



Total Aviation System Risk Picture 2016

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Short abstract: Future Sky Safety is a Joint Research Programme (JRP) on Safety, initiated by EREA, the association of European Research Establishments in Aeronautics. The Programme contains two streams of activities: 1) coordination of the safety research programmes of the EREA institutes and 2) collaborative research projects on European safety priorities.

This deliverable is produced by the Project P4 "Total System Risk Assessment". The main objective is to provide a total aviation system risk picture for 2016 and provide ideas for future improvements of such a risk picture.

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Grant Agreement No.	640597
Document Identification	D4.3
Status	Approved
Version	2.0
Classification	Public

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Document Change Log

Version No.	Issue Date	Remarks
1.0	23-12-2016	First formal release
2.0	29-12-2016	Second formal release

Approval status

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Acronyms

Acronym	Definition
ASIAS	Aviation Safety Information Analysis and Sharing (system)
CATS	Causal model for Air Transport Safety
EASA	European Aviation Safety Agency
EPAS	European Plan for Aviation Safety
ICAO	International Civil Aviation Organization

EXECUTIVE SUMMARY

Problem Area

Future Sky Safety (FSS) P4 *Total system risk assessment* is to produce a prototype Risk Observatory (RO) that takes operational data from a variety of aviation sources with the intention to provide a clearer picture of risk for the European aviation transport system. Although commercial air transport in Europe is generally described as an 'ultra-safe system' the reality is that it is difficult to be sure of the level of safety with any degree of certainty. We do know that accidents are rare but that does not tell us how close we are to having an accident – that kind of knowledge is more the domain of the safety incident, where an unintended event has caused a safety concern but with what is generally considered as a limited consequence safety outcome. Extensive use is currently made of incident data for safety purposes but there still remains an unacceptable lack of clarity in our understanding of how safe we are. The RO will provide analyses from both incident data and risk information derived from models. Risk models are supported by incident and other data, adding an understanding of accident factors to provide a clearer view, potentially safety knowledge, of the potential for catastrophe.

Having a true knowledge of the level of safety is important in order that risks can be appropriately managed. Safety comes at a societal cost and cost versus safety benefit is a major (although not the only) driver in decisions by industry and regulators to protect the public. Clearly for safety to be improved, a key process is the monitoring of key parameters with the intention of improvement and this is the primary purpose of the RO. There will however be a time-lag in the process, and thus any short-term feedback in the benefits of the RO is likely to be difficult to assess. It is, however, the case that by attempting to even measure a parameter, the process of measuring tends to influence the process being measured, thus early, probably unintentional influence on safety performance is likely when there is any significance of awareness of the initiative within industry. It is important to ensure that any unintended consequences to component parts of the safety system by measurement are not to the overall detriment of safety when considered as a holistic process.

Description of Work

The aim of this study is to produce a 'Total Aviation System Risk Picture 2016'. This contains quantified safety performance indicators that measure the actual progress with respect to main safety issues. This study is to 'Produce a safety indicators commentary at regular intervals with respect to the main safety issues in aviation (e.g. runway excursions, mid-air collisions, Controlled Flight into Terrain, Loss of Control in Flight, runway incursions and fire, smoke and fumes).' Such risk picture is scheduled for 2016, 2017 and 2018. For the first version of the risk picture (i.e. for 2016), the focus is on future Risk Observatory capabilities, enhanced by a separate numerical analysis forming part of this study.

This is necessary, because the Risk Observatory is still under further development. It should also be noted that an annual European high-level safety analysis [1] is undertaken by EASA which provides a comprehensive risk view, albeit at a less detailed level than some aspects provided in this document.

Results & Conclusions

As may be anticipated from the planned level of maturity of the RO it has not, at the time of writing (late 2016) had any direct capability for safety improvement. As a concept however there appears to be growing evidence of the utility of this kind of approach. One has to note the apparent growing success of the North American Aviation Safety Information Analysis and Sharing system (ASIAS), an influence for the RO with related programmes such as the EASA initiative Data4Safety. A common theme is the 'Big Data' concept successfully applied commercially in other industries being applied to aviation safety.

As 'system of systems', the complexity of the aviation system makes it challenging to explore root areas of safety concern. Even identification of the potential priority areas is difficult – it is relatively easy to imagine the circumstances of major accidents with antecedents not sufficiently clear to highlight possible consideration towards allocating greater safety resources as a higher priority. Accident data can be limited and incident data not sufficiently compelling in a safety-decision making environment where there are a multitude of known safety risks to be effectively managed. It is also noteworthy that there are also many 'hidden' risks, resistant to logical analysis that remains a safety challenge.

A theoretically ideal RO would collect holistic information in order to provide priority areas for safety action where appropriate. At the time of writing, the international consensus on priorities was that Loss of Control in flight remained the top area of concern, driven largely by major accident experience. It is interesting to note that technical 'solutions' can, relatively quickly in regulatory timescales, address safety issues. Thus Controlled Flight into Terrain, a major risk area, has been considerably reduced by the application of technology monitoring the position of the aircraft against terrain. Potentially faster still, in terms of deployment and often at relatively lower costs are training or procedural changes. However, the performance effectiveness of any change can be difficult to assess in advance, leaving post-introduction monitoring being the major tool for determining objective deliverance.

Applicability

This document provides preliminary indications on the benefits that may be accrued from the application of the RO. They support the developing work of the system and can be expected to have greater detail and utility as the prototype RO matures.

At the present level of knowledge, the RO can be predicted to influence European aviation safety 'Big Data' activities directly in the areas of FSS selected activities, with related benefits outside those main areas.

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1 INTRODUCTION

1.1. The Programme

The Future Sky Safety (FSS) programme looks at areas of significant safety for Europe, with the intent of enhancing safety for European citizens. As a partnership between leading European industry and academic institutions it has the opportunity to make practical improvements by increasing knowledge in key areas of importance in the European aviation transport system. The programme is structured around four main themes with each theme consisting of a small set of projects. Theme 1 (New solutions for today's accidents) aims for breakthrough research with the purpose of enabling direct, specific, significant risk reduction for the two main accident categories. Theme 2 (Strengthening the capability to manage risk) conducts research on processes and technologies to enable the aviation system actors to achieve near-total control over the safety risk in the air transport system. Theme 3 (Building ultra-resilient systems and operators) conducts research on the improvement of organizations, systems and the human operator with the specific aim to improve safety performance under unanticipated circumstances. Theme 4 (Building ultra-resilient vehicles), aims at reducing the effect of external hazards on the aerial vehicle integrity, as well as improving the safety of the cabin environment.

1.2. Project context

FSS P4 "Total system risk assessment" is to develop a prototype Risk Observatory (RO). This innovative task will result in a clearer understanding of the level of risk in a European context and is set against a backdrop of the better use of 'Big Data' which has become an aspiration within the European aviation safety community, fuelled by notable successes in commercial areas outside of safety.

1.3. Research objectives

The aim of this study is to produce a 'Total Aviation System Risk Picture 2016'. This contains quantified safety performance indicators that measure the actual progress with respect to main safety issues. This study is to 'Produce a safety indicators commentary at regular intervals with respect to the main safety issues in aviation (e.g. runway excursions, mid-air collisions, Controlled Flight into Terrain, Loss of Control in Flight, runway incursions and fire, smoke and fumes).'

The focus is on future Risk Observatory capabilities, enhanced by a separate numerical analysis forming part of this study. This implies that this risk picture 2016 indicates which sections of the RO should be the focus in future risk pictures. Input from risk model development tasks is used for possible outputs.

1.4. Approach

The approach has been to combine a risk assessment of key safety processes in the aviation safety system viewed in the 2016 timeframe with a commentary on RO aspiration for the future. The

perspective has been regulatory in nature, although the intended user-base of the RO will be much wider. It is likely that regulatory use will prove to be the area where the most complete use of the integrated data will be refined to safety intelligence, then to safety knowledge or wisdom. The RO approach very much supports the concept of performance-based regulation, where regulatory resources are prioritised to be directed at organisations, sectors or processes of the aviation industry identified as being most likely to benefit from regulatory support. Key to performance-based regulation is the integrated collection and analysis of appropriate data.

The intention will be that as the RO gains in practical capability, future planned deliverables (in 2017 and 2018) on the annual safety commentary will include RO-derived content.

1.5. Structure of the document

Section 1 introduces the document, which then moves to the main content, Section 2 Baseline Risk Picture, which is a full analysis of the state-of-the-art in 2016 on major safety issues in aviation. Section 3 looks at Risk Observatory capability, noting the existence of a 'look and feel' prototype and general system functional requirements. The Section concludes with a brief overview of the potential Business Model for likely operational context. Section 4 summarises the model contributions to the functionality of the RO. Section 5 is Conclusions and Recommendations which are intended to influence ongoing RO development.

2 BASELINE RISK PICTURE 2016

To satisfy the objective to produce a safety indicators commentary at regular intervals with respect to main safety issues in aviation, quantification of accident scenarios has been performed according to the Event Sequence Diagram methodology used in the Causal model for Air Transport Safety (CATS) [1]. The quantification process to create the Baseline Risk Picture 2016 is built on previous work conducted by NLR in the ASCOS project [2].

2.1. Main safety issues in aviation

The European Plan for Aviation Safety (EPAS) 2016-2020 [3] of the European Aviation Safety Agency (EASA) identifies main risk areas of commercial air transport operations. These risk areas are classified according to the type of issues they highlight, amongst which are operational issues. Operational issues are brought to light by the reporting and analysis of safety occurrence data. Safety occurrences are events where the available safety margin towards accidents or serious incidents has been reduced. Accidents and serious incidents are unrecoverable and represent end states in a series of events that include safety occurrences.

The EPAS identifies the following operational issues in commercial air transport by aircraft:

- Loss of control in-flight
- Design and maintenance improvements
- Mid-air collisions
- Runway safety (runway excursions and incursions)
- Ground safety (ground collisions and ground handling)
- Controlled flight into terrain
- Fire, smoke and fumes (on ground and in the air)

2.2. Causal model for Air Transport Safety

The Causal model for Air Transport Safety (CATS) was initially developed as a result of an initiative by the Netherlands Ministry of Transport. The objective was to gain a thorough understanding of the causal factors underlying the risks of air transport and their relation to the different possible consequences. This understanding can be used to make efforts to improve safety as effective as possible.

The causal model uses a backbone structure of generic accident scenarios which have been defined based on the ICAO definition of an accident, in order to systematically develop accident scenarios: abrupt manoeuvre, cabin environment, uncontrolled collision with ground, controlled flight into

terrain, forced landing, mid-air collision, collision on ground, structural overload and fire/explosion. The accident scenarios are grouped by accident type and different flight phases. The Event Sequence Diagram (ESD) methodology is used for representing the accident scenarios.

An ESD consists of an initiating event, pivotal events and end states. A representation of a generic ESD is given in Figure 1.

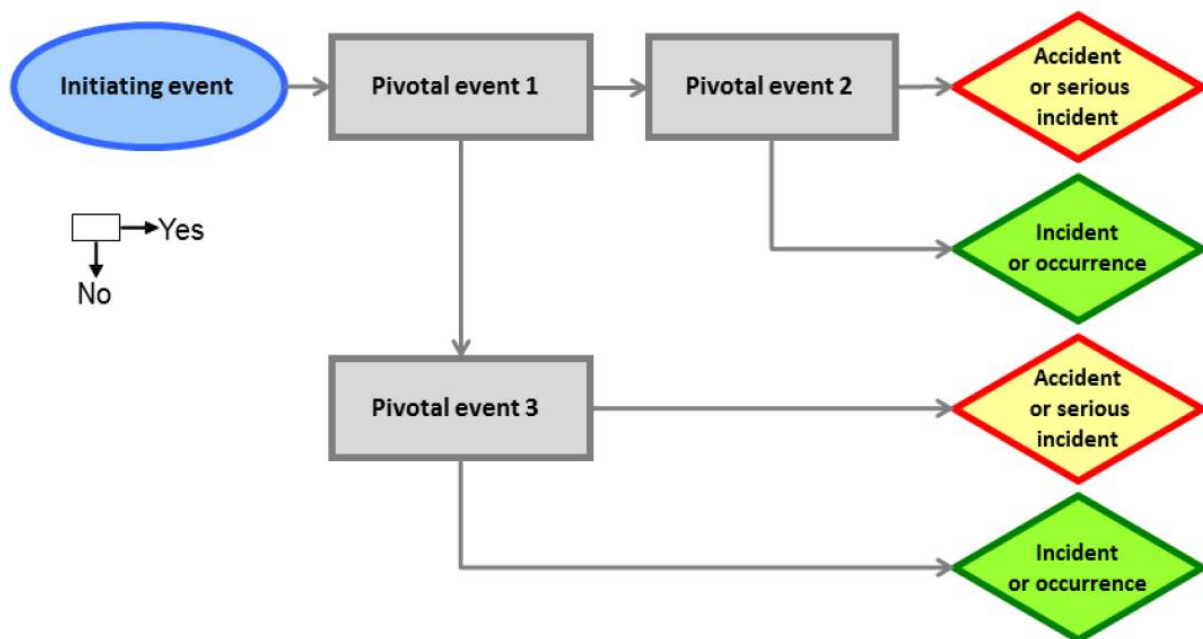


Figure 1: Generic representation of an Event Sequence Diagram.

ESDs provide a qualitative description of series of events leading to accidents. Because pivotal events can also cause avoidance of an accident, an ESD also models scenarios which lead to incidents and reportable occurrences. An initiating event represents the start of the main accident scenario. The initiating event of course also may have causes, and they are represented in a fault tree. Pivotal events also have fault trees. Each pivotal event represents a possibility for the safety occurrence to develop into an accident, or a possibility that the accident is avoided. If all pivotal events contribute towards an unwanted outcome, then the end state is an accident or serious incident. If a pivotal event causes avoidance of an accident, the end state is a safe continuation of the flight. A single ESD therefore can represent more than one accident scenario, and also represents accident avoidance scenarios. In case of the generic ESD of Figure 1, there are two accident scenarios and two accident avoidance scenarios.

In total 35 generic accident scenarios were developed based on a combination of retrospective and prospective analyses. These scenarios were subsequently quantified and allow the user to obtain a probability of occurrence for any given combination of events.

Note that an improved version of CATS, representing all possible accident scenarios in the current total aviation system, is used to establish a total aviation system baseline risk picture.

2.3. Data source and scope

The NLR Air Safety database, which is a large database with data related to aviation safety maintained by NLR, is used as data source. The database uses ECCAIRS to collect, store, and analyse detailed information on accidents, serious incidents and incidents of fixed wing aircraft and helicopters (covering commercial operations and General Aviation) from 1960 onwards. Currently, the Air Safety Database contains information on more than 200,000 accidents, serious incidents and incidents that occurred worldwide. Furthermore, the Air Safety Database contains a large collection of worldwide non-accident related data, flight exposure data, weather data, fleet data, and more. The Air Safety Database is updated frequently using reliable sources including data from official reporting systems, insurance claims, accident investigation boards, aircraft manufacturers, and civil aviation authorities. Table 1 defines the basic data query used to quantify the accident scenarios in EASA Member States by means of the Event Sequence Diagram methodology, which in turn are used to define the basic risk level in 2016.

Table 1: Basic data query

Data	Criteria
Time interval	Between 1-1-1995 to 31-12-2015
Occurrence class	Accidents and Serious incidents
Operation type	Scheduled revenue ops, Non-scheduled revenue ops
Aircraft category	Fixed wing
Aircraft mass group	> 5,701 kg maximum take-off weight
Aircraft propulsion type	Turboprop, Turbofan, Turbojet
State or area of occurrence	EASA Member States: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom, Iceland, Liechtenstein, Norway, Switzerland.

The basic data query resulted in a total of 1438 relevant accidents and serious incidents. An additional check for empty fields in the NLR air safety database revealed additional relevant accidents and incidents, which were included in the final dataset. The final dataset on which the quantification of the main operational issues is based contains 1509 accidents and serious incidents. Appendix B contains a list of all 1509 accidents and incidents in the final dataset.

2.4. Quantification process

The basic principle of the quantification process is that each accident or serious incident has to be assigned to a single accident scenario. For example, the accident scenario ESD 13 'flight control system failure' is chosen when a flight control system failure leads to an unstable approach, which causes the aircraft to land long and fast, eventually resulting in a runway excursion.

The narratives of all 1509 accidents and serious incidents were reviewed by subject matter experts and each of the accidents and serious incidents has been assigned to one of the accident scenarios of the CATS model. When insufficient information was available, the original investigation report was retrieved or other sources on the internet were consulted. For eight runway excursions and one collision with ground the available information was insufficient to assign the accident to a specific scenario. These accidents and serious incidents were equally distributed over the accident end states of 'runway excursion' and 'collision with ground' respectively.

Of the 1509 accidents and serious incidents, 198 could not be assigned to one of the accident scenarios. There are two main reasons:

- The accident was considered out of scope, for instance because it had no significance for flight safety, like a tow truck that drove over a ramp worker's foot;
- The consequences of the initiating events did not progress beyond the level of the Fault Trees in the model, e.g. because existing safety barriers prevented the scenarios from developing into accidents, like a system failure that was solved during flight.

2.5. Baseline risk levels 2016 derived from ESD scenarios

To calculate the probability of occurrence of the main operational issues, the total number of accidents and serious incidents related to a specific operational issue has been divided by the exposure data corresponding to the data scope in Table 1. The exposure data of flights in EASA member states with commercially operated (scheduled and non-scheduled) turbine aircraft with a maximum take-off mass of 5700 kg or heavier has been calculated to be 138,937,650 flights. The exposure data has been derived from the NLR database and complemented with Eurostat data [4] for scheduled and unscheduled flights in EASA Member States. Appendix A provides the number of occurrences and corresponding frequencies for each of the accident end states.

Based on the results shown in Appendix A, the frequencies of the operational issues as identified in the EPAS can be calculated. The results are presented in Table 2.

Table 2: Frequencies of operational issues

EPAS operational issues	Accident/serious incident frequency per flight	Fatal accident frequency per flight	# fatalities (1995-2015)
Loss of control in-flight	3.24E-07	1.8E-07	513
Design and maintenance improvements ¹	5.10E-07	1.24E-07	277
Mid-air collisions	2.88E-08	1.44E-08	86
Runway safety (runway excursions and incursions)	1.21E-06	4.32E-08	241
Ground safety (ground collisions and ground handling ²)	1.36E-06	5.04E-08	7
Controlled flight into terrain	2.91E-08	2.91E-08	249
Fire, smoke and fumes (on ground and in the air)	9.22E-07	3.6E-10	0

¹ Design or maintenance related accidents and serious incidents are derived from system-related accidents or serious incidents in the CATS model and therefore have been quantified separately. It should be noted that this is a subset from the frequency per flight of other accident/serious incident scenarios.

² Ground handling accidents and serious incidents are not included in the CATS model and therefore have been quantified separately and added to the number of ground collision accidents and serious incidents.

Figure 2 provides an indication of the share of fatal accidents in the total number of accidents and serious incidents for each operational issue.

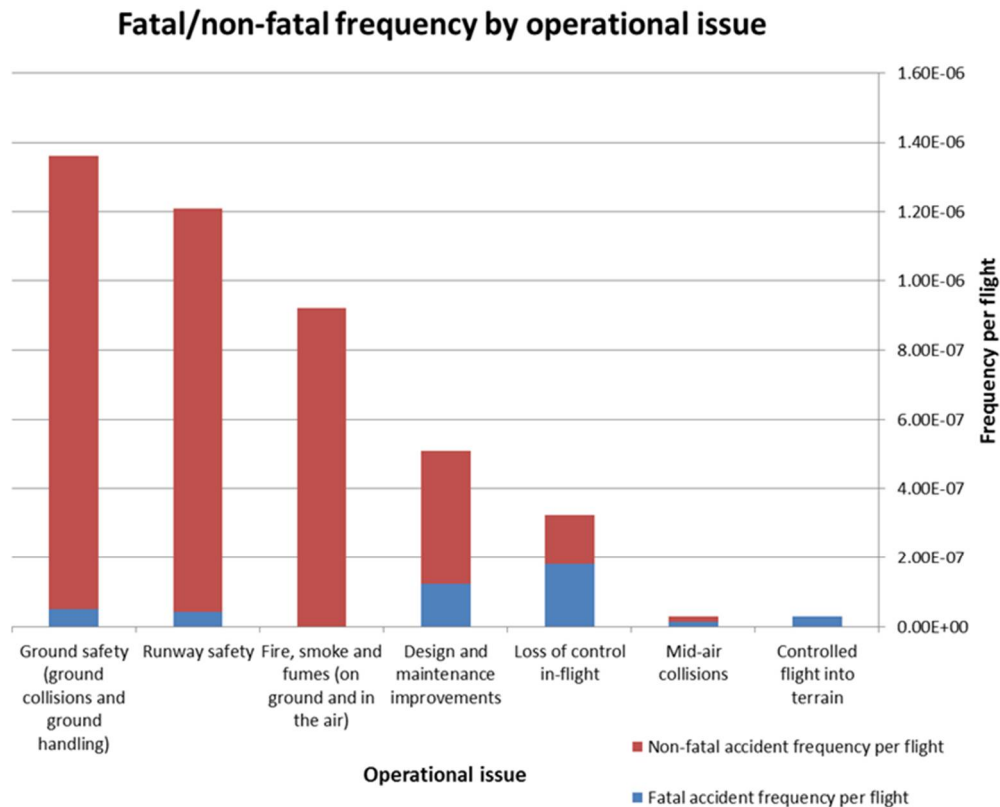


Figure 2: Fatal/non-fatal frequency by operational issue.

Figure 2 shows that all Controlled flight into terrain (CFIT) accidents are fatal and approximately 50% of the Loss of control in-flight and Mid-air collisions have fatal consequences. The other operational issues occur with a higher frequency, but with less, or no, fatal consequences.

2.6. Baseline risk level progress

The baseline risk level 2016 defined in the previous paragraph has shown particular development in the past 20 years. Figure 3 shows the progress of accident/serious incident frequency by operational issue in 5-year intervals.

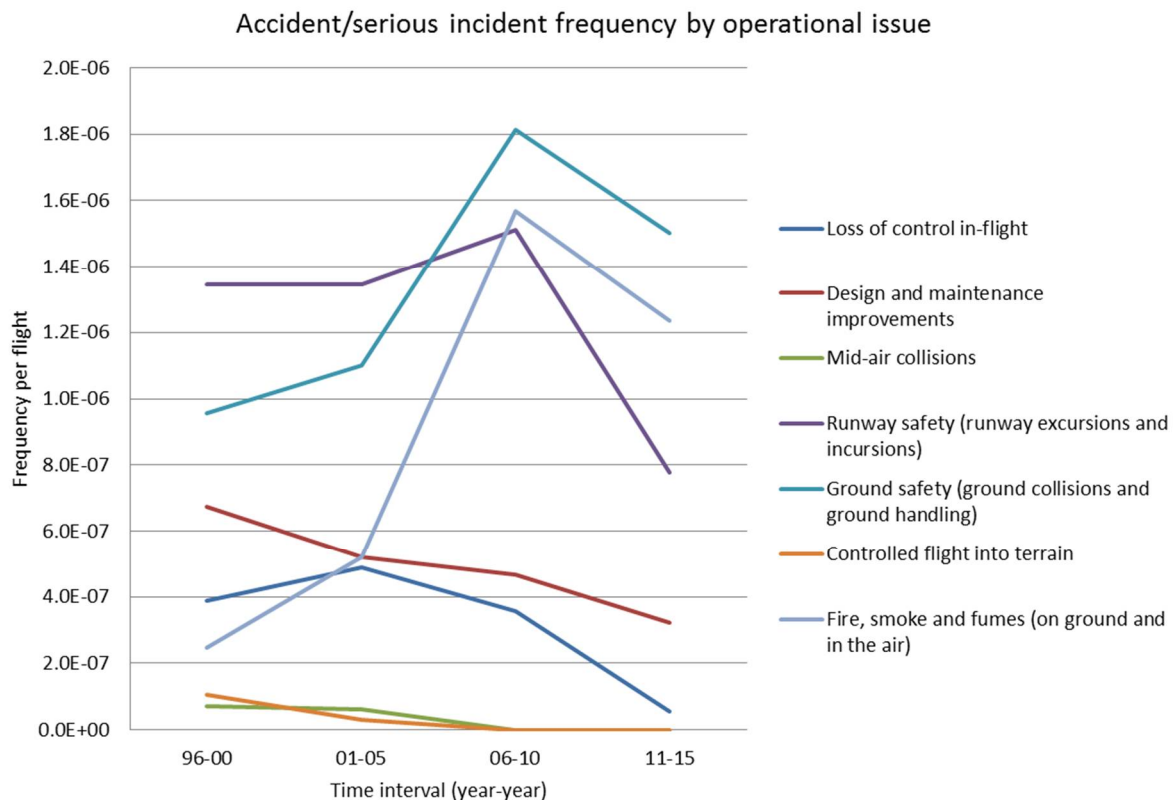


Figure 3: Progress of accident/serious incident frequency by operational issue in 5-year intervals

Figure 3 shows downward trends for all operational issues. Of note is the sharp rise in Ground safety and Fire, smoke and fumes accidents and serious incidents in the time interval 2001-2010. A likely cause for this sharp rise is the introduction of Directive 2003/42/EC on the reporting, analysis and follow-up of occurrences in civil aviation in 2003. The other operational issues were already subject to mandatory occurrence reporting schemes by Aviation Authorities due to their severity (fatalities or damage) or by manufacturers (failure of aircraft systems or parts). Ground safety and fire, smoke and fumes accidents or serious incidents may have been reported previously, but since it was not mandatory to forward such reports to the national Aviation Authority until 2003, they were mostly kept for internal reference and investigation by airlines, airports or Ground Service Providers.

Figure 3 also suggests a prioritisation of actions to lower the risk of operational issues identified in the EPAS. Purely based on accident/serious incident frequency in the time interval 2011-2015, the following prioritisation may be applied:

1. Ground safety
2. Fire, smoke and fumes
3. Runway safety
4. Design and maintenance improvements
5. Loss of control in-flight
6. Mid-air collisions
7. Controlled flight into terrain

However, when the risk of operational issues is based on the fatal accident rate since 1995, the following prioritisation is applied:

1. Loss of control in-flight (513 fatalities)
2. Design and maintenance improvements (277 fatalities)
3. Ground safety (7 fatalities)
4. Runway safety (241 fatalities)
5. Controlled flight into terrain (249 fatalities)
6. Mid-air collisions (86 fatalities)
7. Fire, smoke and fumes (0 fatalities)

To further put this prioritisation into perspective, it is of note that all Controlled flight into terrain accidents are fatal and approximately 50% of the Loss of control in-flight and Mid-air collisions have fatal consequences. The reason why Ground safety accidents and serious incidents are listed as third priority is because each accident involves 1 fatality.

2.7. Baseline risk level severity

As shown in the previous paragraphs, a baseline risk level can be based on the occurrence frequency of specific issues, but this does not account for the occurrence severity. To include this dimension, a severity classification is added to the accident/serious incident frequency. This classification has been applied by the competent authorities of EASA member states. Since only accidents and serious incidents have been included in the dataset, it is convenient to distinguish between the severity classes of accidents and serious incidents. Within the ECCAIRS software, the following definitions are applied for accidents and serious incidents:

Accident:

An occurrence associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time it comes to rest at the end of the flight and the primary propulsion system is shut down, in which:

- a) a person is fatally or seriously injured as a result of:
 - a. being in the aircraft, or,
 - b. direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or,
 - c. 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 and 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 a single engine, (including its cowlings or accessories), to propellers, wing tips, antennas, probes, vanes, tires, brakes, wheels, fairings, panels, landing gear doors, windscreens, the aircraft skin (such as small dents or puncture holes) or minor damages to main rotor blades, tail rotor blades, landing gear, and those resulting from hail or bird strike, (including holes in the radome); or
- c) the aircraft is missing or is completely inaccessible;

Serious incident:

An incident involving circumstances indicating that an accident nearly occurred.

Both severity classes have been derived from the dataset and the resulting accident and serious incident frequencies of each operational issue are provided in Table 3.

Table 3: Accident and Serious incident frequencies of operational issues

EPAS operational issues	Accident frequency per flight	Serious incident frequency per flight
Loss of control in-flight	2.88E-07	2.88E-08
Design and maintenance improvements ¹	3.96E-07	9.36E-08
Mid-air collisions	2.88E-08 (1.92 E-8 per flight hour)	3.24E-06 (2.16 E-6 per flight hour)
Runway safety (runway excursions and incursions)	5.18E-07	6.33E-07
Ground safety (ground collisions and ground handling ²)	1.06E-06	2.88E-07
Controlled flight into terrain	2.91E-08	4.32E-08
Fire, smoke and fumes (on ground and in the air)	1.08E-07	8.13E-07

¹ Design or maintenance related accidents and serious incidents are derived from system-related accidents or serious incidents in the CATS model and therefore have been quantified separately. It should be noted that this is a subset from the frequency per flight of other accident/serious incident scenarios.

² Ground handling accidents and serious incidents are not included in the CATS model and therefore have been quantified separately and added to the number of ground collision accidents and serious incidents.

With these data, a risk matrix is compiled in Figure 4, which combines the severity and frequency of the EPAS operational issues.

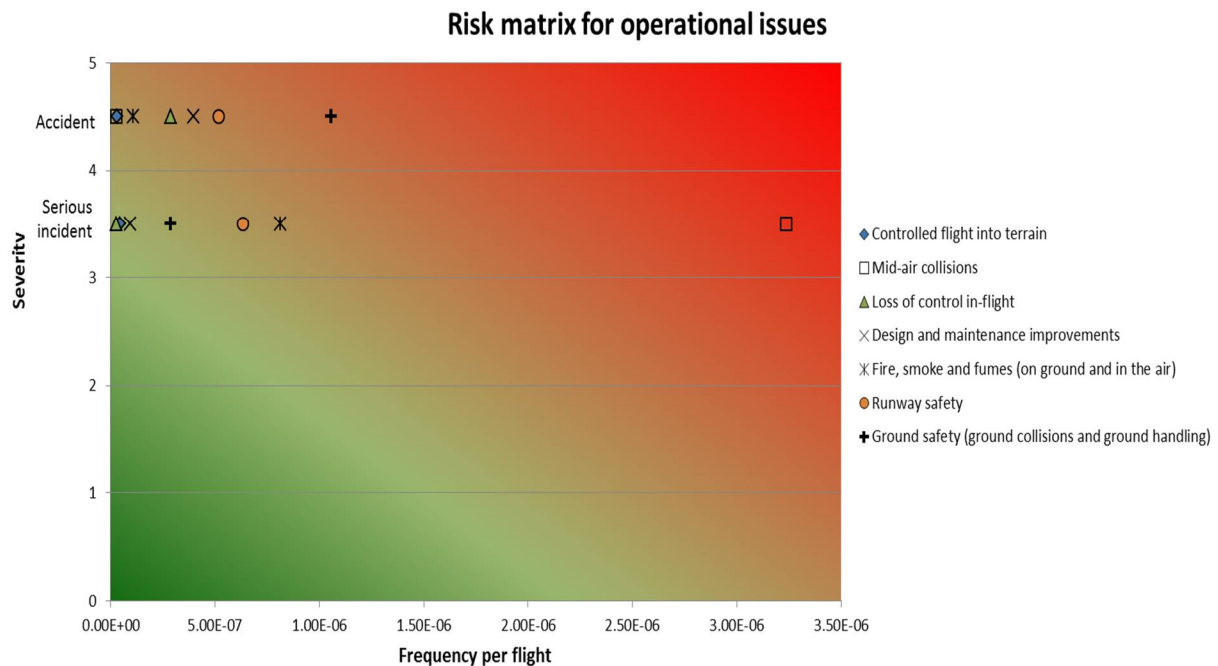


Figure 4: Risk matrix of operational issues.

It should be noted that different severity and frequency classifications are used within the aviation sector; e.g. ICAO [5] ESSAR 4 [6], etc., as well as different units; e.g. per flight, per flight hour, etc. The future Risk Observatory should follow the common European risk classification scheme that the European Commission should develop according to Regulation (EU) No 376/2014 on reporting, analysis and follow-up of occurrences in civil aviation.

Another remark worth noting is that the Basic Risk Picture provided in Figure 4 only contains the high risk levels; i.e. accidents and serious incidents. For organisations to derive actionable safety information from the Basic Risk Picture provided by the Risk Observatory, data should be included from occurrences with a higher frequency but with less severity. This way, organisations using the Risk Observatory are enabled to develop proactive interventions to prevent serious incidents and accidents.

Another advantage to include less-severity, high-frequency occurrences in the Basic Risk Picture is that trends are more easily detected when the Basic Risk Picture 2016 is compared with that of 2017 and onward. When only high-severity, low-frequency occurrences are monitored, it is unlikely that significant changes in the Basic Risk Picture will be detected over the years.

To illustrate the concept of a risk picture that includes also major and minor severity level risks, two risk matrices were developed: one for in-flight fire risk and one for mid-air collision risk.

Data from European operators about in-flight fire/smoke events were used to estimate the frequency of occurrences of major and minor severity level events (see Appendix C). Using the operator data and data from Table 3, a risk matrix and trend line were developed, see Figure 5. The risk of fire/smoke events is expressed as the frequency of occurrence of a fire/smoke event of a particular severity level. The idea is that the risk levels can be monitored over time with such a “dashboard”. Figure 5 shows the risk of in-flight fire/smoke events over the years for a particular airline (“My Airline”) compared to the average risk level from reference airlines. The risk level of a particular airline (“My Airline”) is plotted in the small, solid dots, while the average risk level based on reference airlines is shown as the large, transparent dots.

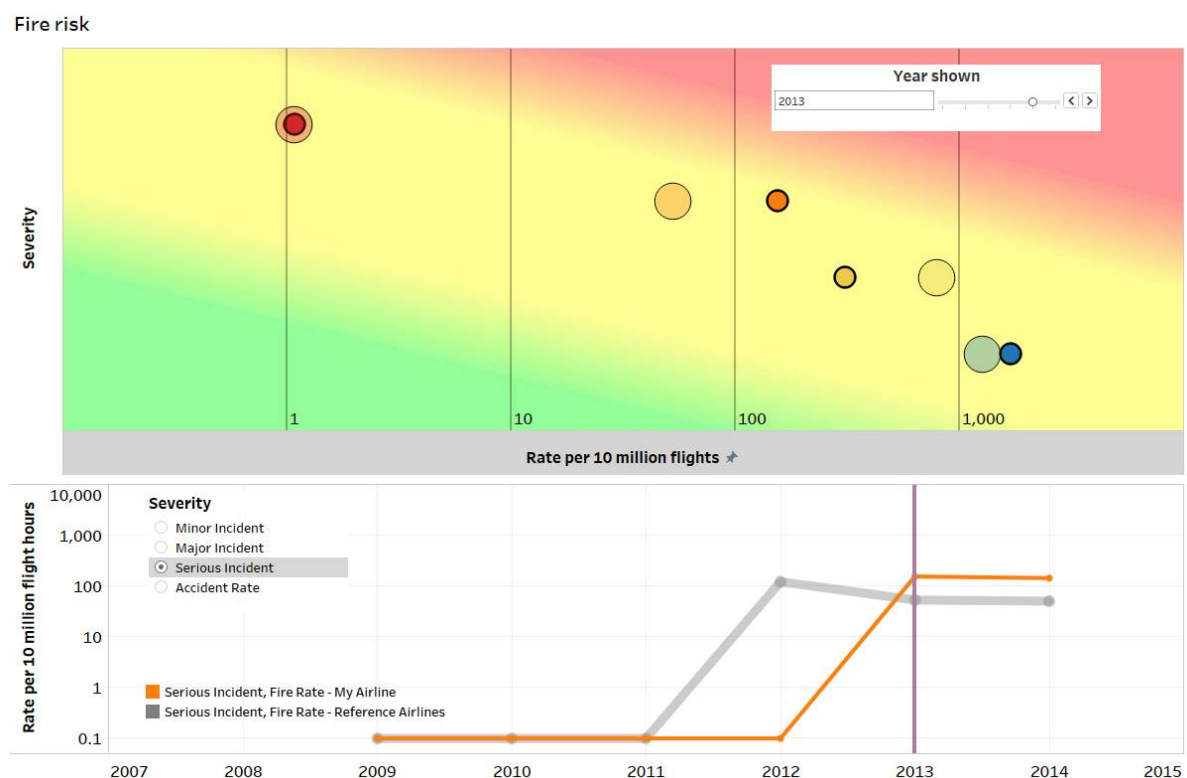


Figure 5: Risk matrix and trend line for in-flight fire risk.

Another example of a risk dashboard, showing a risk matrix and risk trend line over time for mid-air collision risk, is given in Figure 6. Data from Table 3 for accidents and serious incidents were combined with data for minor and major risk level airprox events (see Appendix C). Data from the UK Airprox Board were used to estimate the frequency of occurrence of major and minor risk level airprox events, while the accident and serious incident risk levels are estimated from European data. The UK dataset may not be representative for the rest of Europe and vice versa, the accident and serious incident data may not be representative for the UK (airspace). Therefore, conclusions cannot be drawn from this example, and the reader should keep in mind that this is meant as an illustration of the concept, rather than an actual analysis of risk.

Figure 6 shows for 2013 the frequency of occurrence of an airprox event of a particular severity level in the form of a risk matrix. This representation would help to identify risks that are in the acceptable, tolerable, and not acceptable region. The figure also shows the airprox rate over the years for various severity levels.

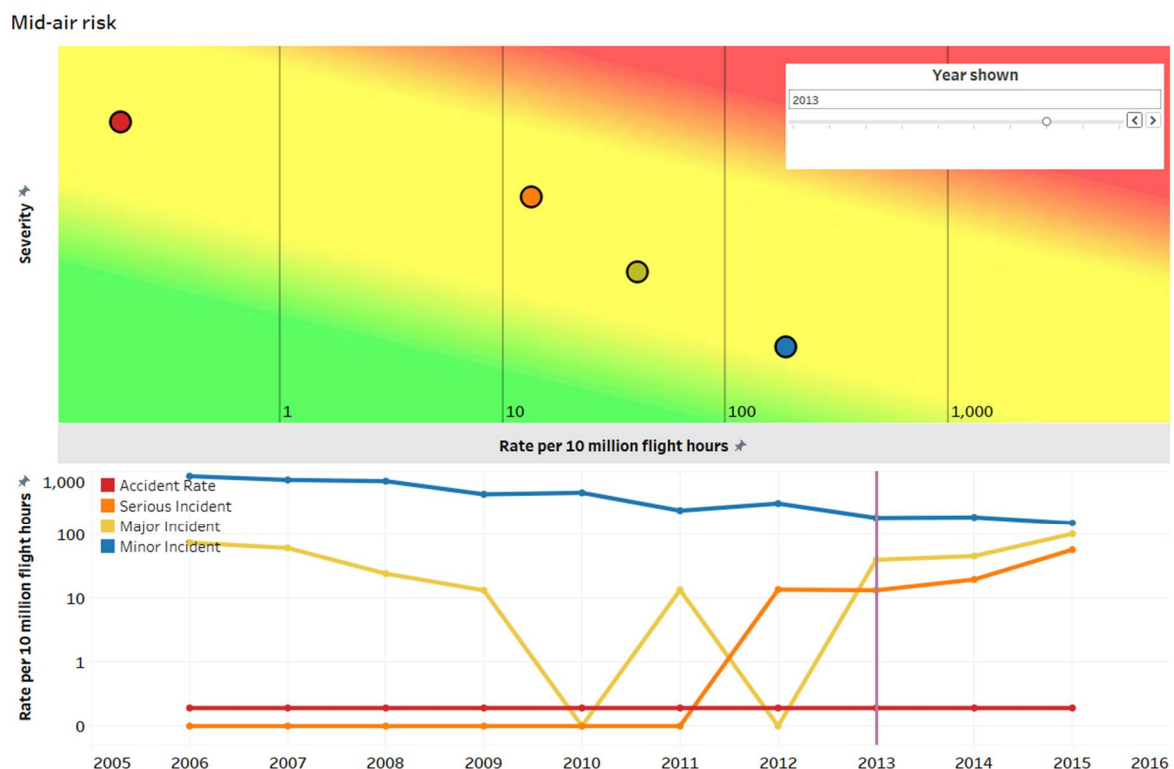


Figure 6: Risk matrix and trend line for mid-air collision risk.

3 RISK OBSERVATORY CAPABILITY

3.1. 'Look and Feel' Prototype

In order for potential users to understand and gain experience with the RO, a 'Look and Feel' early prototype was constructed (described in detail in deliverable FSS_P4_NLR_D4.2), albeit with a modest level of capability and sophistication compared with the ultimate RO deliverable.

Stakeholders were interviewed to collect their experience with current safety management practices and suggestions for the future needs of the organizations. The results of those interviews were used to derive the business, user and system requirements for the Risk Observatory. The business requirements were used to define the business related needs of the Risk Observatory, while the user and system requirements specified the needs of the Risk Observatory's users regarding functionality and design.

The project team reviewed all defined requirements to identify potential groups of similar or related functionalities that could be implemented on a single dashboard. During the review the project team determined which requirements could be implemented in the early prototype based on the definition of the requirement, the available resources and expected maturity level and scope of the early prototype. From reviewing the requirements the team derived the following main dashboards for the early prototype:

1. Homepage
2. Occurrences dashboard
3. Risk dashboard
4. Search dashboard
5. What-if analysis dashboard

The early prototype enabled a developmental move to increased confidence in RO utility, allowing system functionality to be defined.

The general functionality of the RO is described below, developed as part of the design planning process.

3.2. System Requirements for Risk Observatory Functional Design

The table below summarises key functionalities for the RO in terms of inputs and outputs and in terms of value added for stakeholders. Although more detailed specifications have been drawn up through collaboration with stakeholders it has been recognised within FSS that there is an opportunity to offer beyond immediate stakeholder requirements. Within the constraints of cost-effectiveness there may be

opportunities to provide analysis capabilities to a wide range of users that are currently more considered at the cutting edge of analysis capability and perhaps only currently considered by the most able of safety data analysis organisations.

Short Title	Description	Justification
Representation of European aviation safety processes	<p>The RO shall support the safety management processes of European aircraft operators, ANSPs, aircraft manufacturers, aviation authorities and airports.</p> <p>It shall implement tasks to support the following safety management activities:</p> <ul style="list-style-type: none"> • Safety Risk Management • Safety Assurance 	<p>RO has to become a complementing part of the safety management system of stakeholders. It should provide a common database and at the same time a unique approach to data management and analysis.</p> <p>The ICAO Safety Management Manual can represent the referencing guide for RO, both for terminology and functions.</p>
General Inputs	<p>The RO shall allow user to access and to analyse (with varying levels of sophistication according to source) the following:</p> <ul style="list-style-type: none"> • accident investigation data • mandatory reporting data • voluntary reporting data • continuing airworthiness reporting data • operational data (procedures, flight data, radar data, exposure data, weather data, airport infrastructure data) • safety oversight data • Data from audit findings/reports • data from regional accident and incident investigation organizations, etc. 	<p>According to ICAO, effective safety management is data driven. Sound management of the organization's databases is fundamental to ensuring effective and reliable safety analysis of consolidated sources of data.</p> <p>RO should be able to accommodate the occurrence types which are mandatory reported according to regulation 376/2014. A list is available in regulation 2015/1018.</p>
RO General Processing	<p>The RO shall implement the following processes:</p> <ul style="list-style-type: none"> • collecting data 	<p>Safety Risk Management and Safety Assurance are the key areas the RO shall support. RO should support organisations</p>

Short Title	Description	Justification
	<ul style="list-style-type: none"> identifying emerging risks assess known and emerging risks elaborate safety indicators 	to perform the necessary analysis to identify hazards and control their potential consequences.
RO General Outputs	<p>RO shall provide to the user at least the following general outputs:</p> <ul style="list-style-type: none"> comparative analyses; historical trend analyses; position in safety space; risk analysis – assessment, top risks, parameters affecting the risk top hazards contributing most to accident risk (which hazard if removed results in the largest reduction of accident risk) top effective safety mitigation actions data query results 	<p>Among other purposes, the analysis may be used to:</p> <ul style="list-style-type: none"> assist in deciding what additional risk controls are needed; ascertain latent factors underlying safety deficiencies; assist in reaching valid conclusions; monitor and measure safety trends or performance.

The RO will need to be operated by an organisation to maximise its effectiveness; it is not just a question of developing software in isolation from considering operational use. Thus it is anticipated that there will be a Risk Observatory Organisation (ROO) which will manage the collection of data and dissemination of analysis results. It is assumed that there will be one ROO in Europe. There has been an initiative in that direction taken by EASA with the feasibility study and proof of concept of a European big data programme for aviation safety (Data4Safety). It is not the intention of the FSS P4 project to launch an RO or ROO as a competitor to existing programmes, thus the FSS P4 project will assure that the research and development taking place in the project is complementary to, for example, the above-mentioned EASA activity.

A number of key decisions will need to be taken regarding the implementation of the ROO, e.g. the type of organisation that will deliver the RO, (long-term) funding structure and stability, and ambition level of the ROO. It is also concluded that important lessons can be learned from ASIAs and the experience with National Aviation Authority mandatory occurrence reporting schemes.

The ROO will receive aviation safety data under formal agreement from the European aviation community, and analyse the safety data for safety information and safety intelligence. Primary incentives for stakeholders to share data with the ROO are:

- Provision of safety intelligence, enabling risk analysis and defining safety performance indicators;
- Provision of safety intelligence in systemic risks across multiple operators and domains (i.e. total aviation system approach), which could bring together a collective wisdom on aviation safety, with analytical capabilities and data that the industry partners, on their own, may not be able to create.
- Access to dedicated safety studies, benchmark analyses, shared lessons learned and best practice.

There will be a need to develop a strategy to interact with, complement and strengthen the EASA Big Data programme for aviation safety. It will be beneficial for both programmes to exchange information on progress, use cases and analytical capabilities as they develop.

As the RO matures within FSS, planning and promotional activities to consult and inform potential stakeholders about the RO safety proposition and the ROO will take place. As part of these activities, data protection opportunities and challenges for different stakeholders will be explored.

4 MODEL OUTPUT CONSIDERATIONS FOR EFFECTIVE RO FUNCTIONALITY

The use of models is a significant part of the functionality of the RO and considerable resources have been used in exploring the suitability of existing tools.

Several models from different partners (NLR, TUM, AIRBUS, THALES AVIONICS, ONERA and EUROCONTROL) have been proposed for potential use in the RO. All these models are currently being used by the partners in other aviation safety studies. These studies range from ATM operation up to aircraft systems.

The following models were initially considered for this analysis:

- Causal Model for Air Transport Safety (CATS) from NLR.
- Physical Model for the quantification of incident probabilities for aircraft operators (PM) from TU Munich.
- AltaRica A/C, Multi-System and Navigation Safety Model from AIRBUS, THALES AVIONICS and ONERA that combines two AltaRica models:
 - AltaRica Navigation Safety Model
 - AltaRica Multi-System Safety Model (Hydraulic, Electrical, Data Network, Flight Control, Wheel Breaking, Thrust Reverser...)
- Operational and Functional models (ALFA) from AIRBUS
- Accident Incident Model (AIM/IRP) from EUROCONTROL

Additionally, the ICAO Safety Management System (SMS) was considered as a baseline reference, though not as a model itself. ICAO SMS is a valid framework reference for the design of models and tools to support RO features.

Through the use of models the RO will be able to make better use of data, thus the appropriate choice of model is of importance in order to accurately represent the real world situation. The challenge is to produce RO output that can allow actionable safety intelligence, as any other type of outputs are much less able to make safety improvement. The differing needs of users from a variety of aviation sectors, with priorities set from their organizational processes prior to RO operation, will need to be managed as they transition to the wider evidence-based opportunity that the RO allows.

The focus of RO development during 2016 was the consideration of two use cases, Runway Excursions and Mid-Air Collisions. Although the inherent functionality of models does not readily allow unknown hazards to be detected, they do provide the opportunity for at least in-depth consideration of the major known safety issues with some level of balance in safety intervention priorities to be assigned.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

To satisfy the objective to produce a safety indicators commentary at regular intervals with respect to main safety issues in aviation, quantification of accident scenarios has been performed according to the Event Sequence Diagram methodology, which is also used in the Causal model for Air Transport Safety (CATS) developed for the Dutch Ministry of Transport [1].

The European Plan for Aviation Safety (EPAS), established by EASA, identifies the following operational issues in commercial air transport by aircraft [3]:

- Loss of control in-flight
- Design and maintenance improvements
- Mid-air collisions
- Runway safety (runway excursions and incursions)
- Ground safety (ground collisions and ground handling)
- Controlled flight into terrain
- Fire, smoke and fumes (on ground and in the air)

The data analysis performed assigns frequencies per flight to each operational issue and thereby provides the following prioritisation of actions, based on accident/incident frequency:

1. Ground safety
2. Fire, smoke and fumes
3. Runway safety
4. Design and maintenance improvements
5. Loss of control in-flight
6. Mid-air collisions
7. Controlled flight into terrain

However, when only fatal accident rates are considered, the following prioritisation is made:

1. Loss of control in-flight
2. Design and maintenance improvements
3. Ground safety
4. Runway safety
5. Controlled flight into terrain
6. Mid-air collisions
7. Fire, smoke and fumes

As next step, a risk matrix is compiled which combines the frequency and severity of occurrences. This risk matrix provides a risk picture for high-severity, low-frequency occurrences. To enable organisations to develop proactive interventions for accident/serious incident prevention, and to make trends more easily identifiable, low-severity, high-frequency occurrences should be included in the Basic Risk Picture.

From a regulatory perspective, the analysis supports international safety improvement project directions. It is, of course, less effective in supporting analysis at fine granularity level through limitations on supporting data input. Nevertheless it adds to the justification for the benefits of the big data approach.

5.2. Recommendations

The following recommendations can be made regarding the Risk Observatory developed in the Future Sky Safety programme:

- Verify whether the Risk Observatory has the capability to provide relevant risk pictures for now and in the future at both the European level and at the level of the individual EU Member States;
- Validate the Risk Observatory output with the EPAS operational issues and the Basic Risk Picture provided in this document;
- Clearly define how risk levels will be defined in the Risk Observatory; e.g. based on accident/serious incident frequency, fatality rates, or a combination thereof;
- The future Risk Observatory should follow the common European risk classification scheme that the European Commission should develop according to Regulation (EU) No 376/2014 on reporting, analysis and follow-up of occurrences in civil aviation.
- Provide for more granulation of data by including low-severity, high frequency occurrences to enable proactive interventions by organisations using the Risk Observatory and to increase the trend monitoring capability of the Risk Observatory.
- Use the Risk Observatory to obtain further insight in the EPAS operational issues at the European level and at the level of the individual EU Member States.

6 REFERENCES

- [1] CATS Final Report, Dutch Ministry of Transport, March 2009
- [2] N. Aghdassi (Avanssa), A.L.C. Roelen (NLR), A.D. Balk (NLR); Total Aviation System Baseline Risk Picture, ASCOS Deliverable D2.2, 21-08-2013.
- [3] EASA, The European Plan for Aviation Safety, EPAS 2016-2020, <https://www.easa.europa.eu/document-library/general-publications/european-plan-aviation-safety-epas-2016-2020-leaflet>
- [4] <http://ec.europa.eu/eurostat/data/browse-statistics-by-theme>
- [5] ICAO Doc 9859 Safety Management Manual, third edition, 2013
- [6] Eurocontrol safety regulatory requirement (ESARR) 4, Risk assessment and mitigation in ATM, 2004

Appendix A Number of occurrences and corresponding frequencies

ESD	ESD name	Accident/serious incident description	Number of occurrences ²	Number of occurrences not assigned to accident scenarios and distributed over total number of end states ³	Accident/serious accident frequency per flight	Number of fatal accidents	Number of fatal accidents not assigned to accident scenarios and distributed over total number of end states ³	Fatal accident frequency per flight
1	Aircraft system failure during take-off	Runway excursion	2	0.44	1.76E-08	0	0.00	0.00E+00
2	ATC event during take-off	Runway excursion	0	0.44	3.20E-09	0	0.00	0.00E+00
3	Aircraft directional control by flight crew inappropriate	Runway excursion	4	0.44	3.20E-08	0	0.00	0.00E+00

Project: Total System Risk Assessment
Reference ID: FSS_P4_NLR_D4.3
Classification: Public



	during take-off							
3	Aircraft directional control by flight crew inappropriate during take-off	Runway excursion	2	0.44	1.76E-08	0	0.00	0.00E+00
4	Aircraft directional control related system failure during take-off	Runway excursion	4	0.44	3.20E-08	0	0.00	0.00E+00
4	Aircraft directional control related system failure during take-off	Runway excursion	1	0.44	1.04E-08	1	0.00	7.20E-09
5	Incorrect configuration during take-off	Runway excursion	1	0.44	1.04E-08	0	0.00	0.00E+00

5	Incorrect configuration during take-off	Collision with ground	1	0.05	7.56E-09	1	0.05	7.56E-09
6	Aircraft takes off with contaminated wing	Collision with ground	2	0.05	1.48E-08	2	0.05	1.48E-08
8	Aircraft encounters windshear after rotation	Collision with ground	0	0.05	3.60E-10	0	0.05	3.60E-10
9	Single engine failure during take-off	Runway excursion	3	0.44	2.48E-08	0	0.00	0.00E+00
9	Single engine failure during take-off	Runway excursion	2	0.44	1.76E-08	0	0.00	0.00E+00
10	Pitch control problem during take-off	Runway excursion	2	0.44	1.76E-08	0	0.00	0.00E+00

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10	Pitch control problem during take-off	Runway excursion	0	0.44	3.20E-09	0	0.00	0.00E+00
10	Pitch control problem during take-off	Collision with ground	0	0.05	3.60E-10	0	0.05	3.60E-10
11	Fire, smoke, fumes on board aircraft	Aircraft continues flight damaged	41	0.00	2.95E-07	0	0.00	0.00E+00
11	Fire, smoke, fumes on board aircraft	Collision with ground	0	0.05	3.60E-10	0	0.05	3.60E-10
11	Fire, smoke, fumes on board aircraft	Personal injury	6	0.00	4.32E-08	0	0.00	0.00E+00
11	Fire, smoke, fumes on board aircraft	Aircraft damaged	81	0.00	5.83E-07	0	0.00	0.00E+00
12	Flight crew member spatially	Collision with ground	1	0.05	7.56E-09	1	0.05	7.56E-09

NLR

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Issue: 2.0

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	disoriented							
13	Flight control system failure	Collision with ground	2	0.05	1.48E-08	1	0.05	7.56E-09
14	Flight crew incapacitation	Collision with ground	1	0.05	7.56E-09	1	0.05	7.56E-09
15	Ice accretion on aircraft in flight	Collision with ground	0	0.05	3.60E-10	0	0.05	3.60E-10
16	Airspeed, altitude or attitude display failure	Collision with ground	4	0.05	2.91E-08	4	0.05	2.91E-08
17	Aircraft encounters thunderstorm, turbulence or wake vortex	In-flight break-up	7	0.00	5.04E-08	0	0.00	0.00E+00
17	Aircraft encounters thunderstorm, turbulence or wake vortex	Collision with ground	1	0.05	7.56E-09	0	0.05	3.60E-10

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17	Aircraft encounters thunderstorm, turbulence or wake vortex	Aircraft continues flight with injury	39	0.00	2.81E-07	0	0.00	0.00E+00
18	Single engine failure in flight	Collision with ground	1	0.05	7.56E-09	1	0.05	7.56E-09
18	Single engine failure in flight	Collision with ground	8	0.05	5.79E-08	5	0.05	3.63E-08
18	Single engine failure in flight	Aircraft lands off runway	6	0.00	4.32E-08	3	0.00	2.16E-08
19	Unstable approach	Collision with ground	11	0.05	7.95E-08	4	0.05	2.91E-08
19	Unstable approach	Collision with ground	6	0.05	4.35E-08	3	0.05	2.20E-08
19	Unstable approach	Runway excursion	26	0.44	1.90E-07	1	0.00	7.20E-09
19	Unstable approach	Runway excursion	5	0.44	3.92E-08	0	0.00	0.00E+00

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Reference ID: FSS_P4_NLR_D4.3
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19	Unstable approach	Aircraft continues landing roll damaged	13	0.00	9.36E-08	0	0.00	0.00E+00
21	Aircraft weight and balance outside limits during approach	Collision with ground	1	0.05	7.56E-09	1	0.05	7.56E-09
23	Aircraft encounters windshear during approach or landing	Collision with ground	4	0.05	2.91E-08	0	0.05	3.60E-10
23	Aircraft encounters windshear during approach or landing	Collision with ground	1	0.05	7.56E-09	0	0.05	3.60E-10
23	Aircraft encounters windshear during approach or	Runway excursion	1	0.44	1.04E-08	0	0.00	0.00E+00

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	landing							
25	Aircraft handling by flight crew inappropriate during flare	Runway excursion	16	0.44	1.18E-07	0	0.00	0.00E+00
25	Aircraft handling by flight crew inappropriate during flare	Runway excursion	4	0.44	3.20E-08	0	0.00	0.00E+00
25	Aircraft handling by flight crew inappropriate during flare	Aircraft continues landing roll damaged	61	0.00	4.39E-07	0	0.00	0.00E+00
26	Aircraft handling by flight crew inappropriate during landing roll	Runway excursion	46	0.44	3.34E-07	0	0.00	0.00E+00
27	Aircraft directional control related	Runway excursion	34	0.44	2.48E-07	2	0.00	1.44E-08

	system failure during landing roll							
31	Aircraft are positioned on collision course in flight	Collision in mid-air	4	0.00	2.88E-08	2	0.00	1.44E-08
32 ¹	Runway incursion	Collision on runway	7	0.00	5.04E-08	2	0.00	1.44E-08
33	Cracks in aircraft pressure cabin	In-flight break-up	0	0.00	0.00E+00	0	0.00	0.00E+00
33	Cracks in aircraft pressure cabin	Aircraft damage	1	0.00	7.20E-09	0	0.00	0.00E+00
35	TAWS alert	Collision with ground	4	0.05	2.91E-08	4	0.05	2.91E-08
36 ¹	Conflict on taxiway or apron	Collision on taxiway or apron	158	0.00	1.14E-06	2	0.00	1.44E-08
38	Loss of control due to poor	Collision with ground	0	0.05	3.60E-10	0	0.05	3.60E-10

	airmanship							
		Ramp accident/serious incident ⁴	29	0	2.09E-07	5	0.00	3.60E-08
		Design or maintenance related accident/serious incident ⁵	68	2.87 ⁵	5.10E-07	17	0.2	1.24E-07

¹ To ensure correct use of the exposure data, collisions between two aircraft are considered as two separate occurrences.

² Note that only 654 occurrences and 51 types of accident end states codes have been filed while 1509 occurrences corresponding to 79 types of end states codes have been identified in Appendix B. The reason for the difference is that only 654 occurrences actually led to 'accidents' (the other occurrences led to at most 'serious incidents'). Only occurrences with accident end state are used to quantify 'risk frequencies per flight'.

³ One 'collision with ground' accident that could not be assigned to an accident scenario has been equally distributed over all 'collision with ground' end states. Eight 'runway excursion' accidents that could not be assigned to an accident scenario have been equally distributed over all 'runway excursion' end states.

⁴ Ground handling accidents and serious incidents are not included in the CATS model and therefore have been quantified separately.

⁵ Design or maintenance related accidents and serious incidents are derived from system-related accidents or serious incidents in the CATS model and therefore have been quantified separately. It should be noted that this is a subset from the frequency per flight of other accident/serious incident scenarios.

Appendix B Accident and serious incident sample

ECCAIRS State file number	Local date	Manufacturer/model
95005170	05-01-1995	Fokker 50
95000630	10-01-1995	737-200
BFU 5X001-95	19-01-1995	A310
95000100	20-01-1995	FALCON 20
95000720	31-03-1995	A310
95001110	08-04-1995	747-100/200
95001340	22-04-1995	Fokker 50
95001090	27-04-1995	MD80 SERIES
95001310	24-05-1995	110 BANDEIRANTE
95002040	25-05-1995	BAE-ATP
BFU 5X003-95	14-07-1995	F27 FRIEND/FREIGHT SHIP
95002930	02-09-1995	MD80 SERIES
95003020	16-09-1995	767-300
95005490	16-10-1995	DC-9-30
95005000	23-11-1995	757-200
95003870	13-12-1995	AN-24
95004720	15-12-1995	ATR 42 - NO SERIES SPECIFIED
95003960	19-12-1995	DC-10
96001480	14-02-1996	Short SD 330
96000560	19-02-1996	550/551 SP CITATION II

96003260	19-05-1996	BAe 146-200
96002710	28-05-1996	TU-154M/TU-164
96001600	06-07-1996	HINDUSTAN HAL748
96003130	15-07-1996	L1011-1/L1011-100/200
96003230	30-07-1996	188 ELECTRA
96003050	13-08-1996	Learjet 25
BFU 5X002-96	13-08-1996	MD-11
96003390	29-08-1996	TU-154M/TU-164
96006302	27-09-1996	727-200
96006301	27-09-1996	FALCON 10
96004100	08-10-1996	AN-124
96005220	08-12-1996	F27 MK 500
96005280	12-12-1996	146-100
96001720	21-12-1996	DC-10-30
97000690	03-01-1997	Short SD 330
97004270	18-01-1997	737-300
97000400	08-02-1997	737-300
97000770	02-05-1997	Dornier 228 1/2
97001480	06-05-1997	F27 MK 500
97000910	14-05-1997	Saab 340
97012550	14-05-1997	777-200
97002450	18-05-1997	ATR 72 - NO SERIES SPECIFIED
97003180	24-06-1997	TU-154B

97002580	10-07-1997	747-100/200
97001320	30-07-1997	ATR 42 - NO SERIES SPECIFIED
97001770	31-07-1997	A320
97001890	12-08-1997	727-200
97002290	16-08-1997	FAIRCHILD FH227
97004970	24-08-1997	757-200
97001960	11-09-1997	BAe 146-300
97004550	20-10-1997	L1011-1/L1011-100/200
97002140	05-11-1997	A340-300
BFU EX003-97	06-11-1997	737-500
97005090	21-11-1997	BAe ONE-ELEVEN
97005120	06-12-1997	747-100/200
97003270	07-12-1997	F27 MK 500
97002830	17-12-1997	YAK-42
97005140	20-12-1997	737-300
97003140	24-12-1997	757-200
98010750	09-01-1998	767-300
98002660	16-01-1998	650 CITATION III
98000210	20-01-1998	ATR 42 - NO SERIES SPECIFIED
98000310	26-01-1998	31 JETSTREAM
98000230	09-02-1998	Short SD 360
98004820	09-02-1998	HAWKER SIDDELEY HS748/AVRO 748
98002670	15-02-1998	BAE-ATP

98001000	22-02-1998	ATR 72 - NO SERIES SPECIFIED
98004110	27-02-1998	Saab 340
98000610	17-03-1998	737-300
98000970	30-03-1998	HAWKER SIDDELEY HS748/AVRO 748
98000560	02-04-1998	FALCON 20
98002040	05-04-1998	747-400
98004510	07-04-1998	550/551 SP CITATION II
98003070	09-05-1998	BAE-ATP
98000640	21-05-1998	A320
98005170	25-05-1998	CONCORDE
98004680	31-05-1998	A310
98004860	21-06-1998	747 SP
98002540	19-07-1998	L1011-1/L1011-100/200
98002240	28-07-1998	MERLIN III
98002311	30-07-1998	BEECH 1900
98004980	14-08-1998	A321
98002800	27-08-1998	A340-200
2000000	03-09-1998	MU-2B-40 (SOLITAIRE)
98004770	11-09-1998	747-100/200
98005110	29-09-1998	Embraer 120 BRASILIA
98005320	14-10-1998	DC-9-40
98003300	14-11-1998	707-300
98003720	25-11-1998	MD80 SERIES

98004990	25-11-1998	L1011-500 SERIES
98005161	10-12-1998	767-300
99000020	12-01-1999	F27 FRIEND/FREIGHT SHIP
99000280	15-01-1999	767-300
99000260	20-01-1999	747-400
99008180	22-01-1999	737-200
99000300	28-01-1999	MD80 SERIES
BFU 5X001-99	05-02-1999	Boeing\ B737-46J - (not coded)
99000410	07-02-1999	707-300
BFU 5X002-99	10-02-1999	Israel Ind.\ IAI-1125 - (not coded)
99004080	13-02-1999	Saab 340
99006000	13-02-1999	Short SD 330
99000340	25-02-1999	Dornier 328
99000850	28-02-1999	DHC8
99000350	01-03-1999	Lockheed 188 ELECTRA
99001000	04-03-1999	737-200
99001040	24-03-1999	A300-600
BFU EX004-99	29-05-1999	C.A.S.A.\ CASA 352A3 - (not coded)
99004980	03-06-1999	A321
99002720	23-06-1999	DC-10-30F
99007520	27-06-1999	737-400
99008470	30-06-1999	Dornier 228 1/2
BFU 5X004-99	06-07-1999	ATR 42-300

99008280	13-07-1999	DC-8-62
99004020	20-07-1999	DC-8-62
99003641	25-07-1999	737-500
99001570	28-07-1999	SA227AC/METRO III
99004970	12-08-1999	DHC8
99005070	03-09-1999	737-800
991111100	11-09-1999	747-300
99003460	14-09-1999	757-200
99999999	19-09-1999	MD-11
99022990	01-10-1999	A310
99004680	07-11-1999	Fokker 100
BFU 5X009-99	11-11-1999	Swearingen\ SA227AT - (not coded)
99004700	19-11-1999	737-300
99004560	30-11-1999	Canadair CL-600
99007640	04-12-1999	757-200
99004550	06-12-1999	DC-10-10
99004480	11-12-1999	BAE-ATP
99006470	13-12-1999	777-200
99004850	16-12-1999	A310
99006710	18-12-1999	DC-10-30F
99004720	22-12-1999	747-100/200
99008220	28-12-1999	ATR 42-300
20	10-01-2000	Saab 340

8000	11-01-2000	Saab 2000
7530	17-01-2000	Fokker 50
2530	20-01-2000	A320
7560	24-01-2000	A320
160	31-01-2000	AN-12
7181	01-02-2000	737-400
7510	21-02-2000	A321
550	27-03-2000	737-700
660	01-04-2000	737-800
7070	05-04-2000	Fokker 100
7500	15-04-2000	MD80 SERIES
930	22-04-2000	747-300
740	26-04-2000	DC-9-40
790	02-05-2000	Learjet 35 TRANSCONTINENTAL
850	16-05-2000	BAE-ATP
971	25-05-2000	Short SD 330
980	27-05-2000	DHC8
7490	05-06-2000	MD80 SERIES
BFU 5X005-00	27-06-2000	SA227AC/METRO III
2510	01-07-2000	F27 MK 500
2350	04-07-2000	TU-154B
1920	12-07-2000	A310
7520	13-07-2000	AVRO RJ100

2570	25-07-2000	DC-10
2970	17-08-2000	757-200
BFU EX004-00	27-08-2000	A300-B2/B4
7850	14-09-2000	MD90-30
5730	10-10-2000	DC-10-30
7030	10-10-2000	ATR 72-200
BFU 5X010-00	20-10-2000	Fokker\ F27,MK600 - (not coded)
4090	22-10-2000	DHC8
7630	29-10-2000	Fokker 50
4460	05-11-2000	747-100/200
7540	08-11-2000	Fokker 50
7590	13-11-2000	A319
7600	18-11-2000	DC-10-30F
4510	30-11-2000	737-800
1006550	14-01-2001	737-400
1004680	30-01-2001	146-300
1007750	01-02-2001	Saab 2000
1002430	02-02-2001	757-200
1004910	04-02-2001	Short SD 360
1000600	04-02-2001	747-300
1000180	07-02-2001	A320
1007890	11-02-2001	767-300
1007760	20-02-2001	A321

1000290	27-02-2001	Short SD 360
1000530	19-03-2001	DHC8-300
1121530	27-03-2001	767-300
1000720	18-04-2001	A321
1121550	23-04-2001	767-300
BFU EX001-01	28-04-2001	Junkers\ JU52 - (not coded)
1001090	30-04-2001	Cessna 560 CITATION V
1001100	10-05-2001	MD80 SERIES
1002560	29-05-2001	SA227AC/METRO III
1004100	07-06-2001	Beech 350 SUPER KING AIR
1002610	14-06-2001	DHC8
1002460	28-06-2001	757-200
1003020	06-07-2001	L1011-1/L1011-100/200
1121580	08-07-2001	A310
1007780	19-07-2001	A320
1004500	21-07-2001	MD80 SERIES
1007790	03-08-2001	Embraer 145 (145ER)
1003130	24-08-2001	A330-200
1004210	24-08-2001	A319
1002960	29-08-2001	CASA CN 235
BFU 5X016-01	27-09-2001	Swearingen\ SA227AT - (not coded)
1004871	08-10-2001	MD80 SERIES
1005130	18-10-2001	Canadair CL-600

1006700	22-11-2001	DHC8
1006330	23-11-2001	AN-28
1005580	24-11-2001	AVRO RJ100
1006390	30-11-2001	31 JETSTREAM
1008100	11-12-2001	737-300
1007820	18-12-2001	Saab 2000
1007800	24-12-2001	Embraer 145 (145ER)
BFU 5X001-02	02-01-2002	Fokker\ F27,MK600 - (not coded)
2000070	14-01-2002	Embraer 120 BRASILIA
2005740	22-01-2002	757-200
2000210	03-02-2002	MD-11
2006650	16-02-2002	Fokker 70
2006640	22-02-2002	BA 146-200
2005910	02-03-2002	A321
2000620	12-04-2002	SA227AC/METRO III
2001330	14-06-2002	A330-300
BFU 3X128-02	24-06-2002	717-200
2006570	28-06-2002	Embraer 145 (145ER)
BFU AX001-02	01-07-2002	757-200
2001870	06-07-2002	A320
2001810	10-07-2002	Saab 2000
2001880	27-07-2002	737-700
2005750	06-08-2002	737-700

2001910	17-08-2002	737-700
2007100	22-08-2002	DA 40 DIAMOND STAR
2006630	12-09-2002	31 JETSTREAM
2006590	13-09-2002	737-800
BFU 1X002-02	14-09-2002	Canadair CL-600
2004420	14-09-2002	747-300
2006560	17-09-2002	ATR 42-500
2005321	01-10-2002	Embraer 145 (145ER)
2006550	08-10-2002	ATR 42-500
2006540	09-10-2002	Fokker 100
2005440	16-10-2002	747-100/200
2004120	16-10-2002	Dornier 228 1/2
2004460	02-11-2002	F27 MK 500
2005191	05-11-2002	A320
2004330	06-11-2002	F27 MK 500
2006530	25-11-2002	A300-B2/B4
2005130	30-11-2002	Embraer 145 (145ER)
2005220	03-12-2002	A300-600
2006740	06-12-2002	Cessna 550/551 SP CITATION II
2005600	09-12-2002	737-700
2005850	12-12-2002	BAE 146-200
2005540	24-12-2002	Fairchild SA227 III
2006350	25-12-2002	ATR 72-200

3000230	06-01-2003	DHC8
3000840	12-01-2003	737-800
3004700	16-01-2003	747 SP
3000070	17-01-2003	Fokker 50
3004710	18-01-2003	747-400
3000280	20-01-2003	Cessna 550/551 SP CITATION II
3004780	04-02-2003	Embraer 135
3000190	10-02-2003	AN-28
3000610	15-02-2003	747-100/200
3004720	23-03-2003	A319
BFU 5X002-03	10-04-2003	BAE 146-200
3002561	27-04-2003	A321
3002760	28-05-2003	Cessna 560 CITATION V
3001980	02-06-2003	DHC8-300
3003780	14-06-2003	747-100/200
3002110	16-06-2003	A320
309999	16-06-2003	737-800
3002120	17-06-2003	MD80 SERIES
3002160	19-06-2003	AN-124
3002130	22-06-2003	Canadair CL-600
3002820	02-07-2003	737-800
3002411	12-07-2003	TU-154
3004730	13-07-2003	737-200

BFU 6X014-03	13-07-2003	A321
3002780	15-08-2003	737-700
3003130	17-09-2003	31 JETSTREAM
3003490	17-09-2003	31 JETSTREAM
3003260	23-09-2003	Embraer 145 (145ER)
3003520	01-10-2003	747-100/200
3048850	02-10-2003	747-100/200
3003420	07-10-2003	Embraer 145 (145ER)
3004670	17-11-2003	737-800
3004920	25-11-2003	Embraer 145 (145ER)
3003880	04-12-2003	Dornier 228 1/2
3051550	07-12-2003	737-800
3004180	13-12-2003	AVRO RJ100
3004510	22-12-2003	737-700
3004800	22-12-2003	737-300
4000110	02-01-2004	A320
4000050	05-01-2004	Fokker 70
4004320	12-01-2004	Cessna CITATION BRAVO
4000120	19-01-2004	A320
4000190	19-01-2004	DC-10
4001570	22-01-2004	A320
4000630	24-01-2004	757-300
4000160	26-01-2004	Dornier 328JET

4002470	27-01-2004	Embraer 145 (145ER)
4004410	31-01-2004	Embraer 120 BRASILIA
4004400	01-02-2004	A321
4004370	18-02-2004	A330-200
4003470	29-02-2004	A321
4000540	02-03-2004	737-400
4004010	13-03-2004	737-400
4000750	19-03-2004	REGIONAL JET SERIES 100/200
4000610	21-03-2004	737-800
4002370	21-03-2004	MD80 SERIES
4000910	23-03-2004	BOEING 747
4000910	23-03-2004	BOEING 747
4001580	29-03-2004	Canadair CL-600
4001270	15-04-2004	737-400
4001120	20-04-2004	MD80 SERIES
BFU EX005-04	22-04-2004	DC-10
4001280	26-04-2004	BAE 146-100
4000920	27-04-2004	737-300
BFU EX006-04	03-05-2004	ATR 42-500
4004280	04-05-2004	A320
4002170	11-05-2004	A320
4001070	19-05-2004	DHC8
4004340	08-06-2004	A300-600

4001420	12-06-2004	BAE 146-100
4001410	14-06-2004	A321
4001470	22-06-2004	IL-62M/IL-62K
4004150	22-06-2004	737-800
4001390	28-06-2004	A321
4001720	30-06-2004	BOEING 737
4001680	06-07-2004	L1011-1/L1011-100/200
4001710	16-07-2004	767-300
4001980	18-07-2004	Fokker 70
4001810	19-07-2004	A320
4002030	23-07-2004	A320
4002240	04-08-2004	Embraer 120 BRASILIA
4002090	09-08-2004	AVRO RJ100
4002390	20-08-2004	MD80 SERIES
4002230	20-08-2004	A310
4002580	03-09-2004	A320
4002670	16-09-2004	REGIONAL JET SERIES 100/200
4666666	21-09-2004	747-400
4002600	29-09-2004	Dornier 228 1/2
4002810	02-10-2004	A320
4002930	05-10-2004	BAE 748
4002820	06-10-2004	Embraer 120 BRASILIA
4002890	09-10-2004	A319

4002860	19-10-2004	737-300
4002960	31-10-2004	A330-200
4003550	04-11-2004	747-300
4003300	19-11-2004	A340-600
4003260	25-11-2004	Learjet 35 TRANSCONTINENTAL
4003630	28-11-2004	737-400
4003610	02-12-2004	BAE 146-200
4003640	06-12-2004	Gulfstream G IV
4029950	12-12-2004	747-100/200
4003800	21-12-2004	REGIONAL JET SERIES 100/200
4003720	22-12-2004	ATR 72-200
4004420	29-12-2004	737-500
4003830	30-12-2004	BAE 146-300
5004250	17-01-2005	Saab 2000
5100820	19-01-2005	767-300
5000170	20-01-2005	Canadair CL-600
5001280	23-01-2005	MD80 SERIES
5000130	24-01-2005	747-100/200
5000180	27-01-2005	Let L410VP-E
5000320	31-01-2005	ATR 42 - NO SERIES SPECIFIED
5000370	31-01-2005	737-600
5000290	01-02-2005	A319
5000600	08-02-2005	777-200

5000500	09-02-2005	F28 MK 1000
5000550	09-02-2005	A319
5000560	14-02-2005	TU-154M/TU-164
5100840	20-02-2005	747-400
5000720	28-02-2005	747-100/200
5000540	01-03-2005	777-200
5000790	01-03-2005	Embraer 170
5004260	01-03-2005	737-600
5000920	06-03-2005	BOEING 737
BFU 5X007-05	12-03-2005	BAE 146-300
5000890	13-03-2005	Fokker 50
5001240	30-03-2005	AVRO RJ85
BEA f-zd050401	01-04-2005	A321
BFU 5X009-05	01-04-2005	Cessna 172 RG
5002390	16-04-2005	Fokker 100
5001490	18-04-2005	ATR 72 - NO SERIES SPECIFIED
5002550	18-04-2005	ATR 72-200
BFU 5X010-05	18-04-2005	DHC8-300
5001480	19-04-2005	BAE 146-100
5001590	22-04-2005	A320
5001470	23-04-2005	737-300
5001710	29-04-2005	Saab 2000
5002130	01-05-2005	DHC8

5005500	07-05-2005	A320
5108750	12-05-2005	757-200
5001840	13-05-2005	A300 - NO SERIES SPECIFIED
5002040	18-05-2005	A320
51111111	23-05-2005	BAE-ATP
5001890	26-05-2005	MD80 SERIES
5001880	27-05-2005	A320
5001900	29-05-2005	Fokker 100
5002180	01-06-2005	A321
5002370	18-06-2005	A320
5002240	18-06-2005	737-800
5002290	26-06-2005	757-200
5002780	29-06-2005	Canadair CL-600
5999901	29-06-2005	A300-B2/B4
5002620	30-06-2005	A321
5003840	01-07-2005	ATR 42-500
5003160	08-07-2005	737-400
5002480	11-07-2005	A321
5002610	16-07-2005	737-800
BFU EX005-05	18-07-2005	Embraer\ EMB145 - (not coded)
5002630	21-07-2005	737-700
5004280	25-07-2005	757
5002790	29-07-2005	737-500

5002880	06-08-2005	ATR 72-200
5002960	14-08-2005	737-300
BFU EX006-05	14-08-2005	Embraer 145 (145ER)
5003290	17-08-2005	Saab 2000
5004300	18-08-2005	737-800
5004290	18-08-2005	A300-B2/B4
5003300	19-08-2005	737-300
5004310	20-08-2005	A340-300
N2005-00001	21-08-2005	Fokker 50
5003100	22-08-2005	F28 MK 1000
5004320	22-08-2005	737-300
5003310	29-08-2005	ATR 42-500
5003320	01-09-2005	737-400
5004440	10-09-2005	BAE 146-100
5003610	11-09-2005	737-800
5004020	14-09-2005	ATR 42-300
5003410	14-09-2005	Gulfstream G V
5003450	19-09-2005	Fairchild SA227 III
5004470	29-09-2005	MCDONNELL DOUGLAS C-17
5003660	30-09-2005	Saab 340
5004240	07-10-2005	DHC8-300
5005440	15-10-2005	737-300
5003960	20-10-2005	747-100/200

5003970	30-10-2005	Let L410UVP
5004040	30-10-2005	A320
5004330	02-11-2005	737-800
5118410	06-11-2005	A340-300
5117050	06-11-2005	767-200
5004430	17-11-2005	Saab 2000
5004520	17-11-2005	ATR 42-300
5005200	20-11-2005	A340-300
5004840	24-11-2005	DHC8-400
5004610	27-11-2005	Fokker 70
5000340	05-12-2005	AVRO RJ100
5004870	06-12-2005	747-300
5004770	16-12-2005	737-800
BFU EX014-05	16-12-2005	Boeing\ B737-800 - (not coded)
5005050	28-12-2005	737-500
5005010	28-12-2005	767-300
6000040	05-01-2006	767-200
6000050	06-01-2006	737-600
6001420	07-01-2006	MD80 SERIES
6004630	09-01-2006	MD80 SERIES
6000190	10-01-2006	A321
6000240	12-01-2006	737-600
6000100	12-01-2006	747-100/200

2006-0041	13-01-2006	ATR 42-500
6000350	20-01-2006	Embraer 145 (145ER)
6001660	23-01-2006	F27 FRIEND/FREIGHT SHIP
6000330	24-01-2006	ATR 42-300
6000320	25-01-2006	737-400
6000390	26-01-2006	AVRO RJ100
6000300	26-01-2006	Embraer 145 (145ER)
6000540	30-01-2006	757-200
6000340	06-02-2006	737-800
6000630	09-02-2006	MD80 SERIES
6000530	11-02-2006	737-400
BFU AX001-06	15-02-2006	FALCON 20
6000520	21-02-2006	DHC8
6000780	21-02-2006	Embraer 145 (145ER)
6000550	21-02-2006	767
6000610	24-02-2006	FALCON 900
6000590	04-03-2006	A310
6002230	07-03-2006	757
6000650	08-03-2006	AVRO RJ85
6002260	08-03-2006	Hawker Siddeley HS748/AVRO 748
6000640	10-03-2006	AVRO RJ85
6000850	12-03-2006	737-600
6001160	18-03-2006	737-600

6000800	19-03-2006	AVRO RJ100
6000760	21-03-2006	Learjet 45
6000740	23-03-2006	BAE 146-200
6004580	23-03-2006	737-800
6000750	24-03-2006	ATR 42-300
6002350	25-03-2006	BAE-ATP
6000730	26-03-2006	DHC8
2006-0071	27-03-2006	Fokker 50
6000920	28-03-2006	737-400
6000790	29-03-2006	ATR 42-300
6000770	30-03-2006	BAE 146-300
6000990	06-04-2006	DHC8-400
6007500	07-04-2006	757
6001480	23-04-2006	DHC8-400
6002010	03-05-2006	A320
6001760	03-05-2006	BOEING 737
6002080	04-05-2006	BOEING 737
6001490	08-05-2006	Canadair CL-600
6001450	11-05-2006	737-700
6001440	15-05-2006	747-400
6001720	15-05-2006	Canadair CL-600
6055555	16-05-2006	Fokker 70
6001750	17-05-2006	Gulfstream G IV

6001730	19-05-2006	757-200
6999901	22-05-2006	MD80 SERIES
6001740	22-05-2006	737-400
6001990	22-05-2006	A320
6001580	28-05-2006	MD80 SERIES
6000000	28-05-2006	A320
6001770	01-06-2006	Fokker 50
6001640	04-06-2006	A320
6008170	05-06-2006	737-500
6001950	08-06-2006	737-400
6002540	13-06-2006	757
6002040	14-06-2006	Learjet 60
6002500	15-06-2006	737-300
6002620	17-06-2006	737-800
6002550	18-06-2006	A320
6001910	22-06-2006	A340-300
6002900	22-06-2006	Dornier 328
6002780	28-06-2006	Embraer 145 (145ER)
6002760	28-06-2006	BAE 146-300
6002790	30-06-2006	A319
6002680	03-07-2006	Embraer 145 (145ER)
6002690	03-07-2006	Fokker 100
2006100921	07-07-2006	737-300

6002890	13-07-2006	737-700
6003100	15-07-2006	747-400
6999903	17-07-2006	747-100/200
6000000	17-07-2006	747-100/200
2006-0190	18-07-2006	A321
6003570	24-07-2006	Cessna 560 CITATION V
6003030	26-07-2006	A320
6003090	27-07-2006	737-500
6006330	02-08-2006	737-300
6999902	12-08-2006	737-900
6003240	13-08-2006	Lockheed 382B/100 HERCULES
6003370	16-08-2006	737-500
6003350	17-08-2006	737-400
6003470	24-08-2006	MD80 SERIES
6007220	24-08-2006	737-300
6003700	24-08-2006	BOEING 737
6003560	01-09-2006	A320
6004230	07-09-2006	737-800
6003650	10-09-2006	737-500
6003740	11-09-2006	737-800
6003720	13-09-2006	Fokker 100
6003710	14-09-2006	Cessna 525 CITATIONJET
6003800	17-09-2006	767-300

6004070	19-09-2006	BAE-ATP
6003940	21-09-2006	A321
6003920	22-09-2006	777-200
6004150	23-09-2006	737-800
6003960	24-09-2006	737-800
6003950	10-10-2006	BAE 146-200
6004050	13-10-2006	A340-600
6004100	16-10-2006	737-800
6004220	20-10-2006	Embraer 170
6004290	30-10-2006	Embraer 145 (145ER)
6004320	06-11-2006	A321
6004420	06-11-2006	A319
6006820	07-11-2006	MD-11
2006101933	08-11-2006	767-200
6004600	08-11-2006	Saab 2000
6004370	13-11-2006	737-300
6004380	19-11-2006	F27 FRIEND/FREIGHT SHIP
6004840	05-12-2006	AN-124
6006710	05-12-2006	Saab 2000
2006101906	07-12-2006	747-400
6600000	11-12-2006	ATR 42-500
6006690	12-12-2006	AVRO RJ100
7100059	02-01-2007	DHC8-400

7003180	11-01-2007	41 JETSTREAM
7000350	11-01-2007	757-200
7003190	12-01-2007	41 JETSTREAM
7000210	15-01-2007	TB 200 TOBAGO XL
7003200	17-01-2007	REGIONAL JET SERIES 100/200
7003330	18-01-2007	ATR 42-300
7000230	18-01-2007	BAE 146-300
7003210	20-01-2007	737-800
7000260	23-01-2007	Learjet 35 TRANSCONTINENTAL
7000770	24-01-2007	REGIONAL JET SERIES 100/200
7000330	24-01-2007	A320
7100020	25-01-2007	Fokker 100
7000340	25-01-2007	DHC8-400
7000410	28-01-2007	BAE 146-300
7000360	31-01-2007	Embraer 170
7000090	31-01-2007	A321
7000380	06-02-2007	BAE 146-300
7003340	06-02-2007	A319
7000810	07-02-2007	Canadair CL-600
7000420	08-02-2007	MD80 SERIES
7	08-02-2007	Fokker 50
7000080	08-02-2007	TU-154
70057	11-02-2007	AN-124

7000390	12-02-2007	Embraer 120 BRASILIA
7003220	12-02-2007	737-400
7002260	15-02-2007	777
7003350	19-02-2007	BAE 146-300
7003360	20-02-2007	BAE 146-200
7000530	23-02-2007	BAE 146-300
7100090	26-02-2007	777-200
7003370	26-02-2007	41 JETSTREAM
7000750	27-02-2007	737-600
7200180	03-03-2007	767-300
7001790	04-03-2007	A319
700002222	05-03-2007	A319
700	06-03-2007	737-800
7000520	08-03-2007	ATR 72 - NO SERIES SPECIFIED
7003230	09-03-2007	Fokker 70
7000550	12-03-2007	BAE 146-200
7003380	19-03-2007	188 ELECTRA
7002600	20-03-2007	747-400
7001410	22-03-2007	AVRO RJ100
7000630	28-03-2007	Embraer 145 (145ER)
7000620	04-04-2007	Cessna 560 CITATION V
7000660	09-04-2007	A321
7003250	10-04-2007	747-100/200

7000730	11-04-2007	A320
7000840	13-04-2007	747-400
7000820	13-04-2007	A320
7003390	18-04-2007	A319
7100101	22-04-2007	757-200
7003400	23-04-2007	A321
7000920	04-05-2007	737-800
7000720	05-05-2007	A320
7100147	10-05-2007	MD 83
7003410	10-05-2007	Embraer 145 (145ER)
7001020	10-05-2007	Canadair CL-600
7000990	10-05-2007	A321
7002420	11-05-2007	Short SD 360
7200494	13-05-2007	737-800
7001030	15-05-2007	A320
7003260	16-05-2007	A320
20073038	18-05-2007	Fokker 50
7001050	20-05-2007	747-100/200
7001100	22-05-2007	A320
7001340	29-05-2007	AN-26/AN-26B
7001180	03-06-2007	Cessna 560 CITATION V
7003420	04-06-2007	737-500
7001160	05-06-2007	Canadair CL-600

7003430	10-06-2007	737-500
7003580	11-06-2007	737-800
7001130	14-06-2007	747-400
7100383	17-06-2007	RJ-85 AVROLINER
7003280	22-06-2007	757-200
7001320	24-06-2007	BAE 146-200
7001330	25-06-2007	747-100/200
7001350	25-06-2007	737-500
7003440	25-06-2007	737-500
7100179	26-06-2007	41 JETSTREAM
7001310	26-06-2007	A320
7003450	27-06-2007	Learjet 45
7001290	30-06-2007	737-300
7001390	30-06-2007	Embraer 145 (145ER)
N2007-00042	01-07-2007	DHC8-400
7001370	03-07-2007	DHC8-300
N2007-00062	03-07-2007	DHC8-400
N2007-00069	05-07-2007	737-700
7003470	05-07-2007	A320
N2007-00067	05-07-2007	737-700
7001380	08-07-2007	BAE 146-300
7001550	09-07-2007	A320
7001480	09-07-2007	Cessna 404 TITAN

7003130	11-07-2007	737-400
7100226	13-07-2007	A320
7003290	14-07-2007	747-100/200
7001510	15-07-2007	BAE 146-200
7001630	15-07-2007	DHC8
7002090	16-07-2007	737-800
N2007-00189	17-07-2007	MD80 SERIES
7001570	18-07-2007	BAE 146-200
7001580	19-07-2007	767-300
7100195	27-07-2007	777-200
7001640	28-07-2007	A300-600
7003300	30-07-2007	737-700
7001660	31-07-2007	737-800
7100454	02-08-2007	T-6 HARVARD
7100245	04-08-2007	MD 83
7100247	10-08-2007	757-200
7100248	11-08-2007	737-300
7001850	13-08-2007	BOEING 737
7002010	16-08-2007	MD80 SERIES
7001750	17-08-2007	A330-200
7100214	18-08-2007	AVRO RJ100
N2007-00346	19-08-2007	BAE-3200 JETSREAM SUPER 31
7001740	20-08-2007	767-300

N2007-00169	21-08-2007	Fokker 50
7003140	28-08-2007	A321
N2007-00247	29-08-2007	737-300
7001930	09-09-2007	DHC8-400
N2007-00294	09-09-2007	737-600
7002080	09-09-2007	MD 83
7002050	10-09-2007	737-800
7002060	11-09-2007	A320
7003110	11-09-2007	737-300
7001950	12-09-2007	DHC8-400
N2007-00314	12-09-2007	DHC8
7002140	13-09-2007	BAE 146-100
7003310	14-09-2007	737-800
7002200	15-09-2007	ATR 72-200
N2007-00327	16-09-2007	737-300
7002240	16-09-2007	A320
7100268	21-09-2007	DHC8-400
7002150	21-09-2007	Cessna 500/501 CITATION
7201459	23-09-2007	737-300
70000000	27-09-2007	747-400
7002790	02-10-2007	737-800
7003150	03-10-2007	777-200
7003560	03-10-2007	Saab 340

7002610	04-10-2007	A330-300
7002270	04-10-2007	AN-26/AN-26B
7003500	15-10-2007	A340-300
7002510	23-10-2007	A319
7002630	23-10-2007	A321
7002530	24-10-2007	A320
7002470	27-10-2007	DHC8-400
7002460	28-10-2007	737-800
7100352	28-10-2007	717-200
7003510	28-10-2007	HAWKER SIDDELEY HS125 DOMINIE 1-600
7002740	30-10-2007	DASSAULT FALCON900
7003520	06-11-2007	737-800
7002660	09-11-2007	ATR 42-300
7002710	10-11-2007	REGIONAL JET SERIES 100/200
7002720	11-11-2007	AVRO RJ85
7002870	12-11-2007	A319
7002690	13-11-2007	A320
7002700	13-11-2007	737-500
7002820	15-11-2007	REGIONAL JET SERIES 100/200
7201789	22-11-2007	767-300
7002860	22-11-2007	Canadair CL-600
7002850	29-11-2007	A319
7002940	06-12-2007	737-900

7003020	07-12-2007	AVRO RJ85
70000011	10-12-2007	737-800
7100414	11-12-2007	Fairchild SA227AC/METRO III
7002930	11-12-2007	Fairchild SA227 III
BFU 5X028-07	11-12-2007	Fairchild SA227AC/METRO III
7003160	12-12-2007	757-300
7100354	12-12-2007	767-300
7003320	12-12-2007	A320
7003030	16-12-2007	BAE 146-200
7002970	17-12-2007	A 109 HIRUNDO SWALLOW
HCLJ510-000467	26-12-2007	A321
7100339	30-12-2007	737-300
8100004	03-01-2008	737-400
8000030	09-01-2008	BAE 146-200
8000020	09-01-2008	A340-300
BFU 5X001-08	14-01-2008	A300-B2/B4
8100015	15-01-2008	A300-600
8000110	17-01-2008	777-200
8100053	21-01-2008	Fokker 50
8000320	25-01-2008	737-600
8002540	28-01-2008	767-300
8000000	31-01-2008	Saab 340
8000180	31-01-2008	Canadair CL-600

8100065	01-02-2008	F27 MK 500
8002050	04-02-2008	737-600
8003690	04-02-2008	777-200
8000220	04-02-2008	A300-600
8200103	13-02-2008	737-500
8003740	17-02-2008	A321
8000490	01-03-2008	A319
8100100	01-03-2008	747-400
8100077	01-03-2008	A320
8200279	14-03-2008	Cessna 550/551 SP CITATION II
8100099	19-03-2008	Dornier 328
BFU 1X001-08	19-03-2008	Dornier 328
8000770	19-03-2008	Saab 2000
8000610	21-03-2008	BAE 146-300
8100105	21-03-2008	737-800
8000620	21-03-2008	AVRO RJ85
8001950	07-04-2008	737-300
8000970	08-04-2008	Cessna 550/551 SP CITATION II
8100140	22-04-2008	BAE 146-200
8100514	28-04-2008	Let L410UVP
8001960	09-05-2008	Short SD 360
8000960	13-05-2008	A319
8001030	14-05-2008	A319

8001090	19-05-2008	REGIONAL JET SERIES 100/200
8100174	19-05-2008	ATR 72-200
8001170	21-05-2008	BAE 146-300
8100176	25-05-2008	747-100/200
8100180	27-05-2008	A319
8100703	28-05-2008	DHC8-400
8001230	05-06-2008	A319
8001140	09-06-2008	Canadair GLOBAL EXPRESS
8001300	16-06-2008	A340-300
8001370	22-06-2008	DHC8-400
8001350	23-06-2008	737-800
8001320	24-06-2008	757-200
8001340	24-06-2008	A340-300
8100513	28-06-2008	737-300
8001390	29-06-2008	REGIONAL JET SERIES 100/200
8001570	01-07-2008	A320
8100260	02-07-2008	777-200
8100258	02-07-2008	DHC8-400
8100364	12-07-2008	A320
8001610	18-07-2008	A321
8001580	19-07-2008	A319
8100322	20-07-2008	737-800
8003680	27-07-2008	Saab 2000

8003760	28-07-2008	A320
8003750	28-07-2008	A321
8001700	28-07-2008	Canadair CL-600
8001780	31-07-2008	Fairchild SA227AC/METRO III
8003770	06-08-2008	A319
8001670	13-08-2008	Dornier 228 1/2
XXXXXX	16-08-2008	737-800
BFU 5X014-08	16-08-2008	A320
8100704	19-08-2008	SHORT SD3-60 VARIANT 100 - (not coded)
8100375	20-08-2008	MD80 SERIES
8001880	22-08-2008	A320
8100397	24-08-2008	ATR 72-200
8001930	26-08-2008	A320
8001690	28-08-2008	RAYTHEON PREMIERE I
8001890	01-09-2008	Fokker 70
8100625	04-09-2008	Aérospatiale SN 601
8002120	26-09-2008	A321
BFU EX004-08	26-09-2008	A321
8002130	29-09-2008	Fokker 70
8002280	29-09-2008	737-800
8004040	30-09-2008	Cessna 172 RG
BEA ts-k081010	10-10-2008	737-600
8002360	15-10-2008	747-400

8002600	17-10-2008	737-300
8002320	22-10-2008	MD 83
8100566	27-10-2008	747-100/200
8003730	01-11-2008	Boeing\ B737-330 - (not coded)
8003780	03-11-2008	737-800
8002410	11-11-2008	737-500
8002670	19-11-2008	A320
8002590	21-11-2008	A320
8002680	05-12-2008	REGIONAL JET SERIES 100/200
8002710	09-12-2008	BOEING 757-236F - (not coded)
8002950	11-12-2008	Embraer 145 (145ER)
8002730	11-12-2008	Fairchild SA227 III
8002780	13-12-2008	757-200
8100793	31-12-2008	737-700
9000160	03-01-2009	A330-200
9000040	05-01-2009	Embraer 145 (145ER)
9000290	09-01-2009	737-400
9000120	15-01-2009	Fokker 50
9000140	17-01-2009	Saab 340
9000360	05-02-2009	737-800
9100469	06-02-2009	737-300
9000400	09-02-2009	A321
9000390	10-02-2009	A321

9100126	13-02-2009	AVRO RJ100
9100115	18-02-2009	737-400
9003270	18-02-2009	A319
9000340	21-02-2009	737-700
9100210	24-02-2009	REGIONAL JET SERIES 100/200
9100127	25-02-2009	737-800
9100725	25-02-2009	BAE 146-200
9001600	27-02-2009	PA-34 SENECA
9001530	27-02-2009	A320
9000410	28-02-2009	Saab 2000
9100355	02-03-2009	AVRO RJ85
9000500	08-03-2009	747-400
9000530	15-03-2009	A319
9000600	20-03-2009	A330-200
9000630	23-03-2009	Canadair CL-600 Regional Jet CRJ-1000
9000700	26-03-2009	747-400
9100892	27-03-2009	A320
9000740	29-03-2009	747-400
9003250	02-04-2009	Canadair CL-600
9001960	07-04-2009	A320
9000910	10-04-2009	Cessna 172 (T-41)
9000770	15-04-2009	ATR 72-200
9000960	08-05-2009	747-400

9003280	08-05-2009	DHC8
9100277	09-05-2009	A321
9000970	11-05-2009	767-300
9000980	12-05-2009	REGIONAL JET SERIES 100/200
9001060	12-05-2009	BAE 146-300
9003230	20-05-2009	A319
9003240	20-05-2009	A319
9003220	25-05-2009	ATR 42 - NO SERIES SPECIFIED
9001620	28-05-2009	MD80 SERIES
9001170	29-05-2009	757-200
9100339	04-06-2009	757-200
9001360	07-06-2009	737-800
9001210	08-06-2009	737-800
2009-06-13-02	13-06-2009	737-300
9201000	15-06-2009	757-200
9002910	22-06-2009	A340-300
9100959	25-06-2009	ATR 72-200
9001440	29-06-2009	767-300
BEAxxx	04-07-2009	737-800
9002000	09-07-2009	A320
9002540	11-07-2009	ATR 42-500
9001470	11-07-2009	BAE AVRO RJ100
9201394	17-07-2009	737-700

9001520	18-07-2009	737-700
9001500	20-07-2009	767-300
9100529	22-07-2009	737-800
9001700	24-07-2009	A319
9001680	27-07-2009	777-300
9001750	31-07-2009	737-800
9002750	01-08-2009	A320
9001710	01-08-2009	A320
9100581	01-08-2009	A320
9100737	04-08-2009	A320
9100603	05-08-2009	A320
9002130	07-08-2009	A320
9002250	18-08-2009	A320
9002240	27-08-2009	737-800
9002470	27-08-2009	777-200
9003210	28-08-2009	AN-12
9002160	29-08-2009	737-800
9003170	31-08-2009	777-300
9100704	01-09-2009	A320
9003200	01-09-2009	Embraer\ ERJ190 - (not coded)
9001980	02-09-2009	A321
9002010	14-09-2009	Fokker 100
9003190	20-09-2009	MD83

9003040	23-09-2009	A319
9002190	26-09-2009	757-200
9100793	29-09-2009	737-800
9002460	03-10-2009	MD80 SERIES
9100855	09-10-2009	REGIONAL JET SERIES 900
9002290	15-10-2009	737-500
9002360	18-10-2009	737-800
9002310	19-10-2009	737-700
9002350	22-10-2009	737-400
9100872	22-10-2009	DHC8-300
9100884	27-10-2009	AVRO RJ100
9002710	28-10-2009	747-400
9100930	30-10-2009	737-500
9002590	30-10-2009	Cessna 172 (T-41)
9100907	01-11-2009	DHC8
9003050	05-11-2009	757
9002960	06-11-2009	A330-200
N2009-02886	07-11-2009	Cessna F172
9002640	18-11-2009	FALCON 900
91000000	19-11-2009	737-800
9101020	19-11-2009	737-800
10000370	03-01-2010	MD80 SERIES
10100001	03-01-2010	737-800

10000030	04-01-2010	737-800
10100294	05-01-2010	DHC8-400
10000110	05-01-2010	A320
10100030	06-01-2010	Fokker 100
10000080	08-01-2010	737-800
10000180	11-01-2010	BAE-ATP
10000090	16-01-2010	A300-600
10000860	19-01-2010	A320
10000280	19-01-2010	REGIONAL JET SERIES 700
10100055	21-01-2010	747-400
10100064	23-01-2010	ATR 42-500
10000150	25-01-2010	Canadair CL-600
10000190	27-01-2010	ATR 72-200
10000970	27-01-2010	MD80 SERIES
10100143	28-01-2010	737-800
10000220	01-02-2010	A320
10000230	02-02-2010	AVRO RJ85
10100177	06-02-2010	MD 82
10000270	09-02-2010	A300-B2/B4
10100116	10-02-2010	MD80 SERIES
10100113	10-02-2010	737-300
1573521368	14-02-2010	A319
10100473	23-02-2010	DHC8-400

10000410	26-02-2010	747-100/200
10000430	28-02-2010	REGIONAL JET SERIES 700
10100181	01-03-2010	737-800
10000790	09-03-2010	A320
BEA hb-b100310	10-03-2010	A319
10100175	18-03-2010	AN-26/AN-26B
BEA hs-l100318	18-03-2010	B747-4D7 - (not coded)
10000880	19-03-2010	BAE 146-200
ANSV-10-266	26-03-2010	737-800
BEA m-og100329	29-03-2010	REGIONAL JET SERIES 100/200
10000700	30-03-2010	A320
BEA f-zk100331	31-03-2010	A319
10200258	08-04-2010	747-400
BEA b-ov100408	08-04-2010	747-400
10100448	09-04-2010	REGIONAL JET SERIES 700
10100424	10-04-2010	737-500
04/sum/2010	12-04-2010	A319
10100226	13-04-2010	Embraer 170
10000740	15-04-2010	A330-300
10000770	22-04-2010	DHC8-400
10000820	24-04-2010	DHC8
10001190	28-04-2010	A320
10001010	01-05-2010	DHC8-300

ANSV-10-413	02-05-2010	A319
ANSV-10-447	04-05-2010	A321
10201003	08-05-2010	737-800
2020a and b	15-05-2010	A320
BEA f-jr100517	17-05-2010	CANADAIR (REGIONAL JET SERIES 100/200)
2033	21-05-2010	A320
10100337	22-05-2010	A319
ANSV-10-565	23-05-2010	A320
10001180	23-05-2010	A320
2036	23-05-2010	A320
BEA f-bf100524	24-05-2010	Embraer 145 (145ER)
10000940	31-05-2010	747-400LCF Dreamlifter
BEA f-nb100601	01-06-2010	ATR42-300
BEA f-gj100602	02-06-2010	A318
10001240	06-06-2010	737-400
2010/016	06-06-2010	RJ-100 AVROLINER
10001260	07-06-2010	Embraer 170
10001130	07-06-2010	737-800
10201188	12-06-2010	757-200
BEA -06100613	13-06-2010	A320
10100399	15-06-2010	777-200
782927635	16-06-2010	BAE 146-200
10200609	16-06-2010	767-300

10100585	18-06-2010	A320
795021138	20-06-2010	737-700
BFU EX007-10	27-06-2010	REGIONAL JET SERIES 100/200
BEA f-ha100629	29-06-2010	A319
BFU EX008-10	04-07-2010	A320
724951180	05-07-2010	ATR 72 - NO SERIES SPECIFIED
2010/024	08-07-2010	A319
ANSV-10-1030	10-07-2010	DH8C - (not coded)
BFU 5X011-10	17-07-2010	A340-600
BFU EX009-10	18-07-2010	737-800
ANSV-10-1085	18-07-2010	A320
ANSV-10-1118	19-07-2010	MD 82
2010-185	21-07-2010	Embraer 170
ANSV-10-1149	23-07-2010	737-400
BFU EX010-10	06-08-2010	737-800
2010057	06-08-2010	RJ-85 AVROLINER
BFU 5X012-10	08-08-2010	Canadair CL-600
10100580	11-08-2010	DC-8-63
10100605	16-08-2010	A319
ANSV-10-1478	20-08-2010	747-400
BFU 5X013-10	20-08-2010	A340-300
ANSV-10-1488	20-08-2010	737-400
10100728	23-08-2010	737-600

1653510694	23-08-2010	PA-28
10100624	25-08-2010	AN-26/AN-26B
BEA tc-e100907	07-09-2010	737-400
ANSV-10-1687	09-09-2010	AN-124
2010/039	10-09-2010	PC-7
10100702	11-09-2010	DHC8-400
N2010-03334	15-09-2010	DHC8
10100707	15-09-2010	31 JETSTREAM
BEA n-fe100918	18-09-2010	777-200
1109617177	19-09-2010	Embraer 145 (145ER)
ANSV-10-1824	23-09-2010	737-800
ANSV-10-1836	24-09-2010	A319
BFU EX011-10	24-09-2010	747-100/200
10100850	30-09-2010	Cessna 680 CITATION SOVEREIGN
476109527	02-10-2010	737-400
10100746	03-10-2010	767-300
1963674619	05-10-2010	A321
BFU 5X015-10	12-10-2010	737-300
ANSV-10-1978	12-10-2010	A320
BEA f-qp101012	12-10-2010	777-300
BFU EX012-10	17-10-2010	A320
ANSV-10-2001	18-10-2010	A321
1096897843	20-10-2010	737-600

2010/041	25-10-2010	A340-600
A-039/2010-010	27-10-2010	737-800
BEA f-jd101030	30-10-2010	A380
ANSV-10-2114	31-10-2010	MD 82
ANSV-10-2186	06-11-2010	FALCON 900
XXX0034	06-11-2010	737-800
BFU 5X014-10	09-11-2010	747-400
BFU EX013-10	16-11-2010	AVRO RJ100
ANSV-10-2233	21-11-2010	MD 82
516289115	26-11-2010	REGIONAL JET SERIES 100/200
BFU 5X016-10	26-11-2010	747-400
10100893	30-11-2010	747-400
BFU AX001-10	02-12-2010	A321
1692171438	06-12-2010	777-200
1069/UUB/LF/2010	11-12-2010	747-400
IN-040/2010-04	16-12-2010	A320
BEA od-a101217	17-12-2010	A330-200
10100923	19-12-2010	A319
1496192467	03-01-2011	Embraer 145 (145ER)
BFU EX001-11	04-01-2011	737-300
11100016	12-01-2011	A320
1958395328	14-01-2011	737-500
BEA f-pm110117	17-01-2011	777-200

AET/AC-2011/1	20-01-2011	DHC8-400
809993776	21-01-2011	REGIONAL JET SERIES 100/200
11100050	04-02-2011	41 JETSTREAM
L-08/11	05-02-2011	737-800
904610781	10-02-2011	Fairchild SA227AC/METRO III
EX004-11	10-02-2011	AN-124
11100067	13-02-2011	777-300
546486826	14-02-2011	A320
2081405821	14-02-2011	777-300
BEA f-gc110222	22-02-2011	A318
J2011007	24-02-2011	A320
11100140	24-02-2011	A320
1649942998	27-02-2011	A320
117383030	27-02-2011	737-800
BFU 5X001-11	27-02-2011	A320
2137224257	02-03-2011	Fairchild SA227 III
1824429385	05-03-2011	A320
BEA f-ae110310	10-03-2011	A321
BFU EX003-11	12-03-2011	737-800
92859381	13-03-2011	737-800
2011/011	15-03-2011	A320
11100264	15-03-2011	737-800
11100135	18-03-2011	Embraer 145 (145ER)

BFU TX002-11	24-03-2011	A380
BFU 6X001-11	27-03-2011	737-800
BFU 6X001-11	27-03-2011	737-800
ANSV-11-0437	28-03-2011	AVRO RJ85
03/31032011	31-03-2011	Let L410VP-E
ANSV-11-481	02-04-2011	MD 82
454740917	07-04-2011	737-800
IN-010/2011	09-04-2011	REGIONAL JET SERIES 100/200
BEA c-vm110410	10-04-2011	777-300
BFU EX005-11	13-04-2011	747-400
ANSV-11-539	13-04-2011	Cessna 550/551 SP CITATION II
IN-011/2011	14-04-2011	737-800
1476907110	17-04-2011	777-200
BEA ei-j110419	19-04-2011	ATR 72-200
BEA f-zg110424	24-04-2011	ATR 72-200
BFU 6X007-11	24-04-2011	MD-11
L-30/11	25-04-2011	737-800
BFU EX006-11	27-04-2011	Cessna 525 CITATIONJET
11100430	01-05-2011	737-800
N2011-01831	05-05-2011	737-800
11100676	12-05-2011	737-800
BEA oh-i110513	13-05-2011	A319
BFU 6X004-11	17-05-2011	DHC8-400

J2011028	20-05-2011	767
ANSV-11-0809	20-05-2011	737-800
ANSV-11-0815	25-05-2011	A320
2011-16-EBBR-SP-LLB	26-05-2011	Boeing B737-45D - (not coded)
XXXX	29-05-2011	A321
BFU EX007-11	02-06-2011	Embraer 145 (145ER)
11100299	04-06-2011	747-400
2011/024	10-06-2011	A319
BFU 6X006-11	10-06-2011	A319
2011-120-4 POL	17-06-2011	ATR 42-500
AAIASB/994	25-06-2011	737-800
BFU 5X008-11	01-07-2011	BAE 146-200
BFU 6X008-11	04-07-2011	737-800
ANSV-11-1205	05-07-2011	A320
IN-021/2011-1182	06-07-2011	737-800
11100619	08-07-2011	A320
L-7411	11-07-2011	BOEING 737
835/11	14-07-2011	ATR 72-200
IRL00911067	17-07-2011	ATR 72-200
BEA g-Id110723	23-07-2011	737-300
XXXX-212	26-07-2011	A300-B2/B4
A-029/2011-1361	30-07-2011	REGIONAL JET SERIES 100/200
BFU 5X005-11	31-07-2011	757-200

BEA f-yo110801	01-08-2011	ATR42-500
2011/037	06-08-2011	A321
BFU 5X006-11	08-08-2011	757-300
BEA f-zh110815	15-08-2011	REGIONAL JET SERIES 700
BFU 5X007-11	15-08-2011	A330-300
ANSV-11-1519	16-08-2011	A320
BFU 6X009-11	17-08-2011	A320
2011/036	17-08-2011	A320
BFU 6X010-11	26-08-2011	MD 82
ANSV-11-1580	26-08-2011	ATR 42-300
ANSV-11-1589	29-08-2011	737-800
ANSV-11-1647	05-09-2011	A300-B2/B4
AAIASB/1688	07-09-2011	757-200
L 96/11	08-09-2011	AVRO RJ85
BEA f-at110912	12-09-2011	A321
BFU 1X001-11	12-09-2011	737-700
11100547	13-09-2011	ATR 72-200
BFU EX008-11	14-09-2011	737-300
ANSV-11-1740	15-09-2011	MD82
BEA ec-j110917	17-09-2011	A320
BEA f-le110920	20-09-2011	Canadair CL-600 Regional Jet CRJ-1000
BEA - Italy I-MLHT	21-09-2011	F27 MK 500
IN-040/2011-1706	01-10-2011	737-800

ANSV-11-1826	03-10-2011	ATR 72-200
BFU 6X013-11	06-10-2011	CASA - C-101 Aviojet - (not coded)
BFU 1X002-11	07-10-2011	737-800
BFU 5X010-11	07-10-2011	A320
BFU 2X001-11	09-10-2011	A320
BFU EX009-11	16-10-2011	A380
BFU 5X011-11	20-10-2011	737-700
IRL00911095	24-10-2011	737-800
PKBWL/PL 1391/11	29-10-2011	AVRO RJ100
PKBWL/PL 1400/11	01-11-2011	767-300
BFU EX010-11	03-11-2011	777-300
BFU EX011-11	06-11-2011	MD80 SERIES
IN-046/2011-1977	12-11-2011	757-200
PL1465/11	15-11-2011	ATR 42-500
XX	16-11-2011	DHC8-400
BEA f-pp111116	16-11-2011	777-200
BFU 5X012-11	18-11-2011	737-700
11100750	18-11-2011	A319
2140/11	18-11-2011	A319
IN-050/2011-2133	20-11-2011	757-200
ANSV-11-2150	20-11-2011	A320
2011-272	23-11-2011	737-800
BEA f-he111124	24-11-2011	A319

BFU 1X003-11	07-12-2011	A320
BFU XXX	13-12-2011	A320
BEA f-hs111213	13-12-2011	A319
BFU 5X013-11	13-12-2011	A320
BFU AX001-11	14-12-2011	DHC8-300
2011/061	16-12-2011	CITATION MUSTANG
11100819	20-12-2011	A321
11100816	23-12-2011	A321
2011/062	26-12-2011	BAE 146-200
ANSV-11-2335	28-12-2011	DHC8-400
BFU EX012-11	29-12-2011	A320
11100823	29-12-2011	Saab 340
BEA ec-l111230	30-12-2011	737-800
ANSV-11-2351	30-12-2011	737-800
BEA e-18111230	30-12-2011	Canadair CL-600
12000408	2012	737
BFU 5X002-12	2012	767
16.15.01.6/12	2012	747
ANSV-12-1365	2012	A319
BFU 5X007-12	2012	737
12000181	2012	737
BFU FX003-12	2012	737
12000486	2012	A319

EW/C2012/02/02	2012	A340
HCLJ510-2012-86	2012	MD88
BFU 5X005-12	2012	A330
DCA12WA034	2012	737
12000243	2012	A321
IN-028-2012	2012	AVRO146RJ
DCA12WA036	2012	737
12000587	2012	A319
IN-036/2012	2012	737
12000058	2012	A320
IN-007/2010-400	2012	A319
12000106	2012	JETSTREAM3100
12000242	2012	737
L-37/12	2012	737
12000068	2012	AN12
12000281	2012	737
ENG12WA027	2012	747
12000540	2012	ATR72
ENG13RA002	2012	A330
BFU 2X003-12	2012	Cessna 750
BFU 5X001-12	2012	A319
BFU AX001-12	2012	737
12000197	2012	A320

BFU 6X005-12	2012	A320
12000625	2012	737
ANSV-12-2137	2012	A320
13000019	2012	A319
ANSV-2012-174	2012	Learjet 60
BFU 6X004-12	2012	A320
BFU 5X003-12	2012	A319
12000675	2012	A321
12000469	2012	Saab 340
BEA f-zu120313	2012	A340
12000261	2012	A340
IRL00912049	2012	ATR72
12000028	2012	A319
12000064	2012	Saab 340
12000074	2012	A319
IN-009/2012-583	2012	A320
12000191	2012	A300
12000200	2012	737
12000282	2012	A319
BFU 5X011-12	2012	A321
127/12	2012	MD82
BFU 1X001-12	2012	Canadair CL600 2D24
CZ-12-034	2012	ATR42

L-15/12	2012	AVRO146RJ
12000213	2012	DHC8
2012033	2012	777
ANSV-12-0188	2012	ATR42
185/12	2012	777
12000192	2012	A330
12000328	2012	ATR42
12000637	2012	A319
12000639	2012	Canadair CL600 2C10
12000688	2012	A300
02/17052012	2012	A320
BFU 1X002-12	2012	737
BFU AX002-12	2012	ATR72
ANSV-12-1377	2012	A320
12000436	2012	JETSTREAM4100
12000205	2012	BAE (AVRO RJ100)
12000229	2012	F28
BFU BX001-12	2012	Dornier 328
HCLJ5210-2012-096	2012	Saab 2000
12000406	2012	JETSTREAM3100
12000638	2012	737
12000313	2012	Fokker 70
BFU 6X010-12	2012	737

BFU 6X013-12	2012	A321
HCLJ510-2012-172	2012	A319
12000095	2012	ATR42
2012/049	2012	Saab 2000
BFU 5X004-12	2012	737
BFU 6X008-12	2012	Embraer ERJ190
ANSV-12-2041	2012	767
12000054	2012	ATR72
2012/023	2012	F28
48/2015	2012	737
12000250	2012	A320
12000407	2012	ATR42
13000017	2012	737
BFU 6X002-12	2012	757
12000405	2012	737
ANSV-12-0602	2012	ATR72
12000466	2012	JETSTREAM4100
ANSV-12-0789	2012	Saab 2000
12000446	2012	757
BFU 6X016-12	2012	Dornier 328
ANSV-12-2245	2012	737
12/218-7	2012	737
2012/025	2012	A320

BFU EX001-12	2012	A320
12000756	2012	A320
ANSV-12-1383	2012	A320
ANSV-12-1946	2012	777
CZ-12-514	2012	ATR42
12000471	2012	FANJET FALCON
2013/057	2013	A320
ANSV-13-0132	2013	ATR72
13000095	2013	A310
13000295	2013	737
BEA f-ni130802	2013	A320
BEA ok-t131002	2013	ATR72
L-46/13	2013	JETSTREAM3100
13000352	2013	A320
A-028-2013	2013	ATR72
BFU EX010-13	2013	A320
BEA f-zl130305	2013	ATR72
13000499	2013	767
L2013-02	2013	A320
13000318	2013	A320
BEA f-qj130107	2013	777
IRL00913022	2013	Fairchild SA227
13000273	2013	777

2013/034	2013	BAE (AVRO RJ100)
ANSV-13-1052	2013	A320
BEA f-ne130311	2013	A320
2013/56	2013	737
DCA13WA067	2013	737
ANSV-13-1656	2013	A320
2013/051	2013	A320
ANSV-13-2237	2013	737
201304063	2013	JETSTREAM3100
BFU 1X001-13	2013	A320
HCLJ510-2013-190	2013	Fokker 70
AAIASB/930	2013	737
2013/028	2013	F28
ANSV-13-2979	2013	Canadair CL600 1A11
DCA13WA092	2013	767
BFU AX001-13	2013	BAE-ATP
IN-015/2013-1326	2013	757
BFU 5X007-13	2013	Canadair CL600 1A11
BFU EX007-13	2013	A320
2013-06-20-03	2013	A319
BFU 5X006-13	2013	A320
34/2016	2013	757
13000050	2013	A330

AAIASB/1202	2013	A330
13000144	2013	ATR72
13000310	2013	737
13000142	2013	AVRO146RJ
BFU 6X003-13	2013	A319
03/24052013	2013	A320
13000235	2013	A319
BFU EX005-13	2013	737-800
BFU EX009-13	2013	GULFSTREAM150
13000331	2013	737
13000424	2013	Canadair CL600 2D24
13000092	2013	757
BFU 5X004-13	2013	CANADAIR (REGIONAL JET SERIES 900)
BEA tc-z130926	2013	A321
13000374	2013	DHC8
13000549	2013	A321
13000049	2013	737
BFU 5X001-13	2013	A330
BEA f-qa130728	2013	777
2013/059	2013	Saab 2000
BEA sx-s130329	2013	A321
AAIASB/835	2013	737
ANSV-13-2385	2013	A320

ANSV-13-2778	2013	737
201301144	2013	FALCON7X
13000172	2013	BAE-ATP
13000249	2013	737
13000338	2013	A320
201306643	2013	747
BFU EX003-13	2013	Bombardier BD100 1A10
201311970	2013	BAE146
BFU12345	2013	777
ANSV-13-0302	2013	MD82
201313388	2013	ATR72
201300501	2013	A321
BFU6	2013	A330
DENMARK	2013	MD88
BFU2	2013	Embraer ERJ170
201307441	2013	A330
201314981	2013	737
201315939	2013	Gulfstream GV
201310418	2013	757
201306006	2013	A319
201311719	2013	767
201310703	2013	757
201308040	2013	A320

201308425	2013	787
201312247	2013	JETSTREAM4100
DENMARK1	2013	ATR72
201302228	2013	737
Germany-M-YBZI	2014	Canadair CL600 2A12
BEA g-im140901	2014	A319
38/2016	2014	Embraer ERJ190
BEA ei-l140102	2014	ATR72
BEA g-td140602	2014	A320
BFU AX001-14	2014	A320
14/047	2014	ATR72
14000441	2014	Canadair CL600 2C10
BEA lv-v140705	2014	A340
D-AIDP	2014	A321
36/2015	2014	737
14/046	2014	A320
EW/C2014/10/01	2014	BAE-ATP
EX007-14	2014	747
ANSV-14-0050	2014	Embraer ERJ170
L-0004/14	2014	F27
14000654	2014	ATR72
ANSV-14-1899	2014	A319
1863/14	2014	Canadair CL600 2D24

EW/G2014/05/08	2014	ATR72
EW/C2014/08/02	2014	JETSTREAM3100
EW/C2014/12/01	2014	Saab 2000
BEA ei-v140116	2014	A320
14/044	2014	A319
2014-4-EBCI-EI-DYS	2014	737
BEA ok-s140818	2014	ATR72
BEA2014-0049	2014	A320
HCLJ510-2014-273	2014	737
D-CPWF	2014	Dornier 328
ES-PJA	2014	BAE JETSTREAM3100
1752/14	2014	737
IN-028/2014 - 1475	2014	A319
14000029	2014	Canadair CL600 2C10
12/2015	2014	A330
04/ACCID/2014	2014	737
2014-093	2014	A320
BEA oy-v140722	2014	ATR72
Germany, N-120UA	2014	747
A-022/2014-1603	2014	737
14/687-7	2014	737
2014000	2014	A380
BEA cs-p140425	2014	A320

14/650-3	2014	BAE-ATP
Germany, OE-LBM	2014	A320
Portugal, OY-EBW	2014	ATR72
HB-IZG	2014	Saab 2000
EW/ C2014/06/04	2014	737
EW/ G2014/08/13	2014	A320
BEA Iz-b140129	2014	A319
EW/C2014/04/03	2014	737
EW/G2014/07/31	2014	737
I953/14	2014	DHC8
24/2015	2014	747
BEA ec-u141030	2014	737
L-148-14	2014	ATR72
Sweden ES-PJR	2014	JETSTREAM3100
14/2015	2014	A320
Italy, F-GTAZ	2014	A321
IRL00914024	2014	737
EW/ C2014/11/01	2014	Gulfstream G1159A
EW/G2014/04/11	2014	Bombardier BD700 1A10
EASA-2015000075	2015	JETSTREAM4100
EASA-2015001366	2015	737
EASA-2015001986	2015	Canadair CL600 2D24
EASA-2015002004	2015	Cessna 550

EASA-2015002165	2015	A319
EASA-2015000345	2015	Let L410
EASA-2015002685	2015	737
EASA-2015001249	2015	DHC8
EASA-2015001854	2015	757
EASA-2015000353	2015	A320
EASA-2015001164	2015	737
EASA-2015001489	2015	737
EASA-2015001810	2015	ATR72
EASA-2015000842	2015	737
EASA-2015002451	2015	A320
EASA-2015002463	2015	737
EASA-2015003088	2015	737
EASA-2015002152	2015	DHC8
24/2016	2015	Saab 2000
EASA-2015001742	2015	A319
EASA-2015002190	2015	ATR72
EASA-2015002617	2015	AVRO146RJ
EASA-2015002999	2015	A330
EASA-2015000483	2015	A320
EASA-2015000984	2015	A319
EASA-2015001236	2015	A321
EASA-2015001265	2015	737

EASA-2015001196	2015	767
EASA-2015003008	2015	A320
EASA-2015003003	2015	737
EASA-2015001008	2015	A320
EASA-2015003005	2015	A321
EASA-2015001598	2015	Embraer ERJ195
EASA-2015003023	2015	Embraer ERJ190
EASA-2015001737	2015	A319
EASA-2015001908	2015	A319
EASA-2015000311	2015	737
EASA-2015000841	2015	737
EASA-2015002491	2015	A320
EASA-2015000117	2015	A320
EASA-2015002288	2015	DHC8
EASA-2015002348	2015	ATR72
EASA-2015001200	2015	Beech 400
EASA-2015001800	2015	737
EASA-2015001801	2015	DHC8

Appendix C Data sample for risk matrix

Airprox data

Airprox data from the UK Airprox Board were used to estimate the frequency of occurrence of serious, major, and minor airprox incidents. The severity levels A, B, C, D and E used by the UK Airprox Board were 'translated' into Serious incident, Major incident, Minor incident, Risk not determined, and No safety effect. Table 4 shows airprox data for the years 2006-2015, and Table 5 shows the corresponding exposure in flight hours. Note that encounters between Commercial Air Transport (CAT) and drones are included in the figures. Between brackets the number is given of airprox events that did not involve a drone/object.

Table 4: Airprox occurrence data for CAT (Source: UK Airprox Board)

Occurrence data airproxes	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Assigned severity level
CAT Risk A (risk bearing airprox)	0	0	0	0	0	0	1	1	2(1)	9(0)	Serious incident
CAT Risk B (risk bearing airprox)	6	5	2	1	0	1	0	3	4(3)	13(3)	Major incident
CAT Risk C	68	60	58	33	33	18	23	14	15(14)	13(11)	Minor incident
CAT Risk D	0	0	1	1	2	0	4	3	2(1)	7(1)	Risk not determined
CAT Risk E	0	0	0	0	0	3	7	12	8(8)	7(6)	No safety effect
CAT Total	74	65	61	35	35	22	35	33	31(27)	49(21)	

Table 5: Exposure according to the UK Airprox Board for CAT flight hours (Source: UK Airprox Board)

2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
1603000	1620000	1635000	1494000	1416000	1471000	1454000	1490000	1515000	1548000

With the exposure data from Table 5 the frequency per CAT flight hour of the airprox events of different severity levels can be estimated, see Table 7. The number of airprox events is multiplied by a factor of two, since two aircraft are involved in an airprox or mid-air collision. The distribution of airprox events over the type of operation of aircraft involved, i.e. CAT, general aviation (GA), military aviation, drones, is not readily available. For this example it was therefore simply assumed that the number of airprox

events involving at least one CAT aircraft can be multiplied by two for airprox events excluding drones. When the CAT airprox involves a drone, the event is counted as involving one CAT aircraft only. In reality some of the airprox events from Table 4 are between CAT and GA or military aircraft. Those events should actually be counted as involving only one CAT aircraft.

The accident and serious incident risk per flight from Table 3 were converted into a probability per flight hour using an average of 90 minutes per flight (according to the Standard Inputs for EUROCONTROL Cost-Benefit Analyses).

For demonstration purposes a risk matrix and trend line were developed based on Table 3 and Table 7, and illustrated by Figure 6 in section 2.7.

Table 6: Estimated frequency of occurrence of mid-air collision and airprox events.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Accident rate	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08	1.9E-08
Serious incident (cat A)	0	0	0	0	0	0	1.4E-06	1.3E-06	2.0E-06	5.8E-06
Major incident (cat B)	7.5E-06	6.2E-06	2.4E-06	1.3E-06	0	1.4E-06	0.0E+00	4.0E-06	4.6E-06	1.0E-05
Minor incident (cat C)	8.5E-05	7.4E-05	7.1E-05	4.4E-05	4.7E-05	2.4E-05	3.2E-05	1.9E-05	1.9E-05	1.6E-05

Table 7: Estimated frequency of occurrence of airprox events.

Severity level	Average frequency per flight hour	Source
Accident	1.92E-08	Table 3 (1995-2015)
Serious incident	2.16E-06	Table 3 (1995-2015)
Major incident	3.78E-06	UK Airprox Board (2006-2015)
Minor incident	4.30E-05	UK Airprox Board (2006-2015)

In-flight fire and smoke events data

Data from internal occurrence reporting systems from operators were used to estimate the frequency of occurrence of major and minor level in-flight fire/smoke events. The accident and serious incident risk per flight from Table 3 was used in addition. For illustration purposes a risk matrix was developed using an average frequency of occurrence (see Table 8 below and Figure 5 in section 2.7).

Table 8: Estimated frequency of occurrence of in-flight fire/smoke events.

Severity level	Average frequency per flight	Source
Accident	1.08E-07	Table 3 (1995-2015)
Serious incident	8.13E-07	Table 3 (1995-2015)
Major incident	9.89E-05	Operators reporting system (2011-2014)
Minor incident	4.21E-04	Operators reporting system (2011-2014)