Adviescollege Burgerluchtvaartveiligheid

DUTCH EXPERT GROUP AVIATION SAFETY

DEGAS-CR-2008-637

International Developments

Corporate Manslaughter; Developments in Safety Oversight; Safety Aspects of the introduction of Very Light Jets; Shortage of Qualified Personnel

Customer	DEGAS
Contract number	1058106
Owner	DEGAS
Distribution	Unlimited
Classification of title	Unclassified

Approved by:

Author	Reviewer	Chairman
10/11/08	10/11/08	

Summary

In this Report, four different international developments are described and their possible effect on aviation safety in the Netherlands: (1) Corporate Manslaughter, (2) Developments in Safety Oversight, (3) Safety Aspects of the introduction of Very Light Jets and (4) Shortage of Qualified personnel.

Corporate Manslaughter

The first international development described is corporate manslaughter. On 6 April 2007 the Corporate Manslaughter and Corporate Homicide Act came into force, creating an offence of Corporate Manslaughter in England and Wales, and an offence of Corporate Homicide in Scotland. An organisation will be guilty of the offence of Corporate Manslaughter if the way in which its activities are managed or organised causes a person's death and amounts to a gross breach of duty of care owed to that person, provided that the way in which the activities are managed or organised by its senior management is a substantial element of this breach.

The effect on aviation safety of the risk of prosecution for the offense of Corporate Manslaughter is most probably negative, as it could very well lead to an attitude or policy of management that discourages the collection of data and a tendency or policy to get rid of any data as quickly as possible. This all to avoid the use of these data by the prosecutor, in his or her effort to prove that the causal factors of accident X or incident Y where already well known within the company, and that apparently no adequate actions were taken. The effect of possible manslaughter charges on aviation safety in the Netherlands will not differ from the effects described above. However, at this very moment, corporate manslaughter charges are not possible in a comparable way as is now possible in e.g. the United Kingdom.

Developments in Safety Oversight

In the description of developments in safety oversight, attention is subsequently paid to the ICAO Universal Safety Oversight Audit Programme, the FAA International Aviation Safety Assessment programme, the EASA Safety Assessment of Foreign Aircraft programme, the ICAO Safety Management System requirements, EASA developments in the field of the safety of European airports and European ATM/ANS safety and finally to the IATA Operational Safety Audit. The effect of all of these programmes and developments on aviation safety – in general and more specific, in the Netherlands – is positive.

Safety aspects of the introduction of Very Light Jets

Concerning the introduction of Very Light Jets, small turbofan-powered aircraft with 3 – 8 seats and a maximum certified take-off mass (MCTOM) below 10,000 lbs, the following safety aspects are indentified:

- VLJs have a lower standard of airworthiness compared to larger commercial airliners, because different certification standards apply.
- An area of possible risk is the (long-term) airworthiness of the new technologies, production techniques and materials.
- Automation, advanced avionics and single pilot operations are major issues in the context of pilot workload, decision-making, monitoring and automation pitfalls, e.g. complexity, over-reliance.
- The introduction of VLJs will increase the likelihood that relatively inexperienced pilots will be operating in a complex and challenging environment.
- The level of equipment, facilities and services provided at smaller and regional airports will not be of the same standard as at the international or large airports in Europe. Lack of services (e.g. bird control, de-icing) may degrade flight safety and restrict aircraft operations in certain conditions.
- Problems can be expected in pilot-air traffic control communication and traffic sequencing.
- VLJ operators could benefit from airline oriented safety programs such as SMS, FOQA, safety occurrence reporting and analysis.
- Safety data reporting and collection of occurrences in the general aviation sector is nowadays not well covered, resulting in a lack of knowledge and awareness of general aviation safety and in particular VLJ safety issues in the future.

As these safety aspects are related to the introduction of a new aircraft type, they all have their relevance for the safety of aviation in the Netherlands as well.

Shortage of qualified personnel

In the last chapter of this Report, the assumed shortage of qualified personnel is described. Specific for the Netherlands, the conclusion can be drawn that at short and medium term the number of available qualified personnel in the Netherlands is still sufficient. Of the interviewed Dutch organisations, only the Air Force currently has a short term shortage due to a very attractive civil market and less attractive foreign deployments.

At long term a shortage may arise in the Netherlands, due to the fact that a smaller number of qualified people will be available due to the aging of the populations, the trend of an increasing number of young people choosing a non-technical education / career and the attractiveness of lucrative foreign employment in booming markets.

It should be noted though that the trend of an increasing number of young people choosing a non-technical education may be reversible, and the attractiveness of foreign employment in booming markets can be countered by offering higher salaries.

DUTCH EXPERT GROUP AVIATION SAFETY

Contents

This page is intentionally left blank.

Abbreviations

ACAC	Arab Civil Aviation Commission
ACAS	Airborne Collision Avoidance System
AFDD	Audit Findings and Differences Database
ANSP	Air Navigation Service Provider
AOC	Air Operator Certificate
ANS	Air Navigation Services
ATM	Air Traffic Management
ATS	Air Traffic Services
CAA	Civil Aviation Authority
CC	Compliance Checklist
CFR	Code of Federal Regulations
COSCAPs	Cooperative Development of Operational Safety and Continuing Airworthiness Programmes
CRI	Critical Review Item
CS	Certification Specification
CVR	Cockpit Voice Recorder
DoT	Department of Transport
EASA	European Aviation Safety Agency
EC	European Commission
ECAC	European Civil Aviation Conference
ER	Essential Requirements
EU	European Union
FAA	Federal Aviation Authority
FAR	Federal Aviation Regulations
FCL	Flight Crew Licensing
FDR	Flight Data Recorder
FMS	Flight Management System
FOQA	Fight Operations Quality Assurance
FSF	Flight Safety Foundation
GPWS	Ground Proximity Warning System
IASA	International Aviation Safety Assessment
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IFALPA	International Federation of Air Line Pilots' Associations
IMC	Instrument Meteorological Conditions

IOSA	IATA Operation Safety Audit
JAA	Joint Aviation Authorities
JOEB	Joint Operations Evaluation Board
LJ	Light Jet
LVNL	Luchtverkeersleiding Nederland
NAA	National Aviation Authority
NBAA	National Business Aviation Administration
MCTOM	Maximum Certified Take-Off Mass
RIA	Regulatory Impact Assessment
SAAQ	State Aviation Activity Questionnaire
SAFA	Safety Assessment of Foreign Aircraft
SARPs	Standards and Recommended Practices
SES	Single European Sky
SESAR	Single European Sky ATM Research
SMS	Safety Management System
SOAP	Safety Oversight Assessment Programme
TAA	Technically Advanced Aircraft
USOAP	Universal Safety Oversight Audit Programme
VFR	Visual Flight Rules
VLJ	Very Light Jet

1 Introduction

In accordance with the DEGAS Work Programme 2008, a total of four different international developments are described in this report. Successively Corporate Manslaughter, Developments in Safety Oversight, Safety Aspects of the introduction of Very Light Jets and finally Shortage of Qualified Personnel will be discussed.

2 Corporate Manslaughter

2.1 Introduction

In case of aviation accidents there is an increasing desire (from society and victims) towards holding someone responsible, place blame and punish pilots, managers and officials. Consequently, there is an increasing tendency of law enforcement authorities to attempt to criminalize aviation accidents.

Apart from holding an individual responsible, organisations can be criminally prosecuted in case of accidents, too. However, under the 'directing mind principle' used in many jurisdictions, this frequently turns out to be difficult. Therefore, in the Anglo-Saxon world, there appears to be a tendency to go one step further. In the UK organisations can now be prosecuted for the offence of so called 'Corporate Manslaughter'. An organisation is guilty of the offence of Corporate Manslaughter if the way in which its activities are managed or organised causes a person's death and amounts to a gross breach of duty of care owed to that person, provided that the way in which the activities are managed or organised by its senior management is a substantial element of this breach.

This section investigates the potential effect on aviation safety in general and in the Netherlands in particular of this corporate manslaughter development.

To place the offense of corporate manslaughter into a broader context, the current practice of criminal prosecution of individuals in case of aviation incidents and accidents is discussed in paragraph 2.2 first. Subsequently the difficulties of prosecuting organizations using the 'directing mind principle' and the UK Corporate Manslaughter Act are described in paragraph 2.3. Finally, in paragraph 2.4, the potential effects of this corporate manslaughter development on aviation safety in the Netherlands is described.

2.2 Criminal prosecution of individuals following aviation accidents or incidents

In order to be convicted of a crime, many legal systems require intent, or the Public Prosecutor must establish a guilty mind in order to achieve a conviction. In case of an individual, behaviour can be construed as criminal conduct in cases of intent or negligence. Cases of negligence often rest upon comparisons with the 'reasonable conduct' of similar parties. For example negligence may be proven with respect to standard operating procedures and wider industry norms.

In the Netherlands, the Law of Aviation (Wet Luchtvaart) specifies that individuals, active in the aviation sector, can be criminally prosecuted in case of intent or gross negligence (guilt). In certain cases the criminal offence and the corresponding punishment are specified precisely by law, e.g. in case of drunkenness of pilots on duty. In cases were the law is not specific, a judge imposes the punishment.

2.2.1 Examples of criminal prosecution of individuals

Concerning criminal prosecution of individuals involved in aviation accidents or incidents, the following illustrative examples can be given [ref. 1]:

France:

- In January 1992, an Air Inter Airbus A320 crashed into Mount Saint Odile. A French tribunal was due in 2006 to rule on involuntary manslaughter charges faced by six aviation officials comprising lead personnel from Air Inter (now merged into Air France), Airbus, the French civil aviation authority DGAC and air traffic control. Subsequently the French court investigating the crash has cleared the six defendants of manslaughter charges.

- A French engineer involved in the development of Concorde, the former head of France's Civil Aviation Authority and two Continental Maintenance staff must stand trial on manslaughter charges by the French prosecutor over its alleged role in the crash of the Air France Concorde in 2000.

It is routine practice in France to bring charges of 'causing unintentional death' against managers and others with responsibility in a chain of events leading to fatal accidents. Prison sentences are rare but heavy fines can be imposed.

Switzerland

Four employees of Swiss air traffic control service Skyguide have been found guilty of manslaughter following the fatal July 2002 mid-air collision over Lake Constance of a Bashkirian Airlines Tupolev Tu-154 and a DHL Boeing B757-200 freighter. The accident claimed 71 lives. Three Skyguide managers were handed 12-month suspended terms, while a project manager was given a suspended fine.

Italy

In 2004, prison sentences have been imposed on a Milan Linate airport air traffic controller and three managers in a court case arising from the fatal collision in October 2001, in fog, between a Scandinavian Airlines (SAS) MD-87 and a private Cessna Citation CJ2. The accident occurred because the CJ2 was taxiing on the wrong taxiway and then crossed the active runway without permission.

Netherlands (no manslaughter charges, but criminal prosecution)
An LVNL air traffic controller receiving training on the job gave a B747 permission to cross one of the active runways while a Delta B767 was taking-off from that runway. The other air traffic controllers present (and providing the training) were criminally prosecuted and convicted to a fine of 0 Euro.

2.2.2 Possible effects on aviation safety

The above mentioned examples of criminal prosecution following an aviation accident or (serious) incident can have (and actually had) significant negative effects on the process of continuously improving aviation safety by learning from accidents and incidents. It is not without reason that Annex 13 of the International Civil Aviation Organization (ICAO) Convention [Ref. 3] states that "*the sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability*". Many countries therefore provide legal protection for individuals involved in aviation accident and incident investigations, for instance the US Federal Aviation Regulations 14 CFR 91.25. However, these regulations seldom provide protection from criminal prosecutions [Ref. 4].

Effect of criminal prosecution

Prosecutions reveal a tension between the need to learn as much as possible about the causes of an accident or (severe) incident and public pressure to ensure accountability. The possibility of being prosecuted can lead to a situation that professionals involved in an accident or (severe) incident will not cooperate with the investigation being executed by the respective Accident Investigation Branch, if it is not guaranteed that the information provided will not be available to the Public Prosecutor. In the end, also aviation professionals involved in an aircraft accident or (severe) incident have the basic right not to cooperate with the Public Prosecutor when it comes to a criminal prosecution. The possibility of getting involved in a criminal prosecution may also lead to an increasing reluctance among aviation personnel to report occurrences, to the development of a culture that discourages the collection of data and a tendency to get rid of any data as quickly as possible, all to avoid the use of these data by the prosecutor. Hence, prosecutions can have a strong negative effect on aviation safety, because

safety in aviation is strongly based on learning from mistakes made, using collected occurrence, incident and accident data.

Concerning the effect of criminal prosecution, the following stakeholder opinions can be referred to as illustrative:

- IFALPA strongly insists that the principles of just culture hold that there should be no criminal liability without intent to do harm [Ref. 8].
- FSF is very concerned about increasing attempts by prosecutors to turn accidents into crime scenes and to prosecute aviation professionals based on tragic mistakes, often using information and data that are provided voluntarily to improve aviation safety [Ref. 7].
- Air Traffic Control the Netherlands (LVNL) considers criminal prosecution in case of intent or gross negligence acceptable, provided that the information used in the prosecution has not been provided by the individuals involved. Otherwise individuals would be forced to support their own conviction [Ref. 9].

2.3 Criminal prosecution of organisations

2.3.1 The 'directing mind principle'

Many jurisdictions allow for the criminal prosecution of organizations and not just of individuals. In case of organisations, behaviour can be construed as criminal conduct in cases of (gross) negligence. These cases often rest upon comparisons with the 'reasonable conduct' of similar parties.

For example, when standard operating procedures and wider industry norms turn out to be inadequate to protect public safety, it could be argued that the organisation is guilty of negligence.

The criminal prosecution of organisations raises problems because the responsibility for particular acts is usually associated with individuals. If groups are responsible then courts often find it difficult to determine the degree of culpability within the members of the group. It is for this reason that many legal systems rely upon the 'directing mind principle'. This assumes that it is only possible to find a corporation guilty if it is also possible to find one of its senior officers, or directing minds, personally liable for the crime.

This principle has recently been attacked because:

- It is extremely difficult to establish individual liability (to identify this 'directing mind' individual) especially in large organisations when complex decisions may be devolved from the board level through many different layers of management; For example, from 1992 to 2005 there were thirty-four prosecutions for work-related 'corporate manslaughter' in England and Wales but only six, small, organizations were convicted;
- Negligence may be the result of many lesser failures on the part of different managers within an organization;
- It can be very difficult to identify particular individuals with the necessary 'guilty state of mind' when an adverse event is the result of many different decisions taken over a long period of time.

As a result, it seems to be extremely difficult to convict (large) organisations. Therefore, several countries in the Anglo-Saxon world have started to reform their legal systems in the face of public concern over failures to convict large corporations which were involved in big accidents:

- Rail accidents in the UK have focussed public attention on the role that companies play in the causes of incidents and accidents;
- The 1992 Westray, Canada mining disaster motivated significant changes in the Canadian jurisdiction;
- The Longford explosion in Victoria, Australia prompted further reviews in Australia.

In the UK the Corporate Manslaughter Act came into force.

2.3.2 Corporate Manslaughter Act / Corporate Homicide Act in the UK

On 6 April 2007 the Corporate Manslaughter and Corporate Homicide Act came into force, creating an offence of Corporate Manslaughter in England and Wales, and an offence of Corporate Homicide in Scotland [Ref. 2].

The Corporate Manslaughter Act replaces the previous common law regime in which the controlling mind of the company had to be responsible for the way in which the management or organisation of the company led to a person's death.

What is Corporate Manslaughter?

The offence of Corporate Manslaughter will be markedly different from the previous common law regime. From now on, an organisation will be guilty of the offence of Corporate Manslaughter if the way in which its activities are managed or organised causes a person's death and amounts to a gross breach of duty of care owed to that person, provided that the

way in which the activities are managed or organised by its senior management is a substantial element of this breach.

The offence will analyse whether the senior management of a corporation was responsible for a substantial element of the gross breach of the duty of care. The definition of senior management within the Act is very broad. It includes persons who play a significant role in the making of decisions about the whole or a substantial part of the organisation's activities are to be managed or organised, or the actual managing or organising of the whole or a substantial part of its activities. The Act is still in its infancy, and there is therefore little guidance regarding the scope of this definition in practice.

When a jury is deciding whether or not there has been a breach of care, and whether the senior management was responsible for a substantial element of the breach, they can take into account a wide variety of factors. These include the attitudes, policies, systems or practices within the organisations that were likely to have encouraged such a breach, or have produced a tolerance to this level of behaviour. Therefore, the jury will be given access to a very wide range of information relating to all aspects of the organisation in order to reach a verdict.

Scope of the Corporate Manslaughter Act

The Act only applies to deaths caused within the UK or its territorial waters, and extends to include harm resulting in death caused on a British-controlled aircraft, wherever it may be. This means that all operators of UK-registered aircraft will be potentially subject to the new offence.

Punishment

If an offence is committed by an organisation then it will be liable:

- **To pay an unlimited fine:**
  The level of fine will reflect the seriousness of the offence and ensure that those responsible for governance of the organisation are properly aware of the need for a safe environment. Although there is no statutory limit, the Sentencing Advisory Panel have suggested between 2.5% and 10% of average turnover calculated over a three year period. This will then be increased if there are aggravating factors (e.g. multiple persons killed, failure to act on cautions / warnings etc.) and reduced if there are mitigating factors (e.g. an employee was acting outside the scope of his/her authority when the incident occurred).
- **Be given a remedial order:**

This requires specified actions which will address the cause of the deaths.

- **Be given a publicity order (not yet in force):**
  This allows the court to publicise in a specified manner the conviction and the particulars of the offence, along with the terms of the remedial order imposed. This is a potentially very damaging penalty to a company, because it may have a major impact on the reputation- of the company, and will have knock-on affects on business, share prices and insurance premiums etc.

Effect on organisations

Organisations must recognise their increased responsibility, and ensure that all members of its management team are aware of the potential liabilities involved.

Corporate manslaughter versus the common law of gross negligence manslaughter

The corporate manslaughter act will have no application to individuals and therefore the common law offence of gross negligence manslaughter can still be committed by individuals within a company.

2.3.3 Other jurisdictions

Organisations instead of corporations

The term 'corporate manslaughter' is misleading because the provisions of such legislation usually seek to go beyond narrow definitions of a corporation. Australian States have used the term 'industrial manslaughter' to avoid this limitation and leave the scope of the provisions deliberately wide ranging. Other jurisdictions have created legislation that refers to 'organizations' so that they address not simply commercial bodies but any agencies where the neglect of safety legislation may lead to death or injury. Existing legislation differs between jurisdictions as to whether or not government agencies might also be prosecuted for safety violations. Narrow definitions based on the concept of a corporation can often exclude State bodies from the provisions of their legislation.

Punishment

There exists considerable controversy in several different countries about the potential penalties that might be associated with any conviction for 'corporate manslaughter'. Some jurisdictions have implemented laws that allow for unlimited fines. The precise amounts are, typically, determined by the profits of a commercial organization.

2.3.4 Pro's and cons of Corporate Manslaughter legislation

Criminal versus civil liability

It can be argued that civil rather than criminal liability is more effective against organisations infringing safety legislation. The economic disincentives and loss of reputation that dissuades companies from violating rules and regulations can be the same under both civil and criminal legislation. However, civil systems are better tuned to assessing appropriate financial sanctions. This helps companies to extend conventional forms of cost-benefit analysis into any consideration of safety policy. In contrast, criminal systems often result in a form of 'over-deterrence' that dissuades companies from providing important services because executive officers fear personal criminal convictions. A further argument in favour of the civil system is that criminal law offers procedural mechanisms that increase the burden of proof in order to protect individual defendants. Companies have exploited these defences to avoid criminal sanctions in the aftermath of an adverse event.

However, there are important counter arguments in favour of corporate criminal liability. There is a qualitative difference between civil and criminal convictions in many countries and the nature of any violation often justifies public pressure for criminal sanctions. There is also a strong deterrent effect stemming from the seriousness of criminal proceedings. Investigating agencies can also employ a range of additional procedures to support their work, including the ability to detain and question company officials.

Corporate versus individual liability

A number of arguments can be made in favour of corporate rather than individual liability for safety violations. It should be noted that events can be caused by the collective effect of many minor violations, of inadequate engineering and poorly conceived policies. Responsibility is, therefore, distributed across many different levels of an organization. Individuals also often lack the resources necessary to make adequate reparation for the harm that they cause. In contrast, corporate bodies may have access to (financial) resources that can make adequate reparation.

On the other hand, there are also arguments in favour of personal liability. For instance, there may be little deterrent if managers and executives feel that they will not be held individually accountable for personal violations of health and safety legislation. Personal litigation offers a strong deterrent effect that goes well beyond any corporate litigation.

Financial penalties versus restorative justice

A possible factor behind the corporate manslaughter act may be the belief in the Anglo-Saxon world that it is very effective to punish a company financially, because this will make the all important shareholders very unhappy. The shareholders will subsequently demand a more capable management team of the company that is able to organise the company in a way that will prevent these charges.

Drawbacks of financial penalties are that innocent shareholders and employees may be badly affected by them. Fines for corporate manslaughter create further problems if government organisations are convicted. In such cases, fines end up being recycled between different departments of government.

There have been calls for more innovative forms of restorative justice where companies and non-profit organizations are required to reform their safety policy and provide resources to improve the safety of the wider community. But clearly these approaches lack the 'bite' of financial penalties.

Who should decide whether or not to prosecute

It can be difficult to identify appropriate agencies that might be used to investigate potential violations of corporate manslaughter legislation. Problems arise because specialist expertise is often required to enforce safety regulations. Many jurisdictions, therefore, rely on cooperation between government regulatory agencies and police forces during investigations. Even with existing specialist skills, it is not clear that these agencies are well prepared to conduct the type of investigations that would be necessary to establish the aggregated 'management failures' or poor 'corporate culture' that have been advocated as key concepts within the recently proposed legislation.

2.3.5 Examples of criminal prosecution of organisations

News releases from Flight International magazine [Ref. 1] provide the following examples:

- **USA**
  SabreTech, the maintenance contractor for the former ValuJet Airlines has been charged with murder and manslaughter by Florida state prosecutors. The charges relate to the crash of a ValuJet McDonnell Douglas DC-9-30 in Florida in May 1996.
- **Greece**
  In 2000, negligence and possibly manslaughter charges were expected to be brought against the maintenance organisation and the Greek civil aviation authority (CAA) for

the Greek Government Dassault Falcon 900 accident in which seven VIP passengers died.

- **France**
  Continental Airlines must stand trial on manslaughter charges over its alleged role in the crash of the Air France Concorde in 2000, a French prosecutor has decided.
- **UK**
  Supporters of families with relatives killed in a January 2005 hostile fire incident in Iraq have issued a warning to the UK government that they will sue for corporate manslaughter if there is any further loss of life involving Lockheed Martin C-130 Hercules intra-theatre transports.

2.3.6 Possible effects on aviation safety

As already argued, criminal prosecutions reveal a tension between the need to learn as much as possible about the causes of an accident and public pressure to ensure accountability. The risk of prosecution for the offense of Corporate Manslaughter under the Corporate Manslaughter act could very well lead to:

- An attitude or policy of management that discourages the collection of data
- A tendency or policy to get rid of any data as quickly as possible.

This to avoid the use of these data by the prosecutor, in his or her effort to prove that the causal factors of accident X or incident Y where already well known within the company, and that apparently no adequate actions were taken.

Like the prosecution of individuals, prosecutions of organisations can thus have a negative effect on aviation safety as safety in aviation is strongly based on learning from mistakes, using collected incident and accident data. On the other hand though, it may be an effective way to ensure that organisations behave in a responsible manner regarding safety. In the Anglo-Saxon world there is a strong belief that it is very effective to punish a company financially. It can be argued though that draining an organisation's resources at a time when it needs to improve its safety, is not the best way to improve safety.

As the non Anglo-Saxon world is based more on solidarity than the Anglo-Saxon world, a form of restorative justice where an organisation is required to reform their safety policy, could be more suitable for the non-Anglo-Saxon world.

2.4 Effect corporate manslaughter charges on aviation safety in the Netherlands

The effect of possible manslaughter charges on aviation safety in the Netherlands will not differ from the effects described above. However, at this very moment, corporate

manslaughter charges are not possible in a comparable way as is now possible in e.g. the United Kingdom.

3 Developments in Safety Oversight

3.1 Introduction

In this chapter, international developments regarding safety oversight and their potential effect on aviation safety in the Netherlands are described. The content of this chapter is for a large extent based on information available on the websites of the different organisations and programmes described. For references please refer to the references section.

Civil aviation is a global activity like no other. Land frontiers are inconsequential to aircraft, with many flights crossing dozens of frontiers en-route. Even on a continental level, aviation operations are not segregated, and today, aircraft can travel more than halfway round the globe without touching down. Therefore, the safety provisions of one are the safety provisions of all.

Because civil aviation is international by nature, the aviation community has always felt the need for minimum levels of harmonisation, to avoid operators being subject to conflicting requirements when flying from one State to another.

At the Chicago convention in 1944, the International Civil Aviation Organization (ICAO) was established, as a means to secure international co-operation and the highest possible degree of uniformity in regulations and standards, procedures and organisation regarding civil aviation matters. Universally accepted standards known as Standards and Recommended Practices, SARPs, have been established by ICAO. SARPs cover all technical and operational aspects of international civil aviation, such as safety, personnel licensing, operation of aircraft, aerodromes, air traffic services, accident investigation and the environment.

Member States must implement these ICAO standards and recommended practices in their national regulations. However, while governments from around the world have agreed these standards, ICAO has no mechanism in place to ensure that countries are implementing them fully, consistently and effectively. Overall, the regulatory framework resulting from the Chicago Convention has created a situation in which States have differing regulatory systems, and in which certificates, approvals and licences issued by one State do not automatically fully comply with requirements in other States.

ICAO requires the National Aviation Authorities (NAAs) of Member States to oversee that the regulations are properly adhered to by their national aviation organisations and personnel. Hence, NAAs are the most important safety oversight organisations.

Following studies which highlighted the extent of the deficiencies in safety standards in some regions of the world, ICAO and its Member States have begun audit and support programs, the Universal Safety Oversight Audit Programme (USOAP), to address these problems and help bring safety standards up to minimum levels throughout the world. The USOAP programme is described in detail in paragraph 3.2. Even with these ICAO activities in place, deficiencies remain in various countries. Therefore additional safety oversight activities have been initiated:

To address concerns about the safety of foreign air carriers operating into the United States, the Federal Aviation Administration (FAA) initiated the International Aviation Safety Assessment (IASA) programme. IASA involves assessing whether another country's oversight (by its NAA) of its air carriers that operate, or seek to operate, into the United States complies with the minimum international standards and recommended practices for aviation as established by ICAO. The IASA programme is described in detail in paragraph 3.3.

For the same reasons, the European Aviation Safety Agency (EASA) has the Safety Assessment of Foreign Aircraft (SAFA) programme running. Instead of assessing another country's oversight (by its NAA) of its air carriers as is done in the IASA programme, SAFA involves ramp inspections of third-country (i.e. non-EU) aircraft which land at EU airports, and sharing information on their results amongst all Member States. The SAFA programme is described in detail in paragraph 3.4.

To further increase the level of aviation safety in the world, in addition to the existing standards, ICAO developed requirements concerning the establishment of a State's Safety Programme. Within this Programme, aircraft operators, maintenance organizations and air navigation service providers are required to implement a Safety Management System. Details are described in paragraph 3.5.

To address shortcomings of ICAO regarding the safety of airports, and to address shortcomings of the Eurocontrol Single European Sky (SES) programme regarding the safety of Air Traffic Management (ATM), EASA will take on more responsibility for the safety of European airports and European Air Traffic Management in the near future. This is described in paragraph 3.6 and 3.7.

Finally, the IATA Operational safety Audit (IOSA) is described in paragraph 3.8.

3.2 ICAO Universal Safety Oversight Audit Programme (USOAP)

The ICAO Universal Safety Oversight Audit Programme (USOAP) was launched on the 1st of January 1999. The programme calls for the conduct of mandatory and regular safety oversight audits of all Contracting States in order to establish the extent to which Contracting States conform to ICAO Standards and Recommended Practices (SARPs). As such the ICAO USOAP supersedes the voluntary ICAO Safety Oversight Assessment Programme (SOAP), established in March 1996.

The objective of USOAP is to promote global aviation safety through auditing Contracting States, on a regular basis, to determine States' capability for safety oversight by assessing the effective implementation of the critical elements of a safety oversight system and the status of States' implementation of safety-relevant ICAO Standards and Recommended Practices (SARPs), associated procedures, guidance material and safety related practices. The scope of the Programme was initially limited to Annex 1 — Personnel Licensing, Annex 6 — Operation of Aircraft and Annex 8 — Airworthiness of Aircraft. The initial mandate of the Programme was to audit all Contracting States.

An Audit Findings and Differences Database (AFDD) was developed to record actual findings and differences identified during the audits. The analysis conducted through the AFDD has enabled the identification of safety oversight related deficiencies and the prioritization of actions required to resolve safety concerns at a global, regional, State or a group of States level.

In order to assist States in forming an opinion on the status of the safety oversight capability in audited States, ICAO made available to all Contracting States summary reports which included an abstract of the audit's findings, the corrective actions proposed by the State, the status of implementation of ICAO Annex provisions, and comments by ICAO on the overall soundness of the safety oversight system in each audited State. Summary reports were also distributed following an audit follow-up mission, indicating the progress made by the State concerned in the implementation of its corrective action plan.

<u>Comprehensive systems approach</u>

Pursuant to Assembly Resolution A33-8, preparatory work for the expansion of the Programme to Annex 11 — Air Traffic Services, Annex 13 — Aircraft Accident and Incident Investigation and Annex 14 — Aerodromes was conducted in 2003. However, during its 171st Session (March 2004), the Council considered that it was time for USOAP to evolve from an Annex-by-Annex approach to a *comprehensive systems approach*, which would cover all safety-related

Annexes and focus on the overall capability of States for safety oversight. Accordingly, the Council agreed to recommend to the Assembly, in 2004, to further expand the Programme to audit the safety-related provisions contained in all safety-related Annexes to the Convention on International Civil Aviation under a comprehensive systems approach.

The conduct of audits under the comprehensive systems approach was launched on the 1st of January 2005. The new approach consists of three phases:

- Pre-audit phase. During this phase, the information provided by the State in the State Aviation Activity Questionnaire (SAAQ) and Compliance Checklists (CCs) is reviewed to analyze the type of organization for safety oversight established by the State, the implementation of Annexes provisions and the differences from SARPs identified by the States. This allows ICAO to tailor the audit in accordance with the level and complexity of aviation activities in the State and determine the duration of the audit and the size and required composition of the audit team.
- On-site phase. During this phase, the State is visited by an ICAO audit team to validate the information provided by the State and conduct an on-site audit of the State's system and overall capability for safety oversight. This includes an audit of the organization, processes, procedures and programmes established and maintained by the State to help it fulfil its safety oversight obligations.
- Post-audit phase. This phase encompasses all the activities following the on-site audit, including the preparation of the audit interim report, the development by the State of its corrective action plan and the completion of the audit final report. In accordance with Assembly Resolution A35-6, the audit final reports are made available to Contracting States in their entirety through a secure website, along with information derived from the AFDD.

Technical assistance projects

Subsequently, ICAO has launched a number of regional level technical assistance projects, known as Cooperative development of Operational Safety and Continuing Airworthiness Programmes (COSCAPs). So far, COSCAPs have been launched in southern, south-eastern and northern Asia, and in South America. Similar initiatives are in preparation in Africa. All of these programmes have received financial and technical assistance from the EU. The aim of these programmes is twofold, firstly to bring local safety standards up to the level of international norms, and secondly, to develop regional cooperation in oversight activities, thereby encouraging peer pressure as a means of improving standards. For the moment, however, COSCAPs are limited in the fields they cover: addressing mainly personnel licensing, and

operations and airworthiness of aircraft. The EU supports the extension of ICAO actions to additional spheres such as air traffic services and airport operation.

Audit results

The Executive Summary, and of many Contracting States also the Audit Summary Reports (Initial and Follow-up) and comments of the respective State are available on the website of ICAO: http://www.icao.int/fsix/auditRep1.cfm.

From the audit results the conclusion can be drawn that the ICAO programme already contributed to the rectification of deficiencies in many countries. But it also follows that today there are still deficiencies in many countries. No conclusion can be drawn whether the general trend is positive. This is mainly due to the fact that the limited annex 1, 6 and 8 approach was replaced with the comprehensive systems approach in 2005 and that under the systems approach countries have only be audited once. However, the inspection findings of the ECAC/EASA SAFA programme (see paragraph 3.4) over the years may be an indication of an overall improvement in the level of deviation from the ICAO standards.

As there is a strong parallel between regional accident rates and audit findings (the higher the accident rate, the worse the audit findings), and with many regions in the world where accident rates are still (far) above average, it appears that the ICAO Universal Safety Oversight Audit Programme remains a valuable and necessary programme to ensure that States comply with the ICAO standards and recommended practices.

3.2.1 Effect on aviation safety in the Netherlands

The ICAO Universal Safety Oversight Audit Programme remains a valuable and necessary programme to ensure that states comply with the ICAO standards and recommended practices. As such the programme contributes in a positive way to aviation safety in the Netherlands, on the one hand because operators from all States flying into Dutch airports are audited, and on the other hand because the Netherlands is audited as well.

3.3 FAA International Aviation Safety Assessment (IASA) programme

Even with the ICAO Universal Safety Oversight Audit Programme up and running, there remain deficiencies in various countries. Therefore the FAA in the United States decided to initiate an additional safety oversight activity, the International Aviation Safety Assessment (IASA) programme.

IASA involves assessing whether another country's oversight (by its own NAA) of its air carriers that operate, or seek to operate, into the United States complies with the minimum international standards and recommended practices for aviation as established by ICAO. Consistent with international law, certain safety requirements for operations into the United States are prescribed by the FAA's Part 129 regulations (14 CFR part 129). 14 CFR Part 129 specifies that the carrier must meet the safety standards contained in Part 1 (International Commercial Air Transport) of Annex 6 (Operations of Aircraft) to the Convention on International Civil Aviation (Chicago Convention).

IASA focuses on a country's ability, not the individual air carrier, to adhere to these international standards and recommended practices for aircraft operations and maintenance. The FAA assesses whether a foreign civil aviation authority (CAA) complies with the minimum international standards for aviation safety oversight established by the International Civil Aviation Organization (ICAO).

In obtaining information relevant to its assessment, the FAA meets with the foreign CAA responsible for providing the safety oversight to its carriers, reviews pertinent records and meets with officials of the subject foreign air carriers. The FAA then analyzes the collected information to determine whether the CAA complies with ICAO standards regarding the oversight provided to the air carriers under its authority.

Positive recommendation

If a CAA is found to be meeting its minimum safety obligations under the Chicago Convention, the FAA will forward a positive recommendation to the Department of Transportation (DoT). If there is a pending foreign carrier application, the DoT will issue the requested economic authority and FAA will issue operations specifications to permit the carrier to begin operations to or from the United States.

Negative recommendation for existing air carrier service

When CAA's of countries with existing air carrier service to the U.S. are found to not meet ICAO standards, the FAA formally requests consultations with that CAA. The purpose of

consultations is to discuss the findings in some detail and explore means to quickly rectify shortcomings found with regard to ICAO annexes, to enable its air carriers to continue service to the United States. During the consultation phase, foreign air carrier operations from that country into the United States will be frozen at existing levels.
The FAA may also heighten its surveillance inspections (ramp checks) on these carriers while they are in the United States. If the deficiencies noted during consultations cannot be successfully corrected within a reasonable period of time, the FAA will notify the DoT that carriers from that country do not have an acceptable level of safety oversight and will recommend that the DoT revoke or suspend the economic operating authority of that carrier.

Negative recommendation for no existing air carrier service

When CAA's of countries with no existing air carrier service to the United States are found not meeting ICAO standards, the FAA will notify the DoT that the CAA does not have an acceptable level of safety oversight. Its application for economic authority will be denied. The FAA will undertake a reassessment of the CAA after evidence of compliance with ICAO provisions has been received.

Categories

The FAA publicly discloses the results of FAA assessments, and established at the start of the programme three categories of ratings for countries to signify the status of a CAA's compliance with minimum international safety standards:

- Category I (Acceptable)
- Category II (Conditional)
- Category III (Unacceptable).

Category II or III apply to countries whose CAA's are found not to be providing safety oversight in compliance with the minimum international standards established by ICAO.
The FAA normally places a country in Category II if one of its carriers provided air service to the United States at the time of the FAA assessment. Carriers from Category II countries are permitted to maintain, but not expand, current levels of service under heightened FAA surveillance.

The FAA places a country in Category III if none of its carriers provided air service to the United States at the time of the FAA assessment. Carriers from Category III countries are not permitted to commence service to the United States.

To eliminate the common misimpression created that being in Category II reflects a higher degree of compliance with ICAO standards than being in Category III, since 2000 the FAA has

established two ratings for the status of countries at the time of the assessment: does comply with ICAO standards, and does not comply with ICAO standards.

Results

At present, there are close to 600 foreign air carriers that operate into the United States. There are approximately 103 countries or regional country alliances that have oversight responsibilities for air carriers that either currently operate into the United States or that have air carriers that have applied to operate into the United States.

The initial findings of the IASA programme have shown that two thirds of 87 countries were not fully complying with ICAO standards. Deficiencies found in the FAA assessments included:

- Inadequate and in some cases nonexistent regulatory legislation;
- Lack of advisory documentation;
- Shortage of experienced airworthiness staff;
- Lack of control on important airworthiness related items such as issuance and enforcement of Airworthiness Directives, Minimum Equipment Lists, investigation of Service Difficulty Reports, etc.;
- Lack of adequate technical data;
- Absence of Air Operator Certification (AOC) systems;
- Non-conformance to the requirements of the AOC System;
- Lack or shortage of adequately trained flight operations inspectors including a lack of type ratings;
- Lack of updated company manuals for the use by airmen;
- Inadequate proficiency check procedures;
- Inadequately trained cabin attendants.

Some of the same items are also being found on FAA ramp checks of foreign carriers. This list is long but by no means exhaustive and points out a continuing safety oversight problem that several ICAO member States need to address. These are also problems that must be corrected before carriers from that State can operate on a regularly scheduled basis to and from the United States.

At this very moment, 20 countries do not comply with ICAO standards and are in category 2: Bangladesh, Belize, Ivory Coast, Congo, Gambia, Guyana, Haiti, Honduras, Indonesia, Kiribati, Nauru, Nicaragua, Paraguay, Philippines, Serbia and Montenegro, Swaziland, Ukraine, Uruguay and Zimbabwe. This information is available on the website of the FAA.

General effect on aviation safety

With the IASA programme, the FAA requires that a State with one or more air carriers operating into the United States, or willing to operate into the United States, meet its obligations under ICAO and exercises proper oversight to each air carrier operating into the U.S. The continued application of this program will result in a lower number of safety-related problems, including accidents, incidents, and an improved level of safety to the flying public.

3.3.1 Effect on aviation safety in the Netherlands

From the IASA results it follows that 20 countries (out of 87 assessed) do not comply with the minimum ICAO Standards for safety oversight. It could be argued that airline operations from these countries, to and from the Netherlands, carry a higher safety risk.

3.4 EASA Safety Assessment of Foreign Aircraft (SAFA) programme

After the 1996 Birgenair accident, in which a Boeing 767 with German tourists, operated by Turkish managed Birgenair, crashed into the sea on its way to Germany from Puerto Plata, ECAC launched the voluntary Safety Assessment of Foreign Aircraft (SAFA) programme. ECAC Member States participating in the programme were requested to perform SAFA Ramp Checks on foreign operators flying into their territory, with foreign meaning all aircraft not registered on their own State's Register. The operational management of the ECAC SAFA programme was performed by the Joint Aviation Authorities (JAA).

The EASA Safety Assessment of Foreign Aircraft (SAFA) programme

In 2004, the EU adopted legislation on procedures for inspecting third-country aircraft which land at EU airports, and sharing information on their results amongst all Member States. The official definition of 'third-country aircraft' is an aircraft which is not operated under the control of a competent authority of a Community Member State. With this legislation, the ECAC SAFA programme now becomes an obligatory EC programme. All Member States must now inspect an aircraft from a foreign country when it lands at one of their airports, in case there is a legitimate suspicion that it does not conform to international safety standards. Such suspicions may arise from the aircraft's visits to other Member States, about which information must be shared throughout the EU. Unannounced inspections may also take place without grounds for suspicion. In the event that irregularities are found, the aircraft may be grounded until it is repaired, or Member States may ban that aircraft, airline, or even all aircraft from that country, from entering their airspace.

The results of all inspections are shared amongst all Member States and the Commission. Action taken by one Member State such as banning an airline's aircraft from its airspace may, on a Commission proposal, be extended to the whole EU, with significantly greater consequences for the offender.

Engaged States

The States that are engaged in the EC SAFA programme are the EU Member States and the non-EU ECAC Member States who have entered into a Working Arrangement with EASA.

Principles of the SAFA programme

The principles of the programme are simple: in each EU Member State and those States who have entered into a specific 'SAFA' Working Arrangement with EASA, third-country aircraft may be inspected. These inspections follow a procedure common to all Member States and are then reported on using a common format.

In nearly all States, the number of flights by foreign operators is far greater than the inspection capability. This means that only spot checks are possible. Some authorities carry out random inspections while others try to target aircraft or airlines that they suspect may not comply with ICAO standards. In either case only a very small proportion of third country aircraft operating into each State are inspected.

During the inspection, a checklist is used. It comprises a total of 54 different inspection items. In the majority of cases, not all items are checked during an inspection because the time between the arrival of the aircraft and its departure is not sufficient to perform a complete inspection. Checks may include:

- Licences of the pilots
- Procedures and manuals that should be carried in the cockpit
- Compliance with these procedures by flight and cabin crew
- Safety equipment in cockpit and cabin
- Cargo carried in the aircraft
- The technical condition of the aircraft

The references for these inspections are contained in the Standards of ICAO Annexes 1, 6 and 8.

As SAFA ramp inspections are on-the-spot assessments, they cannot substitute or replace the safety oversight responsibilities of the State of Registry. Ramp inspections serve as pointers; over time the results can be used as an indication for the quality of safety oversight performed by the State of registry.

Categorisation of inspection findings

Within the SAFA programme, three categories of findings are defined:

- Category 1 is a minor finding;
- Category 2 is a significant finding;
- Category 3 is a major finding.

The terms “minor”, “significant” and “major” relate to the level of deviation of the finding from the ICAO Standard and its assumed effect on the safety of the aircraft, its crew and passengers. The SAFA procedures contain guidance on the categorisation of findings to ensure a consistent approach by all States participating in the programme.

Pending on the amount and category of findings, different actions can be taken by the State where the inspection was performed. The actions can vary between:

- Information concerning the results of the inspection send to the operator and responsible NAA;
- Restrictions on aircraft operations;
- Corrective actions required before flight authorised;
- Aircraft grounded;
- Entry-permit repercussions.

All inspection results need to be recorded in a dedicated database, available to all participating countries. The collected data are considered confidential; they are not available to the general public.

Whenever an inspection shows the existence of a potential safety threat, or shows that an aircraft does not comply with international safety standards and may pose a potential safety threat, the inspection report will be communicated without delay to each EU Member State and the European Commission.

Apart from the fact that individual Member States may decide to revoke the entry permit of a particular operator, the Commission may decide upon an operating ban in the Community. This operator (or all operators operating from a particular country) will be mentioned on the so-called 'black list'. If an airline feels that it should be taken off the list because it again complies with the relevant safety standards, it can contact the Commission or a Member State, either directly or through its civil aviation authority. Only the Commission or a Member State may ask for the list to be updated. The committee of aviation safety experts will then assess the evidence presented by the airline or the supervisory authority. The Commission will then take a decision based on the committee's opinion. The same procedure will apply if an airline is to be added to the list.

3.4.1 Results

Number of inspections

Since the start of the Programme in 1996, more than 36,000 inspections have been carried out and recorded in the database. Since the year 2000, a continuous increase in the total number of inspections can be observed. This may be explained by the fact that the total number of States participating in the Programme has increased and in most of the States the total number of inspections performed has increased as well.

Number of findings

In the early years of the SAFA programme, between 1998 and 2003, the ratio between the number of findings and the number of inspections varied slightly between 0.93 and 1.08. In other words this means that, on average, during each inspection between 0.93 and 1.08 findings were established. After 2003 an upward change is noticed. For instance in 2006 on average 1.67 findings have been established during each inspection. This increase of the ratio findings / inspections may be attributed to the following:

- In general the majority of States concentrate their inspections on those operators which had findings in the past, this leading to potentially more findings.
- Due to training and continuing building up of experience by the inspectors, the inspections are carried out in more depth.

As in most cases, not all items are checked during an inspection, the relationship between the total number of findings and the total number of inspected items might give a better understanding. For this ratio the same upward trend is noticeable. For every 100 checklist items inspected on average three findings were established in the years up to 2003. In 2005 this increased to 4.7 findings per 100 items inspected and further increased in 2006 to 4.8 findings per 100 items inspected.

Seriousness of inspection findings

Since the beginning of the programme, the relative number of category 1 (minor) findings (relative as related to the total number of inspections) showed a downward trend. In the last years however, a sharp upward trend is noted. The relative number of category 2 (significant) findings remained more or less stable until 2003. After a sharp increase in 2004, a slight decrease is noted in 2006. The relative number of category 3 findings showed since the beginning of the programme until 2005 a continuous and steady increase. In 2006, this development came to a hold. In 2006, the number of Category 3 (major) findings was comparable with the number recorded in 2005.

The relative increase in the number of Category 1 findings and relative decrease of Category 2 and 3 findings may be an indication of an overall improvement in the level of deviation from the ICAO standard.

3.4.2 Effect on aviation safety in the Netherlands

A SAFA inspection primarily gives an indication of the safety level of a particular aircraft being inspected. The combined results of more inspections on (different) aircraft of one operator can give an indication of the safety level of that particular operator, and the combined results of inspections on aircraft of different operators operating from a particular country can give an

indication of the supervisory quality of the responsible NAA. Hence, the SAFA programme is a useful 'bottom-up' instrument to gain insight in the safety level of a particular aircraft, operator and finally of a certain country. Used in this way the SAFA programme can be supplemental to more top down oriented programmes like the ICAO USOAP and the FAA IASA.

Since the start of the programme in 1996, the Netherlands plays an active role in the continuous development of the programme. Further, inspection results are actively used to increase the safety level of certain flights, to focus the inspection effort, and initiatives have been taken to improve the supervisory quality of certain NAA's. With the common approach now in the European Union and the use of the 'Community list of air carriers subject to an operating ban within the EU' a further improvement of aviation safety in the Netherlands might be realised.

3.5 ICAO Safety Management System

Safety management is defined as the systematic management of all activities to secure an acceptable level of safety. Safety management should be both reactive and proactive. A Safety Management System (SMS) is the process that an operator has in place to proactively identify and manage risks and to ensure that safety is maintained at the desired level. In this process there are a number of key elements, like safety objectives set in the safety policy, monitoring safety performance, identification of threats, conducting risk assessments, and taking safety actions (e.g. risk mitigation measures, safety promotion). It is however beyond the scope of this report to extensively address the elements and functioning of a SMS.

Following recently developed ICAO requirements, Member States are now required to establish a State's Safety Programme where aircraft operators, maintenance organizations and services providers implement a Safety Management System. This implies that a SMS becomes a requirement for all aircraft operators, maintenance organizations and Air Navigation Service Providers[1].

3.5.1 Effect on aviation safety in the Netherlands

The development of a State's Safety Programme where aircraft operators, maintenance organizations and service providers implement a Safety Management System will very likely have a positive effect on aviation safety in the Netherlands.

[1] From January 1st, 2009.

3.6 EASA developments: Safety of European Airports

EASA is planning to extend its competences, in the perspective of its total system approach to civil aviation safety, to aerodrome safety and interoperability covering all aerodromes open to public use across the entire Community of Member States. The reason for this extension is the fact that the global ICAO regulatory framework is not sufficient to provide European citizens the level of protection they expect. It exhibits the following main shortcomings:

- ICAO cannot be considered a real "safety regulator" of the aviation system. Safety regulation includes the following three main tasks:
  - Rulemaking
    Rulemaking is the main task of ICAO. But no rule is really legally binding. Parallel legal transposition processes are required in each contracting State, with inherent dis-homogeneity, difference of timescales and duplication of work.
  - Certification / oversight / enforcement
    Despite the ICAO global audit programme (USOAP) this remains a largely uncoordinated national responsibility.
  - Standardisation
    Despite the UCAO global audit programme (USOAP) this remains a largely uncoordinated national responsibility.
- ICAO does not include the regulation of organisations. Rules often specify only the "what", but neither "by whom" (i.e. an organisation), nor "how" (e.g. certification and oversight by competent Authorities).
- ICAO Annex 14 establishes that, as of 27 November 2003, States shall certify 'large' aerodromes (used for international air operations), through an appropriate regulatory framework. The latter shall include criteria for the said certification. Annex 14 only recommends certifying *all* aerodromes open to public use.

EASA concluded that the total system approach is the only means to avoid safety gaps and inconsistent, potentially conflicting, requirements. A high and uniform level of safety can only be attained through common action at the Community level, is the idea.

Scope

The EASA regulations include:

- The airport infrastructure relevant for the safe operation of a single aircraft
- Aerodrome equipment directly contributing to the safe operation of a single aircraft on the ground

- Design and production organisations of specific aerodrome equipment (these shall be subject to specific rules and approval processes)
- Management of the aerodrome operations and services.

Regulations

Uniform high level Essential Requirements have been established, in compliance with the ICAO obligations of Member States and which do not introduce revolutionary changes to existing national practices. These Essential Requirements are the conditions to be fulfilled by a product, an infrastructure, a person or an organisation to ensure as much as possible that the public is not unduly affected by their use, operations or activities. They address therefore the means by which risks associated to a specific activity shall be eliminated or reduced to an acceptable level, when reasonably probable. In other words, the Essential Requirements do not constitute a legal obligation to certain quantitative results (e.g. Tolerable Level of Safety), but on the contrary an obligation for certain means to be implemented to mitigate unacceptable risks. In this context it must be made clear that verification of compliance (certification or approval processes) are not mitigating measures; they are the verification that a mitigating measure is being implemented.

To specify such means, it was necessary to identify the hazards associated to the analysed activity and to evaluate the related risks. The Essential Requirements are then the means to be used to reduce these risks to an acceptable level. The process is as follows:

- Identification of any potential event which could initiate a sequence dangerous for aviation safety: i.e. identification of the hazards
- Assessment of the possible consequences, and categorisation of their “severity”
- Assessment of the probability of occurrence, in the absence of any safeguards (i.e. “probability”)
- Judgement on the tolerability of the risk (i.e. only extremely remote probability is acceptable if a catastrophic severity is possible; greater probability is allowed in the face of less severe consequences
- Definition of mitigating measures to reduce the probability of a hazard occurring or to reduce the severity of the consequences, when the risks associate to a hazard is unacceptable.

Certification and oversight

Each aerodrome open to public use and located in a Member State shall be subject to certification. Such certification shall aim at verifying compliance with the Essential Requirements and cover both design and operations.

For proximity reasons, certification and oversight tasks shall be carried out by competent authorities nominated by Member States.

3.6.1 Effect on aviation safety in the Netherlands

A Regulatory Impact Assessment (RIA) has been performed. On the basis of this RIA, it is considered that the extension of the EASA competences to the safety and interoperability of aerodromes is justified, in particular with regard to safety, social and economic benefits. Regarding the required safety oversight, the Dutch CAA will get the responsibility for certification and oversight of all airports that are open for public use in the Netherlands.

It is expected that this extension of the EASA competences together with the safety oversight executed by the Dutch CAA will have a positive impact on aviation safety in the Netherlands.

3.7 EASA Developments: European ATM/ANS Safety

EASA has the intention to extend its competences, in the perspective of its total system approach to civil aviation *safety*, to Air Navigation Services (ANS) and Air Traffic Management (ATM) *safety* covering all airspace in the entire community of member States.

Safety and certain aspects of interoperability of ATM/ANS shall be regulated under the EASA system as the current Single European Sky (SES) framework addresses simultaneously the various aspects of regulation. As a consequence, capacity, economic performance, interoperability of ATM/ANS systems, air/ground interoperability, safety, environmental protection and other aspects of regulation are mixed in both the applicable rules and the certification processes. This approach reflects the traditional practice in the ATM/ANS domain, where until recently even service provision and regulatory functions were considered as the two sides of the same coin. It primarily aims at improving the overall performance of the ATM system, in particular as regards capacity and economic performance. This might have some advantages, as it allows covering under a single approval all regulatory obligations. However, the SES approach presents some drawbacks as well, as it is unclear how arbitration between safety and other objectives is done. For that reason it is now widely accepted that safety regulation should be separated from economic performance regulation.

The extension of the EASA system to ATM/ANS has been analysed as the best solution in terms of safety and regulatory efficiency. Transfer of responsibility for ATM/ANS safety regulatory activities to EASA is the cheapest and the most appropriate for limiting certification to safety aspects. Hence, only certain aspects of ATM/ANS regulation will be transferred from the SES to the EASA framework.

Scope

The EASA regulations will include:

- *Airspace*
  Safety regulation of air traffic under the EASA system will cover the whole airspace in which the EASA Treaty applies. This includes both controlled and uncontrolled airspace. Safety of air traffic in uncontrolled airspace is provided for by the rules of the air contained in ICAO Annex 2 that are similar to rules used to ensure the safety of road traffic. This will bring the benefit of harmonising those applicable rules of the air related to safety, which currently vary from State to State, constituting therefore a real safety threat by lack of interoperability from an airspace users' point of view.

- *ATM/ANS providers*

  ATM/ANS providers will be subject to common safety requirements and the SES regulations have established the related certification requirements. It might be appropriate to clarify that the Treaty does not allow differentiating between undertakings on the basis of their ownership. This implies that service providers owned by States, including military administrations, may not be treated differently to any other organisation, private or corporatised, providing the same services. EASA is of the opinion that any organisation involved in the provisions of ATM/ANS services, as defined in the SES framework, shall be subject to common safety rules.

- *Systems*

  Design, maintenance and functioning of systems and constituents contributing to ATM/ANS service provision involves significant risks, which need to be appropriately mitigated. This is acknowledged by ICAO SARPs and the SES regulations, which establish certification requirements. EASA concludes, therefore, that such systems and constituents must be subject to common rules under the EASA system.

- *Air traffic controllers*

  Member States have already accepted, through their ICAO commitments and then subsequently under SES regulations, that air traffic controllers must be subject to common requirements for theoretical knowledge, practical skill, language proficiency and medical fitness. Such requirements aim at ensuring not only that they have undergone the necessary training, which is a requirement for all professions, but also that they have the appropriate physical/medical fitness and sufficient current practice. The need to meet such requirements, which limit the freedom of those individuals to exercise that profession and can even force them out of their employment when they do not meet them anymore, lead EASA to conclude that this personnel belongs to a regulated profession and shall therefore be subject to regulations.

- *Organisations involved in design, manufacture, maintenance and operation of systems*

  EASA has identified safety risks related to the design, manufacture, maintenance and operation of systems and constituents of the European Air traffic Management Network (EATMN). Although it is widely accepted that mitigation of these risks shall ultimately be the responsibility of the service providers using such systems or constituents, this does not alleviate that of the organisations that are directly involved in their design, manufacture, maintenance and operational tasks. The Agency is therefore of the opinion that these organisations shall be referred to in the regulations

and may be required to demonstrate their capability, as appropriate, when so decided in the implementing rules based on proper regulatory impact assessment. This does not imply that such organisations should systematically be directly regulated in order to relieve the responsibility of systems and constituents' users. However, this would provide the legal basis to permit doing so when appropriate. This is likely to be the case for GNSS systems and complex satellite/ground communication networks. This could also apply to some value added aeronautical information services, in particular electronic navigation data bases, for which there is currently no legal basis allowing their regulation.

These EASA regulations will not include:

- *Airspace users*

  Air operators are required to comply with the applicable dedicated concepts of operations in the airspace they use at a given time. This implies equipage and training requirements, as well as obligations to use certain services and to implement prescribed procedures. The EASA system already includes the related provisions, consistent with the provisions of ICAO Annex 6. Therefore, EASA is of the opinion that ATM/ANS safety regulation of airspace users is better regulated under that system. Foreign operators will have to comply with Community requirements when in the airspace of Member States; this gives an opportunity to impose on them the necessary rules to comply with airspace requirements.

Regulations

Essential Requirements have been established, that take into account also the applicable ICAO Standards and Recommended Practices (SARPs).

Essential Requirements are the conditions to be fulfilled by a service, a product, a person or an organisation to ensure that the public is not unduly affected by their operations or activities. They address the means by which risks associated to a specific activity, whenever reasonably probable, shall be eliminated or reduced to an acceptable level. To achieve this goal, hazards and associated risks have been identified and analysed, in order to determine the requirements that are essential to mitigate unacceptable risks. In this context, it must be made clear that certification processes are not mitigating measures; they are the verification that a mitigating measure is being implemented.

With the help of experts in the domain, EASA identified the hazards linked with the provision of ATM and ANS, then assessed the related risks, and finally developed the mitigation strategies, which constitute the proposed ERs. These ERs are also intended to provide an appropriate basis to specify implementing means, guaranteeing consistency and continuity with existing SES regulations and implementing rules. The safety hazards are related to the interaction between aircraft, on the ground and in all phases of flight.

The mitigating criteria that were introduced in the essential requirements, when the associated risk appeared unacceptable, allow compliance with relevant ICAO Annexes and SES legislation, as well as Eurocontrol ESARRs insofar as related to the safety and global interoperability requirements.

The Essential Requirements have been drafted with the view to allowing alternative implementation means, which could vary depending on the type of the regulated service, product, person or organisation. They create the legal mandate needed for further implementing rules or for direct enforcement. It would be possible, therefore, to develop implementing rules building on material already developed in the context of ICAO, SES and EUROCONTROL, or to introduce other forms of regulation depending on the answers to the questions raised in this document.

Certification and safety oversight

According to the current SES provisions, compliance verification shall be made by means of certification. Consistent with the sharing of roles established in the EASA system, the competent Authorities responsible for issuing certificates shall be the National Authorities, as regards operators residing in their territory, and EASA for foreign organisations providing services in the European airspace.

However, some certification tasks can be better executed centrally for reasons of uniformity or of efficiency, in particular in domains requiring a rare expertise. This might be the case for ATM/ANS services covering several Members States, e.g. in the field of aeronautical information and navigation or communication networks; SESAR developments are likely to lead to building more pan-European services. It could then be questionable to require the Member State in which the service provider has its principal place of business to be the only competent authority. EASA is therefore of the opinion that it shall be given the power to certify and oversee service providers providing their services in more than three Member States. This will exclude simple cross-border ATS provision and should not affect functional

blocks of airspace in as much as such blocks do not imply that services in there are provided by a single provider.

EASA considers it necessary that its standardisation inspection process is used to oversee how national competent authorities exercise their delegated powers in that field.

3.7.1 Effect on aviation safety in the Netherlands

A Regulatory Impact Assessment (RIA) has been performed. On the basis of this RIA, it is considered that the extension of the EASA competences to Air Traffic Management (ATM) and Air Navigation Services (ANS) is justified, in particular with regard to safety, social and economic benefits. It is expected to give better results than SES. It can thus be stated that the EASA regulations are expected to have a positive impact on aviation safety in The Netherlands.

Regarding safety oversight, the NAA will get responsibility for certification and oversight of Dutch ATM/ATS providers, air traffic controllers, related systems, and organisations involved in design, manufacture, maintenance and operation of systems.

3.8 IATA Operational Safety Audit (IOSA)

The International Air Transport Association (IATA) is an organisation that represents the airline industry. Its members comprise some 240 airlines - the world's leading passenger and cargo airlines are among them - representing 94 percent of scheduled international air traffic.

The IATA Operational Safety Audit (IOSA) was launched in 2003. IOSA is an internationally recognised audit that is open to all airlines and that assesses the operational management and control systems of an airline. IOSA Audit Reports facilitate business arrangements, such as code sharing (in which case the participating airlines must audit one another). With IOSA, airlines are able to share information through the IOSA Audit Report, eliminating the need for costly duplicative audits. Before IOSA airlines were auditing one another on their ability to deliver a safe operation sending auditor teams around the world at great expense and time. The audits had varying standards with no consistency.

IOSA Audit Organisations are formally accredited by IATA to conduct IOSA audits. Each organisation must use approved IOSA Auditors that have all met stringent IOSA training and qualification standards.

IOSA has become a condition of IATA membership. Since IOSA's launch in 2003, some 800 IOSA Audit Report requests have been completed.

IOSA is not intended as a substitute for state regulatory authority oversight as required by ICAO. According to ICAO standards, airlines must be audited by their NAAs. However, since IOSA standards are harmonised with International Civil Aviation Organization (ICAO) annexes and have been endorsed by ICAO, some regulatory authorities are using IOSA for this purpose. IOSA Audit Reports can provide valuable additional data that can assist States in risk assessment and in planning their own inspections. A growing number of governments are planning to incorporate IOSA as part of their certification process. Some countries are already actively using IOSA audit data, and others have mandated IOSA for local or foreign airlines wishing to fly within their jurisdictions. These include the Arab Civil Aviation Commission (ACAC) in conjunction with all of its member states and Brazil, Chile, Costa Rica, Egypt, Madagascar, Mexico, Panama, and Turkey.

IOSA Standards

IOSA Standards are derived from all relevant ICAO Standards, in particular Annex 1 Personnel Licensing, Annex 6 Operation of aircraft, Annex 8 Airworthiness of aircraft, as well as from regulations of the JAA, FAA, and industry best practices.

The IOSA audit standards are based on eight areas that contribute to airline operational safety:

- Corporate Organisation and Management Systems
- Flight Operations
- Operational Control - Flight Dispatch
- Aircraft Engineering & Maintenance
- Cabin and Cargo Compartment Operations
- Ground Handling
- Cargo Operations
- Operational Security

3.8.1 Effect on aviation safety in the Netherlands

Because IOSA provides a common set of audit standards that are centrally managed, continuously updated, and consistently implemented by experts and industry professionals, with a quality-based programme and independent Audit Organisations accredited by IATA, IOSA should effectively be raising the safety level in the industry. Hence, the assumed effect on aviation safety in the Netherlands is positive.

4 Safety Aspects related to the introduction of Very Light Jets

4.1 Introduction

In this chapter, safety aspects related to the market introduction of Very Light Jets (VLJs) will be discussed. VLJs are small turbofan-powered aircraft with 3 – 8 seats and a maximum certified take-off mass (MCTOM) below 10,000 lbs. The wide-spread use of VLJs for private, business, corporate and air taxi flights is foreseen, operating mainly from small and regional airports. Because VLJs are a new type of aircraft which will be widely used, safety issues may arise. Therefore, in this chapter, some relevant characteristics of VLJs are described, safety aspects are identified and their potential effect on aviation safety in the Netherlands is assessed.

The information provided in this chapter is for a large part based on or identical to the information published in *NLR-CR 2008-247 Safety Aspects related to the European Personal Air Transportation System and recommendations for future research*.

4.2 VLJ Concept of Operation

4.2.1 Physical and performance characteristics

As stated in the introduction, VLJs are small turbofan-powered aircraft with 3 – 8 seats that have a maximum certified take-off mass (MCTOM) below 10,000 lbs. The introduction of the VLJs are in fact a downward extension of the business jet spectrum, as existing light jets (LJs) are defined to have a MCTOM between 10,000 lbs and 20,000 lbs, medium jets a MCTOM between 20,000 lbs and 35,000 lbs and heavy jets a MCTOM greater than 35,000 lbs.

The main enabling technologies behind this downward extension are ongoing developments in the application of composite materials and the development of small and cost-effective turbofan engines with a thrust range that makes them viable as means of propulsion of VLJs.

As substantiated by Bonnefoy and Hansman (2006), the 10,000 lbs threshold between VLJs and LJs has emerged from an historical perspective. In fact it distinguishes two generations of aircraft with the Cessna CJ1, certified in 1992, being the lightest twin turbofan-powered aircraft at that time with a MCTOM of 10,600 lbs. The recent market entry of VLJs lowered the business jet spectrum under 10,000 lbs. However, from a vehicle and performance standpoint, the threshold between the two classes is not as clear, and an alternative 12,500 lbs threshold has also been considered. This threshold separates aircraft being certified under Federal Aviation Regulations (FAR) Part 23 (airworthiness standards for normal, utility, aerobatic and

commuter category aircraft) and under FAR Part 25 (airworthiness standards for transport category aircraft). In table 2.1 an overview is given of the downward extension of the business jet spectrum:

Aircraft name	MCTOM (lbs)	# Engines	Aircraft Category[a]	FAR
LearJet 35	17,000	2	LJ	Part 25
Cessna Excel	16,630	2	LJ	Part 25
Hawker 400	16,300	2	LJ	Part 25
Cessna Bravo	14,800	2	LJ	Part 25
Cessna CJ3[b]	13,870	2	LJ	Part 23
SJ30[b]	13,500	2	LJ	Part 23
Beech Premier 1	12,500	2	LJ	Part 23
Cessna CJ2+	12,500	2	LJ	Part 23
Cessna CJ1+	10,700	2	LJ	Part 23
Embraer Phenom 100	9,700	2	VLJ	Part 23
Adam 700	9,350	2	VLJ	Part 23
HondaJet	9,200	2	VLJ	Part 23
Cessna Mustang	8,645	2	VLJ	Part 23
Spectrum 33	7,500	2	VLJ	Part 23
Eclipse 500	5,950	2	VLJ	Part 23
Diamond D-Jet	5,690 (max. ramp mass)	1	VLJ	Part 23
Piper Jet	NA	1	VLJ	Part 23
Cirrus Vision SJ50	NA	1	VLJ	Part 23

a. Aircraft categories are based on the National Business Aviation Association classification.

b. Both the Cessna CJ3 and the Sino Swearingen SJ30 obtained an exemption from the FAA for a Part 23 certification instead of a Part 25 certification despite their maximum certified take-off masses greater than 12,500 lbs.

Table 4.1 Business Jet spectrum with extension to the VLJ category (Source: Bonnefoy and Hansman, 2006, adjusted)

A comparison can be made between VLJ and LJ aircraft physical characteristics and performance metrics. To start with the number of passengers, VLJs are able to carry 3 to 8 passengers. As VLJs are all certified for single-pilot operations, the right front seat could be utilized as a passenger seat when the aircraft is indeed operated with only one pilot. Hence, there is a small overlap here with LJs, which are able to carry 5 to 10 passengers.

The acquisition cost of a (single-engine) VLJ starts at approximately $1,38m, and range up to approximately $4m. LJs start at approximately $4m, and range up to approximately $10m. As

substantiated by Bonnefoy and Hansman (2006), the acquisition price of VLJs extends the linear relationship between price and aircraft weight that light, medium and heavy jets (up to 40,000 lbs) follow.

In terms of operational characteristics and performance, VLJs have lower cruise speeds (approximately from 340 to 390 kts) compared to LJs (approximately from 380 to 460 kts). The maximum ceilings range from 25,000 ft for single engine VLJs up to 45,000 ft for twin engine VLJs, the latter being comparable with the maximum ceiling of LJs. The operating ranges of VLJs are between 1100 and 1750 nm, largely comparable with the operating ranges of LJs. Finally, VLJs require shorter take-off field lengths (approximately from 2100 ft to 3100 ft) compared to LJs (longer than 3300 ft).

4.2.2 VLJ avionics

In principle, VLJs are designed for single-pilot operations. For this type of operation[2)], the enabling technology is advanced avionics, automated engine and systems management, autopilot and advanced FMS. The typical avionics suite comprises:

- Electronic Flight Instrument System (EFIS);
- Primary Flight Display (PFD) and Multi-Function Display (MFD);
- Moving map navigation displays, with terrain, traffic and weather information;
- Advanced navigation means (using GPS combined with Space Based Augmentation Systems - SBAS or Ground Based Augmentation Systems - SBAS);
- Flight Management System (FMS);
- Autopilot and flight-guidance systems;
- Full Authority Digital Engine Control (FADEC);
- Automated engine and systems management;
- Electronic flight bag functions: airport charts, and information, airport taxi display;

At this very moment there is no requirement for VLJs to be equipped with a Ground Proximity Warning System (PGWS), with or without a predictive terrain hazard warning system included, as the MCTOM is less than 5,700 kg and the maximum approved seating configuration is less than 9. The same is applicable for an Airborne Collision Avoidance System (ACAS). However, in Europe, Eurocontrol is studying whether there a requirement for ACAS should be formulated.
A Cockpit Voice Recorder (CVR) and a Flight Data Recorder (FDR) are not required as well because the MCTOM is less than 5,700 kg and the maximum approved seating configuration is less than 9.

[2)] VLJs can only be flown single pilot if operational regulations allow this.

4.2.3 Envisioned VLJ Operations

The operational concept of VLJs is characterized by reducing the door-to-door travel time, using small jet aircraft of low cost that operate from local (small) and regional airports especially located on the periphery of (European) main transportation infrastructure in areas with a low level of accessibility (suburban, rural and remote areas), and in all weather conditions. VLJs can provide a safe, secure and comfortable alternative to other modes of transportation, such as the current commercial air transport and (high-speed) rail transport.

VLJs will be mainly used for business, corporate and air taxi operations, but can also be used for recreational or private flights. Their intended use is not by traditional air carriers. A VLJ operator can be, amongst others, an air taxi service operator with a fleet of 100 VLJs, a medium-sized corporation, a fractional ownership company, or an individual owner.

In the United States, private and corporate operations with VLJs are possible under Part 91, General Operating and Flight Rules, with in Part 91 Subpart (K) operating rules for fractional ownership programs. Commercial operations are possible under Part 135, Commuter and On Demand Operations. Under these regulations, only the unscheduled use of VLJs as for instance an air taxi is allowed.

4.2.3.1 Single-pilot operations

VLJs are certified for single-pilot operations. In the United States, single-pilot operations are allowed when operating under Part 91, i.e. for private and corporate flights and flight operated under Part 91 Subpart (K). For commercial air transport under Part 135, single-pilot operations with VLJs are allowed under Visual Flight Rules (VFR) only.

In Europe, single-pilot operations are allowed when performing private flights. For commercial operations, which include corporate aviation, EU-OPS is applicable[3]. Under these regulations, single-pilot operations with VLJs are allowed under Visual Flight Rules (VFR) only.

4.2.3.2 Single-engine operations

In Europe, for private use, single-engine operations are allowed. For commercial air transport, single-engine operations are not allowed during night, in Instrument Meteorological Conditions (IMC) except under Special VFR, and when there are no surfaces available along the route that permit a safe forced landing to be executed.

[3] In the Netherlands, for corporate aviation (‘vervoer voor eigen bedrijf’), an exemption can be granted from holding an Air Operator Certificate (AOC).

In the United States, for private and corporate flights operated under Part 91 as for commercial air transport under Part 135, single-engine operations are allowed.

4.2.4 Pace of market entry

The mass production of VLJs is a characteristic associated with the foreseen VLJ market. It is related to the low aircraft acquisition cost of between 2 and 4 million US$ (2006), resulting in a potential large number of VLJs entering the aviation system.

The first air taxi operations with VLJs have already started in the United States and Europe, for example DayJet in the US and Bikkair in the Netherlands (on 20 September 2008 the announcement was made that DayJet discontinues operations due to financial problems). As of August 2008, 361 VLJs have been delivered world-wide, of which 40 in Europe. Current orders and delivery dates for Europe indicate 37 deliveries until the end of 2008, 123 in 2009 and 140 in 2010, giving a total number of 340 VLJs in Europe at the end of 2010. This is a minimum because for 17% of the known orders the delivery date is not known. Extrapolating these figures, a delivery rate of 100 VLJs per year seems justifiable, and is also the figure Eurocontrol uses. This would mean around 840 VLJs in Europe by 2015.

What is not known is how many of these will be used to replace older, more expensive aircraft. Since many of the operators are planning significant new business ventures with these new aircraft, the extent of direct replacement is assumed to be relatively low. However, there is likely to be some indirect replacement, where the new offering drives out existing services. In this case it has been widely assumed that the VLJs will be replacing older turboprop aircraft.

Daily utilisation of aircraft varies widely in business aviation, from 2 flights/week average for corporate aircraft, to 5 flights/week typical for charter/taxi work, but up to 3 flights/day for the most intensive users (including positioning flights). Forecasts of future VLJ flights will therefore be sensitive to assumptions about to which type of use the VLJs will go. Most of the orders appear to be for air taxi operators.

Putting these figures together gives a very rough estimate of up to 300 extra/flights per day each year in Europe coming from VLJs (i.e. 100 additional aircraft at 3 flights/day). However, this is most probably an upper estimate because the delivery schedules of new aircraft types are more likely to be delayed than to be advanced, and there is a strong dependence on the success of the air taxi service as a new form of air transport.

4.3 Identification of Safety Aspects

In this paragraph an overview of VLJ safety issues will be provided. Areas covered are:

- Aircraft manufacturing and certification
- Flight operations;
- Training and qualification;
- Airport services and Air Traffic Control;
- Safety programs; and
- Safety oversight.

4.3.1 Aircraft Manufacturing and Certification

Aircraft certification

Safety aspects related to VLJs will be considered as part of the certification process. Where airworthiness is concerned VLJs are certified in accordance with FAR-23 or EASA CS-23, as the MCTOM of VLJs is below 12,500 lbs. A safety concern is the fact that FAR/CS Part 23 is a lower standard from an airworthiness perspective compared to FAR/CS Part 25, which is used for certification of large commercial aircraft. As a result, the safety level of VLJs will be less in some areas compared to airliners. For example, single-engine accountability is not regulated in Part 23 in contrast to Part 25. This means that take-off and climb out performance with one engine failed (N-1) does not need to be taken into account. Likewise, structural requirements are different for Part 23 aircraft. As another example, minimal control speed ground (V_{MCG}) tests do not have to be conducted and requirements for system failure probabilities (versus severity of the failure) are a factor 10 lower than in Part 25. As regulators have recognized that the high performance Part 23 aircraft are going to be used in commercial air transport, special provisions or Critical Review Items (CRI) have been established to bring these aircraft closer to the standard of Part 25. Examples of CRIs are fuel tank crashworthiness, bird strike, speed margins, vibration and buffeting.

Manufacturing and airworthiness

A second safety aspect is manufacturing and related airworthiness regulations. We see new aircraft manufacturers entering the VLJs market with little experience. Aside these new start-ups, aircraft manufacturers of commercial aircraft and business jets have also started developing VLJs (e.g. Embraer and Cessna). The production lines have to output a considerable number of aircraft on a yearly basis since the high number of aircraft to be delivered is obviously related to the required low unit price. For instance, VLJ manufacturer Eclipse expects a delivery rate of two aircraft per day. This production rate and associated support is a significant effort for relatively small aircraft manufacturers. Especially the high number of

aircraft to be produced, low cost and weight drives new production processes and manufacturing techniques. An area of possible risk is the (long-term) airworthiness of the new technologies, production techniques and materials. We have gained a considerable amount of experience and knowledge in the past decades in behaviour of structures, materials and related production processes, which is reflected in current regulations. However, the industry has limited experience today regarding the long-term behaviour and effects of these new technologies etc. It is unclear to what extent the current regulations are appropriate for certification of new designs and new technologies.

Safety issues related to aircraft manufacturing and certification:
VLJs are certified in accordance with FAR/CS Part 23, which is a lower standard from an airworthiness perspective compared to FAR/CS Part 25, which is used for certification of commercial airliners. As regulators have recognized that the high performance Part 23 aircraft are going to be used in commercial air transport, special provisions have been established.
A second safety aspect is the area of manufacturing and airworthiness regulations. An area of possible risk is the (long-term) airworthiness of the new technologies, production techniques and materials. The question is whether the current regulations are appropriate for certification of new designs and new technologies.

4.3.2 Flight Operations

The National Business Aviation Administration (NBAA) has collected a list of potential hazards for operations of VLJs and technically advanced turboprop or piston engine aircraft (TAAs). In table 2.2, a summary is given of this list. In Appendix A, a detailed version is provided [ref. 5].

• Clear air turbulence/jet stream core or boundary encounters • Convective weather encounters • FMS programming and autoflight vs. manual flight control • High-altitude upset • Inadequate "land and hold short" (LAHSO) preparation • Inadequate crosswind takeoff/landing preparation • Inadequate exercise of "command" • Inadequate knowledge of high-altitude weather • Inadequate preparation for high-rate/high-speed climbs • Incorrect/less-than-optimum cruise altitude selection	• Jet blast damage behind larger jets during ground operations • Lack of pilot self-evaluations • Low-fuel arrivals trying to stretch range • Microburst/windshear encounters • Mountain wave encounters • Physiological effect of high-altitude operations • Recognizing single pilot "red flags" (as an alternative to below) • Single pilot adherence to checklists • VLJs misunderstood by ATC (pilot mitigations) • Wake turbulence encounters • Winter operations

Table 4.2 List of hazards for VLJs

Three, closely related, major concerns for VLJs stand out in the area of flight operations:

- Use of automation and advanced avionics;
- Single pilot operations; and
- Pilot training (see paragraph 4.3.3).

The first two issues will be explained below, while the next paragraph addresses pilot training and qualification in more detail.

Use of automation and advanced avionics

The use of automation and advanced avionics in VLJs help to reduce pilot workload and increase situational awareness, *if used well by a well-trained pilot*. A drawback, especially when used by inexperienced pilots, is the potential for over-reliance and over-confidence of pilots on automation and flying too much 'heads-down'. Oftentimes many (too many) options and features are available in avionics, while concern for human factors in design leaves room for improvement. In contrast to the business jets, commercial aircraft avionics have generally less features and are used in a strict procedural environment and a crew concept.

The advanced avionics and aircraft performance may also challenge the (inexperienced) pilot with a non-airline/professional pilot or military training background 'to stay ahead of the aircraft'. Basically VLJs require highly cognitive skills for operating automation, e.g. monitoring aircraft systems, operating the FMS, automation modes, mode changes, understanding the complexity of avionics, and handling failures. Advanced avionics require extra training and cognitive skills. Workload, planning, avionics complexity, decision-making, automation mode confusion etc. are examples of real issues that need attention through design and training of pilots.

Single-pilot operations

VLJs are generally designed for single-pilot operations, using advanced avionics and automation described earlier. A second pilot is normally pivotal in monitoring, cross-checking, decision-making and challenging the pilot flying, meanwhile sharing workload and supporting the pilot flying with 'administrative' tasks, e.g. R/T, programming the FMS, reading checklists, and assisting in failure handling. The role of a second pilot cannot be fully replaced by automation. Technology remains 'passive' in the sense that it does not actively challenge a pilot, and in non-normal situations a high workload can arise.

To help the single-pilot to manage workload, flight planning and decision-making, the concept of Single-pilot Resource Management (SRM) is developed. SRM is the single-pilot version of Crew Resource Management (CRM).

For single-pilot operations, medical and mental fitness is an issue as well. For example pilot incapacitation, fatigue and stress are safety aspects that should be addressed in training.

Safety issues related to flight operations:

Automation/advanced avionics:

- Overreliance, over-confidence
- Lack of experience, knowledge of pilots
- Complexity, understanding of the advanced avionics
- Highly cognitive skills required for operating automation

Single pilot operations:

- Workload in non-normal operations
- No co-pilot: lack of challenging, monitoring, workload sharing
- Medical and mental fitness

4.3.3 Training and qualification

Many organisations have acknowledged the risk associated with relatively inexperienced pilots operating in complex, advanced aircraft, such as VLJs, possibly in single pilot operations. Therefore, training for VLJs (and other technically advanced aircraft, TAAs) is a subject that receive much attention across the aviation industry.

4.3.3.1 Pilot training

Additional pilot training required to prepare for advanced aircraft

As mentioned in the previous paragraph, VLJs with their advanced avionics and flight automation introduce complexity compared to the general aviation and business aircraft with analogue instruments, ground based navigation and simple automation. Operating these more advanced aircraft requires additional knowledge, understanding of the systems, skills in monitoring and automation management, mode awareness and understanding how, when and when not to use automation, while maintaining manual flying skills [Ref. 19]. Training programs should thus be focused on automation management, workload management, cognitive skills, single pilot resource management, flight planning, judgement and decision-making [Refs. 23, 24, 25]. Although the automation and avionics may provide additional safety, the AOPA Air Safety Foundation states that "to actually obtain this available safety, pilots must receive additional training in the specific technically advanced aircraft systems in their aircraft that will enable them to exploit the opportunities and operate within the limitations inherent in their systems" [Ref. 17].

The introduction of VLJ aircraft increases the likelihood that relatively inexperienced pilots will be operating a high performance jet in a complex and challenging environment. Therefore, Regulators should ensure that training standards, experience and medical standards are adequate to deal with this development [Ref. 8].

Different pilot experience levels

It is likely that pilots with a range of experience levels will operate VLJs: some will transition from general aviation, others will come from the corporate or business aviation industry, air taxi operators or fractional ownership companies. There is also an interest in hiring (retired) airline pilots, who bring experience, knowledge and airline training with them, which will benefit safety. We can expect VLJ air taxi operators to adopt similar approaches to pilot qualification as the air taxi operation business in the USA today. For example, VLJ air taxi operator DayJet, before they ceased operation, was looking for pilots with multi-engine aircraft experience and a minimum of 3,000 flights hours, which drew potential pilots from

(retired) airline pilots, the charter and business/corporate sector. Another taxi operator, Linear Air in the United States, typically gets pilots from four groups: flight instructors, regional airline pilots, airline pilots nearing mandatory retirement and military pilots.

The aforementioned mentioned minimum experience requirements for pilots employed in air taxi operations may not be the 'standard'. Especially the smaller companies and individual owners could have relatively inexperienced pilots in the seats of their VLJs.

4.3.3.2 Development of pilot training programs

Manufacturers, together with aviation insurance companies, regulators and flight crew training organisations, establish(ed) training requirements and develop training programs in recognition of the need to prepare pilots for VLJ aircraft and single pilot operations. The manufacturer's pilot training programs typically go a step further than the required type-rating course. The training programs accommodate and address the various backgrounds, levels of experience and expertise of the student pilots.

4.3.3.3 Flight crew licensing regulations

In Europe, EASA concluded that VLJ pilot qualification can be conducted under current rules [Ref. 14]. At this time, the JAA Joint Operations Evaluation Board (JOEB) has proposed requirements for Flight Crew Licensing (FCL) for VLJs, which will form the basis of future EASA rules. The current JOEB proposal includes at a minimum the following training to be completed at an approved type rating or flight training organisation:

- 16 hours in the aeroplane, plus 4 hours line oriented operations for low experience pilots; or
- 32 hours Full Flight Simulator (FFS), including 16 hours flying and 16 hours not flying.

The pre-entry requisite for the student includes a mandatory certificate of high performance aeroplane training. EASA will consider and implement the JOEB recommendations in the future and holds the opinion that with respect to pilot competence on complex aircraft types "a new approach to general aviation training systems is required – to at least commercial pilot standards" [Ref. 11]. EASA is going to develop the rules to cover multi-crew operations of VLJs, including training, skill tests, proficiency checking and recency requirements [Ref. 11, 12].

A VLJ can be flown single pilot under VFR by the holder of:

- An Air Transport Pilot Licence (ATPL), plus the appropriate Type Rating;
- A Commercial Pilot Licence (CPL), plus the appropriate Type Rating;

- A Private Pilot Licence (PPL) with certificate of (JAR-FCL) High Performances Aeroplane Training and the appropriate Type Rating.

For conducting IFR flights, the pilots shall have a full Instrument Rating (IR).

In accordance with JAR-OPS 1, commercial air transport operations, such as a VLJ operating as an air taxi service, require a flight crew of two pilots (at least one with ATPL) if conducted as an IFR flight. Under VFR the commercial air transport flight can be operated by a single pilot if the pilot holds a CPL [Ref. 13].

4.3.3.4 Inspectors training

Not only the pilots, but also inspectors have to be prepared in a proper training program to transition to VLJ aircraft and operations, as inspectors have to inspect VLJs, check flight instructors and pilot examiners, and certify commercial VLJ operators.

Safety issues related to training and pilot qualification:

Pilot training:

- Pilots must receive additional training in VLJs to enable them to exploit the available system capabilities and operate within the limitations inherent in the systems.
- Training programs should focus on automation management, workload management, cognitive skills, single pilot resource management, flight planning, judgement and decision making.
- The introduction of the VLJ will increase the likelihood that relatively inexperienced pilots will be operating a high performance jet in a complex and challenging environment.
- Regulators should ensure that training standards, experience and medical standards are adequate to deal with this development.

Training programs:

- Pilots with a range of experience levels will operate VLJs. Training programs have to cater for the various backgrounds, experience and expertise of the student pilots.

Inspector training:

- Inspectors have to be trained in VLJ aircraft and operations as well.

4.3.4 Airport and Air Traffic Control

The expected large number of VLJs and associated flights could lead to air traffic density and complexity related safety problems in the airspace and on the ground. Examples of expected safety issues are bird strike, separation assurance, wake turbulence, runway incursions, airspace incursions, approach and departure pattern deviations, and level busts. It is remarked

that the aforementioned issues are common today, but their frequency of occurrence and severity may change due to the expected large numbers of VLJs.

Airport safety issues

The airports served by VLJs will mainly be the small and regional airports. The level of equipment, facilities and services provided at these airports will not be of the same standard as at the international or large airports in Europe. The airport infrastructure and availability of services for flight operations at the airport are relevant from a flight safety perspective. For example, bird control at the airport aims to reduce the likelihood of bird strike or bird ingestion and the availability of de-icing service is important in winter operations to prevent take-off with contaminated wing (risk of loss of control). If such services are unavailable at an airport, it may reduce flight safety and restrict operation in certain conditions. The absence of de-icing facilities would preclude operations to/from that airport in icing conditions for example.

Air traffic control safety issues

- *Communication problems*. In general, air-ground communication problems are an issue and occur on a daily basis. Examples are call-sign confusion, loss of communication, wrong frequency selected, using non-standard phraseology, misunderstanding of instructions, instruction issued to wrong aircraft etc. The potential consequences of these problems include altitude deviation, runway incursion, prolonged loss of communication, loss of separation, airspace infringement, and heading or track deviation [Ref. 20]. To what extent these scenarios will be exacerbated by workload associated with single pilot operations and by experience and level of training of VLJ pilots should be further analysed.

- *ATC instructions and traffic sequencing*. Safety issues may stem from pilot interaction with ATC. Air traffic controllers will have to learn how to acknowledge and deal with the performance and limitations of VLJs. Misunderstanding of aircraft performance could result in improper sequencing, speed or altitude instructions etc. Comprehension by ATC of single pilot operations related workload and the specifics of VLJ operations may take time. Air traffic controller workload and airspace capacity will be substantial issues, as is wake vortex (when descending and climbing through levels for instance) [Ref. 29]. Moreover, there is at this moment no mandate for an Airborne Collision Avoidance System (ACAS) on-board VLJs, although it is being considered by Eurocontrol. Soon, VLJs are required to have Mode-S transponders, which means that ACAS-equipped aircraft will be able to see them.

Air traffic controllers will face the challenge of working in a further congesting airspace, especially at and near smaller airports, where VLJs are expected to prevail because of their smaller size and shorter runway requirements [Ref. 9]. This could adversely impact workload and situational awareness of air traffic controller, which could result in loss of separation, communication problems etc.

EASA is concerned about the integration of the VLJs in today's air traffic system, amongst others in the area of accommodating VLJs at the higher flight levels of commercial air traffic (FL300-400) and in the complex and dense TMAs. EASA concluded that they needed to quantify and mitigate risk associated with potentially large number of these jets in the European airspace [Ref. 14].

Safety issues related to airport:

- The level of equipment, facilities and services provided at airports typically used by VLJs will not be of the same standard as at the international or large airports in Europe.
- The airport infrastructure and availability of services for flight operations at the airport are relevant from a flight safety perspective. Lack of services (e.g. bird control, de-icing) may degrade flight safety and restrict aircraft operations in certain conditions.

Safety issues related to air traffic control:

- The frequency and severity of the following events *may* increase due to the introduction of (a large amount of) VLJs: loss of separation, wake turbulence, runway incursions, airspace incursions, approach and departure pattern deviations, and level busts.
- Problems in communication, ATC instructions and traffic sequencing, in relation to single pilot operations, increased traffic and communication volume.

4.3.5 Safety programs

The majority of airlines have implemented programs to maintain and manage flight safety. Examples of these programs are Safety Management System (SMS), voluntary occurrence reporting programs, and Flight Operations Quality Assurance (FOQA). Technologies and strategies are available from the commercial air transport industry that could contribute to achieving and maintaining an acceptable level of safety when operating VLJs. Such safety programs work well for airlines, but they have to be tailored to corporate, business and air taxi operators, flying VLJs. Many operators of VLJs will likely have a small fleet of aircraft, which means that they could lack the resources for equipment and manpower to conduct such safety programs. In addition, small operators with a few aircraft do not benefit from the large amount of data and trend analysis of FOQA and occurrence data. For those reasons, it is yet unclear to what extent the commercial aviation safety programs can be successfully implemented and would really provide meaningful feedback.

Safety programs issues:

- VLJ operators could benefit from airline oriented safety programs such as SMS, FOQA, safety occurrence reporting and analysis.
- The implementation and application of these safety programs will not be straightforward due to the required resources and expertise, scale of operations and type of operations.
- The outsourcing of safety programs (e.g. manufacturer-hosted FOQA) runs into issues regarding privacy and propriety information, effectiveness, and responsibility for improvement action.
- Reporting, collecting and analysing safety data is one pillar of aviation safety.

Safety data reporting and collection of occurrences in the general aviation sector is nowadays not well covered, resulting in a lack of knowledge and awareness of general aviation safety and in particular VLJ safety issues in the future.

4.3.6 Safety oversight

The introduction of new types of aircraft means that regulators need to identify, quantify and mitigate potential risks associated with new types of aircraft and their operation. The expected number of VLJs that will enter the market in the next decades and pace of change will bring challenges, and are sources of concern about new risks being introduced for which EASA and National Aviation Authorities need to prepare to maintain a high standard of safety oversight.

With the introduction of VLJs many different operators and types of operations are envisioned, ranging from air taxi companies operating a large fleet of small aircraft offering on-demand air taxi service to individuals owning and flying these aircraft for business or recreational purpose. Up to 2,000 regional airports in Europe are suitable destinations for VLJs. How are regulators going to cope with the inspection and oversight of all these different aircraft types, operators, and operations across Europe at many regional airports?

It is not clear (yet) how EASA and the National Aviation Authorities will deal with oversight of VLJ aircraft and operators, maintenance organisations and training facilities. To get an idea of the potential impact on safety oversight, we refer to the conclusion of the Government Accountability Office (GAO) in the United States regarding the impact of VLJs on FAA oversight. GAO stated that “the challenge of meeting its [FAA] performance target will be exacerbated by other challenges in human capital management, the acquisition and operation of new safety enhancing technologies, and new types of vehicles, such as very light jets, that may place additional workload strains on FAA inspectors and air traffic controllers. […] Finally, if predictions about new types of aviation vehicles are borne out, it will change the aviation landscape and will require new areas of expertise for FAA’s inspectors and controllers. For

example, the industry predicts there may be as many as 5,000 to 10,000 VLJs operating in the national airspace by 2020, which would further congest the national airspace system especially at and near smaller airports, where VLJs are expected to be prevalent because of their smaller size" [Ref. 9].

In general, there is concern with respect to limited resources and allocation of resources to meet certification, inspection and oversight demand as the number and rate of VLJs entering the NAS increases. A shortage of FAA inspectors, mainly due to retirement, could threaten FAA's ability to conduct safety oversight, but FAA plans to increase its inspector workforce [Refs. 9, 16]. Since the VLJs are likely to operate from many smaller/regional airports across the United States (potentially 3000-5000 airports) the deployment of resources will be a challenge.

Safety oversight issues:

- Oversight will pose a complex and resource intensive oversight process, since operators range from individuals operating a VLJ to air taxi operators operating a hundred VLJs across Europe from different countries to/from hundreds of airports.
- There is concern with respect to limited resources (or shortage) and allocation of resources to meet certification, inspection and oversight demand.

4.4 Safety aspects summarized

The main identified safety aspects related to the introduction of Very Light Jets, also relevant for aviation safety in the Netherlands, can be summarized as follows:

- VLJs have a lower standard of airworthiness compared to larger commercial airliners, because different certification standards apply.
- An area of possible risk is the (long-term) airworthiness of the new technologies, production techniques and materials.
- Automation, advanced avionics and single pilot operations are major issues in the context of pilot workload, decision-making, monitoring and automation pitfalls, e.g. complexity, over-reliance.
- The introduction of VLJs will increase the likelihood that relatively inexperienced pilots will be operating in a complex and challenging environment.
- The level of equipment, facilities and services provided at smaller and regional airports will not be of the same standard as at the international or large airports in Europe. Lack of services (e.g. bird control, de-icing) may degrade flight safety and restrict aircraft operations in certain conditions.
- Problems can be expected in pilot-air traffic control communication and traffic sequencing.
- VLJ operators could benefit from airline oriented safety programs such as SMS, FOQA, safety occurrence reporting and analysis.

- Safety data reporting and collection of occurrences in the general aviation sector is nowadays not well covered, resulting in a lack of knowledge and awareness of general aviation safety and in particular VLJ safety issues in the future.

5 Shortage of qualified personnel

5.1 Introduction

Air traffic is expected to grow at an average annual rate of 4.6 per cent up to the year 2025. This is due to various factors like strong economic growth in parts of the developing world and further liberalisation of international air transport.

Current figures indicate that the airline industry expects fleet growth of 17,000 aircraft by 2020, particularly in the emerging markets such as China, the Middle East, Russia and India.

To meet projected demand 19,000 pilots a year must be trained. With capacity of 16,000 a year, the airline industry will face a shortage of more than 42,000 pilots by 2020 if the situation is not remedied. There will also be a shortage of maintenance personnel, cabin crew, air traffic controllers and regulators.

Complicating factors are the ageing of the world population and the trend in the Western world of an increasing number of young people choosing a non-technical education and career. This means less qualified people becoming available on the labour market.

In the following sections these developments are described in more detail.

5.2 Growth of air traffic

According to forecasts prepared by the International Civil Aviation Organization (ICAO), total world airline scheduled passenger traffic in terms of passenger-kilometres is expected to grow at an average annual rate of 4.6 per cent up to the year 2025, half a percentage point lower than the growth rate achieved over the period 1985-2005. Total freight traffic growth over the same period is forecast to be stronger, at 6.6 per cent per annum in terms of freight tonne-kilometres. The airlines of the Middle-East and Asia/Pacific regions are expected to show the highest growth in both passenger and freight traffic. All international route groups are anticipated to grow at average rates ranging from 3.5 per cent to 6.6 per cent per annum over the forecast period. The fastest growing route groups are those to, from and within the Asia/Pacific region.

Thanks to the social and economic sustainable development, China's air transport is growing fast. Between 1978 and 2006, China's air transport scored an average annual growth rate of 18% in total traffic, 16.3% in passenger traffic, and 15.4% in cargo traffic. In 2006, China's

international air transport achieved a total traffic turnover of 10.3 billion ton-kilometres, carrying 14.15 million passengers and 922 thousand tons of cargo and mail respectively.

According to IATA, current figures indicate that the airline industry expects fleet growth of 17000 aircraft by 2020, particularly in the emerging markets such as China, Middle East, Russia and India which in turn will affect Europe, North America, Australasia and Africa.

The growth in air traffic is due to various factors like strong economic growth in parts of the developing world and further liberalisation of international air transport. These are described in the next paragraphs.

5.3 Economic growth

The world economy will continue to grow, with high growth rates in emerging markets such as China, India and Russia. For example China's national economy has been growing with a high average rate of 9.6% annually since its economy reform nearly 30 years ago.

The baby boom that many industrial countries (Japan, the United States and European industrial countries) enjoyed in the years after World War II now creates the prospects of a 'grey bust'. It is expected that population aging in these countries will reduce economic growth in these countries. Japan will experience this effect first.

Developing countries will experience stronger growth over the next 20-30 years as the relative size of their working-age population increases. But ultimately, the effects of aging will set in for the developing countries also. The population expansion in the currently-poor nations took place in the 1960-1980 period, and a corresponding age bulge will be working its way through the poor countries by 2020.

5.4 Trends towards liberalisation of air transport

The successful liberalisation of the air transport industry ushered in a period of unprecedented growth in air transport and introduced many new entrants and business models into the market. Following the success of Southwest Airlines in the US, the low fares model has been the major driver of the successful liberalisation process in Europe. Liberalisation and the advent of low fares air travel have forced the traditional flag carrier airlines to compete for the first time. Competition has led to lower air fares and better services across the board. As a result air traffic has exploded, having been stifled for years due to the lack of competition and high fares.

United States

Total US air traffic has increased significantly since liberalisation 30 years ago, as traditional airlines have been forced to restructure and offer lower fares to compete in the market.

Following deregulation of the air transport market there in the late 1970s, the low cost/low fares airline business model was developed and successfully implemented in the United States. Low fares airlines have been the fastest growing segment of the air transport market in the US. The low fare airline share of the US market has increased from just 7% in 1990 to approximately 25% in 2004.

A US regional air carrier, Southwest Airlines, relaunched itself as the original low fares airline, offering low fares services from its hub at Love Field, a secondary airport in Dallas, Texas. Today it carries over 65 million passengers a year and is the most profitable US airline. Southwest's remarkable growth was achieved through low costs and high efficiency in every aspect of its business. For example, Southwest operates from uncongested secondary and regional airports where charges are lower, delays rare and turnaround of aircraft can be achieved much more quickly than at a congested hub airport. Southwest Airlines perfected the "25 minute turnaround", i.e. the time it takes to land an aircraft, disembark passengers, refuel if necessary, board the next flight and take off. This led to much improved aircraft efficiency. Southwest operates a Single aircraft type, the Boeing 737, which allows all pilots, cabin crew, and engineers, to operate on any aircraft in the fleet, thereby reducing training and maintenance costs as well as the cost of aircraft financing. The ability to earn revenue is increased beyond that of traditional carriers due to a higher seat density as there is no business class and only limited catering, which requires less storage space. This, combined with high load factors (i.e., average number of seats sold per flight), significantly lowers the average per-seat cost. Southwest's pricing structure is very simple and tickets are primarily sold directly, i.e. via the internet and through call centres, hence minimising distribution costs. The savings achieved through the greater efficiencies are passed on to consumers in the form of lower fares. As demand for air transport is highly price sensitive, reduced fares result in higher passenger numbers, which in turn lead to further efficiencies and therefore lower costs. Southwest and other low fares airlines which followed suit in the US and eventually in Europe and Asia are therefore volume, and not price, driven. More than 20 years of experience has proven that this philosophy reflects consumers' expectations and low fare airlines have grown rapidly as a result.

The benefits of low fare airlines and particularly Southwest, have been widely recognised and the traditional network carriers are still struggling to replicate Southwest's success.

The 1993 US Department for Transportation study on the "Southwest Effect" found that average prices for markets Southwest does not participate in for distances of 0 – 250 miles and 251 - 500 miles, are $109.92 and $130.32, respectively. In Southwest markets of similar distances, the average prices charged by all carriers are $56.29 and $57.61, respectively. Thus, competition from Southwest has led to a 50% reduction in prices on routes where it is present.

Europe

Prior to the liberalisation process of European air transport between 1987 and 1997, the industry was highly regulated and inflexible, with no real competition between national carriers and fares that were set through bilateral agreements between states. A web of bilateral air service agreements shaped the industry, with specified routes and airports, agreed aircraft types, fares and frequencies, and designated carriers. In effect, capacity on the majority of routes was artificially restricted, fares were offensively high and entry into markets by non-flag carrier airlines was virtually impossible. Various European regions left outside agreed route networks due to decisions taken at national level had either no possibility of attracting air services or had to rely on connecting services through the emerging network hubs of the flag carriers. In short, the average consumer could not afford to travel and European Integration suffered.

Deregulation in Europe was preceded by early liberalisation between Ireland and UK in the mid-1980's, which created the conditions for the emergence of the first European low fares airline, Ryanair. Ryanair was permitted to enter certain routes between Ireland and the UK, bringing competition to the duopoly that had existed for years between the national airlines, Aer Lingus and British Airways. The liberalisation of European air transport was achieved in four stages:

1. In 1987, under the first package of liberalisation measures, fare restrictions were reduced. Carriers were also given additional flexibility for cooperation within the limits of existing air service agreements.
2. In 1990 the so-called second package of liberalisation measures allowed all European airlines to carry passengers to and from their home countries to other EU Member States (3rd and 4th freedoms). Also 5th freedom flights, i.e. intra-European flights with stop-over in a third country and the right to pick-up and drop-off passengers during the stopover, were allowed to a greater extent. Fare and capacity restrictions were further abolished.
3. In 1993 the third package of measures, including the common licensing of carriers and freedom of access to the market, was introduced. All carriers holding a community license were allowed to serve any international route within the European Union. Finally, carriers were given almost full freedom to set fares.

4. In 1997, as part of the third liberalisation package, all carriers holding a community license were given the right of cabotage, i.e. the right to operate domestic routes within the whole of the EU. As a result of the creation of the single market for air transport, European carriers obtained practically unlimited freedom to choose their routes, capacity, schedules and fares. Interference from national governments in these decisions was reduced to a minimum. Commercial considerations became the primary incentive for airlines to open/close a new route, to add/reduce capacity and to increase/lower fares. Liberalisation of the European air transport market has been hugely successful in increasing competition and consumer choice and lowering fares across the board. Low fares airlines have also achieved all of the objectives set out by the European Commission for liberalisation.

Emergence of low fare airlines

The national airlines were not particularly enthusiastic about the new competitive environment. Obviously the shift from a highly regulated market, with strong government protectionism, towards an open market and a need to compete was not welcomed by them. Their initial reaction was to consolidate their position in their own national market, by buying out smaller competitors, and making limited in-roads into other national markets.

The real opportunities now being presented by liberalisation were seized upon by a new generation of airlines applying the low fares model – with Ryanair and easyJet being the most noticeable examples. Following early liberalisation between Ireland and the UK, Ryanair emerged as a new entrant in a market that had been dominated by Aer Lingus and British Airways. Ryanair initially introduced services between Ireland and UK destinations, including London. Once the third liberalisation package was introduced in 1993 Ryanair was able to start services between the UK and continental Europe. EasyJet launched flights between London and Scotland in 1995 and commenced its first connections between the UK and continental Europe in 1996. These two most established European low fare airlines are also currently the largest, carrying over 50 million passengers a year between them. At present around 60 new entrant and charter/regional airlines apply the low fares model to varying degrees in Europe offering consumers efficient direct services to many, often previously unserved, destinations around Europe. low fare airlines currently account for around 24% of the scheduled intra-European air traffic and the market share of low fare airlines continues to grow strongly. European Low Fare Airline Association (ELFAA) members themselves serve over 900 routes connecting over 200 cities. They currently operate a total fleet of 249 aircraft and will carry almost 60 million passengers in 2004. Although the United Kingdom is by far the most developed market for low fares services, with several low fares airlines having established

operational bases there and with the low fare share of scheduled traffic at the airports approaching 50% in 20041, this success has been replicated in other markets as consumers are opting for low fares services in continually increasing numbers. Consumers in the new EU Member States are also now benefiting as the same liberalized rules in the field of air transport became applicable in their territories on 1 May 2004.

The development of the low fares sector in Europe following EU liberalisation is essentially a replication of the development of Southwest and other low fares airlines in the US. Similarly in Europe Ryanair, the original European low fares airline, has been followed first by easyJet, with a slightly different variation of the low fares model, and subsequently by several other new entrants as well as charter and regional carriers. Recently, low fares airlines have enjoyed success in the new EU Member States with the emergence of ELFAA members Air Polonia, Wizz Air and Sky Europe.

The vast majority of low fares passengers are new passengers, who either would not have travelled at all in the absence of low fares services or would have taken another, less efficient, higher cost mode of transport.

The success of liberalisation in European air transport industry has largely been due to the ability of new entrants to challenge the traditional way of running an airline and pursue new business models which offer strong competition to the traditional network airlines. The low fares model in Europe has brought huge benefits to consumers, in terms of lower fares and greater choice.

Currently low fare airlines have 60 million passengers per annum or roughly 16% of intra-European scheduled passengers in 2004. The low fares sector has been growing at an average of over 35% per annum over the past 5 years and will continue to grow strongly as the demand for low fares services increases. The total share of low fares traffic in Europe is expected to reach over 40% by 2010.

Passenger numbers for traditional airlines have also generally increased as they have been forced to reduce their fares and improve service due to competition.

World-wide

According to IATA thirty years after deregulation began in the United States, further liberalisation of air transport is necessary. Within the current bilateral system, airlines cannot fly to new markets without an international agreement, cannot look beyond national borders

to try new ideas, cannot grow their business, cannot access global capital, cannot merge and cannot consolidate. This must change to make the industry financially healthy. Airlines must be free to innovate, free to compete, free to grow and free to disappear. Currently there are still 3,500 bilateral agreements. These should all disappear and the industry should be commercially deregulated.

According to ICAO liberalisation of international air transport is on the rise. Liberalisation activities are also on the rise at the national, regional and interregional levels. In 2008 the Association of South East Asian Nations (ASEAN) has taken the decision to liberalise traffic between capital cities. ICAO is promoting the progressive liberalization of air transport regulation, and is assisting States in the liberalization of the economic regulation of international air transport.

5.5 Aging of world population

World population growth has slowed and, using recent projections from the United Nations, it is likely that population growth will slow further. A notable development is the changing distribution of population between the so-called “developed” and “less developed” nations. Population growth has been much faster in the poorer countries than in those with high standards of living and wealth. It seems likely, however, that the population growth of many lesser-developed countries will slow during the present century.

According to the United Nations, world population has more than doubled in the last 50 years, and it has nearly quadrupled since 1900. Currently, world population is growing at a rate of 1.35 percent per year. The most recent forecast predicts a slowing in the growth of world population to about 0.33 percent per year by 2050, at which time forecasters are predicting that world population will total 8.9 billion persons.

It is generally recognized that the world is undergoing a major demographic transition. Population growth is slowing and the age structure of the population is changing, with the shares of the young declining and the elderly increasing. Different countries are at different stages of this demographic transition.

While the world’s population growth has slowed, improvements in life expectancy have continued. These two conditions are leading to a rapid aging of the population. A good summary measure of a population’s age is the median age—the age such that half the population is older and half is younger. Over the past half century, the median age of the world’s population has increased by 2.8 years, from 23.6 in 1950 to 26.4 in 2000. The United

Nations forecasts median age to rise to 36.8 years in 2050. More developed countries are expected to have an increase in median age from 37.3 years to 45.2 years, and lesser developed countries from 24.1 years to 35.7 years. Using an estimate for 2005, Japan is the country with the oldest population, having a median age of 42.9 years. Japan is projected to have a median age of 54.9 years in 2050. Similar changes are occurring in Europe. Italy, with a median age of 42.0 years in 2005, is projected to have a median age of 50.4 years in 2050. Comparable numbers for selected countries in Western Europe are: Germany – 42.1 and 49.4; France – 38.9 and 44.3; and Belgium – 40.3 and 46.2. The United States is not excluded from this aging; however, the United States remains somewhat younger. The median age of the U.S. population, by contrast, is currently 36.0 years, and is forecast to be 41.1 years in 2050.
China will also be undergoing a substantial demographic change. Between 2005 and 2050, the median age in China is projected to increase from 32.5 years to 45.0 years. Note that this absolute change in median age exceeds that of the European countries. Moreover, and remarkably, these projections indicate that in 2050 China's median population age will be above that of the United States. So China has a major demographic problem to face.

5.6 Trends in the Western world towards non-technical education /careers

In the Western world there is a lack of young people choosing science and engineering subjects at school, and of those who do so, a lack of those who actually choose a career in a technical field. This is for example the case in the United States, United Kingdom, Germany and the Netherlands.

In the Netherlands the following effects can be observed, for example:

- During the period 1998 – 2003 a decrease from 36% to 30% in the percentage of HAVO students choosing a Natuur & Techniek (NT) or Natuur & Gezondheid (NG) profile has been observed.
- In The Netherlands only 16% of university student graduates with a beta-profile, compared to 27% in the rest of Europe.
- In the Netherlands, the percentage of girls choosing a beta education is lower than in most European countries.

The general trend of not choosing a technical education and career anymore was considered undesirable by the government. This is because the demand for people with a beta background / technical education is expected to be very strong in the future Dutch economy, which will be highly knowledge-based. Thus to encourage more young people to choose a beta

profile for their education, various projects, experiments and campaigns were started in the Netherlands.

In 2007 a increase of both HAVO and VWO students choosing a Natuur & Techniek (NT) or Natuur & Gezondheid (NG) profile has been observed, and also the interest of university students in beta profiles is on the increase.

It is too early to say whether this trend will continue and whether it is a result of the various projects, experiments and campaigns to promote technical education and careers.

5.7 Shortage of qualified personnel in various world regions

World

According to IATA, current figures indicate that the airline industry expects fleet growth of 17,000 aircraft by 2020, particularly in the emerging markets such as China, Middle East, Russia and India which in turn will affect Europe, North America, Australasia and Africa.
To meet projected demand 19,000 pilots a year must be trained, but current capacity is only 15,000, resulting in an annual shortage is 3,000 pilots. Consequently the airline industry will face a shortage of more than 42,000 pilots to fly the aircraft by 2020 if the situation is not remedied. And there will also be a shortage of individuals to maintain them, and regulators to oversee them.

According to ICAO, there is already a severe shortage of pilots, maintenance personnel, cabin crew and regulators in various parts of the world. The labour shortage is particularly acute in Asia, where airlines have been expanding the fastest. For example, a few years ago in India there were only two major carriers: Air India and Indian Airlines. But today there are several other big players such as Air Deccan, GoAir, Kingfisher Airlines and Jet Airways.
It is suggested that it could take 10 to 15 years before the supply of pilots increases to levels high enough to meet demand.

Pilots, cabin crew, maintenance technicians and engineers, air traffic controllers, aerodrome technicians, telecommunication technicians, fire-fighters, etc., are the biggest source of competitive advantage within the aviation industry. And commercial aviation is a truly global business; skilled pilots and other personnel can go wherever they earn the most money.
Thus airlines are competing in a global market that has a shortage of licensed personnel.

United States

Some years ago, there was a shortage of experienced pilots in the United States. Airlines were changing their recruiting requirements to meet, not exceed, FAA minimums, including eyesight correctable to 20/20. At Southwest Airlines, pilot applicants no longer needed a 737 rating in order to get an interview. Instead, they could be selected and then given six months to earn the rating. Reflecting the shortage, airline pilot salaries were on the rise.

There was also a shortage of airline maintenance technicians that had most companies scrambling to attract and keep talented mechanics. Maintenance technician compensation increased steadily to reflect the shortage of qualified personnel in the industry.

In 2008, according to ICAO, airlines in the United States continued to face difficulties in attracting and retaining qualified aviation personnel, resulting in a staffing shortage.

The cope with this situation the FAA wants to increase the mandatory retirement age of pilots to 65. Provided all pilots continue to have their health monitored through regular physical examinations, there are no critical safety concerns.

Due to the recent credit crisis, it now seems that an increasing shortage has been postponed, and instead a lot of airline pilots could soon be out of work.

Europe

A significant shortage of aviation personnel in Europe has not been observed with the exception of air traffic controllers. According to Eurocontrol, Europe already has around 10% fewer controllers than is necessary, and their average age is increasing rapidly. In addition, the SESAR project, which aims to address the capacity gap through new technologies and automation, requires controllers for validation. As a result, the shortage of controllers could reach 20% in the coming years according to Eurocontrol.

Australia

Countries such as Australia that have traditionally enjoyed a surplus of pilots, now have a shortage. A growing demand for Australian pilots is the primary reason behind the shortage. An increasing number of carriers within Australia and a booming industry in China and India has seen a scrabbling for staff. Smaller airlines and emergency services will bear the brunt of the crisis. Within Australia, it is estimated that the industry will need an additional 1800 pilots over the next two years. But it is likely to train far less than half that number, and many of those will soon be poached by overseas companies. Training for a commercial licence costs

about $80,000, which is a major impediment to increasing recruitment. In addition to these costs, many students are increasingly attracted to industries such as IT that have the promise of higher salaries. Yet while local enrolment numbers have dropped, thousands of international students are being turned away, because there is also a shortage of flying instructors. A Future Pilot Task Force met for the first time in February 2008 to address the crisis. Pilot shortages were put at the top of a list of key industry risk factors, acknowledging instructor numbers needed to increase by at least 15 per cent.

China

China's airline industry has also experienced tremendous growth. The structural shortage of human resources is an acute problem faced by China. There is a shortage of all kinds of technicians and high-level managers. The Civil Aviation Administration of China (CAAC) estimated that from 2004 to 2010 the country would need to recruit 12,000 pilots.

Yet at that time China's state-run pilot training schools were producing only 850-900 pilots a year. To change the situation China has expanded the state-run training colleges, allowed the establishment of privately owned pilot training schools, and has sent recruits overseas for training. China's airlines are also making up for the shortfall by employing foreign pilots.

India

With the sudden boom in civil aviation, India is also faced at present with a shortage of skilled manpower for the sector. The government has taken measures to cope up with the situation and is trying to alleviate the problem by increasing the retirement age for pilots to from 61 to 65, the intake of pupil pilots for training is being increased at the existing flying training institutes, backed up by establishment of new training institutions for pilots and maintenance engineers. To cater for the shortage of trained Indian pilots, Government has recently permitted two foreign pilots to operate together Indian registered aircraft.

Indonesia

In Indonesia passengers carried increased 200% during the period 2000 – 2006, from 10 million to 30 million. There is a severe shortage of safety oversight personnel. Indonesia has only about half the inspectors required.

Africa

According to ICAO, the lack of adequate human resources has become a serious concern for the African aviation sector. This is due to a brain drain among well-trained personnel to operators outside the continent and to the high cost of training personnel. In addition many

experts in the region have also been retiring and African training institutions have not been able to fill these gaps.

The lack of adequate training organizations that offer initial, recurrent or specialized training in African States, with a few exceptions, makes the training of pilots to fly commercial jetliners very expensive. To address the shortage of pilots, some African airlines have launched their own cadet pilot training programmes. However, the high turnover rate amongst pilots, once trained, makes it prohibitively expensive for African States and operators to invest in this type of training. The cause of this high turnover is twofold. In the first place, the exceptional growth of the aviation industry in the Middle East and in some Asian States continues to attract pilots from everywhere. Second, the financial situation of many African airlines (with relatively low enumeration levels) has contributed to pilots leaving to search for other opportunities.

While the severity of this migration varies from one State to another, the overall picture gives the appearance of a mass exodus, with a consequent skills crisis that may be endangering aviation safety. This is a major threat to the development of air transport in Africa.

5.8 International initiatives to tackle the shortage

IATA

In 2007 the International Air Transport Association (IATA) launched the IATA Training and Qualification Initiative (ITQI), to review the shortage of skilled staff and develop a roadmap and strategy. IATA considers it important to quantify and balance the demand and the supply of licensed personnel on a regional as well as on a global level in all segments of the aviation industry, with sustained quality and no compromise to safety.

ITQI is working on a comprehensive approach from recruitment to training, standards and technology, and intends to develop recommendations for meeting the training needs for pilots, maintenance technicians and engineers with no compromise on safety and quality. Governments should cooperate and jointly provide and recognise standards, licensing and training.

ITQI also aims to identify solutions to mitigate the shortage. According to IATA increasing the retirement age of pilots to 65 will help but can't be the only solution. Pilot training and qualification must be rethought to further improve safety and increase training capacity. The airline industry is concerned that there are no global standards for training concepts or

regulation. Pilot training has not changed in 60 years – the emphasis still on flight hours. IATA supports the competency-based approach of multi-crew pilot licensing (MPL) training programmes. Unlike traditional pilot training, MPL focuses from the beginning on training for multi-pilot cockpit working conditions. It also makes better use of simulator technology. Europe was among the first regions to adopt MPL and Australia and China are moving ahead with implementation.

ITQI has secured resources and buy-in from all the segments of the industry including ICAO and key industry stakeholders.

In 2008 IATA and the U.S.-based Flight Safety Foundation (FSF) announced a new partnership to tackle the global shortage in pilots, engineers and maintenance certification staff. FSF will for example work closely with IATA to make senior government officials aware of the serious problems that can occur if there are not enough qualified government safety personnel to oversee this rapid industry expansion. And FSF is concerned that due to air traffic growth pressure, lowered qualifications and generational or culture gaps in the cockpit may have led to loss of control accidents becoming the number one killer in aviation.

ICAO

Part of ICAO's Global Aviation Safety Roadmap is focus area 11, which deals with an insufficient number of qualified personnel. It states that after requirements for sustaining aviation safety against protected growth have been identified, plans must be implemented to provide appropriate numbers of qualified people, and audits must be established to confirm that the plans deliver the appropriate numbers.

5.9 Shortage of qualified personnel in the Netherlands

In order to assess whether international developments described previously are also taking place (short term and long term) in the Netherlands and whether they have or would have an effect on aviation safety in the Netherlands, interviews were held with representatives from KLM, LVNL and the Royal Netherlands Air Force.

KLM does not have a shortage of qualified pilots and is not expecting one at short or mid term. Long term KLM does foresee difficulties of recruiting a sufficient number of pilots, due to less people with a beta background being available and the expected growth of air traffic. However, this will only influence capacity and will have no effect on safety.

LVNL does not have a shortage of air traffic controllers at operational level and is not expecting one at short or mid term. At long term such a shortage could arise due to the expected growth of air traffic, but is by no means certain because new ATM concepts may well reduce the number of air traffic controllers required. In any case, it will only influence capacity and will have no effect on safety.

LVNL has a permanent unsolvable shortage of air traffic controllers for performing side activities, like participation in development or research projects, or managerial tasks.

The Royal Netherlands Air Force has indicated that it has an estimated 10 - 15% shortage of qualified personnel, which sometimes leads to short cuts taken, less supervision and high work pressure resulting in a higher probability of errors. This is due to a very attractive civil market and unattractive foreign deployments of personnel. Whether there will be a long term shortage is dependent on the labour market, the ambition level of the armed forces, and the fact that less people with a technical background are expected to be available.

It can thus be stated that at short and medium term the number of available qualified personnel in the Netherlands is still sufficient. The Air Force currently has a short term shortage, but this is due to a very attractive civil market and unattractive foreign deployments.

At long term a shortage may arise in the Netherlands, due to the fact that a smaller number of qualified people will be available due to the aging of the populations, the trend of an increasing number of young people choosing a non-technical education / career and the attractiveness of lucrative foreign employment in booming markets.

It should be noted though that the trend of an increasing number of young people choosing a non-technical education may be reversible, and the attractiveness of foreign employment in booming markets can be countered by offering higher salaries.

References

Chapter 2 Corporate Manslaughter	
1	News articles on (corporate) manslaughter, Flight International magazine, www.flightglobal.com
2	The Crown Prosecution Service (UK), Corporate Manslaughter, www.cps.gov.uk/legal/section5/chapter_b.html
3	International Civil Aviation Organisation (ICAO) Annex 13
4	US Federal Aviation Regulations 14 CFR 91.25
5	Criminalization trends in accident investigation, presentation by Robert MacIntosh, National Transportation Safety Board (NTSB)
6	Corporate manslaughter by Edward Spencer & Stuart Broom, Focus magazine, summer 2008
7	Discussion of accident criminalization, press release by Flight Safety Foundation (FSF), February 5, 2008
8	Press releases on manslaughter charges, International Federation of Air Line Pilots' Associations (IFALPA), www.ifalpa.com
9	'Evenwicht', Stefan van der Loos, LVNL magazine
Chapter 3 Developments in Safety Oversight	
1	International Civil Aviation Organisation (ICAO), www.icao.int
2	Federal Aviation Administration (FAA), www.faa.gov
3	European Aviation Safety Agency (EASA), www.easa.eu
4	International Air Transport Association (IATA), www.iata.org
5	Regulation (EC) No 2111/2005 of the European Parliament and of the Council, on the establishment of a Community list of air carriers subject to an operating ban within the Community and on informing air transport passengers of the identity of the operating air carrier, and repealing Article 9 of Directive 2004/36/EC, 14 December 2005

Chapter 4 Safety aspects related to the introduction of Very Light Jets	
1	Annex I Description of Work TA1-DoW V1, EPATS European Personal Air Transportation System, 20 October 2006
2	Report on European Business and Personal Aviation Database and Findings. D.1.1 June 2007
3	European Air Transportation System (EPATS) ROADMAP VISION Version/Status: V2c/draft, INSTITUTE OF AVIATION al. Krakowska 110/114, 02-256 Warsaw, Poland July 2007
4	NLR-Memorandum ASAS-2007-066, European Personal Air Transportation System (EPATS) study. Cockpit avionics and human machine interface requirements, L. LeNgoc, December 2007
5	NBAA Training Guide for Single Pilot Operations of Very Light Jets and Technically Advanced Aircraft, January 2005
6	Matthews, R. Very Light Jets: Implications for Safety and Accident Investigation. International Society of Air Safety Investigators, Singapore, August 2007
7	Air Carrier Operations System Model (ACOSM)
8	Statement of the Air Transport Association of America before the Aviation Subcommittee of the Senate Committee on Commerce, Science & Technology concerning the impact of new jet aircraft on the National Airspace System, September 28, 2006
9	Testimony Before the Subcommittee on Aviation, Committee on Transportation and Infrastructure, House of Representatives. FAA's Safety Efforts Generally Strong but Face Challenges, September 2006. GAO-06-1091T
10	EPATS T1.2 documents. Airports and Facilities Data Base Document Number: EPATS T1.2-ArptsDB -V0
11	Woods, F., The Qualification Challenge, EASA, presented at Very Light Jet Workshop, Eurocontrol Brussels, 4 May 2007.
12	Learmount, D., Very Light Jets Face European Struggle, Flight International 22-28May 2007.
13	McGregor, R., JAA-LO, Thoughts on the regulation of operations with Very Light Jets, presented at Very Light Jet Workshop, Eurocontrol Brussels, 4 May 2007.
14	Woods, F., EASA Flight Crew Licensing presented at EU/US International Aviation Safety Conference 2007, 7 June 2007.
15	Cintron, M., FAA Very Light Jet Operations and Pilot Training presented at EU/US International Aviation Safety Conference 2007, 7 June 2007.
16	Very Light Jets. Several Factors Could influence Their Effect on the National Airspace

	System. United States Government Accountability Office, GAO-07-1001. August, 2007.
17	AOPA Air Safety Foundation Special Report, Technically Advanced Aircraft Safety and Training. Published 2005.
18	Chidester, T., Hackworth C, and Knecht, W., Participants Assessment of Aviation Safety Inspector Training for Technically Advanced Aircraft.DOT/FAA/AM-08/16. Federal Aviation Administration, , Oklahoma City, June 2007
19	Aviation Safety Inspector (ASI) Training for Technically Advanced Aircraft Execution Plan, Federal Aviation Administration, Washington DC, June 2005.
20	Wever R., G.W.H. van Es, M.J. Verbeek, Air-Ground Communication Safety Study: Causes and Recommendations, NLR-CR-2005-395. National Aerospace Laboratory NLR, 2005.
21	Lacagnina, M., C-FOQA takes root. AeroSafetyWorld, Flight Safety Foundation., August 2007.
22	Solan, C., Shifting paradigms: Manufacturer-based Safety Programs to Support Very Light Jet Operators. CASS 2007 Proceeding, Eclipse Aviation, 2007.
23	Werfelman, L. On the Verge, AeroSafetyWorld, Flight Safety Foundation, April 2007.
24	Burian, B.K. and R.K. Dismukes, Alone at 41,000 feet, AeroSafetyWorld, Flight Safety Foundation, November 2007.
25	Burian, B.K. and R.K. Dismukes, Training the VLJ Pilot, NASA Ames 8/7/07.
26	Sarsfield, K. Europe's Promise. Flight International, 15-21 May 2007, page 39-44.
27	Here Come the Very Light Jet, Flight Safety Digest, Flight Safety Foundation, July 2005.
28	Business Aviation Safety Strategy, A Blueprint for Making a Safe System Safer, International Business Aviation Council, September 2007.
29	Sultana, J. VLJ Operations & the European Airspace Network, EUROCONTROL, presented at Very Light Jet Workshop, Eurocontrol Brussels, 4 May 2007.
30	Research and Development for Safe, Secure and Affordable Air Transportation for Every Community in America. Small Aircraft Transportation System. National Institute Of Aerospace, January 2006.
31	Eurocontrol planning for sustained expansion in VLJ market in Europe. Eurocontrol Press Release, 30 January 2008.
32	Presentation by Fergus Woods, Head of Flight Standards Department, EASA Rulemaking Directorate at EU / US International Aviation Safety Conference, 7 June 2007
33	Presentation by Eugene O'Brien, Eurocontrol on Airspace Impact Evaulation at Very Light Jet Integration Platform Meeting, 10 April 2008
34	Presentation by Mel Cintron, Manager International Policy & Programs, FAA on Very

	Light Jet Operations and Pilot Training at Flight Crew Licensing Workshop of US / Europe Internationl Aviation safety Conference
35	DAS/DIA Briefing, Eurocontrol VLJ Integration Platform, 10/4/2008
36	Presentation by Thierry Arino, Aval Phase 1 findings, EUROCONTROL AVAL Project
37	VLJ Avionics, Phil Evans, Airspace, network Planning and Navigation Unit (APN), *van welke organisatie?*
38	Update on Part 23 Jet & CS-23 High Performance Aeroplane Issues, John R. Colomy, US/Europe International Aviation Safety Conference, June 5, 2008
39	FAA Certification: Alleged Regulatory Lapses in the Certification and Manufacture of the Eclipse EA-500, Committee on Transportation and Infrastructure, US House of Representatives, September 16, 2008
40	Clavin L. Scovel III, Inspector General US Department of Transportation, FAA's Certification of the Eclipse EA-500 Very Light Jet, before the Committee on Transportation and Infrastructure of US House of Representatives, september 17, 2008
Chapter 5 Shortage of Qualified Personnel	
1	International Civil Aviation Organisation (ICAO), www.icao.int
2	International Air Transport Association (IATA), www.iata.org
3	Flight Safety Foundation (FSF), www.flightsafety.org
4	United Nations, www.un.org
5	European Low Fare Airline Association, www.elfaa.com
6	Flight International magazine, www.flightglobal.com
7	Aviation week magazine, www.aviationweek.com

Appendix A Inventory of safety aspects of Very Light Jets

The following list of safety related issues associated with Very Light Jets and Technically Advanced Aircraft was collected by the National Business Aviation Administration [Ref. 5]:

Wake turbulence encounters

- At altitude and in the traffic pattern
- In-trail spacing and profile adjustments
- Best recovery configuration

Convective weather encounters

- Pre-flight weather analysis
- Alternate route identification
- Contract flight planning and/or dispatch interaction
- Circumnavigation fuel capability

Microburst/windshear encounters

- Area entrance rules or philosophy
- Pre-flight weather analysis
- Condition definition
- Best recovery methods
- Alternate airport identification
- Alternate fuel capability

Clear air turbulence/jet stream core or boundary encounters

- Pre-flight weather analysis
- Contract flight planning and/or dispatch interaction
- Aircraft configuration in various levels of turbulence
- Lower/higher altitude cruise capability
- Fuel burn impact

High-altitude upset

- Performance capability
- Coffin corner education
- Recovery methods from low-speed/high-speed stalls
- Straight/swept wing aerodynamics, as appropriate

Mountain wave encounters

- Thrust and speed adjustments

- Pre-flight weather analysis

Inadequate knowledge of high-altitude weather

- Winds aloft millibar charts
- Tropopause levels
- K index and lifted index chart
- CAT forecasts
- Icing levels
- Severe weather charts

Physiological effect of high-altitude operations

- Altitude chamber or nitrogen simulator training
- Personal health issues
- Medication interaction

Jet blast damage behind larger jets during ground operations

- Proper spacing on taxiways
- Advise/educate ATC
- Close proximity operations in icing conditions

Low-fuel arrivals trying to stretch range

- Cruise chart education
- Identification of maximum range and maximum endurance speeds
- Identification of suitable intermediate airports
- Altitude selection to reduce fuel consumption

Incorrect/less-than-optimum cruise altitude selection

- Contract flight planning and/or dispatch interaction
- Cruise chart education
- Wind/altitude trade capability
- Rule-of-thumb or toolkit approach to altitude/range/fuel burn predictions

Inadequate preparation for high-rate/high-speed climbs

- Course/altitude overshoots
- Excessive airspeed below 10,000 MSL or below Class B airspace
- High deck angles and reduced traffic vigilance
- Thrust-controlled vertical rate
- Toolkit approach to thrust/speed/rate control

Inadequate crosswind takeoff/landing preparation

- Speed adjustments for steady and gust components
- Roll and pitch airframe limits
- Flap selection criteria
- Maximum crosswind and gust limits

Inadequate "land and hold short" (LAHSO) preparation

- Minimum pattern size and programmed drag profile
- Advise/educate ATC

VLJs misunderstood by ATC (pilot mitigations)

- High speed in terminal airspace
- High speed to final approach fix
- Lack of respect for single pilot operation and associated work load
- Improper spacing behind heavier traffic
- Unreasonable requests for configuration or climb/descent performance

Single pilot adherence to checklists

- Overcoming old habits
- Patterns of discipline not developed
- Complacency resulting from simplicity of VLJs
- Degradation of systems knowledge

FMS programming and autoflight vs. manual flight control

- Reluctance to abandon autoflight/reluctance to use autoflight
- Inadequate FMS and/or autoflight skills
- Inadequate manual flight skills
- Raw data/manual flight and FMS/autoflight training

Inadequate exercise of "command"

- Inclusion of captain development training in program
- Inclusion of CRM/SRM training in program
- Inclusion of LOFT or scenario-based training in program
- Inclusion of judgment contrast debriefings in program
- Inclusion of command modeling in program

Recognizing single pilot "red flags" (as an alternative to below)

- POPE, which stands for:
- Psychological (overload, inexperience, emotional)
- Operational (aircraft-mechanical, weather, fuel, performance)
- Physiological (fatigue, medical, pharmaceutical)
- Environmental (time, external pressure, business)

Lack of pilot self-evaluations

- Use of available tools/personal minimums checklist
- PAVE, which stands for: Pilot, Aircraft, EnVironment, External pressure

Winter operations

- Airframe contamination
- Airport contamination: Takeoff, Landing
- Decision making