SAFETY IN AND AROUND AIRPORTS

SUMMARY

During the last ten years 82 per cent of the world's jet aircraft fleet accidents occurred during take off and landing phases and accounted for 58 per cent of all onboard fatalities and all third party fatalities. Over the next 20 years annual passenger traffic is set to grow by as much as 168 per cent. The need to increase airport capacity in an era of decreasing public tolerance of the environmental effects such as noise, air pollution and third party risk of airports, lead actors in the air transport domain to devise new technologies and innovative ways of operating airports and aircraft. However, developments give rise to concerns about the emergence of new hazards and difficulties in containing existing hazards in and around airports.

There are effective ways of managing and containing the risks which require initiatives at European level. A common framework for management of the risks outlined is proposed and the following recommendations for action by the European Union are made:

- Mandatory airport licensing including a requirement to establish, maintain and ensure adherence to an integrated safety management programme.
- Mandatory collection of data on ground-based incidents, with appropriate emphasis on organisational and corporate culture factors.
- Mandatory inclusion of third party risk in Environmental Impact Statements for airports.
- The development of common standards for the safety assessment of operations.
- Further research to bridge current gaps in knowledge.

1. Aims

The aim of this briefing document is to establish that there is an issue which needs to be addressed at European level in relation to the management of safety in and around airports. This issue arises because of the interaction of a number of different trends (in technology, traffic and environment). The interaction of these recent trends poses an increase in identifiable risk. Another reason for specific immediate attention to airport safety lies in the emerging evidence, primarily created in the wake of the 747 crash in Amsterdam in 1992, which shows that the risk to the population living around the airport due to possible aircraft accidents, is comparable to the risk around chemical plants, which are strictly regulated in that regard. And finally, recent events (Dusseldorf 1996 and Heathrow 1997) show that the safety of large numbers of occupants of terminal buildings may be jeopardised in case of an emergency (for example, fires).

While the concerns mentioned address different groups of people, the risks involved share common causal domains which is why the actions recommended in this document will in many cases improve the safety of very large groups of people. The precise identification of the parameters of this risk may be relatively uncertain because appropriate data (accidents, incidents, audits, etc.) are not systematically collected on processes relevant to safety, specifically in and around airports. Furthermore, the institutional framework of

accountability for safety is diffused between airport authorities, airlines, civil aviation authorities and other airport users in a way which does not facilitate an effective response to the safety issues which are emerging.This document will seek, therefore, to identify the safety parameters of these emerging trends in and around airports, outline the type of countermeasures which need to be instituted, identify the need for further research to clarify gaps in the evidence, and make appropriate recommendations in the light of existing evidence.

2. Review of safety in and around airports

2.1 Emerging trends

Rapidly increasing traffic volumes and forecasts of continued growth into the next decades put a strain on airport capacity. Airbus Industrie, for example, predicts an average annual passenger traffic growth rate of 5.0 per cent during the next 20 years, which means that during this time traffic will increase by 168 per cent (1). At the same time, public tolerance of the environmental effects of air traffic around airports such as noise, air pollution and third party risk would appear to have decreased. These conflicting trends lead airports, airlines, air traffic control organisations and the aircraft and equipment industry to devise new technologies and innovative ways of operating airports and aircraft in order to meet both the capacity demands and the environmental limitations. Safety is not the objective of these developments; it is a mere constraint. Consequently, new hazards emerge and existing hazards become difficult to contain unless adequate attention is given to safety aspects in this combination of emerging trends.

In addition, a new dimension, third party risk, presented itself as a safety concern in a growing number of European countries. Airports are hubs in the air transport system. Consequently, their presence causes a convergence of air traffic over the area surrounding the airport. For the population living in the vicinity of an airport this implies involuntary exposure to the risk of aircraft accidents. Although the probability of an accident per flight is very small (typically in the order of 1 in one million), local risk levels around airports are higher than one might expect. This is caused by the fact that, while the probability of an accident per take-off or landing is very small, the number of landings and take-offs is often very large (typically several hundred thousand). The resulting annual probability of an accident at a typical large airport is therefore much greater than the small probability of being involved in an aircraft accident as a passenger.

In addition, accidents tend to happen during the take-off and landing phases of flight and hence close to an airport. Safety data from studies show that approach and landing phase accidents account for a significant proportion of fatal air transport accidents. From Table 1 it can be seen that 82 per cent of the world jet aircraft fleet accidents between 1988-1997 occurred in these flight phases and accounted for 58 per cent of all fatalities (2). Historical data confirms that aircraft accidents involving considerable numbers of third party victims occur several times a year. Probably the best known example is the tragic accident of a Boeing 747 in suburban Amsterdam in 1992. Recent accidents occurred in Taiwan (Taipeh), Russia (Irkoetsk), Paraguay and Zaire (219 3rd party victims). This environmental effect is of growing significance to airports safety responsibility and decision making on airport development and land-use planning for airport regions.

Table 1: Accidents and Onboard Fatalities by Phase of Flight, Worldwide Commercial Jet Fleet 1988-1997 Source: Boeing Commercial Airplane Group

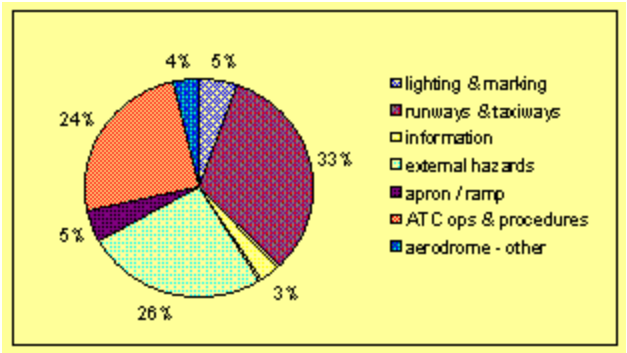
	Accident (100 per cent)	Fatalities (100 per cent)	Exposure (Percentage of flight time based on flight duration of 1.5 hours) (100 per cent)
Taxi, load, parked	8	0	-
Takeoff	16	6	1
Initial climb	5	5	1
Climb (flaps up)	7	23	14
Cruise	9	9	57
Descent	2	10	11
Initial approach	6	17	12
Final approach	11	26	3
Landing	36	4	1

2.2 The safety evidence

Airports play an important role in the safety of air traffic. A recent analysis of accidents showed that around 30 per cent of these accidents involved at least one airport related factor in the causal chain leading up to the accident (3). Airport related factors in this case are taken as those factors which are specific to the airport environment but are not necessarily owned by the airport (and may thus include issues such as snow, fog, inadequate ATC guidance, etc.). The relative importance of airport causal factors may be estimated from their relative frequency of occurrence in causal chains of accidents in the above-mentioned dataset. To this end, the 76 different airport related causal factors found, were grouped into seven categories. These categories are:

- Lighting and marking (approach lighting, sign lighting, stop bar lighting, etc.)
- Runways and taxiways (runway length, obstructions, taxiway surface condition, etc.)
- Information (aerodrome hazard notifications, weather reports, runway information, etc.)
- External hazards (snow, fog, turbulence, wake vortex, etc.)
- Apron and ramp (apron/ramp congestion, apron/ramp surface condition, etc.)
- ATC operations and procedures (approach procedures, communication phraseology use, separation judgement, etc.)
- Aerodrome - other (aerodrome structures, VASI/PAPI, etc.)

Figure 1: Results of the above analysis: distribution of airport related causal factors.



This analysis demonstrates that all parties interacting around the airport are part of the problem and consequently part of the potential solution. Gaining further insight into the causal background of risk around airports is hampered by the fact that there is little systematic collection of accident and incident data concerning air transport incidents occurring or originating on the ground, either in ground operations or maintenance. Within the accident information which is being collected, a general lack of attention to the organisational factors and corporate culture factors in data collection taxonomies is present which further impedes deeper insight.

Recent European accident investigations have, for example, highlighted major deficiencies in the safety systems of many organisations in European airports; two examples of these include the incident at Daventry in 1995 and the accident in Edinburgh in 1991 which highlighted organisational and regulatory failures in the maintenance domain and in ground handling operations respectively.

The evidence presented here sheds light on the safety problems associated with airports and provides information on the broad categories of accident causal factors which are currently a threat to safety at airports. It is expected however that new developments and changes in traffic volume will have an influence on the nature of these accident casual factors. This briefing will examine how these factors will change as a result of new developments, in particular technological and operational, and in view of the predicted growth in traffic volume.

2.3 The institutional framework

2.3.1 The regulatory framework in Europe

European airports are regulated in accordance with ICAO standards. Airports in many European countries are not licensed however, primarily because they are or used to be state-owned/operated. The absence of licensing systems with a periodical renewal process does not facilitate strict regulatory oversight.

In addition, the regulations regarding airports prescribe, in accordance with ICAO Annex 14, what an airport should have as equipment and infrastructure. National authorities regulate adherence to these standards. At European level requirements are needed regarding the way in which the airport should be operated and how safety should be managed. Some countries, notably the UK (CAP 642), the Netherlands and the Nordic countries have established national regulations concerning the management of safety and are considering a harmonisation of their regulations in this regard.

2.3.2 The organisational framework

Airports are complex multi-organisational systems, with diverse safety standards and practices. Frequently, there is a lack of integration amongst airport users with regard to these safety standards and practices. In view of the multi-organisational nature of risks in the operation of airports, the lack of a mechanism to integrate the safety standards and practices of the different actors in and around the airport has a detrimental effect on safety. Such a mechanism is difficult to establish since the respective actors in the overall airport organisation are subject to different regulatory regimes. These include aircraft maintenance, flight operations, ground handling including fuelling, security services, airside services and air traffic control. Even where some of these processes are frequently done by the same organisation, they are usually subject to different management systems, different training standards and exhibit a different safety culture.

3. Airport safety priorities

The following critical safety issues need to be addressed in order to prevent an increase in the airport-related safety deficiencies which may result from operational and technological developments.

3.1 Safety concerns resulting from operational developments

3.1.1 The wind and turbulence environment of airports

The wind and turbulence environment at airports is a matter of growing concern. Airports tend to attract corporate real estate. Offices and other buildings are increasingly being located in the immediate proximity of runways. The wind turbulence caused by these buildings has been such that in some cases aircrews have temporarily lost control of the aircraft shortly before touchdown or shortly after lift-off resulting in serious incidents. Due to the large monetary value of building space at airports, the pressure to allow such building activities will continue to grow. The current ICAO obstacle clearance criteria do not provide adequate protection. A lack of understanding of the turbulence aerodynamics and aircraft dynamic responses to turbulence upsets hampers the development of appropriate regulation.

3.1.2 Wake vortex

Wake vortex constraints govern the minimum required distance (separation) between aircraft lined up in sequence on the approach to the runway. During peak capacity operations, this distance effectively determines runway capacity and thus airport capacity . Capacity constraints lead air traffic control organisations and airports to considering a reduction in separation minima from the current minima under certain conditions. At the same time, increasing use of parallel runways or other combined use of runway configurations and the future arrival of Very Large Aircraft gives rise to a possibly worsening wake vortex environment at airports. These developments do increase the risk of loss-of-control accidents in the final approach and landing phase. Wake vortex modelling is currently being researched as is the use of ground based or airborne sensors to identify and locate wake vortices and the development of associated procedures. These developments must be examined with a view to developing certification standards.

3.1.3 Safety of noise abatement procedures

Environmental constraints, and in particular the noise issue, are increasingly becoming the limiting factor in airport capacity. This, in turn, leads to airports and ATC organisations to develop advanced arrival and departure procedures such as Continuous Descent Approaches, Reduced Flap Approaches, Delayed Gear Approaches, etc. Such procedures may bring about a reduction in safety margins and therefore need close scrutiny. In addition, there are workload concerns and error proneness concerns. Also, the pressure to maximise noise preferential runway utilisation leads to the consideration of relaxed crosswind limitations by airport and ATC organisations which may put aircrews close to controllability limitations. In addition controller workload concerns with regard to the advanced procedures must be carefully considered, particularly when utilising mixed modes.

3.2 The safety implications of new technologies

3.2.1 Enhanced and Synthetic Vision systems

Head up displays are increasingly finding their way onto civil flight decks as a cheap

alternative to autoland systems to allow operations under reduced weather minima. Although such systems are attractive alternatives to conventional systems, certifiability poses a serious safety concern. The same is true for Enhanced and Synthetic Vision Systems (E&SVS). These systems offer a potential safety improvement, but when utilised to reduce operational minima may pose safety problems. In view of the fact the investment in such systems by operators is likely to be made only if, in addition to a potential safety benefit, a financial return can be generated through less cancelled flights and the associated competitive edge, the safety implications should be reviewed. A safety concern related to these technologies lies in the fact that emergency response units may have trouble locating an accident aircraft on the airport in zero visibility conditions.

3.2.2 Very Large Aircraft

The introduction of Very Large Aircraft will give rise to problems of compatibility with the existing design and infrastructure in many airports. Such aircraft are likely to require more ground service equipment at stands than current aircraft. Problems of access to ground service equipment in congested airport apron environments may increase the risk of aircraft damage, which has the potential to compromise flight safety.

3.3 Disaster management plans

Air accidents frequently occur near, rather than at, airports. Therefore integrating the activities of local and airport emergency services becomes a major issue for planning. ICAO requires major accident simulations and exercises on regular annual basis. However this requirement does not encompass planning for potential accidents outside the airport limits. Furthermore recent experience of major disasters has highlighted the importance of planning to manage the traumatic aftermath of major disasters for survivors, relatives and operational personnel. Recent US regulations place requirements on airlines to draw up plans and commit resources to dealing effectively with the traumatic aftermath of aviation disasters (Federal Family Assistance Plan for Aviation Disasters). Consideration should be given to how such a scheme could be instituted in Europe. Planning for an effective response to disaster at or near an airport places a particular requirement for co-ordination between emergency services, for both short term and long term response; it should encompass such aspects as the accessibility of potential accident sites near the airport to emergency vehicles. Experience has also shown the critical importance of effective and comprehensive debriefing following emergency exercises. Such debriefing should include all staff who have a role in the disaster response and is essential if the organisation is to evaluate its preparedness and to learn how to improve its disaster planning.

4. Managing risk

4.1 A common framework for risk management

A common, high safety standard at an airport cannot be achieved by any single actor since the level of safety at the airport is to a large extent governed by the interaction of multiple organisations. An integrated safety management system involving all organisations operating at the airport is thus required. An example of such a program is the Integrated Safety Management System at Amsterdam Schipol Airport. In this system, the airport itself, the main airlines, a representative of all other airline operators, ground handling providers, refuelling services, and the air traffic control organisation work together to improve safety. To that end, parties have established a Terms of Reference, have regular meetings and use a common Operational Airport Information System. All participating organisations are

connected to this system and enter information on air and ground incidents into a common database. This information exchange, the regular meetings and common objectives provide the necessary premises for the early identification of safety bottlenecks, the design of achievable corrective measures and their effective implementation. Consideration needs to be given to how this approach could be developed on a European level.

4.2 A common methodology for risk assessments

In order to promote fair competition and equally high levels of safety across Europe, there should be a common frame of reference for the assessment of new procedures and technologies with regard to safety. While current regulations provide adequate guidance for airworthiness assessments of systems, they do not adequately support the procedural aspects of the safety assessment of new technologies and advanced procedures. In fact, a commonly accepted method which specifically addresses the human operator and the procedural aspects in an appropriate manner does not yet exist. Promising developments in this field are ongoing in the European Air Traffic Control Harmonisation and Integration Programme (EATCHIP) activities of EUROCONTROL. Those and other initiatives should be supported.

4.3 A common framework for managing the risks to third parties

Increasing traffic volumes stretch the air transport infrastructure to its limits and require a considerable increase in available airport capacity. Increases in airport capacity usually necessitate new or improved runways and terminals, and changes in route structures and traffic distributions. Such developments bring about the need to prepare environmental impact statements that also address the issue of third party risk. This has led to considerable progress being established in methods and models for the calculation of third party risk around airports. The results of these calculations often carry a high political charge and form (part of) the basis of far-reaching and very costly infrastructural developments. In order to secure the well being of European citizens, but also in support of fair competition among European airports, European legislation in this regard is necessary. A further reason for urgent European action is the fact that apart from legislation on noise, there is still relatively little national airport legislation and in particular legislation on land use around airports. The establishment of risk tolerability criteria for land use planning purposes as well as common risk assessment methodologies should be pursued.

5. Areas requiring further research

Effective policy making on several of the safety concerns identified in this paper is impeded by a lack of essential knowledge. In order to bridge those gaps in knowledge the following issues require further research:

- The establishment of common methods and tolerability criteria for third party risk.
- The development of adequate methods and models to incorporate the role of human operator and procedural aspects in formal safety assessments.
- The safety aspects of new technologies such as enhanced and synthetic vision systems, Head Up displays for civil cockpits.
- Airport wind and turbulence environments and their dynamic effects on aircraft in take-off or landing
- The operation of safety systems in a multi-organisational environment
- Methods of analysis of organisational precursors of accidents and incidents

- Evaluation of planning for disasters

6. Recommendations for action

In order to effectively address the safety priorities discussed above, the following actions by the European Commission are recommended.

- Mandatory airport licensing including a requirement to establish, maintain and ensure adherence to an integrated safety management programme.
- Mandatory collection of data on ground-based incidents, with appropriate emphasis on organisational and corporate culture factors.
- Mandatory inclusion of third party risk in Environmental Impact Statements for airports.
- The development of common standards for the safety assessment of operations.
- Research support on the issues identified above.

7 References

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