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DOCUMENT APPROVAL

The following table identifies all management authorities who have successively approved the present issue of this document.

AUTHORITY	NAME AND SIGNATURE	DATE
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Philippe Merlo Director, Directorate European Civil-Military Aviation		9.12.20

DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

EDITION NUMBER	EDITION DATE	REASON FOR CHANGE	PAGES AFFECTED
0.1	07/2002	Working draft	All
1.0	09/2002	Revised and upgraded to released issue	All
2.0	02/2004	Updated to 2004 values	All
3.0	06/2007	Updated to 2006 values	All
4.0	10/2009	Updated to 2009 values	All
5.0	12/2011	Updated to 2010 values	All
6.0	09/2013	Updated to 2012 values, review and replacement of some values, addition of four new values	All
7.0	11/2015	Updated to 2014 values, review and replacement of some values, addition of three new values	All
8.0	12/2017	Updated to 2016 values, review and replacement of some values, addition of new values	All
9.0	11/2020	Change of title, updated to 2019 values, review, replacement of some values, addition of new values	All

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General information

Foreword

Although we cannot foresee when, or even if, the world will return to what it was prior to the COVID-19 pandemic, we have decided to publish this new edition of the standard inputs as a valuable source of inputs for economic and cost-benefit analyses in aviation. The recommended values are often based on 2019 statistics and data which do not yet take account of the impact of the pandemic.

For this edition, the focus is on environmental values, a new value for airports, turn-around time, and the introduction of two values related to drones. Drones represent a highly complex and fast-moving market, which makes forecasting more difficult than legacy aviation sectors. Suggestions for improvement and collaboration are welcome. Please send them to aviation.intelligence@eurocontrol.int.

We would like to make a special mention of the launch of the EUROCONTROL Aviation Intelligence Portal, which provides valuable and up-to-date information for economic analyses (https://ansperformance.eu/). The Portal will soon include the standard inputs (2021) and more information of use for cost-benefit analyses.

Introduction

This document provides a set of standard inputs for data commonly used in economic and financial ATM-related analyses and appraisals. The standard inputs will save time in the development, for example, of cost-benefit analyses (CBAs) and economic impact assessments and will also help achieve greater consistency and comparability between different CBAs.

In this, the 9th edition:

- the title has been changed to “EUROCONTROL standard inputs for economic analyses”, a more accurate description of its use;
- the values have been regrouped by stakeholder and key topic of interest;
- all prices have been updated to 2019 euro values unless otherwise specified. The costs can be easily adjusted using the table of indices contained in the section “Conversions, inflation, cost of fuel and exchange rate” on page 4;
- some values have been reviewed and replaced, namely turn-around time, all causes of delay, and statistics;
- comparable historical data have been added;
- two new values have been introduced, namely drone fleet and U-space related investments;
- the value “cost of an ATFM slot swap” was removed because the UDPP concept has evolved and makes reference to “measures” (which involves multiple swaps). The value of a measure has a big range and is still being worked on;
- a link to the EUROCONTROL Aviation Intelligence Portal providing latest information was added when and where appropriate;
- whenever single values are contentious, a range of low, base and high values is given, allowing users of the data to conduct sensitivity analyses.

The standard inputs have been compiled from EUROCONTROL data and intelligence, from values provided by airspace users, ANSPs, airports, IATA, EASA and other organisations, and from other relevant documents which are publicly available.

They are average values and may not be appropriate in all circumstances. The document also gives details of the sources of information, and discusses the applicability and use of the values.

This document will remain a living document, and so comments and suggestions are very welcome. Readers are invited to send these to aviation.intelligence@eurocontrol.int.

Details per data item

For each standard input, the following information is provided, where relevant.

Section	Description
Definition	A statement which describes the concept.
EUROCONTROL recommended value or source	One or a set of recommended values or sources put forward by EUROCONTROL for the specific indicator.
Source and date	The source documents and their publication dates.
Description	Any relevant information or details regarding the standard input. Information can be found here on how the value is computed, the specific use of the indicator, etc. Information regarding the limitations on using the values may also be included.
Other possible values	Other values found in different sources, which are included for the purpose of information or discussion.
Related standard inputs	A link to other related standard inputs included in the document in order to increase its consistency.
Further reading	References to other interesting sources.
Comments	Any questions or further comments regarding the source or derivation of the value, for example the degree of confidence in the values and sources cited.

Conversions, inflation, cost of fuel, exchange rate

1 Inflation

All values are given in euros (€) at December 2019 price levels (unless otherwise indicated). They have been adjusted for inflation from values given in the source documents using the Eurostat European Union (EU6-1958, EU9-1973, EU10-1981, EU12-1986, EU15-1995, EU25-2004, EU27-2007, EU-28-2013, EU27-2020) harmonised index of consumer prices (HICP 2015=100). The annual change in the index is shown below. The values of the index are available at http://ec.europa.eu/eurostat (table prc_hicp_aind).

Annual average inflation values		
Year	**Index**	**Rate of change**
2019	105.4	1.5%
2018	103.9	1.9%
2017	101.9	1.7%
2016	100.2	0.3%
2015	100.0	0.1%
2014	99.9	0.6%
2013	99.4	1.5%
2012	97.9	2.6%
2011	95.4	3.1%
2010	92.5	2.1%
2009	90.6	1.0%
2008	89.7	3.5%
2007	86.7	2.3%
2006	84.7	2.2%
2005	82.9	2.2%
2004	81.1	2.0%
2003	79.5	2.0%
2002	77.9	2.1%
2001	76.4	2.2%
2000	74.7	1.9%

2 Exchange rate conversion

Values in pounds sterling (£) and US dollars ($) have been converted to euros (€) using the 2019 average euro foreign exchange rate.

Currency	Currency-€	€-currency
$	0.89	1.12
£	1.22	0.82

Further information can be found in the related standard input exchange rate (page 123).

3 Cost of fuel

The cost of fuel used in this document is based on the 2019 average jet fuel price handled by IATA (unless otherwise specified).

$/US gallon	€/kg
1.83	0.43

Details can be found in the related standard input cost of aviation fuel (page 62).

4 Conversion values

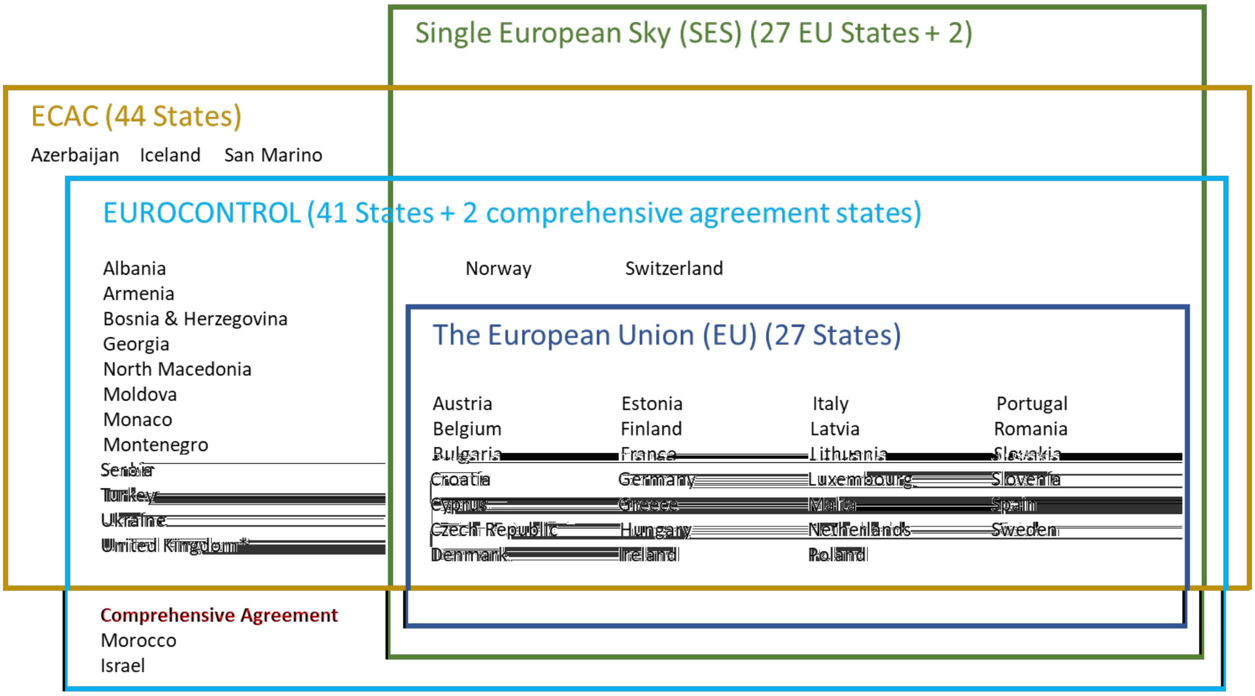
1 nautical mile (NM)	1.852 km
1 kilometre (km)	0.53996 NM
1 tonne (metric = 1 000 kg) of jet fuel	325.33 US gallons 1 235 litres 7.8 barrels
1 barrel (bbl) of jet fuel	42 US gallons 158.99 litres 0.1291 ton = 129.10 kg
1 US gallon of jet fuel (US gal)	3.7854 litres 3.073 kg 6.7764 lb
Density of kerosene	0.812 kg/litre
1 litre of fuel (l)	0.26417 US gallons
1 kilogramme of fuel (kg)	2.2046 lb
1 pound of fuel (lb)	0.45359 kg

5 For Further Information

For any questions relating to this document, please contact EUROCONTROL using the e-mail aviation.intelligence@eurocontrol.int, naming the standard inputs in the subject line.

Geographical areas

1 Member States and geographical areas covered



Single European Sky (SES) (27 EU States + 2)

ECAC (44 States)

Azerbaijan Iceland San Marino

EUROCONTROL (41 States + 2 comprehensive agreement states)

Albania
Armenia
Bosnia & Herzegovina
Georgia
North Macedonia
Moldova
Monaco
Montenegro
Serbia
Turkey
Ukraine
United Kingdom*

Norway Switzerland

The European Union (EU) (27 States)

Austria
Belgium
Bulgaria
Croatia
Cyprus
Czech Republic
Denmark

Estonia
Finland
France
Germany
Greece
Hungary
Ireland

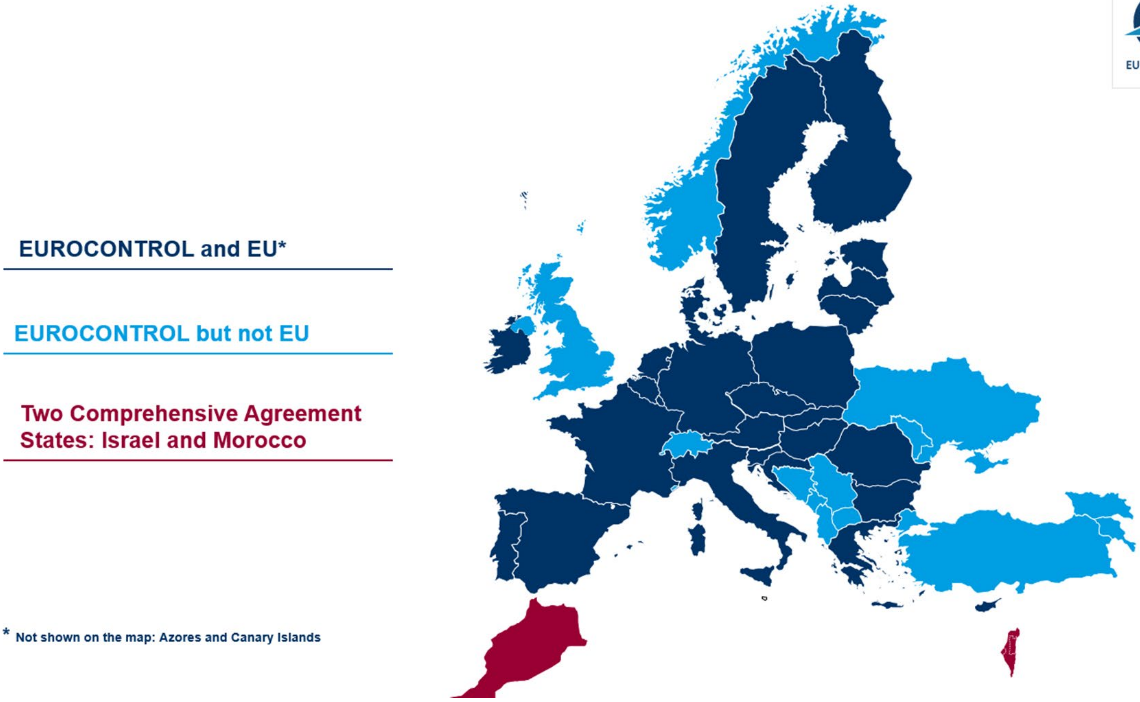
Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Poland

Portugal
Romania
Slovakia
Slovenia
Spain
Sweden

Comprehensive Agreement
Morocco
Israel

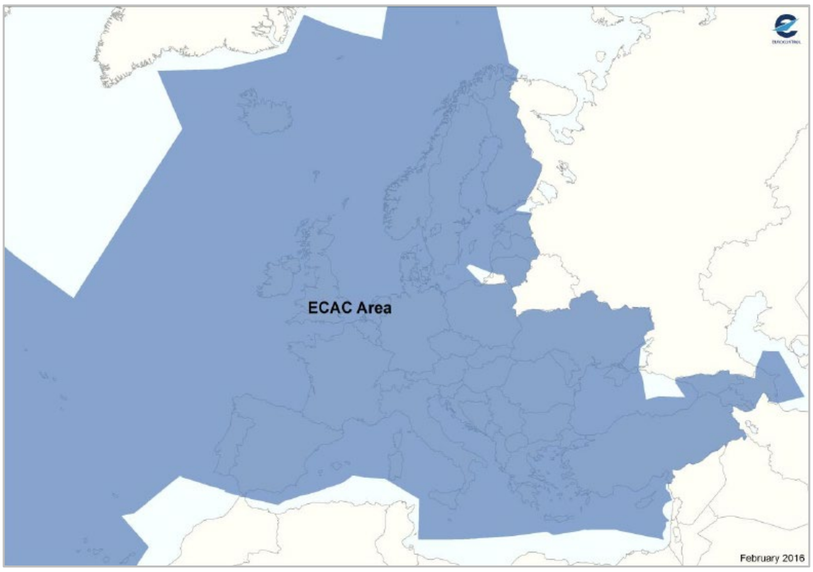
* Subject on final decision on Brexit, the UK might not be part of SES (status: November 2020)

2 EUROCONTROL Member States (status: November 2020)



* Not shown on the map: Azores and Canary Islands

3 Airspace of the ECAC Member States



4 Comment

ECAC is an intergovernmental organisation which was established by ICAO and the Council of Europe. ECAC now has 44 Member States, including all 27 EU Member States, 31 of the 32 European Aviation Safety Agency Member States, and all 41 EUROCONTROL Member States.

Further information on traffic region definitions is available in the EUROCONTROL STATFOR 7-year IFR Flight Movements and Service Units Forecast, Annex 1.
https://ansperformance.eu/traffic/statfor/

1. Air traffic statistics and forecasts

Content
- Definition
- EUROCONTROL recommended sources
- Description
- Related standard inputs
- Comments

1 Definition

Actual and forecast numbers of flights and service units

2 EUROCONTROL recommended source

Source	EUROCONTROL Statistics and Forecasts Service (STATFOR) https://www.eurocontrol.int/forecasting

3 Description

The objective of the Statistics and Forecast (STATFOR) service is to provide statistics and forecasts on air traffic in Europe and to monitor and analyse the evolution of the air transport Industry.

It produces the following:

- Seven-year forecasts
  The 7-year forecasts give a comprehensive picture of anticipated air traffic development in Europe for the next seven years. They combine flight statistics with economic growth and models of other industry drivers, including costs, airport capacity, passenger numbers, load factors and aircraft size. Using high- and low-growth scenarios, they present a likely range for growth, to help planners manage risks. We publish them biannually, in spring and autumn, covering flights, and en route and terminal service units every year.
- Twenty-year forecasts
  The 20-year forecasts look at a range of distinct possible scenarios for how the air traffic industry might look in 20 years' time. This allows a range of 'what if?' questions to be explored, for factors inside the industry (e.g. the growth of small business jets, or of point-to-point traffic) or outside the industry (e.g. the price of oil or environmental constraints). Twenty-year forecasts are usually published every two to three years.
- Ad-hoc publications, such as the Challenges to Growth reports, trends in air traffic studies and other analyses can be found in the EUROCONTROL library: https://www.eurocontrol.int/library

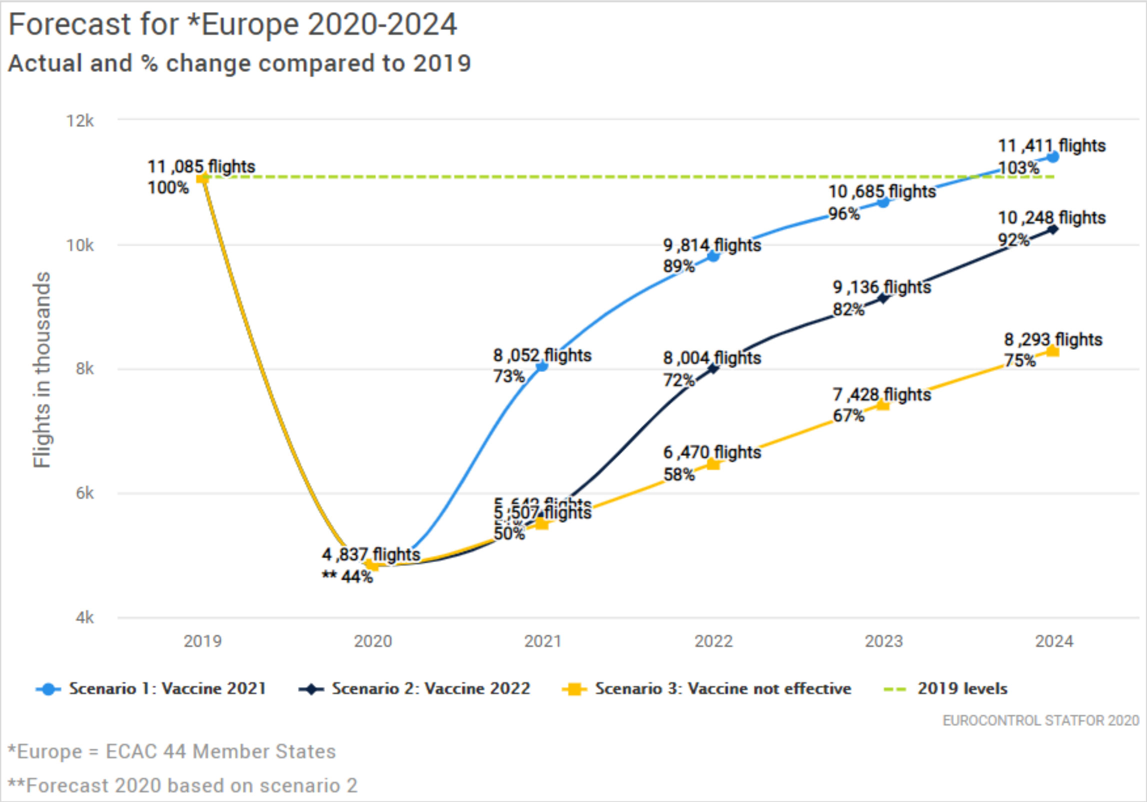
Traffic statistics and forecasts can be obtained directly from the **STATFOR Interactive Dashboard (SID):** https://www.eurocontrol.int/dashboard/statfor-interactive-dashboard.

4 Related standard inputs

Medium-term capacity planning (page 10), air traffic delay (page 17), flow management delay (page 19) and cost of delay (page 45)

5 Comments

The following chart (status: November 2020) shows the traffic forecast taking account of the impact of COVID.



Source: EUROCONTROL STATFOR 2020, https://www.eurocontrol.int/covid19

2. Medium-term capacity planning

Content

1 Definition

ATM capacity forecasts and planning targets over a specific period

Capacity planning is the systematic determination of resource requirements for the projected output, over a specific period.

2 EUROCONTROL recommended sources

Source 1	EUROCONTROL NMD, Network Operations Plan (NOP) 2019-2024 https://www.eurocontrol.int/publication/european-network-operations-plan-2019-2024
Source 2	EUROCONTROL NMD, NOP (6-week) Rolling Seasonal Plan, a consolidated network view of traffic evolution https://www.eurocontrol.int/news/eurocontrol-nm-publishes-network-rolling-plan
Source 3	European ATM Master Plan Level 3, Implementation Plan and **Error! Hyperlink reference not valid.**European ATM Master Plan Level 3, Implementation Report https://www.eurocontrol.int/publication/european-atm-master-plan-implementation-plan-level-3
Source 4	Local Single Sky Implementation (LSSIP) documents prepared for each country including capacity forecasts. https://www.eurocontrol.int/service/local-single-sky-implementation-monitoring

3 Description

Source 1

The Network Operations Plan (NOP) provides a short- to medium-term outlook of how the ATM network will operate. It gives details of capacity and flight efficiency enhancement measures planned at network level and by each area control centre (ACC), as well as a description of the airport performance assessment and improvement measures which are planned at those airports which generate a high level of delay.

Source 2

With the turmoil related to the pandemic, the next edition of the NOP is temporally replaced by source 2**,** the NOP Rolling Seasonal Plan, a special version of the NOP which focuses on the planning of the next six weeks and in managing the execution and implementation of the 5-year NOP.

This Plan is currently playing a major role in helping European aviation to recover by providing aviation's key actors with the global view they need in order to plan effectively. The NM is coordinating with all partners to ensure that capacity is available at ACCs, in the airspace they manage and on the ground at airports, in order to meet the expected traffic demand from the airlines on every day of the next six weeks. The plan is updated every Friday and reviewed every Monday by operational stakeholders in the Ad hoc Enlarged NDOP Recovery Cell, a body which brings Europe’s Network ANSPs, airports, airlines and military directors of operations together to enhance performance and tackle problems on a network basis, as inputs for the next edition.

Note that the normal NOP planning processes will be reinstated as from autumn 2021.

More information about network performance (and access to dashboards and the archive) can be found at https://www.eurocontrol.int/network-performance.

Source 3

The European ATM Master Plan Level 3 (MPL3) Implementation Plan provides the framework for the commonly agreed actions to be taken by ECAC stakeholders, in the context of the implementation of the SESAR Programme.

These actions are consolidated in implementation objectives, addressing elements in SESAR which have reached the necessary operational and technical maturity and for which stakeholders have expressed an interest in their operational introduction. They provide all civil and military implementing parties (ANSPs, airport operators, airspace users and regulators) with a basis for short- to medium-term implementation planning.

The 2020 edition of the implementation plan focuses on the results of the SESAR 1 Programme. It highlights the contribution of each SESAR solution and implementation objective to capacity, operational efficiency, cost-efficiency, safety, the environment and security.

The plan integrates implementation objectives covering 20 SESAR solutions in order to ensure adequate coverage of the Pilot Common Project (PCP) requirements in relation to the SESAR Deployment Manager’s (SDM) deployment programme families.

It also fully addresses transition phase 1 of the Airspace Architecture Strategy up to 2025 through implementation objectives addressing 15 SESAR solutions.

The Master Level 3 Implementation Plan is produced annually.

Source 4

The Local Single Sky Implementation (LSSIP) documents give a comprehensive overview of all ATM information for each State, hence they also show the ATM capacity forecasts and planning targets from the NOP. The documents reflect progress made and detail the plans for each ECAC State for the next five to seven years.

LSSIP documents, one for each State, are derived from the European Single Sky Implementation (ESSIP) (also known as Master Plan Level 3) objectives, and stakeholder lines of action cascade down into the States.

The information from the LSSIP documents is put together in the MPL3 Implementation Report to show progress at pan-European level. This report is also produced annually.

4 Related standard inputs

Air traffic statistics and forecast (page 8) and flow management delay (page 19).

5 Comment

The European ATM Master Plan[1] is the main planning tool for setting ATM priorities, ensuring that the SESAR target concept becomes a reality. It is an evolving roadmap and the result of collaboration between all ATM stakeholders.

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[1] *https://www.eurocontrol.int/portal/european-atm-master-plan-portal*

The Master Plan provides a high-level view of what needs to be done in order to deliver a high-performing ATM system, while also explaining why and by when. It sets the framework for the development activities carried out by the SESAR Joint Undertaking (SJU) and deployed by stakeholders in partnership with the SESAR Deployment Manager (SDM).

3. Number of IFR flights

Content
- Definition
- EUROCONTROL Recommended values
- Description
- Related standard inputs
- Further reading

1 Definition

The number of IFR flights in Europe.

2 EUROCONTROL recommended values

Value 1	Monthly and yearly number of flights by flow category, ECAC, year 2019
Source 1	EUROCONTROL (2020) – STATFOR statistics Traffic statistics and forecasts can be obtained from the STATFOR Interactive Dashboard (SID). http://www.eurocontrol.int/statfor

Month	Arrivals	Departures	Internal	Overflights	Total
January	85 052	84 909	601 427	16 115	787 503
February	75 500	75 447	573 216	13 600	737 763
March	87 907	87 966	653 641	16 928	846 442
April	91 421	91 354	706 721	17 043	906 539
May	94 944	94 649	780 080	16 189	985 862
June	105 522	105 571	810 253	16 782	1 038 128
July	113 863	114 128	846 783	17 788	1 092 562
August	115 290	115 399	831 933	17 932	1 080 554
September	104 350	104 260	809 520	16 192	1 034 322
October	99 236	99 824	764 457	16 532	980 049
November	85 442	85 748	615 031	15 740	801 961
December	87 339	87 539	602 431	16 308	793 617
Total	1 145 866	1 146 794	8 595 493	197 149	11 085 302

<table>
<tr><td>Value 2</td><td>Flights by market segment[2] of operator, ECAC, year 2019
<table>
<tr><th>Operator</th><th>Number of flights</th><th>Proportion</th><th>Evolution 2019 vs. 2018</th></tr>
<tr><td>Traditional scheduled</td><td>5 858 759</td><td>52.9%</td><td>1.4%</td></tr>
<tr><td>Low-cost</td><td>3 352 186</td><td>30.2%</td><td>0.7%</td></tr>
<tr><td>Business aviation</td><td>704 308</td><td>6.4%</td><td>-3.0%</td></tr>
<tr><td>Charter</td><td>441 924</td><td>4.0%</td><td>2.7%</td></tr>
<tr><td>All-cargo</td><td>323 395</td><td>2.9%</td><td>-2.7%</td></tr>
<tr><td>Other types</td><td>294 766</td><td>2.7%</td><td>0.7%</td></tr>
<tr><td>Military</td><td>109 964</td><td>1.0%</td><td>-4.7%</td></tr>
<tr><td>**Grand total**</td><td>**11 085 302**</td><td>**100%**</td><td>**0.8%**</td></tr>
</table></td></tr>
<tr><td>Source 2</td><td>EUROCONTROL (2020) – STATFOR statistics
Traffic statistics and forecasts can be obtained from the STATFOR Interactive Dashboard (SID):. http://www.eurocontrol.int/statfor.</td></tr>
</table>

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[2] *Rules for EUROCONTROL classification of low-cost, all-cargo and business aviation types of flights:* *https://www.eurocontrol.int/publication/market-segment-rules*

Value 3

Top 20 number of flights by civil aircraft operating in airspace in Europe controlled by the EUROCONTROL Network Manager, year 2019.

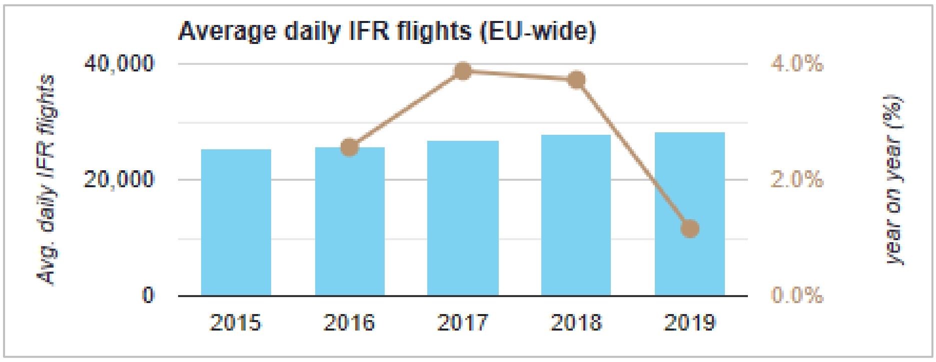
FPL aircraft type	Flights	Proportion	Cumulative
B738	2 165 864	19.54%	19.54%
A320	1 896 439	17.11%	36.65%
A319	870 521	7.85%	44.50%
A321	664 047	5.99%	50.49%
DH8D	311 352	2.81%	53.30%
E190	278 773	2.51%	55.81%
A20N	259 032	2.34%	58.15%
B77W	189 882	1.71%	59.86%
CRJ9	181 291	1.64%	61.50%
A332	166 619	1.50%	63.00%
AT76	162 415	1.47%	64.47%
B737	161 821	1.46%	65.93%
AT75	158 337	1.43%	67.35%
A333	158 229	1.43%	68.78%
E195	154 665	1.40%	70.18%
B789	116 394	1.05%	71.23%
B763	103 803	0.94%	72.16%
B772	101 232	0.91%	73.08%
B752	99 583	0.90%	73.97%
CRJX	92 270	0.83%	74.81%
Other types	2 792 733	25%	100%
Total	**11 107 046**	**100%**	

Source 3

EUROCONTROL (2019) — Network Manager flight plans and PRISME fleet data (ECAC region)

Value 4

Daily average of IFR flights, 2015 to 2019, EU-wide area



	2015	2016	2017	2018	2019
Average daily IFR flights	25 321	25 972	26 980	27 987	28 313

Source 4	Performance Review Board (PRB) – ANS performance monitoring (EU-wide) https://www.eurocontrol.int/prudata/dashboard/vis/2019/

3 Description

Value 1 shows the typical fluctuation in traffic during the year, peaking in July and August. The lowest level usually occurs in February.

Value 2 indicates an overall increase in flights of 0.8% in 2019 compared with 2018. Traditional scheduled traffic increased by 1.4% and charter traffic by 2.7%, whilst business aviation decreased by 3% and cargo by 2.7%. Military traffic covering only those flights operating as general air traffic (GAT) and excluding operational air traffic (OAT) decreased by 4.7%.

Value 3 Of those aircraft which flew IFR in 2019, four hundred and thirty-six (436) different civil aircraft types operated in Europe in 2019. Some 75% of the flights were carried out by the 20 aircraft types displayed.

4 Related standard inputs

IFR flight information per operator segment (page 55), fleet age (page 66), fleet size (page 69) and fleet CNS capability (page 73).

5 Further reading

EUROCONTROL Performance Review Commission
The Performance Review Commission publishes traffic analyses in the annual Performance Review reports (https://www.eurocontrol.int/prc/publications).

6 Comments

These traffic figures are from 2019 and do not yet reflect the impact of COVID. Estimated traffic figures for 2020 and beyond can be found in the EUROCONTROL five year forecast https://www.eurocontrol.int/publication/eurocontrol-five-year-forecast-2020-2024

4. Air traffic delay

Content

1 Definition

Statistical reports on all causes of delay

2 EUROCONTROL recommended values

Value	
Source	EUROCONTROL CODA (2019) All-Causes Delay to Air Transport in Europe https://www.eurocontrol.int/sites/default/files/2020-04/eurocontrol-coda-digest-annual-report-2019.pdf

3 Description

The report identified in the source value gives an overview of the delay situation in the European Civil Aviation Conference area. It has been prepared by the Central Office for Delay Analysis (CODA), a EUROCONTROL service. It is based on delay data provided directly by airlines. This data on all causes of delay is derived by airlines, comparing actual timings with their published schedules.

Statistics on all causes of delay can be obtained directly from the **CODA Interactive Dashboard (CID)** (a request for access is required). This dashboard aims to provide the user with an enhanced understanding of the causes of delay to flights, both that relating to air traffic flow management (ATFM) and non-ATFM-related delay. ATFM delay constitutes only a fraction of primary delays from all causes, and around half of all delay is reactionary rather than primary. Analyses within the dashboard are based on flight-by-flight data provided by airspace users as well as the Network Manager.

More information about CODA can be found at https://www.eurocontrol.int/network-performance (go to CID).

4 Related standard inputs

Air traffic statistics and forecast (page 8), flow management delay (page 19) and cost of delay (page 45)

5. Flow management delay

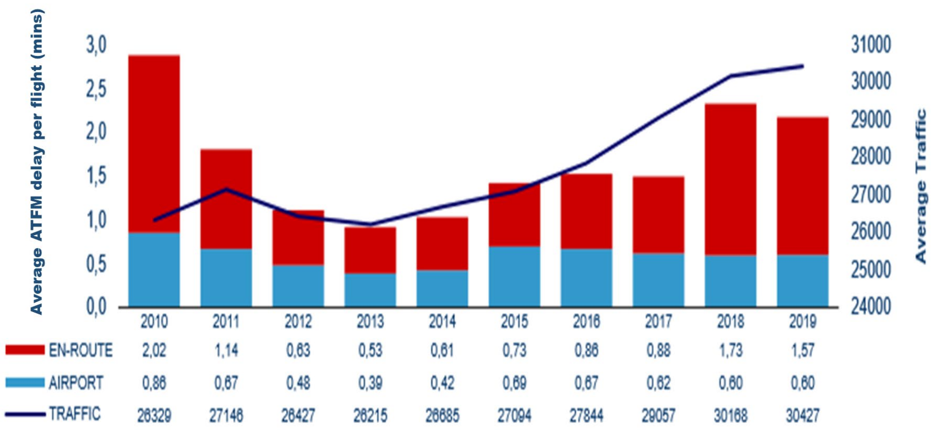
Content
- Definition
- EUROCONTROL recommended value
- Description
- Related standard inputs
- Comments

1 Definition

Statistical reports on European ATM network performance in terms of the number of flights and levels of air traffic flow management (ATFM) delay[3].

2 EUROCONTROL recommended values

<table>
<tr><td>Value</td><td>Daily traffic and ATFM delay per flight (en route and airport) 2009-2019



<table>
<tr><th></th><th>2010</th><th>2011</th><th>2012</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th></tr>
<tr><td>🟥 EN-ROUTE</td><td>2,02</td><td>1,14</td><td>0,63</td><td>0,53</td><td>0,61</td><td>0,73</td><td>0,86</td><td>0,88</td><td>1,73</td><td>1,57</td></tr>
<tr><td>🟦 AIRPORT</td><td>0,86</td><td>0,67</td><td>0,48</td><td>0,39</td><td>0,42</td><td>0,69</td><td>0,67</td><td>0,62</td><td>0,60</td><td>0,60</td></tr>
<tr><td>— TRAFFIC</td><td>26329</td><td>27146</td><td>26427</td><td>26215</td><td>26685</td><td>27094</td><td>27844</td><td>29057</td><td>30168</td><td>30427</td></tr>
</table>
</td></tr>
<tr><td>Source</td><td>EUROCONTROL NMD, Network Operations Report 2019
https://www.eurocontrol.int/sites/default/files/2020-04/nm-annual-network-operations-report-2019-main-report.pdf
Reports from previous years are available in the EUROCONTROL library: https://www.eurocontrol.int/library.</td></tr>
</table>

3 Description

The EUROCONTROL Network Manager produces regular reports on the overall performance of the network. These help the Network Manager to monitor and understand how the network is performing and to take action when a problem occurs.

The value above is extracted from a report providing an overview of the European ATM network's performance in the areas of traffic evolution, capacity offered by the air navigation service providers and airports, delays and flight efficiency. The report analyses the annual results in light of the main events which took place in the course of the year. Airspace users' opinions on network performance are also included. This report is updated annually.

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[3] *flights delayed by an ATFM regulation*

Information can be accessed and downloaded from the EUROCONTROL Network Operations Monitoring and Reporting web page https://www.eurocontrol.int/network-performance, together with access criteria for non-public reports or applications, and source/third party use. The page also gives access to historical data.

4 Related standard inputs

Air traffic statistics and forecast (page 8), air traffic delay (page 17) and cost of delay (page 45).

5 Comments

Flow management delay differs from air traffic delay in that the latter relates to both ATFM-related delay and non-ATFM-related delay. Flow management delay, i.e. ATFM delay, constitutes only a fraction of primary delay from all causes, and around half of all delay is reactionary rather than primary.

Delay statistics for ECAC are also presented on a regular basis in the Performance Review reports (PRRs), published annually by the Performance Review Commission. These publications can be found in the EUROCONTROL library: https://www.eurocontrol.int/library.

6. Rate of fuel burn

Content
- Definition
- EUROCONTROL Recommended value
- Description
- Related standard inputs
- Other possible sources

1 Definition

Average number of kilogrammes per hour of fuel burnt by an aircraft in different flight phases and with different load factors

2 EUROCONTROL recommended values

Value

Fuel burn rates (kg/minutes) in flight phases where delay can occur for most representative aircraft types flying (with restriction in use[4])

Flight phase	Taxi	En route		Arrival management	
Weight (% of max. useful load)[5]	**N/A**	**65**	**80**	**50**	**65**
Scheduled AC type					
B738	12.0	37.7	40.7	36.0	38.3
A320	11.5	38.5	41.7	35.6	37.4
A319	10.0	34.8	37.4	35.6	37.0
A321	13.5	41.7	45.1	40.9	43.1
E190	9.0	28.8	31.2	27.7	28.9
DH8D	-	17.1	17.7	14.5	15.0
B737	12.0	33.3	35.9	32.7	34.6
CRJ9	-	25.2	27.2	17.0	18.1
A332	25.0	94.4	102.5	80.4	85.7
B77W	32.7	144.4	159.4	110.9	125.8
Business AC type					
C56X	-	7.7	8.2	7.7	7.9
BE20	-	3.9	4.2	4.3	4.4
PC12	-	2.4	2.6	3.7	3.8
C510	-	4.7	4.9	4.8	5.0
F2TH	-	11.5	12.6	9.3	9.7

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[4] *It is strictly prohibited to use the fuel burn values to compare fuel efficiency and emission data between aircraft types from the same or different manufactures. Data are provided here to allow the drafting of aggregate business cases.*

[5] *The useful load is the sum of the payload and the fuel. The maximum useful load is approximately the MTOW minus the empty aircraft weight. The "% of max useful load" referred to in the recommended value indicates how the aircraft is loaded, in terms of payload and fuel (combined). This must also not be confused with the load factor, which indicates how the aircraft is loaded in terms of payload only (i.e. not taking the fuel into account).*

Value

Flight phase	**Taxi**	**En route**		**Arrival management**	
Weight (% of max. useful load)	**N/A**	**65**	**80**	**50**	**65**
Rotorcraft AC type					
S92	N/A	8.8	9.5	6.9	7.3
A139	N/A	5.8	6.1	4.8	5.0
EC25	N/A	9.0	9.6	6.9	7.3
EC55	N/A	4.7	4.9	3.7	3.9

Source	EUROCONTROL BADA (Base of Aircraft Data) https://www.eurocontrol.int/model/bada

3 Description

The above data originate from the Base of Aircraft Data (BADA), which is an aircraft performance model (APM) developed and maintained by EUROCONTROL, with the active cooperation of aircraft manufacturers and operating airlines. The data extracted make use of three different families of the BADA model (BADA 3, BADA 4 and BADA Helicopters).

The data are to be treated as approximations, which give an indication of the average fuel burn per flight phase. These data do not, however, take weather and atmospheric influences into account, nor the impact of specific flight conditions (speed, altitude, etc.), and they are therefore to be used with a correction factor when applied in a specific context.

Organisations which are interested in more aircraft types can request access to the full BADA model (see link above).

4 Related standard inputs

Amount of emissions released by fuel burn (page 24), cost of emissions (page 27) and IFR flight information per market segment (page 55).

5 Other possible sources

Source 1	ICAO (2018) – ICAO Carbon Emissions Calculator Methodology, Version 11, June 2018 https://www.icao.int/environmental-protection/CarbonOffset/Documents/Methodology%20ICAO%20Carbon%20Calculator_v11-2018.pdf
Description 1	ICAO has developed a methodology to calculate the carbon dioxide emissions from air travel for use in offset programmes. The ICAO Carbon Emissions Calculator allows passengers to estimate the emissions attributed to their air travel. One of the inputs is the fuel burn for 312 equivalent aircraft types, Appendix C: ICAO Fuel Consumption Table, page 17.

Source 2	EUROCONTROL Advanced Emission Model (AEM) https://www.eurocontrol.int/model/advanced-emission-model
Description 2	The advanced emission model (AEM) is a standalone application, developed and maintained by the EUROCONTROL Experimental Centre, which estimates aircraft emissions and fuel burn. The AEM can estimate: • the mass of fuel burned by the main engines of a specified type of aircraft with a specified type of engine flying a specified 4D trajectory; • the corresponding masses of certain gaseous and particulate emissions which are produced by the burning of that fuel. Access to the tool requires an AEM user license.

Source 3	ICAO Engine Emissions Databank https://easa.europa.eu/document-library/icao-aircraft-engine-emissions-databank
Description 3	Rates of fuel burn for different phases of flight for individual engine types may be found in the manufacturers' datasheets in the ICAO Engine Emissions Databank.

7. Amount of emissions released by fuel burn

Content

- Definition
- EUROCONTROL recommended value
- Other possible sources
- Related standard inputs
- Comments

1 Definition

Amount (mass) of emissions released by the combustion of aviation fuel

2 EUROCONTROL recommended value

Value	<table><tr><th>Emissions</th><th>Amount emitted (per kg of fuel burned)</th></tr><tr><td>CO_2</td><td>3.15 kg</td></tr><tr><td>H_2O</td><td>1.237 kg</td></tr><tr><td>SO_2</td><td>0.00084 kg</td></tr></table>
Source	EUROCONTROL (2018) – “European Aviation Fuel Burn and Emissions Inventory System for the European Environment Agency” https://www.eurocontrol.int/publication/european-aviation-fuel-burn-and-emissions-inventory-system-feis-european-environment

3 Other possible sources

Source 1	European Environment Agency (2017) “EMEP/EEA air pollutant emission inventory guidebook – 2019” https://www.eea.europa.eu/publications/emep-eea-guidebook-2019 Values specific to aviation are available in Part B: sectoral guidance chapters/1. Energy/1.A. Combustion/1.A.3.a Aviation 2019.pdf https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-a-aviation/view
Description 1	The Emission Inventory Guidebook gives values for emission factors (for CO_2, CH_4, N_2O, NOx, CO, NMVOC, SO_2 and $PM_{2.5}$) and fuel consumption in different phases of flight – including taxiing – for different aircraft types, using three different levels of accuracy and complexity. In the table, the emission factors for the “Very Simple” (called Tier 1) methodology are given on a representative aircraft basis, using jet kerosene as fuel.

Source 2	ICAO Aircraft Engine Emissions Databank (for turbojet and turbofan Aircraft with a static thrust greater than 26.7 kilonewtons), August 2020 https://www.easa.europa.eu/domains/environment/icao-aircraft-engine-emissions-databank
Description 2	This Databank contains information on exhaust emissions only for those aircraft engines which have entered production. The information was provided by engine manufacturers and collected by the International Civil Aviation Organization (ICAO). The European Aviation Safety Agency (EASA) hosts this Databank on behalf of ICAO.

Source 3	FOI, Swedish Defence Research Agency (for turboprop aircraft) https://www.foi.se/en/our-knowledge/aeronautics-and-air-combat-simulation/fois-confidential-database-for-turboprop-engine-emissions.html
Description 3	FOI is the keeper of a confidential database of emission indices (EI) of NOx, HC and CO, with corresponding fuel flows for turboprop engines. Datasheets have been supplied by the turboprop engine manufacturers, originally for the purposes of calculating emissions-related landing charges. The data are presented in the same format as in the ICAO (International Civil Aviation Organization) Engine Emissions Database for jet engines, but have not been endorsed by ICAO in a certification process. It should be noted that the data contain many inaccuracies, resulting primarily from the unregulated test methodologies. The data is, however, considered to be the best available, and may be used for emissions inventories, emissions-related landing charges, etc. The data are available on request.

Source 4	Swiss Federal Office of Civil Aviation, FOCA – Aircraft Engine Emissions (for piston engine aircraft, helicopters) https://www.bazl.admin.ch/bazl/en/home/specialists/regulations-and-guidelines/environment/pollutant-emissions/aircraft-engine-emissions.html
Description 4	The Swiss FOCA has developed a measurement and calculation methodology for aircraft piston engine emissions in order to improve aviation emission inventories.

4 Related standard inputs

Rate of fuel burn (page 21), cost of emissions (page 27) and IFR flight information per market segment (page 55).

5 Comments

The Committee on Aviation Environmental Protection (CAEP), a technical committee of the ICAO Council, recommends the use a conversion factor of 3.16 g of CO_2 per g of Jet A. The 3.16 value can be found in ICAO Doc 9889, 1st edition, 2011, and other documents.

However, in Europe, as early as 2009, Commission Decision 2009/339/EC indicated an emission factor of 3.15 for the mass conversion from Jet A to CO_2. Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 (on the monitoring and reporting of greenhouse gas emissions), which integrates the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) in the Emission Trading Scheme (ETS), applicable since 1 January 2019, for the period after January 2021, now recommends, for the time being, that factor 3.15 for Jet A fuel is still to be used in Europe for the ETS and also for CORSIA.

In view of the above, emission factor 3.15 should continue to be used in SESAR 2020, for the sake of internal consistency within the programme, and at least unless the EU ETS decides to move to 3.16. Nevertheless, factor 3.16 should be used when the evaluation concerns comparisons with studies carried out within the ICAO framework or using the factor recommended by ICAO, in order to ensure external consistency. [Extracted from SESAR 2020 – Environment Impact Assessment Guidance Guidance Del: 4.0.080]

8. Cost of emissions

Content
- Definition
- EUROCONTROL recommended values
- Description
- Further reading
- Related standard inputs
- Comments

1 Definition

Estimate of the cost of CO_2 and other aircraft emissions released by the combustion of aviation fuel

2 EUROCONTROL recommended source and values

<table>
<tr>
<td>Value 1</td>
<td>
Price of CO_2
Climate change avoidance costs in € per tonne of CO_2 equivalent
<table>
<tr><th>Forecast</th><th>Low[6]</th><th>Medium</th><th>High</th></tr>
<tr><td>Short and medium run (up to 2030)</td><td>63</td><td>105</td><td>199</td></tr>
<tr><td>Long run (from 2040 to 2060)</td><td>164</td><td>283</td><td>524</td></tr>
</table>
<i>(adjusted from € 2016 to € 2019 prices)</i>
</td>
</tr>
<tr>
<td>Value 2</td>
<td>
Well-to-tank air pollution costs: damage cost estimates in €/kg emission (emissions in the year 2016, EU-27+UK values)
<table>
<tr><th>Costs in € per kg</th><th>NO_x</th><th>NMVOC</th><th>SO_2</th><th>$PM_{2.5}$ (exhaust)</th></tr>
<tr><td>EU-27+UK</td><td>11.5</td><td>1.3</td><td>11.5</td><td>20.4</td></tr>
</table>
<i>(adjusted from € 2016 to € 2019 prices)</i>
</td>
</tr>
<tr>
<td>Value 3</td>
<td>
Total and average air pollution costs for aviation for 33 selected EU airports[7]
<table>
<tr><th>Distance group</th><th>Range</th><th>M€/year</th><th>€-cent/km</th><th>€-cent/ pax (complete flight)</th></tr>
<tr><td>Short-haul</td><td>< 1 500 km</td><td>284</td><td>0.32</td><td>171</td></tr>
<tr><td>Medium-haul</td><td>< 1 500-5 000 km</td><td>400</td><td>0.14</td><td>243</td></tr>
<tr><td>Long-haul</td><td>> 5 000 km</td><td>379</td><td>0.06</td><td>467</td></tr>
<tr><td colspan="2">Total and average</td><td>1 062</td><td>0.11</td><td>259</td></tr>
</table>
<i>(adjusted from € 2016 to € 2019 prices)</i>
</td>
</tr>
</table>

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[6] *These values were derived by calculating the average of the low, central and high estimates for the relevant time periods of the values from the literature, but excluding the lowest and highest values in order to eliminate outliers.*

[7] *The largest airports in each EU country (including the UK)*

<table>
<tr>
<td>Value 4</td>
<td>Marginal air pollution costs[8] of aviation for selected cases[9]
<table>
<tr><th>Type of flight</th><th>Distance [km]</th><th>Emission class</th><th>Example of aircraft type</th><th>€ per LTO</th><th>€-cent per pax km</th><th>€ per pax</th></tr>
<tr><td rowspan="2">Short-haul</td><td>500</td><td>Low</td><td>Bombardier CRJ900</td><td>106</td><td>0.29</td><td>1.49</td></tr>
<tr><td>500</td><td>High</td><td>Embraer 170</td><td>144</td><td>0.32</td><td>1.60</td></tr>
<tr><td rowspan="4">Medium-haul</td><td>1 500</td><td>Low</td><td>Airbus 320</td><td>174</td><td>0.07</td><td>1.17</td></tr>
<tr><td>1 500</td><td>High</td><td>Boeing 737</td><td>195</td><td>0.12</td><td>1.66</td></tr>
<tr><td>3 000</td><td>Low</td><td>Airbus 320</td><td>230</td><td>0.05</td><td>1.55</td></tr>
<tr><td>3 000</td><td>High</td><td>Boeing 737</td><td>258</td><td>0.07</td><td>2.20</td></tr>
<tr><td rowspan="4">Long-haul</td><td>5 000</td><td>Low</td><td>Airbus 340</td><td>528</td><td>0.03</td><td>1.79</td></tr>
<tr><td>5 000</td><td>High</td><td>Boeing 777</td><td>876</td><td>0.04</td><td>2.02</td></tr>
<tr><td>15 000</td><td>Low</td><td>Airbus 340</td><td>748</td><td>0.02</td><td>2.53</td></tr>
<tr><td>15 000</td><td>High</td><td>Boeing 777</td><td>1.240</td><td>0.02</td><td>2.86</td></tr>
</table>
(adjusted from € 2016 to € 2019 prices)</td>
</tr>
<tr>
<td>Source 1 to 4</td>
<td>“Handbook on the external costs of transport”, CE Delft, January 2019 (commissioned by European Union DG Move), tables 24, 49, 17 and 23 https://www.cedelft.eu/en/publications/2311/handbook-on-the-external-costs-of-transport-version-2019
Also available from the Publications Office of the EU.</td>
</tr>
</table>

3 Description

The CO_2 price used to calculate the external costs of climate change in **Value 1** is based on the cost avoidance approach. Extract from the “Handbook on the external costs of transport”: *It determines external cost valuation factors (i.e. shadow prices) by determining the cost to achieve a particular policy target (e.g. EU CO_2 reduction targets). This is done by estimating an avoidance cost function, which provides a proxy for the supply of environmental quality. It determines how much it would cost to supply an additional level of environmental quality (e.g. reduction of one additional tonne of CO_2). Based on this cost curve, the minimal cost required to meet the policy target is estimated. The assumption is that this policy target reflects collective preferences with respect to the externality concerned and hence, that the minimum cost to reach this target is a good proxy of the (collective) willingness-to-pay (WTP) to avoid the damage caused by the externality.”*

The calculations for **Value 2 and 3** have been made on the basis of the cost factor of €100 per tonne of CO_2 equivalent, the central value for short- and medium-run estimates given in value 1.
As was the case in the 2008 Handbook, it is further assumed that the aviation emissions relevant for air quality are restricted to the emissions in the landing and take-off (LTO) phases. The total emissions have been cross-checked with the total emission database from the European Monitoring and Evaluation Programme under the auspices of the European Environmental Agency (EMEP/EEA). The values are for passenger flights.

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[8] *For the following emissions: NH_3, NMVOC, SO_2, NOx, $PM_{2.5}$ and PM_{10}*

[9] *For the cost factors for air pollution costs, the emissions during the LTO cycle are mainly relevant, as the cruise emissions lead to almost no damage costs.*

4 Further reading

EASA/EEA/EUROCONTROL
European Environmental Report, 2019
https://www.eurocontrol.int/publication/european-aviation-environmental-report-2019
The document provides an updated assessment of the environmental performance of the aviation sector published in the first report of 2016. The continued growth of the sector has produced economic benefits and connectivity within Europe and is stimulating investment in novel technology. This draws on a wider pool of expertise and innovative approaches from other sectors, thereby creating potential new opportunities to address the environmental impacts of aviation. However, it is recognised that the contribution of aviation activities to climate change, noise and air quality impacts is increasing, thereby affecting the health and quality of life of European citizens.
Para. 5.3 touches on environmental charges levied by some airports.

European Commission
https://ec.europa.eu/clima/policies/ets/auctioning_en
https://www.eex.com/en/
Extracted from the EC website: *"Twenty-eight countries (25 EU Member States and 3 EEA/EFTA countries) auction their allowances on the common auction platform. The common auction platform is nominated for up to five years by a joint procurement between the Commission and the participating countries, in accordance to the rules laid down by the joint procurement agreement.*
Currently, the European Energy Exchange (EEX) in Leipzig is the common auction platform.
Some countries participating in the EU ETS have opted out of the common auctioning platform:
Germany has nominated EEX as its opt-out platform.
Poland is making use of the common auction platform to auction its share of allowances until the appointment of its opt-out platform.
ICE Futures Europe (ICE) in London acts as the United Kingdom's platform. The Withdrawal Agreement between the EU and the United Kingdom ensures that UK operators remain subject to compliance obligations for the years 2019 and 2020."

ECAC (2011)
NOx emission classification scheme, ECAC recommendation ECAC27/4, 11 September 2011
https://www.ecac-ceac.org/documents/

UK Department for Environment, Food and Rural Affairs (DEFRA)
Air quality damage cost update 2019, prepared by Ricardo Energy & Environment (Ricardo-AEA Ltd)
https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1902271109_Damage_cost_update_2018_FINAL_Issue_2_publication.pdf

Revised sector PM and NOx damage cost estimates and sensitivity boundaries (2017 prices, impacts discounted to 2017, average exchange rate 2017)

Emissions emitted by aircraft[10]	Central damage cost £(€)/kg	Low/high damage cost sensitivity range £(€)/kg	
		Low £(€)/kg	High £(€)/kg
$PM_{2.5}$	194 (222)	41 (46)	560 (639)
NO_x	12 (13)	1.1 (1.2)	45 (51)

Extract from tables 20-21 of the "Air quality damage cost update 2019". Related standard inputs IFR flight information per operator segment (page 55) and rate of fuel burn (page 21) and amount of emissions released by fuel burn (page 24)

5 Related standard inputs

Amount of emissions released by fuel burn (page 24) and rate of fuel burn (page 21).

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[10] *$PM_{2.5}$ is the preferred metric for the change in PM emissions.*

6 Comments

With regard to NOx charges, a LTO NOx charge is currently applied at several European airports. The level of the charge per kg of NOx is set according to the cost of damage caused by NOx to local air quality (LAQ), at or near airports. The charge is levied in several countries, namely Sweden, the UK, Germany, Demark and Switzerland. Two examples are provided below.

At **London Heathrow**, a NO_x emission charge is payable on each movement (per LTO cycle) by a fixed-wing aircraft over 8 618 kg. The charge per kg of NOx is calculated on the aircraft's ascertained NOx emission[11].
https://www.heathrow.com/content/dam/heathrow/web/common/documents/company/doing-business-with-heathrow/flights-condition-of-use/structure-of-charges-decision/Airport_Charges_Decision-5-August-2015.pdf

The Emissions Airport Charges for 2020 **per kg of NOx is £16.84** (€20.5 at the 2019 exchange rate) "Decision – 2020 Airport Charges"
https://www.heathrow.com/content/dam/heathrow/web/common/documents/company/doing-business-with-heathrow/flights-condition-of-use/conditions-of-use-documents/Heathrow_Airport_Charges_and_Conditions_of_Use_2020.pdf

Copenhagen Airports support, through financial incentives, the use of engine types which emit the lowest emissions. The model used for calculating emissions and charges is based on the models currently found in Sweden and Switzerland. The model works with absolute NOx emissions of a specific aircraft engine during a standardised landing and take-off cycle (LTO). NOx emissions per aircraft engine are based on the ICAO specifications and guidelines. The published emissions charge (November 2020) is **kr.16.50 per kg NOx** (€2.2 at the 2019 exchange rate).
https://www.cph.dk/en/cph-business/aviation/charges-and-slot/calculation-of-emission-charges

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[11] *An aircraft's ascertained NOx emission means the product of the engine NOx emission as set out in the ICAO Emission Database and based on the number of engines on the aircraft.*

9. Cost of noise

Content

- Definition
- EUROCONTROL recommended values
- Description
- Other possible value
- Further reading
- Example

1 Definition

Estimate of the cost of noise per person affected, taking into account both the cost of annoyance and health costs due to exposure to traffic noise

2 EUROCONTROL recommended values

Value 1

Environmental price of aviation traffic noise for the EU-27+UK for different noise levels, per person per dB (€2019/dB/person/year)

Noise levels L_{den}[12] in dB(A) [13]	Annoyance	Health	Total
50-54	36	5	41
55-59	72	6	78
60-64	72	9	81
65-69	136	13	148
70-74	136	17	152
≥ 75	136	22	158

(adjusted from € 2016 to € 2019 prices)

Value 2

Total and average noise cost for aviation for 33 selected EU airports

	Total cost	**Average cost**			
	€ billions	€/LTO	€/pax[14]	€/tonne	€-cent/km
Short-haul	0.88	270	2.16	9.51	0.48
Medium-haul					0.12
Long-haul					0.01

(adjusted from € 2016 to € 2019 prices)

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[12] *Lden is the common EU indicator which corresponds to the average noise level throughout the day, evening and night to which a citizen is exposed over the period of a year. One fundamental feature of Lden is that it assumes that evening and night-time noise is more of a nuisance than daytime noise.*
(Evening noise is given a penalty of 5 dB(A). Night-time noise is given a penalty of 10 dB(A).)

[13] *The basic measurement index for noise is the decibel (dB). It is indexed logarithmically, reflecting the logarithmic manner in which the human ear responds to sound pressure. Within the human range of hearing, deep and very high tones at the same sound intensity are experienced as less noisy. To correct for this sensitivity, a frequency weighting is applied to measurements and calculations. The most common frequency weighting is the 'A weighting', dB(A).*
Source: "Handbook on the external costs of transport", CE Delft, January 2019

[14] *Costs per pax include the complete flight (not only the half-way principle).*

Source 1 and 2	“Handbook on the external costs of transport”, CE Delft, January 2019 (commissioned by European Union DG Move) https://www.cedelft.eu/en/publications/2311/handbook-on-the-external-costs-of-transport-version-2019 Also available from the Publications Office of the EU: https://op.europa.eu/fr/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1

3 Description

The table above was extracted from a study carried out by CE Delft (an independent research and consultancy organisation) on the external costs of different types of transport in Europe (tables 33 and 36). It gives an overview of the noise-related costs associated with people exposed to different noise level bands due to aviation. Two major aspects are considered in the study when assessing noise impact and cost:

- Annoyance: This refers to the disturbance which individuals experience when they are exposed to noise (traffic noise in this case), e.g. discomfort, inconvenience.
- Health impacts caused by long-term exposure to noise. The most common symptoms are stress-related health problems. Evidence has not been strong for all noise-related health impacts, and consequently in the European Handbook on External Costs of Transport, only the following health impacts are considered: hypertension, ischaemic heart disease, stroke and dementia. Insomnia is not included in order to avoid double-counting with the costs of annoyance.

The environmental price of noise reflects the welfare loss which occurs with one extra decibel (dB) of noise (CE Delft, 2018). The environmental price of noise needs to be determined implicitly, as there is no market for noise prevention. Previous editions of the European Handbook on External Costs of Transport have recommended using environmental prices based on HEATCO (2006), both for annoyance and health endpoints. HEATCO assumes a constant valuation per dB of noise for annoyance costs, which has recently been disputed. The new version of the Handbook therefore uses increasing prices per dB based on the most recent insights provided by Bristow et al. (2015) for annoyance costs. As for health costs, the prices according to Defra (2014) match the WHO’s recommendations in its latest systematic reviews, and are therefore used in the European Handbook on External Costs of Transport.

Comparable values for road and rail noise costs are also presented in the same study.

Here is an example to show how the environmental price of noise should be applied in calculations: the annual cost for a person exposed to 57dB(A) of aviation noise would be equal to €439 (5dB x €41 + 3dB x €78).

4 Other possible value

<table>
<tr><td>Value</td><td>Aviation noise marginal cost (€/household/year)
<table>
<tr><th colspan="2">Increase in daytime noise metric by one decibel (dB)</th><th>Aviation noise marginal cost (excluding sleep disturbance)</th><th>Sleep disturbance</th></tr>
<tr><td>45</td><td>46</td><td>19</td><td>47</td></tr>
<tr><td>50</td><td>51</td><td>48</td><td>64</td></tr>
<tr><td>55</td><td>56</td><td>60</td><td>82</td></tr>
<tr><td>60</td><td>61</td><td>78</td><td>99</td></tr>
<tr><td>65</td><td>66</td><td>98</td><td>117</td></tr>
<tr><td>70</td><td>71</td><td>119</td><td>117</td></tr>
<tr><td>75</td><td>76</td><td>141</td><td>117</td></tr>
<tr><td>80</td><td>81</td><td>153</td><td>117</td></tr>
</table>
<i>(adjusted from £ 2014 to € 2019 prices at the 2019 exchange rate)</i></td></tr>
<tr><td>Source</td><td>UK Department for Environment, Food and Rural Affairs
Environmental Noise “Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet”, November 2014 (Annex I: Noise marginal values in 2014 prices Table A1.3 & Table A1.4 p.42-43)
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/380852/environmental-noise-valuing-imapcts-PB14227.pdf</td></tr>
<tr><td>Description</td><td>The value presents the results of an economic valuation tool developed by the UK Department for Environment, Food and Rural Affairs. It converts changes in noise exposure to estimated monetary values, in order to support the assessment of the effects of environmental noise.
The report details the current understanding of the links between environmental noise and various effects, including sleep disturbance, annoyance, hypertension and related diseases.
A range of sensitivities is available around these values from the Noise Modelling Tool (see report and excel file for more details https://www.gov.uk/guidance/noise-pollution-economic-analysis).</td></tr>
</table>

5 Further reading

WHO (2018)
“Environmental Noise Guidelines for the European Region”, World Health Organisation (2018)
The World Health Organisation Regional Office for Europe has developed environmental noise guidelines for the European region. The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various sources, such as transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise.

The guidelines focus on the WHO European region and provide policy guidance to Member States which is compatible with the noise indicators used in the European Union's Directive 2002/49/EC. For average noise exposure, the Guideline Development Group (GDG) strongly recommends reducing noise levels produced by aircraft below 45 dB L_{den} and for night noise exposure, below 40 dB L_{night}.
https://www.euro.who.int/__data/assets/pdf_file/0008/383921/noise-guidelines-eng.pdf

WHO (2009)
"Night noise guidelines for Europe",
The World Health Organization (WHO) set the European target limit for outdoor night noise levels at an annual average of 40 decibels (dB) in these guidelines. This would protect the public, including the most vulnerable, such as children and the elderly.
http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf

The reading suggested below broadens the scope of the cost of noise values with documents related to the overall noise levels and related rules and regulations.

EASA/EEA/EUROCONTROL (2019)
"European Environmental Report »
This second European Aviation Environmental Report (EAER) provides an updated assessment of the environmental performance of the aviation sector published in the first report of 2016. The continued growth of the sector has produced economic benefits and connectivity within Europe, and is stimulating investment in novel technology. This draws on a wider pool of expertise and innovative approaches from other sectors, thereby creating potential new opportunities to address the environmental impacts of aviation. It is, however, recognised that the contribution of aviation activities to climate change, noise and air quality impacts is increasing, thereby affecting the health and quality of life of European citizens.
https://www.eurocontrol.int/publication/european-aviation-environmental-report-2019

EASA/EEA/EUROCONTROL (2019)
"Noise country fact sheets"
These country fact sheets summarise information on noise pollution for selected EEA member countries. The fact sheets are based on the latest official noise data reported every five years by EEA member countries under the Environmental Noise Directive (END).
https://www.eea.europa.eu/themes/human/noise/noise-fact-sheets

EC (2002)
Environmental Noise Directive (END) 2002/49/EC
Directive 2002/49/EC relating to the assessment and management of environmental noise (the Environmental Noise Directive – END) is the main EU instrument to identify noise pollution levels and to trigger the necessary action both at Member State and at EU level.
The introduction of the END in 2002 sought to monitor the effectiveness of EU emission controls by requiring the assessment of environmental noise at Member State level. The Directive introduced two key indicators for annoyance and sleep disturbance, which, if exceeded, require action plans to be drawn up which are designed to reduce exposure and protect areas not yet polluted by noise.
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32002L0049

EC (2014), Regulation (EU) No 598/2014
Regulation (EU) No 598/2014 establishes rules and procedures with regard to the introduction of noise-related operating restrictions at EU airports. It follows the guidelines of the ICAO Balanced Approach to Aircraft Noise Management and the rules defined to be applied to airports with more than 50 000 movements per year of civil aircraft.
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014R0598

European Parliament's Committee on Petitions (2020)
"Impact of aircraft noise pollution on residents of large cities", ENVISA/ Study requested by the EU Parliament
This study, provided by the Policy Department for Citizens' Rights and Constitutional Affairs at the request of the Committee on Petitions, aims to provide a clear and simple overview, for the non-

expert reader, of the impact of aircraft noise pollution on residents of large cities, and to make recommendations addressed to the most relevant actors.
https://www.europarl.europa.eu/RegData/etudes/STUD/2020/650787/IPOL_STU(2020)650787_EN.pdf

ACI and CANSO (2015)
“Managing the Impacts of Aviation Noise: A Guide for Airport Operators and Air Navigation Service Providers”
“Managing the Impacts of Aviation Noise” examines the problem of aviation noise and describes methods which airport operators and ANSPs can use to manage and reduce its impact. It reviews four current approaches to managing noise, namely reducing noise at the source, land use planning, noise-reducing operational procedures, and operating restrictions.
https://aci.aero/news/2015/09/23/aci-and-canso-launch-new-initiative-on-reducing-aviation-noise/

6 Example of estimating a noise reduction benefit

Example of estimating a noise reduction benefit

The “cost of noise” values can be used to calculate potential benefits in research project CBAs (cost-benefit analyses) in order to measure the monetary gain of a noise improvement. An example is the SESAR 2020 project Enhanced Arrival Procedures (EAPs). In this case, noise benefits were calculated as the reduction in the noise contour around the airport area when a different EAP concept was applied. The change in the noise contour area results were calculated per decibel band. This value was then multiplied by the number of people affected around the airport within a radius of 10 km, and the value of the cost of noise per person. The cost of noise (see table 1) is also calculated per decibel band. For noise contour results, scenarios were tested and compared using EUROCONTROL IMPACT tool[15].

As mentioned in the further reading section, the EU in 2002 published Directive 2002/49/EC relating to the assessment and management of environmental noise (the Environmental Noise Directive – END). The END, which is the main EU instrument to identify noise pollution levels, requires Member States to prepare and publish noise maps and noise management action plans every five years for major airports (more than 50 000 movements a year, including small aircraft and helicopters).
https://ec.europa.eu/environment/noise/directive_en.htm

The NOISE Observation & Information Service for Europe of the EEA provides an interactive map displaying the exposure to NOISE levels from roads, railways, airports and industry. The map for

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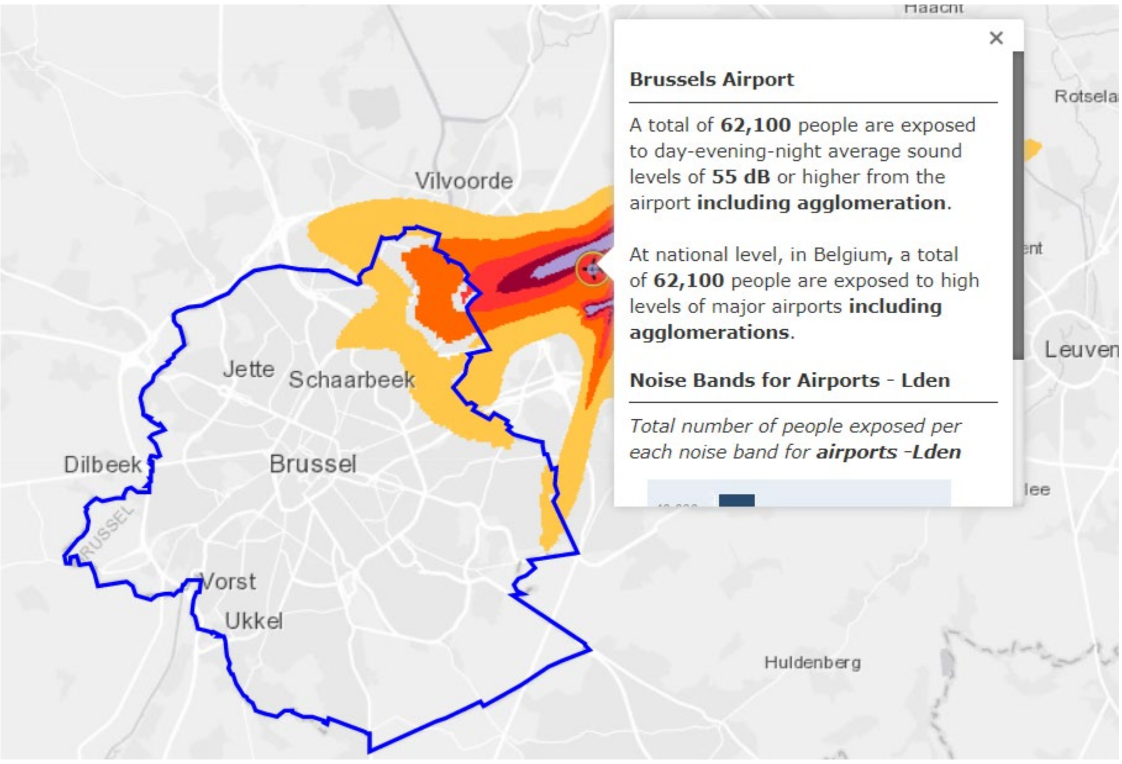
[15] https://www.eurocontrol.int/platform/integrated-aircraft-noise-and-emissions-modelling-platform

airports illustrates the exposure to noise from airports in Europe during the average day and average night period. The example below is Brussels Airport.
https://noise.eea.europa.eu/



Brussels Airport

A total of **62,100** people are exposed to day-evening-night average sound levels of **55 dB** or higher from the airport **including agglomeration**.

At national level, in Belgium, a total of **62,100** people are exposed to high levels of major airports **including agglomerations**.

Noise Bands for Airports - Lden

*Total number of people exposed per each noise band for **airports** -**Lden***

10. Aircraft operating costs

Content
- Definition
- EUROCONTROL recommended values
- Description

1 Definition

Flight and ground costs linked to the operation of an aircraft, such as fuel and oil, flight deck crew, flight equipment depreciation and amortisation, aircraft rentals, landing fees, ground handling, aircraft parking, air bridges and maintenance

2 EUROCONTROL recommended values

Value

Flight operating costs (in $ 2019 prices)

Aircraft type	per aircraft per year (M$)	per flight hour	per flight cycle	per available seat Km (US cents)	per available ton km (US cents)
B737 NG	14.11	4 337	9 231	3.76	33.11
A320 Family	12.84	4 829	8 851	3.60	36.92
B737 Classic	8.26	2 683	5 366	2.96	25.28
B777	40.01	9 507	60 367	3.53	22.07
A330	29.87	7 827	35 857	3.61	24.48
B757	18.21	5 357	18 508	3.73	30.51
B767	26.00	6 675	40 899	3.61	22.18
B787	30.58	7 184	50 827	3.11	19.86
EMB-190	10.87	4 097	5 770	6.35	54.00
Dash 8	4.03	1 921	1 921	6.12	58.08

Source

Values provided by IATA Airline Cost Management Group (ACMG[16])
https://www.iata.org/en/programs/workgroups/airline-cost-mgmt/

3 Description

The above values, provided by IATA, refer to the 2020 ACMG data collection (fiscal year 2019) and provide an overview of the operating costs for 10 types of aircraft (B737 NG, A320 family, B737 Classic, B777, A330, B757, B767, B787, EMB-190 and Dash 8).

The IATA Airline Cost Management Group (ACMG) collects operating costs classified into three categories, which are defined as follows:

- Flight operating expenses are direct operating expenses. They are directly related to the aircraft and the flight activities of an airline, such as flight crews, fuel, flight equipment and navigation. The biggest component of flight operating expenses is fuel and oil at 48%.

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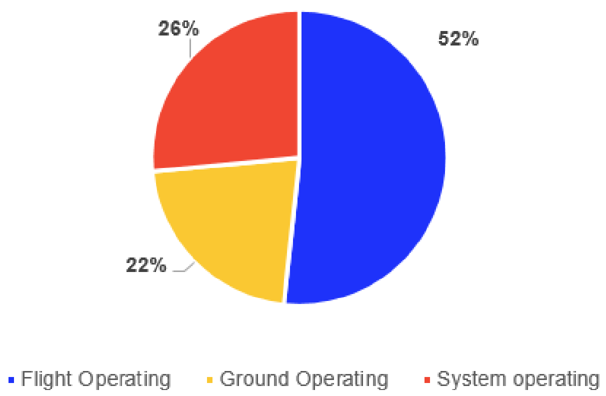
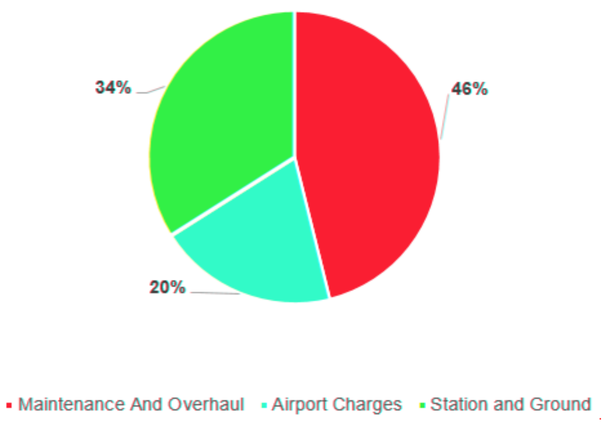
[16] *IATA industry group focusing on matters concerning airline costs and measures to optimise them*

- Ground operating expenses are also direct operating expenses. They are directly related to the ground activities of an airline, such as maintenance and overhaul, airport charges, station and ground. Maintenance and overhaul is the biggest cost component at 46%.
- System operating expenses are overheads and indirect operating expenses. They are not directly related to flight or ground operating expenses. They include costs for cabin attendants, passenger service, load insurance, reservations, ticketing, sales and promotion, IT and communications, and general and administrative costs, with the latter representing 34% of total system operating expenses.

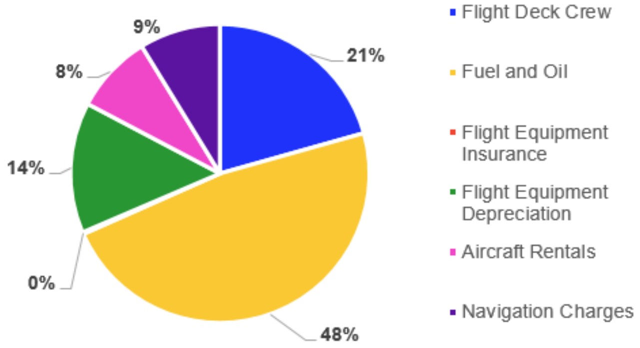
Total Operating Costs Structure



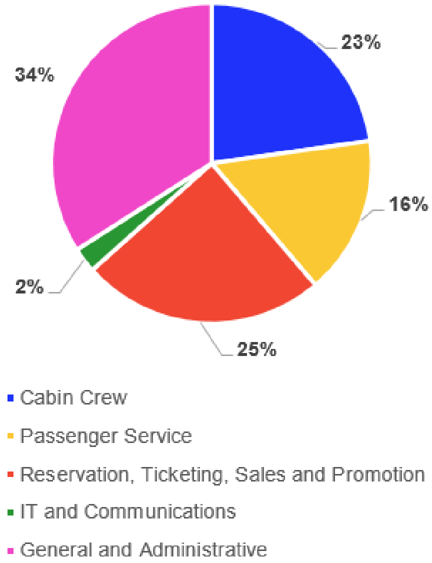
Ground Operating Costs Structure



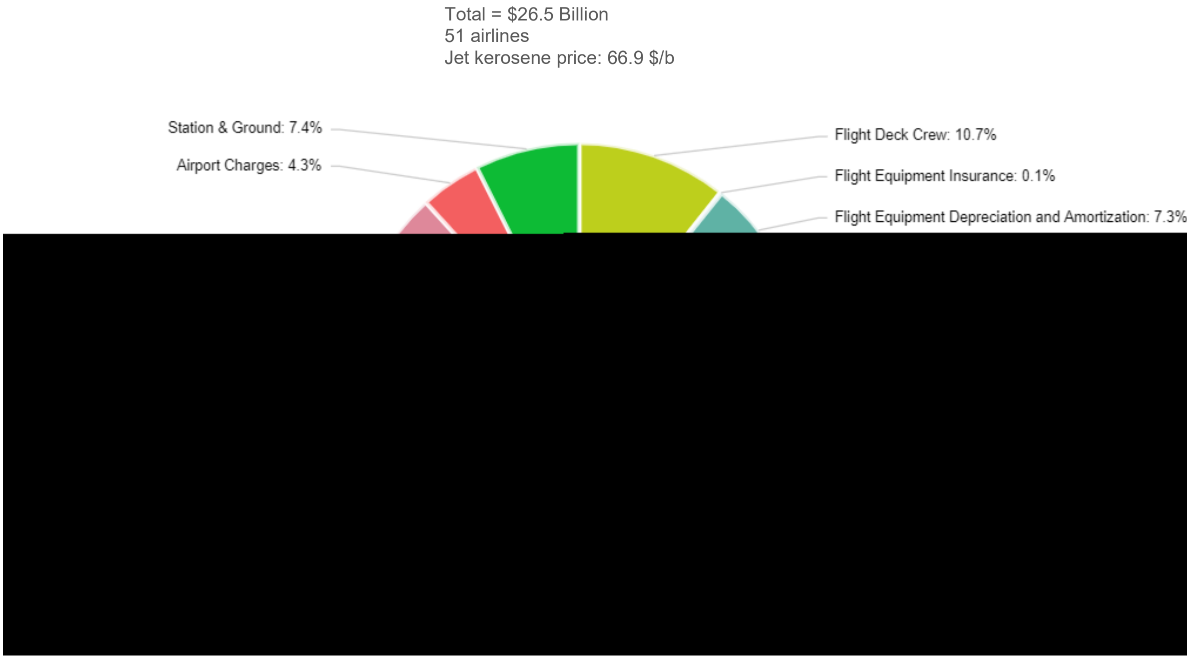
Flight Operating Costs Structure



System Operating Costs Structure



The airline cost structure for 2019:



[redacted]

The values used for analysis are the result of aggregating the cost data provided by 51 airlines worldwide, covering over 35% of the industry in terms of revenue passenger kilometres (RPKs), with European airlines representing 16% of the share and 12% in terms of passengers carried.

Note from IATA

In a number of jurisdictions, airport charges and taxes which are levied on a per-passenger basis are not accounted for in airline profit and loss accounts. As a result, the share of airport charges is likely to be significantly understated, as airports may levy more on a per-passenger or per-aircraft basis in some jurisdictions. To give an order of magnitude, in some regions the ACI (Airports Council International) estimates that over 50% of airport charges are collected on a per-passenger basis, reaching as much as 80% in some regions worldwide.

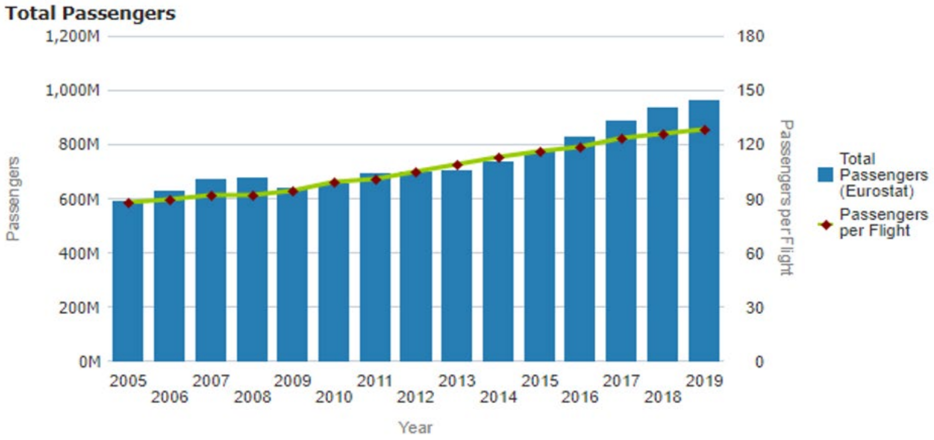
11. Average number of passengers per movement

Content
- Definition
- EUROCONTROL recommended value
- Description
- Other possible value

1 Definition

Average[17] number of passengers per movement (take-off or landing) in Europe

2 EUROCONTROL recommended value

<table>
<tr><td>Value</td><td>Average number of passengers per departing flight, EU-27^{+}UK and EFTA[18]
<table>
<tr><th></th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th></tr>
<tr><td>Average number of passengers per departing flight</td><td>109</td><td>113</td><td>117</td><td>119</td><td>124</td><td>126</td><td>129</td></tr>
</table>


</td></tr>
<tr><td>Source</td><td>Eurostat: air passenger transport by reporting country (extract: avia_paoc)
http://ec.europa.eu/eurostat/web/transport/data/database
EUROCONTROL STATFOR Interactive Dashboard (SID)[19] (goto PAX+)
https://www.eurocontrol.int/dashboard/statfor-interactive-dashboard</td></tr>
<tr><td>Description</td><td>The average number of passengers per movement[20] for a given year is obtained by dividing the number of ‘departing passengers on board’ by the number of ‘departing flights for that year’.</td></tr>
</table>

---

[17] *In this context, the (arithmetic) mean value*

[18] *European Free Trade Association: Iceland, Liechtenstein, Norway and Switzerland*

[19] *Access to the STATFOR Interactive Dashboard can be requested at https://www.eurocontrol.int/dashboard/statfor-interactive-dashboard.*

[20] *A movement is either a take-off or a landing at an airport.*

3 Description

The Eurostat air transport domain contains national and international intra- and extra-EU data. This provides air transport data for passengers (in numbers of passengers) and for freight and mail (in thousands of tonnes) as well as air traffic data for airports, airlines and aircraft. Data are transmitted to Eurostat by the Member States of the European Union as well as the candidate countries Iceland, Norway and Switzerland. The air transport data have been calculated using data collected at airports.

4 Other possible value

<table>
<tr><td>Value</td><td>Values for the main 34 European airports (all operations)
<table>
<tr><th></th><th>2008</th><th>2010</th><th>2012</th><th>2013</th><th>2015</th><th>2017</th></tr>
<tr><td>Passengers per IFR movement</td><td>96</td><td>102</td><td>108</td><td>111</td><td>118</td><td>125</td></tr>
</table>
</td></tr>
<tr><td>Source</td><td>PRC and FAA, "2017 Comparison of ATM-related operational performance: US – Europe", March 2019 (page 25): https://www.eurocontrol.int/publication/useurope-comparison-air-traffic-management-related-operational-performance-2017
Reports from previous years are available in the EUROCONTROL library: https://www.eurocontrol.int/library.</td></tr>
<tr><td>Description</td><td>The table below provides high-level indicators for the main 34 airports[21] in Europe using data reported by the airports.
The number of passengers per IFR movement is calculated by dividing the 'average number of annual passengers per airport' by the 'average number of annual IFR movements per airport'.
<table>
<tr><th></th><th>2008</th><th>2010</th><th>2012</th><th>2013</th><th>2015</th><th>2017</th></tr>
<tr><td>Average number of annual IFR movements per airport ('000)</td><td>260</td><td>237</td><td>233</td><td>228</td><td>223</td><td>248</td></tr>
<tr><td>Average number of annual passengers per airport (million)</td><td>25</td><td>24</td><td>25</td><td>25</td><td>28</td><td>31</td></tr>
</table>
</td></tr>
</table>

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[21] *The list of airports is available in Annex I of the above 2015 report.*

12. Cancellation cost

Content
- Definition
- EUROCONTROL recommended values
- Description
- Related standard input
- Comments

1 Definition

The average cost of cancelling a commercial scheduled flight on the day of operation

2 EUROCONTROL recommended values

<table>
<tr><td>Value 1</td><td>
<table>
<tr><th rowspan="2">Cost of cancellation (€)</th><th colspan="4">Narrow-body</th><th colspan="2">Wide-body</th></tr>
<tr><th colspan="3">Traditional network carrier[22]</th><th>Low-cost carrier</th><th colspan="2">Traditional network carrier</th></tr>
<tr><td>Seats</td><td>50</td><td>120</td><td>180</td><td>189</td><td>250</td><td>400</td></tr>
<tr><td>Value (€)</td><td>6 540</td><td>16 040</td><td>24 900</td><td>19 420</td><td>82 730</td><td>120 830</td></tr>
<tr><td>Of which passenger care and compensation (€)</td><td>3 280</td><td>8 020</td><td>13 090</td><td>18 470</td><td>42 740</td><td>68 390</td></tr>
</table>
<i>(adjusted from 2014 prices)</i>
</td></tr>
<tr><td>Value 2</td><td>System-wide average cancellation cost <i>(adjusted from 2014 prices)</i>: € 18 570</td></tr>
<tr><td>Source</td><td>Data supplied by the airline members of the SESAR CBA team
Expert judgment derived from an analysis of 2012 total flights carried out in Europe</td></tr>
</table>

3 Description

The values refer to cancellation on the day of operation and include the following:

- Service recovery costs, i.e. passenger care and compensation costs (passenger vouchers, drinks, telephone calls, hotels)
- Loss of revenue
- Interlining costs
- Loss of future value, i.e. passenger opportunity costs (individual passenger delay expressed in value)
- Crew and catering costs
- Passenger compensation for denied boarding and missed connections (estimated on the application of the Regulation (EC) No 261/2004)
- Luggage delivery costs
- Operational savings (fuel, airport and navigation fees, maintenance, handling outstations, lounge outstations)

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[22] *Traditional carrier estimates can be used for regional carriers.*

Ground handling costs, e.g. ramp services, passenger services and field operation services, are not included.

4 Related standard input

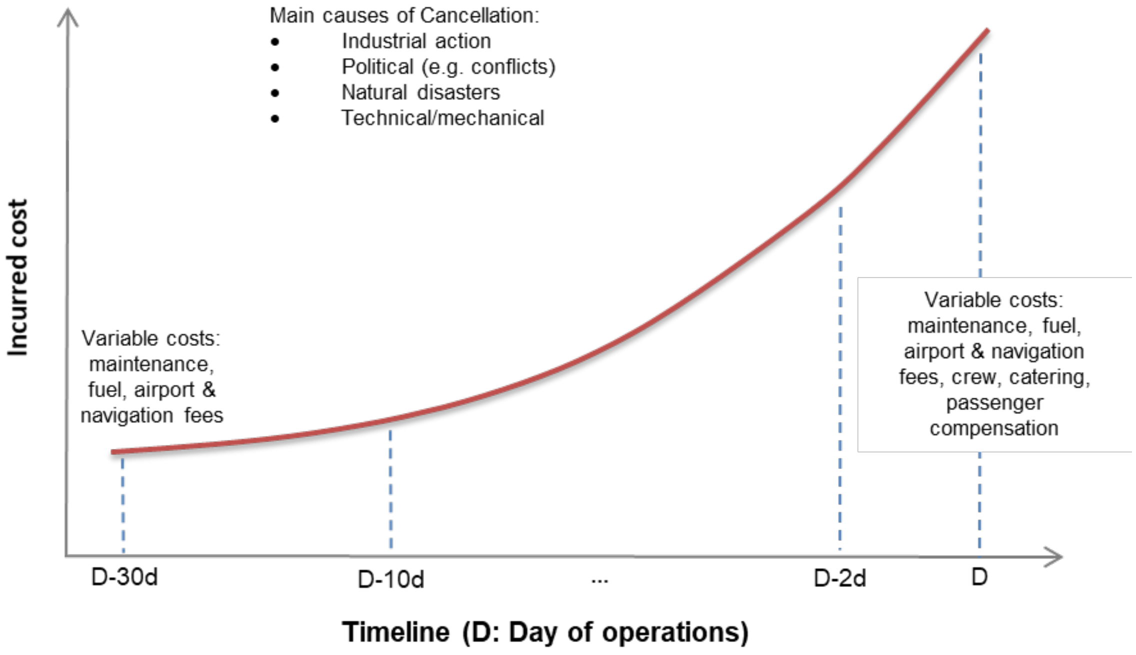
Operational cancellation rate (page 44)

5 Comments

When a flight is carried out, the airline incurs out-of-pocket expenses (i.e. variable costs) but receives revenues which are 60-100% greater than the out-of-pocket expenses. Cancelling a flight means that the airline forgoes a substantial operating profit. Also, in addition to the loss, costs are incurred for the care and compensation of passengers.

Cancellation costs vary as a function of the time of cancellation, as illustrated below.

Timely cancellation will enable the airline to take the necessary measures to mitigate the cost impact, for example by rebooking passengers on another flight and allocating crew and aircraft to a different destination. The cancellation costs will thus be minimal and more in the region of the incurred opportunity cost and passenger value of time. If the cancellation is nearer the flight time, i.e. on the day of operation (D), the cost of cancellation increases, to cover expenses such as fuel, maintenance and crew and catering.



13. Operational cancellation rate

Content
- Definition
- EUROCONTROL recommended value
- Description
- Related standard input

1 Definition

IFR flight cancellation rate in Europe

2 EUROCONTROL recommended value

Value		**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
	Operational cancellation rate	1.5%	1.6%	1.5%	1.6%	1.5%	2.0%	1.7%
Source	EUROCONTROL (2019) – Based on operational cancellation data supplied by 30 European coordinated airports reporting to CODA under EC Regulation No 390/2013. https://www.eurocontrol.int/publication/all-causes-delay-and-cancellations-air-transport-europe-2019 Reports from previous years are available in the EUROCONTROL library: https://www.eurocontrol.int/library.							

3 Description

According to Annex IV of Commission Implementing Regulation (EU No 390/2013, an ‘operational cancellation’ means an arrival or departure of a scheduled flight to which the following conditions apply:

- the flight received an airport slot; and
- the flight was confirmed by the air carrier the day before operations and/or it featured in the daily list of flight schedules produced by the airport operator the day before of operations; but
- the actual landing or take-off did not occur.

For 2019, airlines providing operational cancellation data to CODA reported operational cancellations of 1.7% (this includes daily peaks of up to 9.4% due to ATC industrial action or large-scale weather events).

Section 9 of the referenced document contains a detailed analysis of the cancellations.

4 Related standard input

Cancellation cost (page 42)

14. Cost of delay

Content

- Definition
- EUROCONTROL recommended values
- Description
- Related standard inputs

1 Definition

The average cost per minute to the airline of ground or airborne delay of a commercial passenger flight

2 EUROCONTROL recommended values

Value 1[23]

Tactical delay cost with network effect per minute (€)

	Flight phase	**All delays (0 to more than 300 minutes)**	**Short delays (up to 30 minutes)**
Ground	At gate	147	40
	Taxiing in/out	162	55
Airborne	En route (cruise extension)	188	79
	Arrival management	183	75

(adjusted from 2014 values)

Value 2[23]

Strategic delay cost per minute (€)

	Delay cost per minute (€)	
Ground	At gate	16
	Taxiing in/out	41
Airborne	En route (cruise extension)	74

(adjusted from 2014 values)

Value 3[24]

ATFM[25] delay cost per minute (€)

Ground	**Delay cost per minute (€)**
Network average cost of ATFM delay per minute	100

---

[23] *Values 1 and 2 are **calculated** on the basis of University of Westminster (UoW) reference values (European airline delay cost reference values report, version 4.1). Delay cost details by aircraft and length of delay, extracted from the UoW report, are given in 3iii) below.*

[24] *Value 3 is a reference **extracted** from a University of Westminster report (European airline delay cost reference values report, version 4.1).*

[25] *ATFM delay is **defined** as the duration between the last take-off time requested by the aircraft operator and the take-off slot allocated by the Network Manager following a regulation communicated by the flow management position (FMP), in relation to an airport (airport ATFM delay) or sector location (en route ATFM delay).*

Sources	University of Westminster (2015), “European airline delay cost reference values – updated and extended values, Version 4.1” – December 2015 https://www.eurocontrol.int/publication/european-airline-delay-cost-reference-values University of Westminster (2011) for the EUROCONTROL PRU, “European airline delay cost reference values” – March 2011 https://www.eurocontrol.int/sites/default/files/publication/files/european-airline-delay-cost-reference-values-final-report-4-1.pdf University of Westminster (2004) for the EUROCONTROL PRC, “Evaluating the true cost to airlines of one minute of airborne or ground delay” – May 2004 https://www.eurocontrol.int/sites/default/files/content/documents/sesar/business-case/evaluating_true_cost_of_delay_2004.pdf

3 Description

Values 1, 2 and 3 are **high-level averages** and valid as **indicators**. It is strongly recommended that they be used as indicators or for general insights into delay costs and not for specific analyses or operational planning. Different values may be obtained for other contexts, e.g. other airspace areas or airports (hub or non-hub), with different aircraft and delay distributions.

The University of Westminster (UoW) report, published in 2004 and updated in 2011 and 2015, represents the most recent and comprehensive appraisal of the cost of delays in the air traffic management system in Europe. The report is designed as a reference document for European delay direct costs incurred by airlines, both at the strategic (planning) and tactical stages.

It contains a detailed assessment of the delay cost for 15 specific aircraft types (extended from 12 in the previous report versions), taking into account crew, fuel, fleet, maintenance and passenger additional costs due to delay. Note that the list of aircraft types used for this report does not include some recent types like Airbus NEO Series, A220, A350 or B787.

Costs are assigned under three cost scenarios: ‘low’, ‘base’ and ‘high’. These scenarios are designed to cover the probable range of costs for European operators. The ‘base’ cost scenario is, to the greatest extent possible, designed to reflect the typical case and is the one used here.

The University of Westminster report presents costs of delay in four flight phases: at gate, taxiing, en route (cruise extension) and arrival management. For reasons of accuracy, the definitions used by the University of Westminster are presented as such. They are extracted from the UoW 2004 and 2011 reports.

A description of the flight phases, types of delay and calculation method is given below.

i) Flight phases

<table>
<tr><th colspan="4">Ground (at gate and off gate)</th><th colspan="2">Airborne</th></tr>
<tr><td>At gate, stabled (no delay)</td><td>At gate, turnaround</td><td>Taxiing out/in</td><td>Landing/take-off cycle (no delay)</td><td>En route (cruise extension)</td><td>Arrival management</td></tr>
<tr><td colspan="6">24-hour period</td></tr>
<tr><td></td><td colspan="5">service hours</td></tr>
<tr><td></td><td></td><td colspan="4">block hours</td></tr>
</table>

Block hours are defined as the time spent off-block (aircraft utilisation).

Service hours are defined as the total time spent in service during the operational day.

Ground

- **‘At gate, *stabled*’** refers to time spent at the gate, when the aircraft is inactive (e.g. over night) and not being prepared for a rotation.
- **‘At gate, *turnaround*’** refers to all time spent at the gate during the operational day, i.e. both

passive/slack time and active handling between rotations.

- **‘Taxiing out/in’** refers to the phase of flight just before take-off and after landing of the aircraft.
- **The ‘landing/take-off (LTO) cycle’ includes the initial climb to 3 000ft and (final) approach** (from 3 000ft to touchdown), which are not considered as generating delays.

Airborne

- **‘Arrival management’** encompasses all delays induced in TMAs, including holding in stacks and linear holding. The rest of the airborne phase is classified as **‘en route’.**

ii) Types of delay costs

- **Tactical delay costs:** These are incurred **on the day** of operations. In most cases, it is anticipated that the user will find it appropriate to use the full tactical costs in order to calculate these costs of delay. These include the reactionary costs of ‘knock-on’ delay in the rest of the network, which it is usually pertinent to include.
- **Strategic delay costs:** These are costs accounted for, **in advance**. Strategic costs are typically used to assess the cost of adding buffers to schedules. This could be by airline choice, or imposed by scheduling constraints at an airport (and thus considered a cost of congestion, albeit one which offsets tactical delay costs). Strategic costs may also be incurred as a consequence of factors which contribute to an increase in flight time in a predictable way, such as delay due to route design.

iii) Calculation method

The tactical and strategic delay costs referred to in value 1 and 2 are **calculated** on the basis of the results extracted from the University of Westminster (UoW) study report “European airline delay cost reference values – Updated and extended values Version 4.1” – December 2015. Explicit cost tables for analytical use (up to 30 minutes of delay) are presented at the end of this section. The extended tables can be found in the UoW report mentioned above.

As regards Value 1, tactical delay costs are given for 5, 15, 30, 60, 90, 120, 180, 240 and 300 minutes in the UoW report. These are scaled up to network level, because on the day of operations, original delays caused by one aircraft cause ‘knock-on’ effects in the rest of the network (‘reactionary’ delays).

Based on at-gate data provided by the Central Office for Delay Analysis (CODA) on ranges of departure delays[26] by aircraft type for year 2014, assumptions have been made for the remaining three flight phases, i.e. taxi, en route and arrival management. The same delay distribution has been used as an assumption applicable to all flight phases.

The UoW results have been averaged by minute of delay per type of aircraft (15 in total) and further weighted by the distribution of the number of delayed flights per delay range, at departure, carried out by these aircraft in 2014.

Consequently, for each flight phase, two types of values have been calculated:

- one taking into account long delays, i.e. 0 to more than 300 minutes;

- one taking into account short delays, i.e. up to 30 minutes, which represent most delays (approximately 90%).

As regards Value 2, since costs at the strategic level are incorporated into the aircraft operator’s schedule in advance, they are associated with average costs and therefore only a distribution of the number of flights was applied in order to calculate the strategic high-level averages.

Caveat related to the use of costs in business cases

When comparing two scenarios, it is not correct to calculate the delay avoided as a benefit without taking into account the corresponding marginal cost of capacity. In other words, there is a delay threshold below which the marginal cost of capacity outweighs the delay avoidance benefit.

Every CBA should carefully consider whether the improvements envisaged by the project are of a tactical or strategic nature. For the correct use and precise understanding of the tactical and strategic

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[26] *In the University of Westminster 2015 Study Report, departure delay is assumed to equal arrival delay. For consistency purposes, the calculation methodology developed uses the same assumption.*

delay concepts, see section 4 of and Annex I to the University of Westminster delay study of 2004 referenced above.

Delay cost details by aircraft type and duration

Tactical delay costs with network effect

Base scenario (total amount for all minutes of delay in €)

Aircraft type	Delay magnitude (minutes)											
	At gate			Taxiing			En route			Arrival management		
	5'	15'	30'	5'	15'	30'	5'	15'	30'	5'	15'	30'
A319	74	464	1 687	137	643	2 045	253	1 001	2 761	232	938	2 646
A320	84	527	1 918	158	749	2 371	264	1 064	3 004	264	1 054	2 973
A321	105	611	2 277	179	822	2 698	317	1 255	3 563	295	1 191	3 437
A332	189	1 043	3 743	359	1 528	4 712	600	2 256	6 177	495	1 939	5 534
AT43	32	189	643	63	274	812	74	306	875	74	306	875
AT72	42	253	864	74	348	1 064	95	411	1 191	95	390	1 149
B733	74	453	1 634	147	665	2 056	264	1 012	2 761	222	896	2 530
B734	84	506	1 834	158	728	2 287	274	1 064	2 952	264	1 033	2 878
B735	74	411	1 475	147	632	1 908	243	927	2 499	189	780	2 203
B738	95	569	2 045	158	759	2 435	285	1 139	3 194	264	1 075	3 067
B744	253	1 444	5 270	485	2 129	6 641	980	3 626	9 634	749	2 910	8 201
B752	105	653	2 413	210	970	3 057	359	1 412	3 932	306	1 244	3 605
B763	179	949	3 373	306	1 328	4 132	537	2 024	5 524	506	1 929	5 344
DH8D	42	264	938	74	359	1 128	116	474	1 349	116	474	1 349
E190	63	338	1 212	116	495	1 528	189	738	2 014	189	728	1 982

(adjusted from € 2014 values)

Strategic delay costs

Base scenario (delay per hour in €)

Aircraft type	Delay (hours)		
	At gate	Taxiing	En route
A319	854	2 024	3 605
A320	949	2 277	3 678
A321	1 107	2 446	4 354
A332	1 813	4 469	7 610
AT43	243	791	949
AT72	359	1 033	1 339
B733	569	1 802	3 373
B734	632	1 971	3 468
B735	537	1 802	3 109
B738	1 064	2 182	3 848
B744	1 582	5 228	11 542
B752	759	2 520	4 438
B763	1 381	3 563	6 567
DH8D	569	1 202	1 718
E190	812	1 813	2 899

(adjusted from € 2014 values)

Source: University of Westminster (2015), “European airline delay cost reference values - updated and extended values, para. 8b, Version 4.1” – December 2015
https://www.eurocontrol.int/publications/european-airline-delay-cost-reference-values

4 Related standard input

Air traffic delay (page 17), air traffic statistics and forecast (page 8) and flow management delay (page 19).

15. Cost of diversion

Content
- Definition
- EUROCONTROL recommended values
- Description
- Comments

1 Definition

The average cost of the diversion of a flight to an airport other than the one initially planned

2 EUROCONTROL recommended values

<table>
<tr><td>Value 1</td><td>
<table>
<tr><th>Type of flight</th><th>Cost of flight diverted (€)</th></tr>
<tr><td>Regional flights</td><td>900 to 6 200</td></tr>
<tr><td>Continental flights</td><td>1 200 to 9 300</td></tr>
<tr><td>Intercontinental flights</td><td>6 200 to 68 500</td></tr>
</table>
<i>(adjusted from € 2006 to € 2019 prices)</i>
</td></tr>
<tr><td>Source 1</td><td>Data supplied by the airline members of the SESAR evaluation team, derived from an analysis of 2006 ECAC data</td></tr>
</table>

<table>
<tr><td>Value 2</td><td>
<table>
<tr><th>Type of flight</th><th>Cost of flight diverted (€)</th></tr>
<tr><td>Business aviation</td><td>7 800</td></tr>
</table>
<i>(adjusted from € 2012 to € 2019 prices)</i>
</td></tr>
<tr><td>Source 2</td><td>Data supplied by the airline members of the SESAR CBA team (2015)</td></tr>
</table>

3 Description

For Value 2, the estimated cost for business aviation assumes that for each diverted flight there is one additional positioning flight.

4 Comments

The penalties associated with the late delivery of cargo are not considered, as this type of data is not yet readily available.

In 2019, out of the total number of flights (9.9 million flights) with a destination in the EUROCONTROL Network Manager area, 20 257 flights (0.2%) landed at an airport other than the one initially planned.

16. Turnaround time

Content
- Definition
- EUROCONTROL recommended values
- Description
- Other possible values
- Related standard inputs
- Comments

1 Definition

The time taken for unloading and ground handling preparation for the return journey of an aircraft. This corresponds to the time during which the aircraft must remain parked at the gate, including air traffic flow management (ATFM) delay.

2 EUROCONTROL recommended values

<table>
<tr><td>Value 1</td><td>Mean <u>scheduled</u> turnaround time (in minutes)
<table>
<tr><th>Aircraft category</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th></tr>
<tr><td>Heavy</td><td>80</td><td>86</td><td>87</td><td>88</td><td>92</td></tr>
<tr><td>Medium</td><td>48</td><td>48</td><td>48</td><td>48</td><td>49</td></tr>
</table>
</td></tr>
<tr><td>Value 2</td><td>Mean <u>actual</u> turnaround time (in minutes)
<table>
<tr><th>Aircraft category[27]</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th></tr>
<tr><td>Heavy</td><td>86</td><td>92</td><td>94</td><td>96</td><td>97</td></tr>
<tr><td>Medium</td><td>53</td><td>54</td><td>54</td><td>55</td><td>55</td></tr>
</table>
</td></tr>
<tr><td>Source 1 and 2</td><td>EUROCONTROL – Computed from data supplied by the airline members to CODA</td></tr>
</table>

3 Description

Values 1 and 2 are computed from data supplied by airlines to the EUROCONTROL CODA. The data is filtered according to the following market segments: traditional scheduled, low-cost and charter.

The total ground time of an aircraft includes overnight stops, maintenance slots, fire breaks, etc., so specific cut-off values are applied to obtain the turnaround time. The turnaround cut-off time for wake turbulence category H (Heavy) is 180 minutes, and for M (Medium) 150 minutes.

The actual turnaround time represents the difference between the actual off-block time (AOBT) of a departing flight and the actual in-block time (AIBT) of the same aircraft on the previous inbound flight. The scheduled turnaround time is the difference between scheduled time of departure (STD) of the departing flight and the scheduled time of arrival (STA) of the same aircraft on the previous inbound flight.

---

[27] *The heavy, medium and light aircraft categories relate to ICAO wake vortex categories based on the maximum certificated take-off mass (http://www.skybrary.aero/index.php/ICAO_Wake_Turbulence_Category):*
- ***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.*

In 2019, the mean turnaround time showed a difference of 6% between actual and scheduled for the heavy wake turbulence category, and of 13% for the medium wake category.

4 Other possible values

<table>
<tr><td>Value 1</td><td>Turnaround time ranges: scheduled (in minutes) in 2019
<table>
<tr><th>Aircraft category</th><th>Low (P10) [28]</th><th>Base (Median)</th><th>High (P90)</th></tr>
<tr><td>Heavy</td><td>60</td><td>90</td><td>115</td></tr>
<tr><td>Medium</td><td>25</td><td>45</td><td>75</td></tr>
</table></td></tr>
<tr><td>Value 2</td><td>Turn-round time ranges: actual (in minutes) in 2019
<table>
<tr><th>Aircraft category</th><th>Low (P10)</th><th>Base (Median)</th><th>High (P90)</th></tr>
<tr><td>Heavy</td><td>67</td><td>93</td><td>132</td></tr>
<tr><td>Medium</td><td>31</td><td>49</td><td>86</td></tr>
</table></td></tr>
<tr><td>Source</td><td>EUROCONTROL – Computed from data supplied by airlines to CODA</td></tr>
<tr><td>Description</td><td>Ground handling during turnaround is the service, other than air traffic services, which an aircraft needs on its arrival and for its departure from an airport. The values are calculated on the basis of the same data from which the mean is calculated in section 2.</td></tr>
</table>

5 Related standard input

Airport classification (page 102)

6 Comments

Turnaround time and ground time typically vary as a function of:
- the given airport;
- the type of flight (short, medium or long-haul);
- the market segment (traditional scheduled airline, low-cost, business aviation, etc.);
- the type of aircraft (B738, A320, etc.);
- the type of service (charter, scheduled, positioning, etc.).

The turnaround process involves activities related to the handling of tasks to ensure the cleanliness, safety and efficiency of the next flight. The difference between a turnaround and ground time is that an aircraft at its home base airport will have longer ground time to cover for example for the time it needs for maintenance. The diagram below shows the scope of the various activities, including ground handling time[29].

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[28] *P10, median and P90 are the 10th, 50th and 90th percentiles of the data respectively.*

[29] *An exhaustive definition and list of the ground handling services is given in Council Directive 96/67/EC of 15 October 1996 on access to the ground handling market at Community airports: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A31996L0067*

Ground time

- time between “in block” and “off block”
- includes overnight stops
- includes maintenance windows of aircraft

Turnaround time

- time between “in block” and “off block”
- maximum cut off time for wake turbulence category H (Heavy): 180 minutes and for M (Medium) 150 minutes.
- includes waiting at gate for push-back due to local or Network regulations (ATFM delay)

Ground handling time

Servicing of an aircraft while it is on the ground and (usually) parked at a terminal gate of an airport.

Tasks include: disembarkation, cabin cleaning, loading and ramp handling, inspection of airline and aeroplane and SOPM (safety check), refuelling, catering, loading of luggage and goods, passenger boarding.

17. IFR average flight distance and flight duration

Content

- Definition
- EUROCONTROL recommended values
- Description
- Related standard inputs

1 Definition

The mean distance in kilometres (and nautical miles) and mean duration in minutes of an IFR flight in the ECAC area

2 EUROCONTROL recommended values

Value 1	Average flight distance

Year	2017	2018	2019
Kilometres (NM)	1 197 km (646 NM)	1 209 km (653 NM)	1 220 km (659 NM)

(values based on flights in the ECAC[30] area)

Value 2	Average flight time from take-off to landing

Year	2015	2016	2017	2018	2019
Minutes	91.3	91.5	98.4	100.1	101.3

(values based on flights in the ECAC area

Source	EUROCONTROL – Performance Review Report (PRR 2019), June 2020 http://www.eurocontrol.int/publications/performance-review-report-prr-2016 Reports from previous years are available in the EUROCONTROL library: https://www.eurocontrol.int/library.

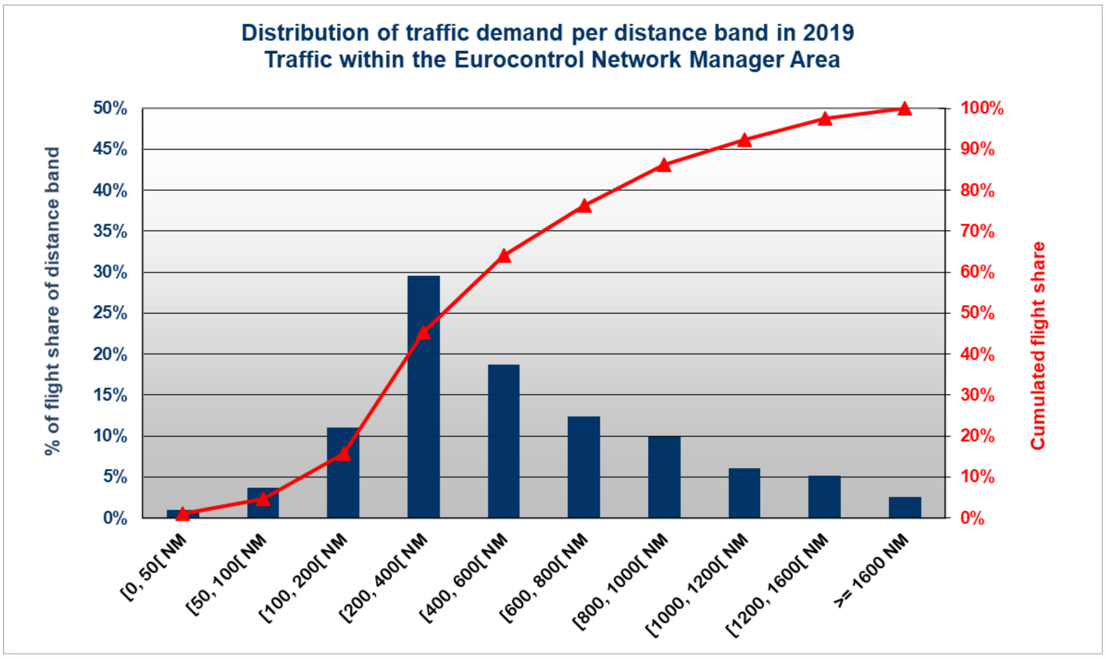
3 Description

Values 1 and 2 are obtained by dividing the total distance actually flown and the total yearly IFR flight hours respectively by the yearly number of IFR flights in ECAC airspace. The calculation stops at the borders of ECAC airspace.

---

[30] *The ECAC traffic region is described in Member States and Geographical Areas*

As regards flight distance, the graph below illustrates that more than 85% of the IFR flight distances with arrivals and departures within the Network Manager area (without overflights) are less than 1 000 NM, and about 50% of the flights have a range of between 200 and 600 NM.



4 Related standard inputs

IFR flight information per operator segment (page 55), distance flown by charging zone (page 57) and IFR flight duration and taxiing time (page 104)

18. IFR flight information per market segment

Content
- Definition
- EUROCONTROL recommended value
- Description
- Related standard inputs

1 Definition

The mean distance, fuel consumption and flight duration of an IFR flight in the ECAC region

2 EUROCONTROL recommended value

Value	Flight average values per market segment[31]

Flight type	Market segment	Number of IFR flights	Average distance (in NM)	Average flight duration (in minutes)	Average fuel burn (in kg)
Flights within ECAC	Traditional scheduled	4 077 653	470	99	3 366
	Low-cost	3 098 905	676	126	4 672
	Business aviation	568 530	390	91	901
	Non-scheduled charter	249 413	684	130	4 370
	Other types	242 793	197	88	560
	All cargo	217 620	460	99	5 794
	Total/average	8 454 914	538	109	3 691
International flights entering and leaving ECAC	Traditional scheduled	1 608 581	2 706	384	39 109
	Low-cost	243 398	1 716	260	14 679
	Business aviation	151 540	1 527	238	13 782
	Non-scheduled charter	94 738	2 709	377	34 981
	Other types	94 514	2 682	383	36 145
	All cargo	7 679	1 862	293	21 150
	Total/average	2 200 450	2 511	360	34 295
Total/average		**10 655 364**	**946**	**161**	**10 011**

(average values for 2019)

Source	EUROCONTROL – derived from an analysis of 2019 IFR flights carried out in Europe (excluding overflights) and calculated by AEM, BADA tabulated

3 Description

The calculations were made on the basis of:

---

[31] *Rules for the EUROCONTROL classification of low-cost, all-cargo and business aviation types of flights: https://www.eurocontrol.int/publication/market-segment-rules*

- 2019 full year total distance and ECAC distance flown, extracted from data collected by the Network Manager, not including overflights;
- the EUROCONTROL Small Emitters Tool (SET) approved by the European Commission by Commission Regulation (EU) No 606/2010;
- use of the latest version of the BADA[32] tabulated model 4 and AEM (Advanced Emission Model) [33];
- fuel burn figures, not taking into account the reduction in the aircraft's weight in fuel during the flight.

4 Related standard inputs

Number of IFR flights (page 13), rate of fuel burn (page 21), amount of emissions released by fuel burn (page 24), cost of emissions (27), IFR average flight distance (page 53), fleet size (page 69) and IFR flight duration and taxiing time (page 104)

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[32] *BADA base of Aircraft Data* *https://www.eurocontrol.int/model/bada*

[33] *EUROCONTROL Advanced Emission Model (AEM)* *https://www.eurocontrol.int/model/advanced-emission-model*

19. Distance flown by charging zone

Content
- Definition
- EUROCONTROL recommended value
- Description
- Related standard inputs

1 Definition

Number of kilometres flown by charging zone.

2 EUROCONTROL recommended value

Value	In millions of kilometres

Charging zone	2015	2016	2017	2018	2019	Variation 2019-2018	Variation 2015-2019[34]
Albania	34	31	32	34	36	6.5%	1.5%
Armenia	7	7	10	13	12	-5.9%	13.2%
Austria	204	204	219	235	244	3.8%	4.6%
Belgium-Luxembourg	181	183	189	193	187	-2.9%	0.9%
Bosnia and Herzegovina	64	63	74	79	88	12.3%	8.1%
Bulgaria	201	205	208	233	236	1.5%	4.2%
Croatia	133	131	134	148	161	9.2%	5.0%
Cyprus	109	109	123	136	146	7.5%	7.6%
Czech Republic	177	189	193	208	204	-1.8%	3.7%
Denmark	123	125	127	130	133	1.6%	1.9%
Finland	55	54	59	65	68	4.4%	5.4%
France	1 514	1 594	1 673	1 714	1 729	0.9%	3.4%
Georgia	41	41	42	42	37	-12.8%	-2.8%
Germany	994	1 029	1 087	1 130	1 137	0.6%	3.4%
Greece	344	328	364	401	426	6.4%	5.5%
Hungary	173	178	189	207	202	-2.4%	3.9%
Ireland	209	224	224	226	228	1.1%	2.2%
Italy	660	671	697	753	796	5.8%	4.8%
Latvia	55	54	59	63	64	1.3%	3.8%
Lithuania	35	36	39	44	45	3.8%	6.2%
Malta	46	49	50	52	57	8.6%	5.6%
Moldova	6	5	6	7	7	5.2%	4.5%
Netherlands	213	226	232	242	240	-0.7%	3.1%
North Macedonia	20	19	23	26	30	15.6%	10.2%
Norway	173	181	182	183	177	-3.2%	0.5%
Poland	288	306	316	344	360	4.7%	5.8%
Portugal Lisboa	226	252	272	277	287	3.6%	6.2%

---

[34] *Average annual variation during the period 2015-2019*

Charging zones	2015	2016	2017	2018	2019	Variation 2019/2018	Variation 2015-2019
Portugal Santa Maria	217	236	251	259	260	0.3%	4.6%
Romania	266	257	274	298	299	0.4%	3.0%
Serbia/Montenegro/KFOR	149	158	166	186	195	5.3%	7.0%
Slovak Republic	72	76	79	86	86	-0.3%	4.5%
Slovenia	37	39	41	44	48	7.9%	6.7%
Spain-Canarias	98	106	114	124	131	5.7%	7.6%
Spain-Continental	725	780	835	881	909	3.1%	5.8%
Sweden	258	261	276	287	283	-1.5%	2.3%
Switzerland	121	124	134	144	144	0.3%	4.4%
Turkey	856	853	933	1 021	1 036	1.4%	4.9%
United Kingdom	720	768	821	838	852	1.7%	4.3%
Subtotal	9 805	10 153	10 748	11 352	11 582	2.0%	4.3%
Estonia[35]			41	56	55	-2.1%	
Total	9 805	10 153	10 789	11 407	11 636	2.0%	4.4%

Source	EUROCONTROL Central Route Charges Office (2019), Reports on the Operation of the Route Charges System in 2019, April 2020 https://www.eurocontrol.int/publication/report-operation-route-charges-system-2019 More information can be accessed via the EUROCONTROL Aviation Intelligence Portal: https://www.eurocontrol.int/ServiceUnits/Dashboard/EnRouteMainDashboard.html.

3 Description

The Report on the Operation of the Route Charges System is published by the CRCO on an annual basis and provides data on traffic volumes and ATM costs for the States for which the CRCO collects en route and terminal charges.

The table above sets out the number of kilometres recorded in the airspace of the Contracting States from 2014 to 2019 for the calculation of route charges (great circle distance after deduction of 20 km for departing and arriving flights) as well as the average annual variation observed during the same period.

Information on the various different charges levied by the CRCO, in particular the charge calculation methods, the basic billing documents, the methods of payment and the submission of claims is described in a “Customer Guide to Charges” available at https://www.eurocontrol.int/publication/customer-guide-route-charges.

4 Related standard inputs

IFR average flight distance (page 53), en route ANS costs (page 82) and route charge share per aircraft operator segment (page 84).

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[35] *No comparison between figures recorded for 2018 and 2017, Estonia integrated as of 1 April 2017*

20. Load factor – cargo

Content
- Definition
- EUROCONTROL recommended value
- Description

1 Definition

The percentage of cargo space filled by paid cargo (freight tonne kilometres)

2 EUROCONTROL recommended value

Value	**Year** | **2017** | **2018** | **2019** Load factor | 48.0% | 56.0% | 53.4%
Source	IATA – Economics Air Freight Market Analysis for 2019, 2018, 2017: https://www.iata.org/en/iata-repository/publications/economic-reports/air-freight-monthly-analysis---dec-2019/ https://www.iata.org/en/iata-repository/publications/economic-reports/air-freight-monthly-analysis---dec-2018/ https://www.iata.org/en/iata-repository/publications/economic-reports/air-freight-monthly-analysis---dec-2017/

Year	2017	2018	2019
Load factor	48.0%	56.0%	53.4%

3 Description

Cargo flights can be defined here as either freight carriers or passenger/cargo carriers.
Note that geographical coverage of IATA Europe covers ECAC States and other countries, including Russia, Tajikistan, Turkmenistan and Uzbekistan.

21. Load factor – passengers

Content
- Definition
- EUROCONTROL recommended values
- Description
- Comments

1 Definition

The percentage of seats filled by fare-paying passengers

2 EUROCONTROL recommended values

Value 1	<table><tr><th>Year</th><th>2016</th><th>2017</th><th>2018</th></tr><tr><td>Load factor</td><td>80.9%</td><td>82.7%</td><td>82.7%</td></tr></table>
Source 1	Eurostat: air passenger transport by reporting country (extract: avia_par) http://ec.europa.eu/eurostat/web/transport/data/database Historical data and other statistics are also available in the EUROCONTROL STATFOR Interactive Dashboard (SID)[36] (goto PAX+) https://www.eurocontrol.int/dashboard/statfor-interactive-dashboard.

Value 2	<table><tr><th>Year</th><th>2017</th><th>2018</th><th>2019</th></tr><tr><td>Load factor</td><td>84.4%</td><td>85.0%</td><td>85.6%</td></tr></table>
Source 2	IATA – Economics Air Passenger Market Analysis for 2019, 2018, 2017: https://www.iata.org/en/iata-repository/publications/economic-reports/air-passenger-monthly---dec-2019/ https://www.iata.org/contentassets/57a5379c75c34c2881ba91238f786138/passenger-analysis-dec-2018.pdf https://www.iata.org/contentassets/0a8a1360badd4bc0a754095b193e2088/passenger-analysis-dec-2017.pdf

3 Description

Value 1 is obtained by dividing the total number of passengers by the total number of available seats. Eurostat covers the EU-27+UK member states and the four EFTA states[37].

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[36] *Access to the STATFOR Interactive Dashboard can be requested from: https://www.eurocontrol.int/dashboard/statfor-interactive-dashboard*

[37] *European Free Trade Association: Iceland, Liechtenstein, Norway and Switzerland*

The Passenger load factor in **Value 2** is the ratio of revenue passenger km to available seat km. The difference with Value 1 is the geographical coverage. IATA's Europe area is larger than EU Europe statistical area. It covers countries such as Russia, Tajikistan, Turkmenistan and Uzbekistan.

4 Comments

A wide range of economic reports from IATA is available at https://www.iata.org/en/publications/economics/.

22. Cost of aviation fuel

Content

- Definition
- EUROCONTROL recommended source
- Description
- Other possible sources
- Related standard inputs
- Further reading

1 Definition

Current price of aviation fuel

2 EUROCONTROL recommended source

Source	IATA Jet fuel price analysis (weekly and yearly average) http://www.iata.org/publications/economics/fuel-monitor/Pages/index.aspx

3 Description

The IATA website provides jet fuel prices for the major regions of the world, together with analysis and commentary. The values are based on Platts Energy Market Data (www.platts.com).

Information on fuel prices is available in two forms, as a spot price at a port and as a retail price at an airport. The spot price is that paid by traders for fuel delivered at the port. The airport retail price is that offered to aircraft operators and includes the costs of transport to the airport, taxes, fees and suppliers' margins, etc. This may be the price paid by small aircraft operators, but large operators are normally able to negotiate substantial discounts with suppliers. These discounts are commercially sensitive and are not generally disclosed.

Consideration should be given to the selection of the geographical area, and hence currency, as a change in oil price can have a different effect on the jet fuel price owing to currency fluctuations, e.g. the downturn in the euro in 2015.

The 'spread' between the aviation fuel price and the underlying oil price covers the cost of refining, but it can vary significantly with time depending on underlying demand (e.g. from consumers needing a similar fraction to aviation), and on supply problems (such as a breakdown at a refinery or increasing local prices relative to oil).

1 Other possible sources

Source 1	IATA Airline Industry Economic Performance Report and Tables https://www.iata.org/en/publications/economics/IATA Airline Industry Economic Performance Report
Description 1	The IATA Airline Industry Economic Performance Report and Tables is published bi-annually and identify trends and forecasts for the current year. An overview of the revenues and expenses (including fuel prices) for the past ten years and a forecast for the current year is given at the end of each briefing.

Value 2	Annual Energy Outlook 2020 with projections to 2050 (extract from the source document)
Source 2	Annual Energy Outlook 2020 with projections to 2050 http://www.eia.gov/forecasts/aeo/
Description 2	The Annual Energy Outlook 2020 presents long-term projections of energy supply, demand and price through to 2050, based on results from the EIA's National Energy Modelling System, on the assumption that current US laws and regulations remain generally unchanged throughout the projection period.

2 Related standard inputs

Conversions, inflation, cost of fuel, exchange rate (page 5)

3 Further reading

US Energy Information Administration
The US Energy Information Administration website provides kerosene-type jet fuel spot price data for the US States.
http://www.eia.gov/

23. Value of an average passenger flight

Content
- Definition
- EUROCONTROL recommended values
- Description

1 Definition

Benefits in monetary value of an average passenger flight in the EU-27[38]

2 EUROCONTROL recommended values

<table>
<tr><td>Value</td><td>
<table>
<tr><th>€</th><th>International flight</th><th>Domestic flight</th></tr>
<tr><td>Consumer benefits per flight</td><td>26 777</td><td>4 913</td></tr>
<tr><td>Airline benefits per flight (excluding fuel and labour)</td><td>804</td><td>145</td></tr>
<tr><td>Other producer benefits per flight (excluding fuel and labour) [39]</td><td>1 447</td><td>716</td></tr>
<tr><td>Wider economic benefit</td><td colspan="2">For a 10% rise in connectivity, long-term labour productivity levels improved by 0.07%</td></tr>
</table>
<i>(adjusted from € 2011 to € 2019 prices)</i>
</td></tr>
<tr><td>Source</td><td>IATA Economic Briefing – September 2013
“The value of an Average Passenger Flight in the EU-27”
https://www.iata.org/en/iata-repository/publications/economic-reports/value-of-an-average-passenger-flight-in-eu-27/</td></tr>
</table>

3 Description

There is no commonly accepted standard for the value of a flight. The value will vary over time and between routes and whether it is an additional frequency on an existing route or a new connection. The COVID-19 pandemic will most probably change the overall picture. This should be taken into account when the above values are used.

The values quoted above are the result of a study on the benefits in monetary value of an average passenger flight in the EU-27.

IATA, in their briefing note, assesses the economic benefits of an average scheduled passenger flight from the perspective of the consumer, producers and the economy as a whole.

Its approach to the various benefits is outlined below.

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[38] *EU27 in 2013 https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:EU_enlargements*

[39] *Other producers along the air transport value chain are airports, ANSPs, manufacturers, lessors, GDS/CRSs, travel agents, ground services, catering and maintenance.*

Consumer benefits

- These are the benefits to passengers in the EU market. Most passengers value air services more than their expenditure. The difference between the consumer's willingness to pay (or the gross consumer benefit) and the price paid constitutes the net consumer benefit.

Producer benefits

- Producer net benefits are assessed from an investor perspective. Investors will measure profitability by what that profit represents as a return on invested capital (ROIC). That return is calculated before payments of debt interest and shows the earnings available to pay both debt and equity investors.
- This analysis draws on earlier work undertaken by McKinsey & Company for IATA on profitability and the air transport value chain, which calculates the global return on invested capital over the last business cycle 2004-2011[40]. The calculated global return on invested capital for each sector in the value chain is based on sample data and represents actual returns earned rather than required and/or desired returns[41]. On the basis of these figures, the share of producer net benefits accrued in the EU-27 is estimated[42].

Wider economic benefits

- These are the benefits to the wider economy, which go beyond the direct users of air transport. They may include spill-over impacts in and across economies as a result of increased competition and more efficient movement of capital and labour.
- One of the largest economic benefits of increased connectivity comes from its impact on the long-term productivity of the wider economy. There are several approaches which may be used to quantify this benefit. One conservative approach which has been developed, on the basis of the statistical relationship between air connectivity and labour productivity, yields an estimate that a 10% rise in connectivity, relative to a country's GDP, will boost labour productivity levels by 0.07%. The methodology for the analysis is detailed in IATA's study "Aviation Economic Benefits" (2007)[43].

The use of these values in CBAs depends on the scope and the viewpoint of the CBA. For example, a CBA for airlines will focus on the benefits to airlines of an additional flight, whereas a CBA for a government or the European Commission should also include an assessment of benefits to consumers and the wider economy.

Note also that these values reflect the market conditions and the passenger demand at the time of the study. For example, changes in passengers' income, changes in their preferences for air transport or changes in airlines' market structure can affect these values.

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[40] *IATA, "Profitability and the Air Transport Value Chain" 2013, available at https://www.iata.org/en/iata-repository/publications/economic-reports/profitability-and-the-air-transport-value-chain/*

[41] *IATA does not endorse the use of the estimated rates of return on invested capital for purposes of economic regulation or for determining the appropriate or desirable rate of return on invested capital. The figures used are based on a global assessment of the actual prevailing returns on invested capital in the air transport value chain.*

[42] *The allocation of producer benefits for airports, GDS/CRS, and travel agents is based on the share of global passengers flown either domestically (6%) or internationally (18%) from and within the EU-27. This approach treats domestic and international passengers equally in their contribution to the producer benefit. The allocation of producer benefits for airlines, ANSPs, manufactures, lessors, ground services, catering, and maintenance is based on the share of global available seat kilometres flown either domestically (2%) or internationally (19%) from and within the EU-27. These approaches do not account for structural differences which may exist between the EU and other regions. Nevertheless, these approaches provide a relevant estimation, because they are less prone to short- and medium-term shocks such as natural disasters and macroeconomic crises, which can create temporary distortions in the value chain.*

[43] *IATA, "Aviation Economic Benefits" 2007, available at https://www.iata.org/en/iata-repository/publications/economic-reports/aviation-economic-benefits/*

24. Fleet age

Content
- Definition
- EUROCONTROL recommended values
- Description
- Related standard inputs

1 Definition

The age of the aircraft operating IFR flights in Europe

2 EUROCONTROL recommended values

Value

Build year of civil aircraft operating in EUROCONTROL Network Manager airspace in Europe in 2019

Build year	Age	Number of aircraft	Flights in 2019
before 1979	> 40	561	23 058
1979	40	123	6 472
1980	39	151	11 488
1981	38	131	9 553
1982	37	101	5 988
1983	36	49	4 709
1984	35	74	6 058
1985	34	73	9 557
1986	33	82	16 276
1987	32	93	13 415
1988	31	119	22 413
1989	30	182	67 528
1990	29	219	84 378
1991	28	273	98 497
1992	27	277	82 829
1993	26	252	84 158
1994	25	230	98 763
1995	24	212	83 414
1996	23	310	136 445
1997	22	372	153 197
1998	21	534	237 008
1999	20	678	361 285
2000	19	639	318 266
2001	18	665	314 116
2002	17	519	306 208
2003	16	492	261 735
2004	15	462	247 402
2005	14	567	297 484

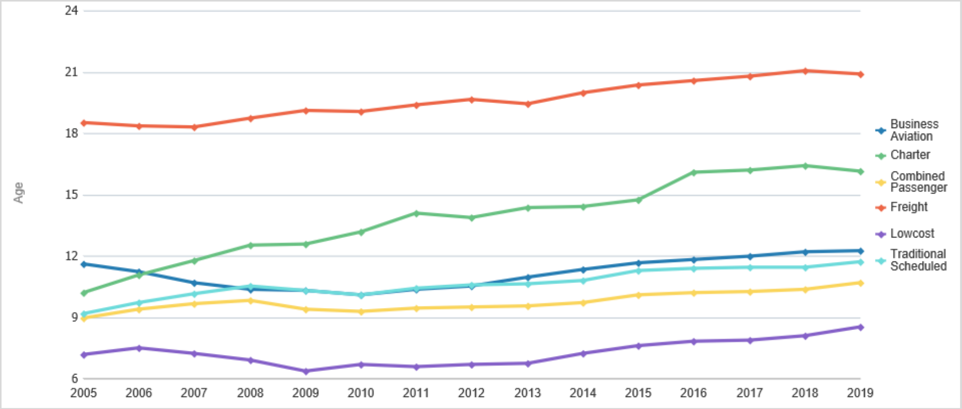
Build year	Age	Number of aircraft	Flights in 2019
2006	13	783	461 223
2007	12	1005	527 489
2008	11	1085	652 315
2009	10	985	663 297
2010	9	932	567 234
2011	8	876	585 429
2012	7	905	501 361
2013	6	934	408 088
2014	5	1066	424 131
2015	4	1003	505 471
2016	3	1 089	694 203
2017	2	1 155	601 728
2018	1	1 255	600 075
2019	0	1 189	165 841
unknown	-	310	237 540
Grand Total		**23 012**	**10 957 125**

Source 1

EUROCONTROL Network Manager flight plans and PRISME fleet data, March 2020

Value 2

Mean aircraft age per flight (EU-27+UK+EFTA[44])



Source 2

EUROCONTROL (2020) – STATFOR statistics
Traffic statistics and forecasts can be obtained from the STATFOR Interactive Dashboard (SID): https://www.eurocontrol.int/dashboard/statfor-interactive-dashboard.

3 Description

The numbers of aircraft were derived from flight plans submitted to the EUROCONTROL Network Manager (NM) for flights in 2019. These aircraft were therefore active in European airspace at some point during that year. The information was analysed using the EUROCONTROL PRISME fleet database to derive the aircraft ages. These are an approximation, as the month of entry into service

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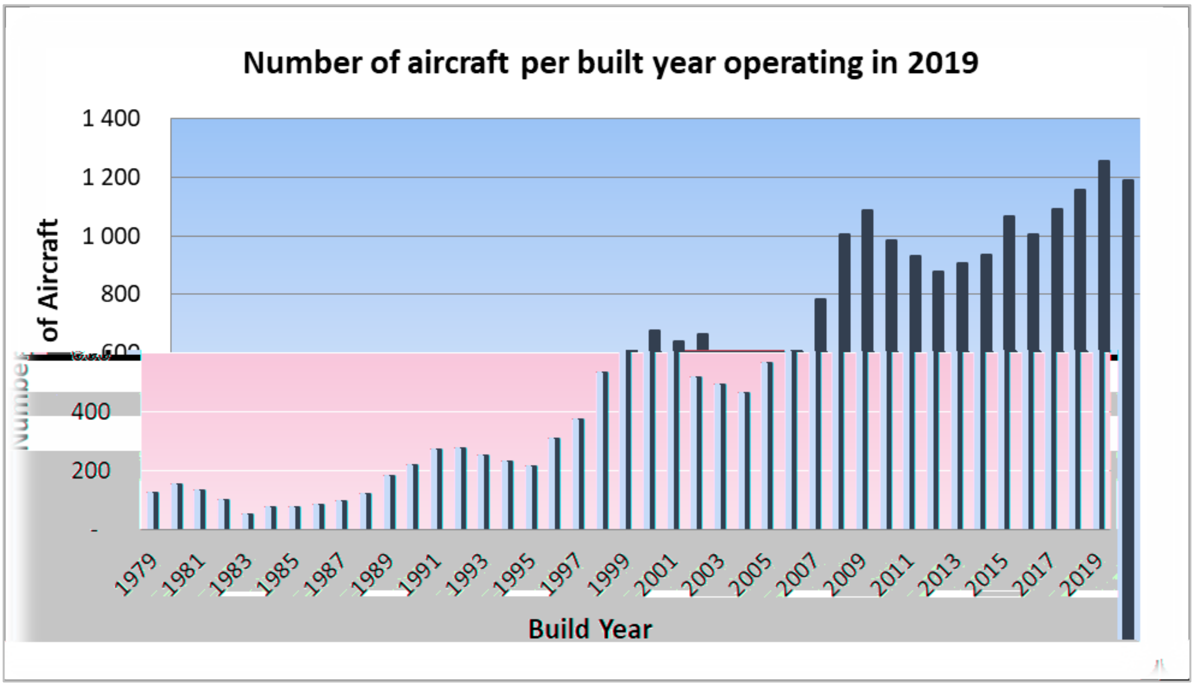
[44] *European Free Trade Association: Iceland, Liechtenstein, Norway and Switzerland*

is not taken into account. Since the numbers are based on flight plans, they exclude aircraft which do not fly in controlled airspace and therefore do not submit flight plans to the NM.

The 310 aircraft whose age was unknown were aircraft which are not recorded in the PRISME database. These are mostly privately owned aircraft or aircraft based outside Europe, together with some smaller aircraft not flying regularly in controlled airspace and some new aircraft which do not feature in the database.

There is a significant cyclicality in the purchase of aircraft, which is illustrated in the figure below.



4 Related standard inputs

Number of IFR flights (page 13) and fleet size (page 69)

25. Fleet size

Content
- Definition
- EUROCONTROL recommended values
- Description
- Other possible source
- Related standard inputs
- Comments

1 Definition

The number and types of aircraft operating in Europe

2 EUROCONTROL recommended values

Value 1

Top 30 numbers of civil[45] aircraft operating in airspace controlled by the EUROCONTROL Network Manager, by aircraft type sorted by number of aircraft, year 2019

AC type	Number of aircraft	Number of flights	Proportion	Cumulative
B738	1 793	2 166 382	7.8%	7.8%
A320	1 624	1 897 580	7.1%	14.8%
B77W	792	190 005	3.4%	18.3%
GLF5	621	17 029	2.7%	21.0%
A319	612	868 804	2.7%	23.6%
A321	573	660 872	2.5%	26.1%
GLEX	568	31 511	2.5%	28.6%
GLF4	523	11 441	2.3%	30.9%
A332	486	163 923	2.1%	33.0%
B789	456	116 278	2.0%	34.9%
A20N	442	259 430	1.9%	36.9%
CL60	435	24 947	1.9%	38.8%
A333	434	158 539	1.9%	40.6%
B763	423	103 604	1.8%	42.5%
DA42	372	45 595	1.6%	44.1%
GLF6	363	13 400	1.6%	45.7%
F900	329	12 402	1.4%	47.1%
B744	324	77 637	1.4%	48.5%
B772	316	102 289	1.4%	49.9%
PC12	304	35 841	1.3%	51.2%
B788	303	85 824	1.3%	52.5%
F2TH	301	27 168	1.3%	53.8%
A359	289	65 455	1.3%	55.1%
B752	275	99 289	1.2%	56.3%
FA7X	269	14 832	1.2%	57.4%

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[45] *Excludes flights classified as military, Head of State, etc.*

AC type	Number of aircraft	Number of flights	Proportion	Cumulative
B737	240	158 961	1.0%	58.5%
PA34	239	10 479	1.0%	59.5%
A388	234	66 240	1.0%	60.5%
B77L	228	55 090	1.0%	61.5%
BE20	197	47 817	0.9%	62.4%
Others types	8 660	3 368 461	37.6%	100.0%
Total	23 031	10 957 125	100%	n/a

Source 1

EUROCONTROL Network Manager flight plans, year 2019

Value 2

Military fleet statistics

AC type	ECAC		USA[46]	Totals	
	2013	***(2012)***	**2012**	**2013**	***(2012)***
Combat aircraft	3 365	*(3 373)*	3 393	6 758	*(6 766)*
Large aircraft	949	*(990)*	2 264	3 213	*(3 254)*
Light aircraft	1 390	*(1 429)*	2 778	4 168	*(4 207)*
Helicopters	3 733	*(3 792)*	5 277	9 010	*(9 069)*
Total	**9 437**	*(9 584)*	**13 712**	**23 149**	*(23 296)*

Source 2

EUROCONTROL (2014) – Military Statistics, Edition 2014, Directorate Single Sky, Civil-Military ATM Co-ordination Division, Version 1.0, March 2014
Document available on request

Value 3

IFR helicopter fleet

	Number of units
Europe and Eastern Europe	2 208
CIS[47]countries	1 312
Total	3 520

(Source: Flight Global HELICAS 2011/2012)

Source 3

European Helicopter Association (EHA) (2013)
European Helicopter IFR Fleet Analysis
http://www.eha-heli.eu/

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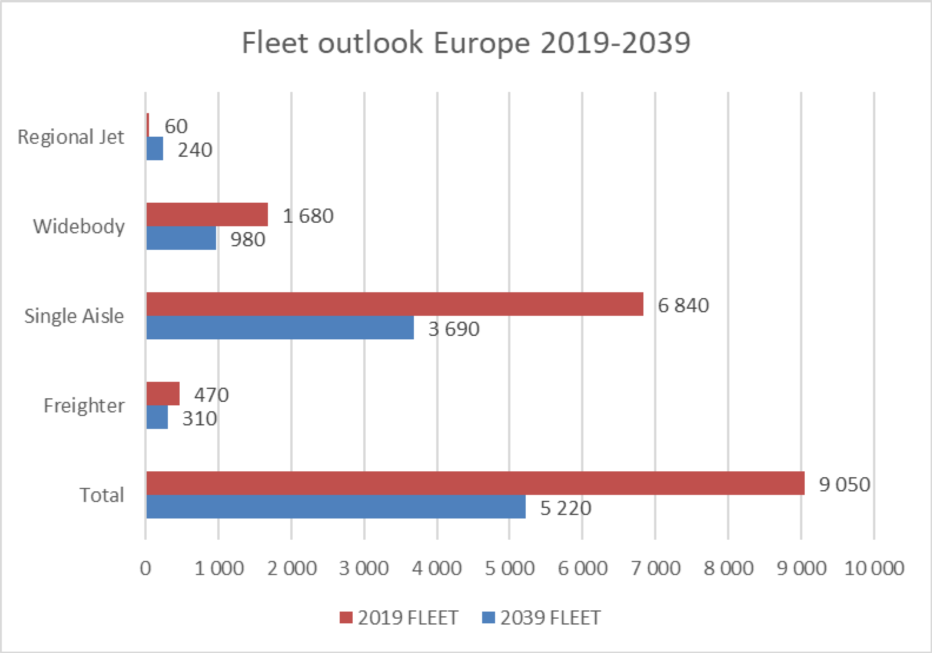
[46] *USA figures refer to the total US fleet. The main impact on European ATM comes from the AMC (Air Mobility Command), which reaches European airspace from many origins (mostly from the US). Figures are from the previous year, 2012, since 2013 figures have not been provided.*

[47] *CIS countries comprise the following: Azerbaijan, Belarus, Georgia, Moldova, Russia and Ukraine.*

<table>
<tr><td>Value 4</td><td>Estimated numbers of airframes operating under visual flight rules (VFR) for the ECAC region
<table>
<tr><th>AC type</th><th>ECAC</th></tr>
<tr><td>Aeroplanes</td><td>20 329</td></tr>
<tr><td>Helicopters</td><td>3 532</td></tr>
<tr><td>Gliders</td><td>18 555</td></tr>
<tr><td>Balloons</td><td>6 623</td></tr>
<tr><td>Total</td><td>49 039</td></tr>
</table>
<i>(Source: International Register of Civil Aircraft (IRCA) – 2014)</i></td></tr>
<tr><td>Source 4</td><td>Aircraft Owners and Pilot Association (AOPA), May 2015</td></tr>
</table>

3 Other possible sources – Forward-looking

<table>
<tr><td>Value 1
(extract from report)</td><td>
</td></tr>
<tr><td>Source 1</td><td>BOEING Current Market Outlook 2020-2029
https://www.boeing.com/commercial/market/services-market-outlook/</td></tr>
<tr><td>Description 1
(extract)</td><td><i>The Boeing Services Market Outlook (SMO) provides an overview of projected performance and anticipated market trends of key life-cycle service capabilities currently serving aerospace customers. The SMO is a 10-year forecast intended to guide business planning and to share Boeing’s analysis of service industry trends in commercial, business aviation and general aviation (BAGA), which includes civil helicopters, and government markets on the basis of past performance, current economic and environmental factors, and customer demand and opinion.</i>
<i>This report takes into account the pandemic’s impact on the aviation sector, which has caused an immediate and sharp decline in the demand for services supporting commercial airplanes and increased demand for services supporting government readiness objectives.</i></td></tr>
</table>

Source 2	AIRBUS Global Market Forecast 2019-2038 https://www.airbus.com/aircraft/market/global-market-forecast.html
Description 2	The Airbus Global Market Forecast for 2019-2038 offers a forward-looking view of the evolution of the air transport sector, accounting for factors such as demographic and economic growth, tourism trends, oil prices, the development of new and existing routes, and ultimately highlighting demand for aircraft covering the spectrum of sizes from 100 seats to the very largest aircraft of over 500 seats. Note that this forecast was provided before the pandemic.

4 Related standard inputs

Fleet age (page 66), IFR flight information per operator segment (page 55) and number of IFR flights (page 13)

5 Comments

The information presented in EUROCONTROL recommended value 1 is derived from flight plans submitted to the EUROCONTROL Network Manager (NM) for flights in 2019. These aircraft were active in European airspace at that time and therefore exclude many of the aircraft featuring in value 2 and, possibly some of the IFR helicopter fleet in “Value 3”, because a large proportion of IFR flights are managed locally in each country and therefore do not submit flight plans to the NM.

The 23 031 aircraft for civil use in the EUROCONTROL recommended values section comprise 483 different aircraft types. Of those, the 30 aircraft types listed represent approximately 62% of the fleet, while 58% of flights are carried out by the 10 most used aircraft types.

26. Fleet CNS capability

Content
- Definition
- EUROCONTROL recommended values
- Description
- Related standard inputs
- Comments

1 Definition

Statistics on flights and aircraft with certain communication, navigation and surveillance (CNS) equipment and capabilities[48]

2 EUROCONTROL recommended values

Navigation (NAV) flight capabilities (weighted by flight)

Value 1

As a % of total "flights", year 2019

Capability	Number of "flights" [49]	As a % of all "flights"
A – GBAS landing system[2]	1 066 532	4.8%
B – LPV (APV with SBAS)	1 154 182	5.2%
D – RNAV 1	20 771 164	93.5%
O –- Basic RNP 1	15 788 068	71.1%
S – RNP APCH	19 241 254	86.6%

Value 2

NAV flight capabilities as a % at the top 10 European Airports, year 2019

Airport	A – GBAS landing system[50]	B – LPV (APV with SBAS)	D – RNAV 1	O – Basic RNP 1	S – RNP APCH
Barcelona	2.6%	2.4%	97.4%	89.5%	94.6%
Frankfurt Main	6.7%	2.0%	97.7%	89.1%	94.0%
Istanbul/New airport	0.8%	0.3%	97.1%	91.3%	93.1%
London/Gatwick	4.2%	0.9%	97.9%	88.2%	95.4%
London/Heathrow	7.5%	1.6%	98.0%	88.1%	96.7%
Madrid Barajas	2.1%	10.0%	97.0%	72.8%	89.6%
Munich 2	2.7%	3.0%	97.4%	90.5%	88.7%
Paris Ch de Gaulle	2.6%	1.1%	97.9%	79.4%	92.7%
Rome Fiumicino	2.2%	0.5%	97.9%	90.6%	93.9%
Schiphol Amsterdam	1.9%	1.5%	97.9%	87.5%	95.7%

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[48] *Capability and equipment rates are based on information as declared in FPLs.*

[49] *For this standard input, the number of "flights" is number of "arrivals" or "departures" or "arrivals and departures" in line with the selection criteria in the CNS dashboard.*

[50] *The values for GBAS are corrected values. They exclude DHC8 equipment only compatible with a GBAS precursor system.*

Value 3	NAV aircraft capability over a one-month period, July 2019

Communication (COM) flight capabilities (weighted by flight)

Value 1

As a % of total “flights”, year 2019

	Capability	Number of “flights”	As a % of all “flights”
Datalink	E2 - D-FIS ACARS	9 160 750	41.2%
	E3 - PDC ACARS	10 252 210	46.2%
	J1 - CPDLC ATN VDL Mode 2	7 065 296	31.8%
	J4 - CPDLC FANS 1/A VDL Mode 2	2 070 030	9.3%
	J5 - CPDLC FANS 1/A SATCOM (INMARSAT)	2 654 930	1.7%
	J7 - CPDLC FANS 1/A SATCOM (iridium)	385 784	1.7%
Voice	H - HF RTF	10 825 396	48.7%
	M1 - ATC RTF SATCOM (INMARSAT)	2 705 550	12.2%
	M2 - ATC RTF (MTSAT)	276 730	1.3%
	M3 - ATC RTF (iridium)	613 286	2.8%
	U - UHF RTF	585 788	2.6%
	V - VHF RTF	2 945 674	13.3%
	Y - VHF with 8.33 kHz channel spacing capability	22 018 258	99.1%

Value 2

COM datalink “flight” capabilities as a % at the top 10 European airports, year 2019

Airport	E2 – D-FIS ACARS	E3 – PDC ACARS	J1 – CPDLC ATN VDL Mode 2	J4 – CPDLC FANS 1/A VDL Mode 2	J5 – CPDLC FANS 1/A SATCOM (INMARSAT)	J7 – CPDLC FANS 1/A SATCOM (Iridium)
Barcelona	26.0%	31.5%	21.9%	5.8%	6.6%	0.8%
Frankfurt Main	78.8%	73.3%	48.7%	15.4%	18.7%	3.8%
Istanbul/New airport	83.4%	83.5%	66.7%	22.8%	23.2%	0.2%
London/Gatwick	64.5%	75.4%	69.0%	6.2%	10.9%	1.6%
London/Heathrow	31.9%	88.5%	36.1%	18.7%	36.8%	2.3%
Madrid Barajas	20.5%	28.0%	23.4%	11.4%	16.2%	0.7%
Munich 2	80.7%	67.8%	41.1%	8.2%	8.9%	0.9%
Paris Ch de Gaulle	72.9%	76.5%	54.3%	11.5%	21.7%	2.7%
Rome Fiumicino	23.3%	28.3%	29.6%	7.8%	11.3%	1.1%
Schiphol Amsterdam	79.9%	82.8%	20.8%	5.7%	15.7%	2.3%

Value 3

COM voice “flight” capabilities as a % at the top 10 European Airports, year 2019

Airport	**H – HF RTF**	**M1 – ATC RTF SATCOM (INMARSAT)**	**M2 – ATC RTF (MTSAT)**	**M3 – ATC RTF (iridium)**	**U – UHF RTF**	**V – VHF RTF**	**Y – VHF with 8.33 kHz channel spacing**
Barcelona	65.8%	9.1%	0.0%	1.7%	0.8%	41.8%	99.9%
Frankfurt Main	32.0%	18.4%	0.4%	3.5%	0.8%	7.2%	99.9%
Istanbul/New airport	95.1%	19.8%	0.0%	2.1%	1.0%	9.6%	100.0%
London/Gatwick	68.9%	9.8%	2.9%	0.8%	0.7%	9.0%	100.0%
London/Heathrow	58.3%	36.8%	14.1%	2.6%	1.2%	5.7%	100.0%
Madrid Barajas	63.2%	32.1%	0.4%	1.1%	0.6%	5.0%	99.9%
Munich 2	24.6%	9.4%	0.2%	1.4%	1.1%	6.1%	99.9%
Paris Ch de Gaulle	48.7%	21.9%	7.7%	3.5%	1.0%	7.7%	99.6%
Rome Fiumicino	39.1%	12.1%	0.2%	1.3%	1.1%	13.3%	100.0%
Schiphol Amsterdam	40.8%	8.0%	0.0%	2.7%	0.4%	6.5%	99.8%

Value 4

COM datalink “flight” capabilities for main aircraft models, year 2019

Aircraft type	**E2 – D-FIS ACARS**	**E3 – PDC ACARS**	**J1 – CPDLC ATN VDL Mode 2**	**J4 – CPDLC FANS 1/A VDL Mode 2**	**J5 – CPDLC FANS 1/A SATCOM (INMARSAT)**	**J7 – CPDLC FANS 1/A SATCOM (Iridium)**
B737	22.5%	28.8%	27.1%	1.0%	0.2%	0.2%
A320	62.5%	62.0%	52.1%	3.5%	0.1%	0.0%
A319	63.3%	75.7%	51.1%	0.6%	0.4%	0.0%
A321	70.2%	70.5%	59.3%	5.0%	0.2%	0.4%
DHC8	12.6%	6.3%	0.0%	0.0%	0.1%	31.5%
ATR72	8.2%	11.4%	0.0%	0.0%	0.0%	0.0%
B777	62.3%	93.3%	26.8%	49.2%	96.9%	8.1%
A330	61.0%	82.3%	3.6%	56.1%	90.5%	4.7%
E190	71.5%	67.4%	27.9%	0.0%	0.0%	0.0%
A320 NEO	32.7%	52.9%	61.2%	0.3%	0.0%	0.1%
B787	62.1%	77.2%	67.5%	82.5%	98.9%	3.6%
CL900RJ	47.6%	0.2%	0.0%	0.0%	100.0%	65.9%
E195	65.9%	57.8%	42.1%	0.4%	22.3%	100%
B767	38.9%	66.5%	1.4%	28.1%	37.5%	36.9%
E175	55.8%	54.3%	48.7%	0.4%	0.5%	16.4%

Value 5

COM voice “flight” capabilities for main aircraft models, year 2019

Aircraft type	H – HF RTF	M1 – ATC RTF SATCOM (INMARSAT)	M2 – ATC RTF (MTSAT)	M3 – ATC RTF (iridium)	U – UHF RTF	V – VHF RTF	Y – VHF with 8.33 kHz channel spacing
B737	22.5%	28.8%	27.1%	1.0%	0.2%	0.2%	53.4%
A320	62.5%	62.0%	52.1%	3.5%	0.1%	0.0%	63.9%
A319	63.3%	75.7%	51.1%	0.6%	0.4%	0.0%	25.1%
A321	70.2%	70.5%	59.3%	5.0%	0.2%	0.4%	51.8%
DHC8	12.6%	6.3%	0.0%	0.0%	0.1%	31.5%	4.2%
ATR72	8.2%	11.4%	0.0%	0.0%	0.0%	0.0%	11.5%
B777	62.3%	93.3%	26.8%	49.2%	96.9%	8.1%	99.9%
A330	61.0%	82.3%	3.6%	56.1%	90.5%	4.7%	99.9%
E190	71.5%	67.4%	27.9%	0.0%	0.0%	0.0%	26.0%
A320 NEO	32.7%	52.9%	61.2%	0.3%	0.0%	0.1%	32.4%
B787	62.1%	77.2%	67.5%	82.5%	98.9%	3.6%	99.8%
CL900RJ	47.6%	0.2%	0.0%	0.0%	100%	65.9%	0.4%
E195	65.9%	57.8%	42.1%	0.4%	22.3%	100%	21.3%
B767	38.9%	66.5%	1.4%	28.1%	37.5%	36.9%	97.8%
E175	55.8%	54.3%	48.7%	0.4%	0.5%	16.4%	5.4%

Source

EUROCONTROL Communication, Navigation & Surveillance (CNS) Dashboard https://www.eurocontrol.int/dashboard/communication-navigation-and-surveillance-dashboard

Surveillance (SUR) Flight capabilities (weighted by flight)	
Value 1	As a % of total flights, year 2019

Capability		**Number of flights**[53]	**As a % of all flights**
SSR Mode S	L – Mode S, including aircraft identification, pressure-altitude, extended squitter (ADS-B) and enhanced surveillance capability	4 785 926	43.1%
	H – Mode S, including aircraft identification, pressure-altitude and enhanced surveillance capability	2 541 601	22.9%
	E – Mode S, including aircraft identification, pressure-altitude and extended squitter (ADS-B) capability	238 086	2.1%
	S – Mode S, including both pressure-altitude and aircraft identification capability	3 446 300	31.0%
	P – Mode S, including pressure-altitude, but no aircraft identification capability	3 493	0.0%
	I – Mode S, including aircraft identification, but no pressure-altitude capability	684	0.0%
	X – Mode S with neither aircraft identification nor pressure-altitude capability	2 148	
	) and Mode C	210 661	

[redacted]

[redacted]

Value 3

ADS-B declared capabilities in “flight”[54] plans at the top 10 European airports, year 2019

Airport	Capability					
	B1	B2	U1	U2	V1	V2
Frankfurt Main	71.5%	1.7%	0.6%	0.0%	0.1%	0.0%
Amsterdam Schiphol	82.0%	1.0%	0.5%	0.0%	0.1%	0.0%
Paris Ch. de Gaulle	42.5%	2.3%	0.9%	0.0%	0.1%	0.1%
London/Heathrow	62.8%	5.7%	0.6%	0.0%	0.0%	0.0%
Madrid Barajas	50.9%	3.1%	0.5%	0.0%	0.6%	0.0%
Munich	55.0%	3.9%	1.1%	0.0%	0.1%	0.0%
Barcelona	56.2%	2.1%	1.0%	0.0%	0.1%	0.1%
Istanbul Main	79.0%	2.3%	0.8%	0.0%	0.0%	0.0%
Rome Fiumicino	77.2%	1.6%	1.2%	0.0%	0.1%	0.0%
London/Gatwick	73.4%	2.5%	0.2%	0.0%	0.0%	0.0%

Value 4

SSR/Mode S declared capabilities in flight plans for main aircraft models, year 2019

Aircraft type	Capability								
	L	H	E	S	P	I	X	C	A
B737-800	46.9%	5.7%	0.7%	46.8%	0.0%	0.0%	0.0%	0.0%	0.0%
A320	46.1%	26.2%	0.7%	26.8%	0.0%	0.0%	0.0%	1.4%	0.8%
A319	53.3%	28.4%	9.1%	8.7%	0.0%	0.0%	0.0%	0.4%	0.2%
A321	49.5%	28.4%	0.3%	21.8%	0.0%	0.0%	0.0%	0.3%	0.0%
DH8D	6.4%	75.0%	0.1%	18.5%	0.0%	0.0%	0.0%	0.0%	0.0%
E190	31.0%	41.9%	0.6%	25.8%	0.0%	0.0%	0.0%	0.1%	0.0%
A320 NEO	62.4%	15.9%	0.1%	21.6%	0.0%	0.0%	0.0%	0.0%	17.8%
B777-300ER	81.8%	5.7%	0.0%	12.4%	0.0%	0.0%	0.0%	0.0%	0.0%
CRJ9	0.0%	88.7%	1.4%	9.9%	0.0%	0.0%	0.0%	0.0%	0.0%
E195	58.4%	32.4%	3.5%	5.6%	0.0%	0.0%	0.0%	0.0%	0.0%
A330-200	71.0%	11.5%	6.5%	10.9%	0.0%	0.0%	0.0%	0.0%	0.0%
ATR72-600	17.7%	9.6%	25.4%	47.1%	0.0%	0.0%	0.0%	0.0%	0.0%
B737	81.5%	12.5%	0.7%	5.3%	0.0%	0.0%	0.0%	0.0%	0.0%
A330-300	84.5%	5.1%	3.4%	6.9%	0.0%	0.0%	0.0%	0.0%	0.0%
E170	48.9%	41.9%	0.0%	8.2%	0.0%	0.0%	0.0%	0.0%	0.0%

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[54] *Figures in value 3 (SUR capabilities per airport) are per flight but include as well any flight departing or arriving to that airport, value 4 (SUR capabilities per aircraft type) are per flight from departure to destination.*

<table>
<tr><td>Value 5</td><td>ADS-B declared capabilities in flight[55] plans for main aircraft models. year 2019
<table>
<tr><th rowspan="2">Aircraft type</th><th colspan="6">Capability</th></tr>
<tr><th>B1</th><th>B2</th><th>U1</th><th>U2</th><th>V1</th><th>V2</th></tr>
<tr><td>B737-800</td><td>86.6%</td><td>0.2%</td><td>1.3%</td><td>0.6%</td><td>0.2%</td><td>0.6%</td></tr>
<tr><td>A320</td><td>49.8%</td><td>1.4%</td><td>2.6%</td><td>0.0%</td><td>0.7%</td><td>0.0%</td></tr>
<tr><td>A319</td><td>47.0%</td><td>9.1%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td></tr>
<tr><td>A321</td><td>58.7%</td><td>0.2%</td><td>4.3%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td></tr>
<tr><td>DH8D</td><td>6.6%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td></tr>
<tr><td>E190</td><td>54.9%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td></tr>
<tr><td>A320 NEO</td><td>93.6%</td><td>0.9%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td></tr>
<tr><td>B777-300ER</td><td>94.2%</td><td>2.3%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td></tr>
<tr><td>CRJ9</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td></tr>
<tr><td>E195</td><td>55.9%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td></tr>
<tr><td>A330-200</td><td>79.3%</td><td>2.5%</td><td>0.0%</td><td>0.0%</td><td>0.1%</td><td>0.0%</td></tr>
<tr><td>ATR72-600</td><td>36.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td></tr>
<tr><td>B737</td><td>75.7%</td><td>0.0%</td><td>0.0%</td><td>0.1%</td><td>1.9%</td><td>0.1%</td></tr>
<tr><td>A330-300</td><td>79.7%</td><td>11.9%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td></tr>
<tr><td>E170</td><td>48.9%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td><td>0.0%</td></tr>
</table>
</td></tr>
<tr><td>Source</td><td>EUROCONTROL Communication, Navigation & Surveillance (CNS) Dashboard (https://ext.eurocontrol.int/analytics/saw.dll?Dashboard) (go to dashboard -> CNS dashboard)</td></tr>
</table>

3 Description

The CNS dashboard provides information for monitoring fleet capabilities and preparing performance-based navigation (PBN) deployment plans. It does so by analysing CNS and PBN information contained in ICAO flight plans, and generates reports on aircraft or flight characteristics. Note that the capability of aircraft which do not submit flight plans is not covered in the above figures. The missing information to a large extent for general aviation (GA) flights.

The tool provides statistics on equipment and capability such as:

- Communication: FMC WPR ACARS, HF RTF; CPDLC FANS 1/A HFDL; etc.
- Navigation: RNAV 5, RNAV 1, RNP 1, RNP APCH (including LPV capability), GBAS, etc.
- Surveillance: ADS-B, ADS-C, Mode S transponder, etc.

Different periods of time, airports, airlines or aircraft types (depending on the user profile) can be analysed.

To access the dashboard, you first need to register on the OneSky Online portal using the link in the source above.

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[55] *Figures in value 5 (SUR capabilities per aircraft type) are per flight from departure to destination.*

4 Related standard inputs

Number of IFR flights (page 13), CNS infrastructure (page 95) and PBN and precision approach procedures (page 100)

5 Comments

The numbers of flights and aircraft provided by the CNS dashboard are derived from flight plans submitted to the EUROCONTROL Network Manager (NM). Consequently, the statistics do not include the capability of aircraft flying in uncontrolled airspace or under VFR and thus do not submit flight plans to the NM.

On-board capability and equipment data made available via the CNS dashboard are those declared in ICAO FPLs by operators. The information is therefore only as reliable as declared. For detailed analysis, additional local assessment is recommended.

27. En route ANS costs

Content
- Definition
- EUROCONTROL recommended values
- Description
- Other possible source
- Related standard inputs
- Comments

1 Definition

The costs of air navigation services (ANS) in en route airspace which is under the control of States/ANSPs

2 EUROCONTROL recommended values

Value

Actual en route ANS costs

	2013	2014	2015	2016	2017	2018	2018 vs 2017	2013-18 CAGR
Total en route ANS costs (M€ 2018)	**7 247**	**7 283**	**7 384**	**7 402**	**7 364**	**7 501**	**1.8%**	**0.6%**
SES States[56]	6 859	6 846	6 924	6 904	6 842	6 927	1.2%	0.2%
Other nine States in the Route Charges System[57]	388	437	460	498	523	574	9.7%	7.4%
Total en route service units (TSU million)	**121**	**129**	**134**	**139**	**148**	**157**	**6.2%**	**5.3%**
SES States (EU-27+3)	107	112	115	120	127	134	5.6%	4.6%
Other nine States in the Route Charges System	14	17	19	19	21	23	9.7%	9.7%
Total en route ANS costs per TSU (€ 2018)	**60**	**57**	**55**	**53**	**50**	**48**	**-4.1%**	**-4.4%**
SES states (EU-27+3)	64	61	60	57	54	52	-4.1%	-4.2%
Other nine States in the Route Charges System	28	26	25	26	25	25	-0.0%	-2.1%

Source

EUROCONTROL – Performance Review Report (PRR 2019), June 2020 chapter 5.2.2
https://www.eurocontrol.int/publication/performance-review-report-prr-2019

Reports from previous years are available in the EUROCONTROL library: https://www.eurocontrol.int/library.

More information is accessible through the EUROCONTROL Aviation Intelligence Portal: https://ansperformance.eu/economics/.

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[56] *"SES States" refer to the 27 Member States of the European Union (EU), plus the United Kingdom, Norway and Switzerland.*

[57] *"Non-SES States" refer to the nine States which are not bound by SES regulations but which were part of the EUROCONTROL Multilateral Route Charges System in 2018 (i.e. Albania, Armenia, Bosnia-Herzegovina, Georgia, Moldova, North Macedonia, Serbia, Montenegro and Turkey).*

3 Description

ANS en route costs per service unit (TSU) in the above **value** are measured on the basis of the total actual and determined en route ANS costs (in real terms) divided by the number of en route service units. A service unit, used for the calculation of route charges, multiplies the aircraft weight factor by the distance factor[58].

En route costs can be calculated for a specific zone, e.g. the Single European Sky (SES) Member States (27 EU states plus the UK, Norway and Switzerland) or a functional airspace block (FAB).

The en route ANS-determined costs for a reference period of five years are the costs pre-determined by the SES States as referred to in Article 15(2)(a) of Regulation (EC) No 550/2004[59] for the provision of air navigation services. These include amounts for interest on debts, return on equity, depreciation of assets, and also staff costs and non-staff operating costs for maintenance, operations, management and administration. These costs are determined at national level and comprise the costs of several entities (the national supervisory authority, air navigation service provider(s), the MET service provider and the State's contribution to EUROCONTROL's budget).

4 Other possible source

Source	EUROCONTROL Central Route Charges Office (CRCO) (2019), Report on the Operation of the Route Charges System in 2019, April 2020 https://www.eurocontrol.int/publication/report-operation-route-charges-system-2019
Description	Aircraft operators are charged a single amount per flight, irrespective of the number of States overflown. The CRCO calculates route charges using flight messages sent by the Contracting States' Route Charges Offices (RCOs) and additional flight information made available via the NM. The CRCO bills aircraft operators on a monthly basis, collects charges, and disburses the amounts collected to the States every week. The system report itself provides an overview of the major developments of the Route Charges System and of the cost-bases, unit rates and statistical information on the operations of the system.

5 Related standard inputs

Distance flown by charging zone (page 57) and route charge share per market segment (page 84)

6 Comments

Terminal ANS costs and ANSP gate-to-gate economic performance are described separately in chapter 5.3 of the EUROCONTROL Performance Review Report (PRR 2019), June 2020, mentioned above.

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[58] *The unit rate of charge is the charge in euros applied by a charging zone to a flight operated by an aircraft of 50 metric tonnes (weight factor of 1.00) and flying 100 kilometres (distance factor of 1.00) in the charging area of that State. Further information on calculating unit rates can be found at https://www.eurocontrol.int/publication/customer-guide-route-charges.*

[59] *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2004R0550:20091204:EN:PDF*

28. Route charge share per market segment

Content
- Definition
- EUROCONTROL recommended values
- Description
- Related standard inputs

1 Definition

The proportion of route charges[60] from air traffic management (ATM) services in Europe (infrastructure, staff and other operational costs) per market segment[61]

2 EUROCONTROL recommended value

Value

Market segment	% of flights	% of km flown	% of total charges collected
	2016 (2019)	**2016 (2019)**	**2016**
Scheduled airlines (including low-cost and charter airlines)	85.4% (87.1%)	89.0% (90.2%)	91.4%
Business aviation	6.7% (6.4%)	4.6% (4.3%)	1.9%
Cargo	3.2% (2.9%)	4.3% (4.0%)	5.5%
Military	1.3% (1.0%)	1.3% (0.9%)	1.1%
Other types	3.4% (2.7%)	0.8% (0.6%)	0.1%
Total	100%	100%	100%

Source

EUROCONTROL STATFOR (2016, 2019), and EUROCONTROL Central Route Charges Office, geographical coverage ECAC (2016)[62]

3 Description

On behalf of EUROCONTROL's Member States, the CRCO bills and collects route charges, which fund air navigation facilities and services and support air traffic management developments. It also bills and collects, on a bilateral basis, terminal charges and air navigation charges on behalf of non-Member States, as well as communication charges in the Shanwick area.

Each aircraft operator receives a single bill per month in euros, no matter how many EUROCONTROL Member States were overflown. The billing and recovery of air navigation charges ensure that air navigation facilities and services are steadily financed and safely operated, paving the

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[60] *There are different sorts of air navigation charges, namely route charges, terminal navigation charges and communication charges. The above distribution relates to route charges only.*

[61] *Rules for EUROCONTROL classification of low-cost, all-cargo and business aviation types of flights https://www.eurocontrol.int/publication/market-segment-rules*

[62] *Data not readily available, update forthcoming*

way for the future evolution of the pan-European air traffic management (ATM) system in the context of the Single European Sky and the European ATM Master Plan (SESAR).

Information on the various different charges levied by the CRCO, in particular the charge calculation methods, the basic billing documents, the methods of payment and the submission of claims, is contained in a “Customer Guide to Charges” available at https://www.eurocontrol.int/publication/customer-guide-route-charges

4 Related standard inputs

Number of IFR flights (page 13), distance flown by charging zone (page 57) and en route ANS costs (page 82)

29. ANSPs’ employment costs

Content

1 Definition

ANSPs’ average annual employment costs for one full-time equivalent (FTE) cost in euro by category of staff

2 EUROCONTROL recommended value

<table>
<tr><td>Value</td><td>
<table>
<tr><th>Staff function</th><th>EUROCONTROL area[63]</th><th>SES[64]</th></tr>
<tr><td>ATCOs in ops</td><td>151</td><td>171</td></tr>
<tr><td>Support staff</td><td>73</td><td>95</td></tr>
<tr><td>Average all staff</td><td>98</td><td>122</td></tr>
</table>
<i>(€’000 – 2018)</i>
</td></tr>
<tr><td>Source</td><td>EUROCONTROL (2020) – ATM Cost-Effectiveness (ACE) 2018 Benchmarking – Performance Review Commission, May 2020. Current and earlier editions can be found at https://www.eurocontrol.int/ACE/.</td></tr>
</table>

3 Description

One full-time equivalent (FTE) is the equivalent of a single person carrying out a particular job or activity working on a full-time basis during a year. A part-time employee working half-time would be counted as 0.5 FTEs. A full-time ATCO working two thirds of her time on duty in ops and one third of her time on teaching at a training academy would be counted as a 0.67 FTE ATCO in ops and a 0.33 FTE ATCO on other duties.

Employment costs comprise gross wages and salaries, payment for overtime, employer contributions to social security schemes and taxes, pension contributions and other benefits.

For a study on employment costs, the categories of staff working in an ANSP have been divided into two:

- **ATCOs in ops**: ATCOs participating in an activity which is either directly related to the control of traffic or where there is a necessary requirement for ATCOs to be able to control traffic
- **Support Staff** or non-ATCOs in ops: This category includes all other staff. It includes ATCOs on other duties (participating in an activity outside ops, such as special projects, teaching at a training academy, providing instruction in a simulator, working in a full-time management position, etc.), trainees, ATC assistants, technical and operational support staff, administration staff, and others.

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[63] 38 Air navigation services providers (ANSPs) participating in the ACE 2018 benchmarking analysis listed in paragraph 1.2 of the identified report

[64] States covered *by the SES Regulation: EU-27 plus UK, Norway and Switzerland*

The following table gives an overview of individual ANSPs and average European system FTE costs for the two categories.

Average cost (€'000/year) European system cost for one FTE				
ANSP	**Country**	**ATCO in ops**	**Support staff**	**All staff**
Albcontrol	Albania	47	21	27
ANS CR	Czech Republic	184	71	94
ANS Finland	Finland	119	101	111
ARMATS	Armenia	21	14	15
Austro Control	Austria	231	191	205
Avinor (Continental)	Norway	142	108	122
BULATSA	Bulgaria	120	51	68
Croatia Control	Croatia	122	56	80
DCAC Cyprus	Cyprus	95	59	77
DFS	Germany	224	117	156
DHMI	Turkey	59	16	25
DSNA	France	139	102	115
EANS	Estonia	106	45	64
ENAIRE	Spain	207	86	137
ENAV	Italy	155	100	127
HCAA	Greece	85	65	71
HungaroControl	Hungary	145	52	75
IAA	Ireland	154	140	147
LFV	Sweden	190	117	151
LGS	Latvia	87	38	49
LPS	Slovak Republic	178	70	92
LVNL	Netherlands	277	104	139
MATS	Malta	111	66	81
M-NAV	North Macedonia	60	29	36
MOLDATSA	Moldova	35	15	21
MUAC	Maastricht	278	156	208
NATS (Continental)	UK	165	79	106
NAV Portugal (Continental)	Portugal	322	136	195
NAVIAIR	Denmark	161	97	119
Oro navigacija	Lithuania	81	50	59
PANSA	Poland	127	53	75
ROMATSA	Romania	130	85	99
Sakaeronavigatsia	Georgia	24	13	15
Skeyes	Belgium	227	141	164
Skyguide	Switzerland	234	154	175
Slovenia Control	Slovenia	131	87	103
SMATSA	Serbia and Montenegro	69	51	58
UkSATSE	Ukraine	25	15	17
All ANSP average		151	73	98

(Source: "ATM Cost-Effectiveness (ACE) 2018 Benchmarking Report" – EUROCONTROL Performance Review Commission, May 2020.)

The values in the table above were calculated using values provided in Annex 8 – Tables 0.3 and 0.5 of the source document.

Note: The employment costs above refer to gate-to-gate cost, i.e. en route and terminal costs, and are expressed in 2018 prices.

4 Other possible value

Value	<table><tr><th>Cost per hour</th><th>EUROCONTROL area</th></tr><tr><td>ATCOs in ops for ACC, APPs and TWRs</td><td>€115</td></tr></table> *(€ 2018)*
Source	EUROCONTROL (2020) - ATM Cost-Effectiveness (ACE) 2018 Benchmarking – Performance Review Commission, May 2020. Current and earlier editions can be found at https://www.eurocontrol.int/ACE/. The values in the table above were calculated using values provided in Annex 8 – Tables 0.5 of the source document.

5 Related standard input

ATM cost-effectiveness indicators (page 91)

accordance with the expected operating life and the pertinent IAS/IFRS standards (https://www.iasplus.com/en/standards).

9 Further reading

European Commission (2014), DG Regional Policy
Guide to Cost-Benefit Analysis of Investment Projects – Economic appraisal tool for Cohesion Policy 2014-2020, December 2014
The European Commission's reference periods by sector are on page 42.
http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf

31. ATM cost-effectiveness indicators

Content
- Definition
- EUROCONTROL recommended value
- Description
- Related standard input

1 Definition

Key performance indicators of cost-effectiveness and productivity for the air navigation service providers (ANSPs)

2 EUROCONTROL recommended value

Value	<table><tr><th>Indicator</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th></tr><tr><td>ATCO-hour productivity expressed as composite flight-hours per ATCO-hour</td><td>0.83</td><td>0.84</td><td>0.88</td><td>0.93</td></tr><tr><td>Employment costs per ATCO-hour</td><td>€112</td><td>€113</td><td>€114</td><td>€115</td></tr><tr><td>Support cost ratio – the ratio of gate-to-gate ANS staff to ATCOs in ops</td><td>3.2</td><td>3.1</td><td>3.1</td><td>3.1</td></tr></table> *(average values of indicators at Pan-European ANS system level – based on 2018 data)*
Source 1	EUROCONTROL (2020) – ATM Cost-Effectiveness (ACE) 2018 Benchmarking – Performance Review Commission, May 2020. Current and earlier editions can be found at https://www.eurocontrol.int/ACE/. Reports from previous years are available in the EUROCONTROL library: https://www.eurocontrol.int/library. More data is accessible through the EUROCONTROL Agency Intelligence Portal: https://ansperformance.eu/economics/.

3 Description

The ACE benchmarking reports comprise data about and analysis of cost-effectiveness and productivity for the ANSPs in EUROCONTROL's Member States.

The key performance drivers of cost-effectiveness are:

- Productivity;
- employment costs; and
- support costs, comprising costs for non-ATCOs in ops employment, non-staff operating costs, exceptional costs, depreciation and capital-related costs.

The above values are the European system averages for ATCO productivity employment costs and support costs.

The 2018 key performance drivers of financial cost-effectiveness for each ANSP are illustrated in Figures 0.7, 2.77 and Table 0.1 in Annex 4 of the source document. There is a wide variation in each of the components:

- ATCO productivity ranges from 0.21 to 2.22.
- Employment costs per ATCO-hour vary from a minimum of €31 to a maximum of €221 per ATCO-hour in purchasing power parity terms.
- Support cost ratios as a component of gate-to-gate cost-effectiveness vary from 0.37 to 1.4 in 2018.

4 Related standard input

ANSP employment cost (page 86)

tonc 0 Tw ( )TjET46598 20151 g-□ 5.071 0 2.22720161 g-□ 5.071 0 2.22720171 g-□ 5.071 0 2.227201

The ATM Cost-Effectiveness (ACE) Benchmarking Report presents data about and analysis of cost-effectiveness and productivity for ANSPs. It presents a review and comparison of ATM cost-effectiveness for the 38 air navigation service providers (ANSPs) in Europe, which provide coverage for EUROCONTROL's 41 Member States and 2 Comprehensive Agreement States[68]. It excludes, however, elements related to services provided to military operational air traffic (OAT), oceanic ANS, and landside airport management operations.

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[68] *Morocco and Israel each signed a Comprehensive Agreement in 2016.*

33. CNS infrastructure

Content

- Definition
- EUROCONTROL recommended values
- Description
- Related standard inputs

4 Definition

The number of systems installed which are devoted to carrying out communication navigation and surveillance functions in Europe[69]

5 EUROCONTROL recommended values

Value 1

Navigation aids in the ECAC Member States

	NDB	VOR	DME	VOR/ DME	TACAN	VORTAC
Albania		1	1	1		
Armenia	6	2	2	2		
Austria	14	9	16	9		
Azerbaijan	5	5	5	5		
Belgium – Luxembourg	12	14	12	12	5	2
Bosnia and Herzegovina	12	7	7	7		
Bulgaria	6	7	12	7		
Croatia	28	8	12	8		
Cyprus	3	2	2	2		
Czech Republic	22	9	11	9		
Denmark	28	9	1	5	4	3
Estonia	7	3	4	2	1	1
Finland	2	12	23	12		
France – Monaco	146	85	62	59	18	
Georgia	5	2	7	2		
Germany	56	6	72	42	6	6
Greece	4	47	46	46		
Hungary	34	12	14	12		
Iceland	34	3	2	2	1	1
Ireland	14	7	12	7		
Italy - San Marino	63	65	58	55	29	9
Latvia						

	NDB	VOR	DME	VOR/DME	TACAN	VORTAC
Poland	25	22	36	22		
Portugal	16	18	22	15	7	2
Romania	22	16	24	16		
Serbia – Montenegro	36	1	1	1		
Slovak Republic	11	5	5	5		
Slovenia	4	5	5	5		
Spain	58	85	89	83	15	2
Sweden	8	25	42	23		
Switzerland	3	1	14	1		
Turkey	78	73	76	72	22	1
United Kingdom	74	47	57	46	1	
Ukraine	58	8	17	8		
Total	**991**	**676**	**846**	**657**	**129**	**27**

Sources 1	Assessment: November 2020 Sources: European AIS Database (EAD) and Aeronautical Information Publications (AIPs)

Value 1
(Continued)

Navigation aids in the ECAC Member States

	ILS		ILS/DME	GLS Cat I
	Cat I	Cat II/III		
Albania	1		1	
Armenia	1	1	1	
Austria	3	6	11	
Azerbaijan	6	6	12	
Belgium – Luxembourg	7	6	1	
Bosnia and Herzegovina	3		4	
Bulgaria	4	1	4	
Croatia	8	1	3	
Cyprus	2		2	
Czech Republic	9	2	12	
Denmark	19	7	27	
Estonia	4		6	
Finland	23	5	27	
France – Monaco	55	31	91	
Georgia	5		5	
Germany	41	44	42	2
Greece	5	6	1	
Hungary	4	4	12	
Iceland	6	2	11	
Ireland	6	5	12	
Italy – San Marino	3	14	46	
Latvia	1	1	3	
Lithuania	5	2	5	
North Macedonia	2		1	
Malta	2		2	
Moldova	2	1	2	
Netherlands	8	7	25	
Norway	29	6	63	19
Poland	7	8	23	
Portugal	7	4	13	
Romania	1	11	21	
Serbia – Montenegro	3	1	2	
Slovak Republic	5	2	6	
Slovenia	1	1	2	
Spain	46	17	62	1
Sweden	54	8	39	
Switzerland	6	3	15	1
Turkey	43	17	73	
United Kingdom	55	28	94	
Ukraine	22	5	7	
Total	514	263	789	23

Sources 1

Assessment: November 2020

Sources: European AIS Database (EAD) and Aeronautical Information Publications (AIPs)

Value 2

Surveillance aids in EUROCONTROL Member States

EUROCONTROL Member State	PSR	SSR	Mode-S	WAM/[70] ADS-B	ADS-B
Albania		1	1		
Armenia	3	3		tbc	
Austria	4	4	9	68	
Belgium	6	3	8		
Bosnia and Herzegovina	1		2		2
Bulgaria	5	4	19	21	
Croatia			10	40	
Cyprus	2		4		3
Czech Republic	2		5	42	
Denmark	4	4	8	30	22
Estonia		2	4	24	
Finland	1	11	27	113	
France	10	41	36	14	19
North Macedonia	1	2	1		
Georgia			4	22	6
Germany	21	15	57	37	
Greece	7	13		26	4
Hungary	4		9		
Iceland		1	4	11	8
Ireland	4	4	7		5
Italy	25		49		20
Latvia	1		3	6	
Lithuania	2		7		
Luxembourg	1	1	1	4	
Malta	2	1	3		3
Moldova	2	2	1		
Montenegro			1		
Netherlands	1	1	10	19	
Norway	6	12	13	82	18
Poland	5	4	18	10	
Portugal	1	3	7	76	6
Romania	1	2	9	36	
Serbia - Montenegro			5		
Slovak Republic	2		4		
Slovenia	2	1	4	26	
Spain	12	19	23	8	7
Sweden	1	4	10	80	
Switzerland	2		11	38	
Turkey			30		1
Ukraine		9	16	18	
United Kingdom	13	3	59	38	
Total	**Not applicable**				

Source 2

1. Surveillance Unit Surveillance Database,
2. EUROCONTROL Surveillance Deployment Plan

Status: September 2020, includes installations planned in 2020

6 Description

Value 1

The report identified in Source 1 presents an overall summary of the ground navaids available in individual ECAC countries. The data reflect the number of operational navaids at the time the information was collected in January 2017.

Value 2

The Mode-S PSR (primary surveillance radar) and SSR (secondary surveillance radar) numbers are extracted from the surveillance database of the EUROCONTROL CNS unit.

According to the most recent figures, there are in Europe some 483 Mode-S radars, 1 547 PSRs and 110 SSRs, either combined or standalone. As the allocation and implementation of Mode-S interrogator codes (ICs) require a coordinated approach, every installation of a Mode-S radar is officially registered. The numbers of PSRs and SSRs reported above are not necessarily accurate, as they are based on voluntary reports by the Member States on updates and changes to their surveillance infrastructure. Work on the collection of MLAT/ADS-B stations is still in progress.

The WAM/ADS-B (wide-area multilateration/automatic dependent surveillance-broadcast) and ADS-B data originate from the database, which is maintained by the EUROCONTROL Surveillance and Code Coordination Unit and is based on inputs from stakeholders.

The ADS-B and WAM Section coordinates the deployment of initial ADS-B applications and WAM in Europe. The WAM/ADS-B sensor count only includes sensors mainly used for surveillance of airborne aircraft (e.g. in TMAs or en route). It does not include sensors mainly used for airport surface surveillance (e.g. airport MLAT used for A-SMGCS).

7 Related standard inputs

Fleet CNS capability (page 73) and PBN instrument approach procedures (page 100)

Please note that the above data were provided by States and may slightly differ from the values in the table “PBN and precision approach procedures” as they are valid for different reference periods.

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[70] *The WAM/ADS-B column lists the number of sensors. The configurations and system boundaries for several WAM/ADS-B implementations are complex and site-specific. It is therefore not possible to consistently identify the corresponding number of systems.*

34. PBN and precision approach procedures

Content
- Definition
- EUROCONTROL recommended values
- Description
- Related standard inputs
- Comments

1 Definition

Proportion and list of airports and runway ends in ECAC with published performance-based navigation (PBN) instrument approach procedures

2 EUROCONTROL recommended values

Value 1

PBN approach deployment status (September 2020)

Approach type	Runway ends covered (Nb)	Runway ends covered (%)	Airports covered (Nb)	Airports covered (%)
RNP APCH to LNAV	974	61.8%	511	67.0%
RNP APCH to LNAV/VNAV	696	44.2%	353	46.3%
RNP APCH to LPV	638	40.5%	345	45.2%
Any RNP APCH (LNAV or LNAV/VNAV or LPV)	993	63.0%	516	67.6%
RNP AR APCH	31	2.0%	18	2.4%
ILS (all, see breakdown below)	814	51.7%	525	68.8%
GLS[71]	42	2.7%	21	2.8%
APV (LPV or LNAV/VNAV or RNP AR APCH)	853	54.1%	440	57.7%
3D (ILS Cat I or ILS Cat II/II or APV)	1 188	75.4%	644	84.4%

Value 2

ILS Cat I, Cat II/III deployment status (September 2020)

Approach type	Runway ends covered (Nb)	Runway ends covered (%)	Airports covered (Nb)	Airports covered (%)
ILS Cat I (and no Cat II/III)	549	34.8%	438	57.4%
ILS Cat II/III	265	16.8%	169	22.2%

Source

EUROCONTROL PBN Approach Map Tool
https://www.eurocontrol.int/platform/performance-based-navigation-map-tool

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[71] *'GLS' does not include instrument approach procedures based on GBAS proprietary precursor systems.*

3 Description

The EUROCONTROL Performance-Based Navigation (PBN) Approach Map tool illustrates the deployment of PBN instrument approach procedures against objectives set in ICAO Assembly Resolution 37-11 and the European Regulation on PBN (in particular Commission Implementing Regulation (EU) 2018/1048 of 18 July 2018).

PBN approaches include instrument approach procedures compliant with the following navigation specifications of the PBN Manual (ICAO Doc 9613):

- RNP APCH
- RNP AR APCH

The PBN Approach Map tool provides a list of the current and planned airports and runway ends covered by each type of approach.

The tool gives information about:

- deployment progress since 2012, on the basis actual publications;
- future deployment trends based on publication plans communicated to EUROCONTROL and ICAO;
- the availability of PBN approaches with vertical guidance (APV) on all runway ends or on runway ends without precision landing (e.g. ILS, MLS or GBAS);
- the deployment status for ECAC, individual countries, PCP airports and individual airports.

In September 2020 (on the basis of the AIRAC cycle, see comments), 1 576 runways ends were equipped with instrument approach procedures and 763 airports had instrument approach procedures.

Access

The PBN Approach Map is available via the OneSky Online extranet:
https://www.eurocontrol.int/platform/performance-based-navigation-map-tool.

4 Related standard inputs

Fleet CNS capability (page 73) and CNS infrastructure (page 95).
Note that the CNS infrastructure is dedicated to the ground infrastructure (physical navigation aids) whereas PBN instrument approach is related to procedures.

5 Comments

The PBN Approach Map tool is updated in accordance with publications with every AIRAC cycle. It therefore provides up-to-date information on the current deployment status.

Information about publication plans captured in the map is collected from individual countries and coordinated with the ICAO EUR/NAT regional office and other implementation-funded programmes. If and when these publication plans materialise depends on a number of factors including:

- difficulties collecting obstacle data for procedure design;
- unforeseen problems in the procedure design phase;
- delays in approval for publication by the supervisory authority.

Implementation plans should consequently not be considered to be a State’s commitment.

35. Airport classification

Content
- Definition
- EUROCONTROL recommended values
- Description
- Other possible sources
- Related standard input
- Comments

1 Definition

Airports are classified according to the number of annual IFR movements.

2 EUROCONTROL recommended values

<table>
<tr><td>Value</td><td>
<table>
<tr><th>Annual IFR movements[72]</th><th>Airport category</th><th>Number of airports</th></tr>
<tr><td>> 250 000</td><td>Very large</td><td>14</td></tr>
<tr><td>[250 000; 150 000]</td><td>Large</td><td>18</td></tr>
<tr><td>[149 999; 40 000]</td><td>Medium</td><td>76</td></tr>
<tr><td>[39 999; 15 000]</td><td>Small</td><td>92</td></tr>
<tr><td>< 15 000</td><td>Other</td><td>957</td></tr>
</table>
Year 2018 – ECAC states
</td></tr>
<tr><td>Source</td><td>Data compiled by SESAR 2020 experts on the basis of data provided by the EUROCONTROL Performance Review Unit (PRU), ECAC States, year 2019</td></tr>
</table>

3 Description

An airport can be classified in several ways. Here we focus on categorisation of airports according to the number of IFR movements.

The list of airports used for this classification was developed using a two-step procedure:

Step 1: The initial worldwide airport list provided by the EUROCONTROL Performance Review Unit (PRU) was restricted to airports located in ECAC Member States and having both ICAO and IATA codes, in order to focus on airports providing commercial air transport services (1 079 airports).

Step 2: Seventy-seven (77) airports located in ECAC Member States were added to the airport list in order to scope all airports for which the EUROCONTROL Performance Review Unit (PRU) provided operational data.

Statistics on individual airport movements can be downloaded from the Aviation Intelligence Unit Dashboard: https://ansperformance.eu/data/.

4 Other possible sources

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[72] *A movement is either a take-off or a landing at an airport.*

Value 1	Airports which have implemented a collaborative decision-making (A-CDM) process
Source 1	Airport collaborative decision-making (A-CDM) https://www.eurocontrol.int/concept/airport-collaborative-decision-making
Description	Airport CDM (A-CDM) aims to improve the overall efficiency of airport operations by optimising the use of resources and improving the predictability of events. It focuses especially on aircraft turnaround and pre-departure sequencing processes. The A-CDM concept has been globally recognised. A-CDM is fully implemented in 30 airports across Europe (status: December 2020), including Amsterdam, Barcelona, Bergamo, Berlin Brandenburg "Willy Brandt", Brussels, Copenhagen, Düsseldorf, Frankfurt, Geneva, Hamburg, Helsinki, Lisbon, London Gatwick, London Heathrow, Lyon, Madrid, Milan Malpensa, Milan Linate, Munich, Naples, Nice, Paris CDG, Paris Orly, Oslo, Palma de Mallorca, Prague, Rome Fiumicino, Stockholm Arlanda, Stuttgart, Venice, Warsaw and Zurich. More details for a selected airport are available in the EUROCONTROL Public Airport Corner in Source 2.

Source 2	EUROCONTROL Airport Corner https://www.eurocontrol.int/tool/airport-corner
Description	The Airport Corner covers a wide range of airport information such as capacities, traffic forecasts, local events affecting operations, the airside and landside infrastructure, intermodality, adverse weather conditions, the TMA/approach, CDO and A-CDM implementation, the environment, civil-military coordination and local contacts. The tool offers the capability for information to be treated as confidential whenever required. In October 2015, the Airport Corner was enhanced, enabling airports to share information on events affecting the pre-tactical phase of operations through so-called enhanced airport information exchange with the NM. In total, more than 100 airports have become partners of the Airport Corner and many more are in the process of joining.

5 Related standard input

Turnaround time (page 50)

6 Comments

The mapping of airports to categories in the recommended value is purely indicative and is based on the situation in 2018. The mapping of airports will most probably change significantly as a result of COVID from 2020 onwards. The local situation of many airports may not be known or be interpreted differently. Final applicability of the assigning of airports to categories needs to be checked and confirmed by the appropriate airport or authority.

36. Taxiing times

Content
- Definition
- EUROCONTROL recommended values
- Description
- Other possible source
- Related standard inputs

1 Definition

The mean duration, in minutes, of taxiing times at airports.

2 EUROCONTROL recommended values

Value 1	Average time taxiing in and taxiing out (in minutes)

	Airport type[73]	**2015**	**2016**	**2017**	**2018**	**2019**
Taxiing in	1. Average, all airports	5.9	6.0	6.1	6.2	6.2
	2. Large to very large airports	6.8	6.8	6.8	6.8	7.1
	3. Medium to small airports	5.1	5.2	5.5	5.6	5.4
Taxiing out	1. Average, all airports	12.5	12.8	12.9	13.8	13.4
	2. Large to very large airports	14.2	14.6	14.4	14.9	15.2
	3. Medium to small airports	11.0	11.3	11.8	12.1	11.7

(values based on flights in the ECAC area)

Source 1	EUROCONTROL – Computed from actual data provided by the EUROCONTROL Central Office for Delay Analysis (CODA)

Value 2	Average additional taxiing-out time (average per departure)

Year	**2015**	**2016**	**2017**	**2018**	**2019**
Minutes	3.70	3.91	3.85	4.21	4.22

(scope: top 30 airports in terms of movements, excluding Turkish airports)

Source 2	EUROCONTROL – Performance Review Report (PRR 2019), June 2020 https://www.eurocontrol.int/publication/performance-review-report-prr-2019 Reports from previous years are available in the EUROCONTROL library: https://www.eurocontrol.int/library. More information is available via the EUROCONTROL Aviation Intelligence Portal: https://ansperformance.eu/dashboard/stakeholder/airport/.

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[73] *Large to very large airports = > 150 000 movements; medium to small airports = 149 999 to 15 000 movements*

3 Description

Value 1 is based on actual data from CODA. The taxiing-out time is defined as the time spent by a flight between its actual off-block time (AOBT) and actual take-off time (ATOT). The taxiing-in time is defined as the time spent between its actual landing time (ALDT) and actual in-block time (AIBT). The taxiing-in and taxiing-out durations are calculated on the basis of data sent by airlines to CODA.

Value 2 is based on actual data from airports. The additional taxiing-out time is a proxy for the average departure runway queuing time on the outbound traffic flow during congestion periods at airports. It is the difference between the actual taxiing-out time of a flight and a statistically determined unimpeded taxiing-out time[74] based on taxiing-out times in periods of low traffic demand. There is one unimpeded time per stand runway combination at each airport.

4 Other possible source

Value	By airport, seasonal taxiing time statistics for the IATA winter season and the IATA summer season: • Taxiing-in times • Taxiing-out times • Taxiing-out times by wake turbulence category
Source	EUROCONTROL CODA https://www.eurocontrol.int/publication/taxi-times-summer-2019 More data is accessible via the EUROCONTROL Aviation Intelligence Portal https://ansperformance.eu/data/.
Description	These taxiing times are calculated using the airline reported actual off-block time, actual take-off time, actual landing time and actual in-block time, providing the aviation community with seasonal benchmark values. Furthermore for additional granularity, taxiing-out times by wake turbulence category are also offered for a number of airports.

5 Related standard inputs

IFR average flight distance (page 53) and IFR flight information per operator segment (page 55)

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[74] *The unimpeded taxiing-out time is the taxiing-out time in non-congested conditions at airports.*

37. Investment in U-space

Content
- Definition
- EUROCONTROL recommended sources
- Description

1 Definition

U-space[75]-related investments required to allow access to airspace for large numbers of drones[76]

2 EUROCONTROL recommended sources

Source 1	SESAR Joint Undertaking (SJU) (2020) – European ATM Master Plan Edition 2020. Digitalising Europe's Aviation Infrastructure. https://www.sesarju.eu/masterplan
Source 2	SJU 2018 – European EATM Masterplan, Roadmap for the safe integration of drones into all classes of airspace https://www.sesarju.eu/node/2993
Source 3	SJU 2016 – European Drones Outlook Study https://www.sesarju.eu/node/2951

3 Description

In **Source 1**, the European ATM Master Plan 2020 highlights the growing importance in a time of new entrants. In particular, the Business View includes a section (6.2) on the "Holistic View of SESAR Net benefits for Drones" from which further U-space-related information can be retrieved.

The investment level considered is that necessary to support the safe and efficient deployment of drones in Europe as described in the European ATM Master Plan 2020. The values consider the civil side of the investments. Military investments are not taken into account. There are three categories of investments considered, namely infrastructure and services, airborne investments, and human resources. Further details of sub-categories and examples are to be found in Annex 3 of **Source 2**.

Source 3, the 2016 European Drones Outlook Study, outlines the drone-related research and development roadmap for the safe integration of drones into all classes of airspace

Important note
As drones are an emerging and dynamic business, the estimates and assumptions made for the sources referenced could already be outdated and should be treated with caution.

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[75] *What is **U-space**? "U-space is a set of new services and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones." Source : SJU- U-Space Blueprint https://www.sesarju.eu/sites/default/files/documents/reports/U-space%20Blueprint%20brochure%20final.PDF*

[76] ***Drones, UAS, RPAS?** In line with the Drones Outlook Study (Source 3 above) and the U-space blueprint document, the term "drones" is used as a generic term to cover all types of unmanned aircraft systems (UAS), whether remotely piloted (RPAS – remotely piloted aircraft system) or automated.*

38. Drone fleet

Content
- Definition
- EUROCONTROL recommended sources
- Description
- Comment

1 Definition

An estimate of the size of the future Drone fleet operating in Europe

2 EUROCONTROL recommended sources

Source 1	SESAR Joint Undertaking (SJU) (2016) – European Drones Outlook Study. Unlocking the value for Europe https://www.sesarju.eu/node/2951

Source 2	SJU (2018) – European ATM Master Plan: Roadmap for the safe integration of drones into all classes of airspace https://www.sesarju.eu/node/2993

3 Description

Source 1 is the main document describing the growing potential of the European market for drones. The development of the drone fleet is dependent on the ability of the industry to operate various areas of airspace. The document analyses the likely evolution of the fleet, linking it with the expected use, whether for military, government and commercial, or leisure purposes.

Source 2 concentrates on the link with the Master Plan 2020 Business View and brings in the topic of urban air mobility.

4 Comment

In view of the rapid evolution in recent years, the role of drones is likely to expand more than the source documents consider. The fleet is rapidly growing, making outlook analyses unstable. The data provided in the source documents should be seen as an estimate and will be reviewed in future editions of the standard inputs as additional data become available.

39. Purpose of passenger travel

Content
- Definition
- EUROCONTROL recommended values
- Description
- Other possible source
- Further reading

1 Definition

The distribution of aircraft passengers according to purpose of travel

2 EUROCONTROL recommended values

Value 1

Purpose of travel (UK)	2015	2016	2017	2018[77]
Business	20.0%	19.2%	19.0%	18.4%
Holidays	42.4%	42.1%	43.9%	43.9%
Visiting friends and relatives	35.2%	36.1%	34.7%	35.4%
Miscellaneous	2.5%	2.6%	2.4%	2.3%

Source 1

UK Department for Transport (2018) – Aviation Statistics, November 2019
AVI0108 – Purpose of travel at selected UK airports: time series
https://www.gov.uk/government/statistical-data-sets/tsgb02

Value 2

Purpose of travel (France)	2014-2015	2015-2016
Business	28%	28%
Holidays	43%	49%
Visiting friends and relatives	27%	22%
Miscellaneous	2%	1%

Source 2

Direction Générale de l'Aviation Civile (DGAC) (2017) – France, Enquête Profil des Passagers aériens 2015-2016, December 2017
https://www.ecologie.gouv.fr/sites/default/files/ENPA_2015_2016.pdf

3 Description

Results for **Value 1** are based on the UK CAA passenger survey, which is carried out at selected airports every year (Gatwick, Heathrow, Luton, Stansted and Manchester, sample size approx. 154 000 passengers in 2018). The scope of the statistics is travel to, from and within the UK. From 2009 to 2018, there was a 3.5 percentage point (p.p.) decrease in business travel and a 4% p.p. increase in holiday travel. Visiting friends and relatives remained the same and miscellaneous was down 0.5 p.p.

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[77] *2019 data not readily available, update expected in December 2020*

Value 2 is based on a yearly survey carried out by the French DGAC since 2009. The results for 2015-2016 are based on a sample size of approx. 41 000 passengers departing from the 12 largest French airports.

4 Other possible source

Value	By selected airport: • Purpose of travel • Final destination or transfer
Source	EUROCONTROL Public Airport Corner https://ext.eurocontrol.int/airport_corner_public/
Description	The Airport Corner covers a wide range of strategic airport information, such as capacity, traffic forecasts, local events with a potential impact on operations, diversion capabilities, airside and landside information, inter-modality, adverse weather conditions, TMA/approach, CDO and CDM implementation, environmental information, and local contacts.

5 Further reading

UK Department for Transport
From the UK Department for Transport: Table TSGB0114: Overseas travel by air: visits to and from the UK: by area and purpose – all modes 2008-2018. This does not include domestic travel by air: https://www.gov.uk/government/statistical-data-sets/tsgb01-modal-comparisons.

Visits to and from the UK by purpose of travel	2015	2016	2017	2018
Business	15.7%	15.1%	13.9%	13.7%
Holidays	55.0%	54.3%	55.4%	56.7%
Visiting friends and relatives	24.7%	26.0%	26.4%	26.0%
Miscellaneous	4.6%	4.6%	4.3%	3.6%

UK CAA (2019)
CAA Passenger Survey Reports
https://www.caa.co.uk/Data-and-analysis/UK-aviation-market/Consumer-research/Departing-passenger-survey/Survey-reports/

UNWTO
The United Nations' World Tourism Organization publishes arrivals by main purpose (personal, business and professional) in its Yearly Compendium.
https://www.unwto.org/global/publication/compendium-tourism-statistics-data-2013-2017-2019-edition

40. Passenger value of time

Content

- Definition
- EUROCONTROL recommended values
- Description
- Other possible values
- Further Reading

1 Definition

The value to a passenger of time spent travelling which might alternatively be spent working or at leisure

2 EUROCONTROL recommended values

<table>
<tr><td>Value 1</td><td>Estimated value of travel time (average EU25)
<table>
<tr><th>Per hour</th><th>Air carrier</th></tr>
<tr><td>Personal[78]</td><td>14.4-22.0</td></tr>
<tr><td>Business</td><td>44.4</td></tr>
</table>
<i>(adjusted from € 2002 to € 2019 prices)</i></td></tr>
<tr><td>Source 1</td><td>European Commission (2006) – HEATCO, Developing Harmonised European Approaches for Transport Costing and Project Assessment – Deliverable 5 Proposal for Harmonised Guidelines, IER Germany, February 2006 Commissioned by the EU (6th RTD Framework Programme)
https://trimis.ec.europa.eu/sites/default/files/project/documents/20130122_113653_88902_HEATCO_D5_summary.pdf</td></tr>
</table>

<table>
<tr><td>Value 2</td><td>Estimated value of air travel time in France per traveller per hour (average distance 1 208 km)
<table>
<tr><th>Per hour</th><th>Air carrier</th></tr>
<tr><td>Personal – holiday</td><td>58.2</td></tr>
<tr><td>Personal – other</td><td>59.6</td></tr>
<tr><td>Business</td><td>81.3</td></tr>
<tr><td>All purposes</td><td>60.6</td></tr>
</table>
<i>(adjusted from € 2015 to € 2019 prices)</i></td></tr>
<tr><td>Source 2</td><td>2.24 142.56 0.481 ref471.96 222.72 -0 0 9.96 218.42.24 142.56 0.481 ref471. 390.9627DC -1 Tf-0.</td></tr>
</table>

<table>
<tr><td>Value 3</td><td>Estimated value of air travel time in the UK
<table>
<tr><th>Per hour</th><th>Air carrier</th></tr>
<tr><td>Leisure</td><td>8.1</td></tr>
<tr><td>UK business</td><td>60.4</td></tr>
<tr><td>Foreign business</td><td>57.5</td></tr>
</table>
<i>(adjusted from £ 2014 to € 2019 prices at the 2019 exchange rate)</i></td></tr>
<tr><td>Source 3</td><td>Values of time used to estimate passenger delay costs in the UK airport system (2014) Airports Commission – Economy: Delay Impacts Assessment Methodology Paper
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/372606/AC08a_tagged.pdf</td></tr>
</table>

3 Description

The passenger value of time is an opportunity cost which corresponds to the monetary value associated with a traveller (passenger) during a journey. It is essentially how much a traveller would be willing to pay (WTP – willingness to pay) in order to save time during a journey (e.g. by travelling on a quicker service or using a faster mode), or how much ‘compensation’ they would accept, directly or indirectly, for ‘lost’ time[79].

It is to be noted that the value of time is not cited as a function of delay duration here. This is an important consideration when using the value. The longer the delay duration, the higher the value.

The HEATCO study in **Value 1** remains a reference value if a European value is sought. The objective of this study is to propose harmonised guidelines for project assessment for transnational projects in Europe. It provides monetary estimates for the values of time saved for employer business, for passenger non-work trips, namely commuting, shopping and leisure purposes, and for commercial goods traffic.

Value 2 reports on a working paper on recommended values for calculating the components of “socio-economic net present value” (VAN-SE), which include travel time. It is part of the evaluation of transport projects in France to meet travel needs, taking into account the challenges of sustainable development, ecological and energy transition, and budgetary constraints. The assessment therefore covers social, environmental and economic effects.

The Delay Impacts Assessment Methodology Paper in **Value 3** sets out the methodology for the analysis which has been undertaken to estimate benefits from reduced delay time to airlines and passengers from changes in aviation capacity constraints in the UK for 11 airports.

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[79] *University of Westminster – European airline delay cost reference values report - Annex C – 31 March 2011*

4 Other possible values

Value 1	€126 per hour per business aviation passenger (adjusted from 2011 prices)
Source 1	Data supplied by the airline members of the SESAR CBA team (2012)
Description 1	Given that typical business jet passengers are high-level executives/CEOs, the passenger cost for lost time adapted from Eurostat was estimated as being three times the value of a regular flyer.

<table>
<tr><td>Value 2</td><td>Based on US DOT guidance on passenger value of time for air and high-speed rail travel by purpose of trip
<table>
<tr><th>Per hour</th><th>Air carrier</th></tr>
<tr><td>Personal</td><td>43.6</td></tr>
<tr><td>Business</td><td>76.3</td></tr>
<tr><td>All purposes</td><td>56.9</td></tr>
</table>
(adjusted from $ 2015 to € 2019 prices at the 2019 exchange rate)</td></tr>
<tr><td>Source 2</td><td>US Department of Transportation (2016) – Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis, September 27, 2016
https://www.transportation.gov/sites/dot.gov/files/docs/2016 Revised Value of Travel Time Guidance.pdf</td></tr>
<tr><td>Description 2</td><td>The value of passenger time saved or lost as a result of investments in transportation facilities or regulatory actions
This version of the guidance updates the guidance furnished by the Office of the Secretary of Transportation (OST) (“Departmental Guidance for the Valuation of Travel Time in Economic Analysis,” Office of the Secretary of Transportation Memorandum, April 9, 1997).
The value of travel time for business travel is calculated on the basis of the median hourly gross wage (hourly wage plus fringe benefits).
The value for personal travel is based on the annual household income category divided by 2 080 hours of work per year.
When general aviation passengers are considered as a separate category, a value of 70% of the median hourly income of Aircraft Owners and Pilots Association (AOPA) members is established for personal travel and 100% of median hourly income for business travel.
The fractions of 70% and 100% were recommended by a panel of transportation economists.</td></tr>
</table>

5 Further reading

International Transport Forum (ITF) (2019)
What is the Value of Saving Travel Time?
https://www.itf-oecd.org/what-value-saving-travel-time
This report revisits the rationale and methods for estimating the value of reductions in travel time. In doing so, it considers changes in the way people use time and specifically explores whether the value of time will fall towards zero as connected technologies allow a wide range of activities while travelling. The report also reviews evidence and methodologies to account for the utility derived from

such activities, as well as implications for modelling, appraisal and policy planning. It summarises the findings of an ITF round table held with 30 experts from 14 countries in September 2018 in Paris.

Economic Development Research Group Inc. (USA), (2015)
Passenger Value of Time, Benefit-Cost Analysis, and Airport Capital Investment Decisions, ACRP WOD 22, April 2015
Commissioned by the US Transportation Research Board of the National Academies
https://www.ebp-us.com/en/projects/passenger-value-time-benefit-cost-analysis-and-airport-capital-investment-decisions
The objective of this research was to prepare a guidebook which helps airport planners, managers, and operators to use benefit-cost analysis and other analytical techniques in order to make airport capital investment decisions in the US.

University of Leeds (2016)
Values of travel time in Europe: Review and meta-analysis
http://eprints.whiterose.ac.uk/104595/1/European meta paper final accepted for publication.pdf
This report builds on a University of Leeds 2012 report. It provides an extensive meta-analysis of values of time, covering 3 109 monetary valuations assembled from 389 European studies conducted between 1963 and 2011. It aims to explain how valuations vary across studies, including over time and between countries. The figures in table 9, an extract from which is set out below, illustrate how the implied values of travel time vary between European countries.

Country	Air employer business
France	49.3
Germany	54.6
Italy	45.8
Spain	45.7
UK	51.8

(adjusted from € 2010 to € 2019 prices)

University of Leeds (May 2012)
European Wide-Meta Analysis of Values of Travel Time
(Final report to the European Investment Bank)
https://significance.nl/wp-content/uploads/2019/03/2012-GDJ-European-wide-meta-analysis-of-values-of-travel-time.pdf
The purpose of this study, commissioned by the European Investment Bank, was to provide values of travel time for the economic appraisal of transport projects performed by the EIB. It reports on the largest meta-analysis undertaken at that time. It focuses on European values of time for value of in-vehicle time (the time spent in the car, train, bus or plane during the journey). In particular, table 24 provides air values of time, comparing three distance bands, namely 250, 500 and 750 kilometres, for business and other purposes in € 2010 values.

41. Accident/incident statistics

Content

- Definition
- EUROCONTROL recommended sources
- Description
- Further reading

1 Definition

Statistical studies and databases containing relevant quantitative and qualitative data on aviation accidents and incidents.

Accident: An occurrence associated with the operation of an aircraft …, in which (a) a person is fatally or seriously injured… or (b) the aircraft sustains damage or structural failure …or (c) the aircraft is missing or completely inaccessible[80].

Incident: An occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.

Definitions: ICAO, Annex 13

2 EUROCONTROL recommended sources

Source 1	EASA Annual Safety Review Report 2020 https://www.easa.europa.eu/document-library/general-publications/annual-safety-review-2020

Source 2	IATA Safety Report 2019, Issued April 2020 https://www.iata.org/en/publications/safety-report/

Source 3	EUROCONTROL Voluntary ATM Incident Reporting Safety Bulletin, EVAIR, August 2020 https://www.eurocontrol.int/publication/eurocontrol-voluntary-atm-incident-reporting-evair-safety-bulletin-21

3 Description

The Annual Safety Review recommended in **Source 1** provides both a statistical summary of aviation safety in the EASA Member States (MS) and identifies the most important safety challenges faced by

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[80] *Full definition of accident: An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which (a) a person is fatally or seriously injured as a result of: being in the aircraft; or direct contact with any part of the aircraft, including parts which have become detached from the aircraft; or direct exposure to jet blast (except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers or crew); or (b) the aircraft sustains damage or structural failure which: adversely affects the structural strength, performance or flight characteristics of the aircraft and would normally require major repair or replacement of the affected component (except for engine failure or damage, when the damage is limited to the engine, its cowlings or accessories; or for damage limited to propellers, wing tips, antennas, tires, brakes, fairings, small dents or puncture holes in the aircraft skin); or (c) the aircraft is missing or is completely inaccessible. (ICAO Annex 13)*

European aviation today. The key statistics on accidents and serious incidents in the different aviation domains can be found at the start of each chapter in the Annual Safety Review.

Source 2 provides the industry with critical information derived from the analysis of aviation accidents to enable to understand safety risks in the industry and to propose mitigation strategies.

EVAIR, recommended in **Source 3**, collects low-severity ATM incidents which involve pilots and controllers. The established process and kinds of data provided by airlines and ANSP SMSs allow day-to day analysis and, in this regard, identification of the causes of incidents. The data are collected from the entire ECAC region and from neighbouring airspace, such as the Eastern part of the ICAO EUR region, the Middle East, Africa, etc.

4 Further reading

EU (2010)
Regulation (EU) No 996/2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:295:0035:0050:EN:PDF
(contains a definition of accidents and incidents)

EU (2014)
Regulation (EU) No 376/2014 on the reporting, analysis and follow-up of occurrences in civil aviation, amending Regulation (EU) No 996/2010 of the European Parliament and of the Council and repealing Directive 2003/42/EC of the European Parliament and of the Council and Commission Regulations (EC) No 1321/2007 and (EC) No 1330/2007
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0376&from=EN
(contains information on the regulatory requirements reporting, analysis and follow-up of occurrences, which include accidents and incidents in civil aviation)

EU Single Sky Performance Review Body
Annual Monitoring Report, 2019
http://www.eusinglesky.eu/prb-report-library.html (registration required)
The Annual Monitoring Reports are prepared by the Performance Review Body (PRB) of the Single European Sky (SES).

Volume 1 of the reports provides a summary of European air navigation service (ANS) performance in four key performance areas (safety, the environment, capacity and cost-efficiency).

Volume 4 of the reports describes the process to assess and review the national/FAB performance monitoring reports (PMRs) from a safety perspective and to provide feedback on safety performance, measured by safety performance indicators (SPIs).

It refers to, and uses data from, the States subject to the provisions of the SES Performance Scheme (RP1 SES States).

ICAO safety reports
Reports on worldwide aviation safety performance and collaborative efforts by international air transport stakeholders to further improve safety in light of the sustained growth of the sector.
http://www.icao.int/safety/Pages/Safety-Report.aspx

Performance Review Commission (2019)
The annual Performance Review Reports issued by the Performance Review Commission provide an annual review of Europe’s ATM safety performance (Chapter 2 in PRR 2019).
https://www.eurocontrol.int/publication/performance-review-report-prr-2019

SKYbrary
SKYbrary is an electronic repository of safety knowledge related to ATM and aviation safety in general. It contains information about accidents and serious incidents by aircraft type and is also a portal which gives users access to the safety data made available on the websites of various aviation organisations (regulators, service providers, industry).
http://www.skybrary.aero/index.php/Main_Page

It also provides links to the latest published statistical summaries:
http://www.skybrary.aero/index.php/Aviation_Safety_Statistics

42. Value of a statistical life (VSL)

Content
- Definition
- EUROCONTROL recommended value
- Description
- Other possible value
- Related standard input
- Further Reading

1 Definition

The monetary value of an improvement in safety to achieve a mortality risk reduction which would prevent one statistical death[81]

2 EUROCONTROL recommended value

Value	Value of a Statistical Life, EU27+UK average: € 3 million *(adjusted from € 2016 to € 2019 prices)*
Source	"Handbook on the external costs of transport", CE Delft, January 2019 (commissioned by European Union DG Move) https://www.cedelft.eu/en/publications/2311/handbook-on-the-external-costs-of-transport-version-2019

3 Description

The above value is extracted from a recent study carried out by CE Delft on behalf of EU DG Move (2019). The proposed VSL is the estimated average human cost per fatality for all modes of transport as set out in paragraph 3.3.2 "Input values" of the source document. The human costs are valued on the basis of the VSL principle based on the Mortality Risk Valuation in Environment, OECD (2012) (see further reading below). The value is based on the willingness to pay (WTP)[82] principle. The EU27+UK VSL used in the handbook is € 3.6 million, from which the consumption loss is deducted. The consumption loss is calculated by combining data on the consumption expenditure per capita per annum with the number of years of life lost owing to an accident (on average 42 years – OECD). This results in an EU27+UK average consumption loss for a fatality of €668 000 (€ 2016 values).

It should be noted that the European Aviation Safety Agency (EASA) uses a mean value of €2 million[83] (€ 2013 values).

4 Related standard input

Value of a statistical injury (page 118)

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[81] *Source : "The Value of a Statistical Life", H. Anderson and N. Treich, Ecole d'économie de Toulouse, February 2009 http://swopec.hhs.se/vtiwps/abs/vtiwps2008_001.htm*

[82] *"The VSL is the amount of money which a community of people is willing to pay to lower the risk of an anonymous instantaneous premature death within that community. It can be calculated by dividing the amount people are willing to pay by the change in mortality risk". Definition extracted from the Handbook identified in the above source.*

[83] *EASA (2013)— Rulemaking Directorate Notice of Proposed Amendment 2013-20 – page 88 https://easa.europa.eu/system/files/dfu/NPA%202013-20.pdf -*

5 Further reading

European Commission (2014), DG Regional Policy
Guide to Cost-Benefit Analysis of Investment Projects – Economic appraisal tool for Cohesion Policy 2014-2020, December 2014
http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf

European Commission (2009), DG Transport and Energy
Cost-benefit analysis (for assessment of the impacts of road safety measures).
https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/specialist/knowledge/pdf/cost_benefit_analysis.pdf

OECD (2012), Environment Directorate
Mortality Risk Valuation in Environment, Health and Transport
This publication presents a major meta-analysis of 'value of a statistical life' (VSL) estimates derived from surveys in which people around the world were asked about their willingness to pay for a reduction in mortality risks.
http://www.oecd.org/env/tools-evaluation/mortalityriskvaluationinenvironmenthealthandtransportpolicies.htm

US DOT (2016)
Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in US Department of Transportation Analyses – 2016 Adjustments
https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-on-valuation-of-a-statistical-life-in-economic-analysis

European Commission (2009),
“Part III: Annexes to Impact Assessment Guidelines”, 15 January 2009
http://ec.europa.eu/governance/impact/commission_guidelines/docs/iag_2009_annex_en.pdf

6 Comments

Worthwhile mentioning are the special drawing rights for air carriers under the ICAO Montreal Convention.

The Montreal Convention is a multilateral treaty which among other things sets limitations on liability for proven damages in the event of passenger death or injury and for damage (baggage or cargo). The air carriers are strictly liable for damages up to 128 821 special drawing rights (SDR 2019 value) a mix of currency values established by the International Monetary Fund (IMF).

With the aim of introducing uniform legal rules to govern air carrier liability in the event of damage caused to passengers, baggage or goods during international journeys, the EU (previously the European Commission) ratified the Montreal Convention by EC Council Decision 2001/539/EC of 5 April 2001 (https://www.eumonitor.eu/9890/01).

An example of an event which can fall within the scope of the Convention is the liability of a carrier for injury or death caused to passengers as a result of an unruly passenger or terrorist if it occurs during ‘international carriage by air’.

It should be noted that special drawing rights are not a measure of the value of a statistical life as they do not reflect the total costs of a fatality for society and hence cannot be used in social cost-benefit analyses.

43. Value of a statistical injury

Content

- Definition
- EUROCONTROL recommended value
- Description
- Further reading
- Related standard input
- Comments

1 Definition

The monetary value of an improvement in safety to achieve an injury risk reduction which would prevent one statistical injury[84]

2 EUROCONTROL recommended value

<table>
<tr><td>Value</td><td>
<table>
<tr><th>AIS[85] level</th><th>Severity</th><th>Fraction of VSL</th></tr>
<tr><td>AIS 1</td><td>Minor</td><td>0.003</td></tr>
<tr><td>AIS 2</td><td>Moderate</td><td>0.047</td></tr>
<tr><td>AIS 3</td><td>Serious</td><td>0.105</td></tr>
<tr><td>AIS 4</td><td>Severe</td><td>0.266</td></tr>
<tr><td>AIS 5</td><td>Critical</td><td>0.593</td></tr>
<tr><td>AIS 6</td><td>Fatal</td><td>1.000</td></tr>
</table>
</td></tr>
<tr><td>Source</td><td>US Federal Aviation Agency (2015) – "Policy and Guidance, Benefit Cost Analysis, Economic Values for Evaluation of FAA Investment and Regulatory Decisions: Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses", US Department of Transportation
http://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/</td></tr>
</table>

3 Description

The data presented above represent the value of improvements in safety which lead to a reduction in the risk of a statistical injury as a proportion of the value of a statistical life (VSL) depending on the severity of the injury. The VSL is based on the concept of the willingness to pay (WTP) for a small risk reduction to prevent one statistical injury (i.e. unidentified in terms of age, gender etc.).

Injuries are categorised in accordance with the Abbreviated Injury Scale (AIS).

The Abbreviated Injury Scale is an anatomically based, consensus-derived, global severity scoring system which classifies each injury by body region according to its relative importance on a six-point ordinal scale. Injuries are classified into six categories on the Abbreviated Injury Scale (AIS), from AIS Code 1 for minor injuries to AIS Code 6 for fatal injuries. To establish a valuation for each injury level, the level is related to the loss of quality and quantity of life resulting from an injury typical of that level. This loss is expressed as a fraction of a fatality. The willingness to pay (WTP) to avoid an injury of a particular level is estimated by multiplying the fraction by the value of a life.

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[84] *Source Association for the Advancement of Automotive Medicine (AAAM) https://web.archive.org/web/20140328041758/http://www.aaam.org/about-ais.html*

[85] *Abbreviated Injury Scale*

As aviation injury data are often incomplete and/or unavailable in the AIS, aviation injuries are reported by the number of victims suffering “serious” and “minor” injuries as defined by ICAO. Under this classification, serious injury victims are typically (but not always) those with at least one injury at AIS 2 or higher, and minor injury victims typically (but not always) have injuries at the AIS 1 level only.[86]

4 Further reading

CE Delft (2019)
“Handbook on the external costs of transport”, CE Delft, January 2019 (commissioned by European Union DG Move)
In chapter 3, the document discusses the cost of accidents in all forms of traffic and the resulting substantial costs, consisting of two types of components, namely material costs (e.g. damage to vehicles, administrative costs and medical costs) and immaterial costs (e.g. shorter lifetimes, suffering, pain and sorrow).
https://www.cedelft.eu/en/publications/2311/handbook-on-the-external-costs-of-transport-version-2019

European Commission (2014), DG Regional Policy, Guide to Cost-Benefit Analysis of Investment Projects – Economic appraisal tool for Cohesion Policy 2014-2020, December 2014
The Guide to Cost-Benefit Analysis of Investment Projects offers practical guidance on major EU project appraisals. It addition to the presentation of the regulatory requirements for the project appraisal process and related decision, it provides general principles for carrying out CBAs and outlines of project analysis in sectors such as transport, the environment, energy etc. It makes explicit those aspects of the CBA which are sector-specific
http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf

European Commission (2009), DG Transport and Energy
This report described the use of cost-benefit analysis to assess the impacts of road safety measures.
https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/specialist/knowledge/pdf/cost_benefit_analysis.pdf

5 Related standard input

Value of a statistical life (page 117)

6 Comments

The above data should be treated with caution as there may be legal implications.

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[86] *Economic Values for FAA Investment and Regulatory Decisions, A Guide* *http://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/media/ECONOMICVALUESFORFAAINVESTMENTANDREGULATORYDECISIONS10032007.pdf*

44. Discount rate

Content

- Definition
- EUROCONTROL recommended value
- Description
- Further reading
- Comments

1 Definition

The annual rate used to discount a stream of cash flows in order to calculate their net present value (NPV).

2 EUROCONTROL recommended value

Value	4% (for constant price cash flows)
Source	European Commission (2014), Commission Delegated Regulation (EU) No 480/2014, Article 19 (Discounting of Cash Flow) http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0480&from=EN

3 Description

A nominal discount rate has three components:

- a basic, risk-free, time value of money (TVM) – traditionally of the order of 2.5%;
- compensation for the erosion of the principal by inflation;
- a premium for risk.

The inflation element should only be included if the cash flows are expressed in 'money of the day' and should be excluded if the cash flows are expressed at constant price levels.

The recommended value is inflation-free and only takes into account TVM and the risk premium.

The assessment of the risk premium depends on the judgment of the investor and can only be analysed over a portfolio of investments. In the case of investment in an air traffic management system, the risk being evaluated is the risk that the system will operate successfully and generate the benefits expected. It is not related to the commercial viability of aircraft operators using the system.

The value is used as an indicative benchmark in (EUROCONTROL) business cases for ATM investments and is applied to costs incurred and benefits achieved by air navigation service providers, aircraft operators and any other parties involved.

Values differing from the 4% benchmark can, however, be justified on the grounds of local and individual conditions which affect the requisite risk premium.

4 Further reading

European Commission (2017)

"Better Regulation" Guidelines, presented in document SWD (2017) 350, have been created to support designing EU policies and laws so that they achieve their objectives at minimum cost. The Guidelines explain what “Better Regulation” is and how it should be applied in the day-to-day practices of Commission officials preparing new initiatives and proposals or managing existing policies and legislation.
http://ec.europa.eu/smart-regulation/guidelines/docs/swd_br_guidelines_en.pdf

The related Toolbox #61 presents a comprehensive array of additional guidance to assist practitioners in the application of “Better Regulation”.
http://ec.europa.eu/smart-regulation/guidelines/docs/br_toolbox_en.pdf

European Commission (2014)

“Guide to Cost-Benefit Analysis of Investment projects, Economic appraisal tool for Cohesion policy 2014-2020”

This guide offers practical guidance on major project appraisals, as embodied in the cohesion policy legislation for 2014-2020 and takes into account the specific requirements for the European Commission.
https://ec.europa.eu/regional_policy/en/information/publications/guides/2014/guide-to-cost-benefit-analysis-of-investment-projects-for-cohesion-policy-2014-2020

GOV.UK, HM Treasury (2018)
“The Green Book: Central Government Guidance on Appraisal and Evaluation”

The EUROCONTROL recommended value of 4% is not suitable for discounting intergenerational projects, especially the projects dealing with environmental matters. A declining long-term discount rate approach may be used following the example on p. 104 of HM’s Treasury’s “The Green Book: Central Government Guidance on Appraisal and Evaluation”, 2003 updated in 2018:
https://www.financeministersforclimate.org/knowledge-center/green-book-central-government-guidance-appraisal-and-evaluation

5 Comments

Different approaches to determining discount rates can be used (social rate of time preference, marginal social opportunity cost of capital, weighted average cost of capital, shadow price of capital). A description of these approaches goes beyond the limits of this document.

The choice of an appropriate social discount rate for the cost-benefit analysis of public projects has long been a contentious issue and subject to intense debate by economists.

Since the choice of discount rate is a matter of judgment, it is recommended that in project appraisals the sensitivity analysis should include a consideration of the effect of differing discount rates. Note that the internal rate of return (IRR) is the discount rate which will give a net present value (NPV) of zero and thus gives the effective overall return on an investment over the period under consideration.

45. Exchange rate

1 Definition

Price or rate at which the currency of a country can be exchanged for another country's currency

2 EUROCONTROL recommended source

Source	European Central Bank: http://sdw.ecb.europa.eu/ (go to "ECB/Eurosystem policy and exchange rates": Exchange Rates, Reference Rates) The website contains information on the yearly, half-yearly, quarterly, monthly and daily exchange rates of 40 currencies

3 Description

The European Central Bank provides daily euro foreign exchange reference rates based on a regular daily concertation procedure between central banks across Europe. The exchange rates published reflect the market conditions prevailing at 14:15 CET and are published at around 16:00 CET.

4 Other possible source

Source	European Commission, InforEuro, Monthly accounting exchange rate: http://ec.europa.eu/budget/contracts_grants/info_contracts/inforeuro/index_en.cfm
Description	InforEuro provides the European Commission's official monthly accounting rates for the euro, the corresponding conversion rates for other currencies, and historic conversion rates from 1994.

5 Further reading

OANDA
Average Exchange Rates. It is a multilingual currency exchange converter which calculates weekly, monthly, quarterly, or yearly average exchange rates for any user-specified time horizon.
http://www.oanda.com/currency/average

6 Related standard input

Exchange rate conversion (page 2vi)

Abbreviations

ACARS	Aircraft Communications, Addressing and Reporting System
ACE	ATM cost-effectiveness
ACI	Airports Council International
ACMG	IATA Airline Cost Management Group
ADS B	Automatic dependent surveillance broadcast
ADS C	Automatic dependent surveillance-contract
AEM	Advanced Emission Model
AFIS	Airport/Aerodrome Flight Information Service
AIBT	Actual in-block time
AIS	Abbreviated injury scale
ANS	Air navigation services
ANSP	Air navigation service provider
AOBT	Actual off-block time
AOPA	Aircraft Owners and Pilots Association
APV	Approach with vertical guidance
ATC	Air traffic control
ATCO	Air traffic control officer
ATFM	Air traffic flow management
ATM	Air traffic management
ATN	Aeronautical Telecommunications Network
BADA	Base of Aircraft Data
bbl	Barrel
CAA	Civil Aviation Authority
CANSO	Civil Air Navigation Service Organisation
CBA	Cost-benefit analysis
CDM	Collaborative decision-making
CH_4	Methane (chemical compound)
CNS	Communications, navigation and surveillance
CO	Carbon monoxide (chemical compound)
CODA	Central Office for Delay Analysis of EUROCONTROL
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CPDLC	Controller-pilot datalink communications
CRCO	Central Route Charges Office
CRS	Central Reservation System
CTOT	Calculated take-off time
dB(A)	Equivalent continuous level
DFS	Deutsche Flugsicherung (German ANSP)
DGAC	Direction Générale de l'Aviation Civile (FR)
DME	Distance measuring equipment
DPI	Departure planning information
DSNA	Direction des services de la navigation aérienne (FR)
EASA	European Aviation Safety Agency
ECAC	European Civil Aviation Conference
EEA	European Environment Agency
EEC	EUROCONTROL Experimental Centre
EEX	European Energy Exchange
EFTA	European Free Trade Association
EHA	European Helicopter Association
EIA	Energy Information Administration (US)
EMEP	European Monitoring and Evaluation Programme
ERA	European Regional Airline Association
ESSIP	European Single Sky Implementation Plan
ETS	Emissions Trading Scheme (of the European Union)
EU	European Union

EU 27+UK	28 EU Member States 2013-2019
EUA	EU Emission Allowance
Eurostat	Statistical Office of the European Union
EVAIR	EUROCONTROL Voluntary ATM Incident Reporting
FAA	Federal Aviation Administration
FAB	Functional airspace block
FANS	Future air navigation systems
FIR	Flight information region
FMC	Flight management computer
FOCA	Swiss Federal Office of Civil Aviation
FOI	Swedish Defence Research Agency
FPL	Flight plan
FTE	Full-time equivalent
GA	General aviation
GAT	General air traffic
GBAS	Ground-based augmentation system
GDP	Gross domestic product
GDS	Global Distribution System
GLS	GNSS landing system
H_2O	Water (chemical compound)
HEAT	Economic assessment tool
HEATCO	Developing Harmonised European Approaches for Transport Costing and Project Assessment
HF	High-frequency
HFDL	High-=frequency datalink
HICP	Harmonised Index of Consumer Prices
IATA	International Air Transport Association
IC	Interrogator codes
ICAO	International Civil Aviation Organization
ICAO EUR/NAT	European and North Atlantic – ICAO
IFR	Instrument flight rules
ILS	Instrument landing system
IMF	International Monetary Fund
IRCA	International Register of Civil Aircraft
IRR	Internal rate of return
ITF	International Transport Forum (OECD)
kg	Kilogramme
KPA	Key performance area (safety, the environment, capacity and cost-efficiency)
KPI	Key performance indicator
lb	Pound (weight)
Lden	Perceived noise level weighted over day/evening/night
IMPACT	Integrated aircraft noise and emissions modelling platform
LNAV	Lateral navigation
LPV	Lateral precision with vertical guidance approach
LSSIP	Local Single Sky Implementation
LTO	Landing/take off cycle
MET	Meteorological service
MLS	Microwave landing system
MUAC	Maastricht Upper Area Control Centre
N_2O	Nitrogen dioxide (chemical compound)
NDB	Non directional beacon
NM	EUROCONTROL Network Manager
NM	Nautical miles
NMVOC	Non-methane volatile organic compound (chemical compound)
NOP	Network Operations Plan
NPV	Net present value
NSDI	Noise Sensitivity Depreciation Index
OAT	Operational air traffic
OECD	Organisation for Economic Cooperation and Development
OST	Office of the Secretary of Transportation (USA)

PAX	Passengers
PBN	Performance-based navigation
PCP	Pilot Common Project
PI	Performance indicator
$PM_{2.5}$	(Atmospheric) Particulate matter
PMR	Performance Monitoring Report
PRB	Performance Review Body
PRC	Performance Review Commission
PRISME	A EUROCONTROL database
PRR	Performance Review Report
PRU	Performance Review Unit
RFT	Radio telephony
RNAV	Area navigation
RNP APCH	Primary surveillance radar navigation performance approach
ROIC	Return on invested capital
RPK	Revenue passenger kilometre
SATCOM	Satellite communications
SBAS	Satellite-based augmentation system
SDR	Special drawing rights
SES	Single European Sky
SESAR	Single European Sky ATM Research (Programme)
SESAR JU	SESAR Joint Undertaking
SID	STATFOR Interactive Dashboard
SMATSA	Serbia and Montenegro Air Traffic Services Agency
SMS	Safety management system
SO_2	Sulphur dioxide (chemical compound)
SPIs	Safety performance indicators
SRC	Safety Regulation Commission
SSR	Secondary surveillance radar
STA	Scheduled time of arrival
STATFOR	EUROCONTROL Statistics and Forecasts Service
STD	Scheduled time of departure
SU	Service unit
TACAN	Tactical air navigation
TMA	Terminal manoeuvring area
TSU	Terminal service unit
TVM	Time value of money
TWR	Tower
UAT	Universal access transceiver
UHF	Ultra-high frequency
UIR	Upper information region
UK CAA	UK Civil Aviation Authority
UNWTO	United Nations World Tourism Organization
US DOT	US Department of Transportation
US gal	US gallon
VDL	VHF digital datalink
VDL Mode 4	Very-High-Frequency (VHF) Data Link Mode 4
VFR	Visual flight rules
VHF	Very-high frequency
VNAV	Vertical navigation
VOR	VHF omnidirectional ranging
VOR C	Very-high frequency omnidirectional radio range conventional
VOR D	Very-high frequency omnidirectional radio range doppler
VOR/DME	VHF omnidirectional ranging/distance measuring equipment
VORTAC	Combined VOR and TACAN
VOT	Value of time
VSL	Value of statistical life
WAM	Wide-area multilateration
WPR	Waypoint position report
WTP	Willingness to pay

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