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Agenda Item 3: **Items/Briefings of interest to the RASG-PA ESC**

PROPOSAL TO AMEND ICAO FLIGHT DATA ANALYSIS PROGRAMME (FDAP) RECOMMENDATION AND STANDARD TO EXPAND AEROPLANES´ WEIGHT THRESHOLD

(Presented by Flight Safety Foundation and supported by Airbus, ATR, Embraer, IATA, Brazil ANAC, ICAO SAM Office, and SRVSOP)

EXECUTIVE SUMMARY

The Flight Data Analysis Program (FDAP) working group comprised by representatives of Airbus, ATR, Embraer, IATA, Brazil ANAC, ICAO SAM Office, and SRVSOP, is in the process of preparing a proposal to expand the number of functional flight data analysis programs. It is anticipated that a greater number of Flight Data Analysis Programs will lead to significantly greater safety levels through analysis of critical event sets and incidents.

Action:	The FDAP working group is requesting support for greater implementation of FDAP/FDMP throughout the Pan American Regions and consideration of new ICAO standards through the actions outlined in Section 4 of this working paper.
Strategic Objectives:	• Safety
References:	• Annex 6 - *Operation of Aircraft*, Part 1 sections as mentioned in this working paper • RASG-PA ESC/28 - WP/09 presented at the ICAO SAM Regional Office, 4 to 5 May 2017.

1. Introduction

1.1 Flight Data Recorders have long been used as one of the most important tools for accident investigations such that the term “black box” and its recovery is well known beyond the aviation industry. The safety advances in the industry from flight data recorders have been invaluable.

1.2 As Flight Data Recorder technology has advanced, the aircraft operators around the world have sought to make use of this data in their safety management systems under Flight Data Analysis/Monitoring FDAP/FDAM programs.

1.3 As a result of both the learning from accident investigations and the desire to learn more from current operational data, the ICAO council adopted a proposal on FDAP/FDMP programs that first became applicable in November 1, 2001. Subsequently this was revised through Amendment 30 in 2006. The latest language of Annex 6, Part 1 (Edition 10, Amendment 41) Chapter 3 states:

3.3 SAFETY MANAGEMENT

> 3.3.1 **Recommendation.—** *The operator of an aeroplane of a certificated take-off mass in excess of 20 000 kg should establish and maintain a flight data analysis programme as part of its safety management system.*
>
> 3.3.2 The operator of an aeroplane of a maximum certificated take-off mass in excess of 27 000 kg shall establish and maintain a flight data analysis programme as part of its safety management system.
>
> *Note.- The operator may contract the operation of a flight data analysis programme to another party while retaining overall responsibility for the maintenance of such a programme.*
>
> 3.3.3 A flight data analysis programme shall be non-punitive and contain adequate safeguards to protect the source(s) of the data.
>
> *Note 1.- Guidance on the establishment of flight data analysis programmes is included in the* Manual on Flight Data Analysis Programmes (FDAP) *(Doc 10000).*
>
> *Note 2.- Legal guidance for the protection of information from safety data collection and processing systems is contained in Attachment B to the first edition of Annex 19.*
>
> 3.3.4 The operator shall establish a flight safety documents system, for the use and guidance of operational personnel, as part of its safety management system.
>
> *Note.- Guidance on the development and organization of a flight safety documents system is provided in Attachment F.*

1.4 Now after two decades of flight data analysis programs, much has changed in the costs and potential benefits of these programs. Early programs were often burdened by the costs of specific aircraft configurations to support FDAP/FDMP with Quick Access Recorders (QARs), computer storage devices for extracted data, software analysis packages, staff headcount to manage the programs and more. The analysis capability has expanded and now benefits many aspects of safety and operational efficiency.

1.5 The RASG-PA FDAP working group was assembled to examine current costs and benefits with the objective of promoting greater participation in FDAP/FDMP programs on all aeroplanes equipped with Flight Data Recorders. This would target aeroplanes over 5 700 kg up to 27 000 kg. There is no current requirement for FDAP/FDMP programs between 5 700 kg and 20 000 kg AND it is only recommended for aeroplanes from 20 000 kg up to 27 000 kg.

1.6 As a result of the review, a new alternative recommendation and standard proposal to expand weight threshold are as follows:

> *3.3.1* ***Recommendation.-*** *All aeroplanes of a maximum certificated take-off mass over 5 700 kg should be equipped with a Quick Access Recorder (QAR). This QAR should record at a minimum the parameters recorded by the Flight Data Recorder and the operator should establish and maintain a flight data analysis programme as part of its safety management system.*
>
> *3.3.2 All aeroplanes of a maximum certificated take-off mass over 5 700kg for which the individual certificate of airworthiness has been first issued on or after 1 January 2005 shall be equipped with a Quick Access Recorder (QAR). This QAR shall record at a minimum the parameters recorded by the Flight Data Recorder and the operator shall establish and maintain a flight data analysis programme as part of its safety management system.*

2. Cost Benefit Analysis for Flight Data Analysis/Monitoring Programs

2.1 The RASG-PA FDAP working group has completed a cost benefit report as of September 2017. The document describes the most likely areas of costs for implementing a FDAP/FDMP program with current operations with a special focus on organizations operating aeroplanes in the 5 700 kg to 20 000 kg MTOW range. The report is included as **Appendix A** to this working paper.

2.2 The report references many of the original implementation considerations and how those have changed. It provides operators and other stakeholders with greater tools to determine their current implementation costs, including optional costs on aircraft configuration.

2.3 Benefits are described in terms of the potential improvements that could be achieved in existing accident rates. The document recognizes that original FDAP/FDMP programs did not forecast a specific rate reduction before programs were adopted. Yet over the past twenty years improvements continue and accident rates are lower than ever before. Implementation may make much more practical sense today as costs have become much more affordable.

2.4 A review of the current accidents in the 5 700 to 27 000 Kg MTOW range is provided for the Pan American region in the cost benefit analysis (CBA) **Appendix A1**.

2.5 A review of all worldwide aeroplanes with MTOW between 5 700 kg to 27 000 kg and organizations operating aeroplanes with that range is also provided in CBA **Appendix A2** and **A3**. It should be noted that a sizeable portion of the existing aircraft are likely to already be operating with on-going FDAP/FDMP programs. Both of these can be used for determination of the level of operations impacted by a proposal to implement FDAP/FDMP programs. In **Appendix B**, a costs and benefits spreadsheet is attached.

3. The need for a Business Case

3.1 In order to accomplish the expansion in implementation, a business case is essential to describe both the costs and benefits. This CBA recognizes the much more affordable options to FDAP/FDMP implementation and helps to provide a compelling story for action. This CBA also provides the necessary tools for organizations and States to assemble this business case as best suites their requirements.

3.2 Ultimately, this can lead to a specific proposal to the ICAO Air Navigation Commission (ANC) for adoption as new ICAO standard.

3.3 In the meantime, the RASG-PA FDAP working group recommends formulating an immediate safety enhancement to be considered by Industry in Pan American RASG-PA States. The FDAP standard proposal would be brought to RASG-PA Plenary using the fast track mechanism, considering that the next RASG-PA Plenary will take place in approximately two years, and to the Pan American RSOOs and RAIOs for coordination and promotion.

4. Suggested actions

4.1 The RASG-PA ESC/29 is invited to take note of this working paper, make comments and circulate a proposal of conclusion to be adopted by RASG-PA members as follows:

a) States take note of the results of the cost-benefit analysis (CBA) developed by RASGPA FDAP working group for the implementation of FDAP on aeroplanes over 5 700 kg;

b) States and RSOO to consider the incorporation of a requirement in their national/regional regulations; and

c) Request to the ICAO ANC to take note on the results of the CBA and consider an amendment to Annex 6 Part I FDAP Recommendation 3.3.1 and Standard 3.3.2 of Section 3.3, as worded in 1.6 of this working paper.

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APPENDIX A

COST-BENEFIT ANALYSIS FOR EXTENDING ICAO'S ANNEX 6, PART I, STANDARD 3.3.2

RASG-PA

International Civil Aviation Organization (ICAO) + States + International Organizations + Industry

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CHAPTER 1 BACKGROUND

In 1999, the Accident Investigation and Prevention (AIG) Divisional Meeting group analyzed several amendments to the existing aviation standards related to the investigation and prevention of air accidents. Among the topics discussed, various airline operators revealed the improvements they had achieved in aircraft safety as a result of successfully employing Flight Data Analysis Programs (FDAPs). However, they noted that the introduction and operation costs of such FDAPs might not be affordable for smaller and regional airline companies. At that time, the AIG Divisional Meeting group recommended that only the largest airlines operating commercial airline fleets were required to implement these programs.

As a result of the Accident Investigation and Prevention (AIG) Divisional Meeting discussions in 1999, the following provisions pertaining to flight data analysis programs were proposed and then adopted by the ICAO Council on March 9, 2001. These provisions were included in Chapter 3 of Annex 6, Part I to the Convention on International Civil Aviation through Amendment 26. This amendment became applicable on November 1, 2001:

3.2.1 An operator shall establish and maintain an accident prevention and flight safety program.

3.2.2 **Recommendation**.- From January 1, 2002, an operator of an aeroplane of a certificated takeoff mass in excess of 20,000 kg should establish and maintain a flight data analysis program as part of its accident prevention and flight safety program.

3.2.3 From January 1, 2005, an operator of an aeroplane of a maximum certificated takeoff mass in excess of 27,000 kg shall establish and maintain a flight data analysis program as part of its accident prevention and flight safety program.

Note: An operator may contract the operation of a flight data analysis program to another party while retaining overall responsibility for the maintenance of such a program.

3.2.4 A flight data analysis program shall be nonpunitive and contain adequate safeguards to protect the source(s) of the data.

ICAO Council adopted Amendment 30 on March 14, 2006. This amendment modified the above provisions as follows:

3.2.6 **Recommendation:** The operator of an aeroplane of a certificated takeoff mass in excess of 20,000 kg should establish and maintain a flight data analysis program as part of its safety management system.

3.2.7 The operator of an aeroplane of a maximum certificated takeoff mass in excess of 27,000 kg shall establish and maintain a flight data analysis program as part of its safety management system.

Note: The operator may contract the operation of a flight data analysis program to another party while retaining overall responsibility for the maintenance of such a program.

3.2.8 A flight data analysis program shall be nonpunitive and contain adequate safeguards to protect the source(s) of the data.

Now, after almost two decades since the implementation of current standard 3.3.2 (Annex 6, Part I, Amendment 41), the Regional Aviation Safety Group – Pan America (RASG-PA) was directed to undertake a cost-benefit analysis (CBA) to evaluate a proposal for extending said standard to aircraft with a maximum certified take-off weight between 5,700 and 27,000 kg. In general, in order to evaluate the implementation of any new standard, the cost-benefit analysis serves as a tool that will allow for the best option — between implementing such a standard and maintaining the status quo — to be chosen by stakeholders.

For instance, in 1997, the Federal Aviation Administration (FAA) carried out a cost-benefit analysis to evaluate the implementation of Flight Operational Quality Assurance (FOQA) programs. According to U.S. GAO (1997), the objectives of those FOQA programs were to "use flight data to detect technical flaws, unsafe practices or conditions outside desired operating procedures, early enough to allow timely intervention to avert accidents or incidents" (p.1). The CBA was performed assuming fleets of 15, 50 and 100 aircraft and considering large-size airliners such as Boeing 737-500s (Maximum Take-off Weight = approximately 72 tons) or Airbus 319s/320s (MTOW = approximately 76.5-79 tons). Furthermore, several of the airlines that had implemented FOQA programs had equipped their aircraft with Quick Access Recorders (QARs). In virtue of the above, Table 1 shows a summary of the estimated costs and benefits:

Table 1 Cost-benefit analysis of the implementation of FOQA Programs in 1998

Concept	15 aircraft	50 aircraft	100 aircraft
Equipment Costs	$98,500	$259,000	$492,000
Personnel Costs	$385,000	$500,000	$775,000
Total annual costs[1]	$483,500	$759,000	$1,267,000
Fuel savings	$145,800	$486,000	$972,000
Engine savings	$300,000	$1,000,000	$2,000,000
Safety savings	$49,500	$165,000	$330,000
Net annual savings[2]	$11,800	$892,000	$2,035,000

Source: U.S. GAO (1997).

During 1997, the airlines which had active FOQA programs were United Airlines, US Airways, Continental Airlines and Alaska Airlines, and all of them equipped at least some portion of their fleet with QARs. In that sense, as mentioned by Fernandes (2002) and U.S. GAO (1997), it's more convenient to capture flight data from an aircraft using a QAR than a flight data recorder (FDR) for — at least — the following reasons: 1) FDRs were not designed nor located to be of easy access, 2) FDRs only capture 25 hours of flight data, 3) FDRs were not required to capture a large number of parameters.

With that said, the same authors realized that the issue of capturing the flight data would not be a problem with solid-state FDRs. In that sense, according to U.S. GAO (1997), "The newer solid-state flight data recorders, however, have no moving parts and would not experience wear problems. Transferring data from these devices takes several minutes to perform" (p.22). Furthermore, according to Fernandes (2002), "If it was a solid state FDR (SSFDR) the data would be recorded on to integrated circuits rather than tapes, making it easier to download, although access would still be difficult" (p.18). As a stylized example, capturing flight data from a solid-state FDR would just consist of plugging in a USB cord and extracting the flight data.

[1]According to U.S. GAO (1997), equipment costs are the invoice price paid to vendors in the FOQA demonstration Project, while personnel costs were based on estimations of FOQA management, analysis, monitoring and engineering costs from the perspective of an airline.
[2]Total savings – Total costs

By contrast, not only do most aircraft have solid-state FDRs nowadays, but they also capture a larger number of parameters. In line with the above, Table 2 clearly shows that current aircraft have solid-state FDRs and capture more than 1,000 parameters. Thus, these advancements in technology impose the need to rethink the employment of Flight Data Analysis services in aircraft with an MTOW below 27 tons, which are not compelled to implement an FDAP[3].

Table 2 Evolution of FDR devices

Aircraft Type	Introduced into service	FDR Type	Number of parameters	FDR data capacity
Boeing 707	1958	Analogue	5	Mechanical limit of about 10 parameters
Airbus 330	1993	Digital (solid state or tape medium)	280	128 wps (serial data input)
Embraer 170	2004	Digital (solid state) Combi-recorder	774	256 wps (serial data input)
Airbus 380	2007	Digital (solid state)	> 4,000	1,024 wps (serial data input)
Boeing 787	2009	Digital (solid state) EAFR	> 1,000	Ethernet system

Source: Neil (2007).

It's important to note that we have considered the acronyms FDM, FDAP and FOQA, present in this report, to be synonyms for Flight Data Analysis Programs.

[3]According to a member of the RASG-PA Working Group, there are registered 111 aircraft with an MTOW between 5.7 and 27 tons in Brazil. Of the aforementioned 111 aircraft, 33 of them may not have an adequate FDR for running an FDAP.

CHAPTER 2 JUSTIFICATION FOR THE NEW STANDARD

As mentioned in the previous chapter, ICAO's Annex 6, Part I, standard 3.3.2 was originally introduced as a result of improvements in safety experienced by airlines that voluntarily used FDAPs. Indeed, given that aviation safety is at the core of ICAO and IATA's fundamental objectives, the possible extension of this regulation for aircraft with an MTOW between 5.7 and 27 tons could be an important milestone to improve safety by reducing the number of accidents.

Table 3 shows a list of different types of accidents that occurred during 2016 involving aircraft with an MTOW between 5.7 and 27 tons[4]. The outcome was that 30 percent of those accidents resulted in hull loss damage, which meant that the aircraft could not be repaired afterwards. For small airlines whose fleet comprises one or two aircraft, a loss of an aircraft would mean the halt of the airline's operations in addition to the significant costs associated with such loss. Thus, the implementation of a Flight Data Monitoring (FDM) Program could reduce hull loss occurrence. For instance, from 1952 to 1978, British Airlines had 30 hull losses. From 1972 to 2002, British Airlines started implementing Flight Data Monitoring programs, reducing the number of hull losses to two. Meanwhile, American Airlines — which didn't have an FDM Program — experienced between 17 and 22 hull losses[5].

Additionally, Table 3 clearly shows that runway excursions are the most frequent type of accident, and they may also lead to hull losses. In that sense, small airlines could further benefit from FDM Programs, as these could help identify precursors to runway excursions[3]. For instance, CAA (2012) demonstrated that a standardized FDM module could help operators to "better monitor and act upon identified high risk issues, [such as] Landing Runway Excursions, through their SMS" (p.4).

Finally, Loss of control – in flight (LOC-I) accidents are not frequent, but whenever they occur, there is a high probability that they will result in fatalities. In that sense, the Department of Civil Aviation of Malaysia has acknowledged the importance of FDAPs to mitigate the risk of LOC-I incidents[7]. Also, in a forum held by the National Transportation Safety Board (NTSB), a member of the panel acknowledged the importance of data-sharing programs and FDM programs to mitigate the risks of LOC-I and improve aviation safety overall[8]. In this regard, it is important to highlight that for small airlines with a fleet of one or two aircraft, the optimal advantage of FDAPs occurs when they are able to share their data with other airlines (this is addressed in Subsection 3.1.2 in the present business case).

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[4]See Annex A1 for a detailed list of these accidents.
[5]See http://www.annesharp.com/fdstext.html (Retrieved on June 21, 2017)
[6]In that sense, some consultant companies offer live demonstrations that show how FDM could be used to identify precursors to runway excursions (See https://jaato.com/courses/catalogue/, retrieved on June 21, 2017)
[7] See https://www.icao.int/APAC/Meetings/2015%20APRAST7/03%20-%20LOC-4%20FLight%20Crew%20Proficiency.pdf (Retrieved on June 21, 2017)
[8]Retrieved from https://www.nbaa.org/ops/safety/20151016-technology-situational-awareness-key-to-reducing-loss-of-control-accidents.php on June 21, 2017.

Table 3	List of accidents incurred in 2016 by aircraft with an MTOW between 5.7 and 27 tons

Aircraft damage	Type of accident	Number of accidents	Fatalities (As a percentage of total passengers)	Region
Hull loss	LOC-I	1	100%	NAM
	Runway excursion	3	0	NAM
	Wheel(s) up landing	1	0	NAM
	Forced landing	1	0	SAM
Substantial damage	Pilot forgot to apply brakes	1	0	CAR
	Runway excursion	1	0	CAR
	Wheel(s) up landing	2	0	CAR
	Hard Landing	1	0	NAM
	Runway excursion	5	0	NAM
	Wheel(s) up landing	1	0	NAM
	Hard Landing	1	0	SAM
	Runway excursion	2	0	SAM

Source: Aviation Safety Network.

On the other hand, the compulsory employment of FDAPs would not only improve safety for the operators, but it would also imply a cost-reduction effect. More specifically, this could be achieved in at least the following ways (Fernandes, 2002; U.S. GAO, 1997):

- Increasing aircraft availability
- Optimizing fuel consumption
- Avoiding unnecessary engine maintenance
- Reducing insurance premiums
- Providing proof in warranty and liability claims
- Reducing ACARS transmissions
- Monitoring engine health and planning for engine removals rather than unscheduled removals
- Crew training enhancements

Given the strong link between FDAPs and safety, as described earlier, the next chapter introduces the cost-benefit analysis for extending ICAO's Annex 6, Part I, standard 3.3.2 for aircraft with an MTOW between 5.7 and 27 tons.

[7]See https://www.icao.int/APAC/Meetings/2015%20APRAST7/03%20-%20LOC-4%20FLight%20Crew%20Proficiency.pdf (Retrieved on June 21, 2017)
[8]Retrieved from https://www.nbaa.org/ops/safety/20151016-technology-situational-awareness-key-to-reducing-loss-of-control-accidents.php on June 21, 2017.

CHAPTER 3 COST-BENEFIT ANALYSIS

3.1. ASSUMPTIONS OF THE MODEL

Chapter 2 provides evidence for a causal relationship between the employment of FDAP and aviation safety improvements. In that regard, the development of a business case to evaluate the extension of the FDAP enforcement to aircraft with an MTOW between 5.7 and 27 tons could be justified if the benefits of the new standard overcome its corresponding costs from the airlines' point of view.

Nevertheless, since airlines between 5.7 and 27 tons are diverse, it is best to first describe the main characteristics of these airlines. First, for the preparation of this business plan, we downloaded, processed and analyzed an airline database from Plane Spotters[9]. From that database, we obtained the following information: 1) registration ID of the airplane, 2) serial number of the airplane, 3) aircraft type, 4) delivery date, 5) age of the airplane, 6) airline and 7) country.

Although the aforementioned database contained substantial information to match an aircraft with an airline, it did not contain the MTOW, which is considered a key variable in our analysis. Hence, we found and processed a database from FAA[10] and data from other online sources in order to match each aircraft with its approximate MTOW. A description of the key findings resulting from the performed analysis is found below.

On average, the airlines which own or have leased aircraft with an MTOW between 5.7 and 27 tons have a fleet of 5.28 airplanes. Furthermore, it's worth highlighting that almost **57.1 percent** of the airlines have a fleet of **two or fewer aircraft** (See Figure 1)[11].

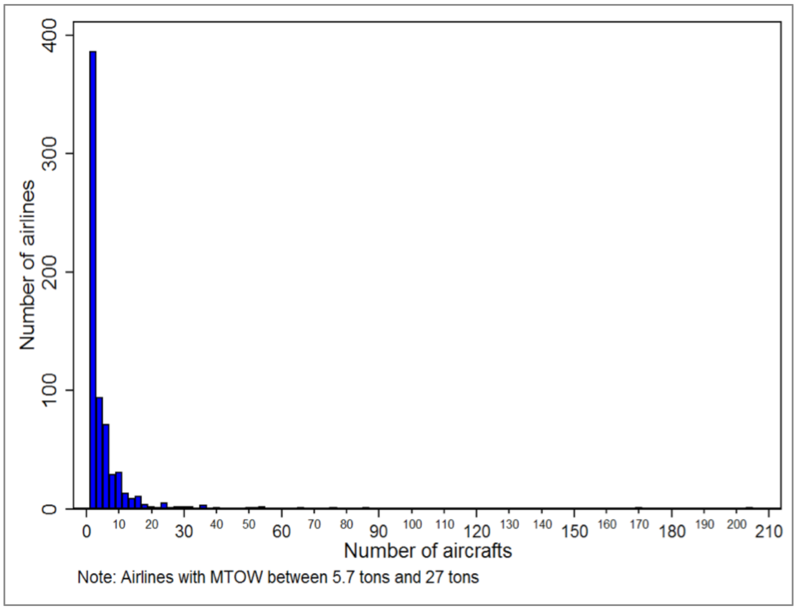

Figure 1 Histogram of aircraft with an MTOW between 5.7 and 27 tons

Source: Plane Spotters, FAA. Own elaboration.

9 www.planespotters.net
10 https://www.faa.gov/airports/engineering/aircraft_char_database/
11 According to a member of the RASG-PA Working Group, the following aircraft models are operated in Brazil but not mentioned in this study: B350, BE40, C25B, C25C, C550, C56+, C560, C56X, C650, E120, E55P, H25B, LJ31, LJ35, LJ40, LJ45, LJ60, WW24. The reason is that information about these particular aircraft and their airlines was not compiled by Plane Spotters.

On the other hand, **55.12 percent** of all aircraft in the target MTOW consist of the following ten models: **1)** Canadair CL-600-2B19 Regional Jet CRJ-200ER, **2)** ATR 72-600, **3)** ATR 72-500, **4)** Embraer ERJ-145LR, **5)** Canadair CL-600-2B19 Regional Jet CRJ-200LR, **6)** Embraer ERJ-145XR, **7)** Saab 340B, **8)** Bombardier De Havilland Canada DHC-8-102 Dash 8, **9)** Embraer EMB-135BJ Legacy and **10)** ATR42-500 (See Annex A2 for the complete list of aircraft).

In addition, **30 percent** of all aircraft in the target MTOW are owned or leased by the following airlines: **1)** ExpressJet Airlines (Unites States), **2)** SkyWest Airlines (United States), **3)** American Eagle (United States), **4)** Air Canada Express (Canada), **5)** Air Wisconsin (United States), **6)** Endeavor Air (United States), **7)** Trans States Airlines (United States), **8)** Wings Air (Indonesia), **9)** Piedmont Airlines (United States), **10)** AZUL Linhas Aereas Brasileiras (Brazil), **11)** HOP (France), **12)** PSA Airlines (United States), **13)** CommutAir (United States), **14)** Swiftair (Spain) and **15)** Regional Express (Australia) (See Annex A3 for the complete list of airlines).

Also, through ICAO's assistance, we requested a call with the following providers of FDM services and QARs in order to obtain more information regarding the costs and benefits of implementing an FDAP: **1)** Avionica, **2)** General Electric Aviation, **3)** Flight Data Services, **4)** ERGOSS, **5)** Applied Informatics and Research, **6)** Aerobytes, **7)** Scaled Analytics, **8)** Teledyne Controls, **9)** Plane Sciences, **10)** Swiss49 and **11)** Cassiopee.

Of those companies, four agreed to a call with the consulting team. The next section describes key information obtained from these conference calls.

3.1.1.QAR vs. FDR

An FDAP could be carried out with aircraft that have FDRs, with the following limitations:

- The Flight Data Recorders must be solid-state FDRs in order to record directly in the memory and not on tapes. From our call, all companies interviewed indicated that the majority of aircraft now have solid-state FDRs (In addition, see Table 2).
- If the data is not accessible, special equipment will need to be purchased in order to extract the data. This special equipment might be, for example, a Handheld Multi-Purpose Interface.
- Only 24 flight hours can be recorded, although some FDRs are able to compress the data and allow recording of up to 100 flight hours.

QARs are designed to record up to 2,000 flight hours, which means that the odds of overwriting the data are much lower than when using only an FDR. Furthermore, some QARs include a 4G module, which automates the data download and allows this operation to be done wirelessly.

Despite the benefits derived from the employment of QAR, there are costs associated with the purchase and installation of such equipment. Thus, large airlines tend to use QARs, as they have an ample budget and their large aircraft have a higher fly rate (between 4,000 and 5,000 hours per year). Small operators often have a less intensive flight pattern (e.g. a business jet may fly about 400 hours per year).

In line with the above, from the perspective of a small airline that has a fleet of one or two aircraft with an MTOW between 5.7 and 27 tons, it may seem expensive to purchase a QAR. Thus, these small airlines may start using FDM services through FDRs, and afterwards, they could decide on the convenience of purchasing QARs. In that sense, one of the interviewed companies — whose main clients were small airlines — confirmed that most of its clients actually use just FDRs. Furthermore, all aircraft whose manufacturers are Bombardier, Embraer and ATR are already delivered with QARs nowadays.

3.1.2. In-house vs. Outsourced Flight Data Analysis

From the perspective of small airlines, it would be advisable to outsource flight data analysis service instead of doing it in house — at least for the following reasons:

- They would save the costs from hiring specialized staff and the infrastructure to run the FDM service (i.e. software license, specialized hardware and others).
- A small airline is unlikely to have a statistically significant dataset so as to run the FDM service in house. Suppose an airline only has two aircraft and there are 19 different airlines with the same 2 aircraft. There would be nearly 40 aircraft altogether. By outsourcing the flight data analysis service, these small airlines would be able to compare themselves within the group. For example, they could find out whether they have a higher rate of unstabilized approaches compared to other de-identified airlines using the same FDM service providers, why are they in that position and what actions they could take in order to improve their current situation.

Given the above, for the purpose of the cost-benefit analysis performed in this case, we have taken the assumption that small airlines outsource the FDM service.

3.1.3. Costs

The costs of enforcing an FDM service may be grouped into two categories: 1) hardware as well as paperwork costs and 2) FDM service costs. Below, we describe each one of these cost categories.

3.1.3.1. Hardware and paperwork costs

It is important to begin by stating that the hardware (the QAR) and paperwork costs are optional for airlines. As explained in Subsection 3.1.1, airlines may run an FDAP without a QAR — just with an FDR. Nonetheless, even if airlines do not want to purchase and install QARs, they might not be able to capture the data directly from the FDR unless they use a Handheld Multi-Purpose Device. Thus, this would represent another cost that must be incurred by that airline should it decide not to install a QAR.

On other hand, if airlines decide to install QARs in their fleet, the installation process may cost nearly $80 USD/hour, depending on the country and the modifications needed. According to one QAR provider interviewed, this could take around 12 hours. The same provider added that the installation process could be done overnight so that the airlines don’t lose operation time.

In addition, whenever an airline modifies its aircraft (e.g. installation of a QAR), it must incur Supplemental Type Certificate (STC) costs. This license, which must be obtained only once, allows the airline to modify all of its fleet. In that sense, some QAR providers incorporate the STC costs within the QAR purchasing cost, while others keep both costs separate.

The specific hardware and paperwork costs can be found in the “Costs” tab of the “Cost-Benefit Analysis” Excel file.

3.1.3.2. FDM service cost

The FDM service cost may be charged in the following two ways, depending on the service provider: 1) a flat annual fee per aircraft or 2) a fee per monthly number of flights uploaded to the FDM provider.
The decision to use either option depends on the number of aircraft that an airline has and the number of flights that will be analyzed per month. Please find the costs related to both options in the "Costs" tab. In addition, the "CBA" tab allows you to choose from either one of the options in order to see the impact of any choice on the Cost-Benefit Analysis.
Finally, it's important to highlight that the FDM service providers operate 24 hours a day throughout the year.

3.1.4. Benefits

As was stated in Chapters 1 and 2 of this report, enforcing an FDAP may lead to safety or cost-saving benefits. Below, we describe each one in regard to the information gathered from the conference calls.

3.1.4.1. Safety benefits

First, it is important to highlight that none of the interviewed companies have made the effort to quantify the benefits derived from the use of FDM. Furthermore, not even those expert companies who provide FDAP and whose entire core business spins around safety have ever quantified the benefit of avoiding a loss of control — in-flight accident or runway excursion — as a result of using an FDAP.

Despite this, safety benefits derived from the use of FDM must be instinctively evident to smaller airlines, as nowadays FDM service companies already provide FDAP services to airlines with aircraft between 5.7 and 27 tons, thereby showing that smaller airlines must have already found it beneficial to employ this sort of service. Indeed, one of the FDM providers interviewed claimed that it specializes almost exclusively in providing FDAP services to small airlines.

Even though FDM providers have not quantified these safety benefits, they recognize that some events might have become accidents if airlines had not used an FDAP. For instance, according to one FDM provider, one of its clients was a small airline that only had one aircraft. This aircraft started having an issue with unstable approaches, so the FDM service provider analyzed the data, factored in weather conditions and realized that there was a problem when flying in good weather. In poor weather, however, there were no issues. From this analysis, it appeared there was an issue with hand-flying the aircraft, as it normally flies on autopilot in poor weather. With this analysis, the airline was able to solve the problem, resulting in a dramatic reduction in unstable approaches in all weather conditions. Notice that if the airline had not employed an FDAP, the risk of an accident would have increased given that unstable approaches could then result in aircraft hull loss and fatalities during the landing phase. Indeed, the Transportation Safety Board of Canada has acknowledged that these unstable approaches were the cause of several serious accidents[12].

Another example is the case of an FDM service provider that serves three small airlines with a fleet MTOW below 27 tons. These corporate airlines acknowledged the value of the FDAP and agreed that this should be tied up with a data-sharing mechanism to allow comparison between them. As stated in Subsection 3.1.2, small airlines will not have a statistically significant dataset if implementing the FDAP only for and by themselves. Thus, a data-sharing mechanism constitutes an important tool to improve aviation safety.

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[12] http://www.tsb.gc.ca/eng/surveillance-watchlist/aviation/2016/air-01.pdf

Another case is that of an airline that uses a Dash 8-400 (MTOW 16,500 kg.). It stated that by implementing an FDAP, it was able to standardize the pilot operations, improve the briefing reports culture and investigate maintenance events coming from high Exhaust Gas Temperatures and bad propeller performance.

Finally, in the “CBA” tab of the “Cost-Benefit Analysis” file, we attempt to quantify what would be the benefits derived from avoiding accidents which may have occurred because of runway excursions, unstable approaches and loss of control – in flight. In the Excel spreadsheet provided, there is an option whereby the reader can select if the FDAP allowed the aircraft to avoid a hull loss and other incidents.

3.1.4.2. Cost-savings benefits

According to some FDM service providers, aircraft from smaller airlines don’t fly as much as their larger counterparts, and in the extreme case of corporate jets, fuel consumption is not a variable of interest at all. For example, take an executive that flies 1,500 km only to shop in Paris for a couple of hours. For that customer, fuel consumption would hardly be a noteworthy variable. On the other hand, large airlines could realize more fuel costs savings, as their aircraft fly closer to around 4,000-5,000 hours per year. Smaller airlines may still improve fuel efficiency by comparing fuel consumption by different pilots traveling in the same route, allowing them to train pilots in order to improve their procedures.

In addition, problems in the aircraft may cause it to be grounded. For instance, after an engine overheat, the aircraft could be on the ground for three to five days in order to be repaired. For a small airline with just one or two aircraft, having one grounded for such a period would likely mean a huge loss. In that sense, according to IFS[13], a 10 percent reduction in aircraft maintenance costs could lead to a doubling in profits. So instead of waiting for a three- to five-day period, the airline could instead send the data directly to the FDM service provider and receive a report on the aircraft’s temperature — including the engine — in less than half an hour. This way, the airline could learn when the engine temperature is within acceptable limits. Therefore, the airline could significantly reduce the time in which the aircraft is grounded to just half an hour. In the “CBA” tab of the “Cost-Benefit Analysis”, we have quantified the benefits that would come from avoiding having a grounded aircraft as a result of enforcing a Flight Data Analysis Program.

Besides, for small aircraft, one key aspect has to do with aircraft availability. Consider for a second what could happen, in terms of reputation, if an executive arrives to an aircraft and it’s not capable of flying. In that sense, a Flight Data Analysis Program could help the airline find out in advance if the aircraft is suitable to take off at a specific time, and when the result is negative, what the reason is. This will in turn allow the airline enough time to maneuver around the mishap.

Additionally, according to ICAO’s Annex 6, Part 1, Appendix 9, paragraph 7.1, annual inspections of FDRs should be executed by the operators. Nonetheless, an airline stated that the Flight Data Analysis Program allowed it to have a regulatory exemption in order to send the FDR just once every five years instead of the regular annual reading. This then resulted in savings to that airline of around $1000 per aircraft.

Finally, there are other potential cost-savings benefits derived from the employment of Flight Data Analysis Programs, such as reducing insurance premiums and providing proof in warranty and liability claims.

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[13] http://www.ifsworld.com/us/company/about-ifs/

3.2. BASELINE MODEL

After describing the key elements of the model in Subsection 3.1, in Table 4 below, we propose a baseline model which can be partially modified in the "CBA" tab of the "Cost-Benefit Analysis" file:

Table 4 Baseline model

Concept	Assumption
Fleet	2
Aircraft type	Bombardier CRJ-200ER
QAR	QAR is not installed in the aircraft and the small airline will run the FDAP only through the FDR in order to save costs.
Flight data service type	Outsourced
Flight data service cost	Flat annual fee per number of aircraft.
Costs of having an aircraft on ground	1,5
Avoided days of aircraft on ground	5
Number of aircraft that benefited from avoided AOG	2
Benefits	Avoided Aircraft on Ground

Source: Own elaboration.

This baseline model captures the case of a small airline that has begun the transition to utilizing an FDAP as a result of the new regulation. At this early stage, the airline's objective is to save costs and train itself in the utilization and application of FDA reports. Later on, as the airline matures and the fleet increases, the small airline could consider purchasing and installing QARs in order to increase data storage and facilitating data download.

3.3. COST-BENEFIT ESTIMATION

First, it's important to highlight that the cost-benefit analysis performed in this opportunity was not done through the traditional Net Present Value framework, as this framework is used for evaluating private investment projects where the investor has an ideal cost of capital that represents its required return of investment. In that regard, since the new standard objective is to improve safety, it would be a mistake to consider this standard as a private investment where the airlines have to use their cost of capital and choose to invest only if they recover at least such cost. Indeed, safety not only concerns the airlines that will assume the investment costs but also the passengers.

In line with the above, an airline with a high cost of capital is likely to decide not to invest in implementing an FDAP. From the perspective of the passengers, such action would be inappropriate. So, for the cost-benefit analysis, we did not consider the airlines' cost of capital but instead compared year by year the standard´s potential benefits with its corresponding costs through a cost-benefit ratio. Thus, we have assumed that airlines won't "profit" from this standard but will instead weigh if they can cover the FDAP implementation costs. Given the above, we have estimated a yearly cost-benefit ratio taking the assumptions of the baseline model. It's important to again draw attention to the fact that the baseline model can be partially modified in the "CBA" tab.

As shown in Table 5 below, the results from the cost-benefit analysis are optimistic in the sense that the ideal small airline could recover the costs of implementing an FDAP each year, given the assumptions drawn on the baseline model. Furthermore, it's important to highlight that if a hull loss accident could be avoided due to the employment of the FDAP (See option "BENEFITS – AVOIDED AIRCRAFT HULL LOSS" in the "CBA" tab), a small airline would then have recovered all of the costs of implementing an FDAP. In addition, this last conclusion is strengthened by the fact that there are other non-monetizable benefits that a small airline gets as a result of the employment of the FDAP, such as improvements in procedure standardization, pilot training, etc.

Table 5 Cost-Benefit Analysis – Baseline model

			Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
COST	**Total Costs**		**9,000**	**9,000**	**9,000**	**9,000**	**9,000**	**9,000**	**9,000**	**9,000**	**9,000**	**9,000**
	Hardware and paperwork	QAR Purchase										
		QAR Installation										
		STC Cost										
		Handheld Multi-Purpose Interface cost										
	Flight Data Analysis Service	FDM service cost	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000	9,000
BENEFITS	Avoided days of aircraft on ground.		**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**	**15,000**
BENEFIT-COST RATIO			**1.67**	**1.67**	**1.67**	**1.67**	**1.67**	**1.67**	**1.67**	**1.67**	**1.67**	**1.67**

CHAPTER 4 CONCLUSIONS AND RECOMMENDATIONS

The proposal to extend ICAO's Annex 6, Part I, 3.3.2 standard to aircraft with an MTOW between 5.7 and 27 tons would be feasible only if such regulation can give the operators freedom to use FDRs or QARs at early stages of the FDAP enforcement. That way, small airlines could start by implementing FDM programs just on FDRs, saving the costs from purchasing and installing QARs while also saving the costs derived from the STC, which authorizes aircraft modification. In addition, at early stages of the FDAP enforcement, the airlines would train themselves in utilizing and applying the analysis gathered from the FDM reports.

Furthermore, in the status quo scenario, small airlines that could be affected by the new regulation are already using FDM services to improve safety in their operations and increase aircraft availability. This is vital for smaller airlines, as having even one aircraft on the ground could be vastly detrimental to their financial performance. In addition, allowing data sharing with an FDM service provider would improve the performance of the analysis report that each small airline receives, as it would be able to compare itself with a pool of similar airlines and also learn how to improve its current situation based on a benchmark.

On other hand, even though the AIG Divisional Meeting group agreed in 1999 to enforce FDAPs only on aircraft with an MTOW above 27 tons because the smaller and regional airlines may not have been able to afford the costs of such enforcement, that is not necessarily true anymore. Advancements in technology (e.g. normalization of solid-state FDRs, increase of stored parameters, etc.) and the increase in the supply of QAR providers and FDR service providers have made a reduction in costs possible, thereby allowing small airlines to benefit as well from the implementation of Flight Data Analysis Programs.

Also, small and large operators do not value some benefits equally. For instance, fuel efficiency may be more important for large operators whose fleet flies thousands of hours a year, whereas small aircraft — such as business jets — may fly less than 1,000 hours per year. Meanwhile, aircraft availability and aviation safety will be top priorities for small airlines.

It's important to acknowledge that some small airlines with older aircraft may have FDRs that are not easily accessible for data download. In those scenarios, they could choose to buy a Handheld Multi-Purpose Interface or a Quick Access Recorder, substantially increasing the investment costs as a result[14]. Despite that, small airlines would probably be able to recover those costs in the following years, and if at least one aircraft hull loss could be avoided as a result of using the FDAP, all costs would be covered[15].

[14]From the Cost-Benefit model, the highest investment costs in terms of purchasing a QAR along with the STC costs associated with it would imply an additional investment of $30,960 in comparison with the option of using just the FDR.
[15]From the Cost-Benefit model, if the airline avoided one hull loss as a result of the implementation of the FDAP, it would have saved $24,375,000 (the cost of the aircraft), which greatly covers the stated costs.

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ANNEXES

A1 Aviation accidents that occurred in 2016 involving aircraft with an MTOW between 5.7 and 27 tons

Date	Type	MTOW (Kg)	Accidents	Operator	Country	Fatalities	Total passengers	Accident damage
5/5/16	Convair CV-580 Airtanker	26372	Runway excursion	Conair Aviation	Canada	0	2	Hull loss
17/7/16	Beechcraft 200 Super King Air	7484	Wheel(s) up landing	Air Nunavut	Canada	0		Hull loss
7/4/16	Douglas C-47A (DC-3)	12701	Forced landing	Aerolineas Llaneras - Arall	Colombia	0	3	Hull loss
18/1/16	Dassault Falcon 20F-5	14515	Runway excursion	Sterling LIHTC LLC	USA	0	4	Hull loss
10/9/16	Beechcraft 200 Super King Air	7484	Runway excursion	Hurricane Joaquin LLC	USA	0	1	Hull loss
5/12/16	Swearingen SA227-AC Metro III	7257	LOC-I	Key Lime Air	USA	1	1	Hull loss
22/3/16	Swearingen SA226-TC Metro II	7257	Runway excursion	CEDMA Aviación	Argentina	0	3	Repairable damage
30/9/16	Beechcraft 1900C	7765	Wheel(s) up landing	Southern Air Charter	Bahamas	0	11	Repairable damage
9/1/16	ATR 72-212A (ATR-72-500)	22000	Runway excursion	Passaredo Linhas Aéreas	Brazil	0		Repairable damage
20/4/16	Beechcraft 1900D	7765	Hard Landing	Exploits Valley Air Services, opf. Air Canada Express	Canada	0	16	Repairable damage
24/10/16	Dornier 328Jet-310	15660	Runway excursion	FlyMex	Mexico	0	4	Repairable damage
21/6/16	Beechcraft 200C Super King Air	7484	Hard Landing	Aer Caribe	Peru	0		Repairable damage
10/1/16	Beechcraft B200 Super King Air	7484	Pilot forgot to apply breaks	Island Airlines	Puerto Rico	0	5	Repairable damage
15/7/16	Beechcraft B200 Super King Air	7484	Wheel(s) up landing	Executed Corp.	Puerto Rico	0		Repairable damage
4/1/16	Beechcraft 200 Super King Air	7484	Wheel(s) up landing	Skyway Aircraft Inc.	USA	0	1	Repairable damage
14/3/16	Raytheon Beechjet 400A	7410	Runway excursion	Flight Options	USA	0	2	Repairable damage
9/4/16	DHC-6 Twin Otter 100	5670	Runway excursion	Skydive San Marcos	USA	0	2	Repairable damage
20/7/16	Beechcraft B200 Super King Air	7484	Runway excursion	Century Equipment Company	USA	0	2	Repairable damage
26/7/16	Embraer EMB-505 Phenom 300	8340	Runway excursion	Flexjet	USA	0	3	Repairable damage
23/11/16	Beechcraft 200 Super King Air	7484	Runway excursion	Flight Development, LLC	USA	0	7	Repairable damage

A2 Aircraft an with MTOW between 5.7 and 27 tons

Aircraft Type	Number of aircraft	Percent	Cum.
Canadair CL-600-2B19 Regional Jet CRJ-200ER	343	9.83%	10%
ATR 72-600 (72-212A)	337	9.66%	19%
ATR 72-500 (72-212A)	297	8.51%	28%
Embraer ERJ-145LR	260	7.45%	35%
Canadair CL-600-2B19 Regional Jet CRJ-200LR	179	5.13%	41%
Embraer ERJ-145XR	107	3.07%	44%
Saab 340B	104	2.98%	47%
De Havilland Canada DHC-8-102 Dash 8	99	2.84%	49%
Embraer EMB-135BJ Legacy	99	2.84%	52%
ATR 42-500	98	2.81%	55%
Fokker F50	72	2.06%	57%
Dornier 328-110	67	1.92%	59%
Embraer EMB-135BJ Legacy 650	67	1.92%	61%
De Havilland Canada DHC-8-202Q Dash 8	57	1.63%	63%
ATR 42-320	55	1.58%	64%
Canadair CL-600-2B19 Challenger 850	53	1.52%	66%
Embraer ERJ-135LR	51	1.46%	67%
Canadair CL-600-2B19 Regional Jet CRJ-100ER	46	1.32%	69%
De Havilland Canada DHC-8-311Q Dash 8	46	1.32%	70%
De Havilland Canada DHC-8-315Q Dash 8	45	1.29%	71%
De Havilland Canada DHC-8-311 Dash 8	44	1.26%	72%

Aircraft Type	Number of aircraft	Percent	Cum.
Saab 2000	42	1.20%	74%
Embraer ERJ-145EP	40	1.15%	75%
Dornier Do-328JET-310	39	1.12%	76%
Embraer EMB-135BJ Legacy 600	39	1.12%	77%
ATR 42-300	35	1.00%	78%
ATR 42-300(F)	32	0.92%	79%
ATR 42-600	31	0.89%	80%
ATR 72-202	27	0.77%	81%
De Havilland Canada DHC-8-106 Dash 8	27	0.77%	81%
British Aerospace Jetstream 4100 (Jetstream 41)	26	0.75%	82%
De Havilland Canada DHC-8-103 Dash 8	26	0.75%	83%
ATR 72-212	24	0.69%	84%
ATR 72-202(F)	22	0.63%	84%
De Havilland Canada DHC-8-314Q Dash 8	21	0.60%	85%
Embraer ERJ-145LI	20	0.57%	85%
British Aerospace BAe ATP-F(LFD)	19	0.54%	86%
Embraer ERJ-145MP	19	0.54%	86%
Dornier Do-328JET-300	18	0.52%	87%
Embraer ERJ-140LR	18	0.52%	87%
ATR 72-212(F)	17	0.49%	88%
Embraer ERJ-135ER	17	0.49%	88%
Canadair CL-600-2C10 Challenger 870	16	0.46%	89%
De Havilland Canada DHC-8-315Q MPA	16	0.46%	89%
Embraer EMB-120ER Brasilia	15	0.43%	90%

Aircraft Type	Number of aircraft	Percent	Cum.
De Havilland Canada DHC-8-103B Dash 8	14	0.40%	90%
De Havilland Canada DHC-8-301 Dash 8	14	0.40%	91%
De Havilland Canada DHC-8-314 Dash 8	12	0.34%	91%
Saab 340A	12	0.34%	91%
Beechcraft 1900D	11	0.32%	92%
Embraer EMB-120FC Brasilia	11	0.32%	92%
De Havilland Canada DHC-8-102A Dash 8	10	0.29%	92%
De Havilland Canada DHC-8-202Q Dash 8 MPA	10	0.29%	92%
De Havilland Canada DHC-8-315 Dash 8	10	0.29%	93%
ATR 42-300(QC)	9	0.26%	93%
ATR 42-320(F)	9	0.26%	93%
British Aerospace BAe ATP-F	9	0.26%	94%
Fokker F50 Freighter	9	0.26%	94%
ATR 72-201(F)	8	0.23%	94%
Canadair CL-600-2B19 Challenger 800	8	0.23%	94%
De Havilland Canada DHC-8-202 Dash 8	8	0.23%	94%
Embraer ERJ-145EU	8	0.23%	95%
ATR 42MP-420	7	0.20%	95%
Embraer C-99A (EMB-145ER)	7	0.20%	95%
Saab 340AF	7	0.20%	95%
ATR 72-202F	6	0.17%	95%
De Havilland Canada DHC-8-201Q Dash 8	6	0.17%	96%
Embraer VC-99B (EMB-135BJ)	6	0.17%	96%
British Aerospace Jetstream 4102 (Jetstream 41)	5	0.14%	96%

Aircraft Type	Number of aircraft	Percent	Cum.
Canadair CL-600-2B19 Regional Jet CRJ-100PF	5	0.14%	96%
Embraer E-99 (EMB-145SA)	5	0.14%	96%
Embraer ERJ-140 (ERJ-135KL)	5	0.14%	96%
Embraer ERJ-145ER	5	0.14%	97%
Embraer ERJ-145LU	5	0.14%	97%
Fokker F50 Enforcer Mk.2	5	0.14%	97%
Saab 2000 AEW&C	5	0.14%	97%
ATR 72-201	4	0.11%	97%
British Aerospace BAe ATP	4	0.11%	97%
De Havilland Canada CT-142 Dash 8 (DHC-8-102)	4	0.11%	97%
Embraer EMB-145H AEW&C (R-99A)	4	0.11%	97%
Fokker F50 UTA	4	0.11%	98%
Fokker F50-120	4	0.11%	98%
Fokker F60 UTA-N	4	0.11%	98%
ATR 72-202(QC)	3	0.09%	98%
Canadair CL-600-2B19 Regional Jet CRJ-100SE	3	0.09%	98%
Canadair CL-600-2B19 Regional Jet CRJ-200	3	0.09%	98%
Canadair CL-600-2D24 Challenger 890	3	0.09%	98%
De Havilland Canada DHC-8-311Q Dash 8 MSA	3	0.09%	98%
Dornier 328-120	3	0.09%	98%
Embraer EMB-145SM	3	0.09%	98%
Embraer R-99 (EMB-145RS)	3	0.09%	98%
Saab 340 AEW&C	3	0.09%	99%
ATR 42MP-500	2	0.06%	99%

Aircraft Type	Number of aircraft	Percent	Cum.
ATR 72-211(F)	2	0.06%	99%
ATR C-72 MPA (72-212A)	2	0.06%	99%
British Aerospace Jetstream 4121 (Jetstream 41)	2	0.06%	99%
British Aerospace Jetstream 4124 (Jetstream 41)	2	0.06%	99%
Canadair CL-600-2B19 Regional Jet CRJ-200PF	2	0.06%	99%
De Havilland Canada DHC-8-103Q Dash 8	2	0.06%	99%
De Havilland Canada DHC-8-201 Dash 8	2	0.06%	99%
De Havilland Canada DHC-8-314B Dash 8	2	0.06%	99%
De Havilland Canada DHC-8-315Q MSA	2	0.06%	99%
De Havilland Canada E-9A Dash 8 (DHC-8-102)	2	0.06%	99%
De Havilland Canada MPA-D8 (DHC-8-106)	2	0.06%	99%
Dornier 328-130	2	0.06%	99%
Embraer EMB-145MPA	2	0.06%	99%
Embraer VC-99C (EMB-135LR)	2	0.06%	99%
Saab 340B(F)	2	0.06%	99%
ATR 42-320(QC)	1	0.03%	99%
ATR 42-420	1	0.03%	100%
ATR 42M-312	1	0.03%	100%
ATR P-72A MPA (72-212A)	1	0.03%	100%
Antonov An-140	1	0.03%	100%
British Aerospace BAe-3102 Jetstream 31	1	0.03%	100%
British Aerospace Jetstream 4101 (Jetstream 41)	1	0.03%	100%
Canadair CL-600-2B19 Regional Jet CRJ-100LR	1	0.03%	100%
Cessna 750 Citation X	1	0.03%	100%

Aircraft Type	Number of aircraft	Percent	Cum.
De Havilland Canada DHC-8-103A Dash 8	1	0.03%	100%
De Havilland Canada DHC-8-311A Dash 8	1	0.03%	100%
De Havilland Canada DHC-8-311B Dash 8	1	0.03%	100%
De Havilland Canada DHC-8-314A Dash 8	1	0.03%	100%
De Havilland Canada DHC-8-314Q MPA	1	0.03%	100%
De Havilland Canada DHC-8-315B Dash 8	1	0.03%	100%
Embraer ERJ-145SA	1	0.03%	100%
Embraer VC-99A (EMB-145LR)	1	0.03%	100%
Hawker Beechcraft 4000	1	0.03%	100%
Saab 340B SAR-200	1	0.03%	100%

A3 Airlines whose fleet has an MTOW between 5.7 and 27 tons

Country	Airline	Number of aircraft	Percent	Cum.
United States	ExpressJet Airlines	204	5.70%	5.70%
United States	SkyWest Airlines	170	4.75%	10459%
United States	American Eagle	86	2.40%	12864%
Canada	Air Canada Express	76	2.13%	14989%
United States	Air Wisconsin	65	1.82%	16806%
United States	Endeavor Air	53	1.48%	18289%
United States	Trans States Airlines	53	1.48%	19771%
Indonesia	Wings Air	51	1.43%	21197%
United States	Piedmont Airlines	49	1.37%	22567%
Brazil	AZUL Linhas Aereas Brasileiras	40	1.12%	23686%
Brazil	Forca Aerea Brasileira	36	1.01%	24692%
France	HOP	36	1.01%	25699%
United States	PSA Airlines	35	0.98%	26678%
United States	CommutAir	31	0.87%	27545%
Spain	Swiftair	31	0.87%	28412%
Australia	Regional Express	30	0.84%	29251%
Norway	Wideroe	30	0.84%	30089%
Sweden	West Air Sweden	28	0.78%	30872%
South Africa	Airlink South Africa	28	0.78%	31655%
New Zealand	Air New Zealand Link	26	0.73%	32383%
United States	Silver Airways	24	0.67%	33054%
United States	Federal Express (FedEx)	24	0.67%	33725%
United Kingdom	Eastern Airways	24	0.67%	34396%
New Zealand	Air Nelson	23	0.64%	35039%
Ireland	ASL Airlines Ireland	23	0.64%	35682%
Mexico	Aeromar	21	0.59%	36270%
Russian Federation	Rusline	20	0.56%	36829%

Country	Airline	Number of aircraft	Percent	Cum.
United Kingdom	Loganair	19	0.53%	37360%
Malaysia	Firefly	18	0.50%	37864%
Spain	Binter Canarias	18	0.50%	38367%
United Kingdom	bmi Regional	17	0.48%	38842%
China	Tianjin Airlines	17	0.48%	39318%
Papua New Guinea	PNG Air	16	0.45%	39765%
United States	USAF United States Air Force	16	0.45%	40213%
Malaysia	Malindo Air	16	0.45%	40660%
Indonesia	Garuda Indonesia	16	0.45%	41107%
Thailand	Bangkok Airways	15	0.42%	41527%
Denmark	Sun Air of Scandinavia	15	0.42%	41946%
China	PLAAF	15	0.42%	42366%
Russian Federation	UTair Aviation	15	0.42%	42785%
Algeria	Air Algerie	15	0.42%	43205%
Canada	Air Creebec	15	0.42%	43624%
United States	Penair	15	0.42%	44044%
Sweden	Amapola Flyg	14	0.39%	44435%
Australia	Virgin Australia	14	0.39%	44827%
Kenya	Skyward International	14	0.39%	45218%
India	Jet Airways	13	0.36%	45582%
Philippines	CEBU Pacific Air	13	0.36%	45945%
Taiwan	UNI Airways	13	0.36%	46309%
Canada	Calm Air International	13	0.36%	46672%
South Africa	Solenta Aviation	13	0.36%	47036%
Canada	Voyageur Airways	13	0.36%	47399%
Portugal	Portuguese Air Force	12	0.34%	47735%
Finland	NORRA Nordic Regional Airlines	12	0.34%	48070%
Spain	Air Nostrum	12	0.34%	48406%

Country	Airline	Number of aircraft	Percent	Cum.
Australia	Eastern Australia Airlines	12	0.34%	48742%
Japan	Japan Coast Guard	12	0.34%	49077%
French Polynesia	Air Tahiti	12	0.34%	49413%
Myanmar	Myanmar	11	0.31%	49720%
Ireland	Aer Lingus Regional	11	0.31%	50028%
Russian Federation	Yamal Airlines	11	0.31%	50336%
Sweden	Braathens Regional	11	0.31%	50643%
Poland	SprintAir	11	0.31%	50951%
Denmark	Danish Air Transport	11	0.31%	51258%
Australia	Surveillance Australia	11	0.31%	51566%
Canada	Air Inuit	10	0.28%	51846%
United Kingdom	Flybe	10	0.28%	52125%
Switzerland	Etihad Regional	10	0.28%	52405%
Pakistan	PIA Pakistan International Air	10	0.28%	52685%
Australia	Skippers Aviation	10	0.28%	52964%
Sweden	BRA Braathens Regional Airline	10	0.28%	53244%
Canada	First Air (Canada)	10	0.28%	53523%
Mexico	Transportes Aereos Regionales	10	0.28%	53803%
South Africa	South African Express Airways	10	0.28%	54083%
Germany	Private Wings Flugcharter	10	0.28%	54362%
United States	Ultimate Jetcharters	10	0.28%	54642%
Antigua And Barbuda	LIAT	10	0.28%	54922%
Poland	Polish Air Force	10	0.28%	55201%
United States	Ravn Alaska	10	0.28%	55481%
Tanzania, United Republic Of	Precision Air	10	0.28%	55761%
Malaysia	MASwings	10	0.28%	56040%
India	Air India Regional	10	0.28%	56320%
Nepal	Buddha Air	10	0.28%	56600%

Country	Airline	Number of aircraft	Percent	Cum.
Myanmar	Air KBZ	9	0.25%	56851%
Brazil	Passaredo Transportes Aereos	9	0.25%	57103%
United States	Sierra Nevada Corporation	9	0.25%	57355%
Colombia	Avianca	9	0.25%	57606%
Romania	TAROM	9	0.25%	57858%
Maldives	Maldivian	9	0.25%	58110%
South Africa	Cemair	9	0.25%	58361%
Japan	Japan Air Commuter	9	0.25%	58613%
Colombia	SATENA	9	0.25%	58865%
Kenya	Aircraft Leasing Services (ALS	9	0.25%	59116%
Indonesia	Trigana Air Service	9	0.25%	59368%
Switzerland	ASL Airlines Switzerland	9	0.25%	59620%
Singapore	Singapore Air Force	9	0.25%	59871%
United States	Via Airlines	8	0.22%	60095%
Portugal	TAP Express	8	0.22%	60319%
Malta	AIR X Charter	8	0.22%	60543%
United States	US Department of State	8	0.22%	60766%
United Kingdom	London Executive Aviation	8	0.22%	60990%
Colombia	Easyfly	8	0.22%	61214%
New Zealand	Air New Zealand Link (Eagle Ai	8	0.22%	61437%
Czech Republic	Czech Airlines (CSA)	8	0.22%	61661%
Germany	Air Hamburg	8	0.22%	61885%
Mexico	Fuerza Aerea Mexicana	8	0.22%	62109%
Canada	Provincial Airlines	8	0.22%	62332%
Czech Republic	ABS Jets	7	0.20%	62528%
United States	US Department of Homeland Secu	7	0.20%	62724%
Canada	Regional 1	7	0.20%	62919%
Sweden	NextJet	7	0.20%	63115%

Country	Airline	Number of aircraft	Percent	Cum.
United States	Victory Air	7	0.20%	63311%
Lao People's Democratic Republic	Lao Airlines	7	0.20%	63507%
Bolivia	Amaszonas	7	0.20%	63702%
Nigeria	Overland Airways	7	0.20%	63898%
Russian Federation	UVT Aero	7	0.20%	64094%
Denmark	Jettime	7	0.20%	64290%
United States	US Army	7	0.20%	64485%
Greenland	Air Greenland	7	0.20%	64681%
United States	Elite Airways	7	0.20%	64877%
Ukraine	Dniproavia	7	0.20%	65073%
Greece	Sky Express (Greece)	7	0.20%	65268%
Kenya	Blue Bird Aviation	7	0.20%	65464%
India	Indian Air Force	7	0.20%	65660%
Papua New Guinea	Link PNG	7	0.20%	65856%
Kenya	Fly540	6	0.17%	66023%
United States	Key Lime Air	6	0.17%	66191%
United States	Empire Airlines	6	0.17%	66359%
Russian Federation	Severstal	6	0.17%	66527%
Serbia	Air Serbia	6	0.17%	66695%
Kazakhstan	Comlux KZ	6	0.17%	66862%
Peru	Peruvian Navy	6	0.17%	67030%
Russian Federation	Aurora	6	0.17%	67198%
Canada	Perimeter Aviation	6	0.17%	67366%
Canada	Summit Air	6	0.17%	67534%
Bangladesh	NovoAir	6	0.17%	67701%
United States	Intel Air Shuttle Aircraft	6	0.17%	67869%
Kazakhstan	SCAT Air	6	0.17%	68037%
United States	Ohana	6	0.17%	68205%

Country	Airline	Number of aircraft	Percent	Cum.
Italy	Mistral Air	6	0.17%	68372%
Kenya	DAC Aviation International	6	0.17%	68540%
Indonesia	Express Air (Indonesia)	6	0.17%	68708%
Indonesia	KalStar Aviation	6	0.17%	68876%
Indonesia	TransNusa Aviation Mandiri	6	0.17%	69044%
Greece	Olympic Air	6	0.17%	69211%
Greece	Hellenic Air Force	6	0.17%	69379%
Papua New Guinea	Hevilift	6	0.17%	69547%
Pakistan	Pakistan Air Force	6	0.17%	69715%
Canada	Central Mountain Air	6	0.17%	69883%
United Arab Emirates	United Arab Emirates Air Force	5	0.14%	70022%
United States	Island Air (USA)	5	0.14%	70162%
Switzerland	Skywork	5	0.14%	70302%
United States	Flight Options	5	0.14%	70442%
Indonesia	Premiair (Indonesia)	5	0.14%	70582%
Venezuela	Santa Barbara Airlines	5	0.14%	70721%
Colombia	Policia Nacional de Colombia	5	0.14%	70861%
Lithuania	DOT LT	5	0.14%	71001%
Morocco	Royal Air Maroc Express	5	0.14%	71141%
Trinidad And Tobago	Caribbean Airlines	5	0.14%	71281%
Spain	Air Europa	5	0.14%	71421%
Japan	J Air	5	0.14%	71560%
United States	Dynamic Aviation Group	5	0.14%	71700%
Austria	Avcon Jet	5	0.14%	71840%
Algeria	Algerian Air Force	5	0.14%	71980%
Canada	Sunwest Aviation (Canada)	5	0.14%	72120%
Belarus	Belavia	5	0.14%	72260%
Egypt	Petroleum Air Services	5	0.14%	72399%

Country	Airline	Number of aircraft	Percent	Cum.
Brazil	MAP Linhas Aereas	5	0.14%	72539%
Russian Federation	Russian Federation Air Force	5	0.14%	72679%
Viet Nam	Vasco Vietnam Air Services Com	5	0.14%	72819%
United States	JetSuiteX	5	0.14%	72959%
Spain	Canary Fly	5	0.14%	73098%
Russian Federation	NordStar Airlines	5	0.14%	73238%
Russian Federation	Angara Airlines	5	0.14%	73378%
Colombia	Fuerza Aerea Colombiana	5	0.14%	73518%
Ireland	Stobart Air	5	0.14%	73658%
Australia	AeroRescue	5	0.14%	73798%
United Arab Emirates	Abu Dhabi Aviation	5	0.14%	73937%
United Arab Emirates	Empire Aviation Group	5	0.14%	74077%
Mexico	Mexican Navy	5	0.14%	74217%
India	JetKonnect	5	0.14%	74357%
Estonia	Airest	5	0.14%	74497%
Malta	Vistajet	5	0.14%	74636%
Ukraine	Air Urga	5	0.14%	74776%
India	TruJet	5	0.14%	74916%
China	Jiangsu Jet	5	0.14%	75056%
Russian Federation	Komiaviatrans State Air Enterp	5	0.14%	75196%
Australia	Alliance Airlines (Australia)	5	0.14%	75336%
Australia	Jetstar Airways	5	0.14%	75475%
Iran, Islamic Republic Of	Naft Air Lines	5	0.14%	75615%
Botswana	Air Botswana	5	0.14%	75755%
United States	Mountain Air Cargo	5	0.14%	75895%
Guadeloupe	Air Antilles Express	5	0.14%	76035%
France	Air Corsica	5	0.14%	76174%
Canada	West Wind Aviation	5	0.14%	76314%

Country	Airline	Number of aircraft	Percent	Cum.
Cuba	Aero Caribbean	5	0.14%	76454%
Australia	JetGo Australia	4	0.11%	76566%
Yemen	Blue Bird Aviation Yemen	4	0.11%	76678%
United Kingdom	Aurigny Air Services	4	0.11%	76790%
Iran, Islamic Republic Of	Iran Aseman Airlines	4	0.11%	76902%
Portugal	Lease Fly	4	0.11%	77013%
Iran, Islamic Republic Of	Iran Air	4	0.11%	77125%
United States	Menard	4	0.11%	77237%
Cambodia	Cambodia Angkor Air	4	0.11%	77349%
Algeria	Tassili Airlines	4	0.11%	77461%
Mongolia	Aero Mongolia	4	0.11%	77573%
Germany	MHS Aviation	4	0.11%	77685%
Russian Federation	Saratov Airlines	4	0.11%	77796%
France	Enhance Aero Group	4	0.11%	77908%
Thailand	Royal Thai Air Force	4	0.11%	78020%
Panama	Air Panama	4	0.11%	78132%
Saudi Arabia	Nesma Airlines Saudi	4	0.11%	78244%
Philippines	AirSWIFT	4	0.11%	78356%
Iran, Islamic Republic Of	Taftan Airlines	4	0.11%	78468%
China	ZYB Lily Jet	4	0.11%	78579%
Guatemala	Avianca Guatemala	4	0.11%	78691%
Colombia	ADA Colombia	4	0.11%	78803%
Kenya	748 Air Services	4	0.11%	78915%
Bahamas	Bahamasair	4	0.11%	79027%
Canada	North Cariboo Air	4	0.11%	79139%
China	China Eastern Airlines Executi	4	0.11%	79251%
Russian Federation	IrAero	4	0.11%	79362%
Belgium	Belgian Air Force	4	0.11%	79474%

Country	Airline	Number of aircraft	Percent	Cum.
Guadeloupe	Air Caraibes	4	0.11%	79586%
Czech Republic	Czech Air Force	4	0.11%	79698%
India	Alliance Air	4	0.11%	79810%
United States	Berry Aviation	4	0.11%	79922%
Mexico	Aereo Calafia	4	0.11%	80034%
China	Sparkle Roll Jet	4	0.11%	80145%
Canada	Canadian Armed Forces	4	0.11%	80257%
Cuba	Aerogaviota	4	0.11%	80369%
Namibia	Air Namibia	4	0.11%	80481%
Netherlands Antilles	Insel Air	4	0.11%	80593%
Italy	Guardia di Finanza	4	0.11%	80705%
Mongolia	Hunnu Air	4	0.11%	80817%
United States	EP Aviation	4	0.11%	80928%
Philippines	PAL Express	4	0.11%	81040%
China	PLANAF	4	0.11%	81152%
Myanmar	FMI Air	4	0.11%	81264%
New Caledonia	Air Caledonie	4	0.11%	81376%
Canada	Suncor Energy Inc	3	0.08%	81460%
United States	Champion Air LLC	3	0.08%	81544%
China	Apex Air	3	0.08%	81628%
Japan	Hokkaido Air System	3	0.08%	81711%
Italy	Guardia Costiera	3	0.08%	81795%
United States	Blue Ridge Aero Services	3	0.08%	81879%
Sweden	Swedish Coast Guard (Kustbevak	3	0.08%	81963%
Ecuador	TAME	3	0.08%	82047%
Kenya	Kenya Air Force	3	0.08%	82131%
Luxembourg	Luxaviation	3	0.08%	82215%
Angola	SEAA Servicos	3	0.08%	82299%

Country	Airline	Number of aircraft	Percent	Cum.
United States	Cape Air	3	0.08%	82383%
Congo, The Democratic Republic Of The	Compagnie Africaine dAviation	3	0.08%	82466%
Denmark	ExecuJet Scandinavia	3	0.08%	82550%
United States	US Department of Justice	3	0.08%	82634%
Switzerland	Zimex Aviation	3	0.08%	82718%
Thailand	Royal Thai Army	3	0.08%	82802%
Japan	Japan Civil Aviation Bureau	3	0.08%	82886%
Papua New Guinea	Asia Pacific Airlines (Papua N	3	0.08%	82970%
Mozambique	Mocambique Expresso	3	0.08%	83054%
Unknown	Unknown	3	0.08%	83138%
Mauritius	Air Mauritius	3	0.08%	83221%
Nigeria	SkyBird Air	3	0.08%	83305%
Indonesia	Pelita Air Service	3	0.08%	83389%
Fiji	Fiji Link	3	0.08%	83473%
Finland	Finnish Air Force	3	0.08%	83557%
Zambia	Proflight Air Services	3	0.08%	83641%
Myanmar	Yangon Airways	3	0.08%	83725%
Indonesia	Indonesia Air Transport	3	0.08%	83809%
Ghana	Africa World Airlines	3	0.08%	83893%
Greece	Astra Airlines	3	0.08%	83977%
Philippines	Royal Star Aviation	3	0.08%	84060%
Japan	Ryukyu Air Commuter	3	0.08%	84144%
United States	Aerodynamics Inc	3	0.08%	84228%
Venezuela	Conviasa	3	0.08%	84312%
Cape Verde	TACV	3	0.08%	84396%
Congo	Equaflight Service	3	0.08%	84480%
Malta	Medavia Mediterranean Aviation	3	0.08%	84564%
Taiwan	Taiwan Air Force	3	0.08%	84648%

Country	Airline	Number of aircraft	Percent	Cum.
Australia	Skytrans Airlines	3	0.08%	84732%
United Kingdom	TAG Aviation UK Ltd	3	0.08%	84815%
Argentina	Avianca Argentina	3	0.08%	84899%
Mexico	MCS AeroCarga	3	0.08%	84983%
China	Asia United Business Aviation	3	0.08%	85067%
United States	Opticap Aviation LLC	3	0.08%	85151%
Nigeria	Dornier Aviation Nigeria Aiep	3	0.08%	85235%
Equatorial Guinea	Ceiba Intercontinental	3	0.08%	85319%
United States	Presidential Airways (PAW)	3	0.08%	85403%
United Kingdom	Blue Islands	3	0.08%	85487%
Nigeria	Barbedos Group Ltd	3	0.08%	85570%
Equatorial Guinea	Cronos Airlines	2	0.06%	85626%
Lithuania	KlasJet	2	0.06%	85682%
India	Air One Aviation	2	0.06%	85738%
Mexico	FlyMex	2	0.06%	85794%
Mexico	Banco de Mexico	2	0.06%	85850%
Iraq	Iraq Gate Company	2	0.06%	85906%
Peru	Aero Transporte (ATSA)	2	0.06%	85962%
Morocco	Dalia Air	2	0.06%	86018%
United States	Aviando Services	2	0.06%	86074%
Libya	Petro Air	2	0.06%	86130%
Canada	Canadian North	2	0.06%	86186%
Vanuatu	Air Vanuatu	2	0.06%	86242%
Saudi Arabia	Nexus Flight Operations	2	0.06%	86298%
Canada	Jazz Air	2	0.06%	86353%
Poland	JetStory	2	0.06%	86409%
Venezuela	Linea Turistica Aereotuy Lta	2	0.06%	86465%
Kenya	Rudufu	2	0.06%	86521%

Country	Airline	Number of aircraft	Percent	Cum.
Russian Federation	Yakutia Airlines	2	0.06%	86577%
Reunion	Air Austral	2	0.06%	86633%
China	Minsheng Financial Leasing	2	0.06%	86689%
Russian Federation	FSB	2	0.06%	86745%
United States	RVR Aviation Charter	2	0.06%	86801%
United States	Hendrick Motorsports	2	0.06%	86857%
Tanzania, United Republic Of	Air Tanzania	2	0.06%	86913%
United States	Meadow Lane Air Partners LLC	2	0.06%	86969%
Senegal	Transair (Senegal)	2	0.06%	87025%
Norway	FlyViking	2	0.06%	87081%
South Africa	Avex Air Transport	2	0.06%	87136%
Thailand	Nok Air	2	0.06%	87192%
South Africa	Fly Blue Crane	2	0.06%	87248%
South Africa	Swift Flite	2	0.06%	87304%
United States	Peed Aviation	2	0.06%	87360%
France	ATR	2	0.06%	87416%
Cyprus	Tus Airways	2	0.06%	87472%
United States	Mauiva	2	0.06%	87528%
Indonesia	Gatari Air Service	2	0.06%	87584%
China	Yalian Business Jet	2	0.06%	87640%
Myanmar	Golden Myanmar Airlines	2	0.06%	87696%
Jordan	Royal Jordanian Air Force	2	0.06%	87752%
Saudi Arabia	Alpha Star Aviation Services	2	0.06%	87808%
Japan	Oriental Air Bridge	2	0.06%	87864%
Nigeria	TopBrass Aviation	2	0.06%	87919%
China	Minsheng International Jet	2	0.06%	87975%
Sudan	Blue Bird Aviation (Sudan)	2	0.06%	88031%
United States	Corning Inc	2	0.06%	88087%

Country	Airline	Number of aircraft	Percent	Cum.
Canada	Flight Inspection Operation	2	0.06%	88143%
Thailand	Royal Thai Navy	2	0.06%	88199%
Hong Kong	TAG Aviation Asia	2	0.06%	88255%
Portugal	SATA Air Acores	2	0.06%	88311%
United States	Bank of America Leasing and Ca	2	0.06%	88367%
Russian Federation	Orion X	2	0.06%	88423%
South Africa	Golden Wings Aviation	2	0.06%	88479%
Tunisia	Tunisair Express	2	0.06%	88535%
Canada	Gouvernement Du Quebec	2	0.06%	88591%
Brazil	Policia Federal	2	0.06%	88647%
Indonesia	PT Deraya	2	0.06%	88702%
Brazil	CBAir	2	0.06%	88758%
Brazil	SETE Linhas Aereas	2	0.06%	88814%
Bangladesh	Sky Capital Cargo	2	0.06%	88870%
Indonesia	Nusantara Air Charter	2	0.06%	88926%
Myanmar	Asian Wings Airways	2	0.06%	88982%
Bangladesh	Regent Airways	2	0.06%	89038%
Turkey	Turkish Navy	2	0.06%	89094%
Myanmar	Mann Yadanarpon Airlines	2	0.06%	89150%
Germany	Rhein Neckar Air	2	0.06%	89206%
Myanmar	Air Mandalay	2	0.06%	89262%
China	Freesky Aviation	2	0.06%	89318%
Paraguay	Amaszonas Paraguay	2	0.06%	89374%
Korea, Republic Of	Korea Express Air	2	0.06%	89430%
Syrian Arab Republic	Syrian Arab Airlines	2	0.06%	89485%
Russian Federation	EMERCOM	2	0.06%	89541%
Germany	Avangard Aviation	2	0.06%	89597%
Austria	International Jet Management	2	0.06%	89653%

Country	Airline	Number of aircraft	Percent	Cum.
Sudan	Nova Airways	2	0.06%	89709%
Taiwan	EVA Airways	2	0.06%	89765%
Indonesia	Airfast Indonesia	2	0.06%	89821%
France	Pan Europeenne Air Service	2	0.06%	89877%
Germany	Aero Dienst	2	0.06%	89933%
Korea, Democratic People's Republic Of	Air Koryo	2	0.06%	89989%
United Kingdom	Air Charter Scotland	2	0.06%	90045%
Australia	Jetcraft Aviation	2	0.06%	90101%
Georgia	Airzena Georgian Airways	2	0.06%	90157%
Kazakhstan	Euro Asia Air	2	0.06%	90213%
Honduras	Avianca Honduras	2	0.06%	90268%
Mexico	TATSA	2	0.06%	90324%
Denmark	Alsie Express	2	0.06%	90380%
Kenya	Jubba Airways	2	0.06%	90436%
Kenya	Jetways Airlines	2	0.06%	90492%
India	Reliance Industries	2	0.06%	90548%
Iceland	Flugfelag Islands	2	0.06%	90604%
Nepal	Saurya Airlines	2	0.06%	90660%
Bolivia	Boliviana de Aviacion (BoA)	2	0.06%	90716%
Maldives	Flyme (Maldives)	2	0.06%	90772%
Russian Federation	Russian Copper Company	2	0.06%	90828%
United States	Dow Chemical Company	2	0.06%	90884%
Canada	Nav Canada	2	0.06%	90940%
Russian Federation	Russia Special Detachment	2	0.06%	90996%
Austria	Europ Star	2	0.06%	91051%
Nigeria	Bristow	2	0.06%	91107%
Australia	Maroomba Airlines	2	0.06%	91163%
Gabon	Afric Aviation	2	0.06%	91219%

Country	Airline	Number of aircraft	Percent	Cum.
United States	Stewart Haas Racing	2	0.06%	91275%
United States	IBC Airways	2	0.06%	91331%
United Arab Emirates	Falcon Aviation Services (FAS)	2	0.06%	91387%
Uruguay	Amaszonas Uruguay	2	0.06%	91443%
Russian Federation	RusJet	2	0.06%	91499%
United Arab Emirates	Gama Aviation (UAE)	2	0.06%	91555%
United States	SAS Aviation Holdings	2	0.06%	91611%
Russian Federation	MBK S	2	0.06%	91667%
Cayman Islands	Cayman Airways	2	0.06%	91723%
United States	Set Jet	2	0.06%	91779%
Yemen	Felix Airways	2	0.06%	91834%
Bahamas	SkyBahamas Airlines	2	0.06%	91890%
France	Regourd Aviation	2	0.06%	91946%
Israel	Israir Airlines	2	0.06%	92002%
Cape Verde	Binter Cabo Verde	2	0.06%	92058%
Australia	QantasLink	2	0.06%	92114%
Algeria	Government of Algeria	2	0.06%	92170%
United States	Meregrass Inc	2	0.06%	92226%
Hong Kong	Government Flying Service of H	2	0.06%	92282%
Hungary	Fleet Air International	2	0.06%	92338%
Peru	LC Peru	2	0.06%	92394%
Netherlands Antilles	Caribbean Coast Guard	2	0.06%	92450%
Lesotho	Maluti Sky	2	0.06%	92506%
Tanzania, United Republic Of	Tropical Air	2	0.06%	92562%
Denmark	BackBone Aviation	2	0.06%	92617%
Nigeria	Nigerian Air Force	2	0.06%	92673%
United Kingdom	BA CityFlyer	2	0.06%	92729%
Mexico	Estafeta Carga Aerea	2	0.06%	92785%

Country	Airline	Number of aircraft	Percent	Cum.
Kazakhstan	7th sky airlines	2	0.06%	92841%
Nepal	Yeti Airlines	1	0.03%	92869%
Turkey	Turkey Government	1	0.03%	92897%
Nigeria	Air Peace	1	0.03%	92925%
Ukraine	Aerostar (Ukraine)	1	0.03%	92953%
Bermuda	Artjet	1	0.03%	92981%
Ghana	Ghana Air Force	1	0.03%	93009%
Austria	Tyrol Air Ambulance	1	0.03%	93037%
Nicaragua	La Costena	1	0.03%	93065%
United States	Aurogold Aviation	1	0.03%	93093%
Kazakhstan	Caspiy	1	0.03%	93121%
Brazil	Companhia Vale do Rio Doce	1	0.03%	93149%
Lithuania	Charter Jets	1	0.03%	93177%
Switzerland	Nomad Aviation	1	0.03%	93205%
Colombia	Colombian Navy (Armada Naciona	1	0.03%	93233%
United States	GY Challenger II LLC	1	0.03%	93261%
China	Anhui Foreign Economic Constru	1	0.03%	93289%
Jordan	Arab Wings Company	1	0.03%	93317%
Germany	JetAir Flug	1	0.03%	93345%
China	Zhonggeng Group	1	0.03%	93372%
New Zealand	Air Chathams	1	0.03%	93400%
Portugal	Masterjet	1	0.03%	93428%
United States	Mesa Airlines	1	0.03%	93456%
Belgium	Brussels Airlines	1	0.03%	93484%
Nigeria	Air Taraba	1	0.03%	93512%
United States	BDG Air Charter	1	0.03%	93540%
Canada	Wasaya Airways	1	0.03%	93568%
South Africa	DHL Aviation	1	0.03%	93596%

Country	Airline	Number of aircraft	Percent	Cum.
Solomon Islands	Solomon Airlines	1	0.03%	93624%
Brazil	Mac Bens Patrimonial	1	0.03%	93652%
South Africa	Sishen Iron Ore Company	1	0.03%	93680%
Russian Federation	Premier Avia	1	0.03%	93708%
France	Aviation Defense Service	1	0.03%	93736%
Kenya	Fanjet Express	1	0.03%	93764%
Gabon	Afrijet Business Service	1	0.03%	93792%
United States	Embraer Executive Aircraft	1	0.03%	93820%
United Kingdom	Pendley Aviation	1	0.03%	93848%
Brazil	Flyways Linhas Aereas	1	0.03%	93876%
United States	Wing Aviation	1	0.03%	93904%
United States	BMH Air LLC	1	0.03%	93932%
United States	Win Services	1	0.03%	93960%
Burkina Faso	Colombe Airline	1	0.03%	93988%
United States	Fly Eagle	1	0.03%	94016%
Canada	Hydro Quebec	1	0.03%	94044%
Uruguay	Delbitur	1	0.03%	94072%
Russian Federation	Jet Air Group	1	0.03%	94100%
United States	Hamister Group	1	0.03%	94128%
United States	Heidi Aviation LLC	1	0.03%	94155%
United States	Palu Aviation	1	0.03%	94183%
Kenya	CMC Aviation	1	0.03%	94211%
Brazil	Embraer	1	0.03%	94239%
United States	Kinetic Motion	1	0.03%	94267%
Israel	Arkia Israeli Airlines	1	0.03%	94295%
Thailand	Kan Air	1	0.03%	94323%
South Africa	SafariLink Aviation	1	0.03%	94351%
Kazakhstan	Prime Aviation JSC	1	0.03%	94379%

Country	Airline	Number of aircraft	Percent	Cum.
United States	Dalcam LLC	1	0.03%	94407%
Namibia	Westair Aviation (WAA)	1	0.03%	94435%
Honduras	Fuerza Aerea Hondurena	1	0.03%	94463%
Mauritania	Mauritania Airlines Internatio	1	0.03%	94491%
Sudan	Tarco Air	1	0.03%	94519%
Chad	Republique du Tchad	1	0.03%	94547%
Isle of Man	Hermitage Air	1	0.03%	94575%
South Africa	MCC Aviation	1	0.03%	94603%
Iraq	Fly Baghdad	1	0.03%	94631%
United States	ACM Aviation	1	0.03%	94659%
China	Beijing Capital Airlines	1	0.03%	94687%
Nigeria	Government of Nigeria	1	0.03%	94715%
United States	Up Management LLC	1	0.03%	94743%
United States	Admiralty Air	1	0.03%	94771%
United States	Stone Tower Air	1	0.03%	94799%
South Africa	Titan Helicopters Group	1	0.03%	94827%
United States	Freeport McMoran	1	0.03%	94855%
United States	HR INV LLC	1	0.03%	94883%
Kuwait	United Aviation	1	0.03%	94911%
Russian Federation	Ak Bars Aero	1	0.03%	94938%
Thailand	Royal Thai Police	1	0.03%	94966%
Dominican Republic	Air Century	1	0.03%	94994%
India	Border Security Force	1	0.03%	95022%
Niger	Niger Airlines	1	0.03%	95050%
United States	Penske Jet Inc	1	0.03%	95078%
Malta	Blue Square Aviation Group Mal	1	0.03%	95106%
India	Indiabulls	1	0.03%	95134%
United States	Comtran International	1	0.03%	95162%

Country	Airline	Number of aircraft	Percent	Cum.
Japan	Amakusa Airlines	1	0.03%	95190%
United States	Wumac Inc	1	0.03%	95218%
Switzerland	FTC Consulting AG	1	0.03%	95246%
United States	Cummins Inc	1	0.03%	95274%
Turkmenistan	Turkmenistan Airlines	1	0.03%	95302%
United States	McKee Food Transportation LLC	1	0.03%	95330%
Spain	Spanish Air Force	1	0.03%	95358%
Ukraine	Antonov Design Bureau	1	0.03%	95386%
United States	MI Homes	1	0.03%	95414%
Peru	Star Peru	1	0.03%	95442%
United States	Executive Flightways	1	0.03%	95470%
Tanzania, United Republic Of	Government of Tanzania	1	0.03%	95498%
Singapore	MyJet Asia	1	0.03%	95526%
South Africa	Aircraft Africa Contracts	1	0.03%	95554%
Ukraine	Business Jet Travel	1	0.03%	95582%
China	China Sonangol International	1	0.03%	95610%
Honduras	Aerolineas Sosa	1	0.03%	95638%
Angola	Angola Air Services	1	0.03%	95666%
United Arab Emirates	Nakheel Aviation	1	0.03%	95694%
Virgin Islands, British	Saby Finance	1	0.03%	95721%
Suriname	Hi Jet Helicopters	1	0.03%	95749%
India	Zoom Air	1	0.03%	95777%
India	India Fly Safe Aviation	1	0.03%	95805%
United States	Northrop Grumman Corporation	1	0.03%	95833%
Austria	Welcome Air	1	0.03%	95861%
Afghanistan	Afghan Jet International	1	0.03%	95889%
Saudi Arabia	Almusa	1	0.03%	95917%
United States	Leon Legacy LLC	1	0.03%	95945%

Country	Airline	Number of aircraft	Percent	Cum.
South Sudan	Kush Air	1	0.03%	95973%
South Africa	Execujet Flight Operations	1	0.03%	96001%
United States	Integrity Aircraft	1	0.03%	96029%
United Kingdom	HM Coastguard (HMCG)	1	0.03%	96057%
United States	Challenger Management	1	0.03%	96085%
Aruba	AEG Air	1	0.03%	96113%
Azerbaijan	SW Business Aviation	1	0.03%	96141%
United States	Blue Sky Aviation LLC	1	0.03%	96169%
Venezuela	Vensecar Internacional (DHL Ve	1	0.03%	96197%
United States	Cyberjet	1	0.03%	96225%
Philippines	SEAir International	1	0.03%	96253%
United States	Elite Air (USA)	1	0.03%	96281%
Gabon	Nouvelle Air Affaires Gabon	1	0.03%	96309%
Greece	GainJet Aviation	1	0.03%	96337%
Brazil	EMS SA	1	0.03%	96365%
Ecuador	Trans Am Aero Express del Ecua	1	0.03%	96393%
Malta	Hyperion Aviation	1	0.03%	96421%
Korea, Republic Of	uSky Air	1	0.03%	96449%
United States	Skydive Guam	1	0.03%	96477%
Canada	Barrick Gold Corporation	1	0.03%	96504%
Kenya	AirKenya	1	0.03%	96532%
France	Centre d Aviation Meteorologiq	1	0.03%	96560%
Mexico	Redwings	1	0.03%	96588%
Guatemala	DHL de Guatemala	1	0.03%	96616%
France	Airlinair	1	0.03%	96644%
Canada	Labrador Airways	1	0.03%	96672%
Mexico	Policia Federal Mexico	1	0.03%	96700%
Mexico	Mayair	1	0.03%	96728%

Country	Airline	Number of aircraft	Percent	Cum.
Equatorial Guinea	Equatorial Guinea Government	1	0.03%	96756%
Mexico	First Jet	1	0.03%	96784%
Unknown	Silvershore Trading Ltd	1	0.03%	96812%
Gabon	Republique Gabonaise	1	0.03%	96840%
Japan	Ibex Airlines	1	0.03%	96868%
Marshall Islands	Air Marshall Islands	1	0.03%	96896%
Angola	Angolan Air Force	1	0.03%	96924%
India	Club One Air	1	0.03%	96952%
United States	RBGT LLC	1	0.03%	96980%
Indonesia	Jhonlin Air Transport	1	0.03%	97008%
Lebanon	A Kassar SAL	1	0.03%	97036%
Ecuador	Petroecuador	1	0.03%	97064%
United States	Harwicke Properties LLC	1	0.03%	97092%
United States	JSV Leasing	1	0.03%	97120%
India	Karnavati Aviation	1	0.03%	97148%
Canada	Morningstar Air Express	1	0.03%	97176%
Saudi Arabia	Samco Aviation	1	0.03%	97204%
Myanmar	APEX Airlines	1	0.03%	97232%
United States	WingsWest Aviation Group LLC	1	0.03%	97260%
Mauritius	Blue Wings Mauritius	1	0.03%	97287%
Isle of Man	Legacy Aviation	1	0.03%	97315%
Saudi Arabia	AlNahla Aviation	1	0.03%	97343%
Equatorial Guinea	Punto Azul	1	0.03%	97371%
Canada	Flightexec	1	0.03%	97399%
China	Liuzhou Zhengling Group	1	0.03%	97427%
United States	Encore LLC	1	0.03%	97455%
Isle of Man	Caropan Company SA	1	0.03%	97483%
United States	Transcon International Inc	1	0.03%	97511%

Country	Airline	Number of aircraft	Percent	Cum.
United States	Air by Jet Aircraft Charter	1	0.03%	97539%
Canada	Alberta Inc	1	0.03%	97567%
Brazil	Total Linhas Aereas	1	0.03%	97595%
Bhutan	Druk Air Royal Bhutan Airlines	1	0.03%	97623%
United States	ConocoPhillips Aviation Alaska	1	0.03%	97651%
Angola	AeroJet	1	0.03%	97679%
Saint Pierre And Miquelon	Air Saint Pierre	1	0.03%	97707%
China	JC Jet	1	0.03%	97735%
Senegal	ASECNA	1	0.03%	97763%
South Africa	National Airways Corporation	1	0.03%	97791%
United States	RCR Air	1	0.03%	97819%
Canada	Pacific Coastal Airlines	1	0.03%	97847%
United States	Fabair	1	0.03%	97875%
Egypt	Egypt Air Force	1	0.03%	97903%
Indonesia	Enggang Air Service	1	0.03%	97931%
South Africa	Rainbow Airlines	1	0.03%	97959%
Pakistan	Pakistan Navy	1	0.03%	97987%
Nigeria	Max Air	1	0.03%	98015%
Moldova, Republic Of	Nobil Air	1	0.03%	98043%
United States	Continental Carrier	1	0.03%	98070%
United States	Pratt Whitney Engine Services	1	0.03%	98098%
Rwanda	RwandAir	1	0.03%	98126%
Isle of Man	Hermes Executive Aviation	1	0.03%	98154%
Philippines	Platinum Skies Aviation	1	0.03%	98182%
United States	Pebuny LLC	1	0.03%	98210%
India	Air Carnival	1	0.03%	98238%
United States	WFBN Wells Fargo Bank Northwes	1	0.03%	98266%
United States	ExcelAire LLC	1	0.03%	98294%

Country	Airline	Number of aircraft	Percent	Cum.
United States	Boston Enterprises LLC	1	0.03%	98322%
Saudi Arabia	NasJet	1	0.03%	98350%
Bangladesh	Hello Airlines	1	0.03%	98378%
Ukraine	Motor Sich	1	0.03%	98406%
Bangladesh	Easy Fly Express	1	0.03%	98434%
Turkey	IC Holding	1	0.03%	98462%
Cuba	Cubana	1	0.03%	98490%
Indonesia	Travira Air	1	0.03%	98518%
Ethiopia	Trans Nation Airways (TNA)	1	0.03%	98546%
Macao	New Macau Landmark Management	1	0.03%	98574%
Germany	DC Aviation	1	0.03%	98602%
Taiwan	Executive Aviation Taiwan	1	0.03%	98630%
Australia	Air South (Australia)	1	0.03%	98658%
Nigeria	State of Rivers	1	0.03%	98686%
Argentina	American Jet	1	0.03%	98714%
Tonga	Real Tonga	1	0.03%	98742%
Spain	Air Europa Express OVA	1	0.03%	98770%
China	Sino Jet	1	0.03%	98798%
Italy	Aeronautica Militare	1	0.03%	98826%
Sweden	EFS European Flight Service	1	0.03%	98853%
Australia	Corporate Air (Australia)	1	0.03%	98881%
Bahrain	Bexair	1	0.03%	98909%
Botswana	Botswana Defence Force	1	0.03%	98937%
Virgin Islands, British	Sino Europe Aircraft	1	0.03%	98965%
Ecuador	Fuerza Aerea Ecuatoriana	1	0.03%	98993%
Brazil	Global Taxi Aereo	1	0.03%	99021%
Brazil	Imetame	1	0.03%	99049%
Nigeria	Toucan Aviation	1	0.03%	99077%

Country	Airline	Number of aircraft	Percent	Cum.
United States	International Bank of Commerce	1	0.03%	99105%
Myanmar	Myanmar Air Force	1	0.03%	99133%
Angola	Airjet Exploracao Aerea de Car	1	0.03%	99161%
Sweden	Swedish Aircraft Holdings	1	0.03%	99189%
Canada	Novajet	1	0.03%	99217%
Mayotte	EWA Air	1	0.03%	99245%
France	Fly Kiss	1	0.03%	99273%
South Africa	ECB Aviation	1	0.03%	99301%
Myanmar	Air Bagan	1	0.03%	99329%
Panama	Panama Government	1	0.03%	99357%
United States	Omni Air Transport	1	0.03%	99385%
Germany	ImperialJet	1	0.03%	99413%
Canada	Canada Transport Canada	1	0.03%	99441%
South Africa	TAB Charters	1	0.03%	99469%
Australia	Marcplan Charter	1	0.03%	99497%
Ireland	VipJet	1	0.03%	99525%
Russian Federation	Sirius Aero	1	0.03%	99553%
Bulgaria	Bright Flight	1	0.03%	99581%
United States	BizCharters	1	0.03%	99609%
Kenya	Freedom Airline Express	1	0.03%	99636%
Iceland	Icelandic Coast Guard	1	0.03%	99664%
Canada	Skycharter	1	0.03%	99692%
Macao	Galaxy Entertainment Group	1	0.03%	99720%
Vanuatu	Tathra International Holdings	1	0.03%	99748%
United States	Pacific Gas and Electric Compa	1	0.03%	99776%
Brazil	Neo Taxi Aereo	1	0.03%	99804%
United Kingdom	BAe Systems	1	0.03%	99832%
Mexico	Transpais Aereo	1	0.03%	99860%

Country	Airline	Number of aircraft	Percent	Cum.
Indonesia	Polisi (Indonesian Police)	1	0.03%	99888%
France	Direction Generale de l Aviati	1	0.03%	99916%
United States	Gaughan Flying LLC	1	0.03%	99944%
United States	BD Advisors LLC	1	0.03%	99972%
China	DMG Media	1	0.03%	100000%