Flygsäkerhetsinfo nr 2/2007

Första kvartalet 2007

RAPPORT 2007:7
ISSN 1652-9707

1 INNEHÅLLSFÖRTECKNING

2 FÖRORD

Den svenska luftfarten präglas av en god rapporteringskultur som är en väsentlig del av det övergripande kvalitets- och säkerhetsarbetet. Luftfartsstyrelsen arbetar med denna information som ett viktigt underlag i tillsyns- och analysverksamheten. Ett av målen är att identifiera problemområden och återföra dessa i flygsäkerhetsarbetet.

Målet med utgivningen av denna flygsäkerhetsinformation är att regelbundet presentera flygsäkerhetsläget på ett översiktligt sätt. Den kommer att innehålla en översikt av inkomna rapporter under perioden med kortfattade analyser. Utvalda händelser kommer emellanåt att penetreras djupare.

Sammanställningen riktar sig till alla som omfattas av reglerna för rapportering av händelser som rör flygsäkerheten. Distributionen sker via e-post.

3 STÖRNINGSRAPPORTERING

Varje rapport som kommer in till Luftfartsstyrelsen analyseras. Antalet rapporter uppgår för närvarande till c:a 2800 per år. Vid analysen rubriksätts, struktureras och sammanfattas rapporten. Lagring av alla rapporter sker via programvaran/databasen ECCAIRS. Personnamn läggs inte in i databasen. Informationen översätts till engelska för att underlätta det internationella utbytet av flygsäkerhetsinformation.

Sammanställningen grundas på delvis preliminära uppgifter. Informationen i databasen uppdateras efter hand som uppgifter kommer in.

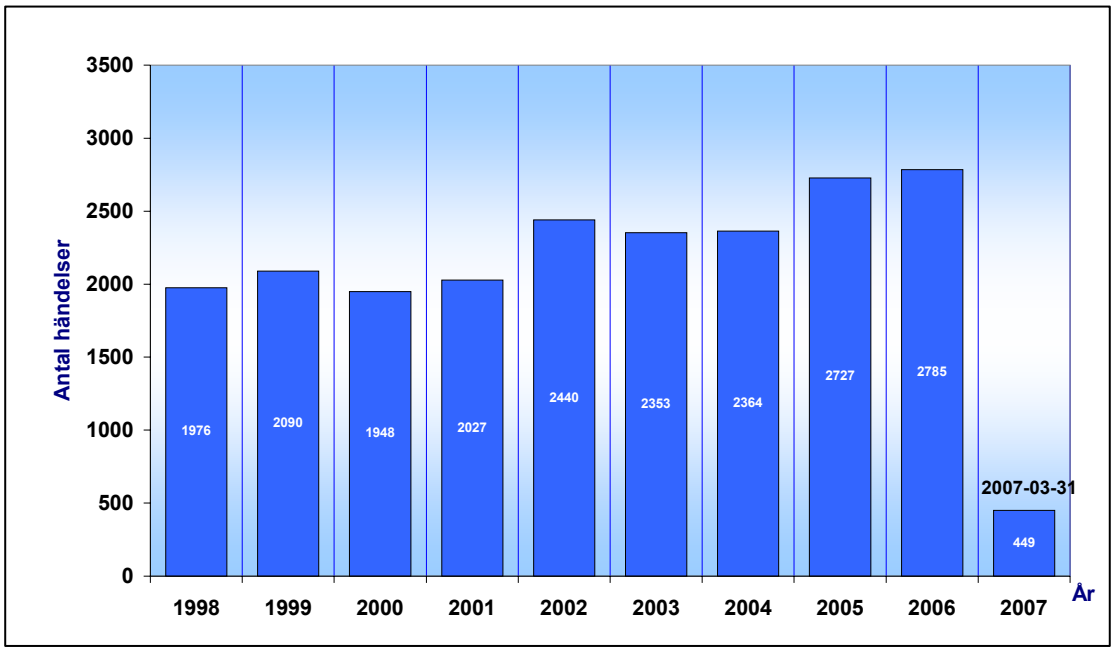
Underlaget innehåller information från alla delar av luftfarten, vilket ger god överblick över alla typer av händelser.

Målet är att materialet skall komma till användning i såväl det interna som externa flygsäkerhetsarbetet.

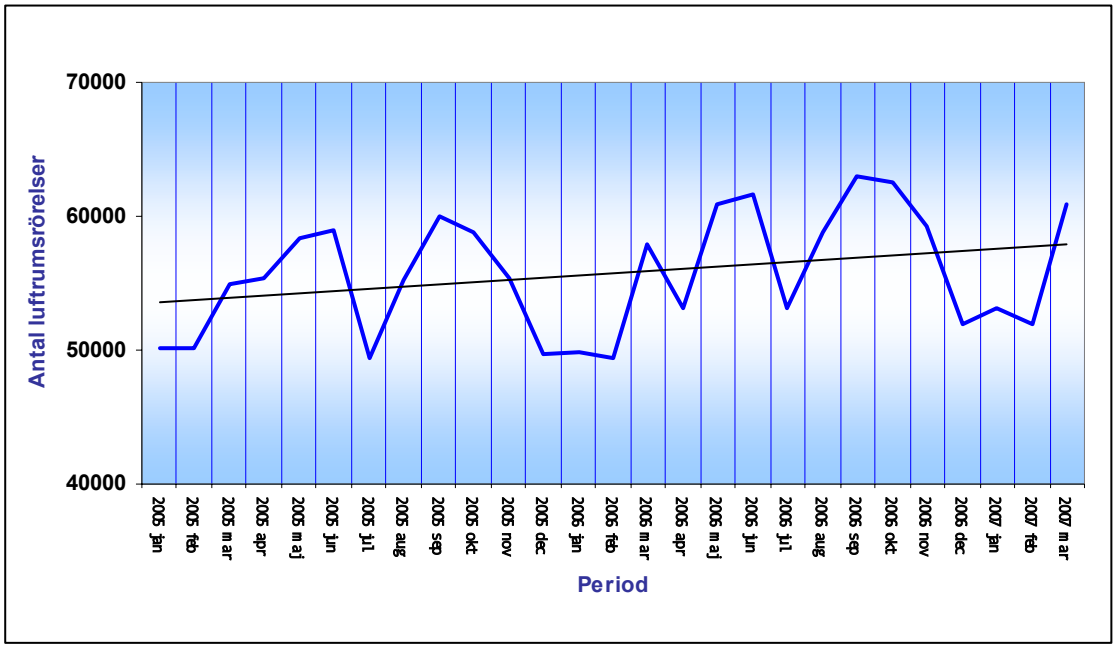
Synpunkter rörande utformningen eller innehållet i Flygsäkerhetsinformation mottages tacksamt på asr@luftfartsstyrelsen.se

4 STÖRNINGSRAPPORTER (OCCURRENCE REPORTS)

Staplarna i diagrammet visar antal rapporterade händelser mellan 1998-01-01 och 2007-03-31.



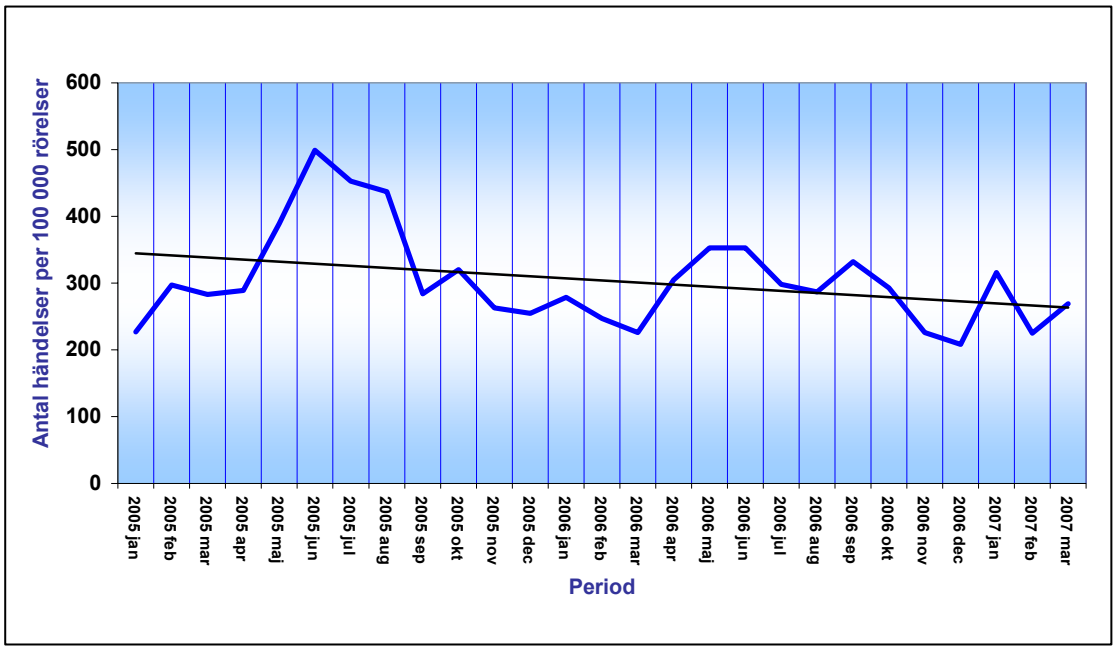
4.1 Luftrumsrörelser (IFR) – Periodjämförelse



Antal IFR-rörelser i luftrummet ökade med 5,63 % under kvartal ett jämfört med samma period 2006.

	2006 Kvartal 1	2002 Kvartal 1	Förändring Antal	Förändring Procent
Antal rörelser	157 188	166 044	+ 9 639	+ 5,63

4.2 Antal rapporterade händelser per 100 000 luftrumsrörelser (IFR)



Antal rapporterade händelser per 100 000 luftrumsrörelser ökade med 8,43 % jämfört med samma period 2006. Det förekommer alltid en viss fördröjning innan en händelse har behandlats i systemet. Därav är siffrorna för mars månad 2007 osäkra.

	2006 Kvartal 1	2007 Kvartal 1	Förändring Antal	Förändring Procent
Antal händelser per 100´ rörelser	249	270	+ 21	+ 8,43

5 HAVERIER (ACCIDENTS) INOM SVENSK LUFTFART

5.1 Översikt

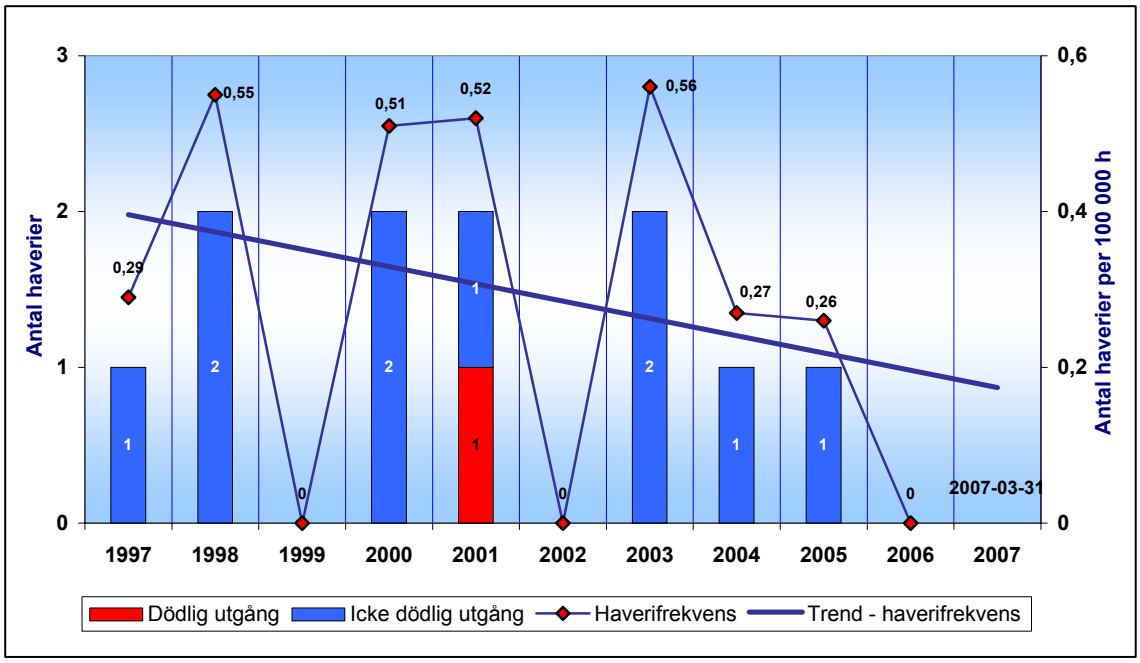
Under kvartal ett 2006 har sex haverier inträffat.

Verksamhetsform	2007	
	Kvartal 1	Ackumulerat
Linjefart/Charter		
Bruksflyg – flygplan		
Bruksflyg – helikopter		
Bruksflyg – ballong		
Skolflyg	1	1
Privatflyg – flygplan	1	1
Privatflyg - helikopter	1	1
Sport	3	3
Totalt	6	6

5.2 Luftfart i förvärvssyfte med tunga flygplan (≥ 5700 kg) (commercial air transport)

Haveriet 2001 med dödlig utgång skedde på Linate-flygplatsen i Italien. Totalt omkom 118 personer ombord i haveriet. Inget haveri med tunga flygplan i förvärvssyfte inträffade under 2006.

Haverifrekvensens medelvärde för luftfart i förvärvssyfte över 10-årsperioden 1996–2005 är 0,30 haverier per 100 000 timmar. Säkerhetsutvecklingen över 10-årsperioden uppvisar en förbättring vad beträffar den totala haverifrekvensen.



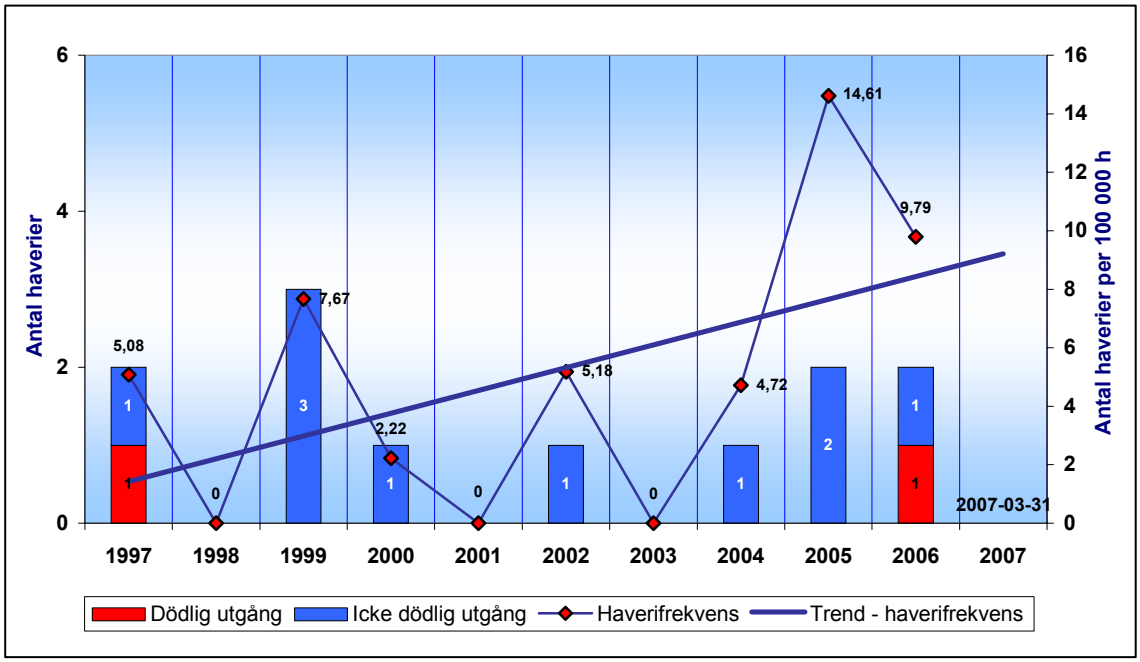
Haverier 2003 – 2005:

År	Land	Plats	Modell
2003	Irland	Londonderry	McDonnell-Douglas MD-83
2003	Sverige	LULEÅ/Kallax	Jetstream 3200-3201
2004	Sverige	STOCKHOLM/Arlanda	Cessna 560 Citation V
2005	Egypten	Sharm el Sheikh	Airbus A321

5.3 Bruksflyg (aerial work) – flygplan

Senaste haveriet med dödlig utgång skedde den 26 oktober 2006 i Falsterbo kanal med Kustbevakningens CASA 212. Total omkom fyra personer vid haveriet.

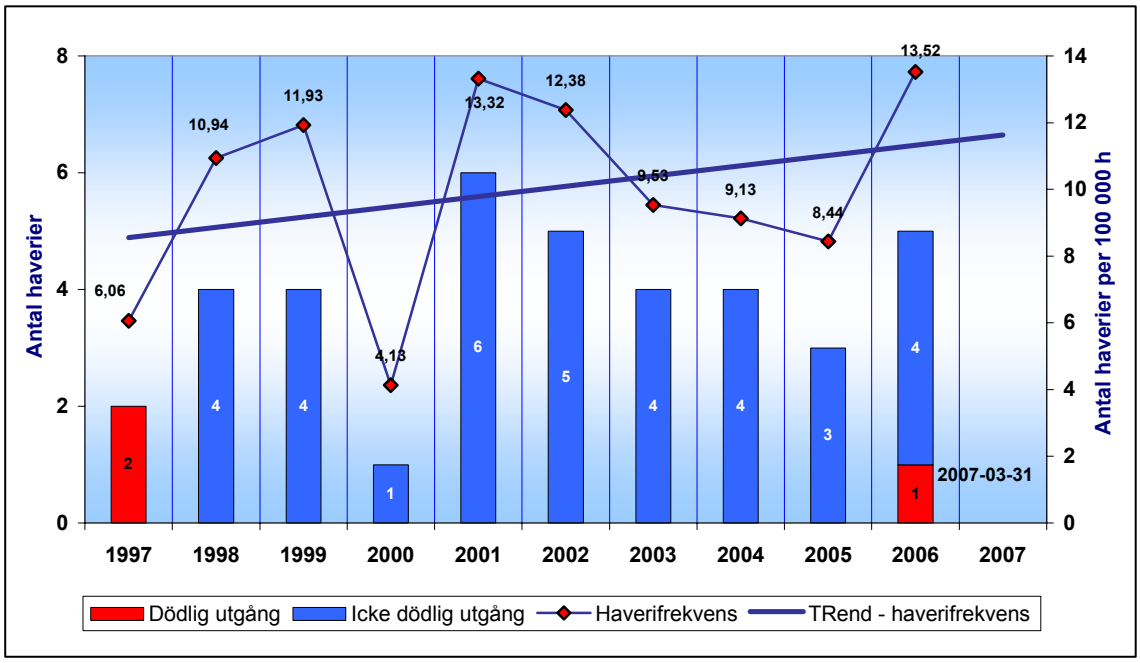
Haverifrekvensens medelvärde för bruksflyg med flygplan över 10-årsperioden 1996–2005 är 3,52 per 100 000 timmar. Säkerhetsutvecklingen över 10-årsperioden för bruksflyg med flygplan uppvisar en negativ trend. Till stor del beror detta på en minskad flygtidsproduktion.



5.4 Bruksflyg (aerial work) – helikopter

Det senaste haveriet med dödlig utgång inträffade den 30 oktober 2006 norr om Katrineholm med en Robinson R44. Tendensen med ett minskat antal haverier sedan 2001 vände uppåt 2006 då det totalt inträffade 5 haverier inom bruksflyget med helikopter.

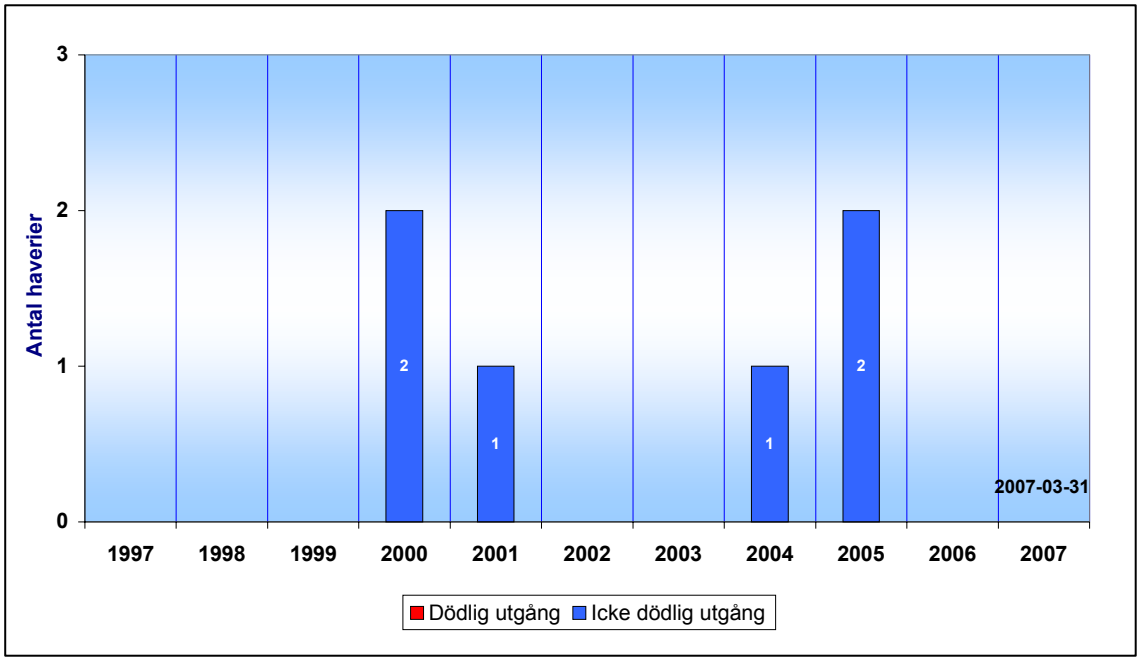
Haverifrekvensens medelvärde för bruksflyg med helikopter över 10-årsperioden 1996–2005 är 8,25 haverier per 100 000 timmar. Säkerhetsutvecklingen över 10-årsperioden för bruksflyg med helikopter uppvisar en negativ trend.



5.5 Bruksflyg (aerial work) – ballong

Staplarna i diagrammet visar antal rapporterade haverier. Inget haveri inträffade under 2006.

Eftersom produktionsdata saknas visas ej haverifrekvensen.

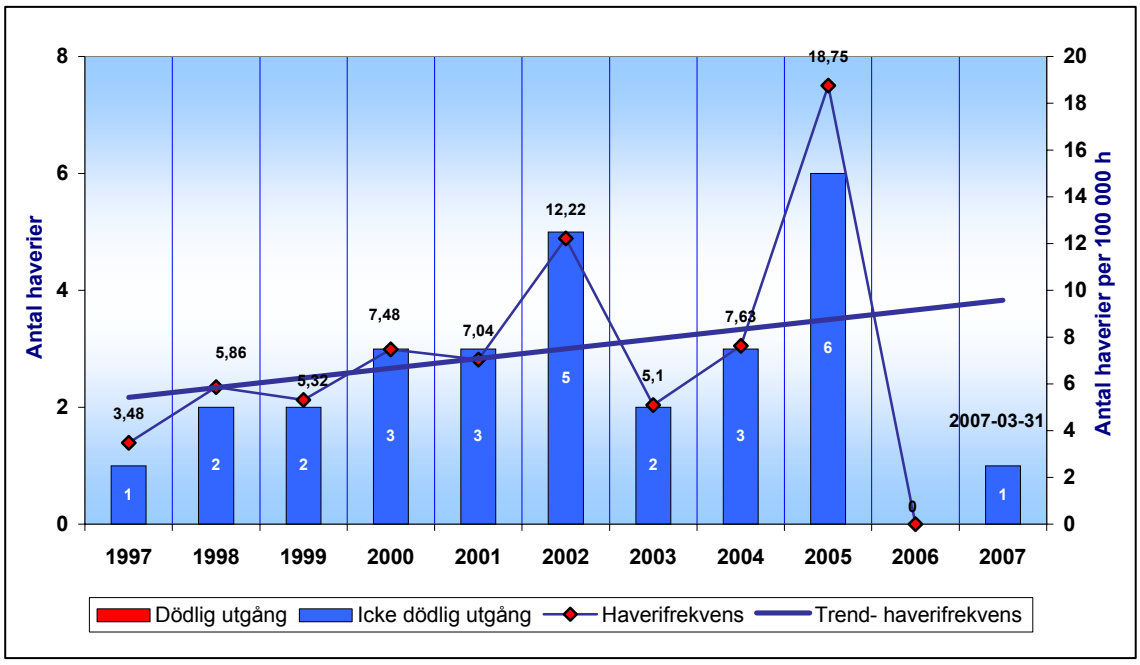


5.6 Skolflyg (training)

Inom skolflyg ingår kommersiell skolning och skolning på klubbnivå med normalklassade luftfartyg. Skolflyg inom sportflyget redovisas inom respektive sportflygverksamhet.

Det senaste haveriet med dödlig utgång inträffade 1996 under landning vid Mellansel flygplats. Inget haveri inträffade under skolflyg 2006.

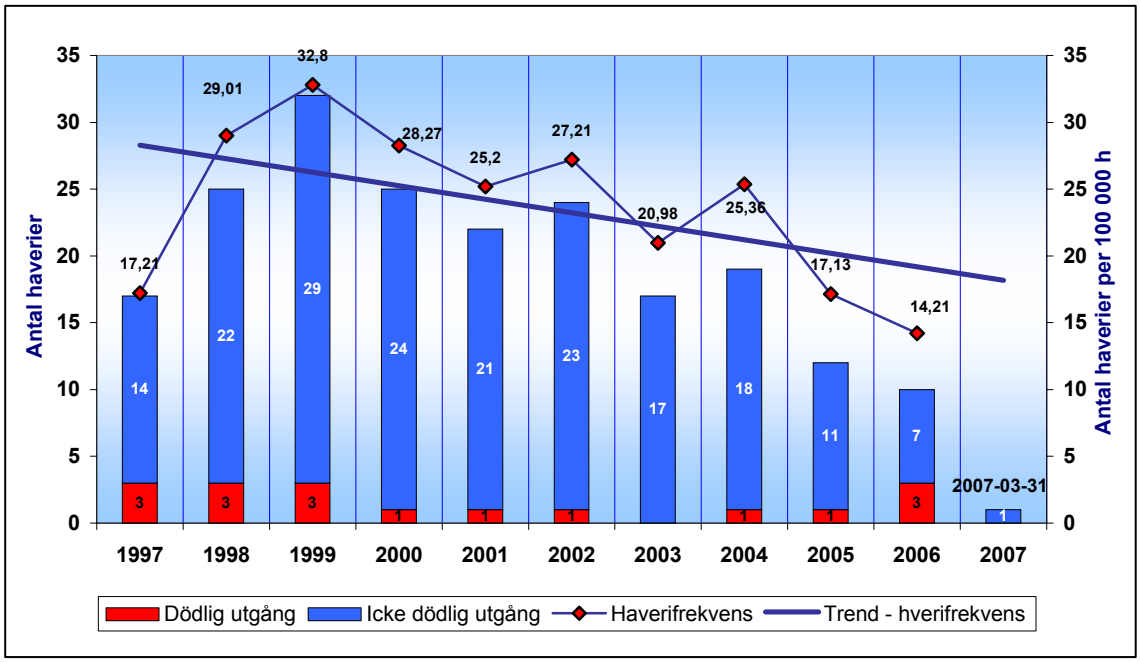
Haverifrekvensens medelvärde för skolflyg över 10-årsperioden 1996–2005 är 8,22 haverier per 100 000 timmar. Säkerhetsutvecklingen över 10-årsperioden uppvisar en negativ trend.



5.7 Privatflyg (General Aviation) – flygplan

Det senaste haveriet med dödlig utgång inträffade den 16 oktober 2006 med en Diamond DA 40. Händelsen inträffade under en leveransflygning från Österrike till Sverige. Piloten och två passagerare omkom vid haveriet.

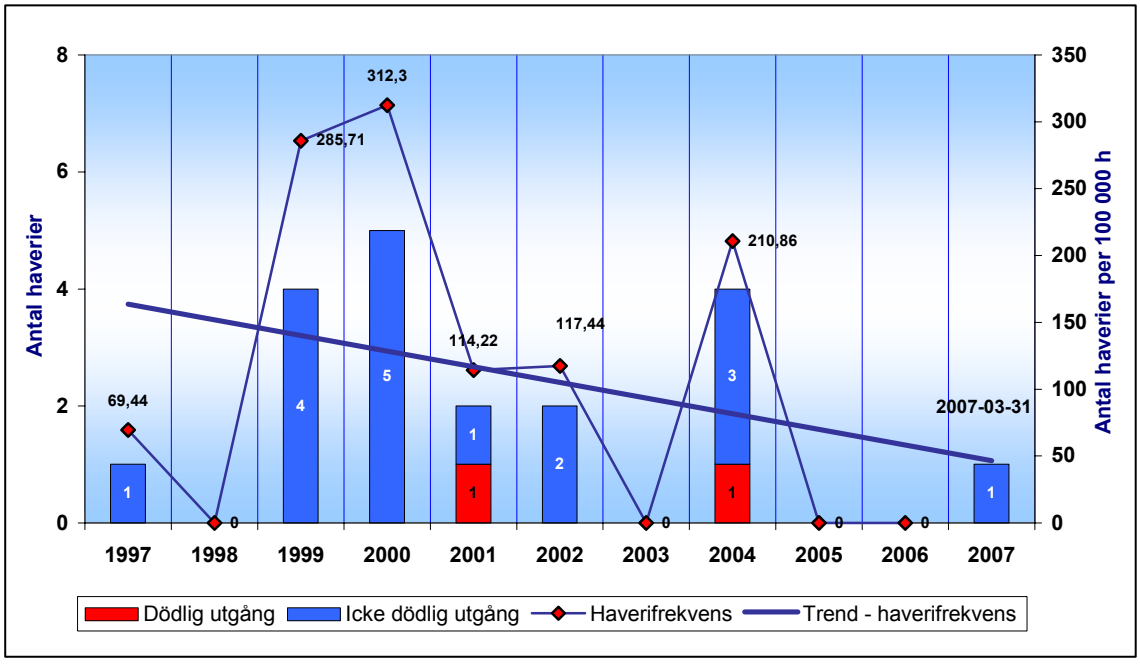
Haverifrekvensens medelvärde för privatflyg med flygplan över 10-årsperioden 1996–2005 är 23,13 haverier per 100 000 timmar. Säkerhetsutvecklingen över 10-årsperioden uppvisar en gynnsam utveckling.



5.8 Privatflyg (General Aviation) – helikopter

Det senaste haveriet med dödlig utgång inträffade 2004 med en Robinson R44 utanför Göteborg. Alla tre ombordvarande omkom. Inget haveri inträffade 2006.

Haverifrekvensens medelvärde för privatflyg med helikopter över 10-årsperioden 1996–2005 är 110,26 haverier per 100 000 timmar. Säkerhetsutvecklingen över 10-årsperioden uppvisar en gynnsam utveckling.

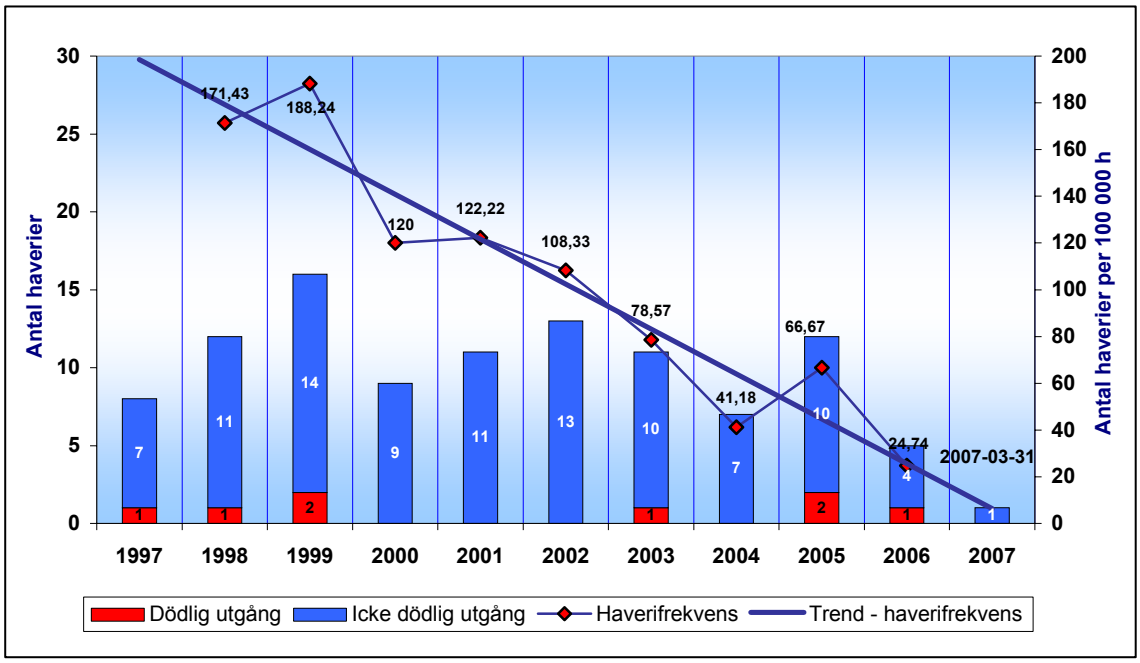


5.9 Sportflyg

5.9.1 Ultralätt

Det senaste haveriet med dödlig utgång inträffade den 2 augusti 2006 med en Jodel D18 ca 2 km söder om Kristinehamn. Luftfartyget var under flygutprovning. Antalet haverier 2006 var det lägsta sedan 1996.

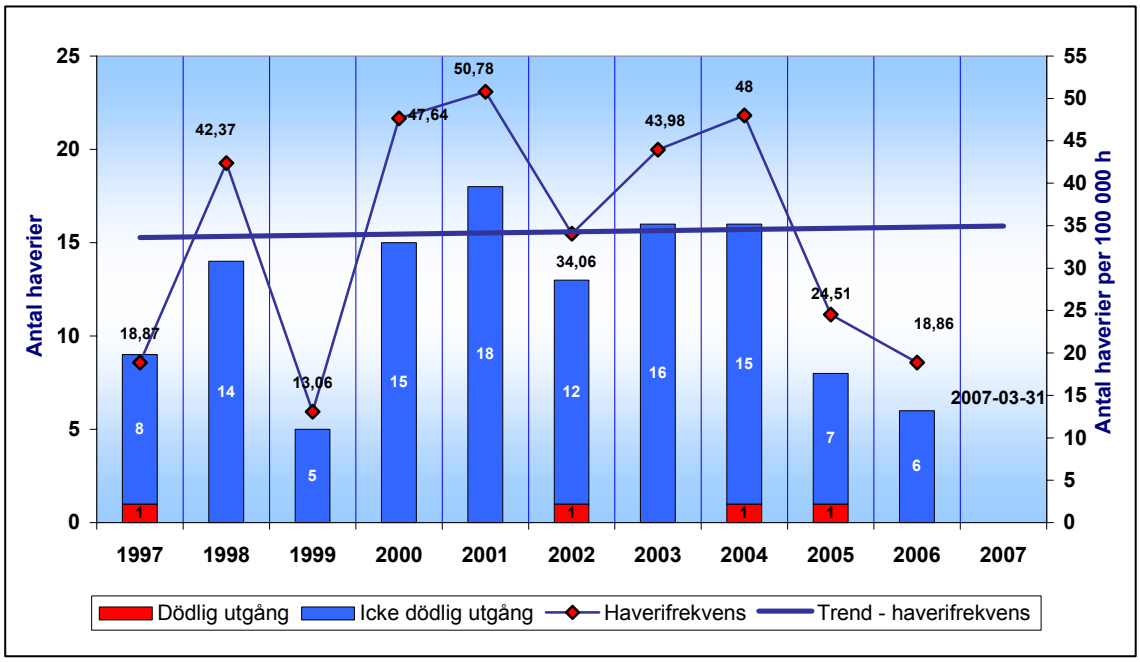
Produktionsdata saknas för 1997 vilket medför att ett 10-års medelvärde ej kan beräknas. Haverifrekvensens medelvärde för ultralätta flygplan över 8-årsperioden 1998–2005 är 100 haverier per 100 000 timmar. Säkerhetsutvecklingen över 8-årsperioden uppvisar en mycket gynnsam utveckling.



5.9.2 Segelflyg (inklusive motorseglare)

Det senaste haveriet med dödlig utgång inträffade 2005. Haveriet inträffade med en motorseglare av modell Scheibe SF25C. Antalet haverier 2006 var det lägsta sedan 1999.

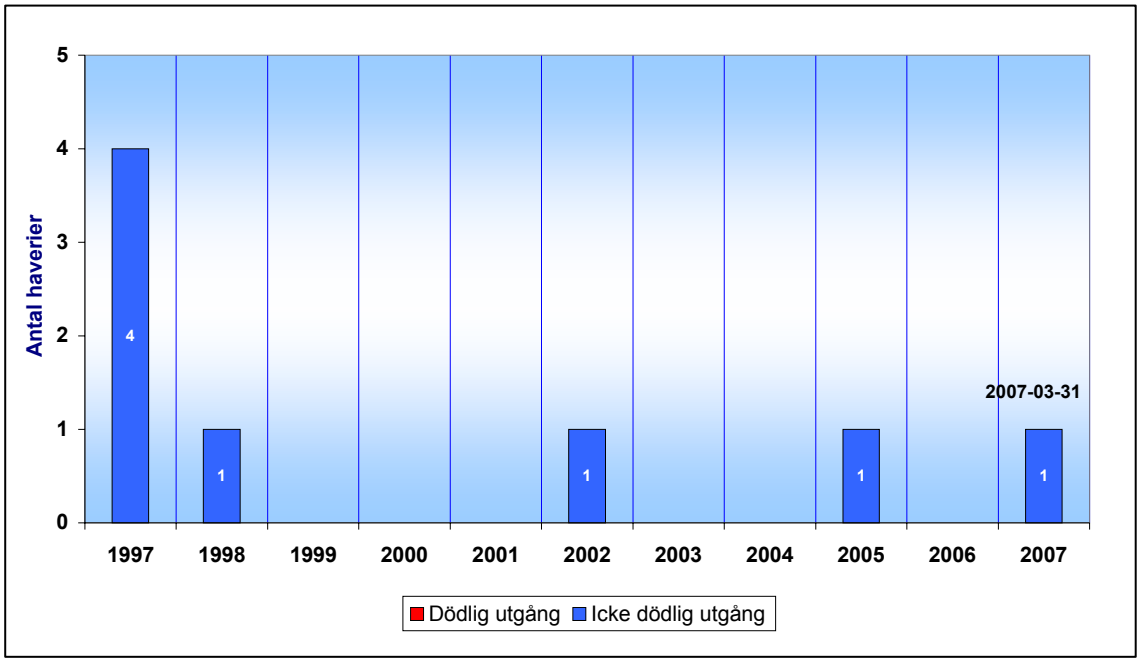
Haverifrekvensens medelvärde för segelflyg över 10-årsperioden 1997–2006 är 33,49 haverier per 100 000 timmar. Säkerhetsutvecklingen över 10-årsperioden uppvisar en negativ trend. Dock har haverifrekvensen minskat sedan 2004.



5.9.3 Ballong

Staplarna i diagrammet visar antal rapporterade haverier mellan 1996-01-01 och 2006-12-31. Under 2006 inträffade det inget haveri inom ballongflyget. Det senaste haveriet med dödlig utgång inträffade 1996.

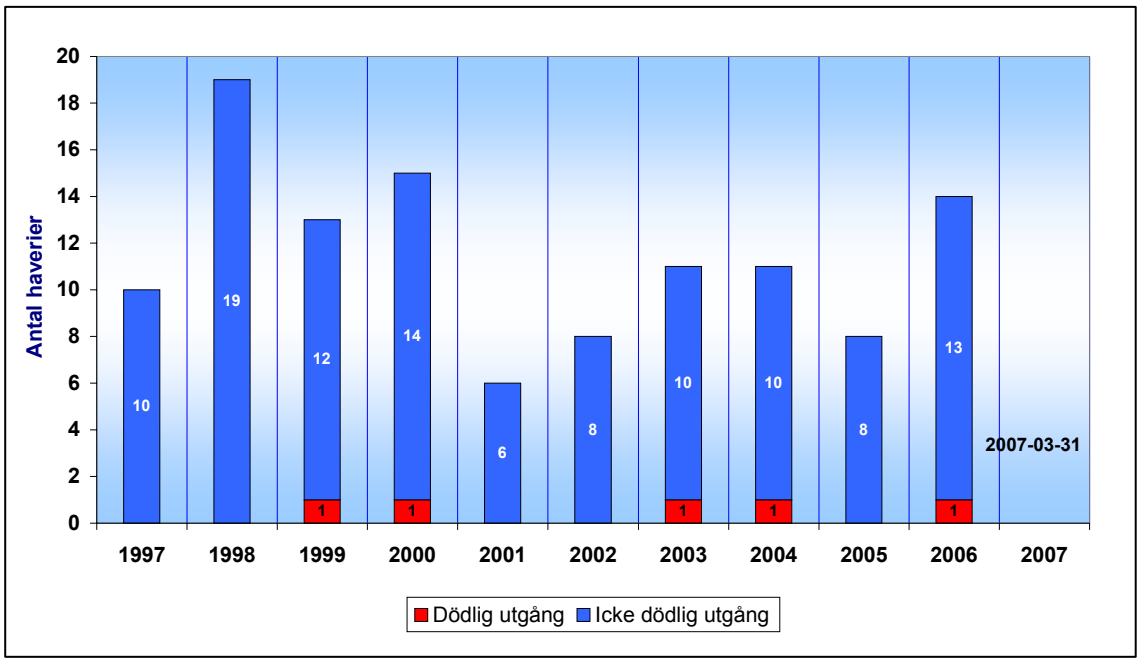
Eftersom produktionsdata saknas visas ej haverifrekvensen.



5.9.4 Skärmflyg

Staplarna i diagrammet visar antal rapporterade haverier mellan 1997-01-01 och 2006-12-31. Det senaste haveriet med dödlig utgång inträffade den 27 juni 2006 i Österrike. Sedan 2004 har haverier inom skärmflyget uppvisat en ökad trend.

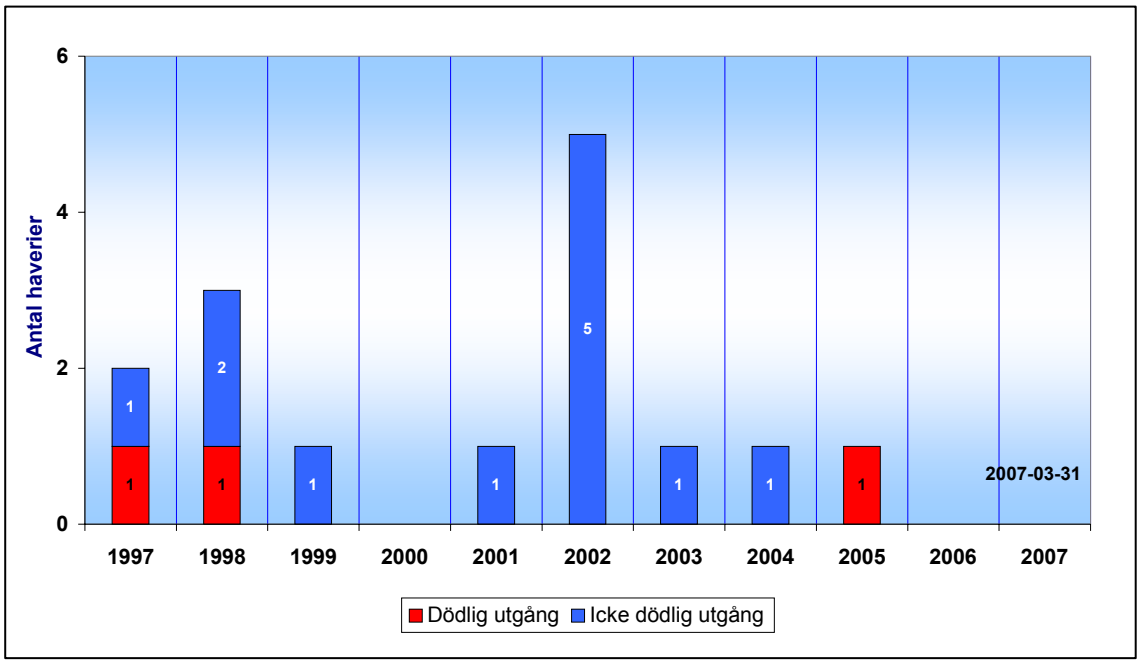
Eftersom produktionsdata saknas visas ej haverifrekvensen.



5.9.5 Hängflyg

Staplarna i diagrammet visar antal rapporterade haverier mellan 2001-01-01 och 2006-12-31. Haveriet med dödlig utgång 2005 skedde direkt efter start under utbildning. Inget haveri inträffade 2006.

Eftersom produktionsdata saknas visas ej haverifrekvensen.



5.10 Information om haverier under kvartal ett 2007

Under kvartal ett 2007 har sex haverier registrerats.

Kortfattade redogörelser över haverier som har inträffat under perioden

Date	2007-01-06
Location of occ.	Hosjön/Rättvik
Operation type	Sport - Segelflyg
Model	Scheibe SF 25C Falke
Narrative	Scheibe SF 25C Falke - The aircraft departed a frozen lake with frost-covered wings. During initial climb at 200 feet, the engine partly lost power and the aircraft started a descend and collided hard with the ground. Substantial damage occurred to the aircraft. The pilot who was serious injured. The pilot was not a holder of a valid Pilot License since 5 years and the case is transferred to the public prosecution authority.

Utreds av KSAK Segel efter delegering av SHK

Date	2007-01-07
Location of occ.	Abfaltersbach
Operation type	Sport - Ballong
Model	Thunder Colt 105A
Narrative	Colt Balloon - During approach for landing, the pilot observed a ground speed of 15 knots. The balloon was over a large and flat field at 5-10 meters. The wind/track of the balloon was towards an electrified railway and beyond that a major electric power line. The pilot decided to land immediately and briefed his two passengers about a possible rough landing. After touch down, the balloon basket trailed on the ground about 100 meters. The balloon pilot and one passenger suffered light injuries

Utreds av utländsk myndighet

Date	2007-02-16
Location of occ.	Ängelholm
Operation type	Privatflyg - flygplan
Model	Rockwell Commander
Narrative	Rockwell Commander 112B - The pilot was training take-off and landings. After having trained 3 power-assisted landings he changed to power-off landings. During the third power-off landing the pilot failed to extend the landing-gear. The aircraft skidded 125 meters on its belly and was partly damaged. The pilot - sole occupant onboard received no injury. The pilot described a more demanding flying during a power-off landing with a sink rate of 1500feet/minute and focus on the landing spot. In the process he lost focus on the check-list reading. The pilot also stated that the acoustic "landing gear warning signal" in the aircraft sometimes was activated when it not should, thus creating a "false warning" environment.

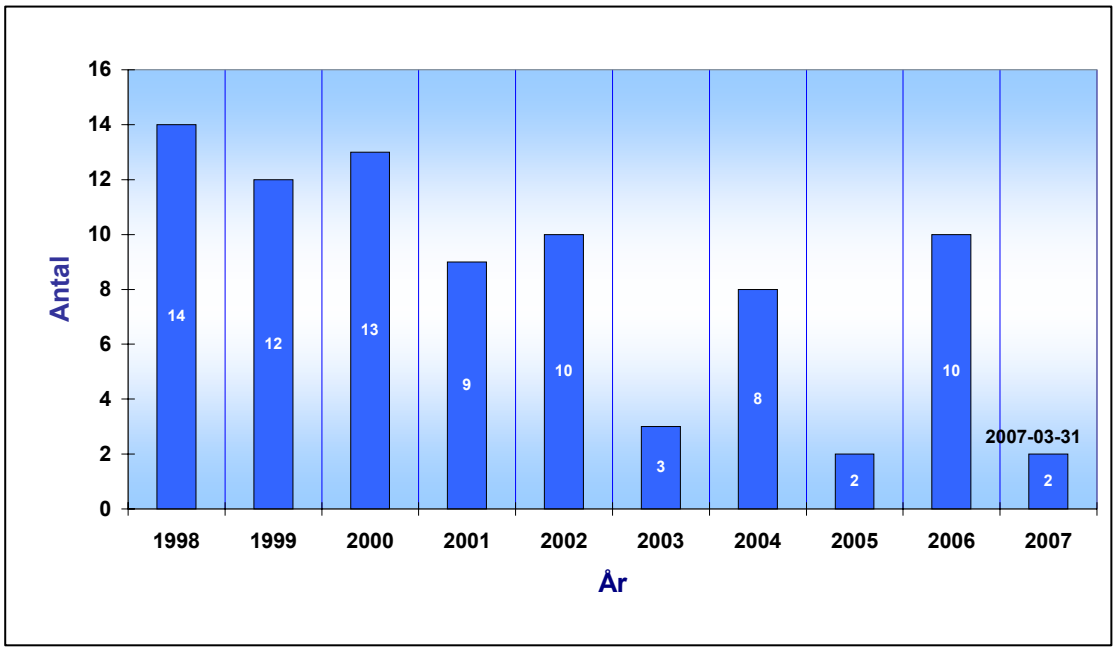
Date	2007-03-14
Location of occ.	Löttinge Täby
Operation type	Sport - Ultralätt
Model	WT-9 Dynamic
Narrative	Aerospool WT-9 Dynamic UL - The aircraft was used for type training with one instructor and one student onboard. Stall training was carried out at an altitude of 2000 feet MSL. For some reason, loss of control occurred and the aircraft was observed to enter a flat spin. The pilots failed to recover and the aircraft collided with the ground. The instructor was serious injured and the student received minor injuries.

Date	2007-03-22
Location of occ.	Broby Säteri
Operation type	Privatflyg - Helikopter
Model	Eurocopter SA 342J
Narrative	Eurocopter SA 342J - The Helicopter was on a short local flight. Onboard was the pilot and one passenger. They were both Italian citizens and had just bought the helicopter. A sudden loss of engine power occurred and an auto-rotation was initiated. The pilot failed to arrest the high sink rate and the helicopter made a very hard landing, tilted over and was totally destroyed. The two onboard received only minor injuries.
Utreds av SHK	

Date	2007-03-25
Location of occ.	Ängelholm
Operation type	Privatflyg - flygplan
Model	Piper PA34 Seneca
Narrative	Piper PA34 - ESTA - Training flight with instructor and one student onboard. Single engine approach and landing was trained. The student made a normal approach towards final but failed to extend the landing gear at the normal point. The landing gear warning horn sound was weak and hard to hear with headset on. The instructor - who was occupied with the com-radio and look out for other traffic - noticed the mistake during the landing flare, but too late. The aircraft landed on its belly. Damage occurred on the propellers, some antennas and a footstep. There was minor fuselage damage.

6 ALLVARLIGA TILLBUD (SERIOUS INCIDENTS) ICAO ANNEX 13

Staplarna i diagrammet visar antal rapporterade händelser som har klassats som allvarliga tillbud mellan 1998-01-01 och 2007-03-31.



6.1 Information om allvarliga tillbud under kvartal ett 2007

Under kvartal ett 2007 har två allvarliga tillbud rapporterats.

Kortfattade redogörelser

Date	2007-02-27
Location of occ.	Luleå
Operation type	Commercial Air Transport
Model	Boeing 737
Narrative	B736 - Take-off - The aircraft was cleared for taxi and take-off from runway 14 but took off from runway 32. Low visibility made it impossible for the ATCO to see the aircraft and prevent the incident, and there was no ground movement surveillance equipment available.

Utreds av SHK

Forts.

Date	2007-03-23
Location of occ.	ESSB - ZZZZ
Operation type	Commercial Air Transport
Model	BAe RJ100
Narrative	BAe RJ100 - During climb, passing approximately 10000 feet, avionic fan off warning was issued. The climb was continued. In the cabin passenger oxygen masks dropped. The cabin altitude indicated between 10-20000 feet. Cabin altitude warning was not issued. Emergency descent was performed and the pack switches were found to be in off position. At FL80 packs were selected and the flight continued to destination.

Utreds av SHK

7 STÖRNINGSRAPPORTER (OCCURRENCE REPORTS)

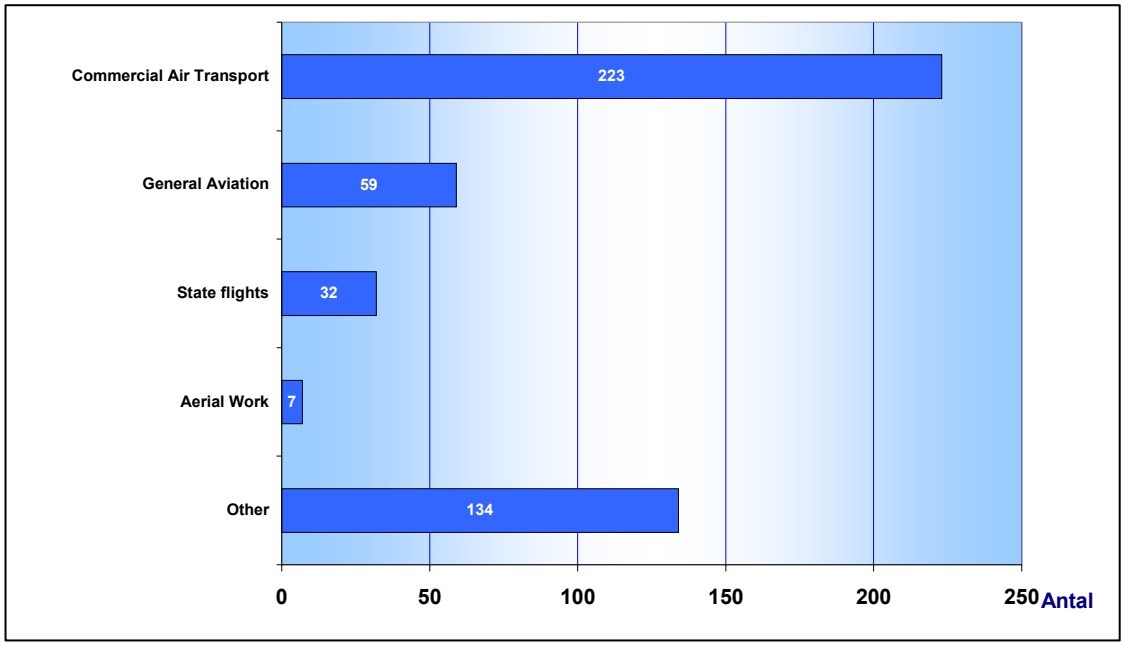
7.1 Störningsrapporter fördelade på typ av rapport

Under kvartal ett 2007 har 449 störningar rapporteras.

	2007	
	Kvartal 1	Ackumulerat
ANS-rapporter	288	228
Operativa rapporter	131	131
Flygplatsrapporter	25	25
Tekniska rapporter	25	25
Viltrapporter	7	7
Övrigt	3	3

7.2 Störningsrapporter fördelade på verksamhetsform

Diagrammet visar störningsrapporternas fördelning på verksamhetsform under kvartal ett 2007.



8 FLYGPLANBURET KOLLISIONSVARNINGSSYSTEM UR FUNKTION

Den 29 september 2006, kolliderade I Brasilianskt luftrum en B737-800 med en Embraer Legacy 600 Business Jet.

Utredningen pågår för närvarande men preliminära fakta pekar mot att förlust av ett flygplans kollisionsvarningssystem kan ha varit en kritisk faktor I händelseförloppet.

Kollisionsvarningssystemet består av transponder och TCAS med tillhörande varningssystem I cockpit.

Efter rekommendationer från **NTSB, USA** har **Eurocontrol´s** "Safety Alert Board" publicerat ett "**Safety Warning Message**"

Luftfartsstyrelsen återger här:

Från **Eurocontrol:** "Safety Warning Message"

Från **"National Transportation Board" NTSB**: "Safety Recommendation" med beskrivning av kollisionen I Brasilien.

Safety Warning Message

- *Safety Subject:* **Loss of functionality of aircraft's collision avoidance system**
- *Origin:* **United States National Transportation Safety Board**
- *Date:* **04/05/2007**
- *Distribution:* **Aviation Safety Professionals**

BACKGROUND INFORMATION FROM NTSB

- A mid-air collision occurred in Brazil on 29 September 2006 in between a Boeing 737-800 and Embraer Legacy 600 business jet.
- The investigation of this accident is ongoing. However, preliminary findings suggest that a critical safety issue exists regarding the loss of functionality of an aircraft's collision avoidance system (comprising a transponder and TCAS) and associated cockpit warnings to flight crews.
- For a TCAS II equipped aircraft to provide a flight crew with collision avoidance information, the TCAS II unit and the transponder must be turned on, and the transponder cannot be selected to the STANDBY mode.
- If the transponder is not turned on and is not responding to interrogations, the aircraft's TCAS cannot display information about potentially conflicting aircraft nearby nor can it provide instructions to the crew to resolve impending collision threats. Also, the aircraft will be invisible to TCAS II units of other aircraft in the vicinity. In addition, as the aircraft will not be tracked by ground-based secondary surveillance radars, it will be invisible to ATC.
- In many aircraft types, the only notification the pilots are likely to receive regarding the loss of TCAS functionality is a small, static text message on the pilots' flight display that reads "TCAS OFF" (or similar). In the event of a TCAS failure, the warning "TCAS FAIL" would illuminate; the type of text message will vary depending on the reasons for the loss of function.
- Static text messages to indicate a loss of collision avoidance system functionality is not a reliable means to capture pilots' attention because these visual warnings can be easily overlooked if pilots' attention is directed elsewhere in the flight environment.
- Until this problem is systematically addressed by the manufacturers and airworthiness authorities, pilots' attention is drawn to the lack of a conspicuous warning to indicate the loss of collision protection resulting from a compromise in functionality of either the transponder or TCAS unit.

NTSB RECOMMENDED ACTIONS

- All pilots who use transponders or transponder/TCAS units should ensure that they are familiar with the means currently used to indicate failure or lack of active functionality of these components.

EURCONTROL MODE S & ACAS PROGRAMME ADVICE

- The relevant displays/indicators should be routinely scanned during the flight to monitor continued operation of transponder and TCAS.
- In a case when a failure message is detected, the crew should verify if the failure condition is still present if the second transponder is selected and, then follow the appropriate trouble-shooting procedures. As necessary, further action should be taken to initiate engineering rectification action.

REFERENCE

- United States National Transportation Safety Board Safety Recommendation A-07-35 through 37 of 2 May 2007.

YOUR SUPPORT IS REQUIRED

- Note the subject and investigate the relevance for your operational environment.

DISCLAIMER

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: May 2, 2007

In reply refer to: A-07-35 through -37

Honorable Marion C. Blakey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On September 29, 2006, about 1657 Brasilia standard time,[1] a Boeing 737-800 (PR-GTD) operated by Gol Airlines of Brazil and an Embraer Legacy 600 business jet (N600XL) owned and operated by Excelaire of Long Island, New York, collided in flight over the Amazon jungle approximately 100 nautical miles (nm)[2] southeast of Cachimbo Air Base, Brazil. The Boeing 737 was destroyed by in-flight breakup and impact forces; all 154 occupants were killed. The Embraer Legacy sustained damage to the left wing and left horizontal stabilizer, and the flight crew subsequently performed an emergency landing at Cachimbo Air Base. The two crew members and five passengers were not injured, and there was no further damage to the airplane. The Boeing 737 was operating as a scheduled domestic air carrier flight on an instrument flight rules (IFR) flight plan; the Embraer Legacy was operating under 14 *Code of Federal Regulations* (CFR) Part 91 and was also on an IFR flight plan. Visual meteorological conditions prevailed in the area at the time of the accident.

The investigation[3] of this accident is ongoing; however, preliminary findings suggest that a critical safety issue exists regarding the loss of functionality of an aircraft's collision avoidance system (comprising a transponder[4] and a traffic alert and collision avoidance system [TCAS][5])

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[1] Unless otherwise indicated, all times are Brasilia standard time, based on a 24-hour clock.

[2] Unless otherwise indicated, all distances are nautical miles.

[3] The investigation of this accident is being conducted by the Brazilian Aeronautical Accident Prevention and Investigation Center. Under the provisions of Annex 13 to the Convention on International Civil Aviation, the National Transportation Safety Board is participating in the investigation as a representative for the State of Registry and Operator of the Excelaire-operated Embraer Legacy airplane and the State of Manufacture of the Boeing 737 and the avionics equipment in both airplanes.

[4] A transponder reports a unique code that aids in radar identification and provides an accurate indication of an airplane's altitude. Currently, three types of transponders are used in aircraft: modes A, C, and S. Mode A transponders provide an enhanced radar return with a discrete beacon code to ground-based radars, mode C transponders provide enhanced radar returns with a discrete beacon code and encoded altitude data to ground-based radars, and mode S transponders provide the same functions as a mode C transponder in addition to incorporating a unique digital address for each mode S transponder and an air-to-air digital data link capability that allows mode S transponders on two aircraft to communicate with each other.

[5] TCAS is anticollision equipment that is required by Federal Aviation Regulations to be installed on all turbine-powered airplanes of more than 33,000 pounds maximum certificated takeoff weight operating under 14 CFR Parts 121, 125, and 129 and on all airplanes with 10 to 30 seats that are operated under Parts 121, 129, and

and resulting cockpit warnings to flight crews. Flight data recorder (FDR) and cockpit voice recorder (CVR) information from both airplanes revealed no indication of any TCAS alert on board either airplane (both airplanes were equipped with mode S transponders and TCAS II[6] computer units), no evidence of pre-collision visual acquisition by either flight crew, and no evidence of evasive action by either crew.

Background

The Boeing 737 departed Eduardo Gomes International Airport in Manaus, Brazil, about 1535 en route to Presidente Juscelino Kubitschek International Airport, Brasilia, Brazil. The flight plan filed requested flight level (FL) 370, or approximately 37,000 feet above sea level, as a cruise altitude and a routing via airway UZ6 to Brasilia VOR[7] (BRS). The airplane was cleared as filed, and there were no anomalies in communication with or radar surveillance of the Boeing 737 throughout the flight.

The Embraer Legacy, on its delivery flight from the Embraer factory to Excelaire's base in New York, departed Professor Urbano Ernesto Stumpf Airport, São Josè dos Campos, Brazil, about 1451 with a planned stopover in Manaus. The filed flight plan included a routing via airway UW2 to BRS then via airway UZ6 to Manaus. After takeoff, the Legacy was issued a number of interim altitudes during climb, the last of which was to the initial cruise altitude of FL370.

About 1551, the Legacy flight crew performed a routine frequency change to air traffic control (ATC) at a point just south of Brasilia. Radar and radio communications indicate that the airplane was level at FL370 about this time. ATC acknowledged and instructed the crew to "ident," or provide an enhanced radar return from its transponder. ATC radar data indicates that the Legacy's transponder return was observed. At this time, the airplane was approximately 40 nm south of BRS. This was the last radio communication between the Legacy crew and ATC. About 1556, the Legacy passed BRS, continuing level at FL370. There is no record of a request from the Legacy crew, nor instruction from ATC, to change the cruise altitude. About 1602, when the airplane was about 30 nm north-northwest of BRS, the transponder return from the Legacy airplane was no longer observed on ATC radar and remained undetected by ATC radar until shortly after the collision. According to ATC radar data, other aircraft in the vicinity produced normal transponder returns.

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135. In addition, aircraft operating under 14 CFR Part 91 Subpart K (fractional ownership programs) are also required to have TCAS. Title 14 CFR 91.221 requires that all aircraft with a TCAS installed have the system on and operating.

[6] Two versions of TCAS are currently in use: TCAS I (required on aircraft with 10 to 30 seats) detects nearby aircraft and provides flight crews with traffic advisories (TA); TCAS II (required on aircraft with more than 30 seats) provides TAs and, if nearby aircraft present a collision threat, issues resolution advisories (RA), which instruct pilots to climb or descend to avoid potential collision with another aircraft. Aircraft equipped with TCAS II also require at least one mode S transponder to provide the data communications needed to coordinate RAs with nearby aircraft.

[7] VOR stands for very high frequency omnidirectional radio range.

About 1626, ATC attempted to contact the Legacy flight crew without success and continued trying to establish contact until about 1653. Beginning about 1648, the Legacy flight crew also made several unsuccessful attempts to contact ATC. Data from the FDR indicated that the Legacy crew did not perform any abnormal maneuvers during the flight. FDR information indicates that the airplane was level at FL370, on course along airway UZ6, and at a steady speed until the collision with the Boeing 737 at a point about 460 nm north-northwest of BRS, on airway UZ6.

CVR data from the Legacy airplane indicate that, during the crew's emergency descent to Cachimbo Air Base, the crew made a series of comments related to whether or not the TCAS was on.[8] ATC radar data indicate that the transponder return for the airplane was again visible to ATC radar less than 30 seconds after these comments. About 2 minutes later, the crew made a comment related to setting the transponder to the emergency code (7700); ATC radar subsequently indicated the emergency code.

Discussion

Preliminary findings in the ongoing investigation indicate that, for reasons yet to be determined, the collision avoidance system in the Legacy airplane was not functioning at the time of the accident, thereby disabling the system's ability to detect and be detected by conflicting traffic. In addition, CVR data indicate that the flight crew was unaware that the collision avoidance system was not functioning until after the accident.

For a TCAS-equipped aircraft to provide a flight crew with collision avoidance information, the TCAS unit and the transponder must be turned on, and the transponder cannot be selected to the STANDBY mode (that is, powered but not transmitting data).[9] If the transponder is not turned on and responding to interrogations, the aircraft's TCAS cannot display information about potentially conflicting aircraft nearby nor can it provide instructions to the crew to resolve impending collision threats. Failures of the TCAS computer unit itself can also occur; however, these failures only affect the TCAS-equipped aircraft's ability to detect nearby aircraft. The aircraft containing the inoperative TCAS unit remains visible to other aircraft as long as its transponder remains operative. The consequences of a TCAS unit failure are magnified, however, when the transponder is inoperative[10] because not only is TCAS information lost on the affected aircraft, but also that aircraft will not be visible to other airborne

[8] According to the collision avoidance system logic, the accident flight crew should have received a white "TCAS OFF" warning on the flight display while the transponder was set to STANDBY. About 2 minutes after impact (at 1959:13.5), the first officer questioned whether TCAS was on, the captain confirmed it was not and, immediately afterwards, the transponder signal returned to ATC radar returns. Therefore, there is evidence that the flight display warning was available to the crew but not noticed and acted upon until after impact.

[9] TCAS-equipped aircraft interrogate transponders in nearby aircraft to determine the relative position of these aircraft and determine whether they are a potential collision hazard. If the transponder is not on or is on but selected to the STANDBY mode, it will not respond to TCAS interrogations and the aircraft in which it is installed cannot be detected by TCAS nor will the aircraft be visible to ground-based radar interrogation.

[10] Despite the multiple reasons that a transponder would not respond to interrogations (including a failure of the transponder, the flight crew's failure to turn the transponder on, or an inadvertent deactivation of the transponder), the functional consequence to the collision avoidance system is the same and the affected aircraft will not be visible to other airborne collision avoidance systems or ground-based air traffic controllers.

collision avoidance systems. Regardless of whether the transponder has failed or the TCAS has become inoperative, a flight crew's ability to mitigate the risk of collision is significantly degraded if the collision avoidance system becomes inoperative and the failure is not quickly and reliably brought to the crew's attention, as this accident demonstrates.

In the Legacy airplane involved in the accident, the only notification the pilots likely received regarding the loss of TCAS functionality was a small, static text message on the pilots' flight display[11] that read "TCAS OFF" in white lettering. In the event of a TCAS failure, the warning "TCAS FAIL" would illuminate in amber; the type of text message varies depending on the reasons for the loss of function. Loss of transponder functionality is indicated by a small message on the radio management unit that reads "ATC FAIL" or "STANDBY." In the event of loss of transponder functionality, the "TCAS OFF" or "TCAS FAIL" message will also be displayed (again, depending on the reasons for the loss of function). The collision avoidance system does not require pilots to acknowledge or cancel these warnings. National Transportation Safety Board investigators' preliminary survey of a number of transport-category aircraft found that annunciations of TCAS and transponder failure were consistent with those used on the Legacy airplane.

Using only static text messages to indicate a loss of collision avoidance system functionality is not a reliable means to capture pilots' attention because these visual warnings can be easily overlooked if pilots' attention is directed elsewhere in the flight environment. The Safety Board notes that the notifications for other critical aircraft system failures that could result in catastrophic consequences generally use both aural alerts and conspicuous visual alerts, such as the use of a salient color (which can help draw a pilot's attention to a significant abnormal situation)[12] and perceptible movement (provided by a flashing light or text message). These warnings also require the flight crew to acknowledge that the annunciation has been detected. Because the silent and static annunciation accompanying loss of the collision avoidance system on most airplane types can be easy to miss, the Safety Board is concerned that pilots may not be quickly alerted or aware that the TCAS and/or transponder are not functioning, leading to their aircraft not being detectable to other TCAS-equipped aircraft and a potential accident. Although loss of a transponder during IFR operations can be detected by ATC, in many circumstances, this is not a reliable method to ensure the integrity of the collision avoidance system because of normal limitations in radar or communication coverage.[13]

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[11] In the accident Legacy airplane, if a separate TCAS display (a box covering approximately 1/3 of the display) is being presented on the multifunction display, a similar small text message will also be displayed in this box. Use of the TCAS display box is at crew discretion, and FDR data for the Legacy indicates that it was not being displayed at the time of the accident.

[12] Title 14 CFR 23.1322 requires that cockpit warning lights be colored red to indicate a hazard that may require immediate corrective action and amber to indicate the possible need for future corrective action. In the Legacy accident airplane, the "TCAS OFF" warning appears in white lettering.

[13] For example, radar coverage is typically limited in remote areas, below certain altitudes, in oceanic airspace, and especially near nontowered fields. In addition, verbal warnings may not be timely because they depend on a controller noting and properly assessing the situation before making a two-way radio transmission, which is subject to coverage limitations, blocking, misunderstanding, etc.

Federal Aviation Regulations require that all aircraft equipped with TCAS must have the TCAS unit operational, thereby helping to ensure that the safety benefits these systems provide in mitigating the risk of midair collision are realized. However, it is also imperative that when a failure of these systems occurs that flight crew attention is rapidly captured so that actions can be taken to mitigate this failure. The Safety Board is aware that the Federal Aviation Administration (FAA) and avionics manufacturers are currently planning new designs for collision avoidance systems that will provide increased functionality compared to the current systems and will enhance safety once they are incorporated. The Board is concerned, however, that, similar to the current systems, the new system designs will lack an aural alert that quickly notifies flight crews in the event that collision avoidance system functionality is lost. Therefore, the Safety Board believes that the FAA should require, for all aircraft required to have TCAS installed and for existing and future system designs,[14] that the airborne loss of collision avoidance system functionality, for any reason, provide an enhanced aural and visual warning requiring pilot acknowledgment. This is an important consideration for the development of runway incursion collision avoidance systems, as well. Without aural and visual warning requiring pilot acknowledgement, there would be a loss of runway incursion avoidance system functionality if a system on an individual aircraft were to fail or be inadvertently turned off. Therefore, the Board believes that the FAA should evaluate the feasibility of providing enhanced aural and visual warnings for future systems that may provide ground collision avoidance functionality. If feasible, require that future design criteria include such warning functionality.

Until such upgrades in warning systems can be implemented, all pilots who use transponders and TCAS units can benefit from a greater awareness of issues regarding pilot verification and monitoring of transponder and TCAS status. This consideration applies not only to pilots with TCAS units but also to the large population of general aviation pilots without TCAS units who, through a failure to activate a transponder in flight, could inadvertently compromise collision protection and violate regulatory flight requirements in congested airspace. Therefore, the Safety Board believes that the FAA should (a) inform all pilots who use transponders or transponder/TCAS units about the circumstances of this accident and the lack of a conspicuous warning to indicate the loss of collision protection resulting from a compromise in functionality of either the transponder or TCAS unit and (b) ask all pilots who use transponders or transponder/TCAS units to become familiar with the annunciations currently used to indicate failure or lack of active functionality of these components.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Require, for all aircraft required to have a traffic alert and collision avoidance system installed and for existing and future system designs, that the airborne loss of collision avoidance system functionality, for any reason, provide an enhanced aural and visual warning requiring pilot acknowledgment. (A-07-35)

[14] The Safety Board acknowledges that for TCAS-equipped aircraft, warnings concerning the loss of transponder function on the ground would be useful for ground collision avoidance systems based on transponder output.

Evaluate the feasibility of providing enhanced aural and visual warnings for future systems that may provide ground collision avoidance functionality. If feasible, require that future design criteria include such warning functionality. (A-07-36)

Inform all pilots who use transponders or transponder/traffic alert and collision avoidance system (TCAS) units about the circumstances of this accident and the lack of a conspicuous warning to indicate the loss of collision protection resulting from a compromise in functionality of either the transponder or TCAS unit and ask all pilots who use transponders or transponder/TCAS units to become familiar with the annunciations currently used to indicate failure or lack of active functionality of these components. (A-07-37)

Chairman ROSENKER, Vice Chairman SUMWALT, and Members HERSMAN, HIGGINS, and CHEALANDER concurred with these recommendations.

[*Original Signed*]

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