

European Helicopter Safety Analysis Team
(EHSAT)

Report

Preliminary results of helicopter accident analysis

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(EHSAT)



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Preliminary results of helicopter accident analysis

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The safety improvement analyses and recommendations produced by the EHSAT are based on expert judgment and are supplementary to the official reports of the accident investigation boards (AIBs). Such recommendations, and the safety improvement actions that may follow, are solely aimed at improving helicopter safety, are not binding and under no circumstances should be considered to take precedence over the official AIB reports. The adoption of such safety improvement recommendations is subject to voluntary commitment, and engages only the responsibility of those who endorse these actions. The EHSAT accepts no responsibility or liability whatsoever with regard to the content or for any actions resulting from the use of the information contained in these recommendations.

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Acronyms

CAST	Commercial Aviation Safety Team
EASA	European Aviation Safety Agency
ECAST	European Commercial Aviation Safety Team
EGAST	European General Aviation Safety Team
EHEST	European Helicopter Safety Team
EHSAT	European Helicopter Safety Analysis Team
EHSIT	European Helicopter Safety Implementation Team
ESSI	European Strategic Safety Initiative
FAA	Federal Aviation Administration
HFACS	Human Factors Analysis and Classification System
ICAO	International Civil Aviation Organisation
IHSS	International Helicopter Safety Symposium
IHST	International Helicopter Safety Team
SPS	Standard Problem Statement
JHSAT	Joint Helicopter Safety Analysis Team
JHSIT	Joint Helicopter Safety Implementation Team



Executive summary

The **European strategic safety initiative (ESSI)**, a 10-year programme to enhance aviation safety for European citizens, is a partnership between the European Aviation Safety Agency (EASA), other European national aviation authorities, manufacturers, operators, professional unions, research organisations, military operators and the general aviation community. More than 150 organisations participate to date. The basic principle is to improve aviation safety by complementing regulatory action by voluntarily committing to cost-effective safety enhancements. Analysis of occurrence data, coordination with other safety initiatives and implementation of cost-effective action plans are carried out to achieve fixed safety goals.

The ESSI has three components: the European Commercial Aviation Safety Team (ECAST) — the European equivalent to CAST in the United States — the European General Aviation Safety Team (EGAST) and the **European Helicopter Safety Team (EHEST)**.


The EHEST is also the European component of the **International Helicopter Safety Team (IHST)**. The IHST was formed as a major initiative to improve helicopter safety worldwide. It is a combined government and industry effort to reduce the helicopter accident rate — both civil accidents and non-combat military mishaps — by 80 % by 2016. The EHEST is committed to this IHST objective, with emphasis on European safety.

In order to pursue the 80 % accident rate reduction goal, the IHST adopted and adapted a process originally developed by the United States Commercial Aviation Safety Team (CAST). The CAST strategy is to significantly increase public safety by adopting an integrated, data-driven methodology to reduce the fatality risk in commercial air travel (fixed-wing aircraft). The process involves a data-driven methodology based on the review of occurrence data, on the basis of which safety enhancements and action plans are developed.

The IHST has so far created two working groups to deal with the different process steps: the Joint Helicopter Safety Analysis Team (JHSAT) and the Joint Helicopter Safety Implementation Team (JHSIT). The analysis team focuses on the review of occurrence data. The development and implementation of the safety enhancements are the tasks of the implementation team.

Under EHEST the analysis team is called the **European Helicopter Safety Analysis Team (EHSAT)**. This EHEST working group performs the first step in the process: the review of occurrences. Eleven regional teams have been created in Finland, France, Germany, Hungary, Ireland, Italy, Norway, Spain, Sweden, Switzerland and the United Kingdom to analyse helicopter accidents and derive recommendations for interventions. It is estimated that the current eleven EHSAT regional analysis teams cover more than 90 % of the civil European helicopter fleet. The analysis results of the different regional teams are consolidated on a European level. This initiative is unique in its efforts to prepare a Europe-wide accident analysis of helicopter accidents. The EHSAT will also ultimately be involved in the measuring of results and effectiveness.

The EHSIT was launched on 5 February 2009 and will develop action plans for safety enhancement based on the intervention recommendations produced by the EHSAT. These action plans will be submitted to EHEST for approval.



The EHSAT analysis consolidates analysis of Europe-wide helicopter accident data. Section 6 presents the preliminary results based on the 186 helicopter accidents analysed up to 15 September 2008. The scope of the dataset is accidents ⁽¹⁾ within EASA Members States within the time frame 2000–05 and where a final investigation report from the accident investigation board has been issued.

Of the accidents analysed so far, 72 involve general aviation operations. Some 66 involve aerial work operations, 40 involve commercial air transport operations and 8 concern state flights. It is estimated that this number covers 58 % of the accident reports currently available and 25 % of the estimated total number of helicopter accidents within this time frame.

Most accidents analysed by the EHSAT (34 %) occurred during the en route phase of flight. Also, 68 % of the *fatal* accidents in the dataset occurred during the en route phase. In 26 % of the accidents, the pilot had less than 100 hours flight experience on the helicopter type involved in the accident. It was also observed that pilot experience is not always a barrier to having an accident.

The accident analysis aims at identifying all factors, causal or contributory, that played a role in the accident. Factors are coded using two taxonomies: Standard Problem Statements (SPS) and Human Factors Analysis and Classification System (HFACS) codes.

The top three identified areas for the Standard Problem Statements are:

- pilot judgment and actions,
- safety culture/management,
- pilot situation awareness.

The high-level results were compared with the US analysis results and showed a high correlation of 0.89.

The use of the HFACS taxonomy by the EHSAT provided a complementary perspective on human factors. In 76 % of the accidents, at least one HFACS factor was identified. In most accidents unsafe acts or preconditions for unsafe acts were identified. In fewer accident reports issues related to supervision or organisational influences were captured. The possibility of identifying those factors is very much dependent on the depth of the accident investigation performed.

For both the SPS and HFACS taxonomies, different patterns were observed for commercial air transport, aerial work and general aviation.

Most intervention recommendations (IRs) were identified in the areas of training/instructional, flight operations and safety management/culture, and regulatory/standards/guidelines.

When more analysed accident data become available, the results may change. Nevertheless, it is estimated that the preliminary results already provide a good indication of the final results.

⁽¹⁾ As defined by ICAO Annex 13, 'Aircraft accident and incident investigation'.

1. European Helicopter Safety Team

The broader picture: ESSI and IHST

The **European Strategic Safety Initiative (ESSI)** ^(?), a 10-year programme to enhance aviation safety for European citizens, was launched in 2006. The ESSI is a partnership between the European Aviation Safety Agency (EASA), other European national aviation authorities, manufacturers, operators, professional unions, research organisations, military operators and the general aviation community. More than 150 organisations participate to date.

The basic principle is to improve aviation safety by complementing regulatory action by voluntarily committing to cost-effective safety enhancements. Analysis of occurrence data, coordination with other safety initiatives and implementation of cost-effective action plans are carried out to achieve fixed safety goals.

The ESSI has three components: the European Commercial Aviation Safety Team (ECAST) — the European equivalent to CAST in the United States — the European General Aviation Safety Team (EGAST) and the **European Helicopter Safety Team (EHST)**.

The EHST is also the European component of the **International Helicopter Safety Team (IHST)** ^(?). The IHST was formed in 2005 after the International Helicopter Safety Symposium (IHSS) in Montreal, Canada. The central theme of this symposium was the persistence of unacceptably high helicopter accident rates and the need to improve this record. The IHST was formed as a major initiative to improve helicopter safety worldwide. It is a combined government and industry effort to reduce the helicopter accident rate — both civil accidents and non-combat military mishaps — by 80 % within 10 years.

The IHST is led by representatives of the Helicopter Association International, the United States Federal Aviation Administration (FAA), American Helicopter Society International, Transport Canada, the European Aviation Safety Agency (EASA), the European Helicopter Association and several industry partners.

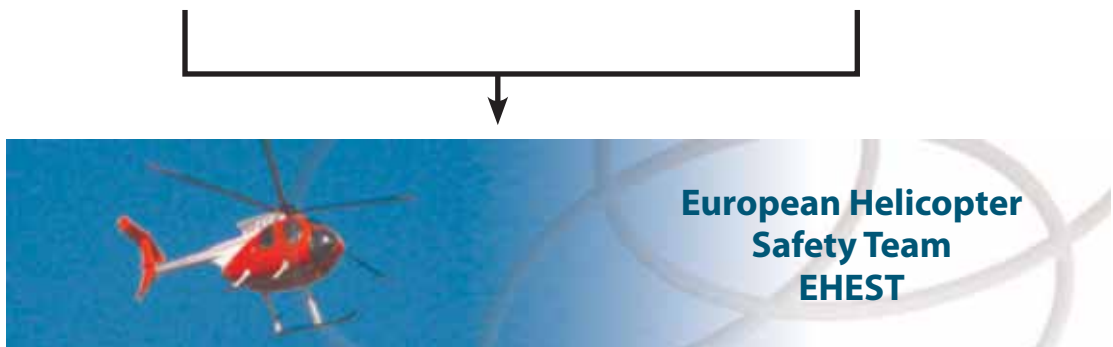
So far, regional teams have been established in the US, Europe, Canada, India, Brazil and Australia. At the same time the IHST is seeking to further expand, for example by creating new groups in the Middle East, Far East, Commonwealth of Independent States and south Asia.

^(?) <http://easa.europa.eu/essi/>

^(?) www.ihst.org

The EHEST is committed to the IHST goal of reducing the helicopter accident rate by 80 % by 2016 world-wide, with emphasis on European safety.

The EHEST brings together helicopter manufacturers, operators, EASA, national aviation authorities, helicopter and pilots associations, research organisations, accident investigators, the general aviation community and a few military operators from across Europe [Ref. 1–5]. EHEST comprises more than 75 participating organisations. A listing of participants is provided on the ESSI/EHEST website ⁽⁴⁾. The safety team addresses the broad spectrum of helicopter operations across Europe, from commercial air transport to general aviation.



⁽⁴⁾ <http://www.easa.europa.eu/essi/ehestEN.html>

2. Background data for Europe

In Europe ⁽⁵⁾, helicopters are used in a wide variety of operations and regions — from North Sea offshore operations to mountain flying and from firefighting operations to pleasure flights.

For 2007, it was estimated that approximately 6 860 ⁽⁶⁾ helicopters were registered in Europe for civil use.

No reliable flight hour data are available for all registered helicopters across Europe. However, an estimate can be determined for turbine-powered helicopters ⁽⁷⁾. For the year 2007 a total of 1.7 million flight hours and 5 million landings was estimated for civil use helicopters registered in Europe.



Figure 1 — Helicopter accidents in EASA Member States (Civil aviation, EASA Member States registered helicopters)

Data collected for the EASA annual safety review [Ref. 6] provide an indication of the total number of helicopter accidents within Europe (see Figure 1). For the year 2006, 116 helicopter accidents were reported to EASA. In 2007 the number decreased to 96. It has to be noted, however, that four states did not provide data to EASA for the year 2007, compared with only one state for 2006. In 2006, EASA started collecting accident information for light aircraft (maximum take-off mass below 2 250 kg). Because of this, no trend can be observed based on the two-year data.

A total of 16 fatal accidents occurred in 2007, compared with 14 in 2006. In these accidents, 92 people were fatally injured (47 in 2007 and 45 in 2006).

It can be concluded that helicopter operations are an important part of aviation for Europe. Accidents continue to occur. The following section describes what process the EHEST/IHST initiative had developed to work towards the goal of helicopter accident rate reduction.

⁽⁵⁾ For this report, Europe is considered to be the 27 European Union Member States plus Iceland, Liechtenstein, Norway and Switzerland.

⁽⁶⁾ Source: Helicas and EASA Data Warehouse

⁽⁷⁾ Source: EASA Data Warehouse

3. Process description

In order to pursue the 80 % accident rate reduction goal, the IHST adopted and adapted a process originally developed by the United States Commercial Aviation Safety Team (CAST) ⁽⁸⁾. The CAST strategy is to significantly increase public safety by adopting an integrated, data-driven methodology aimed to reduce the fatality risk in commercial air travel (fixed-wing aircraft). CAST was formed in 1998.

The process involves a data-driven methodology, where safety enhancements and action plans are developed based on the review of occurrence data. These enhancements may address both regulators and industry and should be implemented by the participating organisations. Both the level of the actual implementation and the effects have to be measured, in order to ensure that effective actions were put in place.

The IHST has so far created two working groups to deal with the different process steps: the Joint Helicopter Safety Analysis Team (JHSAT) and the Joint Helicopter Safety Implementation Team (JHSIT). The analysis team focuses on the review of occurrence data. The development and implementation of the safety enhancements are the tasks of the implementation team.

Under EHEST the analysis team is called the European Helicopter Safety Analysis Team (EHSAT). This working group performs the first step in the process: the review of occurrences. Eleven regional teams have been created in France, Germany, Hungary, Ireland, Italy, Spain, Switzerland, the United Kingdom and the Nordic region (Finland, Norway and Sweden) to analyse helicopter accidents and derive recommendations for interventions. It is estimated that the current nine EHSAT regional analysis teams cover more than 90 % of the civil European helicopter fleet. The results of the analyses of the different regional teams are consolidated on a European level. This initiative is unique in its efforts to prepare a pan-European analysis of helicopter accidents. The EHSAT will also ultimately be involved in the measuring the effectiveness of the implemented safety enhancements.

Launched on 5 February 2009, the EHSIT will develop action plans for safety enhancement based on the intervention recommendations produced by the EHSAT. These action plans will be submitted to EHEST for approval.

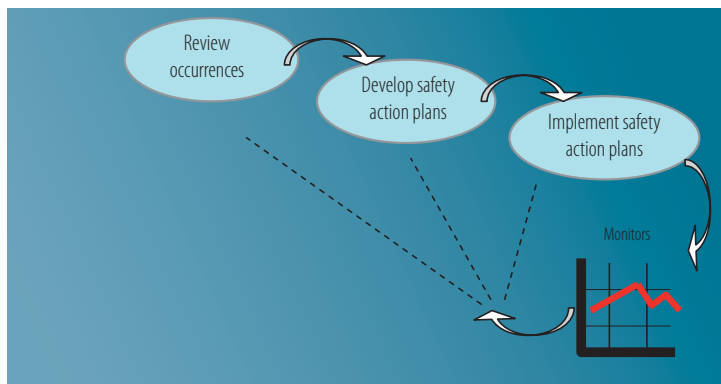


Figure 2 — Data-driven process adapted from CAST

⁽⁸⁾ <http://www.cast-safety.org>

4. The EHSAT

EHSAT work is based on analysis of accident reports but must not be confused with an accident investigation performed by the accident investigation boards. The EHSAT accident analysis is based on a standardised method featuring the use of taxonomies and expert judgment. Analysing an accident in all its aspects requires a diverse and balanced set of competences. An analysis team should therefore present a balanced range of competences, bringing together representatives with different backgrounds from the national aviation authority, accident investigation board, civil operator, helicopter equipment manufacturer or type certificate holder, pilot association, the general aviation community, research organisations and, optionally, military organisation, etc.

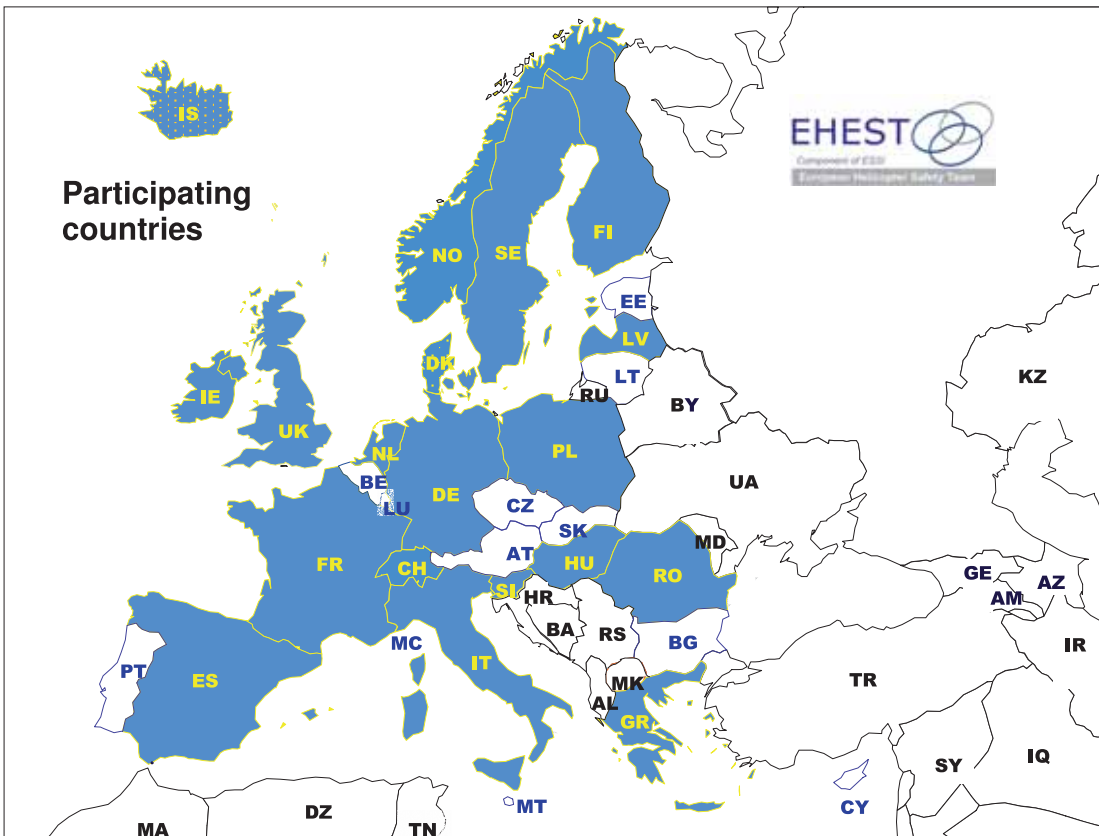


Figure 3 — Countries participating in the EHSAT (blue)



To tackle the variety of languages used in accident reports and optimise the use of resources, EHSAT has established regional teams. The use of local language facilitates work within national teams, whilst for aggregation purposes all teams are requested to deliver results in English. In a regional team-based organisation, relations between team members are often already established and the teams are well aware of local contexts. Regional teams can also facilitate implementation of future safety enhancements at regional level.

EHSAT regional teams have been formed in France, Germany, Hungary, Ireland, Italy, Spain, Switzerland, the United Kingdom, Finland, Norway and Sweden. So far the countries covered by the regional teams account for more than 90 % of the helicopters registered in Europe (Figure 3).

Analyses performed at regional level are aggregated by a central EHSAT team composed of representatives from all regional EHSATs and from EASA. The central EHSAT collects regional results and experiences, checks and aggregates results (including quality control), revises the taxonomies and tool and process manual for the purpose of standardisation, trains new regional teams, reports to the EHEST, and coordinates with the EHSIT, the JHSAT and the IHST.

5. Analysis methodology

The EHSAT analysis scope has been initially limited to:

- accidents (definition ICAO Annex 13) reported by the accident investigation boards
- with date of occurrence in the years 2000–05 and
- state of occurrence located in Europe.

In order not to interfere with ongoing accident investigation board investigations, only those accidents where a final investigation report has been issued are analysed.

The EHSAT is committed to ensuring that the analysis carried out in Europe is compatible with the work performed by other analysis teams worldwide, so that the analyses can be discussed at global level. The methodology therefore was basically inherited from the US JHSAT [Ref. 7], which itself adapted to helicopters the methodology originally developed in the late 1990s by CAST for the analysis of fixed-wing commercial air transport accidents. The analysis is carried out by a team looking at what happened and why (the chain of events), and what might have been done differently (interventions) to prevent similar events in the future.

The analysis methodology features five steps:

1. Collect general information

Several accident identification elements are collected for classification and analysis purposes, such as occurrence date, state of occurrence, aircraft registration, helicopter make and model, operation type, aircraft damage, injury level, phase of flight, meteorological conditions and crew flight experience. The EHSAT has introduced the ICAO ADREP 2000 taxonomy to collect this information, with the purpose of standardisation and of allowing exchange of information with the ECCAIRS^(*) system.

2. Describe and analyse the accident

The analysis aims at identifying all factors that played a role in the accident. The underlying assumption is that accidents are the result of a chain of events that could have been prevented by altering or eliminating one or more of the 'links' in the chain. Instead of focusing on an accident's 'primary cause', the proc-

^(*) ECCAIRS stands for European Coordination Centre for Accident and Incident Reporting Systems.

The mission of ECCAIRS is to assist national and European transport entities in collecting, sharing and analysing their safety information in order to improve public transport safety. The ECCAIRS reporting system is composed of various applications that together form a suite of products allowing organisations to create, maintain and deploy a repository of accident and incident reports. ECCAIRS is used by many national aviation authorities and accident investigation boards in Europe and also worldwide.



ess focuses on identifying and removing one or more links in the accident causal chain, which could have been initiated hours, days or even weeks before the accident.

An event is defined as a decision, action or failure that contributed to or led to an occurrence. Events and conditions are presented in chronological order, and analysed one by one. The method requires analysing what happened and why. The teams can first use ‘free text’ to describe the accident. ‘What happened’ provides factual description, using or summarising statements from the accident report, whilst identification of ‘why’ certain things happened is based on the analysis provided in the accident report and/or on aspects identified by the analysis team based on expert judgment.

3. Assign standardised codes to the factors

The next step in the methodology is to translate the free text in step 2 into standardised codes. The use of standardised codes supports accident aggregation and statistical analysis. The EHSAT uses two models to assign codes: Standard Problem Statements and HFACS codes.

The **Standard Problem Statements (SPS)** taxonomy inherited from IHST/US JHSAT has over 400 codes in 14 different areas. The structure consists of three levels: the first level identifies the main area of the SPS, and the second and third levels go into more detail. Level 1 categories are: ground duties; safety management; maintenance; infrastructure; pilot judgment and actions; communications; pilot situation awareness; part/system failure; mission risk; post-crash survival; data issues; ground personnel; regulatory; and aircraft design. A single factor identified in the accident can be coded using more than one SPS. Figure 4 presents an example of the translation of the analysis into a three-level SPS code.

Analysis/Why/Contributing factors	SPS nr.	level 1	level 2	level 3
The commander inadvertently entered IMC and probably became spatially disoriented	701005	Pilot situation awareness	Visibility/Weather	Inadvertent entry info IMC

Figure 4 — Example of Standard Problem Statement

Because of the ambitious goal setting of an 80 % accident rate reduction, where it can be foreseen that many of the identified factors will lie within the human factors domain, the EHSAT decided to include a second model and taxonomy in the analysis phase to better address these human factors: the **Human Factors Analysis and Classification System (HFACS)**. HFACS was developed from Reason's concept of latent and active failures by Wiegmann and Shappell [Ref. 8–9]. The HFACS model describes human error at four levels: organisational influences, unsafe supervision, preconditions for unsafe acts and the unsafe acts of operators (e.g. flight crew, maintainers, air traffic controllers) (See Figure 5). The classification system contains over 170 codes in these four main areas. In addition to providing more detail on human factors, it also encouraged the EHSAT not only to identify the human error on an operator level, but also to search for underlying management and organisational factors. An example of HFACS coding in the EHSAT analysis is provided in Figure 6.

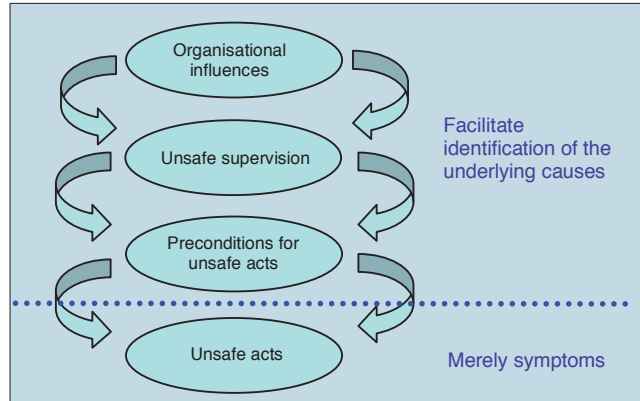


Figure 5 — Model structure of HFACS by Wiegmann and Shappell

The classification system contains over 170 codes in these four main areas. In addition to providing more detail on human factors, it also encouraged the EHSAT not only to identify the human error on an operator level, but also to search for underlying management and organisational factors. An example of HFACS coding in the EHSAT analysis is provided in Figure 6.

Analysis/Why/Contributing factors	HFACS nr.	level 1	level 2	level 3
The commander inadvertently entered IMC and probably became spatially disoriented	5305100	Preconditions – Condition of Individuals	Perceptual Factors	Spatial Disorientation 3 Incapacitating
	5001040	Unsafe Acts – Errors	Skill-based Errors	Overcontrol/Under control
	5501030	Supervision	Inadequate Supervision	Local Training Issue/Programs
	5603020	Organizational Influences	Organizational Process	Program and Policy Risk Assessment

Figure 6 — Example of application of HFACS code

Additionally, a special HFACS maintenance extension (HFACS ME) was introduced to code maintenance-related human factors. HFACS ME is the coding system for maintenance personnel and organisation developed by the US Naval Safety Center. The system features the following main categories (from local to remote): maintainer acts, maintainer conditions, working conditions and management conditions.

4. Produce intervention recommendations

The next analysis step consists of identifying Intervention Recommendations (IRs) for all the factors identified in the previous steps. IRs are aimed at preventing factors, directly or more remotely involved, from reoccurring. One or several IRs can be formulated for each SPS or HFACS. IRs are freely generated and are formatted in free text, using the diverse expertise in the analysis team and supporting creativity. A special support table was created to invite the analysis teams to go through all flight phases and to target various aspects within the IRs such as regulations, design and other technical factors (e.g. weight and balance), certification, operations, procedures, staffing, qualification, licensing and training, weather, winds, turbulences and other environment factors, working environment factors, workload, fatigue, attitudes, national, regional, company and professional culture and other human factors, production, commercial and market factors, management, Safety Management Systems (SMS) and safety culture, and accident investigation aspects. Finally, the IRs are categorised to allow consolidation of results. Figure 7 presents an example of an IR.

Intervention recommendation	Intervention recommendation
(Free text)	(coded on Category level)
All periodic base check flying tests carried out by the operator should include the pilot's capability to fly by sole reference to flight instruments.	Training/Instructional
Regulations should address the hazards of flight in a Degraded Visual Environment (DVE).	Regulatory

Figure 7 — Example of intervention recommendations

5. Score Standard Problem Statements and Intervention Recommendations

To assist the implementation team, and ultimately the industry and authorities, to determine the best course of action, all the coded factors in step 3 are scored on validity and importance and the IRs identified in step 4 on ability and usage. Validity is dependent on the level, quality and credibility of data and information available in the event report: factors associated with hypothetical events not supported by documented evidence in the accident reports are scored low on validity. Importance is the measure of the identified factor importance in the event's chain of causal factors. Ability is the measure of how well an IR can mitigate an event's problem or contributing factor, assuming it performed exactly as intended. Usage is the measure of how confident we are that this intervention will be utilised and will perform as expected given this particular accident scenario.

Accident analyses provided by all regional teams are then analysed at aggregated level to present a European picture. The analysis results will finally be passed on to the implementation team, the EHSIT. Economic and other considerations are introduced in the EHSIT process to decide on the best course of action and develop suitable safety enhancement action plans.

6. Preliminary analysis results

Analyses focus on:

- accidents,
- date of occurrence between 1 January 2000 and 31 December 2005,
- state of occurrence located in EASA Member States,
- and only those accidents where a final report from an accident investigation board is available.

The results presented in this report are preliminary results, based on the 186 accidents analysed by the nine EHSAT regional teams up to 15 September 2008.

It is estimated that this number covers some 58 % of the accident reports currently available and some 25 % of the estimated total number of helicopter accidents within this time frame.

6.1. General data

Of accidents analysed so far, a total of 72 involve general aviation operations (see Figure 8). A relatively large proportion of commercial air transport accidents have been analysed (40). This is most probably the result of good availability of accident reports for this type of operation. The same reasoning applies to the relatively large share of fatal accidents analysed within the dataset (see Figure 9).

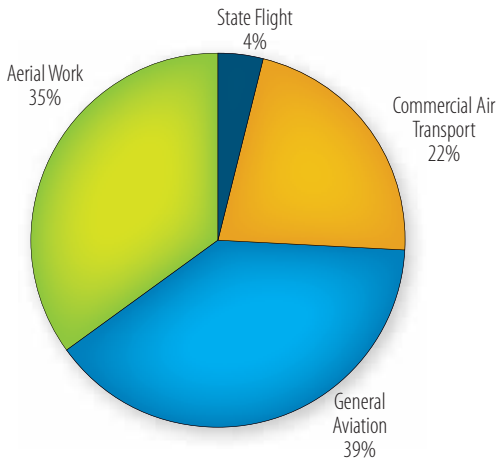


Figure 8 — Number of accidents per type of operation in the analysed dataset

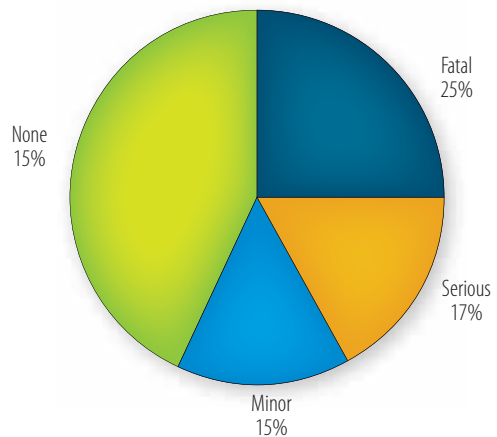


Figure 9 — Injury level in the analysed dataset

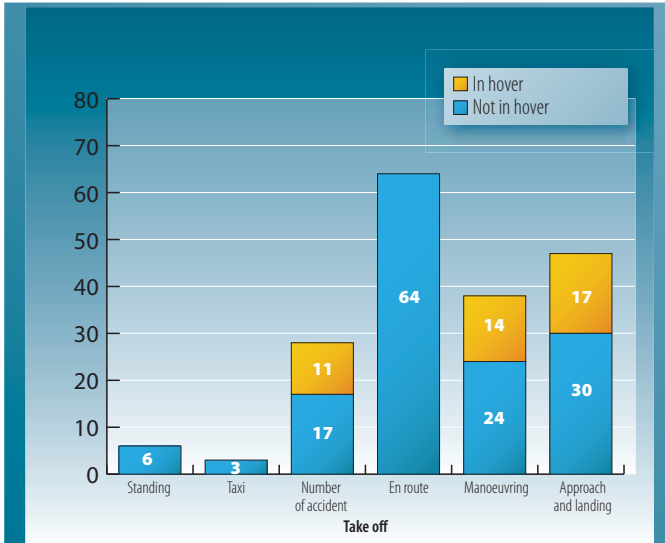


Figure 10 — Distribution of accidents over the phase of flight

in the EASA annual safety review [Ref. 6], where the share of approach and landing accidents is the highest.

In total, the helicopter was in the hover in 24 % of the accidents. When looking only at fatal accidents, 68 % of these occurred during the en route phase (see Figure 11).

Data were gathered on the pilot-in-command flight experience for 83 % of the accidents in the dataset. In most accidents the pilot had limited flight experience (see Figure 12). In 26 % of the accidents, the pilot had less than 100 hours experience on the helicopter type involved in the accident. It was also observed that pilot experience is not always a barrier to having an accident. In general, the proportion of less experienced pilots is higher for general aviation accidents. In 49 % of the general aviation accidents the pilot-in-command had between 0 and 100 flight hours experience on the *accident helicopter type*, compared with 14 % and 9 % for commercial air transport and aerial work operations. These statements on flight experience should, however, be interpreted with care, since no data are available on the overall distribution of flight experience in the helicopter community and for the different types of operation.

The majority of the accidents occurred during the *en route* phase of flight (see Figure 10). In general, during the *en route* phase more time is spent at speed and therefore the energy available is higher. Additionally it has to be considered that for helicopters the *en route* phase is conducted very often at low height above ground level thus exposing the helicopter to wire strike, inadvertent entry into Instrument Meteorological Conditions (IMC) and Controlled Flight Into Terrain (CFIT). These threats are not applicable to the same extent to the *en route* phase of the fixed wing. The preliminary results distribution over the phase of flight is different from the distribution for fixed-wing aircraft in commercial air transport operations, published

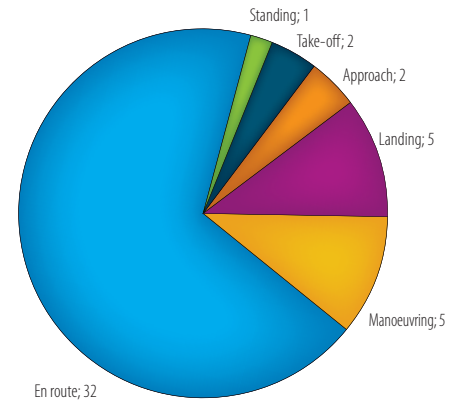
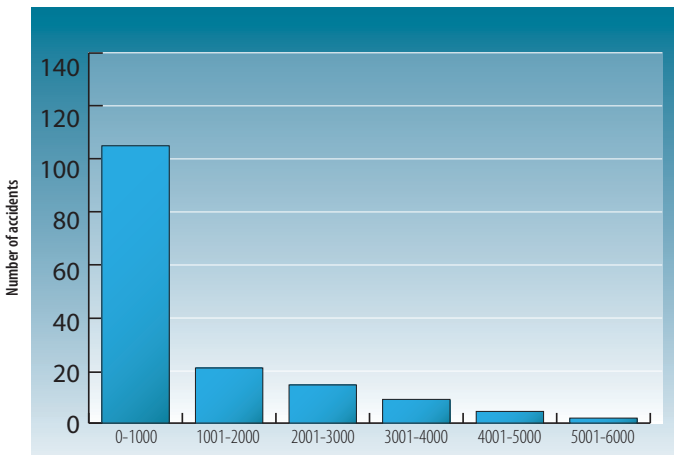


Figure 11 — Distribution of fatal accidents over the phase of flight

6.2. Factor identification

The accident analysis aims at identifying all factors, causal or contributory, that played a role in the accident. Factors are coded using two taxonomies: Standard Problem Statements (SPS) and Human Factors Analysis and Classification System (HFACS) codes. The SPS is a taxonomy developed by the IHST. The HFACS model specially focuses on human factors. The analysis teams were asked to identify, using both taxonomies in parallel, as many factors in an accident as felt needed by the team.

Pilot-in-command flight experience on type in hours
Accident helicopter type



6.2.1. Standard Problem Statements

The SPS is a three-level taxonomy developed by the IHST. It consists of a list of over 400 codes in 14 different areas. For the 186 accidents in the dataset, a total of 1 067 SPS counts were identified (see Figure 13).

Pilot-in-command flight experience on type in hours
Accident helicopter type
0-1000 flight hours only

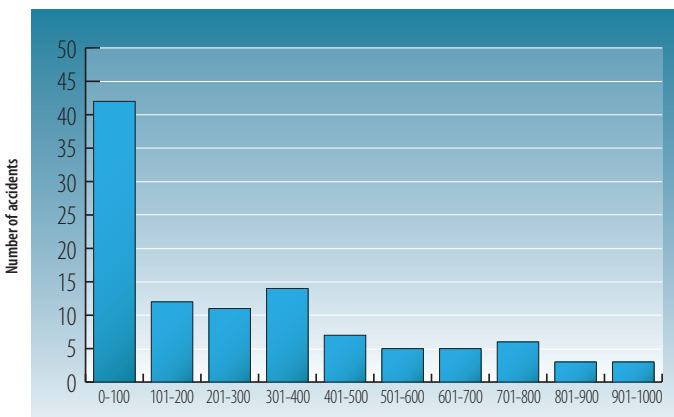


Figure 12 — Pilot-in-command flight experience on the accident helicopter type in hours (data from 155 accidents)

Percentage of accidents in which SPS Category (level 1) was identified at least once

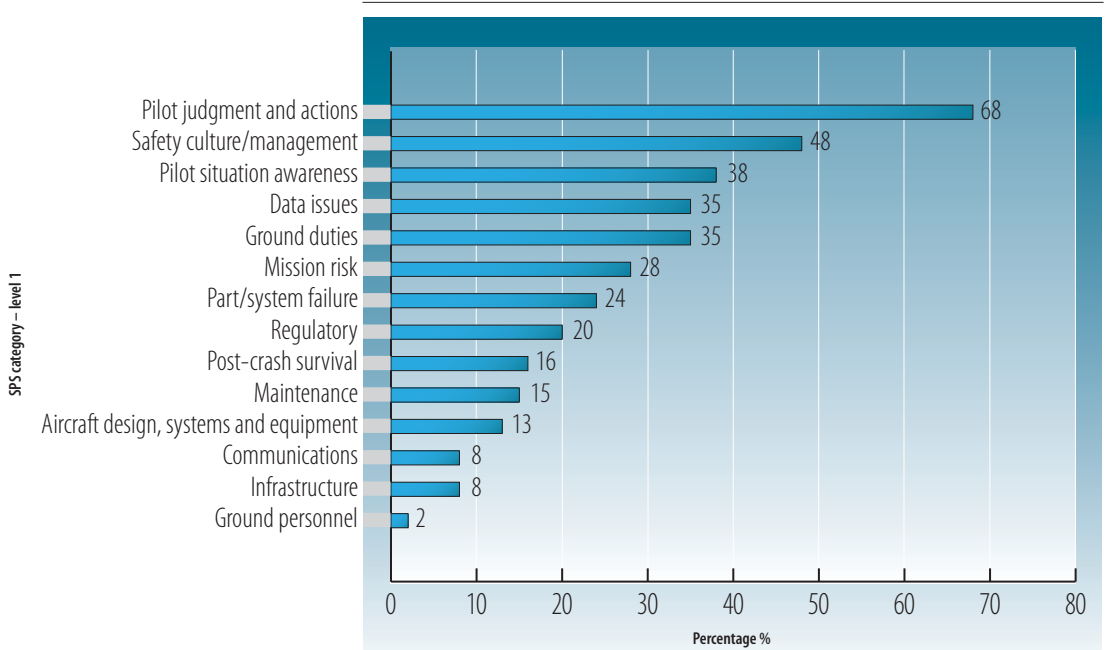


Figure 13 — Highest-level Standard Problem Statement results in percentage of total number of accidents in dataset

The area identified in most accidents in the dataset is **pilot judgment and actions**. This includes factors related to pilot decision-making, unsafe flight profile, procedure implementation, crew resource management and human factors such as diverted attention, perceptual judgment errors and aeromedical factors. The second most-identified area is **safety culture and management**. This includes safety management systems, training, pilot disregard of known safety risk, self-induced pressure and pilot experience. The third area is **pilot situation awareness**. This covers in-flight factors such as reduced visibility and external obstacle or hazard awareness.

The area of **data issues** is a specific area to code factors related to the lack of availability of information in the accident report. The teams found that in 35 % of the analysed accident reports there was insufficient information available to fully analyse and understand the accident. One of the reasons for insufficient information being available is the absence of a flight data recording capability in many helicopters ⁽¹⁰⁾. In addition, some accidents were not investigated in detail. Since this is a special area not dealing with actual issues in the accident event sequence, it will be left out from here on.

⁽¹⁰⁾ EASA launched a research project on this subject in 2008.

Percentage of accidents in which top five SPS Category (level 1) was identified at least once
EHSAT data versus US JHSAT data

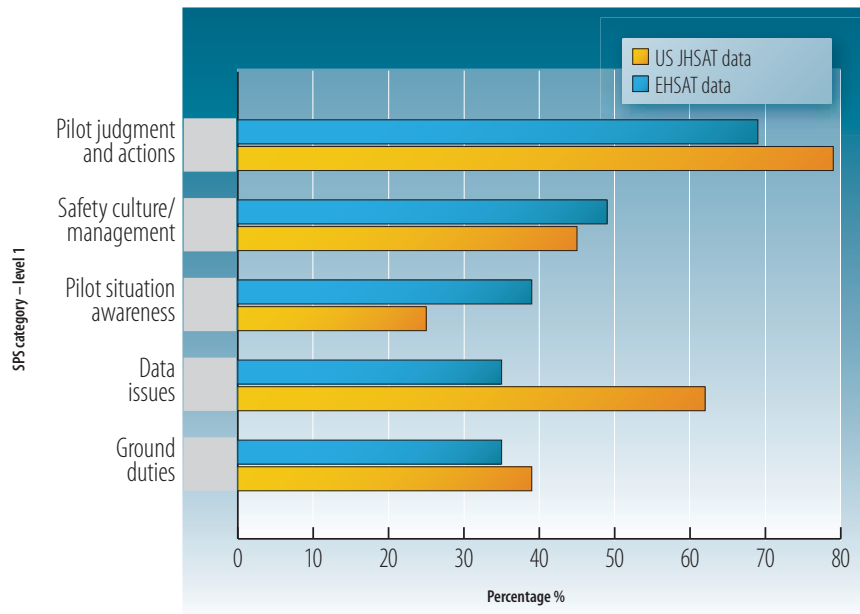


Figure 14 — EHSAT results on Standard Problem Statements level 1 compared with US JHSAT results

The area of **ground duties**, identified in 35 % of the accidents, includes factors such as mission planning and aircraft pre- and post-flight duties.

The United States Joint Helicopter Safety Analysis Team (US JHSAT) completed a first analysis report in September 2007. A total of 197 accidents from the year 2000 were analysed. When comparing the European data with the US results on a high level (SPS level 1), it was calculated that the correlation of the results was high (0.89) (see Figure 14). The top five of the level 1 areas are similar for both the US [Ref. 10] and the EHSAT analyses, but the order differs slightly.



Percentage of accidents in which SPS Category (level 2) was identified at least once

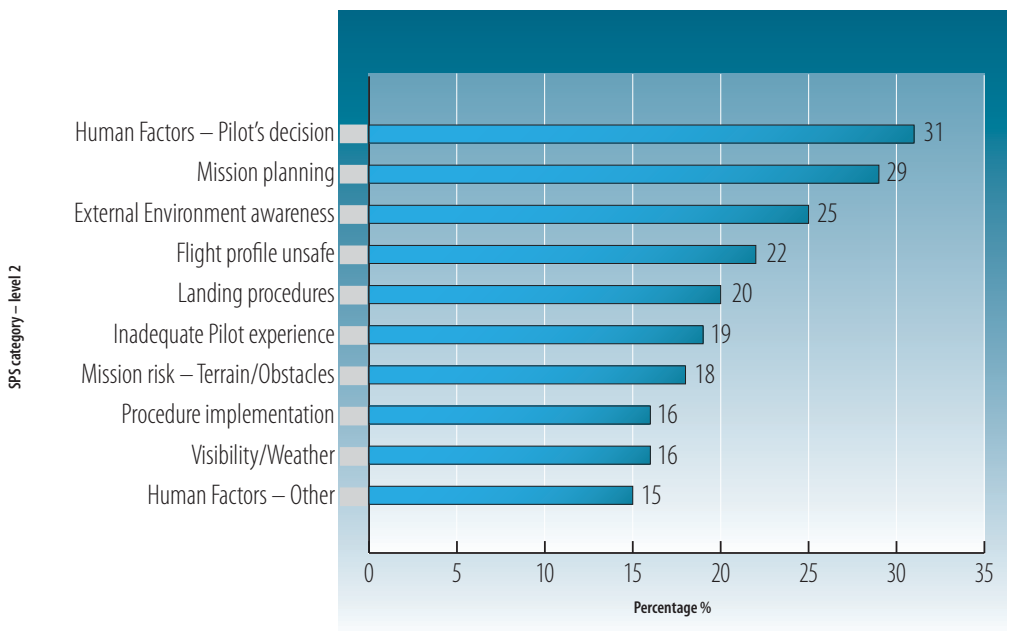


Figure 15 — Top 10 second-level Standard Problem Statement results in percentage of total number of accidents in dataset (excluding factors related to data issues)

The highest level of Standard Problem Statements, level 1, only provides information on a general level. To better understand what kind of factors played a role in the accident dataset one must look at a deeper level in the taxonomy. Looking at the level 2 Standard Problem Statements, it becomes clearer that the main factors identified involve issues in the human factors domain. Pilot’s decision-making, mission planning and external environment awareness are the three most relevant factors, identified in respectively 31 %, 29 % and 25 % of the accidents in the dataset (see Figure 15).

Because most of the identified factors lie within the human factors domain, EHSAT adopted a second model and taxonomy for factor identification to better address these human factors. Results will be presented in Section 6.2.2 below.



6.2.2. Human factors analysis and classification system

Human factors (HF) must be addressed in order to meet the IHST objective of achieving an 80 % reduction in helicopter accident rates by 2016. HFACS address HF in a detailed and structured manner. The system is well documented and has been used with success in other studies. It is based on a well-known theoretical framework [Ref. 9, 11–13] ⁽¹⁾, and the analysis instructions are clear and easy to apply. HFACS was introduced in Section 5.

For the 186 accidents in the dataset, a total of 445 HFACS factor counts were identified. In 76 % of the accidents, at least one HFACS factor was identified. In most accidents unsafe acts or preconditions for unsafe acts were identified (see Figure 16). In fewer accidents issues related to supervision or organisational influences were captured. The possibility of identifying those factors is, however, very much dependent on the depth of the accident investigation performed: if the accident investigator did not look into managerial or organisational aspects related to the accident, the EHSAT analysis team could not assign factors in those areas.

Unsafe acts

For the lowest level in the model, the unsafe acts, 84 % of the identified factors concerned errors: activities that failed to achieve their intended outcome. Most errors were identified as being judgment and decision-making errors, such as poorly executed procedures, improper choices or misinterpretation of information. These errors represent conscious and goal-intended behaviour. Skill-based errors, on the other hand, are errors that occur with little or no conscious thought, such as inadvertent operation of switches and forgotten items in a checklist. These errors were identified in 28 % of the errors. Finally, perceptual errors are related to a degraded sensory input.

Violations, wilful disregard of rules and regulations were identified in 16 % of the unsafe acts.

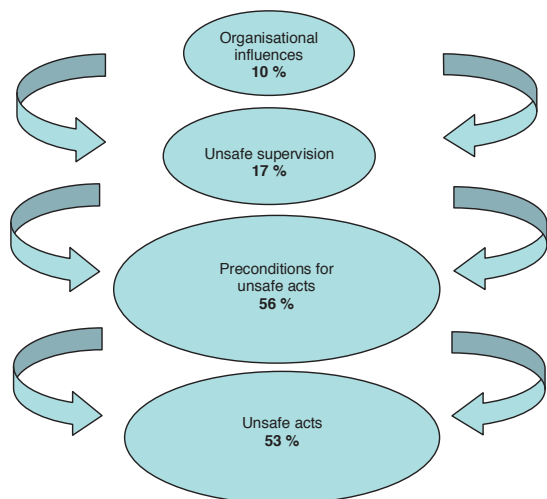


Figure 16 – Percentage of accidents where HFACS level was identified at least once

⁽¹⁾See also <http://www.hfacs.com/>

Preconditions for unsafe acts

Only focusing on unsafe acts, however, is 'like focusing on a patient's symptoms without understanding the underlying disease state that caused it' [Ref. 9]. Therefore, one must look deeper into preconditions to identify why the unsafe acts took place. Some 60 % of the identified preconditions related to the condition of the individual. These conditions include overconfidence, channelised attention, 'press-on-itis', inattention, distraction, misperception of operational condition and excessive motivation. Personnel factors mostly concerned mission planning. Also cross-monitoring performance and mission briefing were mentioned. For the environmental factors, restricted vision by meteorological conditions, brownout/whiteout and windblast were identified.

Unsafe supervision

In 17 % of the accidents, latent failures at middle-management level were identified. Under planned inappropriate operations, the factors of limited total and recent experience and formal risk assessment, in case

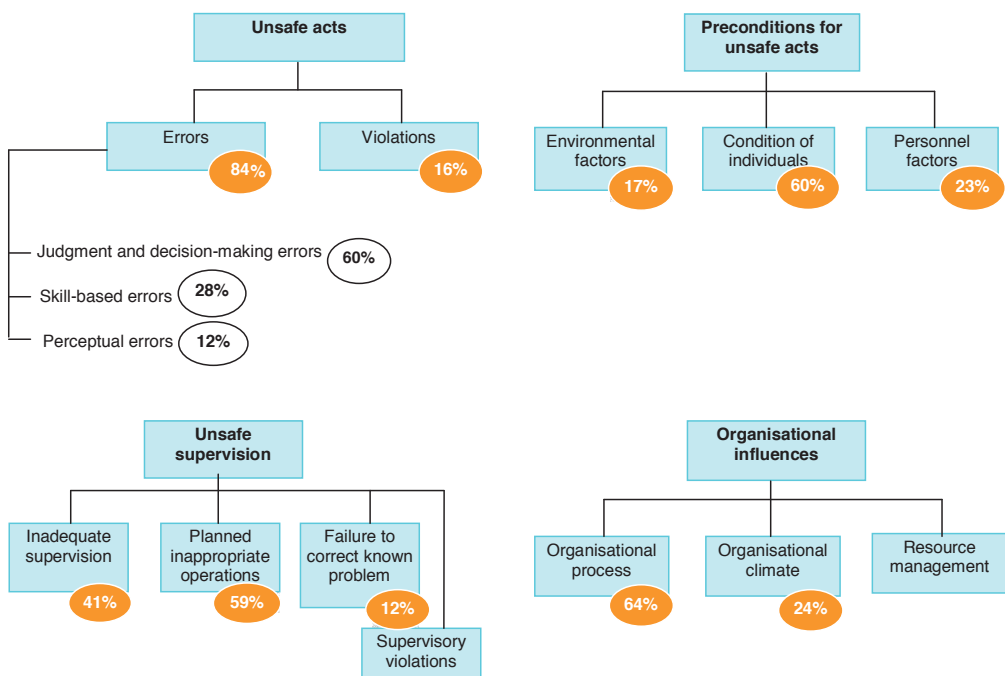


Figure 17 — HFACS results

a supervisor does not adequately evaluate mission risks or risk assessment programmes are inadequate, were identified. In addition, cases were identified under inadequate supervision relating to inadequate leadership/supervision or oversight and lack of policy or guidance.

Organisational influences

In 10 % of the accidents, latent failures at the higher management level or organisational level were identified. Items identified under organisational process included issues related to procedural guidelines and publications, and doctrine. Under organisational climate, organisational values/culture and organisational structure were identified.

6.2.3. Analysis per type of operation

The results presented so far were consolidated for all types of operations. Especially on a detailed level, it is interesting to see if differences can be observed for the different types of operation. Tables 1 to 3 present examples of the top issues identified for commercial air transport, aerial work and general aviation operations. The issues are presented on the lowest level of the taxonomies used.

The data in the tables provides the reader with an understanding of a 'typical' accident scenario for the different types of operation. Differences and similarities between the three can be observed from the tables below.

Top issues — Commercial air transport	
Top issues, Standard Problem Statements	Top issues, HFACS
Pilot decision-making	Brownout/whiteout
Pilot-in-command self-induced pressure	Decision-making during operation
Pilot's flight profile unsafe for conditions	Communication critical information
Reduced visibility — whiteout, brownout	Pressing
Pilot inexperienced with area and/or mission	Risk assessment — during operation
Pilot experience leads to inadequate planning regarding weather/wind	Procedural error
Selection of inappropriate landing site	Excessive motivation to succeed
Management disregard of known safety risk	Mission planning
Inadequate consideration of aircraft operational limits	Inattention
Failure to enforce company SOPs	Limited recent experience
Standard Operating Procedures	Procedural guidelines/publications

Table 1 — Top issues for helicopter commercial air transport operations (excluding factors related to data issues)

Top issues — Aerial work

Top issues, Standard Problem Statements

Mission involves flying near hazards, obstacles, wires
 Pilot decision-making
 Mission requires low/slow flight
 Low flight near wires
 Inadequate consideration of obstacles
 Diverted attention, distraction
 Risk management inadequate
 Inadequate response to loss of tail rotor effectiveness
 Inadequate training on avoidance, recognition and recovery of vortex ring state or LTE

Top issues, HFACS

Risk assessment — during operation
 Channelised attention
 Mission planning
 Decision-making during operation
 Error due to misperception
 Inattention
 Misperception of operational condition
 Excessive motivation to succeed
 Fatigue — physiological/mental
 Windblast
 Overconfidence
 Limited total experience

Table 2 — Top issues for helicopter aerial work operations (excluding factors related to data issues)

Top issues — General aviation

Top issues, Standard Problem Statements

Pilot decision-making
 Mission planning — other
 Inadequate consideration of weather/wind
 Pilot inexperienced
 Pilot control/handling deficiencies
 Pilot misjudged own limitations/capabilities
 External environment awareness — other
 Disregard of known safety risk
 Failed to recognise cues to terminate current course of action or manoeuvre

Top issues, HFACS

Risk assessment — during operation
 Overconfidence
 Vision restricted by meteorological conditions
 Procedural error
 Mission planning
 Decision-making during operation
 Overcontrol/undercontrol
 Violation — lack of discipline
 Inadvertent operation
 Error due to misperception
 Channelised attention
 Get-home-itis/get-there-itis

Table 3 — Top issues for helicopter general aviation operations (excluding factors related to data issues)

HFACS and SPS complement each other well: SPS codes are technically more adapted to helicopter operations while HFACS adds a valuable, theory-driven HF analysis system. As shown in the tables above, the real benefit comes from jointly considering SPS and HFACS results in a single shell. When used in combination, HFACS and SPS provide a basis for richer analyses and recommendations.

The distribution of HFACS results per layer can be compared to other studies using the same taxonomy. When reviewing HFACS studies on commercial air transport and general aviation operations [Ref. 11–12] the preliminary EHSAT results show some differences with respect to a relatively lower frequency of skill-based errors as part of the unsafe acts and relatively lower frequency of environmental conditions within the preconditions.

These differences can be partly due to a reporting bias. Human factors can only be addressed as far as they were reported in the accident investigation report. This concerns especially the managerial and organisational issues. It is therefore suggested that the AIBs include in the investigation reports those factors remote in time and space from the accident scene. Recommendations targeting the remote layers can help to prevent reoccurrence not only of the accident investigated but also of a whole set of potential accidents in which such factors can play a role.

6.3. Intervention recommendations

The regional EHSAT teams were also asked to develop intervention recommendations that could possibly prevent similar accident factors from reoccurring. These intervention recommendations are free text and have been assigned to one of 11 categories. For the preliminary results, most recommendations fall into:

- training/instructional,
- flight operations and safety management/culture, and
- regulatory/standards/guidelines (see Figure 18).





The actual recommendations have not been prioritised so far. Examples of intervention recommendations are: better training for specific missions, for example mountain operations, better training for specific operating environments, such as inadvertent entry into IMC conditions, risk assessment training, promoting safety culture and introduction of safety management systems, increase of obstacles awareness, requirements for flight data recording, and establishment of training requirements for aerial work operational crew other than flight crew.

These intervention recommendations will be input for the second step of the European Helicopter Safety Team (EHEST) process: the development of safety action plans by the implementation team. This team will prioritise the intervention recommendations based on safety benefit and practicality and from there develop the safety action plans.

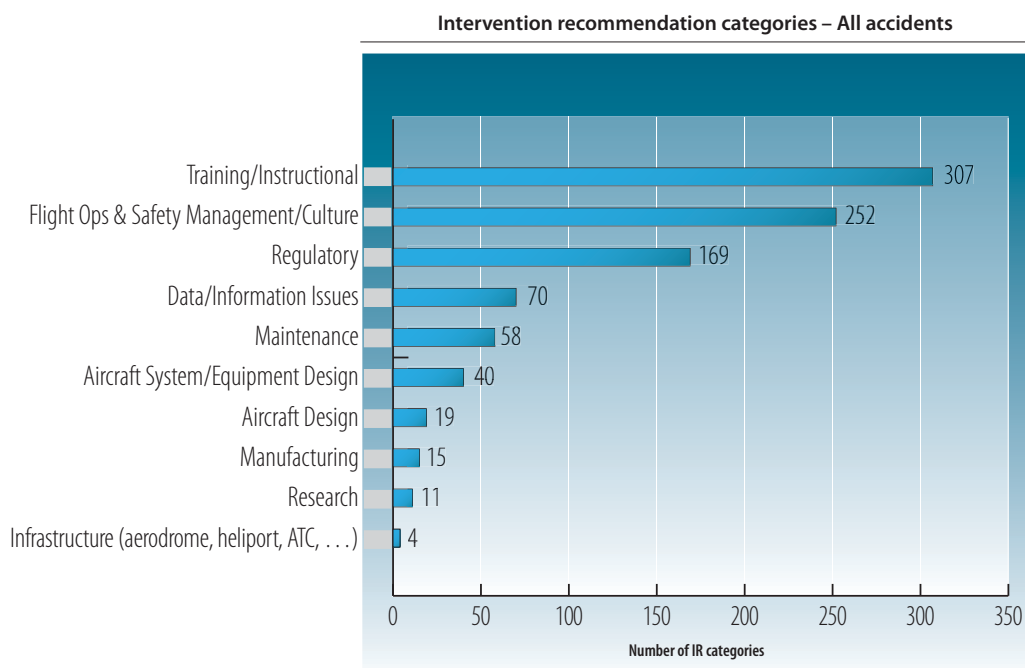


Figure 18 — Distribution of intervention recommendation categories for all analysed accidents

7. Concluding remarks and way forward

The EHSAT analysis consolidates analyses of Europe-wide helicopter accident data. This report presents the preliminary results of this analysis. The preliminary dataset consists of 186 helicopter accidents analysed by the nine regional EHSAT teams up to 15 September 2008.

Although these results are preliminary and might change when more data become available, it is estimated that they already provide a good indication of the type of accidents and the factors identified.

The top three identified areas are: pilot judgment and actions, safety culture/management and pilot situation awareness. The high-level results were compared with the US analysis results and showed a high correlation.

On the lowest level in the taxonomy, different patterns were observed for commercial air transport, aerial work and general aviation.

The use of the HFACS taxonomy by the EHSAT provided a complementary perspective on human factors. Most intervention recommendations were identified in the areas of training/instructional, flight operations and safety management/culture, and regulatory/standards/guidelines.

The EHSAT will continue analysis of accidents to complete the time frame 2000–05.

Launched on 5 February 2009, the European Helicopter Safety Implementation Team (EHSIT) will use the preliminary and final EHSAT results to develop safety action plans. These results will be shared with the International Helicopter Safety Team (IHST).

In parallel the regional EHSAT teams will continue analysing accidents reports at the rate of one year of accidents per year to expand the database for further processing and for monitoring the effects of future safety enhancements by the EHSIT.



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