EARPG

European Aviation Research Partnership Group

EARPG Thematic Programme 2011 - 2013

29 March 2011

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Executive Summary

For many years the National Aviation Authorities (NAA) have developed and financed research in the field of aviation safety and environmental protection to ensure that requirements are justified and regulations are written on a sound scientific basis. Safety research can for instance reduce the likelihood of negligent or inappropriate regulations.

With the foundation of EASA which has in its Basic Regulation the permission to develop and launch research projects and to coordinate them with the Commission and the Member States, the European Aviation Research Partnership Group (EARPG) was created. The objective is make optimal use of available resources and synergies by jointly setting priorities for research projects providing answers to emerging safety and environmental protection issues and to fulfil the Agency's coordination function.

Supporting a coordinated development of individual Research Plans for the Agency and the NAAs, the EARPG developed this Thematic Programme as a guidance document which also may serve as an input to the definition of the EC Framework Programme. Thematic areas for research were identified particularly by referencing the top priorities of the European Aviation Safety Plan (EASP) and results of proactive analysis processes such as the European Strategic Safety Initiative (ESSI) under the management of EASA. Since human factors related accidents are still a significant contributor to the accident rate recommendations for research from the European Human Factors Advisory Group (EHFAG) are incorporated in the Thematic Programme.

The EARPG Thematic Programme comprises a timespan of three years as this is a period which can realistically be overviewed and managed. However, the programme will be continuously amended once a year and when deemed necessary by also taking into consideration stakeholder opinions.

1. Introduction

EARPG Objectives and Scope

The European Aviation Research Partnership Group (EARPG) has been formed with representatives of EASA, National Aviation Authorities (NAA), European Commission DG MOVE and DG RTD and EUROCONTROL through with the following main objectives:

- gather information from the EASA member states on on-going and planned research programmes,
- identify and coordinate priorities to avoid unnecessary duplication of work,
- establish collaborative programmes where appropriate.

Purpose and Structure of the document

The document contains the identified priority thematic areas for research activities identified by the partners for a timespan of three years (2011-2013) as this period can realistically be overviewed and managed.

The document will be periodically amended (once a year at least) and other aviation stakeholder proposals will be taken into consideration.

2. Background

The purpose of doing aviation safety research is generally to ensure that safety regulations are written on a sound scientific basis. Research can also address wider issues where the solutions to problems are not known. The deliverables from research are usually technical papers and guidance material rather than products e.g. a new type of safety equipment. The regulator may then be in a position to develop appropriate rules and/or other associated material. Research and development in the field of safety equipment is seen by EASA and most National Aviation Authorities (NAAs) as an innovative activity for industry to address, although regulators need to be familiar with the regulatory issues that may then be raised.

Safety research can reduce the likelihood of negligent or inappropriate regulation. For example, new structural material, e.g. used in new fuselage design, is of composite construction but current regulations have evolved with the experience of metals. Thus, to maintain the high level of safety it is important to fully understand the characteristics of these new structural materials and the equivalence to metallic structure, e.g. in the area of damage tolerance or the development of toxic gases in the event of the fuselage skin burning during an in-flight fire. If no research is undertaken, the certifying aviation authority would be largely reliant upon just the information supplied by the manufacturer. In addition, Europe may be put at commercial disadvantage if a foreign regulator should choose to impose an unresearched and possibly unjustified safety restriction on a European aviation product.

Research can be initiated as a result of an accident, incident experience, a change in the aviation industry such as a new generation aircraft with a wide range of novel technology or as a result of a proactive analysis process such as the European Strategic Safety Initiative (ESSI) under the management of EASA.

Since 2010 safety issues of priority have been organised in a Safety Plan addressing pan-European-wide safety issues. Furthermore, this European Aviation Safety Plan (EASP) also proposes dedicated action items to address them.

In this strategic approach the various activities contributing to the improvement of safety in Europe are grouped in three complementary functions: rulemaking, oversight, and safety assurance and promotion. Fostering research in areas where safety concerns exist is a crucial part of the safety assurance and promotion function.

SAFETY PLAN FRAMEWORK		
SYSTEMIC ISSUES	**OPERATIONAL ISSUES**	**EMERGING ISSUES**
Working with States to address SSPs	COMMERCIAL AIR TRANSPORT BY AEROPLANES	New products, systems, technologies and operations
Working with States to foster the implementation of SMS in the industry	Runway Excursions	Environmental factors
Safety Management enablers	Mid-air collisions	Regulatory considerations
Complexity of the system	Controlled Flight Into Terrain	Next Generation of Aviation Professionals
	Loss of Control In Flight	
	Ground Collisions	
	OTHER TYPES OF OPERATION	
	Helicopters	
	General Aviation	
HUMAN FACTORS AND PERFORMANCE		

Figure 1: European aviation Safety Plan (EASP) framework

3. Framework for Research Focus Areas

3.1. Identification of Research Needs

The identification of research needs is based on a set of general criteria (scope) that encompass the mission and goals of the cooperation between National Aviation Authorities and EASA. The priorities and defined actions set up in the European Aviation Safety Plan (EASP) are also duly considered.

On high level the criteria are the following:

1. Contributing to air transport system and/or aviation safety, namely the EASP;
2. Contributing to the execution of the tasks and responsibilities of the Agency and other National Aviation Authorities;
3. Contributing to improvement and perfection of the tasks and expertise;
4. Relating and contributing to better understanding of aviation safety aspects;
5. Constraints by non-availability of an appropriate research funding;

6. Risk Considerations.

Experience from existing certification projects may well raise questions which need further ad hoc research.

In identifying research needs it is essential that there is a high degree of confidence that potential hazards have been identified. Full use of prior studies is made and will continue to be made so as to ensure a sound and comprehensive coverage of risk areas prior to develop new research project.

3.2. Links to Agency's and National Research Plans

Besides the European Aviation Safety Plan, the EARPG Thematic Programme is for the Agency the second specific source for the development of the EASA Research Plan. Prior to approval by the EASA Internal Safety Committee the research plan is revised and updated annually taking into account revisions of the EASP and the Thematic Programme.

Member States are encouraged to also include the EARPG thematic areas for potential research as part of their national research programmes and to share the actions taken to address the issue as well as the measures that are in place to monitor their effectiveness.

Member States not in a position to include a topic in their national programme will be able access the results to provide a justification for proceeding a certain way and policy.

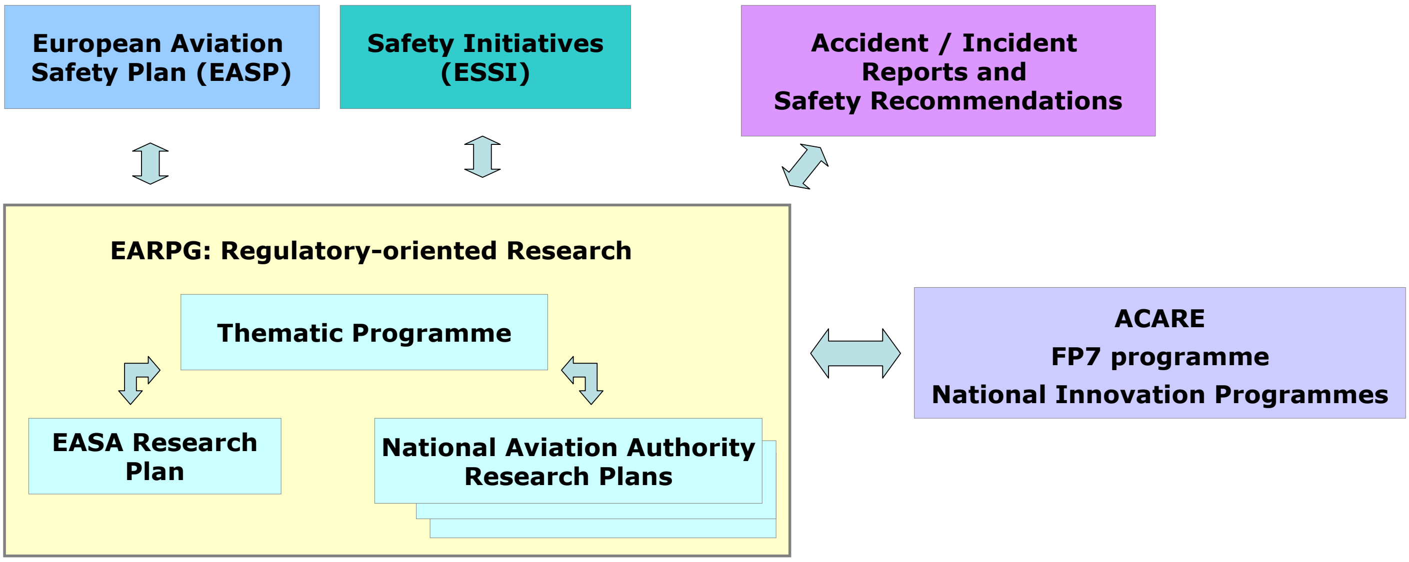

Figure 2: EARPG context and information flows

3.3. Operational Issues

3.3.1. Commercial Air Transport by Aeroplanes

- **Runway Excursions (RE)**

According to the definition provided by ICAO, a runway excursion is a veer-off or overrun of the runway surface which can happen on take-off or landing. Analyses of accident data over the last years show that Runway Excursions (RE) has become an important risk to aviation safety. Significant contributing factors are uncertainties in a reliable determination of the runway contamination, runway condition and runway friction measurement, and a runway condition reporting to the flight crews to enable a timely in-flight landing performance assessment.

Contributing factors to runway excursions and options for mitigation measures are well studied by projects of CAA UK, FAA and EASA. Although many initiatives and studies already address this particular safety issue further research could provide additional cognition to both the regulators as for instance the ICAO Friction Task Force and to the stakeholder such as airlines and airport operators.

Photo source: NLR

Areas where research could be in support of safety initiatives pursuing the runway excursion risk are assessments of the methods to deliver accurate runway friction readings using continuous friction measuring equipment (CFME) in contaminated conditions leading to a CFME standard, correlation of determined runway condition/expected aircraft braking action and actual experienced aircraft braking action, use of the data link to download information on aircraft braking action in real time from a landing aircraft.

Mid-air collisions (MAC)

A Mid-Air Collision (MAC) is an accident where two aircraft come into contact with each other while both are in flight; which in most cases cause loss of both aircraft and all people on board. The main direct operational issues regarding the risk of collision are allocated to loss of separation due a variety of contributing factors in the air and on the ground. Although several airborne and ground-based safety nets are installed such as ACAS, STCA, MSWA, and APM from operational experience there are sufficient indications that there is still room for further mitigating measures. A possible option could be studies addressing the monitoring of the safety nets such as the AMOR (ACAS Monitoring) project by DFS.

Controlled Flight into Terrain (CFIT)

Controlled Flight into Terrain (CFIT) occurs when an airworthy aircraft under the complete control of the pilot is inadvertently flown into terrain, water, or an obstacle. The pilots are generally unaware of the danger until it is too late. Loss of situational awareness is the common human factor component of CFIT together with night and/or IMC conditions.

CFIT has been the object of many actions and initiatives in the past years. Most CFIT accidents occur in the approach and landing phase of flight and are associated with non-precision approaches.

More widespread equipment of aircraft with TAWS, greater awareness of approach and landing risks, constant descent angle approaches (CDA) and minimum safety altitude warning systems are among the known mitigation measures that are being implemented to alleviate the risk of CFIT. The residual risk is being addressed through various regulatory changes.

Fatigue plays also a role in many CFIT events (it is also a factor in all type of human errors and aircraft accidents). Amendments to flight time limitations regulations will mitigate part of the risk in the short term.

Loss of Control in Flight (LOC)

Loss of control in flight has been one of the most significant causes of fatal aircraft accidents for many years and reasons include:

- Unusual atmospheric conditions
- Weather hazards such as wind shear, icing, thunderstorms
- Malfunction of aircraft systems
- Inappropriate handling of the aircraft and aircraft system
- Erroneous interpretation of indications and warnings
- Constantly growing complexity of an automation environment
- Loss of situational awareness.

Although these issues have already been addressed by many actions and mitigation measures as for instance pilot training of unusual attitude recovery in flight simulators there is still plenty of room for research projects which could investigate further measures providing additional safety benefits assisting prevention of loss of control. Initiatives and studies working on mitigating measures are, amongst many more, for instance the UK CAA loss of control Task Force, International Committee for Aviation Training in Extended Envelopes (ICATEE) and the EC FP7 project SUPRA - Simulation of Upset Recovery in Aviation.

As loss of control may have a variety of contributing factors potential areas to reduce the number of related accidents and incident could be for instance detection of LOC situations and recovery from unusual situations by means provided in a highly automated aircraft, measures to reduce procedure errors, wake turbulence detection and warnings. Other contributing factors are imaginable but can also be related to other thematic areas such in section 3.4.2 Environmental Factors, 3.5 Human Factors, and complex electronic / hardware in section 3.4.1.

Ground Collisions (GC)

Ground collisions refer to aircraft collisions occurring on aerodrome surfaces (manoeuvring area, apron). The subject is addressed through the topics 'Runway incursions' and 'Safety of Ground Operations'.

Runway Incursions

Runway incursions, defined as "un-authorised presence of an aircraft, vehicle or a person on an active runway area" represent a key safety concern for European airports. Several mitigations have been developed through the provision of specific training or information to pilots and controllers (e.g. runway hotspots), the implementation of new procedures and systems (A-SMGCS). Research activities are being conducted within the framework of SESAR programme to address the development of additional 'barriers' to such safety hazard, implying either on ground or on-board systems.

- **Safety of Ground Operations**

Ground operations involve all aspects of aircraft handling at the airport as well as aircraft movements on aprons and taxiways. Key concerns are damages caused to aircraft by towing, apron movements and the safety of ground handling operations, e.g. refuelling, loading / unloading. Regulatory oversight has been varied in approach across EU Member states and types of airports (regional, major hub) and operational changes pose new threats which might require further research.

- **Fire and Cabin Safety (FCS)**

Photo source: Monroe Community College

Fire is a constant threat and substantial efforts have been made over many years to reduce this hazard. There are however many areas where improvements may be made, notably in the areas of materials but also in the areas of detection and suppression. Cabin safety also has much scope for improvement particularly in the area of impact protection. New generation of aircraft with the use of novel materials and configurations bring new challenges which might have to be investigated in more detail.

3.3.2. Other Types of Operation

- **Rotorcraft (RC)**

The wide range of rotorcraft types and the often very different and specialised types of operation lead to a variety of incidents and accidents. Consequently, thematic areas for safety improvement are very diverse and include technical as well as operational issues. A practical way to identify such thematic areas is to review the applicability of technologies and operations which have proven to provide a safety gain on larger rotorcraft and/or even on

Photo source: aerospace-technology.com

fixed wing aircraft. Potential examples are: head-up displays, electronic guidance systems, night vision goggles used in conjunction with Night Vision Image System (NVIS), health and usage monitoring systems (HUMS) and helicopter Flight Data Monitoring (FDM).

The special flying capabilities of rotorcraft make them very useful for certain kinds of operations such as fire fighting, emergency medical services, off-shore operations and others more. Thematic areas addressing these special kinds of operation are also derived from the work of the European Helicopter Safety Team (EHEST) and the Helicopter Safety Research Management Committee (HSRMC). As these issues do not solely relate rotorcraft some thematic areas are also addressed in section 3.3.3 Special Types of Operation.

- **General Aviation (GA)**

The limitations of the 'see and avoid' principle applied in non-controlled airspaces to separate traffic have been raised by the GA community. Research actions towards improvements of Pilots' situational awareness through training or technical means have been progressed at a national or local level. There is now a need to foster at European level harmonisation, standardisation and further sharing of available solutions and best practices.

Photo source: TU Braunschweig

- **Unmanned Aircraft Systems (UAS)**

The introduction of UAS in non-segregated airspace requires to address the provision of an equivalent safety level compared to manned flight operations, the ability to 'see and avoid' VFR traffic in uncontrolled airspace and to integrate UAS specific mission needs with traditional IFR planning process and procedures.

The applicability of UAS automated landing systems based on optical sensor technology require regulatory investigation.

3.3.3. Special Mission Types of Operation

- **Fire Fighting (FF)**

This topic encompasses the analysis of practices and available technologies contributing to the safety of Fire Fighting Aerial Operations.

The safety of fire fighting missions by aeroplanes, helicopters and UAVs could be supported by different standards encompassing initial and continuing airworthiness requirements as well as by operation rules taking into account the potential modification from the initial aircraft design to fire fighting aircraft. Besides these technical issues particular attention should be paid to other safety aspects like human factors (CRM), flight coordination and ground operations, flight dispatch.

With regard to safe operation during these special kind of missions pilot training for instance in dedicated Flight Simulation Training Device (FSTD) can play an extraordinary role exercising operations under conditions of poor visibility, operations in close terrain and in turbulent atmospheres as well as critical changes in weight during water discharge.

- **Emergency Medical Service (EMS)**

Emergency Medical Service operations are specific due to the emergency nature of the missions. The regulatory bodies as well as the operators are key players who ensure the safety of passengers, flight crews, and medical professional on these kinds of missions.

Photo source: aerospace-technology.com

This thematic area encompasses on one hand the improvements in the quality of aeromedical clinical care, and on the other hand improving operation and standards through the implementation of the latest technologies, knowledge and experience.

Considering operational standards and their impact on design this should take into account the potential modification of a standard aircraft adapting aircraft access openings, cabin ECS system, identifying properly cabin configuration adapted to patient care during transport. In this context the compatibility between life support systems versus Airworthiness requirements must be assured.

3.4. Look Ahead and Emerging Issues

3.4.1. New Products, Systems, Technologies and Operations

- **New Advanced and Composite Materials (CM)**

New generations of aircraft such as Boeing B787, Airbus A350 and other projects under development, introduce extensive use of composite structure in damage-exposed applications, e.g. pressure hulls exposed to ground impact. It is commonly recognised that significant damage, e.g. delamination, blind-side fibre damage may be difficult to detect visually in composite structure, e.g. NVD (Non-Visible Damage), BVD (Barely Visible Damage). Confidence regarding the successful detection during inspections of such damages is to


Photo source: DLR / EASA

be addressed taking into consideration the main threats, the damage modes and growth behaviour as well as the relevant detection and repair methods.

Manufacturers develop aircraft and engine designs which increasingly require higher performance from the materials used. Changes to any one particular material property tend to be associated with other property changes which may be beneficial, or detrimental, to other design and safety objectives. It is important that all such changes be identified, quantified, and understood, the engineering being adapted accordingly.

There is a requirement to investigate the acceptability of new generation of composite material for aerospace applications able to provide electromagnetic characteristics such to ensure interference shielding (EMI), and lightning protection of structures.

Further study is needed of the regulatory aspects of Natural Fibre Composites which potentially offer light weight structure, worldwide availability of material, and ease of recycling and sustainability.

- **Complex Electronic Hardware and Software**

New aircraft and engine designs include items of integrated digital equipment with increasing level of complexity, as a result current practices and techniques used for design verification (integrity) and airworthiness certification need to be enhanced.

The use of commercial-off-the-shelf (COTS) parts, the introduction of new hardware platforms, e.g. reconfigurable platforms or the higher level of integration of software applications require to adapt safety assessment methods taking into account the concepts of system resilience and system of systems.

- **Alternative Fuel (AF)**

  'Alternative fuel' is the general term used to describe any alternative to crude oil based fuels. The following fuels are considered as alternative fuels: synthetic fuels, hydrogenated vegetable oils, esters and alcohols.

  'Drop-in' alternative fuels that are blended with conventional crude oil based fuels are being introduced for aviation. Such fuels meet all requirements of the fuel specification but testing methods and quality control processes need to be adapted.

  Non 'drop-in' liquid fuels may imply significant changes in their properties or their inappropriate use may present a potential single cause of catastrophic failure risk.

- **Regulatory aspects of availability of flight data**

  The need to have accident recorded data available even if the FDR is lost or is unpractical to find (e.g. in the ocean) research could be focused on other means of availability of data. In addition such data could be optimised for search and rescue purposes.

3.4.2. Environmental Factors

- **Effects of Climate Change on Aviation (CC)**

  Weather hazards have always been a challenge for aviation. Although aircraft designs have been improved to extend the operational capability of the aircraft facing known severe weather events associated risks may be influenced (positively, negatively, neutral) by a combination of the impact of climate change and the development of aircraft technologies and operations.

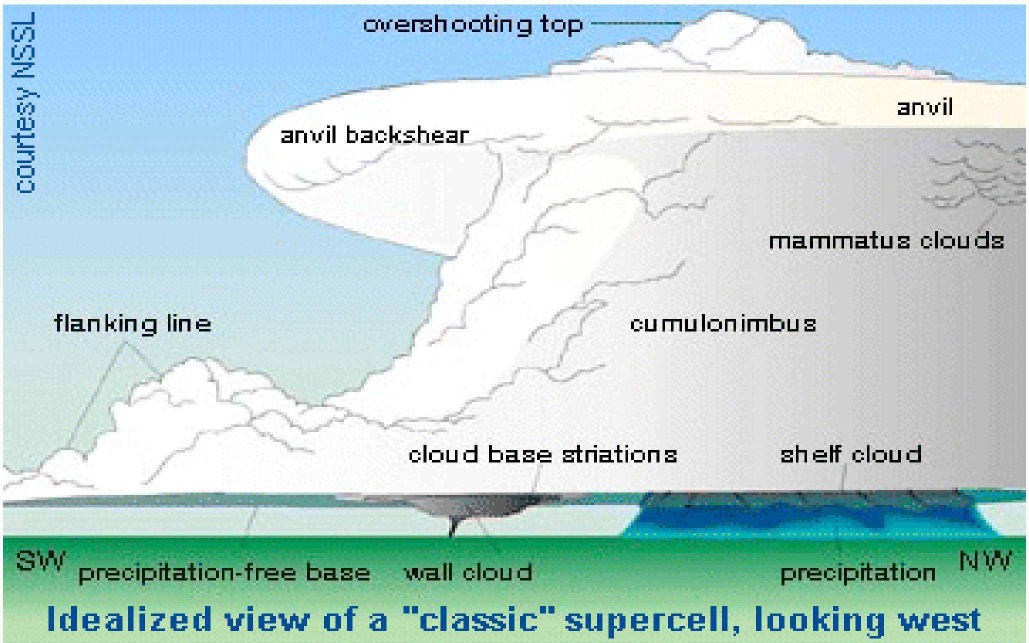

Photo source: NSSL and John Halpin

The potential of an increase of severity of weather events influenced by climate change was subject of the EASA conference in September 2010 on the impact of climate change on aviation safety (http://easa.europa.eu/iascc/).

A tentative list of evolving threats was developed during the conference as for example:

- Ice crystals from cirrus clouds at very low temperatures
- Increase of extreme hurricanes affecting north western Europe
- Reduced / increased frequencies of winter related hazards (snow/ice) in some parts of Europe
- Possible increase of freezing rain events
- Higher and extremes temperatures in summer leading to reduced engine performance
- Regional variations in the response of hazardous weather due to climate change
- For most of Europe – change of rainfall frequency in summer and maybe more severe rain events, lower rainfall in winter but possibly more severe snow storms
- Climate change may effect bird migration and bird strike frequencies and distribution.

Thematic areas related to climate change issues and which are considered to be of high priority as they regard to aviation safety are addressed in the following section amongst other topics of unusual atmospheric conditions.

Unusual Atmospheric Conditions (UAC)

- Icing

Operation in (un)known icing conditions is a potential risk and a contributing factor to accidents and incidents. Areas of concern are for instance engine icing and pitot probe icing particular at high altitude.

Photo source: Transport Canada

A start of mitigating measures could be the characterization of mixed phase & ice crystals conditions, the investigation of potential means to improve the understanding of environmental conditions leading to engine and pitot probe icing, including physics of icing particles, simulation means and flight tests. This could be the basis for the establishment of related safety standard and development of acceptable means of compliance.

- Environmental Threats

Environmental threats to be taken into account already today in aircraft are for instance wind, gust, pressure, hot and cold temperature, humidity, lightning strike, ice, snow, rain, etc. Hence, a thematic area for further investigation is the identification of the impact of climate changes on the standard hazard definition using an accepted model; providing the basis for revision where necessary of such standard hazards taking into account also new aviation technologies and operations.

Photo source: John Halpin

With regard to operation in extreme cold temperatures this Thematic Programme also captures research initiatives addressed to loss of engine power derived from accident investigations to study water/ice in fuel issues at low temperatures. FAA and EASA have agreed on an action plan, which encompasses several dedicated research studies relating to the principles of ice formation in fuel, the role of antifreeze additive and system-level tests on ice accumulation in the fuel system.

- Volcanic Ash

The Iceland's Eyjafjallajokull eruption in spring 2010 showed very clear how vulnerable to natural events a modern transportation system such as aviation can be. This event demonstrated the importance and the need of a comprehensive overview of the situation for the decision makers on flight restrictions; namely the intensity of the eruption, the dispersion of the volcanic ash cloud and its characteristics. On the other hand the debate about the effects of volcanic ash on the engines and aircraft systems left questions open which could be answered by further studies and research projects. Clearly, there is a demand for the development of consistent guidance/methodologies to support safety risk assessment application by operators on a Regional basis.

Space weather (SpW)

There is very limited practical experience of the potential problems that cosmic radiation or solar effects might bring to the air transport system. Besides the potential effects of cosmic radiation on flight crews and to some extent on passengers a known issue is the degradation of satellite navigation systems, e.g. GNSS ranging error and differential vertical errors, but other effects are likely.

3.4.3. Next Generation of Aviation Professionals

- **New Procedures and complex Technologies**

A framework for analysing system risk would be developed including the following elements: functional modelling of integrated operational systems that can encompass the identification of complex interactive hazards (technical, human, organizational, environmental); integrating, from different sources, a range of data including routine flight data, operational performance indicators, operational reports, audits and investigations; adjusting current taxonomies to support integrated data collection and analysis; applying advanced analysis methodology to address complex interactive risks; and using this methodology in case study analysis of selected system risks using operational data.

- **New training methods**

The training requirements for aviation personnel need to be adapted to new learning techniques and forthcoming safety challenges, taking also into account the potential shortage of available instructors to meet the increasing demand.

- **Reliance on automation**

Modern aircraft have an increasing amount of automation, which poses significant issues regarding the careful delineation of human-machine interactions, particularly covering unusual situations as well as the potential transfers between piloting and system monitoring skills. Specific issues are presented in 3.5

The regulatory aspects of improved training methodologies such as Competency Based Training in maintenance require investigation.

3.5. Human Factors

Photo source: CASA Australia

The European Aviation Safety Plan (EASP) recognizes the importance of integrating the discipline of Human Factors into a comprehensive strategy. At its core, Human Factors is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design, training, policies, or procedures in order to optimize human well-being and overall system performance. Three thematic areas are identified within Human Factors:

- **HF in design and certification**

The general subject of how the effectiveness of a major safety system can be eroded should be researched. The HF concern is why operators are inconsistent about following automated safety advice. This erosion trend has been evidenced with pilots not reacting properly to stall warnings and ACAS. Research should focus on windshear warnings, master warning, and EICAS displays. Findings would subsequently influence design and certification standards.

Design resiliency, capabilities to recover from failures caused by human users.

- **HF in OPS and Licensing**

  Identified research themes having Operational and Licensing implications:

  - Understanding preconditions for false optical cues
  - Consequences of full automation / single pilot operation, understanding the consequences and risks
  - Occupational health of flight-crew. (addressed through research in noise, vibration, radiation, air quality, dehydration, physical comfort, under stimulation)
  - Consequences of new features and pilot skills. Emergency descent features / Resolution Advisor
  - Researching mitigation response training for loss-of-control. Review equipment design: Simulator fidelity
  - Explore the influence of dynamic SMS programs (mitigation risk on a continuous loop can create additional risk due to continuous change)
  - Mitigating hazards of night visual approaches

- **HF in continuing airworthiness and maintenance**

  The maintenance world has unique HF issues that tend to be more severe and longer lasting than elsewhere in aviation; some research directions include:

  - Fatigue Risk Management in Aircraft Maintenance: Mitigating perceptual judgment error
  - Type Certificate holders should be required to validate maintenance instructions prior to aircraft certification
  - Create a link between several HF domains, show how Design and Training and Maintenance are interconnected
  - Study the implications of SMS for maintenance organizations

3.6. Environmental Protection

During the last decade, the relevance of environmental protection matters to the aviation sector has increased significantly. This holds for both, noise and emissions. In view of the environmental challenges that face the aviation system, a comprehensive approach using all options to mitigate the negative environmental impact of aviation and promoting any positive impacts is needed in Europe and globally. In this respect one important cornerstone is environmental protection research.

At the present stage the European environmental essential requirements as laid down in Article 6 of Regulation (EC) 216/2008 refer directly to the ICAO Environmental Standards (Annex 16 to the Chicago Convention). Therefore, one important aspect of research should be to further improve and also expand, if appropriate, the standards of ICAO Annex 16. For noise this might include research related to new technologies (e.g. open rotors and supersonic transport). Concerning emissions further research on envisaged new requirements (e.g. particulate matter and CO_2) is needed. In addition the ICAO process needs to be supported by promoting the development of robust Regulatory Impact Assessment tools within Europe. This includes research projects on aviation modelling.

Aside of research related to rulemaking activities, Member States have a need to investigate environmental protection aspects, which are of "practical" concern to their citizens. Typical examples are research activities on the annoyance of aircraft noise around airports, on local air quality, and on noise and emissions related landing fees.

4. Prioritisation of Thematic Areas

Prioritisation of proposals for themes is a significant and time consuming issue; it needs to be well documented why a topic is not followed, whether cost/benefit considerations are used - how much lives does the follow-up of a topic safe and how much does it cost to implement. Identification and prioritisation of themes should be organised systematically, for example by the use of decision support systems[1].

1 - Significant safety benefit with high degree of confidence

2 – Significant safety benefit with lower degree of confidence

3 – Moderate safety benefit with high degree of confidence

4 - Moderate safety benefit with lower degree of confidence

5 – Not prioritised

In the prioritisation process special attention was paid to projects initiated as a result of an accident, incident or adverse service experience. Furthermore, as selection criteria were taken into consideration such as addressing issues arising from the use and implementation of novel products having a potential effect on safety and related regulations.

Another reason for the identification of topics is the rapid change in the aviation industry such as a new generation aircraft with a wide range of novel technology. Justified by the results of studies and research projects the current requirements and regulations which are based to conventional technologies are to be amended so that the new generation aircraft can meet an equivalent level of safety.

[1] Decision support systems provide a structured process for prioritisation and synthesis of organizational goals and decision alternatives.

5. Working Arrangements and Funding Methods

In the definition of their own research plans EASA and the Member States are encouraged, in a coordinated manner, to take into consideration as much as possible this Thematic Programme. The European Commission and its advisory bodies for research programming such as ACARE may also refer to this Thematic Programme when defining work programmes for aeronautics.

It is anticipated that the aviation industry may well wish to initiate research in some of these areas for close-to-market applications.

It is noted that many NAAs don't possess research budgets; however, many of these activities potentially could be undertaken by universities initially as academic studies.

The coordination and selection of research projects originating from thematic areas of this programme should ideally be achieved in regular meetings of the EARPG.

In the currently given financial frame work each NAA and EASA will have to care for the cost of their as high priority selected and realised research project. Further to be developed and approved would be a Memorandum of Cooperation which might enable jointly funded projects in the future.

Annex A : Proposed focus areas for research activities

The following table provides the initial list of specific research themes identified by EARPG members. Prioritisation exercises will be organised to support the planning of dedicated research projects on a regular basis.

Ref.	Theme	Description
Operational Issues		
Commercial Air Transport by Aeroplanes		
Runway Excursion (RE)		
RE-1	Runway friction versus actual aircraft braking action	Comparison of measured runway friction and estimated aircraft braking versus actual aircraft braking action
RE-2	Use of aircraft-derived data	Broadcast of runway friction measurements from aircraft for interpretation by other aircraft crew – an investigation of regulatory needs
RE-3	Use of friction test machines	Propose standardisation of current equipment used
RE-4	Unstable approaches	Investigate methods for reducing unstable approaches - from training to approaches with vertical guidance
Mid-air Collisions (MAC)		
MAC-1	Protection device for airspace infringements caused by GA and UAS	Research how effective this solution might be considering long term perspectives
MAC-2	New generation of on-board collision avoidance systems	for ADS-B environment – potential regulatory needs
MAC-3	Better use of ACAS	Research to improve the use of ACAS including part-task training aids to ensure appropriate and timely crew responses
Controlled Flight into Terrain (CFIT)		
CFIT-1	Terrain warning systems	Improve human – system interaction for warning systems
Loss of Control in Flight (LOC)		
LOC-1	High automated aircraft – detection of LOC situations and recovery from unusual situations	Covering training needs and identification of best practice
LOC-2	Weight and balance procedures errors reduction	Development of guidance material, mechanisms to improve self-monitoring and reporting of loading errors
LOC-3	Wake detection	Integration of wake turbulence detection and modelling for warnings
Ground Collision (GC)		
GC-1	Runway incursion detection and alerting	Build on technology investigated by UK CAA, SESAR, review human factors
GC-2	Large aircraft wingtip clearances – on-board support to Pilots on aprons	Investigate technology and human factors regulatory implications
GC-3	Research on human factors involved in ground collisions	Development of guidance material and training framework for drivers on the apron, manoeuvring area and runways
GC-4	Regulatory oversight	Investigate the likely benefits of increased oversight of ground handling
Fire and Cabin Safety (FCS)		
FCS-1	In-flight Fires in hidden areas	Investigate occurrence rate and causes of hidden fires
FCS-2	In-flight Fires in hidden areas	Investigate options for hidden area fire detection
FCS-3	In-flight Fires in hidden areas	Investigate hidden area fire suppression e.g. use of ports to discharge extinguishers from the cabin

Ref.	Theme	Description
FCS-4	In-flight Fires in hidden areas	Review fire fighting equipment and define tools for panel removal
FCS-5	In-flight Fires in hidden areas	Investigate the feasibility of identifying smells, fume and smoke in the cabin
FCS-6	Protection of wirings and critical systems against in-flight fire	Define acceptable levels of contamination (dust, lint) that may fuel a fire
FCS-7	Fire fighting and rescue – Management of passengers after crash	improved rescue of passengers, cabin crew fire training, automatic opening of exit doors…
FCS-8	Aircraft of novel construction	Investigate new fire threats related to the use of new materials
Other Types of Operation		
Rotorcraft (RC)		
RC-1	Augmented vision technologies in helicopter	A helicopter HUD could harness the full potential of new technologies. It would also enable other helicopter specific safety enhancements, such as Autorotation or Category A cuing, demanding phases of flight during which the scan of the pilot is best directed outside. Incl. Degraded visual environment
RC-2	Data collection and analysis	Lightweight health monitoring – how existing technology may be applied to helicopters
RC-3	Helicopter operations	Safety of helidecks on ships/moving structures to be investigated
RC-4	Tail rotor damage tolerance	To investigate methods to prevent or mitigate the effects of tail rotor failures
RC-5	Improved instrumentation	Helicopter Low Airspeed and Warning Device and generally improved alerting to pilots review
RC-6	Greater systems redundancy	Investigate helicopter gearbox reliability with respect to oil leakage
RC-7	Helicopter decision making	Investigate the benefits of formal decision making tools
General Aviation (GA)		
GA-1	See and avoid improvements for GA	Investigation of technology and human factors
GA-2	Recurrent Pilot training	Combining simulator and new means for training (e.g. internet based)
Unmanned Aircraft Systems (UAS)		
UAS-1	Integration of UAS in non-segregated airspace	Refine areas to be investigated
UAS-2	Integrate UAS mission planning with traditional flight planning	Assess safety aspects of new concept of operations
UAS-3	UAS flight termination systems (in case of catastrophic situation)	Regulatory needs investigation
UAS-4	UAS automated landing system	The applicability of UAS automated landing systems based on optical sensor technology require regulatory investigation
Special Mission Types of operation		
Fire Fighting (FF)		
FF-1	Modelling in flight simulators of FF operations	Tools for training and mission preparation
FF-2	Conversion of transport aircraft to FF	New standards for on-board equipment
FF-3	Improving communication and training between Pilots and Ground Station	Regulatory needs study
Emergency Medical Service (EMS)		

Ref.	Theme	Description
EMS-1	Cabin and aircraft configuration and equipment adapted to airworthiness standards	Compatibility and harmonisation between Life Support versus Airworthiness requirements (Certification Standards referring aeroplanes and helicopters and equipment) must be ensured. E.g. detection of unsafe situations (O2 rate)
New Products, Systems, Technologies and Operations		
New Advanced and Composite Materials (CM)		
CM-1	In-flight fire	Degradation of structure strength in case of fire in composite aircraft;
CM-2	Life span of CM aircraft	Analysis of life span and its extension of composite aircraft, e.g. glider
CM-3	Fatigue risk management	Assessment criteria for fatigue risk management system
CM-4	EMI and Lightning protection	Requirements for composite materials designed to interface with EMI and Lightning protection.
CM-5	Natural fibre composites	Regulatory aspects of Natural Fibre Composites for interiors application dealing with sustainability and renewability for environmental protection.
Complex Electronic Hardware and Software(CEHS)		
CESH-1	Software integrity	Techniques to ensure software integrity for regulatory purposes
CESH-2	Formal proof methods	Confidence level investigation of formal proof methods
CESH-3	Hazard analysis methods for system of systems	Adaption of traditional methods
CESH-4	System of systems resilience	Tight coupling of applications safety issues investigation
New types of operations		
NTO-1	Remote aerodrome control (remote tower)	Safety assessment (redundancies needed)
NTO-2	Regulatory aspects of remote availability of flight data	Research about remote system and other means of availability of data. In addition such data could be optimised for search and rescue purposes.
Alternative fuel (AF)		
AF-1	Alternative fuel	Investigation whether properties of synthetic fuels, hydrogenated vegetable oils, esters and alcohols may present a potential single cause of catastrophic failure risk.
Environmental Factors		
Unusual Atmospheric Conditions (UAC)		
UAC-1	Pitot Probe and Engine Icing -	Analysis and definition of mixed phase & ice crystals conditions
UAC-2	Volcanic ash detection, dispersion modelling and forecast in support to aviation safety assessment	Overview to ensure that regulatory needs are being met
Space Weather (SP)		
SP-1	Space weather and radiations impact on aviation	Space weather and radiations impact on aviation incl. effects on GNSS; Started at UK CAA, EUROCONTROL
Next Generation of Aviation Professionals		
New procedures and complex technologies		
AP-1	Competency based training	The regulatory aspects of improved training methodologies such as Competency Based Training in maintenance require investigation.

Ref.	Theme	Description
Human Factors (HF)		
HF in design and certification (HF-CD)		
HFCD-1	Automated safety advice	Wind shear warnings, master warning, and EICAS displays
HFCD-2	Design resiliency	Error protection features
HF in OPS and Licensing (HFOL)		
HFOL-1	HF in operation	Communication methods in maintenance and handling to prepare an aircraft for flight.
HFOL-2	Regional data analysis in operations	Means to Prevention accidents and incidents by means of regional data analysis in operations
HF in continuing airworthiness and maintenance (HFCAM)		
HFCAM-1	Mitigating perceptual judgment error	Fatigue risk management evaluation
HFCAM-2	Verify maintenance schedule	Validate maintenance instructions prior to aircraft certification
Environmental Protection (ENV)		
General		
ENVG-1	Env. Indicators	Assess the relevant indicators for monitoring purpose
ENVG-2	New technologies	E.g. open rotor, supersonic transport and sub-orbital aircraft
Noise (ENVN)		
ENVN-1	Noise around airports	Incl. impact of more stringent noise limits and sleep disturbances
Emissions (ENVE)		
ENVE-1	New requirements	E.g. particulate matter and CO_2
ENVE-2	Contrails/cirrus clouds	Need for scientific certainty of the impact to the climate

Annex B : Abbreviations

ACARE	Advisory Council for Aeronautics Research in Europe
ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependent Surveillance-Broadcast
AF	Alternative Fuel
APM	Approach Path Monitor
A-SMGCS	Advanced Surface Movement Guidance & Control System
BVD	Barely Visible Damage
CAA	Civil Aviation Authority
CB	Cumulus Nimbus
CBT	Competency Based Training
CC	Climate Change
CDA	Continuous Descent Approach
CEHS	Complex Electronic Hardware and Software
CFIT	Controlled Flight into Terrain
CFME	Continuous Friction Measuring Equipment
CFRP	Carbon Fibre Reinforced Plastic
CM	Composite Material
COTS	Commercial-Off-The-Shelf
CRM	Crew Resource Management
DFS	Deutsche Flugsicherung GmbH (German Air Navigation Service Provider)
DG MOVE	EC Directorate-General for Mobility and Transport
DG RTD	EC Directorate General for Research
EARPG	European Aviation Research Partnership Group
EASA	European Aviation Safety Agency
EASP	European Aviation Safety Plan
EC	European Commission
ECS	Environmental Control System
EHEST	European Helicopter Safety Team
EHFAG	European Human Factor Advisory Group
EICAS	Engine Indicating and Crew Alerting System
ELT	Emergency Locator Transmitter
EMI	Electro-Magnetic Interference
EMS	Emergency Medical Service
ENV	Environment
ESSI	European Strategic Safety Initiative
EU	European Union

EUROCONTROL	European Organisation for the Safety of Air Navigation
EVS	Enhanced Vision System
F&DT	Fatigue and Damage Tolerance
FCL	Flight Crew Licensing
FCS	Fire and Cabin Safety
FDM	Flight Data Monitoring
FDR	Flight Data Recorder
FF	Fire Fighting
FP7	EU research and technology Framework Programme (seventh)
FSTD	Flight Simulation Training Device
GA	General Aviation
GC	Ground Collisions
GNSS	Global Navigation Satellite System
HF	Human Factor
HSRMC	Helicopter Safety Research Management Committee
HUD	Head-Up Display
HUMS	Health and Usage Monitoring Systems
HW	Hardware
ICAO	International Civil Aviation Organization
ICATEE	International Committee for Aviation Training in Extended Envelopes
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
LOC	Loss Of Control
MAC	Mid-Air Collision
MSAW	Minimum Safe Altitude Warning
NAA	National Aviation Authorities
NFC	Natural Fibre Composites
NTO	New Type of Operations
NVD	Non-Visible Damage
NVIS	Night Vision Image System
OPS	Operational
PAPI	Precision Approach Path Indicator
RC	Rotorcraft
RE	Runway Excursion
SESAR	Single European Sky ATM Research
SMS	Safety Management System
SpW	Space Weather
SRA	Strategic Research Agenda

SSP	State Safety Programme
STCA	Short Term Conflict Alert
SUPRA	Simulation of Upset Recovery in Aviation
SVS	Synthetic Vision System
SW	Software
TALS	Tracking Automated Landing System
TAWS	Terrain Awareness and Warning System
UAC	Unusual Atmospheric Conditions
UAS	Unmanned Aircraft System
UAV	Unmanned Aircraft Vehicle
VAA	Volcanic Ash Advisory
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions