It should be noted that flights are for all international State pairs. For the 2023 version of the ICAO CORSIA CERT, this total splits between State pairs with offsetting requirements and State pairs not subject to offsetting requirements (see Annex 16, Volume IV, Chapter 3 for details).
 - The user can manually enter the Total emissions reductions claimed from the use of CORSIA eligible fuels.
 - If the ICAO CORSIA CERT is used for data gap filling and actual fuel quantities (based on one of the five Fuel Use Monitoring Methods) are used, the break down will be automatically calculated by the ICAO CORSIA CERT and presented in section b).
 - The user can manually enter the details of emissions reductions claimed from the use of CORSIA eligible fuels.
 - Based on input and calculations in the "CO2 Emissions Estimation & Data Gap Filling"

⁶ Reference: ICAO document, "CORSIA States for Chapter 3 State Pairs", Version July 2022, available at: <u>https://www.icao.int/environmental-protection/CORSIA/Documents/CORSIA%20States%20for%20Chapter</u> <u>%203%20State%20Pairs 3Ed web.pdf</u>, last retrieved on August 7th, 2023.

section, the ICAO CORSIA CERT automatically generated the list of State Pairs including; State of departure, State of arrival, whether the CO_2 emissions were estimated by the ICAO CORSIA CERT, total number of flights, fuel type, total mass of fuel, fuel conversion factors, total CO_2 emissions. In the 2023 version, the ICAO CORSIA CERT indicates whether the State Pair is subject to offsetting requirements.

b) 5.2 Reporting at Aerodrome Pair Level. This comprises:

- Total annual measured and/or estimated CO₂ emissions (international). It should be noted that emissions are for all international State pairs. For the 2023 version of the ICAO CORSIA CERT, this total splits 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 number of flights during the reporting period (international). It should be noted that flights are for all international State pairs. For the 2023 version of the ICAO CORSIA CERT, this total splits between State pairs with offsetting requirements and State pairs not subject to offsetting requirements (see Annex 16, Volume IV, Chapter 3 for details).
- The user can manually enter the Total emissions reductions claimed from the use of CORSIA eligible fuels.
- If the ICAO CORSIA CERT is used for data gap filling and actual fuel quantities (based on one of the five Fuel Use Monitoring Methods) are used, the break down will be automatically calculated by the ICAO CORSIA CERT and presented in section b).
- The user can manually enter the details of emissions reductions claimed from the use of CORSIA eligible fuels.
- Based on input and calculations in the "CO₂ Emissions Estimation & Data Gap Filling" section, the ICAO CORSIA CERT automatically generates the list of Aerodrome Pairs including; ICAO aerodrome code and State for the Departure, ICAO aerodrome code and State for the Arrival, whether the CO₂ emissions were estimated by the ICAO CORSIA CERT, total number of flights, fuel type, total mass of fuel, fuel conversion factors, total CO₂ emissions. In the 2023 version, the ICAO CORSIA CERT indicates whether the Aerodrome Pair is subject to offsetting requirements.

c) 6 Data Gaps. This comprises:

Based on input and calculations in the "CO₂ Emissions Estimation & Data Gap Filling" section, the ICAO CORSIA CERT automatically assesses whether data gaps occurred during the reporting year and whether the threshold of 5 per cent for data gaps was exceeded and reports the percent of data gaps. The 2023 version of the ICAO CORSIA CERT follows the requirements from Annex 16 Volume IV, where starting in 2021, the percentage of data gaps are calculated by dividing the total number of flights subject to offsetting requirements with data gaps by total number of international flights subject to offsetting requirements.

Note. – In the 2019 and 2020 versions of the ICAO CORSIA CERT, the percentage of data gaps were calculated by dividing total number of flights with data gaps by total number of international flights.

- The user can manually enter the details on the data gaps if the 5 per cent threshold has been exceeded in the reporting year.

4.5 Exporting copies of the Emissions Report and Generation of Log of Assumptions

To support the Emissions Reporting (ER) in 2023, the aeroplane operator can use the ICAO CORSIA CERT to estimate its emissions and generate a filled version of the Emissions Report.

The ICAO CORSIA CERT can export and produce a copy of the Emissions Report in Excel Format (i.e., as a stand-alone version of the Emissions Report).

The ICAO CORSIA CERT can also generate (if needed and/or for purposes of record keeping) a time stamp pdf version of the Emissions Report. The user can save a copy for its records.

In addition, the ICAO CORSIA CERT returns a Log of Assumptions containing general information as well as the Custom aeroplane and Custom aerodrome information (if entered in the tool).

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 Log of Assumptions to its State along with the Emissions Report.

For purpose of tools interfaces (if needed), the user can export a .csv file of the data contained in " CO_2 Emissions Estimation & Data Gap Filling". Similarly, the user can export a .csv file of the data contained in "Custom aeroplane information" and "Custom aerodrome information".

5. VALIDATION AND REVIEW OF THE ICAO CO₂ ESTIMATION MODELS (CEMS)

The work on the ICAO 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 Working Group 4 (WG4). 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.

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. CO₂ 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 CO₂ emissions data gaps.

6.1 Phased development of the ICAO CORSIA CERT and expected 2024 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.

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 aeroplane that will be the focus of further and targeted data collection towards the 2024 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 ICAO CORSIA CERT functionalities or questions can be directed to CERT@icao.int

APPENDIX A-1: ICAO CO₂ Estimation Model (CEM) based on Great Circle Distance (GCD) Input in version 2023 of the ICAO CORSIA CERT

Туре	Example of Model*		CEM based on Equivalent Aircraft Type		CEM based on ICAO Fuel Formula	
Designator		Source of CEM	Source of CEM	Type Designator of Equivalent Aircraft	Source of CEM	ICAO Aircraft Code
A124	An-124 Ruslan	Yes				
A306	A-300B4-600	Yes				
A310	A-310	Yes				
A332	A-330-200	Yes				
A333	A-330-300	Yes				
A339	A-330-900	Yes				
A343	A-340-300	Yes				
A346	A-340-600	Yes				
A359	A-350-900 XWB	Yes				
A388	A-380-800	Yes				
B744	747-400 (international, wingle	Yes				
B748	747-8	Yes				
B762	767-200	Yes				
B763	767-300	Yes				
B764	767-400	Yes				
B772	777-200	Yes				
B773	777-300	Yes				
B77L	777-200LR	Yes				
B77W	777-300ER	Yes				
B788	787-8 Dreamliner	Yes				
B789	787-9 Dreamliner	Yes				
B78X	787-10 Dreamliner	Yes				
MD11	MD-11	Yes				
A20N	A-320neo	Yes				
A21N	A-321neo	Yes				
A318	A-318	Yes				
A319	A-319	Yes				
A320	A-320	Yes				
A321	A-321	Yes				
B38M	737 MAX 8	Yes				
B722	727-200	Yes				
B733	737-300	Yes				
B734	737-400	Yes				
B735	737-500	Yes				
B736	737-600	Yes				
B737	737-700	Yes				
B738	737-800	Yes				
B739	737-900	Yes				
B752	757-200	Yes				
B753	757-300	Yes				
BCS1	BD-500 CSeries CS100	Yes				
BCS3	BD-500 CSeries CS300	Yes				
E295	E195-E2	Yes				
MD82	MD-82	Yes				
MD87	MD-87	Yes				
MD88 MD90	MD-88 MD-90	Yes				
B462	BAe-146-200	Yes Yes				
B462 B463	BAe-146-200 BAe-146-300	Yes				
B463 B712	717-200	Yes				
BF4W	Hawker 400XT	Yes				
C25B	525B Citation CJ3	Yes				
C256	5256 Citation CJ3	Yes				
C550	550 Citation 2	Yes				
C56X	560XL Citation Excel	Yes				
C68A	680A Citation Latitude	Yes				
C750	750 Citation 10	Yes				
CL30	BD-100 Challenger 300	Yes				
CL35	BD-100 Challenger 350	Yes				
CL60	CL-600 Challenger 650	Yes				

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

* 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: <u>https://www.icao.int/publications/DOC8643/Pages/Search.aspx</u>

Туре	Example of Model [*]			Equivalent Aircraft ype	CEM based on I	CAO Fuel Formula
Designator		Source of CEM	Source of CEM	Type Designator of Equivalent Aircraft	Source of CEM	ICAO Aircraft Code
CRJ1	Regional Jet CRJ-100	Yes				
CRJ2	Challenger 800	Yes				
CRJ7	Challenger 870	Yes				
CRJ9	Challenger 890	Yes				
CRJX	Regional Jet CRJ-1000	Yes				
DC95	DC-9-50	Yes				
E135	ERJ-135	Yes				
E145	ERJ-145EP	Yes				
E170	ERJ-170-100	Yes				
E190	ERJ-190 Lineage 1000	Yes				
E195	ERJ-190-200	Yes				
E290	E190-E2	Yes				
E35L	EMB-135BJ Legacy	Yes				
E45X	EMB-145XR	Yes				
E55P	EMB-505 Phenom 300	Yes				
E75L	ERJ-170-200 (long wing)	Yes				
E755	ERJ-170-200 (short wing)	Yes				
F100	100	Yes				
F2TH	Falcon 2000	Yes				
F70	70	Yes				
F900	Falcon 900	Yes				
FA50 FA7X	Falcon 50 Falcon 7X	Yes Yes				
FARX	Falcon 8X	Yes				
G280	Gulfstream G280	Yes				
GA6C	G-7 Gulfstream G600	Yes				
GL5T	Global 5000	Yes				
GL7T	Global 7000	Yes				
GLEX	Global Express	Yes				
GLF4	Gulfstream 4	Yes				
GLF5	Gulfstream 5	Yes				
GLF6	Gulfstream G650	Yes				
H25B	Hawker 800	Yes				
U31	31	Yes				
LI40	40	Yes				
LI45	45	Yes				
LI60	60	Yes				
LJ75	75	Yes				
RJ85	RJ-85 Avroliner	Yes				
AN26	An-26	Yes				
AT43	ATR-42-300	Yes				
AT45 AT46	ATR-42-500 ATR-42-600	Yes Yes				
AT72	ATR-72-201	Yes				
AT75	ATR-72-500	Yes				
AT76	ATR-72-600	Yes				
B190	1900	Yes				
BE20	Super King Air (200)	Yes				
BE30	300 Super King Air	Yes				
D328	328	Yes				
DH8A	Dash 8 (100)	Yes				
DH8D	Dash 8 (400)	Yes				
F50	50 Maritime Enforcer	Yes				
SB20	2000	Yes				
SF34	SF-340	Yes				

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

* 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: <u>https://www.icao.int/publications/DOC8643/Pages/Search.aspx</u>

Туре	Example of Model*	CEM based on AO data (from COFdb)	CEM based on Equivalent Aircraft Type		data Type CEM based on Equivalent Aircraft CEM based on ICAO Fuel Form		CAO Fuel Formula
Designator	Enample of Woder	Source of CEM	Source of CEM	Type Designator of Equivalent Aircraft	Source of CEM	ICAO Aircraft Cod	
A30B	A-300B2		Yes	A306			
A338	A-330-800		Yes	A339			
A342	A-340-200		Yes	A343			
A345	A-340-500		Yes	A346			
A35K	A-350-1000 XWB		Yes	A359			
B741	747-100		Yes	B744			
B742	747-200		Yes	B744			
B743	747-300		Yes	B744			
B74R	747SR		Yes	B744			
B745	747SP		Yes	B744			
A19N	A-319neo		Yes	A20N			
B37M	737 MAX 7		Yes	B38M			
B39M	737 MAX 9		Yes	B38M			
B3XM	737 MAX 10		Yes	B38M			
MD81	MD-81		Yes	MD82			
MD83	MD-83		Yes	MD82			
B461	BAe-146-100		Yes	B462			
B732	737-200		Yes	B733			
C525	525 Citation CJ1		Yes	C550			
C55B	550B Citation Bravo		Yes	C550			
C560	560 Citation 5		Yes	C550			
FA6X	Falcon 6X		Yes	FA7X			
GA5C	Gulfstream G500 (G-7)		Yes	GA6C			
GA7C	Gulfstream G700		Yes	GLF6			
H25A	HS-125-1		Yes	H25B			
H25C	Hawker 1000		Yes	H25B			
LJ25	25		Yes	LI40			
LJ35	35		Yes	LI40			
RJ1H	RJ-100 Avroliner		Yes	B463			
RJ70	RJ-70 Avroliner		Yes	RJ85			
AN30	An-30		Yes	AN26			
AN32	An-32		Yes	AN26			
AT73	ATR-72-211		Yes	AT72			
DH8B	Dash 8 (200)		Yes	DH8D			
DH8C	Dash 8 (300)		Yes	DH8D			
DHC7	DHC-7 Dash 7		Yes	DH8D			

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

* 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: <u>https://www.icao.int/publications/DOC8643/Pages/Search.aspx</u>

Туре	Example of Model*	CEM based on AO data (from COFdb)		quivalent Aircraft /pe	CEM based on ICAO Fuel Formula		
Designator	Example of Model*	Source of CEM	Source of CEM	Type Designator of Equivalent Aircraft	Source of CEM	ICAO Aircraft Code	
DC10	DC-10				1	D10	
DC85	DC-8-50					D8T	
DC86	DC-8-60					D8L	
DC87	DC-8-70					D8Q	
IL62	11-62					IL6	
IL76	11-76					IL7	
IL86	11-86					ILW	
IL96	11-96					IL9	
L101	L-1011 TriStar					L10	
B701	707-100					70M	
B721	727-100					721	
T134 T154	Tu-134 Tu-154					TU3 TU5	
T204	Tu-204					T20	
A148	An-148					A81	
AN72	An-72					AN7	
BA11	BAC-111 One-Eleven					B11	
DC91	DC-9-10					D91	
DC92	DC-9-20					D92	
DC93	DC-9-30					D93	
DC94	DC-9-40					D94	
F28	F-28 Fellowship					F28	
FA10	Falcon 10					DF2	
J328	Dornier 328JET					FRJ	
\$601	SN-601 Corvette					NDC	
WW24	1124 Westwind					WWP	
YK40	Yak-40					YK4	
YK42 A140	Yak-42 IRAN-140 Faraz					YK2 A40	
A140 A748	748					HS7	
AN12	An-12					ANF	
AN24	An-24					AN4	
AN28	An-28					A28	
ATP	ATP					ATP	
BELF	SC-5 Belfast					SHB	
C130	L-100 Hercules					LOH	
C212	C-212 Aviocar					CS2	
CN35	CN-235					CS5	
CVLP	Convairliner					CVR	
CVLT	Cosmopolitan					CV5	
D228	Dornier 228					D28	
DC3	DC-3					DC3	
DC6	DC-6					DC6	
DHC6 E110	DHC-6 Twin Otter EMB-110 Bandeirante					DHT EMB	
E110 E120	EMB-120 Brasilia					EM2	
F27	F-27					F27	
G159	G-159 Gulfstream 1					GRS	
1114	II-114					114	
IL18	II-18					IL8	
JS31	BAe-3100 Jetstream 31					J31	
JS32	BAe-3200 Jetstream Super 31					J32	
JS41	BAe-4100 Jetstream 41					J41	
L188	Electra (L-188)					LOE	
L410	L-410 Turbolet					L4T	
N262	N-262 Frégate					ND2	
SC7 SH33	SC-7 Skyliner SD3-30					SHS SH3	
SH33 SH36	360					SH6	
51130	500					5110	

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

* 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: <u>https://www.icao.int/publications/DOC8643/Pages/Search.aspx</u>

Table format of ICAO CO₂ Estimation Models (CEMs) based on Great Circle Distance (GCD) Input in version 2023 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 ICAO CEM based on aeroplane operators data from the COFdb

A124 6.71 15.059 23.347 31.635 39.923 48.211 55.730 62.655 69.581 76.506 83.422 71.12 42.868 A306 1.527 43.99 7.271 10.144 13.016 15.888 18.760 21.622 24.940 27.376 30.246 33.126 37.464 41.056 15.75 A332 2.236 5.391 18.433 14.74 14.516 17.57 70.599 23.404 26.776 30.463 33.946 47.884 40.056 51.37 A339 1.660 4.676 10.265 1.642 1.663 25.463 29.762 33.064 36.861 40.661 44.460 48.260 56.338 65.45 A343 2.666 6.465 10.265 1.064 17.864 43.043 57.77 27.22 56.040 35.08 57.473 37.77 74.675 72.37 A348 8.887 15.811 2.773 2.944 3.404 39.01 56	24 106 110 132 133 139 143 146	6,771 2,718 1,527 2,350	15,059	1000	1500													
A360 2,718 5,868 8,484 17,322 14,909 7,075 19,925 2,729 2,561 28,729 31,96 34,264 37,132 42,864 A310 1,527 4,399 7,271 10,14 14,516 15,757 20,599 28,404 27,76 30,46 33,916 37,486 41,056 45,085 56,34 A332 2,036 6,014 9,99 13,314 16,080 17,677 16,661 56,685 36,653 36,63 28,640 31,653 34,644 41,604 44,604 48,200 56,38 45,44 A346 3,558 8,424 12,927 17,611 22,955 28,900 12,642 24,926 21,800 55,88 43,707 70,340 81,041 A3454 15,811 2,137 16,613 2,2101 12,012 14,012 88,987 12,012 14,012 14,012 14,012 14,012 14,012 14,012 14,012 14,014 14,014 14,014 14,014 14,014 14,014 14,014 14,014 14,014 14,014	106 110 132 133 139 143 1443	2,718 1,527 2,350			1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	7000	8000	9000	10000
A310 1,527 4,399 7,271 10,144 13,016 15,888 18,760 21,632 24,504 27,76 30,248 31,120 35,992 41,786 47,48 A333 2,350 5,014 8,331 1,474 14,516 17,57 20,599 23,400 6646 27,563 30,456 36,333 30,456 43,656 43,636 44,676 7,671 10,667 15,662 15,663 25,646 25,750 64,620 25,646 25,766 26,757 7,243 48,74 45,747 48,74 45,647 41,413 43,717 50,402 26,763 36,747 41,467 42,647 42,747 40,763 36,777 7,263 36,724	110 132 133 139 143 146	1,527 2,350										83,432						
A332 2,350 5,91 8,43 1,474 1,516 1,557 20,599 3,460 20,767 30,465 30,405 36,30 30,408 40,056 41,056 40,965 56,34 A339 1,680 4,676 7,671 10,667 1,662 16,658 10,656 10,651 10,661 14,661 14,664 14,667 14,674	332 333 339 443 446	2,350														17.100	53 334	
A333 Code 6.014 9.993 1.3.14 1.603 1.9.801 2.9.180 2.8.180 2.8.163 2.8.164 <th2.8.164< th=""></th2.8.164<>	333 339 143 146																53,224 62,476	69,616
A339 1,680 4,676 7,671 10,667 13,62 16,653 19,532 25,463 25,464 27,464 46,464 47,464 48,464 47,413 33,603 36,665 42,674 47,474 48,174 32,703 36,663 36,461 51,705 56,474 51,705 56,474 56,474 32,674 32,674 32,674 32,674 32,674 32,674 32,674 32,674 <	139 143 146	Z.U30														56,842	63,719	70,596
A346 3.558 6.42 12.927 17.611 22.275 26.80 31.64 46.34 41.033 45.717 50.402 53.086 59.70 70.340 81.273 A388 2.865 6.181 2.7300 82.087 35.735 64.282 71.202 36.040 39.757 64.28 71.208 85.715 64.788 73.88 84.97 75.88 73.88 84.97 75.88 84.97 75.88 84.97 75.88 84.97 75.93 84.97 95.93 B748 6.000 11.302 16.064 2.100 2.117 17.150 18.476 21.42 92.161 32.083 36.665 42.769 85.717 B764 1.164 7.861 7.802 10.721 13.028 15.050 18.476 21.442 92.263 32.428 35.414 48.634 56.66 65.16 B774 3.166 8.051 1.263 16.62 20.900 25.259 28.84 34.44 30.944 45.55 57.55 58.97 61.51 57.55 58.97 61.51 65.57	46															51,707	58,411	65,115
A359 2,865 6,182 9,500 12,817 16,135 19,452 22,70 26,087 29,405 32,722 36,040 39,37 42,675 49,776 57,23 A388 8,887 15,811 22,735 26,603 35,374 43,041 45,098 50,795 56,422 71,208 66,503 71,838 42,077 77,07 79,00 B748 6,000 11,302 16,604 21,006 27,208 32,11 37,813 43,115 48,417 53,719 59,021 64,323 69,847 42,693 42,693 37,613 36,658 42,794 48,91 B764 1,764 4,816 7,869 10,221 13,974 17,02 20,97 25,88 29,679 33,403 47,04 48,31 48,64 56,66 46,60 76,00 B772 3,142 6,933 10,721 14,975 18,050 22,057 25,88 3,044 43,704 48,214 52,446 57,446 65,406 76,40 B773 3,716 4,025 1,2351 1,4361 1,37,		2,666	6,465	10,265	14,064	17,864	21,663	25,463	29,262	33,062	36,861	40,661	44,460	48,260	56,338	65,452	74,566	82,067
A388 8.887 15.811 22.735 29.600 36.584 43.508 50.433 57.377 64.282 71.206 78.10 85.055 91.979 105.828 ###### B744 5.0101 10.001 11.601 22.310 22.000 32.511 37.131 43.115 53.715 69.429 67.86 73.53 69.477 20.901 32.693 75.53 B762 1.279 4.146 7.012 9.878 12.741 17.06 18.476 21.420 27.075 29.941 32.803 35.663 44.948 50.60 B764 1.764 4.816 7.869 10.921 13.971 17.02 20.970 23.31 43.164 39.84 34.04 39.04 43.248 52.448 44.98 66.80 76.04 66.80 76.04 76.04 55.333 40.474 48.314 52.441 17.44 34.46 39.84 34.464 39.84 34.914 48.914 66.80 76.05 55.837 76.55 55.837 76.85 55.897 76.55 55.876 76.18 76.95 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>81,207</td><td>92,073</td><td>102,939</td></td<>																81,207	92,073	102,939
B744 S,219 10,916 16,613 22,310 28,007 33,704 39,401 45,098 50,795 56,422 6,128 67,383 84,977 97,90 B748 6,000 11,302 16,604 12,90 27,208 32,511 37,813 48,115 48,417 59,021 64,323 69,847 82,693 65,33 B762 1,729 41,46 70,272 10,150 13,024 15,006 18,784 24,209 27,075 30,541 33,603 36,665 42,789 44,98 50,60 B772 31,42 6,835 12,361 16,662 20,960 22,59 28,848 43,704 48,314 44,384 48,644 43,644 B774 3,766 8,065 12,361 16,641 20,482 25,552 28,448 38,314 49,074 45,655 45,644 52,444 52,646 52,426 66,707 76,353 B778 1,344 4,320 7,275 1,8214 1,4214																57,238	64,700	72,162
B748 6,000 11.302 16,604 21,906 27,208 32,511 37,813 43,115 48,417 53,719 59,021 64,323 69,847 82,693 95,533 B763 1,515 4,393 7,272 9,8761 1,050 18,764 21,862 27,075 29,941 32,807 35,673 41,406 47,389 B764 1,764 4,816 7,869 10,921 13,974 17,026 20,979 32,418 2,203 32,288 35,341 38,393 44,498 50,60 B771 3,766 8,065 12,363 16,662 20,960 25,255 29,848 34,644 30,044 43,204 48,324 52,445 57,564 66,804 76,48 B771 3,245 7,155 1,065 14,081 20,737 21,822 31,413 42,904 45,313 44,914 50,76 56,718 57,537 22,821 31,101 34,31 43,116 40,813 43,814 40,813 43,816<																	136,960 113,443	155,352 128,982
B762 1,279 4,146 7,012 9,878 12,744 15,610 18,764 21,422 24,209 27,075 29,941 32,807 35,673 41,406 74,789 B764 1,764 4,816 7,869 10,921 13,974 17,026 12,979 31,12 26,184 29,236 32,828 36,665 42,849 46,693 65,661 65,661 65,661 65,661 65,661 65,661 65,661 65,661 65,661 65,661 65,661 65,867 66,160 76,661 76,661 76,661 76,661 76,661 76,661 76,661 76,661 76,661 76,661 76,661 76,661 76,675 76,55 76,55 76,55 76,55 76,55 76,55 76,575 76,575 76,55 76,575																95,539	108,384	121,230
B764 1,764 4,815 7,869 10,921 13,974 17,026 20,079 23,131 26,184 29,236 32,288 35,341 38,393 44,498 50,60 B772 3,766 8,065 12,233 16,662 20,960 25,259 29,844 34,044 43,044 45,215 52,046 66,804 76,04 B771 3,766 8,065 12,333 16,641 20,848 34,449 34,044 45,615 50,756 55,897 66,180 76,48 B77W 4,021 8,228 12,435 16,641 20,848 25,055 26,705 30,615 35,334 40,474 45,615 50,756 52,464 57,242 66,797 76,35 B789 1,344 4,320 7,295 10,271 13,474 16,212 12,174 28,125 31,101 34,067 37,417 44,081 0,41 D780 1,374 1,9131 1,544 18,117 19,517 14,117 15,461																47,138	52,870	
B772 3,142 6,933 10,724 14,515 18,306 22,097 25,888 29,679 33,470 37,261 41,052 44,843 48,634 56,361 65,165 B773 3,766 8,065 12,363 16,662 20,960 25,259 29,844 44,444 43,004 48,244 52,944 57,246 66,804 76,04 B774 3,245 7,155 11,065 14,975 18,885 22,795 52,625 33,469 38,131 42,904 47,665 52,444 57,242 66,797 76,335 B788 2,035 4,592 7,148 9,705 12,211 13,247 16,922 19,918 22,174 25,125 31,101 34,076 37,417 44,081 50,74 B788 1,989 4,932 7,876 10,819 13,762 16,706 12,488 39,576 44,264 48,951 53,638 88,325 67,697 7,070 A20N 817 2,213 3,481 4,724 6,553 7,397 8,741 10,085 11,429 12,773 <td< td=""><td>63</td><td>1,515</td><td>4,393</td><td>7,272</td><td>10,150</td><td>13,028</td><td>15,906</td><td>18,784</td><td>21,663</td><td>24,541</td><td>27,479</td><td>30,541</td><td>33,603</td><td>36,665</td><td>42,789</td><td>48,913</td><td>55,037</td><td>61,161</td></td<>	63	1,515	4,393	7,272	10,150	13,028	15,906	18,784	21,663	24,541	27,479	30,541	33,603	36,665	42,789	48,913	55,037	61,161
8773 3,766 8,065 12,363 16,662 20,960 25,259 29,844 34,464 39,084 43,704 48,324 52,944 57,564 66,804 76,04 B77L 3,245 7,155 11,065 14,975 18,885 22,795 26,705 30,615 35,333 40,474 45,615 50,756 55,897 66,804 76,46 B77W 4,021 8,228 12,435 16,641 20,848 25,055 29,262 33,469 38,11 42,099 47,666 52,464 57,242 66,797 76,35 B788 1,344 4,320 7,295 10,271 13,247 16,222 19,198 22,154 28,180 31,412 34,367 37,417 44,081 50,74 M011 2,000 6,767 11,454 16,112 20,828 25,515 30,202 34,889 39,576 44,264 48,951 53,638 88,322 67,697 77,07 A21N 921 2,376 6,583 8,401 0,046 11,652 12,551 14,640 18,076 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>50,603</td><td>56,708</td><td>62,813</td></t<>																50,603	56,708	62,813
B77L 3,245 7,155 11,065 14,975 18,885 22,795 26,705 30,615 35,333 40,474 45,615 50,756 55,897 66,180 76,466 B77W 4,021 8,228 12,435 16,641 20,488 20,555 29,262 33,469 38,131 42,909 47,686 52,464 57,242 66,797 76,35 B788 2,035 4,592 7,148 9,705 12,261 14,818 17,374 19,249 28,212 31,813 34,067 37,017 43,003 49,35 B788 1,989 4,932 7,876 10,819 13,742 16,706 19,649 22,593 25,516 28,480 31,423 34,367 37,417 44,081 50,74 A20N 817 2,213 3,481 4,724 6,053 7,397 8,711 10,851 14,241 14,811 14,117 15,451 16,454 18,117 19,715 23,018 A21N 921 2,376 3,832 5,258 6,657 8,575 7,373 11,545 15,557																65,168	73,975	82,782
B77W 4,021 8,228 12,435 16,641 20,848 25,055 29,262 33,469 38,131 42,909 47,686 52,464 57,242 66,797 76,355 B788 2,035 4,592 7,148 9,705 12,247 16,222 19,198 22,122 25,821 38,101 34,076 37,052 43,003 45,031 B788 1,989 4,932 7,767 10,819 13,761 16,706 19,649 25,535 28,480 31,423 34,367 37,417 4,0431 50,74 MD11 2,080 6,767 11,454 16,141 20,82 2,515 30,202 34,889 39,576 44,264 48,951 53,638 58,325 67,699 77,07 A20N 817 2,313 3,481 4,724 6,053 7,397 8,764 13,251 14,654 15,051 15,656 15,655 15,650 15,652 15,650 15,652 15,650 15,652 15,650 15,652																	85,284	94,524
B788 2,035 4,592 7,148 9,705 12,261 14,818 17,374 19,931 22,822 25,821 28,819 31,818 34,816 40,813 46,813 B789 1,344 4,320 7,295 10,271 13,247 16,222 19,198 22,174 25,149 28,125 31,101 34,076 37,052 43,003 49,353 B788 1,999 4,932 7,876 10,819 13,72 16,706 19,649 22,576 24,808 31,423 34,367 37,417 44,081 50,749 A20N 817 2,133 3,481 4,724 6,053 7,397 8,741 10,085 11,429 12,773 14,117 15,461 16,605 A21N 921 2,376 3,832 5,287 6,743 8,317 9,505 11,584 13,217 14,851 16,461 18,017 19,011 A319 810 2,469 3,912 5,324 6,858 0,656 12,525 13,556 17,456 19,041 4,369 1,481 1,418 1,4161																	86,455 85,908	94,533 95,464
B789 1,344 4,320 7,295 10,271 13,247 16,222 19,188 22,174 25,149 28,125 31,101 34,076 37,052 43,003 49,355 B788 1,989 4,932 7,876 10,819 13,762 16,706 19,649 22,593 25,556 28,480 31,423 34,367 37,417 44,081 50,74 MD11 2,080 6,767 11,454 16,141 20,828 5,515 30,202 34,89 95,756 44,264 48,951 53,638 58,325 6,7699 77,77 A20N 817 2,213 3,481 4,724 6,653 7,397 8,741 10,085 11,429 12,743 14,117 15,461 16,805 A318 1,244 2,460 3,859 5,258 6,657 8,057 9,456 10,855 12,251 13,654 15,050 16,452 17,861 14,807 18,097 3,048 14,317 19,751 23,018 4,320 1,481 14,161 10,642 15,551 17,455 19,272 1,080 2																46,810	52,807	58,804
MD11 2,080 6,767 11,454 16,141 20,828 25,515 30,202 34,89 39,576 44,264 48,951 53,638 58,325 67,699 77,07 A20N 817 2,213 3,481 4,724 6,053 7,397 8,741 10,085 11,429 12,773 14,117 15,461 16,605 A21N 921 2,376 3,832 5,287 6,767 8,057 9,456 10,555 12,254 13,654 15,053 16,452 17,851 23,018 A319 810 2,499 3,912 5,324 6,834 8,040 10,046 11,655 12,258 13,654 16,470 18,062 17,851 19,042 14,821 14,811 14,811 14,811 14,811 14,811 14,811 14,811 14,811 14,811 14,811 14,811 14,813 14,813 14,813 14,813 14,813 15,853 16,851 16,813 14,813 16,452 17,76 19,927													1.20201251			49,357	56,220	63,082
A20N 817 2,213 3,481 4,724 6,053 7,397 8,741 10,085 11,429 12,773 14,117 15,461 16,805 A21N 921 2,376 3,832 5,287 6,743 8,317 9,950 11,584 13,217 14,851 16,484 18,117 19,751 23,018 A318 1,244 2,460 3,859 5,258 6,657 8,057 9,456 10,655 12,254 13,654 16,450 18,076 19,682 A320 1,084 2,623 4,162 5,701 7,240 8,868 10,651 13,254 15,650 17,345 19,041 A321 756 3,003 4,811 6,619 8,426 10,241 13,489 15,657 17,465 19,272 21,080 22,888 B38M 656 1,970 3,284 4,598 5,975 7,373 8,770 10,168 11,565 12,963 14,645 16,198 17,726 19,252	8X	1,989	4,932	7,876	10,819	13,762	16,706	19,649	22,593	25,536	28,480	31,423	34,367	37,417	44,081	50,745	57,409	64,073
A21N 921 2,376 3,832 5,287 6,743 8,317 9,950 11,584 13,217 14,851 16,484 18,117 19,751 23,018 A318 1,244 2,460 3,859 5,258 6,657 8,057 9,456 10,855 12,254 13,654 15,053 16,452 17,851 45,657 A319 810 2,499 3,912 5,324 6,848 4,040 10,045 16,55 12,559 13,654 15,650 17,345 19,041 4,321 756 3,003 4,811 6,619 8,426 10,241 12,042 13,849 15,657 17,455 19,272 21,080 22,888 17,55 17,55 19,272 1,080 2,888 17,55 12,527 14,365 16,459 16,481 14,81 14,815 16,459 16,459 16,459 16,459 16,459 16,459 16,557 16,459 16,451 16,459 16,557 16,351 14,557 12,557 15,55	011	2,080	6,767	11,454	16,141	20,828		30,202	34,889			48,951	53,638	58,325	67,699	77,073	86,448	95,822
A318 1,244 2,460 3,859 5,258 6,657 8,057 9,456 10,855 12,254 13,654 15,053 16,452 17,851 A319 810 2,499 3,912 5,324 6,834 8,440 10,046 11,652 13,258 14,864 16,470 18,076 19,682 A320 1,084 2,623 4,162 5,701 7,240 8,868 10,563 12,259 13,954 15,650 17,455 19,041 A321 756 3,003 4,811 6,619 8,426 10,224 12,042 13,849 15,657 17,455 19,272 12,080 22,888 B38M 656 1,970 3,284 4,598 5,975 7,373 8,770 10,168 15,657 14,360 15,758 17,155 B722 1,215 4,475 7,009 9,445 11,881 14,316 16,72 19,183 13,457 14,649 16,049 19,202 2,2,55 2,558 B733 507 2,518 4,055 5,592 7,129 8,656 </td <td></td> <td>10000000</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>											10000000							
A319 810 2,499 3,912 5,324 6,834 8,440 10,046 11,652 13,258 14,864 16,470 18,076 19,682 A320 1,084 2,623 4,162 5,701 7,240 8,868 10,563 12,259 13,954 15,650 17,345 19,041 A321 756 3,003 4,811 6,619 8,426 10,234 12,042 13,849 15,657 17,455 19,041 22,888 B38M 656 1,970 3,284 4,598 5,975 7,373 8,770 10,182 21,623 24,059 26,495 28,930 B722 1,215 4,475 7,009 9,445 1,814 14,161 16,111 13,140 14,669 16,198 17,726 19,255 B733 590 2,438 3,966 5,495 7,24 8,553 10,022 11,173 14,647 16,481 16,350 17,88 19,424 22,498 25,57 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>23,018</td><td></td><td></td><td></td></td<>															23,018			
A320 1,084 2,623 4,162 5,701 7,240 8,868 10,563 12,259 13,954 15,650 17,345 19,041 A321 756 3,003 4,811 6,619 8,426 10,234 12,042 13,849 15,657 17,465 19,272 21,080 22,888 B38M 656 1,970 3,284 4,598 5,975 7,373 8,770 10,168 11,565 12,963 14,360 15,758 17,155 B722 1,215 4,475 7,009 9,445 11,881 16,752 19,181 13,400 14,669 16,198 17,726 19,255 B733 590 2,438 3,966 5,495 7,249 8,553 10,020 11,111 13,407 14,075 16,489 19,250 22,552 2,558 B736 7072 8,252 7,129 8,655 10,202 11,739 13,276 14,813 16,350 17,887 19,442 22,498 25,57 B736 10,202 2,276 3,522 4,789 6,318 7,																		
A321 756 3,003 4,811 6,619 8,426 10,234 12,042 13,849 15,657 17,465 19,272 21,080 22,888 B38M 656 1,970 3,284 4,598 5,975 7,373 8,770 10,168 11,555 12,963 12,405 26,405 28,930 17,726 19,252 19,255 19,252 28,930 19,252 29,393 19,252 28,930 19,252 25,58 19,252 25,58 19,252 25,52 25,58 13,457 10,465 11,411 13,457 14,973 16,489 19,205 22,552 25,58 25,57 7,373 8,910 10,426 11,911 13,457 14,973 16,489 19,502 22,552 2,558 6735 7,85 2,518 4,055 5,592 7,129 8,655 10,202 11,739 13,475 14,813 16,350 17,887 19,424 22,498 25,57 8736 10,292 2,2,75 3,522 4,789														19,002				
B38M 656 1,970 3,284 4,598 5,975 7,373 8,770 10,168 11,555 12,963 14,360 15,758 17,155 B722 1,215 4,475 7,009 9,445 11,881 14,316 16,752 19,188 21,623 24,059 26,495 28,930 19,255 B733 590 2,438 3,966 5,495 7,224 8,553 10,082 11,011 13,407 16,469 16,198 17,726 19,255 B734 907 2,557 4,225 5,878 7,34 8,910 10,426 11,914 13,457 16,493 16,481 16,350 17,871 19,520 2,2,52 2,588 B735 7,85 2,518 4,055 5,592 7,129 8,655 10,202 11,731 13,475 14,813 16,350 17,872 19,634 19,633 B736 1,029 2,276 3,522 4,789 6,518 7,715 9,237 10,604														22,888				
B733 590 2,438 3,966 5,495 7,024 8,553 10,082 11,611 13,140 14,669 16,198 17,726 19,255 B734 907 2,567 4,226 5,878 7,394 8,910 10,426 11,911 13,477 14,873 16,489 18,004 19,520 22,552 25,58 B735 785 2,518 4,055 5,592 7,129 8,665 10,202 11,739 13,276 14,813 16,350 17,887 19,424 22,498 25,57 B736 10,29 2,276 3,522 4,789 6,312 7,415 9,231 10,610 12,082 14,235 15,585 19,923 14,933 14,515 16,350 17,72 19,633 17,72 19,633 16,77 19,633 16,75 14,927 16,350 17,72 19,633 14,927 16,350 17,72 19,633 14,927 14,933 14,933 16,350 17,72 19,633 14,927 <t< td=""><td>8M</td><td>656</td><td></td><td></td><td></td><td></td><td></td><td></td><td>10,168</td><td>11,565</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	8M	656							10,168	11,565								
B734 907 2,567 4,226 5,878 7,394 8,910 10,426 11,941 13,457 14,973 16,489 18,004 19,520 22,552 25,588 B735 785 2,518 4,055 5,592 7,129 8,665 10,202 11,739 13,276 14,813 16,350 17,887 19,424 22,498 25,57 B736 10,202 2,276 3,522 4,789 6,138 7,488 8,837 10,167 12,086 14,235 15,585 16,941 19,633 B737 614 2,138 3,555 4,972 6,392 7,815 9,237 10,606 12,082 13,050 14,927 16,350 17,777 14,613 B738 615 2,327 3,909 5,491 7,074 8,656 10,201 11,654 13,071 14,515 16,014 17,467 B739 1,134 2,822 4,511 6,199 7,888 9,576 11,265 15,593	22	1,215	4,475	7,009	9,445	11,881	14,316	16,752	19,188	21,623	24,059	26,495	28,930					
B735 785 2,518 4,055 5,592 7,129 8,665 10,202 11,739 13,276 14,813 16,350 17,887 19,424 22,498 25,57 B736 1,029 2,276 3,522 4,789 6,138 7,488 8,837 10,187 11,536 12,886 14,225 15,585 16,934 19,633 B737 614 2,138 3,555 4,972 6,392 7,815 9,237 10,604 12,002 13,505 14,927 16,350 17,772 16,350 17,772 B738 615 2,327 3,090 5,491 7,074 8,656 10,201 11,651 16,014 17,477 18,019 7,888 9,576 11,265 13,007 14,621 16,310 18,019 7,815 2,918 1,174 1,819 2,424 2,438 3,111 B752 1,533 3,670 5,747 7,824 9,831 1,175 13,611 16,044 18,049 2,9,542																		107032533
B736 1,029 2,276 3,522 4,789 6,138 7,488 8,837 10,187 11,536 12,886 14,235 15,585 16,934 19,633 B737 614 2,138 3,555 4,972 6,392 7,815 9,237 10,660 12,082 13,505 14,927 16,350 17,772 B738 615 2,327 3,090 5,491 7,074 8,656 10,201 11,654 13,107 14,561 16,014 17,472 B739 1,134 2,822 4,511 6,199 7,888 9,576 11,265 12,953 14,642 16,330 18,019 B752 1,593 3,670 5,747 7,824 9,833 11,773 13,713 15,654 17,594 19,534 21,474 23,415 25,355 29,236 33,11 B753 1,379 3,823 6,268 8,712 11,157 13,601 16,046 18,490 2,0379 25,824 28,268 30,713																25,583	28,615	31,646
B737 614 2,138 3,555 4,972 6,392 7,815 9,237 10,660 12,082 13,505 14,927 16,350 17,772 B738 615 2,327 3,909 5,491 7,074 8,656 10,201 11,654 13,107 14,561 16,014 17,472 B739 1,134 2,822 4,511 6,199 7,888 9,576 11,265 12,953 14,642 16,330 18,019 B752 1,593 3,670 5,747 7,824 9,831 11,773 13,713 15,654 17,94 19,534 21,474 23,415 25,355 29,236 33,11 B753 1,379 3,823 6,268 8,712 11,157 13,601 16,046 18,490 20,379 25,842 28,268 30,713 35,602 40,498 BC51 498 2,017 3,127 4,238 5,448 6,459 7,569 5 5 408 3,071 3,5602 40,49																25,5/1	28,645	
B738 615 2,327 3,909 5,491 7,074 8,656 10,201 11,654 13,107 14,561 16,014 17,467 B739 1,134 2,822 4,511 6,199 7,888 9,576 11,265 12,953 14,642 16,330 18,019 B752 1,593 3,670 5,747 7,824 9,833 11,773 13,713 15,654 17,594 19,534 21,474 23,415 25,355 29,236 3,111 B753 1,379 3,823 6,268 8,712 11,157 13,601 16,046 18,649 20,379 25,824 28,268 30,713 35,602 40,49 BC51 498 2,017 3,128 5,348 6,459 7,569 - </td <td></td> <td>19,035</td> <td></td> <td></td> <td></td>															19,035			
B739 1,134 2,822 4,511 6,199 7,888 9,576 11,265 12,953 14,642 16,330 18,019 B752 1,593 3,670 5,747 7,824 9,833 11,773 13,713 15,654 17,594 19,534 21,474 23,415 25,355 29,236 31,11 B753 1,379 3,823 6,668 8,712 11,071 16,040 16,040 20,935 23,739 25,824 28,268 30,713 35,602 40,49 BC51 498 2,017 3,226 4,349 5,702 6,906 8,109 9,312 10,515 5 5 5 5,762 2,933 3,826 4,826 5,828 6,831 7,833 8,835 9,837 5 5 5 5 5 5,824 4,826 5 5 6,831 7,833 8,835 9,837 5 5 5 5 5 5 5 5 5 5 5 <td></td>																		
B753 1,379 3,823 6,268 8,712 11,157 13,601 16,045 18,490 20,935 23,379 25,824 28,268 30,713 35,602 40,49 BCS1 498 2,017 3,127 4,238 5,348 6,459 7,569 -<	39	1,134	2,822	4,511	6,199	7,888	9,576	11,265	12,953	14,642	16,330							
BCS1 498 2,017 3,127 4,238 5,348 6,459 7,569 BCS3 576 2,093 3,296 4,499 5,702 6,906 8,109 9,312 10,515 E295 540 1,819 2,822 3,824 4,826 5,828 6,831 7,833 8,835 9,837	52	1,593	3,670	5,747	7,824	9,833	11,773	13,713	15,654	17,594	19,534	21,474	23,415	25,355	29,236	33,116		
BCS3 576 2,093 3,296 4,499 5,702 6,906 8,109 9,312 10,515 E295 540 1,819 2,822 3,824 4,826 5,828 6,831 7,833 8,835 9,837									18,490	20,935	23,379	25,824	28,268	30,713	35,602	40,491		
E295 540 1,819 2,822 3,824 4,826 5,828 6,831 7,833 8,835 9,837																		
											0.827							
MD82 820 2,867 4,915 6,962 9,010 11,057 13,105 15,152 17,200 19,247			2,867	4,915	6,962	9,010	11,057	13,105	15,152	17,200	19,247							
MD87 1.691 3.154 4.616 6.079 7.720 9.517 11.315 13.112 14.910 16.707 18.505 20.302 22.100												18,505	20,302	22,100				
MD88 1,739 3,680 5,622 7,563 9,807 12,200 14,594 16,987	088	1,739	3,680	5,622	7,563	9,807	12,200	14,594	16,987									
MD90 703 3,105 5,099 6,858 8,616 10,375 12,134 13,892	090	703	3,105	5,099	6,858	8,616	10,375	12,134	13,892									
8462 750 2,396 4,043 5,690 7,336 8,983																		
B463 667 2,543 4,420 6,296 8,172 10,048								10 000										
B712 705 2,368 4,030 5,693 7,356 9,018 10,681 12,344 BE4W 159 512 780 1,047 1,315 1,582 1,850 2,118 2,385										2 295								
C25B 107 562 824 1,086 1,348 1,610 1,872									2,110	2,303								
C25C 171 615 929 1,243 1,557 1,871 2,185 2,499 2,813									2,499	2,813								
C550 199 702 1,039 1,376 1,713 2,050 2,386 2,723																		
C56X 224 767 1,110 1,453 1,796 2,139 2,482 2,825	6X	224	767	1,110	1,453	1,796	2,139	2,482	2,825									
C68A 309 981 1,438 1,870 2,302 2,734 3,167 3,599 4,031 4,463 4,895 5,327 5,759																		
C750 382 952 1,522 2,092 2,662 3,231 3,801 4,371 4,941 5,510 6,080 6,650 7,220	50													7,220				
Cl30 264 1,025 1,566 2,107 2,648 3,122 3,552 3,982 4,412 4,842 5,272 5,702																		
CL35 305 1,028 1,473 1,918 2,398 2,891 3,384 3,877 4,370 4,863 5,356 5,849 CL60 338 1,077 1,658 2,239 2,850 3,488 4,126 4,764 5,402 6,040 6,678 7,316 7,954 9,230	30	505												7 054	0.320			

							Fuel (in	kg) for gi	ven Great	t Circle Di	stance (in	km)					
Type Designator		500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	7000	8000	9000	10000
CRJ1	454	1,223	1,981	2,653	3,325	3,997	4,669	5,341	6,013	6,685	7,357	8,029	8,701				
CRJ2	380	1,230	2,023	2,737	3,450	4,164	4,877	5,591	6,304	7,018	7,731	8,445	9,158				
CRJ7	501	1,665	2,655	3,646	4,636	5,627											
CRJ9	579	1,773	2,778	3,759	4,740	5,720											
CRJX	566	1,847	2,926	4,004	5,082												
DC95	1,684	3,675	5,666	7,657													
E135	247	1,337	2,104	2,820	3,535	4,251	4,966	5,682	6,397								
E145	317	1,275	1,941	2,604	3,266	3,929	4,591	5,254	5,916								
E170	495	1,773	2,734	3,939	5,145	6,350	7,556	0.650	10.050	13 363	13564	14955	10 107	10 770	34 374		
E190 E195	720 572	2,107 2,152	3,332 3,468	4,507	5,753 6,101	7,055	8,357 8,733	9,659 10,049	10,960 11,365	12,262 12,681	13,564	14,865 15,313	16,167	18,770	21,374		
E195 E290		1,791	2,715	4,784 3,638	4,561	5,485	6,408	7,332	8,255	9,178	13,997 10,102	15,313	16,630	19,262	21,894		
E35L	562 342	1,238	1,899	2,559	3,220	3,880	4,541	5,201	5,862	6,522	7,183	7 9 4 2	8,504	9,825			
E45X	327	1,392	2,196	2,999	3,752	4,463	5,175	5,886	5,002	0,522	7,105	7,843	0,004	9,023			
E55P	211	671	944	1,210	1,476	1,741	2,007	2,273									
E75L	551	1,569	2,566	3,521	4,475	5,430	6,385	4413									
E755	671	1,951	3,072	4,165	5,258	6,351	7,444	8,537	9,630								
F100	713	2,268	3,571	4,868	6,165	7,462	8,759	10,056	11,353								
F2TH	320	1,044	1,559	2,074	2,588	3,103	3,618	4,133	4,648	5,162	5,677	6,192	6,707	7,736			
F70	640	1,957	3,126	4,296	5,466	6,635	7,805										
F900	176	1,042	1,643	2,244	2,845	3,446	4,047	4,648	5,249	5,850	6,451	7,052	7,653	8,855	10,057		
FASO	337	1,084	1,696	2,189	2,682	3,175	3,668	4,161	4,654	5,147	5,640	6,133	6,626	1000			
FA7X	359	1,310	1,970	2,630	3,291	3,951	4,611	5,272	5,932	6,593	7,253	7,913	8,574	9,895	11,215	12,536	13,857
FA8X	396	1,245	1,959	2,674	3,389	4,103	4,818	5,532	6,247	6,962	7,676	8,391	9,106	10,535	11,964	13,393	14,823
G280	260	848	1,311	1,775	2,238	2,702	3,165	3,629	4,092	4,556	5,019	5,483	5,946				
GA6C	264	1,448	2,282	3,116	3,950	4,785	5,619	6,453	7,287	8,121	8,956	9,790	10,624	12,293	13,961	15,629	17,298
GLST	697	1,816	2,678	3,539	4,401	5,262	6,124	6,985	7,847	8,708	9,570	10,431	11,292	13,015	14,738	16,461	
GL7T	759	1,588	2,416	3,245	4,073	4,902	5,730	6,559	7,387	8,216	9,044	9,873	10,701	12,358	14,015	15,672	17,329
GLEX	636	1,768	2,640	3,513	4,385	5,257	6,130	7,002	7,874	8,747	9,619	10,491	11,364	13,109	14,853	16,598	18,343
GLF4	542	1,830	2,543	3,257	4,090	4,928	5,767	6,605	7,444	8,282	9,121	9,959	10,798	12,475			
GLF5	716	1,688	2,501	3,313	4,125	4,937	5,749	6,561	7,374	8,186	8,998	9,810	10,622	12,155	13,647	15,138	16,629
GLF6	557	1,753	2,568	3,383	4,198	5,013	5,828	6,643	7,458	8,273	9,088	9,903	10,718	12,348	13,978	15,608	17,238
H25B	236	802	1,234	1,665	2,097	2,528	2,960	3,391	3,823	4,254							
U31	132	554	895	1,209	1,415	1,621											
LI40	129	604	997	1,391	1,784	2,177	2,570										
LJ45	72	651	981	1,311	1,640	1,970	2,300	2,630	2,960	100001							
LI60	210	635	1,016	1,397	1,778	2,159	2,539	2,920	3,301	3,682	4,063						
LJ75	123	588	909	1,230	1,551	1,872	2,193	2,514									
RJ85	911	2,487	4,063	5,639	7,215	8,791	10,367	11,943									
AN26 AT43	458	1,696	2,924	3,699	4,474 2,383	5,250	2 402	4.047	4.602	5 457	5 744						
A143 AT45	118 75	719 836	1,274	1,829		2,938 3,108	3,493 3,677	4,047	4,602	5,157	5,711						
AT45	138	865	1,404	1,972	2,540	5,108	3,077										
AT72	54	866	1,489	2,112	2,735												
AT75	154	890	1,489	2,251	2,733												
AT76	179	923	1,622	4,6.34													
B190	96	446	796	1,146	1,496	1,845											
BE20	125	407	690	972	1,450	1,537	1,820	2,102									
BE30	78	407	736	1,056	1,226	1,396	1,566	1,736	1,906								
D328	141	674	1,208	1,741		21020	4000	4, 50	4,000								
DH8A	96	841	1,586	2,332	3,077												
DH8D	307	1,176	2,013	2,850	3,686												
F50	108	865	1,486	2,107	2,727	3,348	3,969	4,590	5,211	5,832	6,453	7,074	7,695				
SB20	387	1,005	1,623	2,241	2,859	3,477	0017070				10000000	10.005/5/	0.0000000				
SF34	149	617	1,085	1,553	2,021	2,489											

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

							Fuel (in	kg) for gi	ven Great	Circle Di	itance (in	km)					
Type Designator		500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	7000	8000	9000	10000
A30B	2,634	5,414	8,193	10,972	13,751	16,530	19,309	22,088	24,867	27,647	30,426	33,205	35,984	41,542	47,100		
A338	1,663	4,629	7,595	10,561	13,527	16,492	19,458	22,424	25,390	28,356	31,321	34,601	37,920	44,557	51,195	57,833	64,470
A342	2,527	6,128	9,730	13,332	16,933	20,535	24,137	27,738	31,340	34,942	38,543	42,145	45,747	53,405	62,044	70,683	77,794
A345	3,580	8,293	13,007	17,720	22,434	27,148	31,861	36,575	41,288	46,002	50,715	55,429	60,142	70,778	81,712	92,646	103,580
A35K	3,305	7,133	10,960	14,788	18,615	22,443	26,271	30,098	33,926	37,754	41,581	45,409	49,236	57,429	66,038	74,648	83,257
B741	4,465	9,338	14,212	19,085	23,958	28,832	33,705	38,579	43,452	48,325	53,199	58,072	62,946	72,692	83,751		
B742	4,937	10,326	15,715	21,104	26,493	31,881	37,270	42,659	48,048	53,437	58,826	64,215	69,604	80,381	92,609	107,308	122,007
B743	4,959	10,372	15,784	21,197	26,610	32,022	37,435	42,848	48,261	53,673	59,086	64,499	69,911	80,737	93,019	107,782	122,546
B74R	4,273	8,937	13,600	18,264	22,928	27,592	32,256	36,919	41,583	46,247	50,911	55,575	60,239	69,566	80,149	92,870	105,591
B745	4,145	8,669	13,192	17,716	22,240	26,764	31,288	35,812	40,336	44,860	49,384	53,908	58,432	67,480	77,745	90,084	102,424
A19N	814	2,206	3,469	4,708	6,032	7,371	8,711	10,050	11,389	12,728	14,068	15,407	16,746				
B37M	620	1,864	3,107	4,350	5,653	6,975	8,297	9,620	10,942	12,264	13,586	14,908	16,230	18,875			
B39M	711	2,136	3,560	4,985	6,479	7,994	9,509	11,024	12,540	14,055	15,570	17,085	18,601				
B3XM	694	2,084	3,474	4,863	6,321	7,799	9,277	10,755	12,234	13,712	15,190	16,668	18,147				
MD81	792	2,771	4,749	6,728	8,706	10,685	12,664	14,642	16,621	18,599	20,578						
MD83	902	3,155	5,409	7,662	9,915	12,168	14,421	16,674	18,927	21,181	23,434	25,687	27,940	32,446			
B461	676	2,160	3,645	5,129													
B732	522	2,157	3,510	4,863	6,216	7,569	8,922	10,275	11,628	12,981	14,334						
C525	157	552	816	1,081	1,346	1,610											
C558	216	759	1,123	1,488	1,852	2,216	2,580	2,945									
C560	235	828	1,225	1,623	2,020	2,417	2,815	3,212									
FA6X	380	1,387	2,086	2,785	3,485	4,184	4,883	5,583	6,282	6,981	7,681	8,380	9,080	10,478	11,877	13,276	14,674
GA5C	223	1,225	1,932	2,638	3,344	4,050	4,756	5,462	6,169	6,875	7,581	8,287	8,993	10,406	11,818	13,230	
GA7C	625	1,968	2,884	3,799	4,714	5,630	6,545	7,461	8,376	9,291	10,207	11,122	12,037	13,868	15,699	17,530	19,360
H25A	219	744	1,144	1,544	1,944	2,344	2,744	3,145	3,545	3,945	4,345						
H25C	263	894	1,374	1,855	2,335	2,816											
LJ25	92	432	714	995	1,276	1,557	1,839										
LJ35	113	527	871	1,214	1,557	1,900	2,243	2,586	2,930	3,273							
RJ1H	690	2,631	4,571	6,512	8,453	10,393	12,334	14,274	16,215								
RJ70	899	2,455	4,011	5,566	7,122	en instant 55		1.5910012	0000000000								
AN30	439	1,625	2,802	3,545	4,288	5,031											
AN32	515	1,908	3,289	4,161	5,034	5,906	6,778										
AT73	54	867	1,491	2,115	2,739												
DH8B	174	665	1,138	1,611	000												
DH8C	205	784	1,342	1,900	2,458												
DHC7	213	816	1,396	1417.70													

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

							Fuel (in	kg) for gi	ven Great	Circle Di	stance (in	km)					
Type Designator		500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	7000	8000	9000	10000
DC10	3,297	7,887	12,476	17,066	21,655	26,245	31,309	36,660	42,010	47,361	52,711	58,062	63,412	74,113	85,021	199.50-05	
DC85	3,118	6,126	9,135	12,143	15,152	18,160	21,169	24,177	27,186	30,194	33,203	36,211	39,220	45,237	51,254	57,271	
DC86	3,118	6,126	9,135	12,143	15,152	18,160	21,169	24,177	27,186	30,194	33,203	36,211	39,220	45,237	51,254	57,271	
DC87	3,118	6,126	9,135	12,143	15,152	18,160	21,169	24,177	27,186	30,194	33,203	36,211	39,220	45,237	51,254	57,271	
IL62	2,656	6,827	10,997	15,168	19,338	23,509	27,679	31,850	36,020	40,191	44,361	48,532	52,702	61,043	69,384		
IL76	7,415	11,716	16,018	20,749	25,845	30,941	36,037	41,133	46,229	51,325							
11.86	7,365	12,963	18,561	24,159	29,757	35,427	41,154	46,882	52,609	58,337	50.093	EA 943	50.602	60.124	70 646	00 166	07.40
IL96	2,477	7,237	11,998	16,758 17,482	21,519 22,399	26,279	31,040	35,800	40,561	45,321	50,082	54,842	59,603	69,124	78,645 85,970	88,166	97,492
L101 B701	2,733	7,649 6,027	12,566 9,421	12,816	16,210	27,315 19,605	32,232 22,999	37,148 26,394	42,065 29,594	46,981	51,898 35,766	57,340 38,852	63,066	74,518 48,110		97,422	108,874
B701 B721	1,520	3,586	5,651	7,717	9,782	11,848	13,788	15,716	17,644	32,680 19,572	35,700	30,032	41,938	40,110	54,282	60,454	
T134	2,065	3,584	5,104	6,623	8,142	9,662	11,181	12,701	17,044	19,572							
T154	2,805	5,809	8,813	11,817	14,821	17,825	20,734	23,594	26,453	29,313	32,172						
T204	2,801	5,806	8,812	11,817	14,823	17,828	20,734	23,594	26,453	29,313	32,172	35,032	37,891				
A148	783	1,732	2,681	3,630	4,579	5,528	6,477	7,427	20,155	20,020	54,474	33,032	51,051				
AN72	783	1,732	2,681	3,630	4,579	5,528	6,477	7,427	8,376								
BA11	558	2,209	3,861	5,512	7,164	8,815	10,467	12,118	13,770	15,421							
DC91	685	2,234	3,784	5,333													
DC92	693	2,262	3,830	5,399	6,967	8,536											
DC93	741	2,418	4,095	5,772	7,449	9,126	10,803	12,480	14,157	15,834	17,511						
DC94	796	2,596	4,397	6,197	7,998	9,798	11,599										
F28	419	2,221	3,404	4,588	5,771	6,955	8,138	9,322	10,505								
FA10	159	844	1,293	1,743	2,192	2,642	3,091										
J328	183	968	1,484	2,000													
S601	184	407	630	853	1,076	1,299											
WW24	122	646	990	1,334	1,678	2,022	2,366	2,710	3,054								
YK40	171	906	1,389	1,872													
YK42	703	3,514	5,076	6,638	8,200	9,762	11,324	12,886	14,448								
A140	314	963	1,612	2,261	2,909	3,558	4,207										
A748	321	982	1,644	2,306													
AN12	1,262	3,335	5,408	7,482	9,555	11,629	13,702	15,776	17,849	19,923	21,996	24,069					
AN24	433	1,135	1,837	2,539	3,241												
AN28	157	482	806			100000											
ATP	282	865	1,447	2,029	2,612	3,194	3,777	4,359	4,942					27 626	15 700		
BELF	397	3,910	6,502	9,094	11,686	14,278	16,870	19,462	22,054	24,646	27,238	29,830	32,422	37,606	42,790		
C130	869	2,664	4,459	6,254	8,049	9,844	11,639	13,434									
C212	138 210	423	707	992	1,940	7 272	2 805	2 227	2 670								
CN35 CVLP	20	642 1,294	1,075	1,507	1,940	2,372	2,805	3,237	3,670								
CVLF	20	1,294	1,856	2,418	2,980	3,542	4,104	4,666									
D228	115	353	590	828	1,065	1,303	4,104	4,000									
DC3	6	397	569	742	914	2,505											
DC6	22	1,412	2,026	2,639	3,253	3,866	4,480	5,093	5,707	6,320	6,934	7,547	8,161	9,388			
DHC6	26	366	608	2,000		-,	1,100	-10-23			-1004			-,000			
E110	35	342	569	796													
E120	169	539	909	1,279													
F27	48	1,048	1,743	2,438	3,133	3,828	4,523	5,218	5,913	6,608							
G159	90	977	1,625	2,273	2,921	3,569	4,217	4,865	5,513								
1114	113	1,195	1,987														
IL18	890	2,729	4,567	6,405	8,243	10,082	11,920										
JS31	120	369	618														
JS32	129	394	659														
JS41	177	544	910	1,276	1,642	2,008	2,375	2,741									
L188	287	3,149	5,236	7,324	9,411	11,499	13,586	15,674									
L410	49	434	722	1,010													
N262	132	404	677														
SC7	87	267	448														
SH33	166	508	850	1,193													
SH36	177	544	910	1,276													

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

APPENDIX A-2: ICAO CO₂ Estimation Model (CEM) based on Block Time (BT) Input in version 2023 of the ICAO CORSIA CERT

Туре		CEM based on AO data (from COFdb)		quivalent Aircraft ype	CEM based on I	CAO Fuel Formula
Designator	Example of Model*	Source of CEM	Source of CEM	Type Designator of Equivalent Aircraft	Source of CEM	ICAO Aircraft Code
A124	An-124 Ruslan	Yes				
A306	A-300B4-600	Yes				
A310	A-310	Yes				
A332	A-330-200	Yes				
A333	A-330-300	Yes				
A339	A-330-900	Yes				
A343	A-340-300	Yes				
A346 A359	A-340-600 A-350-900 XWB	Yes Yes				
A388	A-380-800	Yes				
B744	747-400 (international, wingle	Yes				
B744	747-8	Yes				
B762	767-200	Yes				
B763	767-300	Yes				
B764	767-400	Yes				
B772	777-200	Yes				
B773	777-300	Yes				
B77L	777-200LR	Yes				
B77W	777-300ER	Yes				
B788	787-8 Dreamliner	Yes				
B789	787-9 Dreamliner	Yes				
B78X	787-10 Dreamliner	Yes				
MD11	MD-11	Yes				
A20N	A-320neo	Yes				
A21N	A-321neo	Yes				
A318	A-318	Yes				
A319	A-319	Yes				
A320	A-320	Yes				
A321	A-321	Yes				
B38M	737 MAX 8	Yes				
B722	727-200	Yes				
B733	737-300	Yes				
B734	737-400	Yes				
B735	737-500	Yes				
B736	737-600	Yes				
B737	737-700	Yes				
B738 B739	737-800 737-900	Yes				
B752	757-200	Yes Yes				
B753	757-300	Yes				
BCS1	BD-500 CSeries CS100	Yes				
BCS1 BCS3	BD-500 CSeries CS100 BD-500 CSeries CS300	Yes				
E295	E195-E2	Yes				
MD82	MD-82	Yes				
MD87	MD-87	Yes				
MD88	MD-88	Yes				
MD90	MD-90	Yes				
B462	BAe-146-200	Yes				
B463	BAe-146-300	Yes				
B712	717-200	Yes				
BE4W	Hawker 400XT	Yes				
C25B	525B Citation CJ3	Yes				
C25C	525C Citation CJ4	Yes				
C550	550 Citation 2	Yes				
C56X	560XL Citation Excel	Yes				
C68A	680A Citation Latitude	Yes				
C750	750 Citation 10	Yes				
CL30	BD-100 Challenger 300	Yes				
CL35	BD-100 Challenger 350	Yes				
CL60	CL-600 Challenger 650	Yes				

Table A-2.1.a. Aircraft types (by ICAO type designator) modelled with ICAO CEM based on aeroplane operator data from the COFdb

* 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: <u>https://www.icao.int/publications/DOC8643/Pages/Search.aspx</u>

Туре		CEM based on AO data (from COFdb)		quivalent Aircraft /pe	CEM based on I	CAO Fuel Formula
Designator	Example of Model*	Source of CEM	Source of CEM	Type Designator of Equivalent Aircraft	Source of CEM	ICAO Aircraft Code
CRJ1	Regional Jet CRJ-100	Yes				
CRJ2	Challenger 800	Yes				
CRJ7	Challenger 870	Yes				
CRJ9	Challenger 890	Yes				
CRJX	Regional Jet CRJ-1000	Yes				
DC95	DC-9-50	Yes				
E135	ERJ-135	Yes				
E145	ERJ-145EP	Yes				
E170	ERJ-170-100	Yes				
E190	ERJ-190 Lineage 1000	Yes				
E195	ERJ-190-200	Yes				
E290	E190-E2	Yes				
E35L	EMB-135BJ Legacy	Yes				
E45X	EMB-145XR	Yes				
E55P	EMB-505 Phenom 300	Yes				
E75L	ERJ-170-200 (long wing)	Yes				
E755	ERJ-170-200 (short wing)	Yes				
F100	100	Yes				
F2TH	Falcon 2000	Yes				
F70	70	Yes				
F900	Falcon 900	Yes				
FA50	Falcon 50	Yes				
FA7X	Falcon 7X	Yes				
FA8X	Falcon 8X	Yes				
G280	Gulfstream G280	Yes				
GA6C	G-7 Gulfstream G600	Yes				
GL5T	Global 5000	Yes				
GL7T	Global 7000	Yes				
GLEX	Global Express	Yes				
GLF4	Gulfstream 4	Yes				
GLF5	Gulfstream 5	Yes				
GLF6	Gulfstream G650	Yes				
H25B	Hawker 800	Yes				
LJ31	31	Yes				
LJ40	40	Yes				
LJ45	45	Yes				
LI60	60	Yes				
LJ75	75	Yes				
RJ85	RJ-85 Avroliner	Yes				
AN26	An-26	Yes				
AT43	ATR-42-300	Yes				
AT45	ATR-42-500	Yes				
AT46	ATR-42-600	Yes				
AT72	ATR-72-201	Yes				
AT75	ATR-72-500	Yes				
AT76	ATR-72-600	Yes				
B190	1900	Yes				
BE20	Super King Air (200)	Yes				
BE30	300 Super King Air	Yes				
D328	328	Yes				
DH8A	Dash 8 (100)	Yes				
DH8A	Dash 8 (400)	Yes				
	50 Maritime Enforcer	10.0202				
F50 SB20	2000	Yes Yes				
	SF-340	0.640				
SF34	31-340	Yes				

Table A-2.1.a (cont.). Aircraft types (by ICAO type designator) modelled with ICAO CEM based onaeroplane operator data from the COFdb

* 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: <u>https://www.icao.int/publications/DOC8643/Pages/Search.aspx</u>

Түре	Example of Model*	CEM based on AO data (from COFdb)		quivalent Aircraft ype	CEM based on I	CAO Fuel Formula
Designator		Source of CEM	Source of CEM	Type Designator of Equivalent Aircraft	Source of CEM	ICAO Aircraft Code
A30B	A-300B2		Yes	A306		
A338	A-330-800		Yes	A339		
A342	A-340-200		Yes	A343		
A345	A-340-500		Yes	A346		
A35K	A-350-1000 XWB		Yes	A359		
B741	747-100		Yes	B744		
B742	747-200		Yes	B744		
B743	747-300		Yes	B744		
B74 R	747SR		Yes	B744		
B74S	747SP		Yes	B744		
A19N	A-319neo		Yes	A20N		
B37M	737 MAX 7		Yes	B38M		
B39M	737 MAX 9		Yes	B38M		
B3XM	737 MAX 10		Yes	B38M		
MD81	MD-81		Yes	MD82		
MD83	MD-83		Yes	MD82		
B461	BAe-146-100		Yes	B462		
B732	737-200		Yes	B733		
C525	525 Citation CJ1		Yes	C550		
C55B	550B Citation Bravo		Yes	C550		
C560	560 Citation 5		Yes	C550		
FA6X	Falcon 6X		Yes	FA7X		
GA5C	Gulfstream G500 (G-7)		Yes	GA6C		
GA7C	Gulfstream G700		Yes	GLF6		
H25A	HS-125-1		Yes	H25B		
H25C	Hawker 1000		Yes	H25B		
LJ25	25		Yes	LI40		
LJ35	35		Yes	LI40		
LJ55	55		Yes	LI45		
LJ70	70		Yes	LJ45		
RJ1H	RJ-100 Avroliner		Yes	B463		
RJ70	RJ-70 Avroliner		Yes	RJ85		
AN30	An-30		Yes	AN26		
AN32	An-32		Yes	AN26		
AT73	ATR-72-211		Yes	AT72		
DH8B	Dash 8 (200)		Yes	DH8D		
DH8C	Dash 8 (300)		Yes	DH8D		
DHC7	DHC-7 Dash 7		Yes	DH8D		

Table A-2.1.b. Aircraft types (by ICAO type designator) modelled with equivalent aircraft types

* 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: <u>https://www.icao.int/publications/DOC8643/Pages/Search.aspx</u>

Туре		CEM based on AO data (from COFdb)		quivalent Aircraft ype	CEM based on I	CAO Fuel Formula
Designator	Example of Model*	Source of CEM	Source of CEM	Type Designator of Equivalent Aircraft	Source of CEM	ICAO Aircraft Cod
DC10	DC-10					D10
DC85	DC-8-50					D8T
DC86	DC-8-60					D8L
DC87	DC-8-70					D8Q
IL62	11-62					IL6
IL76	11-76					IL7
IL86	11-86					ILW
IL96	11-96					IL9
L101	L-1011 TriStar					L10
B701	707-100					70M
B721	727-100					72
T134	Tu-134					TU3
T154	Tu-154					TUS
T204	Tu-204					T20
A148	An-148					A81
AN72	An-72					AN7
BA11	BAC-111 One-Eleven					B11
DC91	DC-9-10					D91
DC92	DC-9-20					D92
DC93	DC-9-30					D93
DC94	DC-9-40					D94
F28	F-28 Fellowship					F28
FA10	Falcon 10					DF2
J328	Dornier 328JET					FRJ
5601	SN-601 Corvette					NDC
WW24	1124 Westwind					WWP
YK40	Yak-40					YK4
YK42	Yak-42					YK2
A140	IRAN-140 Faraz					A40
A748	748					HS7
AN12	An-12					ANF
AN24	An-24					AN4
AN28	An-28					A28
ATP	ATP					ATP
BELF	SC-5 Belfast					SHB
C130	L-100 Hercules					LOH
C212	C-212 Aviocar					CS2
CN35	CN-235					CS5
CVLP	Convairliner					CVR
CVLT	Cosmopolitan					CV5
D228	Dornier 228					D28
DC3	DC-3					DC3
DC6	DC-6					DC6
DHC6	DHC-6 Twin Otter					DHT
E110	EMB-110 Bandeirante					EMB
E120	EMB-120 Brasilia					EM2
F27	F-27					F27
G159	G-159 Gulfstream 1					GRS
1114	II-114					114
IL18	11-18					ILS
JS31	BAe-3100 Jetstream 31					J31
JS32	BAe-3200 Jetstream Super 31					J32
JS41	BAe-4100 Jetstream 41					J41
L188	Electra (L-188)					LOE
L410	L-410 Turbolet					LOE L4T

Table A-2.1.c. Aircraft types (by ICAO type designator) modelled with ICAO Fuel Formula

* 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: <u>https://www.icao.int/publications/DOC8643/Pages/Search.aspx</u>

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

Table A-2.2.a. Aircraft types (by ICAO type designator) modelled with ICAO CEM based on aeroplaneoperators data from the COFdb

	Fuel (in kg) for giver	Block Ho	ur (in min)													
Type Designator	0	60	120	180	240	300	360	420	480	540	600	660		780	840	900	960
A124	2,434	11,321	22,760	34,394	46,028	57,662	69,296										
A306	603	4,836	9,070	13,303	17,536	21,769	26,002	30,235	34,469								
A310	388	3,204	7,525	11,898	16,272	20,645	25,018	29,391	33,764	38,137	42,511	46,884					
A332		4,621	9,483	14,346	19,208	24,293	30,276	36,260	42,243	48,226	54,210	60,193	66,176	72,159	78,143	84,126	
A333	376	4,801	9,226	14,476	19,743	25,793	31,933	38,073	44,213	50,353	56,494	62,634	68,774	74,914	75 040	01.015	
A339 A343	1,573	3,910 4,114	8,500 10,584	13,405 17,054	18,310 23,523	23,215 29,993	28,120 36,463	34,086 42,933	40,052 49,435	46,019 56,889	51,985 64,343	57,951 71,796	63,917 79,250	69,883 86,704	75,849 94,157	81,815 101,611	
A346	1,575	6,354	14,001	21,648	29,295	36,943	44,590	42,933	61,324	70,794	80,264	89,735	99,205	108,675	118,145	127,615	137.085
A359		4,497	9,745	14,993	20,242	26,291	32,656	39,021	45,387	51,752	58,117	64,483	70,848	77,213	83,579	89,944	96,309
A388	550	8,807	19,788	31,994	44,201	56,408	68,615	80,822	93.071	107,754	122,437		151,803	166,486	181,169	195,852	210,535
B744	204	6,070	16,218	26,367	36,516	46,665	56,813	66,962	78,216	89,983	101,749	113,516	125,282	137,048	148,815	160,581	172,348
B748	-	7,525	16,789	26,053	35,317	44,581	53,845	63,109	74,892	86,805	98,718		122,544	134,457	146,370	158,283	170,196
B762	628	3,792	7,471	12,354	17,237	22,121	27,004	31,887	36,770	41,653	46,537	51,420					
8763	507	2,846	7,466	12,174	16,883	21,591	26,299	31,326	36,387	41,448	46,509	51,570	56,631	61,692	66,753	71,814	
B764	1,379	4,846	8,313	11,781	16,723	22,545	28,367	34,189	40,011	45,833	51,655	57,477	63,299	69,121	74,943		
B772	2,221	5,428	9,873	16,796	23,718	30,641	37,563	44,486	51,408	58,699	66,357	74,016	81,674	89,333	96,991	104,650	112,308
B773	2,761	7,040	11,477	18,926	26,375	33,436	39,992	46,547	53,102	59,658	66,213	72,768	79,324	85,879	92,435	98,990	
B77L	02	6,459	12,917	19,376	25,834	32,345	40,860	49,503	58,146	66,789	75,431	84,074	92,717	101,360	110,003	118,645	127,288
B77W	1	4,708	11,922	19,136	26,350	34,322	42,775	51,228	59,681	68,133	76,586	85,039	93,492	101,945	110,398	118,850	
B788	2	3,729	7,825	12,104	16,383	20,661	25,980	31,435	36,890	42,346	47,801	53,256	58,711	64,167	69,622	75,077	80,533
B789	48	3,968	8,169	12,911	17,653	22,395	27,208	33,117	39,025	44,934	50,843	56,751	62,660	68,568	74,477	80,386	86,294
B78X	1,441	4,737	8,033	11,330	15,205	21,678	28,152	34,625	41,099	47,573	54,046	60,520	66,994	73,467	79,941	86,415	92,888
MD11 A20N	550	5,220	12,098	20,324	28,550	36,776	45,002	53,228	61,454	69,680	77,906	86,133	94,359	102,585	110,811	119,037	127,263
A20N A21N	2	1,849 2,078	3,850 4,295	5,985 6,672	8,119 9,351	10,253 12,030	12,387 14,710	14,521 17,389	20.068								
A318	62	2,078	4,125	6,705	9,351	11,864	14,444	17,023	19,603								
A319		2,160	4,399	6,668	9,278	11,887	14,496	17,105	19,715								
A320		2,243	4,589	7,180	9,771	12,363	14,954	17,100	10,710								
A321		2,596	5,345	8,394	11,444	14,493	17,543	20,593									
B38M	63	1,610	3,608	5,868	8,128	10,388	12,648	14,908									
B722	187	3,697	7,721	11,772	15,823	19,874	23,926										
8733	244	2,112	4,365	6,773	9,181	11,589	13,997	16,405									
B734	329	2,362	4,569	6,980	9,391	11,802	14,213	16,624	19,035	21,446	23,857	26,268	28,679	31,090			
B735	79	2,135	4,192	6,248	8,305	10,362	12,418	14,475	16,531	18,588	20,644	22,701					
B736	24	1,894	3,813	5,733	7,652	9,571	11,491	13,410	15,329								
B737	46	1,821	3,956	6,201	8,446	10,692	12,937	15,182									
B738	261	2,011	4,421	6,961	9,501	11,844	14,158										
B739	158	2,269	4,748	7,441	10,133	12,826	15,518										
B752	661	3,071	5,924	9,138	12,352	15,566	18,780	21,994	25,209	28,423	31,637						
B753	231	3,167	6,579	10,515	14,451	18,387	22,323	26,260	30,196	34,132							
BCS1 BCS3	22	1,654 1,666	3,379 3,551	5,100 5,436	7,297	9,155											
E295	31	1,565	3,551	4,804	6,490	9,155											
MD82	173	2,805	5,615	8,602	11,590	14,577											
MD82 MD87	82	2,621	5,161	7,720	10,528	13,337	16,145	18,954									
MD88	168	2,969	5,770	8,453	9,837												
MD90	27	2,499	5,084	7,717	10,350												
B462	290	1,781	3,792	5,803													
B463	163	1,923	3,682	5,442													
B712	+	2,060	4,120	6,180	8,240												
BE4W	4	440	853	1,249	1,645												
C258	26	441	856	1,271	1,686												
C25C	4	558	1,039	1,507	1,975												
C550	10	525	956	1,345	1,735												
C56X	47	710	1,212	1,709	2,205												
C68A	1	833	1,558	2,207	2,855	3,504	4,153	4,801									
C750	42	851	1,808	2,766	3,723	4,680	5,637	6,594									
CL30 CL35	9	885	1,761	2,637	3,404	4,082	4,761										
		849	1,622	2,369	3,116	3,863	4,610										

											188						
							Fuel (in F	g) for given	Great Circle	e Distance (i	n km)						
Type Designator		60	120	180	240	300	360	420	480	540	600	660		780	840	900	960
CRJ1	40	1,110	2,059	2,998	3,936	4,874	5,812	6,750	-								
CRJ2	19	843	1,874	2,960	4,046	5,132	6,218	7,305									
CRJ7	26	1,367	2,901	4,223													
CRJ9	94	1,539	2,984	4,428													
CRJX	+	1,616	3,000														
DC95	1,549	3,673	5,797														
E135	+	1,080	2,189	3,298	4,407	10101017											
E145	5	1,053	2,011	2,966	3,921	4,876											
E170	130	1,455	3,020	4,585	1000					122121							
E190	313	1,814	3,704	5,594	7,484	9,374	11,264	13,154	15,044	16,934							
E195	-	1,820	3,888	6,031	8,175	10,319	12,462	14,606	16,750	18,893							
E290	201	1,538	2,876	4,213	5,550	6,887	8,224	7.776	0.000								
E35L	-	998	2,009	3,019	4,065	5,119	6,172	7,226	8,280								
E45X	47	1,144	2,314	3,484	4,655												
E55P	8	557	1,007	1,404	1,800												
E75L	200	1,355	2,872	4,389 4,444	6.047												
E755	387	1,490	2,672		6,217	8,981											
F100	158	1,855	3,833	5,573	7,277		E 006	6.022	6 769								
F2TH F70	158	915 1,641	1,751 3,340	2,587 5,039	3,424	4,260	5,096	5,932	6,768								
F900					4,089	E 033	1.000	6.000	7.010	0.747	0.676						
F900 FA50	17	1,035	2,053 2,019	3,071 2,893	3,767	5,033 4,641	5,961 5,515	6,890 6,389	7,818	8,747	9,675						
FATX	51	1,145	2,019	3,398	4,514	5,629	6,745	7,860	8,976	10,092	11,207	12,323	13,439				
FASX	49	1,107		3,586	4,514							12,523	14,807	16.053			
G280	9	782	2,339	2,366	3,158	6,079 3,950	7,326 4,742	8,573 5,534	9,820	11,066	12,313	13,300	14,007	16,053			
GA6C		1,086	2,599	4,111	5,623	7,136	8,648	10,160	11,673	13,185	14,697	16,210	17,722	19,234	20,747		
GLST	464	1,713	2,952	4,398	5,939	7,480	9,021	10,100	12,104	13,645	15,186	16,727	21,166	19,234	20,747		
GL7T	404	1,231	2,902	4,113	5,555	6,996	8,437	9,878	11,319	12,760	14,125	15,451	16,778	18,105	19,431	20,758	22,085
GLEX	47	1,493	2,938	4,383	5,829	7,275	8,819	10,363	11,908	13,452	14,996	16,540	18,084	19,629	19,431	20,730	22,005
GLF4	59	1,433	2,831	4,031	5,467	6,903	8,338	9,774	11,210	15,452	14,550	10,540	10/004	19,029			
GLF5	310	1,673	3,036	4,398	5,761	7,124	8,486	9,849	11,212	12,574	13,937	15,300	16,663	18,025	19,388	20,751	22,113
GLF6	21	1,573	3,000	4,398	5,979	7,468	8,957	10,447	11,936	13,425	14,915	16,404	17,893	19,383	20,872	22,361	22,115
H258	63	797	1,445	2,093	2,742	3,390	0,201	10,447	*******	10,72.0	******	10,404	11,055	13,303	20,072	22,001	
U31	88	487	950	1,414	A.,	2,220											
LI40	18	592	1,190	1,788													
LI45	54	575	1,097	1,618	2,140												
LI60	81	570	1,157	1,743	2,330	2,917	3,503										
LJ75		523	1,045	1,568	2,091		0,000										
RI85	363	1,958	3,553	5,149	6,744												
AN26	98	985	1,872	2,759													
AT43	52	507	972	1,444	1,917	2,390											
AT45	19	601	1,156	1,704	13.2526	1999-1993											
AT46	27	558															
AT72	28	553	1,078														
AT75	63	654															
AT76	25	577															
B190		298	600	902													
BE20	47	297	547	797	1,046												
BE30	110	343	577	810	1,044												
D328	78	475	873	0.000	and a diffe												
DH8A	3	491	979														
DH8D	112	896	1,767														
F50	96	541	1,085	1,628	2,171	2,715	3,258	3,801									
5820		849	1,698	2,548			10	23									
SF34	108	373	638	902													

Table A-2.2.a (cont.). Aircraft types (by ICAO type designator) modelled with ICAO CEM based onaeroplane operators data from the COFdb

							Fuel (in k	g) for given	Great Circle	e Distance (i	in km)						
Type Designator		60	120	180	240	300	360	420	480	540	600	660	720	780	840	900	960
A308	585	4,687	8,789	12,891	16,994	21,096	25,198	29,301	33,403	37,505							
A338		3,871	8,416	13,272	18,129	22,985	27,841	33,748	39,655	45,562	51,469	57,376	63,283	69,190	75,097	81,004	86,911
A342	1,491	3,900	10,033	16,166	22,299	28,432	34,565	40,697	46,861	53,927	60,992	68,058	75,124	82,189	89,255	96,320	103,386
A345	÷.	6,394	14,088	21,783	29,478	37,172	44,867	52,562	61,706	71,235	80,764	90,293	99,822	109,351	118,880	128,409	137,938
A35K	100	5,188	11,243	17,299	23,354	30,333	37,677	45,021	52,365	59,710	67,054	74,398	81,742	89,086	96,430	103,774	111,118
8741	175	5,192	13,874	22,555	31,237	39,918	48,600	57,282	66,909	76,974							
8742	193	5,741	15,341	24,941	34,541	44,141	53,741	63,341	73,986	85,116	96,246	107,376	118,506	129,636	140,766		
B743	194	5,767	15,409	25,051	34,694	44,336	53,978	63,621	74,313	85,492	96,672	107,851	119,030	130,209	141,389	152,568	163,747
B74R	167	4,969	13,277	21,585	29,894	38,202	46,510	54,818	64,031	73,664	83,296	92,929	102,561				
B745	162	4,820	12,879	20,938	28,997	37,056	45,115	53,174	62,111	71,454	80,798	90,142	99,485				
A19N		1.842	3,837	5,964	8,090	10,217	12,344	14,471	16,597								
837M	60	1,523	3,414	5,552	7,690	9,828	11,966	14,104	16,242								
B39M	69	1,745	3,912	6,362	8,813	11,263	13,713	16,164									
B3XM	67	1,703	3,817	6,207	8,598	10,988	13,379	15,769									
MD81	167	2,711	5,426	8,312	11,199	14,086	16,973										
MD83	191	3,087	6,179	9,466	12,754	16,041	19,328	22,616	25,903								
B461	262	1,606	3,419				Contra 1	1.5									
B732	216	1.869	3,862	5,993	8,125	10,256	12,387										
C525	8	412	751	1,057													
C558	11	567	1,034	1,455	1,876												
C560	12	619	1,128	1,587	2,046												
FA6X	54	1,235	2,417	3,598	4,780	5,961	7,143	8,324	9,506	10,687	11,869	13,050					
GASC	1.4	919	2,200	3,480	4,760	6,040	7,320	8,601	9,881	11,161	12,441						
GA7C	24	1,697	3,369	5,042	6,715	8,388	10,060	11,733	13,406	15,079	16,751	18,424	20,097	21,770	23,442	25,115	26,788
H25A	59	739	1,340	1,941	2,542	3,143	3,745	*******	10,400	20,000	20,102	10,71.7	201031	A.4.11.14	6.0, 116	******	20,700
H25C	71	888	1,610	2,332	2,542	3,243	341.43										
U25	13	424	851	1,279													
U35	16	517	1,039	1,560	2,082	2,604											
LJ55	53	561	1,070	1,579	2,088	6,000											
U70	54	577	1,099	1,622	2,145												
RJ1H	169	1,989	3,809	5,629	7,449												
RJ70	358	1,989	3,508	3,023	Cherry .												
AN30	94	944	1,794	2.644													
AN32	110	1,108	2,106	3,104	4,056												
AT73	28	554	1,079	3,10%	4,000												
DH8B	63	507	1,079														
	75																
DH8C DHC7	75	598 622	1,178														

Table A-2.2.b. Aircraft types (by ICAO type designator) modelled with equivalent aircraft types

							Fuel (in)	g) for given	Great Circl	e Distance (i	in km)						
lype Designator		60	120	180	240	300	360	420	480	540	600	660		780	840	900	960
DC10		8,921	17,843	26,764	35,686	44,607	53,528	62,450	71,371	80,293							
DC85	6 4	5,165	10,330	15,494	20,659	25,824	30,989	36,154	41,318	46,483	51,648						
DC86	8 *	5,165	10,330	15,494	20,659	25,824	30,989	36,154	41,318	46,483	51,648	56,813					
DC87		5,165	10,330	15,494	20,659	25,824	30,989	36,154	41,318	46,483	51,648						
IL62	1.	7,518	15,036	22,554	30,072	37,590	45,108	52,626	60,144	67,662							
IL76	904	9,597	18,289	26,981	35,673	44,365											
IL86	1,685	11,453	21,220	30,987	40,755	50,522											
11.96	- C	6,839	13,678	20,517	27,356	34,195	41,040	47,899	54,758	61,617	68,475	75,334	82,193		1.500 mar (n. 1702 1.500		
L101	19 7	8,959	17,918	26,878	35,837	44,796	53,755	62,714	71,674	80,633	89,592	98,551	107,510	116,470	125,429	134,388	
B701	6	5,555	11,104	16,653	22,202	27,751	33,300	38,849	44,398	49,948	55,497						
B721	-	3,305	6,610	9,914	13,219	16,524											
T134	705	3,279	5,854	8,428	11,002	2007-2007 T	1227805										
T154	792	5,654	10,516	15,379	20,241	25,103	29,965										
T204	792	5,654	10,516	15,379	20,241	25,103	29,965	34,828									
A148	5	1,600	3,200	4,800	6,400												
AN72	-	1,600	3,200	4,800	6,400	8,000											
BA11	10	3,057	6,114	9,172	12,229	15,286											
DC91	-	2,638	5,276														
DC92	- 33	2,670	5,340	8,010													
DC93	22	2,855	5,709	8,564	11,419	14,274	17,128										
DC94		3,065	6,130	9,195													
F28	1	2,000	4,000	6,000	8,000	10,000											
FA10	2.9	760	1,520	2,280	3,040												
1328	1	872	1,744														
5601 WW24	34 54	376 582	752	1,745	2,326	2,908											
YK40		816	1,163	1,745	2,320	2,908											
YK42	683	3,316	5,949	8,582	11,214												
A140	005	720	1,440	2,160	11,214												
A748	- 2	734	1,440	2,100													
AN12	354	2,651	4,947	7,243	9,539	11,835	14,132										
AN24	126	903	1,680	1,245	3,333	11,033	14,132										
ANZ8	-	360	1000														
ATP		646	1,293	1.939	2,586	3,232											
BELF	1.9	2,880	5,760	8,640	11,520	14,400	17,280	20,160	23,040	25,920							
C130		1,992	3,984	5,976	7,968				2.070 · · ·								
C212		316															
CN35		480	960	1,440	1,920	2,400											
CVLP	2	0.0070	100.00		5775753	0.0000000											
CVLT	1.0	992	1,984	2,976	3,968												
D228	1	264	527	791													
DC3	1.4	304	608														
DC6		1,082	2,165	3,247	4,330	5,412	6,494	7,577	8,659								
DHC6	1	270	10000000	1012803766			0.0000003	2742623									
E110	1.5	252	504														
E120	4	413															
F27		772	1,544	2,316	3,088	3,860											
G159	1	720	1,440	2,160	2,880												
1114	32	880															
IL18		2,040	4,080	6,120													
1531	4	276															
1532		294															
JS41	14	406	813	1,219	1,626												
L188	12	2,319	4,638	6,958	9,277												
L410	1	320															

Table A-2.2.c. Aircraft types (by ICAO type designator) modelled with an ICAO Fuel Formula

APPENDIX A-3: Aircraft types (by type designator) that will be the focus of further and targeted data collection towards the 2024 version of the ICAO CORSIA CERT

As described above in this document, the CO_2 Estimation Models (CEMs) are developed using flight level data provided by aeroplane operators (AO based data). The CAEP continuously strive to increase the scope and accuracy of CEMs towards future versions of the CERT. The list below presents the aircraft types that will be the focus of further and targeted data collection towards the 2024 version of the ICAO CORSIA CERT. Aeroplane operators and/or data providing organization interested in contributing to future improvements of the CERT are welcome to contact <u>cert@icao.int</u>.

/pe Designator	Manufacturer	Example of Model*	Type Designator	Manufacturer	Example of Model*
B39M	BOEING	737 MAX 9		continued from previous	column
MD83	BOEING	MD-83			
A35K	AIRBUS	A-350-1000 XWB	H25C	BRITISH AEROSPACE	Hawker 1000
DC10	BOEING	DC-10	HA4T	HAWKER BEECHCRAFT	4000 Hawker 4000
F28	FOKKER	F-28 Fellowship	FA10	DASSAULT	Falcon 10
A30B	AIRBUS	A-300B2	C650	CESSNA	650
IL76	ILYUSHIN	II-76	ATP	BRITISH AEROSPACE	ATP
SU95	SUKHOI	Superjet 100-95	T154	TUPOLEV	Tu-154
IL96	ILYUSHIN	11-96	B721	BOEING	727-100
AN12	ANTONOV	An-12	G150	GULFSTREAM AEROSPACE	Gulfstream G150
A345	AIRBUS	A-340-500	MD81	BOEING	MD-81
B742	BOEING	747-200	DHC6	DE HAVILLAND CANADA	DHC-6 Twin Otter
T204	TUPOLEV	Tu-204	JS31	BRITISH AEROSPACE	BAe-3100 Jetstream 31
A148	ANTONOV	An-148	DC87	DOUGLAS	DC-8-70
RJ1H	AI(R)	RJ-100 Avroliner	GALX	GULFSTREAM AEROSPACE	Gulfstream G200
C680	CESSNA	680	C551	CESSNA	551
B732	BOEING	737-200	D228	DORNIER	Dornier 228
BE40	BEECH	400	CN35	AIRBUS	CN-235
A342	AIRBUS	A-340-200	JS41	AI(R)	BAe-4100 Jetstream 41
C525	CESSNA	525 Citation CJ1	E110	EMBRAER	EMB-110 Bandeirante
MD87	BOEING	MD-87	BE20	BEECH	Super King Air (200)
DH8C	DE HAVILLAND CANADA	Dash 8 (300)	GLF3	GULFSTREAM AEROSPACE	G-1159A
DC93	DOUGLAS	DC-9-30	T134	TUPOLEV	Tu-134
GLF2	GRUMMAN	G-1159	B461	BRITISH AEROSPACE	BAe-146-100
F27	CONAIR	F-27	SH36	SHORT	360
CVLT	CANADAIR	Cosmopolitan	AJ27	COMAC	ARJ-21-700 Xiangfeng
LJ35	GATES LEARJET	35	C212	AIRBUS	C-212 Aviocar
E545	EMBRAER	EMB-545 Legacy 450	LI55	GATES LEARJET	55
AN24	ANTONOV	An-24	G159	GRUMMAN	G-159 Gulfstream 1
ASTR	GULFSTREAM AEROSPACE	Gulfstream G100	YK40	YAKOVLEV	Yak-40
E120	EMBRAER	EMB-120 Brasilia	B37M	BOEING	737 MAX 7
DC91	DOUGLAS	DC-9-10	L101	LOCKHEED	L-1011 TriStar
YK42	YAKOVLEV	Yak-42	SC7	SHORT	SC-7 Skyliner
B74S	BOEING	747SP	A748	AIL	748
B743	BOEING	747-300	1114	ILYUSHIN	II-114
A158	ANTONOV	An-158	⊔70	LEARJET	70
DH8B	DE HAVILLAND CANADA	Dash 8 (200)			
C25A	CESSNA	525A			
SW2	SWEARINGEN	SA-26 Merlin 2			
C560	CESSNA	560 Citation 5			
FA20	DASSAULT	Falcon 200			
	continue on top of next c	olumn			

ICAO Code	Location Name	Latitude	Longitud e	Territor y Code	ICAO Member State	Link for Confirmation of Location
FAJS	O R Tambo International	-26.1337	28.2423	FA	South Africa	https://www.google.com/maps/search/- 26.13369444,28.24231667
FLLI	Livingstone	-17.8218	25.8227	FL	Zambia	https://www.google.com/maps/search/- 17.8218,25.822701
FLLS	Kenneth Kaunda Intl	-15.3306	28.4525	FL	Zambia	https://www.google.com/maps/search/- 15.330556,28.4525
FLND	Ndola Airport	-12.9985	28.6640	FL	Zambia	https://www.google.com/maps/search/- 12.998512,28.664047
FVBU	Bulawayo/Joshua Mqabuko Nkomo Intl	-20.0174	28.6179	FV	Zimbabw e	https://www.google.com/maps/search/- 20.017401,28.617901
HCMF	Bosaso International	11.2752	49.1392	нс	Somalia	https://www.google.com/maps/search/11.275235,49.1392 31
нсмн	Hargeisa/Egal International	9.5132	44.0824	нс	Somalia	https://www.google.com/maps/search/9.513207,44.08238
нсмм	Mogadishu/Aden Adde International Airport	2.0136	45.3047	нс	Somalia	https://www.google.com/maps/search/2.013611,45.30472
HECW	Cairo West Air Base	30.1079	30.9152	HE	Egypt	https://www.google.com/maps/search/30.107943,30.9152 22
НЕМК	Moubarak / Intl	26.3400	31.7394	HE	Egypt	https://www.google.com/maps/search/26.34,31.739444
HSSJ	Juba	4.8790	31.5928	HS	South Sudan	https://www.google.com/maps/search/4.879,31.59283333
HSSK	Khartoum	15.5895	32.5532	HS	Sudan	https://www.google.com/maps/search/15.5895,32.5532
HSSS	Khartoum	15.5894	32.5531	HS	Sudan	https://www.google.com/maps/search/15.589444,32.5530 56
KANJ	Sault Ste Marie Muni/Sanderson Fld	46.4792	-84.3684	КА	United States	https://www.google.com/maps/search/46.479198,- 84.368401
KBKV	Brooksville-Tampa Bay Rgnl	28.4736	-82.4554	КВ	United States	https://www.google.com/maps/search/28.4736,- 82.455399
KDTO	Denton Enterprise	33.2007	-97.1980	КD	United States	https://www.google.com/maps/search/33.200699,- 97.197998
KDTS	Destin Exec	30.4001	-86.4715	KD	United States	https://www.google.com/maps/search/30.400101,- 86.471497
KGYH	Donaldson Fld	34.7583	-82.3764	KG	United States	https://www.google.com/maps/search/34.758301,- 82.376404
KHEF	Manassas Rgnl/Harry P Davis Fld	38.7214	-77.5154	кн	United States	https://www.google.com/maps/search/38.721401,- 77.515404
KHXD	Hilton Head	32.2244	-80.6975	кн	United States	https://www.google.com/maps/search/32.2244,- 80.697502
кнүі	San Marcos Rgnl	29.8927	-97.8630	кн	United States	https://www.google.com/maps/search/29.8927,- 97.862999
кјуо	Leesburg Exec	39.0780	-77.5575	кJ	United States	https://www.google.com/maps/search/39.077999,- 77.557503
KJZI	Charleston Exec	32.7009	-80.0029	кJ	United States	https://www.google.com/maps/search/32.700901,- 80.002899
КМКҮ	Marco Island Exec	25.9950	-81.6725	км	United States	https://www.google.com/maps/search/25.995001,- 81.672501
KPMP	Pompano Beach Airpark	26.2471	-80.1111	КР	United States	https://www.google.com/maps/search/26.247101,- 80.111099
KSUT	Cape Fear Rgnl Jetport/Howie Franklin Fld	33.9293	-78.0750	кs	United States	https://www.google.com/maps/search/33.929298,- 78.074997
кткі	Mckinney Ntl	33.1779	-96.5905	кт	United States	https://www.google.com/maps/search/33.177898,- 96.5905
KTME	Houston Exec	29.8072	-95.8979	кт	United States	https://www.google.com/maps/search/29.807199,- 95.897903
KTYQ	Indianapolis Exec	40.0307	-86.2514	кт	United	https://www.google.com/maps/search/40.030701,-
KUZA	Rock Hill/York County/Bryant Fld	34.9878	-81.0572	ки	States United States	86.251404 https://www.google.com/maps/search/34.987801,- 81.057198
MHSC	Comayagua International	14.3824	-87.6212	мн		https://www.google.com/maps/search/14.3824,-87.6212

APPENDIX B-1: Complementary List of Aerodromes Towards the CERT Aerodrome Database

ICAO Code	Location Name	Latitude	Longitud e	Territor y Code	ICAO Member State	Link for Confirmation of Location
	Airport				state-	
ммім	Isla Mujeres	21.2460	-86.7404	ММ	Mexico	https://www.google.com/maps/search/21.245962,- 86.740365
MPHO	Howard Intl	8.9148	-79.5996	MP	Panama	https://www.google.com/maps/search/8.91479,- 79.599602
MPRH	Scarlett Martinez International Airport	8.3759	-80.1279	MP	Panama	https://www.google.com/maps/search/8.37588,- 80.127899
MYGW	West End Airport	26.6853	-78.9750	MY	Bahamas	https://www.google.com/maps/search/26.685301,- 78.974998
MYPI	Nassau Paradise Island Airport	25.0781	-77.2987	MY	Bahamas	https://www.google.com/maps/search/25.078138,- 77.298689
OERY	Riyadh / King Salman Air Base	24.7257	46.7223	OE	Saudi Arabia	https://www.google.com/maps/search/24.725725,46.7223 36
OKBK	Kuwait Intl	29.2268	47.9800	ок	Kuwait	https://www.google.com/maps/search/29.22676667,47.97 995278
OOSR	Sur	22.5377	59.4798	00	Oman	https://www.google.com/maps/search/22.537729,59.4797 66
OPRN	Islamabad/ Benazir Bhutto International	33.6167	73.0992	ОР	Pakistan	https://www.google.com/maps/search/33.616699,73.0991 97
SBJH	Sao Paulo Catarina Aeroporto Executivo - Intl	-23.4269	-47.1658	SB	Brazil	https://www.google.com/maps/search/-23.426944,- 47.165833
SDSC	Sao Carlos International Airport	-21.8754	-47.9037	SD	Brazil	https://www.google.com/maps/search/-21.875401,- 47.903703
SPIM	Lima - Callao / Jorge Chavez Intl	-12.0219	-77.1143	SP	Peru	https://www.google.com/maps/search/-12.02188611,- 77.11431667
SYGO	Ogle International Airport	6.8063	-58.1059	SY	Guyana	https://www.google.com/maps/search/6.80628,-58.1059
TKPN	Vancew.Amoryinternational_Air port	17.2034	-62.5873	тк		https://www.google.com/maps/search/17.203405853,- 62.587252651
UAFL	Tamchy/Ysykkul	42.5856	76.7012	UA	Kyrgyzsta n	https://www.google.com/maps/search/42.585584,76.7011 81
UAFM	Bishkek/Manas	43.0614	74.4775	UA	Kyrgyzsta n	https://www.google.com/maps/search/43.061389,74.4775
UAFO	Osh	40.6089	72.7931	UA	Kyrgyzsta n	https://www.google.com/maps/search/40.608889,72.7930 56
UAIT	Turkistan	43.3131	68.5499	UA	Kazakhsta n	https://www.google.com/maps/search/43.313126,68.5498 81
UTKF	Fergana International Airport	40.3588	71.7450	UT	Uzbekista n	https://www.google.com/maps/search/40.358799,71.7450 03
UTKN	Namangan Airport	40.9846	71.5567	UT	Uzbekista n	https://www.google.com/maps/search/40.9846,71.556702
UUMU	Chkalovskiy Air Base	55.8783	38.0617	UU	Russian Federatio n	https://www.google.com/maps/search/55.8783,38.061699
VAGO	Goa	15.3808	73.8314	VA	India	https://www.google.com/maps/search/15.3808,73.831398
VGZR	Dhaka / Hazrat Shahjalal Int	23.8433	90.3978	VG	Banglades h	https://www.google.com/maps/search/23.84334722,90.39 778333
VIBN	Lal Bahadur Shastri/Varanasi Domestic	25.4521	82.8618	VI	India	https://www.google.com/maps/search/25.452129,82.8618 05
VREI	Ifuru Island/Airport	5.7083	73.0250	VR	Maldives	https://www.google.com/maps/search/5.7083,73.025
WIPT	Padang Pariaman/Minangkabau	-0.7869	100.281 0	wi	Indonesia	https://www.google.com/maps/search/- 0.786917,100.280998
ZSQD	Qingdao/Jiaodong	36.3620	120.088 2	zs	China	https://www.google.com/maps/search/36.361953,120.088 171
ZUTF	Chengdu/Tianfu	30.3125	104.441 3	ZU	China	https://www.google.com/maps/search/30.31252,104.4412 84