# Swiss Transportation Safety Investigation Board STSB
# Annual Report 2018


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**Swiss Transportation Safety Investigation Board STSB**

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# 1 Editorial

The investigations into the tragic crash of the commercially operated Junkers Ju 52 vintage aircraft on 4 August 2018 at Piz Segnas, which claimed 20 lives, had a major impact on the work of the Swiss Transportation Safety Investigation Board (STSB) in the year under review, tying up many resources. Fortunately, major accidents of this type are not everyday occurrences for the STSB. We were all the more appreciative of the fact that, for this mission, we could rely on the cooperation of the federal, cantonal and municipal emergency forces involved, which had been documented in concepts and tested in exercises. The investigations into this accident are not yet complete, but, on the basis of an interim report by the STSB, have already led to preventive measures at authorities and airlines. This is the purpose of the STSB's work.

It is not only this individual case that is creating a lot of work for us, but also the general trend over the last few years. In 2018, a total of 1,860 notifications of accidents and serious incidents were received by the Investigation Bureau of the Swiss Transportation Safety Investigation Board and assessed for whether they required investigation. While the number of notifications from railways, cableways, public bus operations and inland and maritime navigation has remained more or less stable over the years, the number of notifications from aviation has increased steadily over the last six years, in 2018 alone by 14 % year-on-year. This trend is accompanied by an increase in both the number of STSB safety investigations opened and the number of safety investigations pending. New developments, such as the increased use of drones, are also contributing to this. This is a challenge all those involved in the safety infrastructure are facing and for which solutions are being sought.

*Pieter Zeilstra*
*President of the extra-parliamentary board*

# 2 Management summary


A total of 1860 incidents were reported to the STSB in 2018, with aviation recording an increase of 14 % year-on-year. In public transport, the number of notifications was around the longterm average. An analysis of these notifications led to 133 safety investigations being opened. The tragic accident involving the Junkers Ju 52 on 4 August 2018, which claimed 20 lives, certainly had a formative impact on aviation. The STSB has already published an interim report on this accident, but the investigations into the course of events and the causes have not yet been completed. In the case of the railways, investigations of incidents that took place in the year under review have shown that the development of the international legal basis has created a complex landscape of responsibilities involving numerous players. This complexity will pose new challenges for our investigations, in particular in terms of identifying safety deficits and the corresponding safety recommendations.

The Investigation Bureau as a whole completed 115 investigations into accidents and serious incidents. These included 69 summary investigations into incidents of lesser significance. We published 35 final reports and 70 summary reports. As part of its investigations, the STSB issued a total of 15 safety recommendations and 17 pieces of safety advice during 2018.

In the year under review, fewer accidents but significantly more serious incidents were reported in aviation compared with 2017. At 119, the number of investigations opened was higher than in any other year since 2006. At 36, the number of persons fatally injured in accidents was also the highest of the 2006 to 2018 time series. However, this figure is outweighed by the Ju 52 accident, in which alone 20 people died. Without this accident, the number of fatalities would have been slightly lower than in the previous year, at 16.

The number of accidents reported in public transport increased from 156 to 177 year-on-year. This increase is primarily due to the significantly higher number of bus accidents compared to 2017. The number of accidents in the other modes of transport was slightly lower or comparable with the previous year. The number of people killed remained roughly the same across all modes of transport, excluding trams, where the figure of 7 fatalities was the highest since 2012. The number of seriously injured persons in public transport fell from 135 to 116 year-on-year.

# 3 Organisation

## 3.1 Personnel

With the appointment of the Investigation Bureau's new Director in the summer of 2018, the management structure was improved and tasks and responsibilities were unbundled. This should ultimately lead to a reduction in the workload of the Heads of Division and investigators.

Before being appointed Director of the Investigation Bureau, Tobias Schaller worked at the Federal Office of Transport (FOT) for 12 years. During this time, he worked in environmental safety (incidents, transport of dangerous goods, water protection) and headed up the Scientific Bases section (operational risk management, tunnel safety, interoperability). He studied surveying and cultural technology at the Federal Institute of Technology (ETH) Zurich, obtaining a doctorate in environmental sciences.

Increasing the workload of the technical investigator has improved the preconditions for operating the flight data and tachograph laboratory (FFL) professionally. In addition, the technical investigator can offer the other investigators increased support in individual investigative work. The number and workload of the other investigators remained unchanged in the year under review. Eight new experts have been appointed as part-time investigators and 5 have left, taking their total number to 120.

An important prerequisite for the quality of incident investigations is the competence of the investigators. It is important that their knowledge covers not only changes in the legal framework or developments in operational and technical areas, but also topics such as occupational safety at accident sites and the psychological processing of stressful situations. In the year under review, investigators and part-time investigators employed at accident scenes attended a basic course in psychological emergency care. Basic training in occupational safety and a refresher course were also provided for working at accident sites.

Employees from both the aviation and railways/ships divisions have taken part in several specific staff and operational exercises on accidents. Staff from the Investigation Bureau have given lectures at various training and prevention events (police forces, fire brigades, emergency services at airports). The international network was also cultivated through participation in several meetings and professional development courses.

## 3.2 Finances

In the year under review, the Swiss Transportation Safety Investigation Board had a budget of almost CHF 8.1 million at its disposal. The major accident involving the Junkers Ju 52 on 4 August at Piz Segnas required additional investment in laboratory equipment, special expenses for expert opinions and personnel, costs for wreck recovery, etc., which had not been included in the normal budget. For this reason, the STSB requested a supplement of CHF 1.7 million, which Parliament approved.
Of the total of CHF 9.8 million, CHF 8.0 million was actually required by the end of the year under review. The increase in the technical investigator's workload and the appointment of the Director of the Investigation Bureau led to a 6 % overrun of the personnel budget. In contrast, material and operating expenses were CHF 1.7 million less than budgeted. Some of the services rendered in connection with the Ju 52 accident in the year under review were invoiced so late that they cannot be booked until 2019. In addition, other work had to be postponed due to the accident, which led to lower expenditure on the normal budget.

As is also customary in other countries, the work of the Swiss Transportation Safety Investigation Board represents a basic service provided by the state to improve safety. The work of the STSB is therefore almost exclusively publicly funded. For example, all STSB products, in particular the final reports of investigations, are provided free of charge on the Internet. Printed and bound copies of these reports can be purchased for a fee, individually or by subscription, if required. The sale of these printed products generated a total of CHF 34 170 in 2018, which was the STSB's only regular external source of income.

## 3.3 Performance targets

On 1 January 2017, the new management model for the federal administration (NFB) was introduced; it is designed to strengthen administration management at all levels and to increase transparency and control of services. The STSB has also introduced the NFB and defined the following operational projects, guidelines and performance targets:

## Projects and initiatives

- Focus on preventive elements, especially in summary investigations and acceleration of the investigation process;
- Re-design of and training in processes for major accidents in civil aviation and public transport;
- Evaluation of the initial investigations of incidents involving Swiss maritime ships with the aim of increasing the efficiency of future investigations.

All projects were completed by the end of 2018, with the exception of the investigation of incidents involving Swiss maritime ships. Although a great deal of progress was made here, this could not be completed for various reasons, in particular capacity bottlenecks due to the Ju 52 major accident. As such, it has not yet been possible to carry out any evaluations with a view to increasing the efficiency of future investigations. With regard to focusing on preventive elements, the necessary prerequisites have been created; application and implementation will be a permanent task.

## Performance targets

| Targets and indicators | 2017 ACTUAL | 2018 TARGET | 2018 ACTUAL | 2019 PLAN |
|---|---|---|---|---|
| **Conformity assessment:** The internal guidelines and procedures are adapted to the current international guidelines | | | | |
| Annual conformity assessment procedure in aviation according to International Civil Aviation Organisation (ICAO) Annex 13, EU Regulation No. 996/2010 (yes/no) | yes | yes | yes | yes |
| **Quick completion of safety investigations:** By applying adequate measures, the STSB ensures that incident investigations are completed in a timely manner and in compliance with the law. | | | | |
| Investigations into serious incidents and accidents involving aircraft with a take-off mass of more than 5700 kg completed within 12 months (%, minimum) | 60 | 80 | 11 | 80 |
| Investigations into serious incidents and accidents involving railways, boats and buses with a federal licence completed within 12 months (%, minimum) | 78 | 80 | 20 | 75 |
| Investigations into serious incidents and accidents involving aircraft with a take-off mass of more than 5700 kg completed within 18 months (%, minimum) | 72 | 70 | 17 | 80 |
| Summary investigations into serious incidents and accidents involving aircraft completed within 2 months (%, minimum) | 40 | 70 | 30 | 70 |
| Summary investigations into serious incidents and accidents involving railways, boats and buses completed within 2 months (%, minimum) | 30 | 65 | 31 | 70 |

The targets were only partially achieved. In the case of the measurement criteria for the quick completion of safety investigations, the values achieved in 2018 are well below those of 2017 and the target values for 2018. In most cases, the time required to carry out investigations and prepare reports was longer than the set time limit and the STSB's internal requirements, albeit by only a few weeks. Other urgent work in aviation had to be carried out as a matter of priority, leading to delays in the completion of ongoing investigations:

- The major accident involving the Ju 52 on 4 August 2018 tied up a significant proportion of resources over several months.
- The number of event notifications for aviation has increased markedly (chapter 4.2, Aviation section) – by 14 % in 2018 compared to the previous year and by 60 % compared to 2013 – and has accordingly tied up more resources for preliminary enquiries. Unless these are carried out without delay, data and information relevant to the investigation cannot be collected.
- With resources remaining the same, pending cases have accumulated as a result of the sharp increase in the number of aviation events notified in recent years. Reducing these older pending cases has led to delays in preparing reports on more recent incidents.

In the railways and ships sector, the resources available in 2018 were below the actual value due to personnel changes. The period required to train new investigators to be productive is comparatively long, as this competence is in short supply in the labour market.

In 2018, in light of the preventive effect of safety investigations, i.e. publishing the findings of investigations as soon as possible, the Board decided that completion of investigations within the meaning of Article 52 of the Ordinance on the Safety Investigation of Transport Incidents (OSITI; SR 742.161) should mean the approval of the respective report and not, as before, the completion of the actual investigation work. The results for the measurement criteria for 2018 were calculated according to this guideline, in contrast to the results for 2017 and 2016. The annual values for the measurement criteria are therefore only comparable to a limited extent. As a result of tightening the financial reporting requirements, many studies already in the "prepare report" phase did not meet these requirements, which is another reason for the comparatively significant deviations from the values for 2017.

Although the target of completing safety investigations quickly was not achieved, the STSB's performance in 2018 – taking into account the major accident involving the Ju 52 – is comparable to that of previous years, as can be seen in chapter 4 below.

In 2017, the Board conducted an audit of the STSB Investigation Bureau, during which it identified requirements and options for action. On this basis, it established organisational, structural, personnel and procedural measures, which were implemented during 2018. The full effect of these measures will be seen in 2019/2020.

# 4 Investigations and results

## 4.1 Overview of the Investigation Bureau

A total of 1860 incidents, i.e. accidents and other dangerous events, were notified to the STSB during 2018. This therefore represented another significant increase in the number of notifications. Safety investigations were opened in 132 cases, i.e. for approximately 7 % of notifications.

The Investigation Bureau as a whole completed 115 investigations into accidents and serious incidents. These included 69 summary investigations into incidents of lesser significance. 35 final reports (see Annexes 1 and 2) and 70 summary reports were published in the year under review. As part of its investigations, the STSB issued a total of 15 safety recommendations and 17 pieces of safety advice during 2018. At the end of the year, 189 investigations were still in progress.

In aviation, 83 investigations concerning incidents were completed in the reporting year. 22 final reports (see Annex 1), 1 interim report and 53 summary reports were published in the same year. With regard to aviation, 7 safety recommendations and 7 safety advices were issued. At the end of the year, 156 investigations were in progress.

In the reporting year, for the 5 modes of transport (railways, cableways, buses and inland and maritime navigation), 32 investigations were completed and 13 final reports, 1 interim report and 17 summary reports were published. In 2018, a total of 8 safety recommendations and 10 safety advices were issued in final reports. At the end of the year, 33 investigations were in progress concerning railways, cableways, buses and inland and maritime navigation, including a study on natural hazards and a summary investigation into construction machinery.

## 4.2 Overview by mode of transport

### Aviation

In 2018, 1556 notifications of aviation incidents were received, which were assessed in accordance with the law. Here, additional technical aids were often used to assess the level of danger, in particular with airproxes. Based on these preliminary enquiries, a total of 33 investigations into accidents were opened and 86 investigations into serious incidents. These included 28 airproxes with a high or considerable risk of collision. An extensive investigation was opened for 22 incidents, whilst the initial investigation findings suggested a summary investigation for 97 events.

In the reporting year, there were 30 accidents on Swiss territory involving aircraft with a maximum permissible take-off mass of up to 5700 kg. With regard to aircraft with a maximum permissible take-off mass exceeding 5700 kg, investigations into 18 serious incidents were opened. This aircraft category also included an accident involving a historic airliner that claimed 20 lives. In all accidents involving aircraft, 36 occupants were killed and 3 were seriously injured.

Since 2011, the number of reported incidents has steadily increased, to a provisional maximum of 1556 in 2018 (diagram 1). As a consequence, there was an increase in the number of investigations opened during the same period, to a provisional maximum of 119 in 2018 (diagram 2).

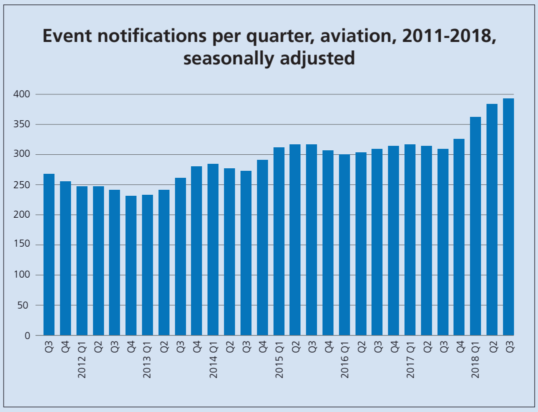



**Diagram 1:** Number of incidents reported per quarter and relevant to the aviation sector between 2011 and 2018. Seasonal effects were adjusted by means of a moving average.


**Diagram 2:** Number of investigations opened per quarter in aviation due to reported incidents. Seasonal effects were adjusted by means of a moving average.

### Public transport and maritime navigation

As diagram 3 shows, the number of incidents reported in the year under review is around the long-term average. In contrast to the aviation sector, no seasonal pattern in the number of reported incidents can be identified in public transport. In maritime navigation, only a few incidents are recorded per year. These have no impact on the statistics for total notifications.

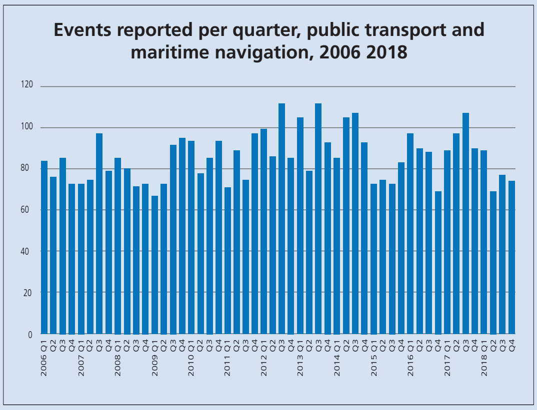



**Diagram 3:** Number of incidents reported per quarter and relevant to public transport, 2006-2018.

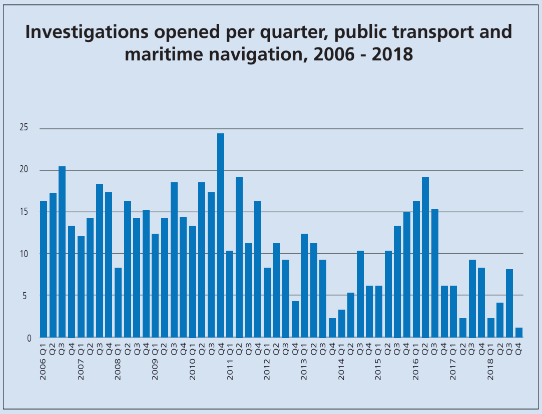



**Diagram 4:** Number of investigations opened per quarter in public transport and maritime navigation due to reported incidents.

The time series for opened investigations (diagram 4) shows no clear patterns either, except that the number of opened investigations has tended to decrease since 2006.

The figures for the individual modes of transport are shown below.

## Railways

In 2018, 270 events relevant to safety on the railways were reported, 27 of which concerned trams. In 33 cases, an investigator attended the scene. An investigation was opened in 13 cases.

The events of greater significance include, in chronological order, the collision between a passenger train and a service vehicle on 6 March in Rivaz, in which construction workers were endangered; runaway construction vehicles on 23 March in La Conversion and on 30 April in Ringlikon; the derailment of a construction service vehicle in a freight train on 15 June in Winterthur; the derailment of a tank wagon on 5 July in Eglisau; the loss of a driver's cab of a tracklaying machine while in motion on 11 July in Castione-Arbedo; the derailment of a freight train on 16 August in Basel and the hazard posed by a loose metal casing of a tank container while in motion on 19 September in Claro.

In the events reported to the STSB, 22 people sustained minor injuries and 2 were seriously injured. Three railway company employees were fatally injured, 2 were seriously injured and 17 sustained minor injuries. In the railways sector (incl. trams), another 20 people were fatally injured, 28 were seriously injured and 11 sustained minor injuries. As in recent years, the most common cause of accidents involving people is careless behaviour by individuals crossing the tracks in a manner that is not permitted or otherwise entering the clearance gauge of trains. Transport and infrastructure companies cannot usually directly influence such incidents.

## Cableways

Fourteen notifications concerning cableways were received. In none of the cases did the facts justify an investigator attending, and no investigations were initiated either.

Of the reported events, 4 passengers were seriously injured and 1 sustained minor injuries. Two employees of cableway companies suffered serious injuries. Apart from travellers and employees, no other persons suffered injuries. Most of the injuries to passengers occurred while they were entering or leaving a cableway.

## Buses

The STSB was alerted to 14 incidents concerning buses. As in the case of cableways, in none of the cases did the facts justify an investigator attending or the opening of an investigation.

Of the reported events, 4 passengers sustained minor injuries. No bus company employees were injured. In addition to the passengers, 2 other persons were fatally injured, 5 severely injured and 3 slightly injured. Six out of the 14 events related to a fire in which nobody was hurt. Most of the injuries to persons were the result of buses colliding with other road users.

## Inland navigation

In 2018, the STSB was alerted on 4 occasions. Two cases involved vessels running aground. In another case, a scheduled boat collided with a motorboat while mooring. In the fourth incident, a fault in a hydro-power plant triggered a tidal wave that caused damage to moored ships. An investigation was opened. No one was hurt.

## Maritime navigation

During 2018, 2 incidents involving maritime navigation ships sailing under the Swiss flag were reported to the STSB. In 1 case, an asphalt tanker ran aground lightly while it was being piloted out of a port. Neither the ship nor the environment was damaged. The second report concerned a yacht flying the Swiss flag on which an Emergency Position Indicating Radio Bacon (EPIRB) had been mistakenly triggered. In neither case did the situation justify the opening of a safety investigation from the point of view of preventing further incidents.

# 5 Safety recommendations and advices

## 5.1 General

In the first half of the last century, accidents in the transport sector were usually investigated by the respective supervisory authorities. However, since these may be involved in causing an accident or a hazardous situation as a result of their activity, a separation of tasks and powers has prevailed over the course of recent decades: in most countries, in addition to the supervisory authority, an independent, staterun safety investigation body also exists, which is expected to impartially clarify the reasons for an accident or a serious incident. Since the introduction of the Directive (EU) 2016/798 of the European Parliament and of the Council on railway safety, this also applies to incidents on the railways in EU countries. Because of the separation of powers, the investigation body does not itself mandate measures to improve safety but proposes such measures to the relevant authorities. Consequently, these retain their full responsibility. The safety investigation body – the STSB in Switzerland – approaches the relevant supervisory authorities by expounding a possible safety deficit and issuing corresponding safety recommendations as part of an interim or final report. It is then up to the relevant supervisory authority, together with the stakeholders concerned, to decide whether and how the safety recommendations should be implemented.

In 2003, the European Union established the European Aviation Safety Agency (EASA), whose mission is to provide uniform and binding rules on aviation safety in the European aviation sector on behalf of the member states. Since then, EASA has increasingly exercised its authority, particularly in the areas of technology, flight operation, air traffic control and aerodromes and airports. Here, the national supervisory authorities primarily play an executive and mediating role and their exclusive competence is increasingly limited solely to the nationally regulated aspects of civil aviation. Since Switzerland decided to participate in EASA, this change also applies to Swiss civil aviation. For this reason, the Swiss Transportation Safety Investigation Board addresses its safety recommendations concerning aviation to either EASA or the Federal Office of

Civil Aviation (FOCA), depending on the area of competence.

Regulation by the EU is becoming increasingly important in the area of railways. In particular, this concerns technical interoperability in international transport. The EU Safety Directive (2004/49/EC) sets only general standards, but also stipulates that each state must have an independent safety investigation body. However, full safety supervisory authority over the railways continues to reside with the national supervisory authorities for safety. Therefore, all safety recommendations in the area of railways are ad-dressed to the Federal Office of Transport (FOT), in accordance with article 48, paragraph 1 of the Ordinance on the Safety Investigation of Transport Incidents of 17 December 2014 (OSITI), as per 1 February 2015 (SR 742.161). The OSITI implements the EU Safety Directive (2004/49/EC) equivalently into Swiss law. This EU Safety Directive is part of the Annex to the agreement between the Swiss Federation and the European Union on the carriage of goods and passengers by rail and road. However, the EU revised the Safety Directive completely in 2016, such that certain enforcement responsibilities should now be assumed by the EU authorities. If Switzerland followed this development, it would be conceivable that certain recommendations from the STSB concerning the railways would also be addressed to the EU authorities in future.

Safety objectives and requirements for cableway installations and their operation are regulated by the EU Cableways Regulation (EU) 2016/424 dated 9 March 2016. Supervision and enforcement are exclusively within the remit of the national supervisory authorities, in the case of federally licensed cableways within the remit of the FOT. STSB recommendations are therefore addressed to this authority.

Regulations applying to licensed inland navigation in Switzerland are primarily national regulations. Consequently, recommendations from the STSB are addressed to the FOT as the national supervisory authority for safety.

With regard to maritime navigation, the European Union established the European Maritime Safety Agency (EMSA) in 2002. Its mission is to reduce the risk of accidents at sea, the pollution of the seas through maritime navigation and the loss of human life at sea. EMSA advises the European Commission on technical and scientific matters concerning the safety of maritime traffic and in relation to preventing the pollution of the seas by ships. It plays a part in the ongoing development and updating of legislative acts, the monitoring of their implementation and in assessing the efficacy of existing measures. However, it has no authority to issue directives over Switzerland. Any safety recommendations from the STSB are therefore addressed to the Swiss Maritime Navigation Office as the national supervisory authority.

Having received a safety recommendation, the supervisory authority informs the STSB of the measures taken which arise from the safety recommendations. If no measures have been taken, the supervisory authority justifies its decision. The measures taken by supervisory authorities in relation to safety recommendations are categorised as follows by the STSB:

– **Implemented:** Measures have been adopted which are very likely to significantly reduce or eliminate the identified safety deficit.
– **Partially implemented:** Measures have been adopted which are very likely to slightly reduce the safety deficit or eliminate it in part, or a binding implementation plan with a defined timeline is at hand and has been initiated which is very likely to lead to a significant reduction in the safety deficit.

– **Not implemented:** No measures have been adopted which have led or will lead to any noteworthy reduction in the safety deficit.

Following the introduction of the OSITI, the STSB started to issue safety advice in addition to the safety recommendations, as and when required. As stated above, safety recommendations are addressed to the relevant supervisory authorities and propose improvements which can only or, at least primarily, be brought about through stipulations from this authority or its supervisory activity. However, occasionally safety deficits also become apparent as part of an investigation that cannot be eliminated by amending rules or regulations and by direct supervisory activity, but rather by changing or improving risk awareness. In these cases, the STSB formulates safety advice which is addressed to particular stakeholders or interest groups in relation to transport. This is intended to help the people and organisations concerned to recognise a risk and provide possible approaches for sensibly dealing with it.

All of the safety recommendations and pieces of safety advice issued by the STSB in interim or final reports during 2018 are set out below. To aid understanding, these are accompanied by a brief description of both the incident concerned and the safety deficit which is to be eliminated. Each safety recommendation is followed by the implementation status as at mid-February 2019. The current implementation status of safety recommendations and further details can be found on the website of the Swiss Transportation Safety Investigation Board.

## 5.2 Aviation

**Serious incident involving a commercial aircraft descending 110 NM west-north-west of Basel, 21/11/2014**

On a scheduled flight from Newark to Zurich with an Airbus A330-343 commercial aircraft, the amber warning message CAB PR SYS 1 FAULT was displayed in the cockpit during the descent from flight level (FL) 370 to FL 310. A single chime sounded a minute later and the amber warning message CAB PR SYS 1+2 FAULT was displayed simultaneously. The flight crew put on their oxygen masks, initiated an emergency descent and informed the cabin crew. A short time later, it issued a mayday signal to air traffic control and received clearance to descend to FL 150.
The flight crew believed that the oxygen masks had been released in the cabin and worked through the corresponding procedure, which required, among other things, the cabin altitude to be controlled manually. The flight crew briefly discussed the displayed cabin altitude and judged it to be correct. About five minutes later, the captain observed that the cabin altitude was no longer displayed. Shortly before landing, the co-pilot noticed that the cabin altitude was being displayed again.

**Safety deficit**
The investigation showed that below -2,060 ft, by design, the digital display of the cabin altitude on the CAB PRESS page is replaced by amber crosses and the analogue display is blanked out. This also applies to the display of the cabin differential pressure. This circumstance was not known to the operators of the aircraft. However, it contributes to the fact that in such a case, a flight crew loses almost all ability to manually regulate cabin pressure.

**Safety recommendation no. 504, 23/10/2018**
The European Aviation Safety Agency (EASA), together with the aircraft manufacturer, should ensure that flight crews are notified in an appropriate way when the cabin altitude is below -2,060 ft.

**Implementation status**
Not implemented. In a letter dated 18 January 2019, the European Aviation Safety Agency said that it would contact the aircraft manufacturer to obtain the information required to assess the safety recommendation.

**Safety deficit**
The investigation showed that the flight crew immediately thought of a possible decompression when the two cabin pressure controllers failed and, as a consequence, con-

sidered an emergency descent, which they commenced shortly afterwards. Executing the emergency descent and processing the check list at the same time took up valuable time. During this time, the cabin altitude fell below -2,060 ft since, because the outflow valves were not opened, the cabin pressure built up to the maximum value or to the point where the safety valve responded.

**Safety advice no. 3, 23/10/2018**

Topic: Simulator training

Target group: Flight crews, training officers of flight operators, manufacturers of training equipment.

Flight operators should ensure there is broader coverage during flight simulator exercises of the topic of pressure problems so that flight crews do not continue to focus exclusively on decompression and emergency descents in the event of pressure problems.

## Accident involving a light aircraft, Zweisimmen, 27/04/2015

A simulated engine failure involving the aircraft turning at a low altitude above ground was carried out as part of an internal annual flight review that is mandatory within the flight group. The light aircraft's engine power could not be increased, leading to an accident in which the pilot and a flight instructor suffered injuries and the aircraft was destroyed.

**Safety deficit**

The investigation found that the manufacturer had published the following recommendations on the topic of turning after take-off in connection with an engine failure in the "Emergency Procedures" chapter of the Aircraft Flight Manual (AFM) of the HB-WAS:

"3.2.1.2. Engine failure during take-off

Depending on speed and flight altitude, immediately push on the stick, pay attention to gliding speed (90-100 km/h) and bring the aircraft under control normally.

When making a turn, a minimum flight altitude of approx. 80 m above ground is required after establishing the gliding attitude. Below this altitude, land straight ahead or straight ahead with small course corrections."

The engine power in the type C 42 aircraft is controlled by means of two throttles. These throttles are located centrally in front of each seat and can be folded down sideways towards the cockpit door to facilitate entry and exit. This system's design has no mechanical throttle stop in the "idle" position. When the throttle is fully pulled back, the silver screw head is about 5 mm in front of the front edge of the pilot's seat.

According to the engine manufacturer's installation manual, the throttle should have a mechanical stop on the airframe, which can be synchronised with the idle stops of both carburettors after the throttle cable has been installed. A test demonstrated that when the mechanical idling stops of the carburettors are overpulled by a few millimetres, the engine can cut out spontaneously.

**Safety advice no. 11, 27/03/2018**

Topic: Emergency procedure concerning the Comco Ikarus C 42; engine failure after take-off

Target group: Pilots and flight instructors in general aviation, manufacturers, flight schools and the Federal Office of Civil Aviation (FOCA)

The manufacturer's recommendation in the AFM stands in marked contradiction to the widely known recommendations in current teaching materials of well-known aviation organisations in Switzerland. Furthermore, the manufacturer does not specify the conditions under which such turns would ideally be feasible. In this case, a turn was initiated between 135 m and 255 m above the airfield's elevation, i.e. clearly above the minimum altitude mentioned, from which the crew was unable to reach the airfield. This shows that the relevant situational factors – such as runway, obstacles, topography, wind, mass, etc. – must be analysed before take-off in order to determine a decision height. The operators of this specific aircraft type should make their pilots aware of this issue and address the risk accordingly.

**Safety advice no. 12, 27/03/2018**

Topic: Design of the engine power control system for the Comco Ikarus C 42 aircraft

Target group: Pilots and flight instructors in general aviation, manufacturers, flight schools, maintenance providers and the Federal Office of Civil Aviation (FOCA)

There was no evidence of pre-existing technical defects that could have caused or influenced the accident. In particular, the technical examination of the engine did not find any-

thing to explain the engine failure.
It cannot be excluded that the HB-WAS crew, to correct the overly steep descent, manipulated the fuel too abruptly and the engine subsequently cut out. It should be noted, however, that this phenomenon is rarely observed with this type of engine.
The design of the system for controlling engine power in the Comco Ikarus C 42 aircraft type has no mechanical stop for the "idling" position on the cockpit side. It is therefore possible, by unconsciously pulling back the throttle to the front edge of the seat, to override the mechanical stops of the carburettors. As a result, as demonstrated in a test, the engine shuts down spontaneously. A mechanical stop in the cockpit, as deemed necessary by the engine manufacturer, would exclude this possibility..

## Serious incident involving a commercial aircraft while taxiing, Bern Airport, 07/12/2015

A Dornier DO 328-100 commercial aircraft back tracked onto runway 32 after dark to take off on runway 14, which was in operation at that time. The air traffic controller transmitted a Runway Visual Range (RVR) of 600 m to the flight crew. The captain did not see the yellow line painted on the ground where the runway ended and the runway turn pad started. This line is designed to visually guide him when changing direction by 180°. Both pilots also said that they could no longer remember noticing the red lights at the end of the runway.
When the captain noticed that he had become disorientated along the runway, he began to brake. The plane came to a standstill in the grass immediately after the runway turn pad.

### Safety deficit

The boundary of the runway turn pad consisted of blue lights. These were difficult to see when taxiing on runway 32, especially because of the bright approach lights on runway 14.

### Safety recommendation no. 532, 26/09/2018

In cooperation with the airport operator, the Federal Office of Civil Aviation (FOCA) should seek solutions that make it possible for flight crews to clearly identify the limits of the runway turn pad.

### Implementation status

Implemented. In a letter dated 6 December 2018, the Federal Office of Civil Aviation announced that yellow lines had been marked on the two turn pads at the end of summer 2017 as part of the runway restoration project. The airport operator stated that the blue edge lights had been replaced by brighter LED lights.

### Safety deficit

While taxiing on the runway, the crew decided to calculate the icing speeds in preparation for take-off. The co-pilot used the laptop taken on board for this purpose. He told the captain he would now stop looking outside. The captain continued taxiing.

### Safety advice no. 17, 26/09/2018

Topic: Taxiing in poor visibility
Target group: Flight crews, training officers of flight operators
Flight operators should make flight crews aware that when taxiing, especially in poor visibility, they need to adjust taxiing speed and keep cockpit operations to an absolute minimum. The aircraft should be stopped when work that interrupts the closed loop is being carried out.

## Serious incident involving a helicopter near Worb, 06/04/2016

During a training flight with a helicopter of type Robinson R22 Beta II, an open fire broke out in the engine near the generator. The crew managed to extinguish the fire, which was triggered by a short circuit between a retrofitted suppression capacitor and the generator connection, after landing.

### Safety deficit

Installation of an interference suppression capacitor of type LoneStar Aviation Corp. LS03-01004 in various light aircraft (e.g. Cessna C172) is allowed by a US Federal Aviation Administration approval governing the manufacture of spare and modification parts for aircraft (FAA/PMA). However, the installation instructions do not describe how the interference suppression capacitor must be mounted on the generator.
As a result, the interference suppressor capacitor can be mounted in such a way that an electrical short circuit can occur between the grounded capacitor housing and the generator connection.
In general, detailed installation instructions for FAA/PMA components that are allowed to be installed in certain aircraft types are not always available. The STSB recognises that this creates a fundamental risk that installations are carried out that may conceal a hidden or long-term potential hazard.

**Safety advice no. 18, 06/02/2018**
It should be ensured, with respect to all aircraft that have been retrofitted with an interference suppression capacitor on the generator in accordance with an FAA/PMA, that no electrical short circuit can occur between the grounded capacitor housing and the on-board electrical system.

## Airprox between a commercial aircraft and a light aircraft north-east of Friedrichshafen, 21/04/2016

On the second day of the "Aero Friedrichshafen" air show, an airprox occurred in the Echo class airspace, around 10 NM north-east of Friedrichshafen Airport at an altitude of 4000 ft above mean sea level (AMSL), between a radar-controlled commercial aircraft approaching runway 24 and a light aircraft approaching under visual flight rules from the south-east and in contact with air traffic control. The smallest proximity was 0.5 NM horizontally and 100 ft vertically.

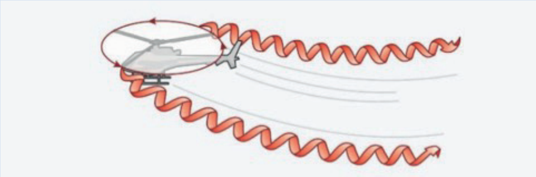
**Safety deficit**
According to the rules of the visual approach chart, which was published especially for the air show, approaches from landing direction 24 to the hard surface runway were to be made via mandatory reporting point OSCAR to the north of the airport, with the recommendation not to follow the approach corridor at higher than 4000 ft AMSL. As a result, aircraft under visual flight rules (VFR) have to cross the runway axis when approaching from the south-east. Furthermore, given the lack of flight altitude limits in the approach corridor area and outside the Friedrichshafen control zone (CTR) and with aircraft simultaneously approaching runway 24 under instrument flight rules (IFR) via a right transverse approach, an increased concentration can be expected of mixed traffic north-east of the airport.
The option to bundle VFR traffic transversely to the runway via VFR reporting points NOVEMBER and SIERRA for approach and take-off, as stipulated for normal operations, allows IFR traffic to be geographically segregated to runways 06 and 24. Similarly, because flight altitude is limited to 3000 ft AMSL, VFR traffic near the CTR is stacked vertically to IFR traffic for take-off and landing as this does not cut into the gliding path of IFR approaches below 4000 ft AMSL.
Management of the airspace structure around Friedrichshafen Airport, which is divided between various air navigation service providers (ANSPs) and into responsibilities, service obligations, rights and obligations, contains many interfaces. These make it difficult or even impossible to quickly implement practical procedures.
The STSB has therefore identified systemic risks in the operational rules and in the visual approach chart published specifically for the aviation trade fair.

**Safety recommendation no. 541, 25/09/2018**
The German Federal Supervisory Authority for Air Navigation Services (BAF), together with DFS (German air traffic control), Skyguide and Austro Control GmbH, should examine the scope for improving the operational concept during the air show.

**Implementation status**
Awaiting response.

## Serious incident involving a light aircraft in conjunction with a helicopter, Bern Airport, 12/08/2016

Shortly after take-off after a touch and go, a light aircraft of type Aero AT-3 flew into the wake turbulence of a helicopter which had flown over the runway centreline shortly before. The crew of the light aircraft only just managed to prevent a crash.



**Safety deficit**
Insufficient awareness by air traffic control and the crews of the risk of wake turbulence from a helicopter was identified as a causal factor in the occurrence of the serious incident.

**Safety recommendation no. 542, 20/09/2018**
The Federal Office of Civil Aviation (FOCA), in conjunction with flight schools and other affected stake-holders, should ensure that pilots and other persons involved in flight operations are instructed and made aware of wake turbulence from helicopters and the resulting hazards.

**Implementation status**
Partially implemented. On 10 January 2019, the FOCA published an article on its website under the headline "stay safe!". Drawing on the relevant comments from the STSB investigation report, it dealt with the topic of hazards from wake turbulence emanating from helicopters. In addition, the FOCA published safety awareness notification FOCA SAND-2019-001, which explains the topic of wake turbulence from helicopters on the basis of information from reference documents, such as the STSB's investigation report and US Air Force and US Federal Aviation Administration reports.
A solution, in direct cooperation with flight schools and other affected stakeholders, whereby pilots and other persons involved in flight operations are sensitised to wake tur-

bulence from helicopters and the resulting dangers, has not yet been sought, which is why the STSB considers the safety recommendation to have been partially implemented.

## Accident involving a tow plane, Bern-Belp, 15/07/2017

When returning from a glider tow, the tow plane's approach to the glider airfield did not allow sufficient landing distance with a preceding glider. The pilot decided to make a full circle close to the ground to increase the landing distance. During this manoeuvre, he lost control of the tow plane and it collided with the roof of a house.

### Safety deficit

The accident under investigation shows that the pilot in the accident had a misconception of the contents of the agreement concluded by the gliding club with air traffic control under the FOCA's supervision. As the investigation revealed, other pilots in the gliding club have comparable misconceptions. This gliding agreement contains a special arrangement for the provision of traffic information to aircraft involved in gliding operations. Air traffic control does not provide such aircraft with traffic information relating to each other. If another aircraft without any link to the gliding operator is in transit in the control zone, air traffic control must provide traffic information, as is usual in airspace class D. Although this regulation is theoretically quite clear, in practice pilots may have false expectations or uncertainty regarding traffic information. It should also be noted that a standard of the International Civil Aviation Organization (ICAO) regarding the rules in airspace classes has been locally suspended in this case. This eliminates the safety nets provided by ICAO, such as the provision of traffic information, which had a dangerous impact on the accident investigated here.

### Safety recommendation no. 544, 13/11/2018

The Federal Office of Civil Aviation (FOCA), together with Skyguide air navigation services and the Bern gliding club, should review the practicality of the gliding agreement and, if it is to be retained, take appropriate measures to ensure that users can handle this special arrangement simply and safely.

### Implementation status

Partially implemented. In a letter dated 19 February 2019, the Federal Office of Civil Aviation (FOCA) announced that it supported the safety recommendation, saying that since the accident, an internal analysis of gliding procedures had taken place at Bern airport and internal workshops had been held on the LB gliding sector. The FOCA shares the view that it is essential that the contents of the procedural agreement between Bern Airport, Skyguide and Bern gliding club be understood, which is why the FOCA, represented by two sections, actively participated in this year's briefing, on 9 March 2019, at the start of the Bern gliding group's season. A presentation was delivered which elaborated on the valid procedure, in particular the importance of traffic information, and the problems between the gliding group and Skyguide. And on 19 March 2019, a workshop was held at the FOCA in Ittigen on the subject of the "Gliding sector LB" with representatives from the FOCA, Skyguide, Bern Airport, the Aeroclub and Bern gliding club. The safety recommendation will also be adopted bilaterally between the FOCA and Skyguide.

### Safety deficit

As the accident investigated here shows, a go-around procedure for the pilot of a light aircraft, who could not land as planned, was not an obvious solution that he could safely implement. The general experience is that go-arounds are rarely performed. Therefore, although they are standard procedure, they are often not safely controlled or implemented.

### Safety advice no. 22, 13/11/2018

Topic: Practise take-off procedures
Target group: Pilots of light aircraft
It makes sense to practise take-off procedures regularly, for example in the context of training flights, so that this procedure can be invoked and implemented at any time in a time-critical situation in which landing does not appear a certain possibility.

### Accident at work during helicopter operations, Tesserete, 13/10/2017

While a helicopter was transporting a load, two workers in the danger area were hit and seriously injured by prefabricated building elements that tipped over under the influence of the downwash.

**Safety deficit**
Accidents caused by downwash during work and rescue flights and involving significant or fatal injuries to persons in the danger area have repeatedly been the subject of safety investigations.

**Safety recommendation no. 540, 31/07/2018**
The Federal Office of Civil Aviation (FOCA), together with SUVA (Swiss accident insurance fund) and helicopter transport companies, should take measures to increase the safety of employees and third parties during helicopter transport flights with respect to the consequences of downwash.

**Implementation status**
Partially implemented. In a letter dated 1 November 2018, the FOCA announced that, with the introduction of Part Specialised Operations (SPO) in April 2017, new Standard Operating Procedures (SOP) had been developed and approved in cooperation with the Swiss Helicopter Association (SHA) and operators. It said that SUVA had been involved in preparing the SOP with regard to "ground installations", but that the final report does not indicate whether the company had complied with the relevant SOP. From the FOCA's point of view, no further measures are needed because the contents of the safety recommendation are sufficiently covered in the SOP.

The present accident is the second one investigated by the STSB in which downwash played a direct role, even after introduction of the SPO on 21 April 2017 and publication of the first edition of the 9 vital rules ("9. Watch out for danger from downwash") in October 2014. The STSB is therefore of the opinion that an in-depth sensitisation to the dangers posed by downwash would be appropriate in order to increase the safety of employees and third parties.

### Accident involving a historic airliner, Flims, 04/08/2018

On 4 August 2018 at 16:10, an historic Junkers Ju 52/3m g4e commercial aircraft, registered as HB-HOT and operated by Ju-Air from Locarno airport, took off on a flight to Dübendorf military airfield. The plane collided approximately vertically with the terrain at 16:56 about 1.2 km south-west of Piz Segna. All 20 people on board the plane were killed in the accident. The plane was destroyed.

**Safety deficit**
Considerable corrosion damage was found on the wreck of the HB-HOT on the spars, hinges and fittings of the wings and in the area of the cabin floor plate. Two of the three engines were equipped with newly manufactured cam disks which had defects.
Given the same year of construction and similar operating mode and operating hours, it is expected that the sister aircraft, HB-HOP and HB-HOS, have similar defects.

**Safety recommendation no. 548, 21/11/2018**
The Federal Office of Civil Aviation (FOCA), in cooperation with the flight operator, should take appropriate measures to ensure that the sister aircraft, HB-HOP and HB-HOS, are inspected for corrosion damage and defects in system components.

**Implementation status**
Implemented. In a letter dated 28 March 2019, the Federal Office of Civil Aviation (FOCA) announced that it supported the safety recommendation. It has withdrawn the certificate of airworthiness for the two aircraft, HB-HOS and HB-HOP, until further notice. On the basis of the findings of the accident investigation and the Ageing Aircraft Programme, the FOCA has already placed requirements on Ju-Air regarding engineering support, the establishment of an inspection programme and the operation and maintenance of the aircraft.
The relevant inspections and the resulting findings must be carried out and rectified before a permit to fly is issued.
In the meantime, several audits and an inspection of Ju-Air by the FOCA have resulted in Ju-Air not being allowed to continue its operations under Part 145 due to serious and systemic deficiencies. With the suspension of the Part 145 certificate, Ju-Air had to stop all work on its aircraft with immediate effect.
The FOCA will determine how to proceed, including on the basis of the results of the pending Part 145 inspections.
In the FOCA's view, there are growing indications that the

use of historic aircraft or aircraft without a type certificate (TC) holder entails increased risks. On the one hand, the aircraft's fuselage, wing structures and systems were not designed for indefinite use and should therefore only continue to be operated in compliance with an ageing aircraft programme. On the other hand, aircraft without a TC holder lack an essential function for maintenance of airworthiness. The FOCA is currently examining whether to implement measures to ensure flight safety in the absence of a TC holder. The following points are being considered as safety measures. However, depending on further findings, this list may be expanded:

- Banning the carriage of passengers or limiting their number
- Introducing measures to increase the risk perception of potential passengers
- Restricting flyovers of populated areas or critical infrastructure
- Requiring maintenance to be carried out in an approved maintenance organisation similar to Part 145
- Introducing a continuous maintenance management system based on CAMO
- Integrating a safety management system for maintenance
- Developing and implementing the necessary engineering competencies
- Integrating a quality inspection system for manufacturing activities
- Introducing an ageing aircraft programme

**Safety deficit**
The examination of the maintenance work identified various shortcomings, in particular in the documentation for carrying out major modifications and managing spare parts. Such deficiencies represent a potential risk.

**Safety advice no. 25, 21/11/2018**
The air carrier and the maintenance companies should, together with the Continuing Airworthiness Management Organisation (CAMO), review and improve existing procedures to ensure traceability of maintenance and clear spare parts management.

## 5.3 Railways

### Derailment of a locomotive Bm 6/6, Neyruz, 03/03/2014

On 3 March 2014 at 13:50, the front axle of a towed locomotive, Bm 6/6, derailed shortly after the Neyruz stop. The investigation showed that the axle had already broken more than 5 km before the derailment.
The derailment of the front axle of locomotive Bm 6/6 was caused by an axle breakage due to a crack initiated by corrosion. The inspection deadline rules for ultrasonic inspection of the axles were exceeded substantially, which was found to be a systemic cause of the axle breakage.

**Safety deficit**
Locomotive Bm 6/6 no. 18509 was mothballed for several years and put back into operation without the condition of the axle shafts being checked. Corrosion damage can occur to the axle shafts after lengthy downtimes, which can lead to cracks and thus to weakening. This damage cannot be identified without the necessary ultrasonic testing. It is not known how many axles are in a similar state.

**Safety recommendation no. 133, 08/05/2018**
The FOT should ensure that all axles of the same type as those of Bm 6/6 undergo a complete non-destructive test.

**Implementation status**
Partially implemented. In a letter dated 24 October 2018, the FOT called on all owners of Bm 4/4 and Bm 6/6 locomotives to ensure that a regular, non-destructive crack test is carried out at the intervals specified in the vehicle maintenance instructions. If evidence of these periodic tests cannot be provided, a new test must be carried out as soon as possible. In addition, before a locomotive that has been mothballed or taken out of service for a lengthy period can be put back in service, a non-destructive test of the axles must be carried out. The results of the test must be documented.
The owners had until 31 January 2019 to inform the FOT of the measures taken.

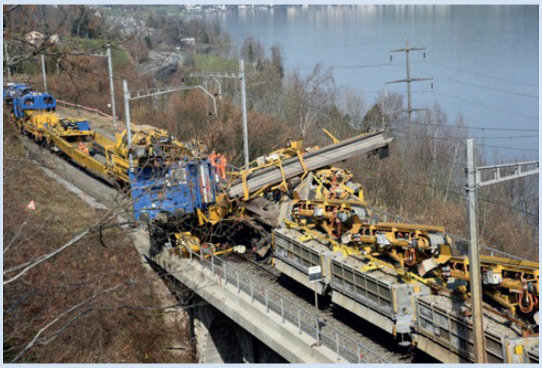
### Collision between two construction compositions, Immensee, 18/03/2015

In Immensee, track reconstruction involving subsoil rehabilitation was taking place, for which a working composition with special vehicles was used. At about 03:45 on Wednesday, 18 March 2015, after completion of the works, the work combination was divided into two construction combinations, which were to travel independently towards Arth-Goldau. The first construction combination had to wait at the track crossover in Brunnmatt to continue its journey. At 04:27, the second construction combination was driven as an indirectly guided shunting movement into the preceding, stationary construction combination. A shunting supervisor was killed, a track-laying worker suffered serious injuries and four track-laying workers suffered minor injuries. Vehicles and infrastructure suffered serious damage.
The collision between two construction compositions was due to the fact that several people in different functions did not follow rules, such as the correct application of processes

for shunting movements with special vehicles, compliance with speaking rules and perception of defined roles. This led to a situation where the persons involved had different levels of knowledge and to misunderstandings about the size of the workplace, responsibilities for the route between Immensee and the Brunnmatt track crossover and therefore responsibilities for driving on the route between Immensee and the Brunnmatt track crossover.

Contributing factors to the accident were:

- Discrepancies were not questioned and several people behaved without regard for safety.
- There were pre-existing defects in the radio equipment of shunting supervisor 2 in terms of the sluggishness of the transmit button.
- A control tone was activated, giving the impression that the operator was still conscious or able to act.



**Safety deficit**

For longer journeys by indirectly guided shunting movements where the shunting supervisor does not give instructions to the train driver, a control tone is the only signal that exists between the shunting supervisor and the train driver and is used for monitoring the connection. However, reception of the control tone does not guarantee that the radio operator is still conscious or able to act.

**Safety recommendation no. 134, 18/09/2018**

The STSB recommends that the FOT discontinue technical connection monitoring, such as the control tone, for safety-relevant communication connections unless it is ensured that these are dependent on active action by the operator.

**Implementation status**

Partially implemented. The FOT notes that, in the present case, there is a difference regarding application of the operating process pursuant to clause 9.4.5, R 300.3, Swiss Train Operating Regulations (FDV) as to whether the connection is monitored by the shunting supervisor by telephone with the words "come" or "go" or technically with the control tone. The telephone version also includes monitoring of the status of the shunting supervisor: If the supervisor stops speaking (e.g. due to unconsciousness), the connection monitoring fails and the locomotive driver reacts accordingly. An activated control tone – in the version used in this incident – continues to sound if the shunting supervisor is no longer able to switch it off manually.

In the FOT's assessment, the operational process and the Swiss Train Operating Regulations (FDV) are complete and the detail of regulation is appropriate.

With regard to Art. 38 of the Railways Ordinance (RailO), AB 38.1, para. 4 of the Implementing Provisions to the Railways Ordinance (IP-RailO) contains the following overarching legal basis in the context of the safety recommendation: "The features of the fail-safe and telematics applications must be harmonised with the operating processes and regulations."

However, the official technical specifications (RailO/IP-RailO) do not currently contain any further requirements for technical connection monitoring.

When developing the regulations (RailO/IP-RailO & FDV) further, the FOT will analyse whether the official technical specifications and the context with the operational rules are adequate and, if necessary, make appropriate adjustments.

**Safety deficit**

The tasks of arranging schedules and thus determining the driving arrangements for the construction compositions were transferred to a train driver. There was no operational concept covering the operating conditions for how the construction compositions were to travel to and from the workplace, or the necessary safety measures for this.

**Safety advice no. 13, 18/09/2018**

Target group: Infrastructure companies

The role and tasks of safety management, in particular the perception of safety responsibility in the planning and implementation of workplaces, should be reviewed. This should take account of aspects such as the burden on personnel and the monitoring of safety measures.

**Safety deficit**

Not all those involved were aware of the difference or meaning of the terms "securing" (German: "sichern") and "closing" (German: "sperren") tracks in connection with the transportation of a particular vehicle. The fact that technical measures involving closing tracks amount to the same as securing tracks has led to misunderstandings and erroneous actions in communication.

**Safety advice no. 14, 18/09/2018**

Target group: Train drivers, shunting supervisors, dispatchers, personnel at workplaces

On training and development courses, train drivers, shunting supervisors, dispatchers and personnel at workplaces, in particular safety managers and safety heads, should receive an explanation of the difference and the meaning of "securing" and "closing" tracks, based on the FDV and the Implementing Provisions to FDV Infrastructure. This is to ensure that these terms are applied correctly.

## Collision between a pushed shunting movement and parked vehicles in Zurich marshalling yard, 18/10/2015

On 18 September 2015 at 12:22, a pushed shunting movement consisting of several passenger coaches and a shunting locomotive crashed into a parked passenger train composition in Zurich marshalling yard. Various vehicles suffered considerable damage. There were no passengers in the vehicles. The driver of the shunting locomotive was slightly injured and went for medical treatment.

The collision between a pushed shunting movement and the stationary train composition was due to the fact that the shunting supervisor assumed there was an unobstructed journey to the desired destination and did not adapt the travelling speed in line with a dwarf signal saying "Proceed with caution" (German: "Fahrt mit Vorsicht"), whereupon it was no longer possible to stop in time.
Contributing factors to the accident were:
- A wrong destination track was requested by mistake.
- The destination track requested by mistake was occupied by parked vehicles.
- Because of the routine nature of the operation, the driver expected an unobstructed journey and attributed lesser importance to the dwarf signal showing "Proceed with caution".

**Safety deficit**
Staff are aware of the importance of a dwarf signal showing "Proceed with caution". Because of the routine nature of the operation, the driver expected an unobstructed journey and attributed lesser importance to the dwarf signal showing "Proceed with caution". It is the shunting personnel's task to ensure that a shunting movement is carried out safely. If there is a difference between the expectation of a clear route to the expected destination and the actual situation (wrong destination track, obstacle on the route), the probability of a collision or derailment increases.

**Safety recommendation no. 109, 02/03/2017**
The FOT should carry out an in-depth study for the shunting service on the conflicts between the applicable regulations and operational reality and implement appropriate measures. The study should address the following issues:
A) How do shunting accidents compare in terms of risk (frequency and number) with other accidents over which railway companies have influence? To what extent is there a need for action (risk acceptance) with regard to risks and possible risk development?
B) Are there safety deficits in shunting operations due to centralising the operation of signal boxes?
C) How does the daily conduct of personnel differ from the regulations on shunting movements in systems with dwarf signals stipulated by the Swiss transport service guidelines?
D) What impact does carrying out shunting movements correctly in systems with dwarf signals have on operations? What need for action can be derived from this?
E) What measures can be taken to eliminate any conflict between acting correctly when shunting in systems with dwarf signals and not disturbing operations?
F) For a safety net to work for moving vehicles in a shunting operation in a similar way to the automatic train stop system, what would it have to look like?
G) What are the opportunities and risks involved in increasing the exchange of information between the transport and infrastructure staff involved?
H) Does it make sense to have additional tools for ensuring that all transport and infrastructure parties involved have equal access to information, and how should they be designed?

**Implementation status**
Partially implemented. On the basis of its risk assessment of shunting accidents, the FOT plans the following measures to reduce the risks of shunting movement in the medium to long term:
- Develop the Swiss transport service guidelines (FDV) further (e.g. FDV 2020);
- Monitor safety with a focus on operational control of shunting safety;
- Apply the results of studies on human factors, together with Fachhochschule Nordwestschweiz (University of Applied Sciences Northwestern Switzerland), on the topics of

"Safety-enhancing supervisory styles", "Guidelines for an adequate regulatory culture", "Supervision and compliant conduct in operational practice";
- Support potential developments for the technical monitoring of shunting movements

For the time being, the FOT intends to set its priorities elsewhere in terms of the use of its resources and will not be carrying out an in-depth study.

## Collision between runaway vehicles and an obstacle, Widnau, 18/05/2016

On 18 May 2016 at around 16:50, a freight train was assembled at the Widnau siding. When it approached three wagons waiting to be picked up, they ran away a few metres in the direction of the company's terrain, colliding with an outrigger working platform located in the track area. The impact caused the outrigger working platform to move, and an employee fell from it and was fatally injured.

**Safety deficit**

SBB Cargo employees have the necessary knowledge and authorisation to carry out their duties. The correct procedure for approaching wagons is taught in internal training courses. Although internal audits have been carried out to verify implementation in practice, the approach taught was not applied in the present case

**Safety advice no. 10, 02/07/2018**

Target group: Railway transport companies that deliver and collect goods wagons in sidings.

Wagons that run away are a considerable safety risk. The STSB therefore recommends that the railway companies concerned check whether this safety deficit also exists in other shunting teams.

If necessary, training and monitoring of practical implementation should be improved.

**Safety deficit**

The "Rules of use of junction track by SBB Cargo" sets out provisions for securing parked wagons that go beyond the Swiss transport service guidelines. The descriptions given by the shunting teams of SBB Cargo and SAW suggest that these regulations were regularly broken and that the sidings operator failed to require them to be implemented adequately.

**Safety advice no. 11, 02/07/2018**

Target group: Railway transport companies that deliver and collect goods wagons in sidings.

The STSB recommends that the railway transport companies concerned check whether the contractual regulations are also being broken in practice in other sidings. If necessary, the shunting teams should be made aware of this issue so that the contractual partners can be required to comply with these regulations.

**Safety deficit**

For employees who carry out shunting movements on sidings, this activity is often only an incidental part of their job. In the case under investigation, the employee on duty as part of SAW's shunting service had completed practical training on the shunting locomotive. Employees who are deployed in the shunting service must be trained in and tested on the Swiss transport service guidelines (FDV) in accordance with Article 10 of the DETEC Ordinance on the Licence to Drive Railway Locomotives.

**Safety advice no. 12, 02/07/2018**

Target group: Sidings operators operating their own shunting service on their tracks.

The STSB recommends that the siding operators concerned ensure that all shunting staff have completed the appropriate training and examinations.

## Explosion and fire in the engine room of a locomotive, Hohtenn 08/08/2016

A freight train with double traction at the front and a bank engine at the back was travelling from Domodossola to Spiez. Shortly before entering Hohtenn station (VS), an explosion occurred in the second locomotive and the engine room caught fire.

The explosion and ensuing fire in the locomotive's engine room was caused by a defect in the NO 32/4 high-voltage tap changer.

**Safety deficit**

Although tap changers are monitored, damage to the tap changer housing by an explosion cannot be ruled out. If the tap changer's insulating oil is then sprayed in the engine room and an explosive gas mixture forms in the engine room through oil degradation, an ignition source is enough to trigger another explosion and an ensuing fire.

**Safety recommendation no. 132, 19/08/2018**

The FOT should ask owners of traction units with a tap changer type NO 32/4 or tap changers with an identical operating principle to take measures to prevent the occurrence or spread of a fire after a tap changer explosion due to the release of flammable liquids or gases from leaks, or to reduce the effects.

**Implementation status**

Partially implemented. BLS has taken various measures in connection with the explosion of Re 425 169 on 8 August 2016. These relate both to the protection of personnel and to the maintenance and monitoring of the tap changers. With regard to the protection of personnel, measures have been taken against shock waves and flue gases. In addition, maintenance of the tap changers has been checked and adapted. The BAV is also clarifying which other railway transport companies use locomotives with the NO 32/4 tap changer. It will then contact these companies and instruct them to take measures.

## Collision between a construction shunting movement and a road-rail excavator, Samstagern, 13/07/2017

On 13 July 2017 at 04:10, a construction shunting movement, consisting of a locomotive and three loaded service wagons, drove downhill from Samstagern station to a track construction site. A road-rail excavator was waiting on the track at the construction site to distribute the material after unloading. The shunting movement could not be brought to a standstill in time and collided with the road-rail excavator, pushing it downhill for 150 m and causing considerable damage to the infrastructure. The shunting supervisor, a machine operator travelling on a service wagon and the excavator driver jumped off the vehicles while still in motion. One person was injured. The driver remained in the locomotive until the vehicles came to a stand-still at the Grüenfeld stop.

The collision was due to the fact that the design of the retrofitted parking brake impeded the function of the air brakes of the MFS wagons to such an extent that they could not function.

The accident was caused by the fact that the regulations in force concerning the inspection of brakes do not take full account of the possible operational conditions when shunting on closed tracks.

**Safety deficit**

In the case of shunting movements on a track with a gradient, the regulations do not provide for a check, adapted to the circumstances, of the brakes of all vehicles or of the braking performance of the vehicle composition. The required tests of the function of the brakes during shunting movements are less extensive than for trains.

At the same time, it is possible, under identical braking conditions, to perform shunting movements at a higher speed than the maximum speed permitted for trains on the same section of track with identical braking conditions.

**Safety recommendation no. 137, 18/12/2018**

The FOT should check whether the operational regulations for shunting movements on closed tracks are sufficient for gradients and, if necessary, issue additional regulations.

**Implementation status**

Awaiting response.

**Safety deficit**

Train drivers operate various locomotives. Standard gauge traction units can be braked with the maximum braking force over the entire range of speeds, with the brake acting only on the locomotive. In this case, Am 847 909 9, the locomotive involved in the accident, behaved differently. The driver must be aware of the limited effect of hydrodynamic brakes at low speed. When switching to this traction unit, there is a danger of expecting more effective braking behaviour.

**Safety advice no. 18, 18/12/2018**

Target group: Carlo Vanoli AG

A comprehensible notice should be visible on locomotive Am 847 909-9 saying that the brake, which only affects the locomotive, behaves differently to other standard gauge traction vehicles.

## Collision between a freight train and a road-rail excavator, Vevey, 14/11/2017

On Tuesday, 14 November 2017, at around 04:20, SBB Cargo train no. 50772 from Lausanne collided with a road-rail excavator operating on Vevey station’s track 2, which was closed. No one was injured.

When lifting the closure of track 22 and points 12 and 13, the dispatcher also lifted the closure of track 2, even though the safety manager had not reported that this track was navigable. For this reason, the route of train no. 50722 was automatically adjusted by the signal box via track 2.

The following factors contributed to the accident:

- The road-rail excavator joined the track between two axle counting points, which meant that the signal box did not receive any notification that the track was occupied. Con-

sequently, the dispatcher did not see on his Ilitis monitor that the track was occupied.
- A section of track was partially recommissioned and then closed again within a short period of time.


**Safety deficit**

A roadrail vehicle joining, between two axle counting points, a closed track equipped with a clear track detection device in the form of an axle counter system does not automatically generate an occupied signal for the track concerned. The presence of the vehicle is not signalled to the signal box. This means that the track closure can be lifted, even though there is a vehicle on the track.
The Swiss transport service guidelines (FDV) do not cover a situation where a road-rail vehicle joins a track at a closed section.

**Safety recommendation no. 131, 15/05/2018**

The STSB advises the FOT to cover in the FDV the issue of a road-rail vehicle joining a track at a track section equipped with a clear track detection device in the form of an axle counter system.

**Implementation status**

Not implemented. The FOT is of the opinion that there is no guarantee at a technical level that a road-rail vehicle will be detected by the clear track detection system, by means of either a track circuit or axle counters. For this reason, the process of shunting special vehicles is regulated in R 300.4, section 2.2.4 of the Swiss transport service guidelines. In particular, it mentions that these vehicles may only join a track with the dispatcher's permission. This provision applies in this case to all clear track systems. As a result, the FOT will not implement this safety recommendation.

**Safety deficit**

In the implementing provisions for the works, it was mentioned that track 22 and points 12 and 13 were to be released for operation between 04:15 and 04:25 and subsequently closed again between 04:25 and 05:17. From a risk perspective, the re-commissioning of a track section for such a short period of time during works entails an increased risk of errors.

**Safety advice no. 9, 15/05/2018**

Target group: SBB, BLS, SOB
In order to reduce the risks associated with re-commissioning a track section in working areas to allow a train through, SBB should give preference in its work planning to operational measures, such as requiring the train to join a different track from the one in the timetable. This means that the automatic monitoring systems, which are still active, are put to the best operational use.

## Runaway of a shunting movement and collision with a buffer stop, La Conversion, 23/03/2018

On 23 March 2018, night works to dispose of cable waste were carried out on the blocked track between Grandvaux and La Conversion. A shunting movement took place at around 01:34 on the downhill stretch towards La Conversion station. This consisted of a motorised rail vehicle to which a trailer wagon loaded with cable waste was coupled. The shunting movement ran away and eventually collided with the buffer stop of track 3 in La Conversion station. The five people who were on the rail vehicle and the trailer wagon jumped off shortly before impact. One person suffered a leg injury.
As a result of inappropriate work planning, a motorised HiA 95 rail vehicle and a trailer wagon without brakes were employed for shunting movements on a closed line, although the vehicles were not suitable for use. The motorised rail vehicle was operated by employees without appropriate training. During the shunting movement towards La Conversion station, the braking force of the motorised vehicle was not sufficient to absorb the thrust of the loaded, unbraked trailer wagon. The train ran away and stopped at the buffer stop of track 3 in La Conversion station.

The following factors contributed to the accident:

- The information sent by e-mail concerning the use of the motorised railway vehicle, which allowed a person without minimum training under Article 10 para. 2 LDO to carry out a shunting movement on a closed line. The information provided contradicted the provisions of the Swiss transport service guidelines (FDV).
- The use of a vehicle which is not suitable and not authorised to carry out shunting movements on a closed track.
- The driver of the motorised railway vehicle had no minimum training in driving this type of vehicle or in carrying out shunting movements.
- The difficulties and uncertainties in allocating vehicles that led to the selection of the HiA 95 motorised rail vehicle to carry out this work.
- The waiver of a safety plan or a risk assessment for night work with shunting movements on a closed line.

**Safety deficit**

For years, infrastructure operators have been using numerous, non-approved vehicles equipped for rail-bound driving. It is difficult to assign these vehicles to one of the service vehicle categories in accordance with RailO/IP-RailO. Improper use of such vehicles can lead to dangerous situations.

**Safety recommendation no. 136, 16/10/2018**

The STSB recommends that the FOT ask the infrastructure managers to draw up an inventory of non-approved rolling stock for rail-bound driving currently in their possession, classify these vehicles and then submit an application for approval of the vehicles in accordance with the FOT guideline "Railway Vehicle Approval" (Annex 4, Service Vehicles). Any restrictions on the scope of use should be indicated in the approval and an appropriate label should be affixed to the vehicle.

**Implementation status**

Not implemented. The FOT is of the opinion that point 57.1 of the Implementing Provisions to the Railways Ordinance contains the harmonised European standards, which clearly define the various vehicles and machinery. Each of the different standards contains a diagram of its scope.

Under Article 10 para. 1 of the Railways Ordinance, railway transport companies are responsible for the proper planning and construction, safe operation and maintenance of structures, installations and vehicles. Responsibility for maintaining an inventory of unauthorised vehicles lies with the infrastructure operators. Any access restrictions are listed in the operating rules.

In cooperation with the infrastructure managers, it was decided to equip road-rail vehicles (SN EN 15746-x) and derailable machines (SN EN 15955) with a plate or sticker. This should list the main technical data and operational limitations.

**Safety deficit**

It is not appropriate to set up a safety plan for a long period of time because the risk can change depending on the construction phase, the status of the works and the topography of the site. The initial risk assessment carried out during preparation of the safety plan and the resulting risk-reduction measures may not cover all situations that arise during the works.

**Safety advice no. 15, 16/10/2018**

Target group: Infrastructure operators

To ensure that the safety plan and the risk assessment derived from it correspond to the actual status of the onsite work, the STSB proposes that infrastructure operators regularly check the plan's suitability.

**Safety deficit**

If the availability of the vehicles required for the safe execution of works is not guaranteed, employees look for other solutions to meet the specified deadlines. There is a latent risk that employees may decide on an inappropriate solution.

**Safety advice no. 16, 16/10/2018**

Target group: Infrastructure operator SBB

The STSB proposes that the infrastructure operator verify whether the centralised management process for infrastructure maintenance vehicles, which was introduced in July 2017, meets expectations in terms of availability and flexibility, and adapts the process if necessary.

**Safety deficit**

Without an exceptional licence from the FOT as supervisory authority, it is not permitted to draw up specifications or instructions that contradict the overarching regulations. In an organisation such as SBB Infrastructure, which comprises numerous businesses, there is a latent risk that safety-relevant regulations will be issued without being approved by the next higher hierarchical level. The procedures and responsibilities for issuing a guideline are described in SBB's internal document "Implementing provisions for steering instructions" (Regulation K 001.0). However, it contains no reference to verifying and releasing instructions communicated by e-mail.

**Safety advice no. 17, 16/10/2018**

Target group: Infrastructure operator SBB

Infrastructure operator SBB should supplement document K 001.1 with provisions on a verification and release system for issuing instructions.

**Interim report, loose metal casing of a tank container which in motion, Claro, 19/09/2018**

At 04:16 on 19 September 2018, freight train 42017, travelling from Cologne Eifeltor (D) to Busto Arsizio (I), triggered an alarm in the profile and antenna location system after the south portal of the Gotthard Base Tunnel (GBT) in Claro (CH). The train was stopped in accordance with regulations for an inspection at the Bellinzona San Paolo intervention station. During the inspection, the locomotive driver discovered that the metal casing of a tank container loaded on the 16th wagon had come loose and was protruding sideways into the track area. This metal casing protruding beyond the clearance gauge damaged infrastructure elements over several kilometres between Claro and Bellinzona San Paolo.

**Safety deficit**

Violation of the clearance gauge by incorrectly fastened or loose parts of a wagon or its load can lead to hazards that can cause not only material damage but also injuries.
Examples:

- When a train passes through the public area of a station, people can be injured or killed by protruding parts.
- Other trains or the infrastructure can be damaged.
- Loose or lost parts of a wagon or load can cause a derailment.

**Safety recommendation no. 135, 23/10/2018**

With regard to the possible factors that could cause the clearance gauge to be violated, the STSB recommends that the FOT carry out a risk assessment as a basis for checking and/or determining the need for immediate measures and initiating their implementation. In particular, it should also be clarified whether tank containers of the same type that travel through Switzerland have comparable defects.

**Implementation status**

Partially implemented. The FOT will carry out a risk assessment by the end of 2019.

## 5.4 Cableways, buses, inland and maritime navigation

In the year under review, no reports with safety recommendations were published for cableways, buses or inland or maritime navigation.

# 6 Analysis


## 6.1 Aviation

The following chapters 6.1.1 to 6.1.4 illustrate the trend over time in the absolute number of aircraft accidents and the accident rates of various aircraft categories between 2007 and 2018. Accident rates are calculated by standardising the absolute number of accidents by the respective annual number of aircraft movements (number of accidents per million aircraft movements per year). The number of aircraft movements is recorded by the Federal Office of Civil Aviation (FOCA).

The following three aircraft categories have been analysed:

– Aeroplanes with a maximum take-off mass of up to 5700 kg (including motor gliders and touring motor gliders in powered flight);
- Gliders (including motor gliders and touring motor gliders when gliding);
- Helicopters.

In addition, an analysis was carried out that considered the accidents in the three aircraft categories as a whole.

As some of the aircraft movements for the various aircraft categories are collected in different ways, it is virtually impossible to compare the different categories. Caution should also be exercised when comparing figures from other countries, as other definitions and delimitations have been used in some cases.

Causes of tendencies or trends for more or fewer accidents or higher or lower accident rates in the time series cannot be derived from the available data and their analysis.

What is common to all categories is that the absolute number of accidents can vary sharply from year to year. The respective time series for accident rates run almost in parallel to those for absolute values. This suggests that the increasing number of aircraft movements has not had a significant influence, to date at least, on the trend in absolute accident figures and that these are instead determined by the random component. Models for trend calculations, or regression calculations, are usually based on the assumption that a time series comprises systematic and random components. For time series with small absolute values, as is the case here, the random component can outweigh the significance calculations. In other words, the influence of an existing systematic component on changes in the time series is marginal and the random component dominates the change. For these reasons, the statistical tests on presumed decreases or increases (trends) in the time series also showed no significance.

### 6.1.1 Motorised aircraft with a maximum take-off mass of up to 5700 kg

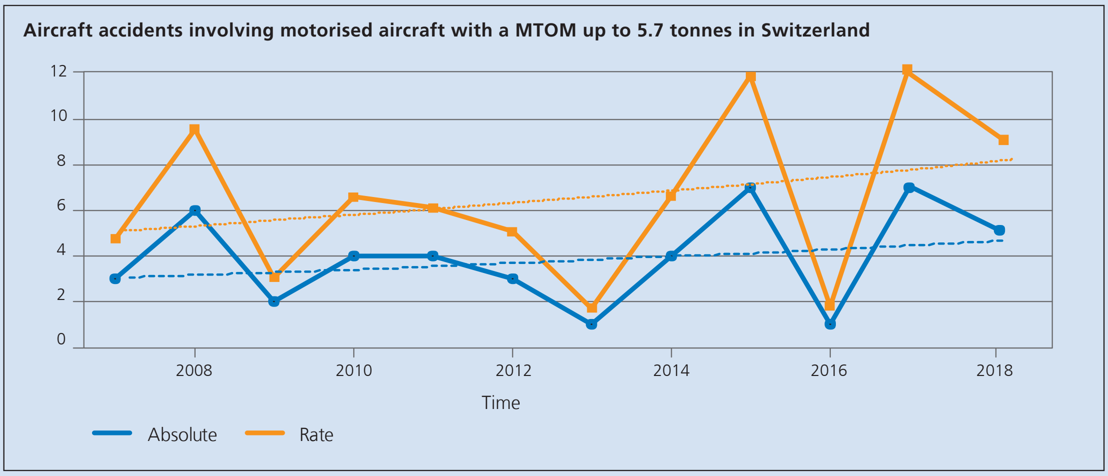
In 2018, 5 aircraft accidents were recorded in this category. Over the entire time series, the absolute accident figures range between 3 and 7. Three of the 4 highest values were recorded in the last 4 years. For this reason, each linear regression shows a slight, positive slope. The results of the statistical analysis show an estimated increase in the anticipated value of +3.4 % per year for the number of accidents and +4.7 % for the accident rate. In both cases, however, the value is not significantly different from zero ($p = 0.435$ or $p = 0.278$).

The number of accidents per year is shown as a blue dot; the accident rate per year is shown as a yellow square. For better legibility, the data points have been connected using corresponding lines. The blue dotted line shows the anticipated number of accidents; the yellow dotted line shows the anticipated accident rate.

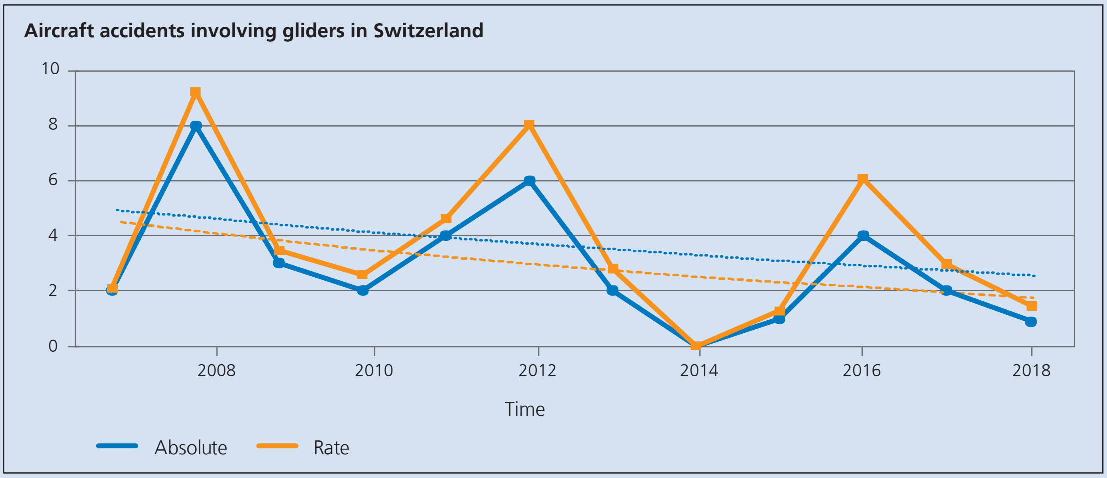
### 6.1.2 Gliders

In the year under review, 1 aircraft accident was recorded in this category; this is the second-lowest value recorded since 2007. Over the entire time series, the absolute number of accidents ranged between 0 and 8. Three of the 4 lowest values were recorded in the last 5 years. For this reason, each linear regression shows a slight, negative slope. The results of the statistical analysis show an estimated increase in the anticipated value of  9.2 % per year for the number of accidents and  6.5 % for the accident rate. In both cases, however, the value is not significantly different from zero ($p = 0.056$ or $p = 0.182$).

Accidents (Absolute) / Accidents per 1 million aircraft movements (Rate)

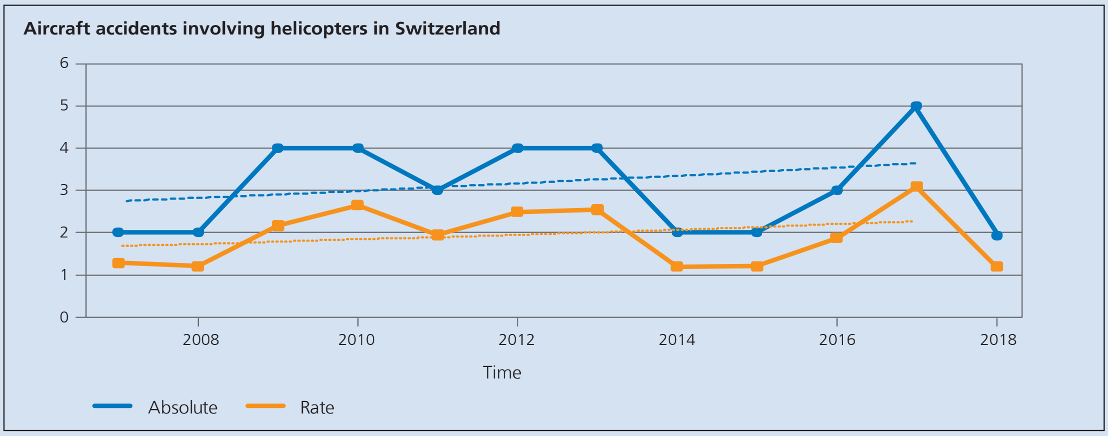


Accidents (Absolute) / Accidents per 100 000 aircraft movements (Rate)




Of note is the regular pattern, clearly visible in both time series, with peaks occurring every four years (2008, 2012 and 2016). However, no plausible explanation could be found for this pattern.
The number of accidents per year is shown as a blue dot; the accident rate per year is shown as a yellow square. For better legibility, the data points have been connected using corresponding lines. The blue dotted line shows the anticipated number of accidents; the yellow dotted line shows the anticipated accident rate.

Accidents (Absolute) / Accidents per 100 000 aircraft movements (Rate)



### 6.1.3 Helicopters

In 2018, 2 aircraft accidents were recorded in this category. This is the lowest value recorded in this period. This low was also recorded in 2007, 2008, 2014 and 2015. Over the entire time series, the absolute number of accidents ranged between 2 and 5. It should be noted that in 2017, 3 of the 5 helicopter accidents that took place in 2017 were, in actual fact, accidents at work where the aircraft remained undamaged and people who were not in the helicopter were injured. The annual fluctuations are fairly small compared to both of the categories presented above and range around an apparent average of 3. The linear regressions therefore show only marginal slopes. The results of the statistical analysis show an estimated increase in the anticipated value of +0.8 % per year for the number of accidents and +0.6 % for the accident rate. In both cases, however, the value is not significantly different from zero (p = 0.868 or p = 0.893).

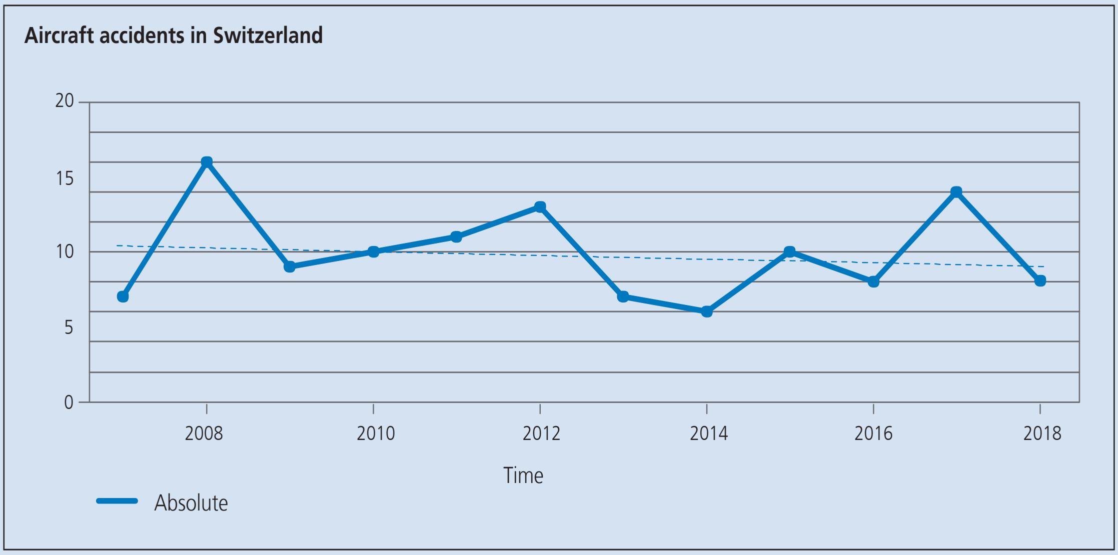
The number of accidents per year is shown as a blue dot; the accident rate per year is shown as a yellow square. For better legibility, the data points have been connected using corresponding lines. The blue dotted line shows the anticipated number of accidents; the yellow dotted line shows the anticipated accident rate.

### 6.1.4 Total for motorised aircraft, gliders and helicopters

Taking all three categories together, 8 aircraft accidents were recorded in this category in 2018. Over the entire time series, the absolute number of accidents ranged between 6 and 16. Overlaying each of the 3 individual categories shows a linear regression with a slightly negative slope. The results of the statistical analysis show an estimated increase in the anticipated number of accidents of 1.2 % per year. However, this figure is not significantly different from zero (p = 0.642). Due to the above-mentioned differences in calculating aircraft movements for the individual categories, only the absolute number of accidents is taken into account here.

The number of accidents per year is shown as a blue dot. For better legibility, the data points have been connected using corresponding lines. The blue dotted line shows the anticipated number of accidents.

Absolute no. of accidents



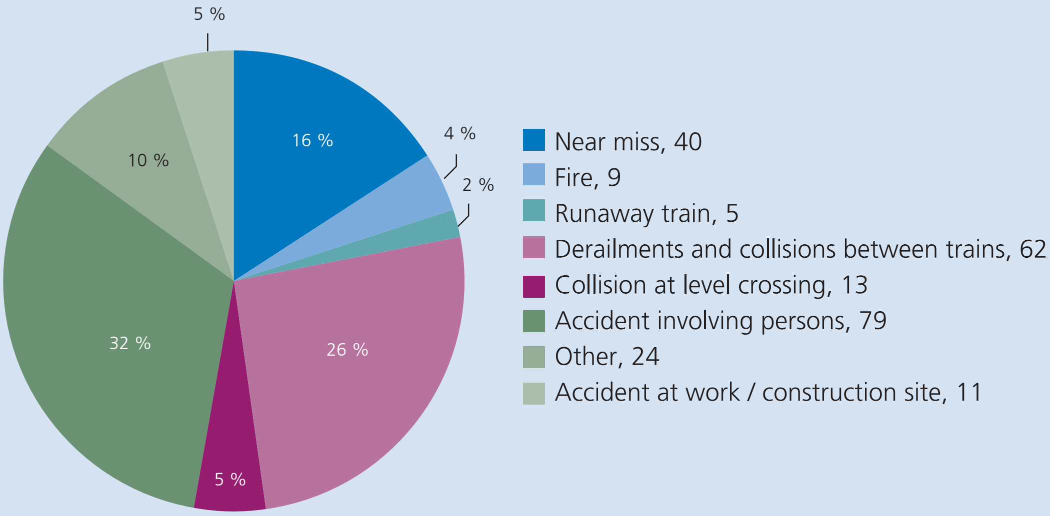

## 6.2 Railways, cableways, buses, inland and maritime navigation

**Distribution of event notifications, investigations opened and reports published**

| Modes of transport | Notifications | | Investigations | | Final reports | | Summary Report | |
|---|---|---|---|---|---|---|---|---|
| | Number | % | Number | % | Number | % | Number | % |
| **Railways** | 243 | 79.9 % | 13 | 93 % | 14 | 100 % | 18 | 95 % |
| **Trams** | 27 | 8.9 % | 0 | 0 % | 0 | 0 % | 1 | 5 % |
| **Cableways** | 14 | 4.6 % | 0 | 0 % | 0 | 0 % | 0 | 0 % |
| **Buses** | 14 | 4.6 % | 0 | 0 % | 0 | 0 % | 0 | 0 % |
| **Inland navigation** | 4 | 1.3 % | 1 | 7 % | 0 | 0 % | 0 | 0 % |
| **Maritime navigation** | 2 | 0.7 % | 0 | 0 % | 0 | 0 % | 0 | 0 % |

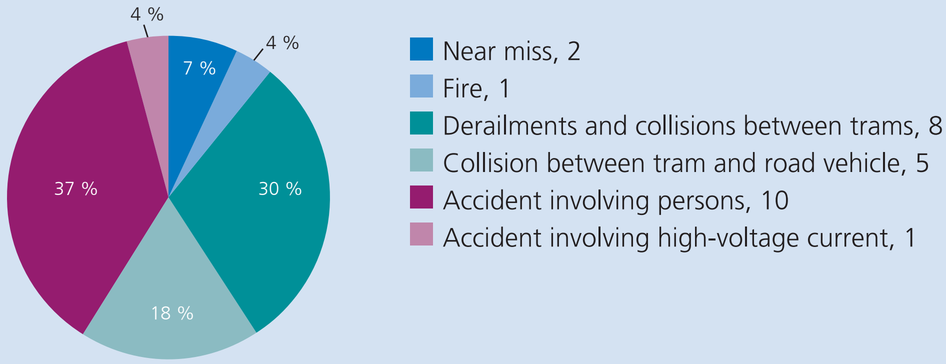
The proportion of notifications relating to railways (incl. trams) was 89 %. The remaining 33 – i.e. 11 % of notifications – relate to the other modes of transport: buses and cableways, as well as inland and maritime navigation. In the year under review, 13 investigations were opened into railways and 1 into inland navigation. The majority of reports published (incl. summary reports) relate to railways. The distribution by mode of transport is roughly equivalent to the distribution of event notifications and investigations opened.

**Distribution of event types from the event notifications for railways (excluding trams)**



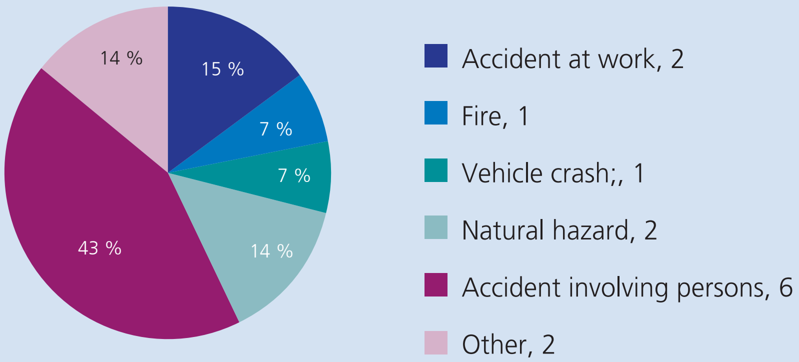

The number of event notifications for railways (excluding trams) requiring clarification was 243. The vast majority were accidents involving persons, with 43 cases subsequently proving to be suicide.

**Distribution of event type from the event notifications for trams**



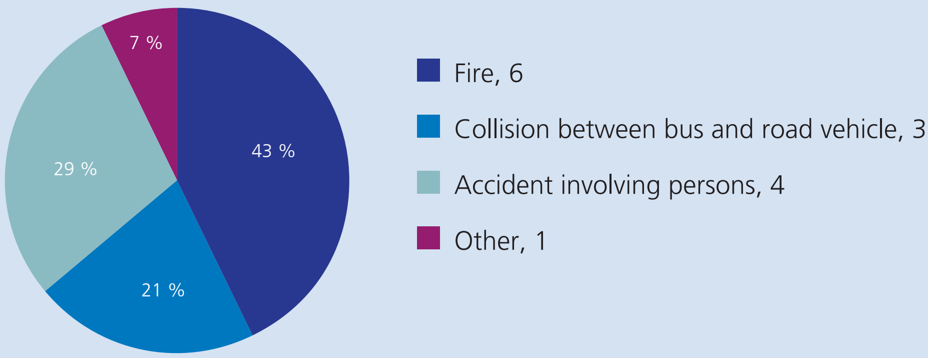

For trams, the majority of the events involved collisions with other road users, whether this was a pedestrian (accident involving persons) or a road vehicle. It should be noted that incidents on public roads that can be attributed to a violation of road traffic regulations are not required to be reported to the STSB.

**Distribution of event type from the event notifications for cableways**



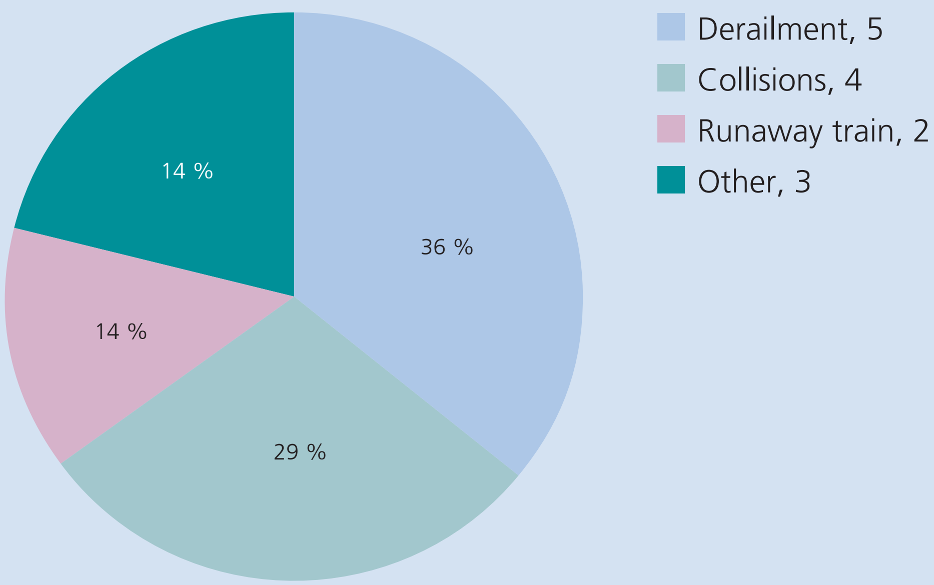

The majority of the 14 event notifications for cableways concerned accidents involving persons (6), accidents at work (2) and natural hazards (2). Accidents involving persons mostly relate to entering or leaving vehicles.

**Distribution of event type from the event notifications for buses**




Incidents on public roads that can be attributed to a violation of road traffic regulations are not required to be reported to the STSB and are also not investigated. With regard to all event types, fires and collisions with road vehicles formed the majority of events reported. One accident involving persons subsequently proved to be a suicide.

**Distribution of investigations opened by event type for all modes of transport**



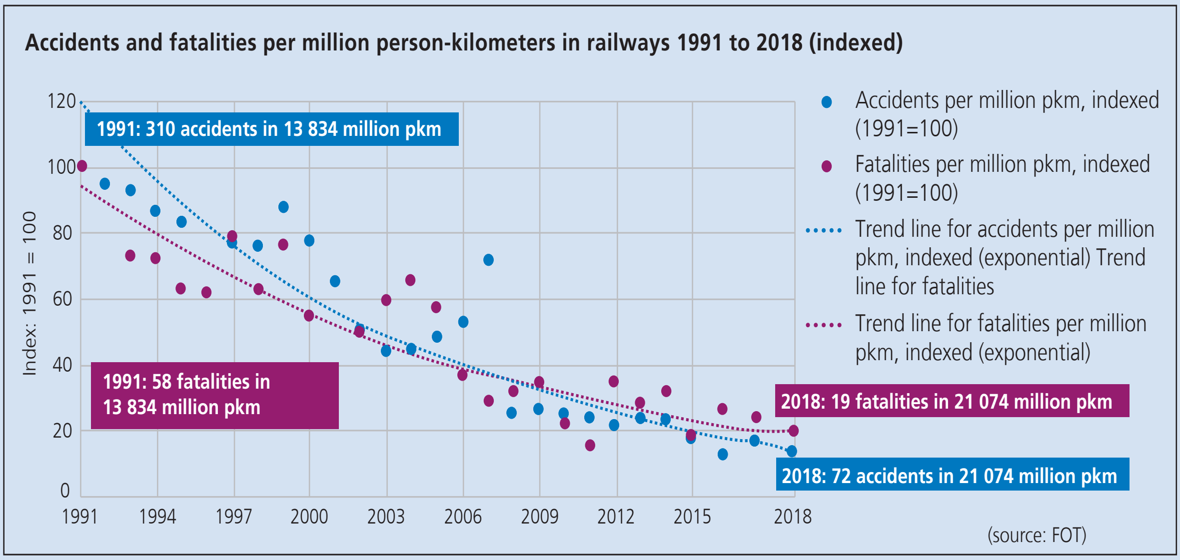

The majority of the 14 investigations opened relate to derailments (5) and collisions (4). The Other category comprises a shifting load, an irregularity with danger and a grounding.

**Development of accidents as well as fatally and seriously injured persons in public transport**

| Modes of transport | Accidents | | | | | | | Fatalities | | | | | | | Seriously injured persons | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | **2018** | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | **2018** | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | **2018** |
| **Railways** | 96 | 107 | 107 | 83 | 71 | 84 | 74 | 29 | 23 | 27 | 16 | 22 | 21 | 20 | 37 | 65 | 68 | 43 | 22 | 41 | 25 |
| **Trams** | 54 | 54 | 49 | 35 | 36 | 35 | 37 | 2 | 4 | 6 | 5 | 3 | 2 | 7 | 53 | 45 | 37 | 28 | 30 | 50 | 29 |
| **Cableways** | 9 | 4 | 8 | 10 | 6 | 5 | 0 | 2 | 1 | 3 | 1 | 0 | 0 | 0 | 5 | 3 | 5 | 9 | 6 | 5 | 0 |
| **Buses** | 67 | 39 | 37 | 49 | 42 | 42 | 65 | 4 | 2 | 4 | 5 | 4 | 7 | 5 | 59 | 34 | 39 | 44 | 37 | 39 | 62 |
| **Inland navigation** | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 0 |
| **All modes of transport** | **227** | **205** | **204** | **178** | **156** | **167** | **177** | **37** | **30** | **40** | **27** | **29** | **30** | **32** | **115** | **148** | **149** | **124** | **97** | **135** | **116** |

Over the past 7 years, the number of accidents and fatally and seriously injured persons has shown a tendency to decrease (source of table: FOT).

**Development of accidents and fatally injured persons on railways**




During the past 27 years, the number of railway accidents and persons fatally injured on the railways has de-creased by around a quarter. This is the result of the efforts made by all parties in the overall safety infrastruc-ture, including those made by the STSB (source of diagram: FOT).

# Annexes

Annex 1: List of the number of notifications, the opened, ongoing and completed investigations and the final reports, interim reports and studies published regarding aviation

Annex 2: List to the number of notifications, opened, ongoing and completed investigations and the final reports, interim reports and studies published regarding public transport and maritime navigation

Annex 3: Statistical information on aviation incidents

Annex 4: Aviation data for statistical analysis (chapter 6) and methods and conceptual considerations used

# Annex 1

## List of the number of notifications, the opened, ongoing and completed investigations and the final reports, interim reports and studies published regarding aviation

### Notifications, opened, ongoing and completed investigations

| Aviation | | | | | | |
|---|---|---|---|---|---|---|
| Year | Number | Opened investigations | Completed investigations | | | Ongoing investigations |
| | | | total: | with final report: | with summary report: | |
| 2018 | 1556 | 119 | 83 | 23[1] | 53 | 156 |
| 2017 | 1259 | 86 | 93 | 30 | 48 | 111 |
| 2016 | 1219 | 92 | 58 | 28[2] | 31 | 142 |
| 2015 | 1260 | 86 | 33 | 33 | n/a | n/a |

### Final reports, interim reports and studies

| Number | Code | Date | Location | Safety recommendation | Safety advice |
|---|---|---|---|---|---|
| 2269 | HB-JHB | 21/11/2014 | Zurich Airport | 504 | 3 |
| 2283 | HB-WAS | 27/04/2015 | Zweisimmen Airport | | 11, 12 |
| 2290 | HB-KDF | 18/07/2015 | Münster Airport | | |
| 2312 | HB-AEO | 07/12/2015 | Bern Airport | 532 | 17 |
| 2319 | HB-ZGO | 06/04/2016 | Worb | | 18 |
| 2320 | HB-XSL | 09/06/2016 | Heimenschwand | | |
| 2321 | HB-JHR (EDW3A) / D-KOWC | 25/08/2016 | Zurich Airport | | |
| 2322 | HB-OPL | 24/04/2017 | Langenthal Airport | | |
| 2323 | HB-YLO | 24/08/2016 | Bad Ragaz Airport | | |
| 2324 | HB-XVM | 13/10/2017 | Tesserete | 540 | |
| 2325 | OO-VLF (VLM22TX) / OK-ELL | 21/04/2016 | Friedrichshafen Airport | 541 | |
| 2329 | HB-PGF | 22/10/2016 | Lenzerheide | | |
| 2330 | HB-HFH | 13/10/2015 | Neuchâtel Airport | | |
| 2333 | HB-SEW | 17/03/2017 | St. Gallen-Altenrhein Airport | | |

[1] Including 1 interim report
[2] Including 1 interim report

| Number | Code | Date | Location | Safety recommendation | Safety advice |
|---|---|---|---|---|---|
| 2334 | HB-ZOK / HB-SRC | 12/08/2016 | Bern Airport | 542 | |
| 2335 | HB-ZRW | 23/06/2016 | Wasserauen | | |
| 2336 | I-NIBO | 12/08/2017 | Gaggiolo / Stabio | | |
| 2337 | HB-2370 | 13/08/2017 | Villarvolard | | |
| 2340 | D-EPPW | 12/09/2017 | above Braunwald | | |
| 2341 | HB-PPY | 26/06/2016 | Grenchen Airport | | |
| 2342 | HB-IZW | 10/12/2015 | Billund Airport | | |
| 2344 | HB-KFK | 15/07/2017 | Bern Airport | 544 | 22 |
| i. r. | HB-HOT | 04/08/2018 | Piz Segnas | 548 | 25 |

## Summary reports

| Code | Date of incident | Location | Short description of incident |
|---|---|---|---|
| N184KP | 25/08/2018 | Grenchen Airfield (LSZG) | Runway excursion |
| HB-YLP | 16/08/2018 | Lommis Airport (LSZT) | Damage after hard grounding |
| D-KRID | 05/08/2018 | Schaffhausen Airport (LSPF) | Landing accident |
| N4927 | 19/07/2018 | Lugano-Agno Airport (LSZA) | Luggage doors lost |
| HB-3214 | 14/07/2018 | Bellechasse Gliding Field (LSTB) | Impact of a glider after canopy opened |
| D-KAHZ / HB-JWA | 22/06/2018 | Zurich Airport (LSZH) | Airspace violation with airprox |
| D-KBBZ | 19/06/2018 | Zurich Airport (LSZH) | Approach to runway 14 of Zurich Airport endangered |
| HB-KOU | 17/05/2018 | Biel | Near miss |
| HB-CNK | 13/05/2018 | Paltano, Val Bedretto | Accident on open terrain |
| HB-PMN | 27/04/2018 | Bec de Nendaz (LSYD) | Loss of control after landing |
| HB-HFJ / D-9820 | 15/04/2018 | Schänis (LSZX) | Contact with tow rope after coupling released |
| HB-IOC / HB-QPY | 15/04/2018 | Sullens | Near miss |
| HB-1629 | 14/04/2018 | Grenchen Airfield (LSZG) | Near miss during landing |
| HB-2070 | 14/04/2018 | St. Gallen-Altenrhein Airport (LSZR) | Landing before runway |
| F-JBRG | 14/04/2018 | Buttwil Airfield (LSZU) | Hard landing |
| HB-KAW | 07/04/2018 | Sion Airport (LSGS) | Towing with damaged aircraft |

| Code | Date of incident | Location | Short description of incident |
|---|---|---|---|
| HB-1784 / D-EAIO / HB-LEM | 07/04/2018 | Steinhausen | Airprox |
| HB-SDL | 02/04/2018 | La Côte Airport (LSGP) | Collision with obstacle while rolling |
| HB-PHD | 23/03/2018 | Zurich Airport (LSZH) | Aircraft lifted by jet blast |
| HB-DVZ | 05/03/2018 | Wangen-Lachen (LSPV) | Runway overshoot |
| HB-ODH / HB-EDB | 04/03/2018 | Sarnen | Near miss |
| EC-KES | 02/03/2018 | Bern Airport (LSZB) | Runway side excursion |
| HB-SGT | 31/01/2018 | Birrfeld Airfield (LSZF) | Landing with grounding of propeller |
| HB-PKR | 27/10/2017 | Lausanne La Blécherette Airport (LSGL) | Emergency landing |
| HB-KLM | 26/10/2017 | Schwarzsee | Engine failure |
| HB-TDD | 13/10/2017 | Wangen-Lachen Airport (LSPV) | Landing accident |
| I-FVAB | 08/10/2017 | Zurich Airport (LSZH) | Smoke in cockpit |
| G-IIMI | 04/10/2017 | Bex Airport (LSGB) | Landing accident |
| HB-SAW | 29/08/2017 | Geneva Airport (LSGG) | Collision with fuel station |
| N68061 | 23/08/2017 | Audincourt, France | Loss of cabin pressure |
| HB-1593 | 10/07/2017 | Münster Airport (LSPU) | Landing accident |
| HB-PAT | 16/06/2017 | Gruyere | Engine failure |
| HB-LEM / HB-KHR | 15/06/2017 | Zurich Airport (LSZH) | Runway collision |
| HB-3144 | 10/06/2017 | Buochs Airport (LSZC) | Bad landing |
| HB-SVB | 10/06/2017 | Bad Ragaz Airport (LSZE) | Emergency landing |
| HB-SRA | 10/06/2017 | Bern Airport (LSZB) | Landing accident |
| HB-JYK | 30/05/2017 | Thessaloniki / Greece | Smoke in cockpit |
| F-PAUR | 11/04/2017 | Bressaucourt Airport (LSZQ) | Engine failure |
| HB-DIA | 27/03/2017 | Speck-Fehraltorf Airport (LSZK) | Runway overshoot |
| HB-FKL / A-108 | 23/03/2017 | Sitterdorf Airport (LSZV) | Civil/military airprox |
| YU-BST | 19/12/2016 | Sion Airport (LSGS) | Near miss with drone |
| F-GRHS | 07/11/2016 | Geneva Airport (LSGG) | Technical problem |
| HB-IYR | 24/10/2016 | Zurich Airport (LSZH) | Oil smell in cockpit |
| HB-ZLB | 13/09/2016 | Botterens | Engine failure |
| HB-IYT | 21/07/2016 | Luxembourg Airport (ELLX) | Hard landing |
| HB-HOP | 16/07/2016 | Pfifegg / SZ | Airprox |

| Code | Date of incident | Location | Short description of incident |
|---|---|---|---|
| N1218F | 09/06/2016 | Payerne Airport (LSMP) | Collision with obstacle while rolling |
| EC-LQF | 09/04/2016 | Geneva Airport (LSGG) | Emergency landing after engine failure |
| D-AJOY | 12/03/2016 | Geneva Airport (LSGG) | Technical problem |
| G-EZAY | 08/03/2016 | Geneva Airport (LSGG) | Technical problem |
| D-ACNP | 10/12/2015 | Geneva Airport (LSGG) | Smoke in cockpit |
| G-EUPJ | 24/07/2015 | Zurich Airport (LSZH), north-west | Smoke in cockpit |
| D-ABJB | 12/04/2015 | Zurich Airport (LSZH) | Smoke in cockpit |

# Annex 2

## List to the number of notifications, opened, ongoing and completed investigations and the final reports, interim reports and studies published regarding public transport and maritime navigation

### Notifications, opened, ongoing and completed investigations

| Public transport and maritime navigation | | | | | | |
|---|---|---|---|---|---|---|
| Year | Number notifications | Opened investigations | Completed investigations | | | Ongoing investigations |
| | | | total: | with final report: | with summary report: | |
| 2018 | 304 | 14 | 32 | 14[3] | 17 | 33 |
| 2017 | 376 | 25 | 38 | 27 | 12 | 50 |
| 2016 | 332 | 64 | 39 | 14[4] | 26 | 79 |
| 2015 | 296 | 87 | 31 | 20[5] | 13 | n/a |

### Final reports

| Number | Mode of transport | Type of accident | Date | Location | Safety recommendation | Safety advice |
|---|---|---|---|---|---|---|
| 2014030301 | Railways | Derailment | 03/03/2014 | Neyruz | 133 | |
| 2015031801 | Railways | Collision between train and shunting movement | 18/03/2015 | Immensee | 134 | 13, 14 |
| 2015082102 | Railways | Derailment | 21/08/2015 | Realp | | |
| 2015091801 | Railways | Collision between train and obstacle | 18/09/2015 | Zurich marshalling yard | 109 | |
| 2015111201 | Railways | Train endangerment | 12/11/2015 | Trois-Villes | | |
| 2016051802 | Railways | Runaway train | 18/05/2016 | Widnau | | 10, 11, 12 |
| 2016080801 | Railways | Fire in locomotive engine room | 08/08/2016 | Hohtenn | 132 | |
| 2017020701 | Railways | Collision between train and obstacle | 07/02/2017 | Winterthur | | |
| 2017071301 | Railways | Collision between train and obstacle | 13/07/2017 | Samstagern | 137 | 18 |
| 2017072701 | Railways | Axle failures | 27/07/2017 | Les Brenets II | (128)* | |

* The figures in brackets mean that the respective safety recommendation had already been published earlier, together with the interim report concerning the case.

3 Including 1 interim report
4 Including 1 interim report
5 Including 2 interim reports

| Number | Mode of transport | Type of accident | Date | Location | Safety recommendation | Safety advice |
|---|---|---|---|---|---|---|
| 2017111401 | Railways | Collision | 14/11/2017 | Vevey | 131 | 9 |
| 2018030601 | Railways | Collision | 06/03/2018 | Rivaz | | |
| 2018032301 | Railways | Runaway train | 23/03/2018 | La Conversion | 136 | 15, 16, 17 |
| 2018091903_i. r. | Railways | Irregularity with danger | 19/09/2018 | Claro | 135 | |

## Summary reports

| Number | Mode of transport | Type of accident | Date | Location | Safety recommendation | Safety advice |
|---|---|---|---|---|---|---|
| 2014102302 | Railways | Collision | 23/10/2014 | St. Maurice | 109 | |
| 2014112402 | Railways | Collision | 24/11/2014 | Bern | 109 | |
| 2015031301 | Railways | Collision between train and shunting movement | 13/03/2015 | Basel | 109 | |
| 2015051301 | Railways | Collision | 13/05/2015 | Erstfeld | | |
| 2015111701 | Railways | Collision between train and obstacle | 17/11/2015 | Dietikon | 109 | |
| 2015121802 | Railways | Derailment | 18/12/2015 | Faido, Pianotondo | | |
| 2016030101 | Railways | Derailment of a shunting movement | 01/03/2016 | Huttwil | 109 | |
| 2016122001 | Trams | Collision between trams | 20/12/2016 | Zurich, Kreuzplatz | | |
| 2017042901 | Railways | Collision between train and shunting movement | 29/04/2017 | Chiasso | 109 | |
| 2017083102 | Railways | Glancing collision | 31/08/2017 | Bern | 109 | |
| 2017090101 | Railways | Derailment of tank wagon | 01/09/2017 | Brig | | |
| 2017100202 | Railways | Collision with shunting movement | 02/10/2017 | Zofingen | | |
| 2017112203 | Railways | Derailment of shunting movement | 22/11/2017 | Lucerne | | |
| 2018061502 | Railways | Derailment of construction train | 15/06/2018 | Winterthur | | |
| 2018062501 | Railways | Derailment of train or tram | 25/06/2018 | Untervaz (GR) | | |
| 2018071103 | Railways | Shifted load | 11/07/2018 | Castion-Arbedo (TI) | | |
| 2018090401 | Railways | Collision at controlled level crossing | 04/09/2018 | Châtel-Saint-Denis | | |

# Annex 3

## Statistical information on aviation incidents

## Contents

## 1. Preliminary remarks

The following annual statistics contain all accidents and serious incidents investigated involving civil-registered Swiss aircraft in Switzerland and abroad, and involving foreign-registered aircraft in Switzerland.

Accidents involving parachuters, hang gliders, kites, paragliders, tethered balloons, unmanned balloons and model aircraft are not subject to investigation.

## 2. Definitions

Some significant terms used in air accident investigation are explained below:

### Accident

An event associated with the operation of an aircraft which, in the case of a manned aircraft, takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, or in the case of an unmanned aircraft, takes place between the time the aircraft is ready to move with the purpose of flight until such time it comes to rest at the end of the flight and the primary propulsion system is shut down, in which

a) a person is fatally or seriously injured as a result of
   - being in the aircraft, or
   - direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or
   - direct exposure to the aircraft's jet blast, except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or

b) the aircraft has sustained damage or structural failure which adversely affects the structural strength, performance or flight characteristics of the aircraft, and would normally require major repair or replacement of the affected component, except for engine failure or damage when the damage is limited to a single engine (including its cowlings or accessories), to propellers, wingtips, antennas, probes, vanes, tyres, brakes, wheels, fairings, panels, landing gear doors, wind-screens, the aircraft skin (such as small dents or puncture holes), or minor damage to the main rotor blades, tail rotor blades, landing gear, and those resulting from hail or bird strike (including holes in the radome); or

c) the aircraft is missing or is completely inaccessible.

### Serious injury

An injury which is sustained by a person in an accident and which involves one of the following:

a) Hospitalisation for more than 48 hours, commencing within seven days from the date the injury was received;
b) A fracture of any bone (except simple fractures of fingers, toes, or nose);
c) Lacerations which cause severe haemorrhage, nerve, muscle or tendon damage;
d) Injury to any internal organ;
e) Second- or third-degree burns or any burns affecting more than 5 % of the body surface;
f) Verified exposure to infectious substances or harmful radiation.

### Fatal injury

An injury which is sustained by a person in an accident and which results in his or her death within 30 days of the date of the accident.

### Large aircraft

An aircraft which has a maximum take-off mass (MTOM) of at least 5700 kg is classified in the "Transport" sub-category of the "Standard" airworthiness category or has more than ten seats for passengers and crew.

### Country of registration

The country where the aircraft is registered with the national aviation authority.

### Country of manufacture

The country or countries that have certified the airworthiness of the prototype (type).

### Country of the operator

The country in which the operator's principal place of business or permanent residence is located.

## 3. Tables and diagrams

**3.1 Aircraft accidents and serious incidents involving Swiss-registered aircraft, number of aircraft and fatalities**

| Year | Number of registered aircraft[6] | Flight hours[6] | Flight personnel licences[6] | Number of accidents investigated | Number of accidents with summary procedure | Total number of accidents | Number of serious accidents | | Total number of accidents and serious incidents | Number of fatalities |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | incl. airproxes | airproxes investigated[7] | | |
| 2006 | 3822 | 715 572 | 15 368 | 27 | 31 | 58 | 10 | 7 | 68 | 10 |
| 2007 | 3813 | 766 557 | 15 076 | 23 | 20 | 43 | 4 | 6 | 47 | 12 |
| 2008 | 3765 | 784 548 | 14 691 | 28 | 19 | 47 | 5 | 6 | 52 | 11 |
| 2009 | 3685 | 842 017 | 14 973 | 26 | 17 | 43 | 4 | 3 | 47 | 5 |
| 2010 | 3705 | 793 592 | 15 313 | 21 | 16 | 37 | 8 | 4 | 45 | 8 |
| 2011 | 3709 | 873 548 | 12 855[8] | 21 | 24 | 46 | 13 | 8 | 59 | 13 |
| 2012 | 3657 | 875 708 | 12 840 | 22 | 20 | 42 | 23 | 10 | 65 | 22 |
| 2013 | 3620 | 933 752 | 11 871 | 28 | 16 | 44 | 20 | 11 | 64 | 15 |
| 2014 | 3556 | 919 987 | 11 563 | 18 | 28 | 46 | 13 | 5 | 59 | 8 |
| 2015 | 3494 | 865 404 | 11 536 | 29 | 24 | 53 | 22 | 4 | 75 | 12 |
| 2016 | 3414 | 849 373 | 12 264 | 21 | 16 | 37 | 46 | 16 | 83 | 5 |
| 2017 | 3333 | 850 525 | 12 101 | 25 | 22 | 47 | 32 | 8 | 79 | 18 |
| **2018** | **3284** | **872 408** | **12 027** | **16** | **15** | **31** | **68** | **28** | **99** | **36** |

[6] Source: Federal Office of Civil Aviation
[7] Incl. airproxes involving foreign-registered aircraft
[8] Due to the revision of the law on aviation, provisional licences are no longer issued effective from 01/04/2011

### 3.1.1 Air accidents and serious incidents involving Swiss-registered aircraft exceeding 5700 kg MTOM

| Jahr | Number of re-gistered aircraf[9] | Flight hours[9] | Number of ac-cidents investi-gated | Number of acci-dents with sum-mary proce-dure | Total num-ber of acci-dents | Number of serious accidents | | Total number of acci-dents and serious incidents | Num-ber of fatali-ties |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | incl. air-proxes | airproxes investi-gated[10] | | |
| 2006 | 248 | 434 050 | 1 | 0 | 1 | 8 | 7 | 9 | 0 |
| 2007 | 260 | 393 368 | 3 | 0 | 3 | 0 | 5 | 3 | 1 |
| 2008 | 285 | 385 686 | 1 | 0 | 1 | 3 | 5 | 4 | 0 |
| 2009 | 293 | 394 055 | 0 | 0 | 0 | 4 | 3 | 4 | 0 |
| 2010 | 303 | 419 323 | 0 | 0 | 0 | 6 | 3 | 6 | 0 |
| 2011 | 299 | 458 225 | 0 | 0 | 0 | 9 | 8 | 9 | 0 |
| 2012 | 294 | 475 786 | 0 | 0 | 0 | 11 | 7 | 11 | 0 |
| 2013 | 290 | 540 826 | 1 | 0 | 1 | 11 | 8 | 12 | 0 |
| 2014 | 284 | 483 673 | 1 | 0 | 1 | 7 | 3 | 8 | 0 |
| 2015 | 284 | 466 086 | 1 | 0 | 1 | 11 | 1 | 12 | 0 |
| 2016 | 279 | 471 650 | 0 | 0 | 0 | 17 | 9 | 17 | 0 |
| 2017 | 254 | 482 135 | 0 | 0 | 0 | 6 | 2 | 6 | 0 |
| **2018** | **262** | **499 170** | **1** | **0** | **1** | **17** | **10** | **18** | **20** |

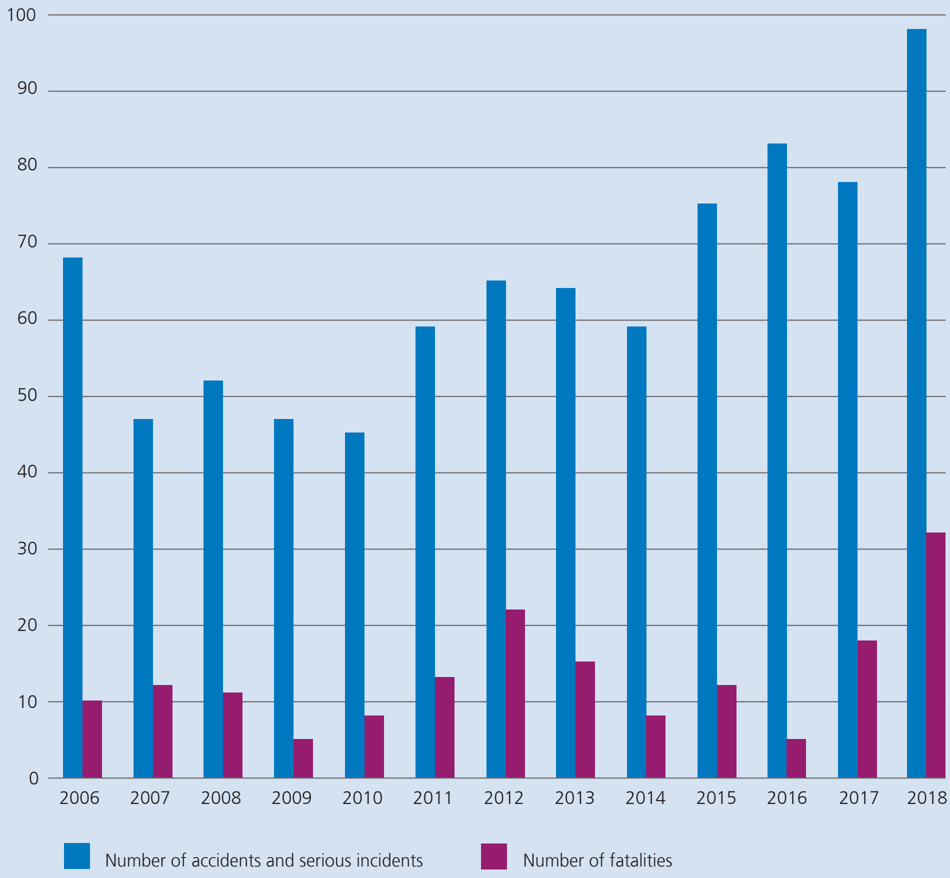
9 Source: Federal Office of Civil Aviation
10 Incl. airproxes involving foreign-registered aircraft

### 3.1.2 Air accidents and serious incidents involving Swiss-registered aircraft up to 5700 kg MTOM

| Jahr | Number of registered aircraf[11] | Flight hours[11] | Number of accidents investigated | Number of accidents with summary procedure | Total number of accidents | Number of serious accidents | | Total number of accidents and serious incidents | Number of fatalities |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | incl. airproxes | airproxes investigated[12] | | |
| 2006 | 3574 | 281 522 | 26 | 31 | 57 | 2 | 0 | 59 | 10 |
| 2007 | 3553 | 373 189 | 20 | 20 | 40 | 4 | 1 | 44 | 11 |
| 2008 | 3480 | 398 862 | 27 | 19 | 46 | 2 | 1 | 48 | 11 |
| 2009 | 3392 | 447 962 | 26 | 17 | 43 | 0 | 0 | 43 | 5 |
| 2010 | 3402 | 374 269 | 21 | 16 | 37 | 2 | 1 | 39 | 8 |
| 2011 | 3410 | 415 323 | 22 | 24 | 46 | 3 | 0 | 49 | 13 |
| 2012 | 3363 | 399 922 | 22 | 20 | 42 | 12 | 3 | 54 | 22 |
| 2013 | 3330 | 392 926 | 27 | 16 | 43 | 9 | 3 | 52 | 15 |
| 2014 | 3272 | 436 314 | 17 | 28 | 45 | 6 | 2 | 51 | 8 |
| 2015 | 3210 | 399 318 | 28 | 24 | 52 | 11 | 3 | 63 | 12 |
| 2016 | 3135 | 377 723 | 21 | 16 | 37 | 29 | 7 | 66 | 5 |
| 2017 | 3079 | 368 390 | 25 | 22 | 47 | 26 | 6 | 73 | 18 |
| **2018** | **3022** | **374 743** | **15** | **15** | **30** | **51** | **18** | **81** | **16** |

[11] Source: Federal Office of Civil Aviation
[12] Incl. airproxes involving foreign-registered aircraft

3.1.3 **Diagram showing air accidents and serious incidents involving Swiss-registered aircraft and fatalities**



### 3.2 Summary of accident data for the reporting period 2017/2018

#### 3.2.1 Accidents and serious incidents with and without injured persons involving Swiss-registered aircraft in Switzerland and abroad, and foreign-registered aircraft in Switzerland

| | Accidents and serious incidents involving Swiss-registered aircraft | | | | | | Accidents and serious incidents involving Swiss-registered aircraft | | | | | | Accidents and serious incidents involving foreign-registered aircraft in Switzerland | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | in Switzerland | | | | | | abroad | | | | | | in Switzerland | | | | | |
| | Total | | of which injuries to persons | | of which no injuries to persons | | Total | | of which injuries to persons | | of which no injuries to persons | | Total | | of which injuries to persons | | of which no injuries to persons | |
| | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 |
| Total | **90** | 70 | **9** | 14 | **81** | 56 | **9** | 9 | **3** | 2 | **6** | 7 | **25** | 15 | **1** | 2 | **24** | 11 |
| Aircraft with MTOM of up to 2250 kg | **46** | 48 | **3** | 7 | **43** | 41 | **2** | 5 | **2** | 1 | **0** | 4 | **11** | 5 | **1** | 1 | **10** | 4 |
| Aircraft with MTOM of 2251-5700 kg | **2** | 1 | **0** | 0 | **2** | 1 | **1** | 1 | **0** | 1 | **1** | 0 | **4** | 0 | **0** | 0 | **4** | 0 |
| Aircraft with MTOM exceeding 5700 kg | **14** | 3 | **1** | 0 | **13** | 3 | **4** | 3 | **0** | 0 | **4** | 3 | **5** | 7 | **0** | 0 | **5** | 7 |
| Helicopters | **16** | 11 | **2** | 5 | **14** | 6 | **1** | 0 | **1** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Motor gliders and gliders | **10** | 7 | **3** | 2 | **7** | 5 | **1** | 0 | **0** | 0 | **1** | 0 | **3** | 1 | **0** | 1 | **3** | 0 |
| Balloons and airships | **2** | 0 | **0** | 0 | **2** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **1** | 0 | **0** | 0 | **1** | 0 |
| Ultralight aircraft | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **1** | 0 | **0** | 0 | **1** | 0 |

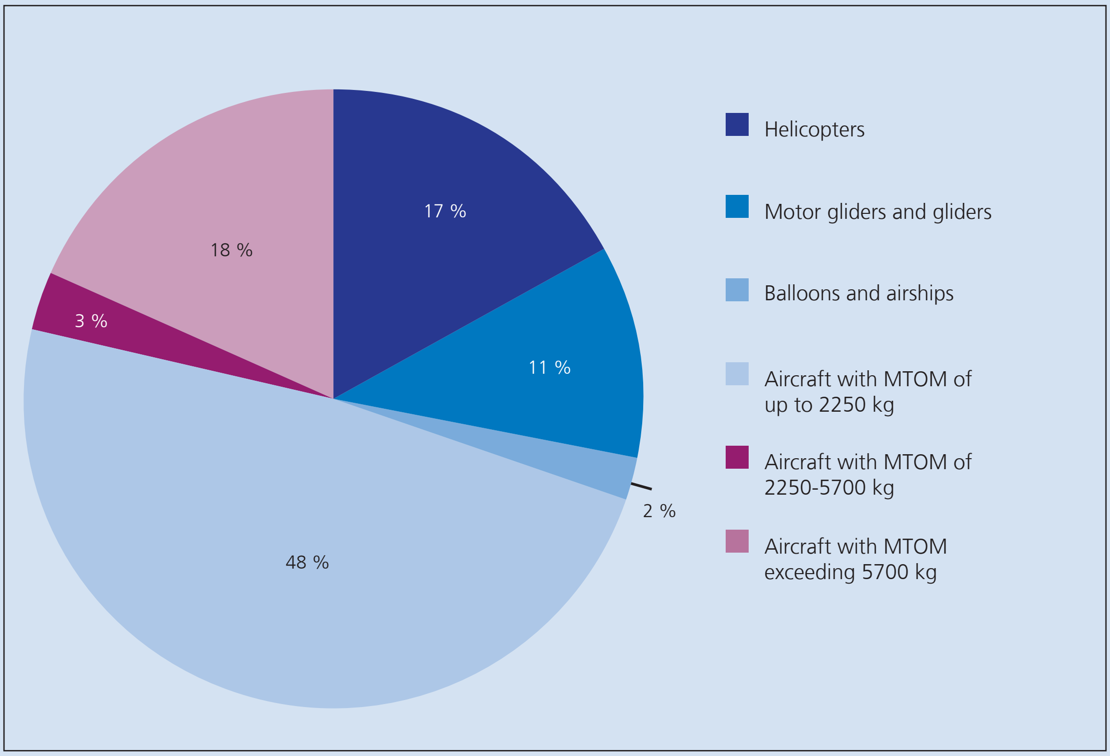
### 3.2.2 Number of registered aircraft and air accidents / serious incidents involving Swiss-registered aircraft

| | Number of aircraft[13] (01/01/2019) | | Total number of accidents and serious incidents | |
|---|---|---|---|---|
| | **2018** | 2017 | **2018** | 2017 |
| Aircraft with MTOM of up to 2250 kg | **1359** | 1358 | **49** | 53 |
| Aircraft with MTOM of 2250-5700 kg | **162** | 174 | **3** | 2 |
| Aircraft with MTOM exceeding 5700 kg | **262** | 254 | **18** | 6 |
| Helicopters | **335** | 335 | **16** | 11 |
| Motor gliders and gliders | **845** | 874 | **11** | 7 |
| Balloons and airships | **332** | 338 | **2** | 0 |
| Ultralight aircraft[14] | **0** | 0 | **0** | 0 |
| Total | **3284** | 3333 | **99** | 79 |

13 Source: Federal Office of Civil Aviation
14 The number of ultralight aircraft is not collated separately.

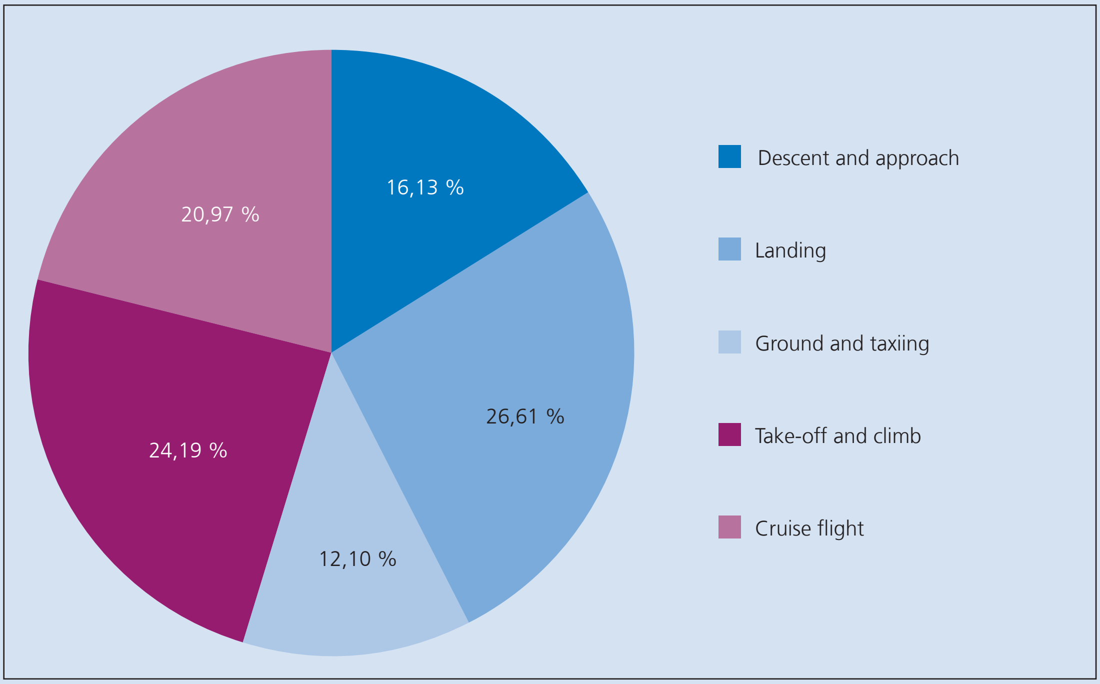
### 3.2.3 Accidents and serious incidents by type of aircraft involving Swiss-registered aircraft

| | **2018** | 2017 |
|---|---|---|
| Aircraft with MTOM of up to 2250 kg | **48 %** | 67 % |
| Aircraft with MTOM of 2250-5700 kg | **3 %** | 3 % |
| Aircraft with MTOM exceeding 5700 kg | **18 %** | 8 % |
| Helicopters | **17 %** | 14 % |
| Motor gliders and gliders | **11 %** | 9 % |
| Balloons and airships | **2 %** | 0 % |



**3.2.4 Flight phase (accidents and serious incidents involving Swiss-registered aircraft in Switzerland and abroad, and foreign-registered aircraft in Switzerland)**

| | Ground and taxiing / hover flight | | Take-off and climb | | Cruise flight | | Descent and approach | | Landing | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 |
| Aircraft with MTOM of up to 2250 kg | **12** | 10 | **10** | 16 | **12** | 6 | **8** | 8 | **17** | 21 | **59** | 61 |
| Aircraft with MTOM of 2250-5700 kg | **0** | 0 | **2** | 1 | **1** | 1 | **2** | 0 | **3** | 1 | **8** | 3 |
| Aircraft with MTOM exceeding 5700 kg | **1** | 0 | **7** | 4 | **7** | 3 | **8** | 5 | **0** | 1 | **23** | 13 |
| Helicopters | **0** | 1 | **9** | 4 | **3** | 3 | **1** | 2 | **3** | 1 | **16** | 11 |
| Motor gliders and gliders | **1** | 0 | **2** | 1 | **3** | 3 | **1** | 0 | **7** | 4 | **14** | 8 |
| Balloons and airships | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **3** | 0 | **3** | 0 |
| Ultralight aircraft | **1** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **1** | 0 |
| Total | **15** | 11 | **30** | 26 | **26** | 16 | **20** | 15 | **33** | 28 | **124** | 96 |



**3.2.5 Injured persons by role in accidents and serious incidents involving Swiss-registered aircraft in Switzerland and abroad, and foreign-registered aircraft in Switzerland**

| | Accidents and serious incidents involving Swiss-registered aircraft in Switzerland | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | | Aircraft with MTOM of up to 2250 kg | | Aircraft with MTOM of 2250-5700 kg | | Aircraft with MTOM exceeding 5700 kg | | Helicop-ters | | Motor gliders and gliders | | Balloons and airships | | Ultra-light aircraft | |
| | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 |
| Accidents / serious incidents | **90** | 70 | **46** | 48 | **2** | 1 | **14** | 3 | **16** | 11 | **10** | 7 | **2** | 0 | **0** | 0 |
| Fatalities | **31** | 11 | **8** | 8 | **0** | 0 | **20** | 0 | **1** | 1 | **2** | 2 | **0** | 0 | **0** | 0 |
| Crew | **8** | 7 | **2** | 4 | **0** | 0 | **3** | 0 | **1** | 1 | **2** | 2 | **0** | 0 | **0** | 0 |
| Passengers | **23** | 4 | **6** | 4 | **0** | 0 | **17** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Third parties | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Seriously injured persons | **3** | 11 | **1** | 6 | **0** | 0 | **0** | 0 | **1** | 5 | **0** | 0 | **0** | 0 | **0** | 0 |
| Crew | **3** | 5 | **1** | 4 | **0** | 0 | **0** | 0 | **1** | 1 | **0** | 0 | **0** | 0 | **0** | 0 |
| Passengers | **0** | 2 | **0** | 2 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Third parties | **0** | 4 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 4 | **0** | 0 | **0** | 0 | **0** | 0 |

| | Accidents and serious incidents involving Swiss-registered aircraft abroad | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | | Aircraft with MTOM of up to 2250 kg | | Aircraft with MTOM of 2250-5700 kg | | Aircraft with MTOM exceeding 5700 kg | | Helicop-ters | | Motor gliders and gliders | | Balloons and airships | | Ultra-light aircraft | |
| | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 |
| Accidents / serious incidents | **9** | 9 | **2** | 5 | **1** | 1 | **4** | 3 | **1** | 0 | **1** | 0 | **0** | 0 | **0** | 0 |
| Fatalities | **7** | 7 | **3** | 2 | **0** | 5 | **0** | 0 | **4** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Crew | **6** | 2 | **2** | 1 | **0** | 1 | **0** | 0 | **4** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Passengers | **1** | 4 | **1** | 1 | **0** | 3 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Third parties | **0** | 1 | **0** | 0 | **0** | 1 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Seriously injured persons | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Crew | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Passengers | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Third parties | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |

| | Accidents and serious incidents involving foreign-registered aircraft in Switzerland | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | | Aircraft with MTOM of up to 2250 kg | | Aircraft with MTOM of 2250-5700 kg | | Aircraft with MTOM exceeding 5700 kg | | Helicop-ters | | Motor gliders and gliders | | Balloons and airships | | Ultra-light aircraft | |
| | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 | **2018** | 2017 |
| Accidents / serious incidents | **25** | 15 | **11** | 5 | **4** | 1 | **5** | 7 | **0** | 1 | **3** | 1 | **1** | 0 | **1** | 0 |
| Fatalities | **2** | 2 | **2** | 2 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Crew | **1** | 1 | **1** | 1 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Passengers | **1** | 1 | **1** | 1 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Third parties | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Seriously injured persons | **0** | 1 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 1 | **0** | 0 | **0** | 0 |
| Crew | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |
| Passengers | **0** | 1 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 1 | **0** | 0 | **0** | 0 |
| Third parties | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 | **0** | 0 |

# Annex 4

## Aviation data for statistical analysis (chapter 6) and methods and conceptual considerations used

### Measures and their component parts

*Absolute and relative numbers of accidents*
Alongside the absolute numbers of accidents, the relative numbers of accidents – accident rates – have been collected and compared in the accident statistics. This means that whenever the data has allowed it, not only has the number of accidents that occurred been looked at, but also the number of accidents that took place per 1 million air traffic movements. The absolute numbers of accidents, as well as the relative numbers of accidents (i.e. accident rates), each refer to a particular year and a particular aircraft category or to the total of the three defined aircraft categories.

The advantage of accident rates is that they allow comparisons over a longer time period to be made more easily, even if the exposure[15] changes over this time period. As exposure generally fluctuates to a lesser extent than the number of accidents, the advantage of using a rate as a measure has a lesser effect for a period of just a few years.

For accident rates, it is important only to include accidents in the rate whose corresponding exposure is also included. For example, the take-off and landing of a flight from Friedrichshafen (GER), via Switzerland to Grenoble (FRA), is not included in the FOCA's air traffic movement statistics. If this aircraft were to have an accident in Switzerland, this accident must also not be included in this analysis. This is because the FOCA's air traffic movement statistics are included as a component part of the measure of accident statistics. This situation is taken into account in these accident statistics. A similar situation arises for flights from Switzerland to countries abroad or from abroad to Switzerland: accidents that take place during flights from Switzerland to countries abroad or from abroad to Switzerland can potentially occur in foreign territory. In such cases, the STSB is not always notified of the accident. As a result, the STSB is not aware of certain accidents for flights of this type and cannot therefore count them; in order to be consistent, the corresponding exposure must not be included in the measure. These accident statistics take this situation into account, too..

*Accident*
For an aviation event to be classified as an accident for the purpose of these statistics, the STSB must be aware of the event. As soon the STSB is aware of the event, the event is reviewed to see if it meets the criteria for an accident, according to article 2 of (EU) Regulation No. 996/2010[16]. In this analysis, once again only those events classified as an accident are included where at least one person is seriously or fatally injured and where the event was not caused deliberately. The definitions of serious and fatal injuries can also be found in article 2 of (EU) Regulation No. 996/2010.

The reason for only including serious or fatal injuries in the accident statistics is due to the fact that the number of unreported accidents without serious or fatally injured persons is assessed as "not insignificant". If all accidents – or perhaps even the serious incidents – were to be included in the statistics, the figures being looked at would be

[15] Here, exposure is equivalent to the number of air traffic movements.
[16] (EU) Regulation No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and inci-dents in civil aviation and repealing Directive 94/56/EC.

higher and it would be easier to make statistical statements. However, these statements would more likely describe the reporting system and reporting culture, rather than safety.

*Air traffic movement*

Air traffic movements are used to quantify the exposure for the accident statistics. Figures for air traffic movements are provided by the FOCA. The FOCA collects these figures using forms that have been completed and submitted by the majority of aerodromes and heliports since 2007. Take-offs and landings are normally considered to be air traffic movements, meaning that a flight from A to B results in two air traffic movements. However, the term is not precisely defined by the FOCA. The following types of air traffic movements are not recorded in the FOCA's data collection:

– Movements on certain military airfields;
– Movements on open terrain, for example, off-airport landings of gliders or landings and take-offs of helicopters on open terrain during work flights;
– Take-offs and landings abroad, even when the flight passes over Swiss territory.

Movements at Basel/Mulhouse/Freiburg Airport are recorded by the FOCA, but are not included in the STSB's analysis. This airport is not in Swiss territory. As a consequence of this, accidents that occur at this airport, or in the French area surrounding this airport, are neither reported to the STSB, nor investigated by the STSB.

*Aircraft category*

The following three aircraft categories have been analysed:

– Aeroplanes with a maximum take-off mass of up to 5700 kg (including motor gliders and touring motor gliders in powered flight);
– Gliders (including motor gliders and touring motor gliders when gliding);
– Helicopters.

Furthermore, analysis has been carried out where the accidents involving the three aircraft categories were examined jointly and were not separated into the three categories ("total").

For motorised aircraft with a maximum take-off mass exceeding 5700 kg (in particular for commercial air-craft) as well as for airships and balloons, no statistics are produced due to the sample sizes being too small.

*Statistical method*

The number of accidents $U_t$ in the year $t$=2007,...,2018, is a discrete random parameter range. In this case, the standard model is given by the Poisson distribution function.

$$U_t \sim Poisson(\lambda_t).$$

Here, parameter $\lambda_t$ is the anticipated number of accidents in the year $t$, i. e. $E[U_t] = \lambda_t$. The number of accidents over time is modelled with a Poisson regression, i. e.

$$\log(\lambda_t) = \beta_0 + \beta_1 \cdot t.$$

TThe temporal development of the anticipated number of accidents can be read from the $\beta_1$ parameter. In practice, the number of accidents changes from one year to the next by coefficient $\exp(\beta_1)$. If $\beta_1$ is negative, the anticipated number of accidents decreases over time, otherwise, it increases. The $\beta_0, \beta_1$ ccoefficients are estimated using the maximum likelihood method within the generalised linear model framework. For all adapted models, the null hypothesis $\beta_1 = 0$ is tested in each case. This corresponds to the statement "no change in the anticipated number of accidents" over time. The test result is given by the p-value. This parameter in the interval [0,1] states how compatible the observed data are with the claim of the null hypothesis (the bigger, the more compatible). The commonly used threshold, which is also used here, is 0.05. Which means: If the p-value is less than 0.05, the change in the number of accidents is called "significant". If the p-value is equal to or greater than 0.05, then the change is called "not significant".

A Poisson-rate model is used to estimate the accident rate. Here, the development of the accident rate, to which a logarithm is continuously applied, is described using a linear model, i.e.

$$\log\left(\frac{U_t}{n_t}\right) = \beta_0' + \beta_1' \cdot t$$

In this case $U_t$ remains the accident rate in year $t$ . In addition, $n_t$ is the population size, i. e. the number of flight movements in year $t$ . We regard the latter as a fixed observation value and therefore convert to:

$$\begin{aligned} \log(U_t) &= \log(n_t) + \beta_0' + \beta_1' \cdot t \\ &\Leftrightarrow \\ U_t &= n_t \cdot \exp(\beta_0' + \beta_1' \cdot t) \end{aligned}$$

Here, the population size $n_t$ is used as an offset in the generalised linear model. That means the impact of the population size on the accident is assumed to be directly proportional without estimating a coefficient for this. Thus, we remain conceptually in the framework of the Poisson regression; after all, it is still true that:

$$U_t \sim Poisson(\lambda_t')$$

The parameter $\lambda_t'$ here is now the exposure-corrected anticipated number of accidents per year. Again, the model is estimated using maximum likelihood estimation in the generalised linear model framework. it is even more important that the accident rate's development over time can be deduced from the parameter $\beta_1'$ In practice, the accident rate changes from one year to the next by the factor $\exp(\beta_1')$. If $\beta_1'$ is negative, the accident rate decreases and if $\beta_1'$ is positive, the rate increases. Just as for the number of accidents, it is possible to make statements about the significance of this change, i.e. again, the null hypothesis $\beta_1 = 0$ is tested for all adjusted models, which is equivalent to the statement "no change in anticipated accident rate" over time. The test result is given by the p-value. This parameter in the interval [0,1] states how compatible the observed data are with the claim of the null hypothesis (the bigger, the more compatible). The commonly used threshold, which is also used here, is 0.05. Which means: If the p-value is less than 0.05, the change in the number of accidents is called "significant". If the p-value is equal to or greater than 0.05, then the change is called "not significant".

NB) The accident rate is reported extrapolated to 1 million (gliders and helicopters 100 000) flight movements for easier readability (see tables below).

## Data and results of calculations (diagrams in chapter 6)

**Motorised aircraft with maximum take-off mass of 5700 kg:**

| Year | Number of aircraft movements | Number of accidents | Calculated accident rate | Calculated anticipated number of accidents | Calculated anticipated accident rate |
|---|---|---|---|---|---|
| 2007 | 629 846 | 3 | 4.7631 | 3.2432 | 5.0226 |
| 2008 | 627 770 | 6 | 9.5576 | 3.3524 | 5.2598 |
| 2009 | 651 746 | 2 | 3.0687 | 3.4653 | 5.5082 |
| 2010 | 607 227 | 4 | 6.5873 | 3.5820 | 5.7684 |
| 2011 | 654 074 | 4 | 6.1155 | 3.7026 | 6.0408 |
| 2012 | 591 434 | 3 | 5.0724 | 3.8273 | 6.3262 |
| 2013 | 579 790 | 1 | 1.7248 | 3.9562 | 6.6249 |
| 2014 | 603 165 | 4 | 6.6317 | 4.0894 | 6.9378 |
| 2015 | 589 493 | 7 | 11.8746 | 4.2271 | 7.2655 |
| 2016 | 552 385 | 1 | 1.8103 | 4.3694 | 7.6087 |
| 2017 | 570 367 | 7 | 12.2728 | 4.5165 | 7.9680 |
| 2018 | 562 397 | 5 | 8.8905 | 4.6686 | 8.3444 |

**Gliders:**

| Year | Number of aircraft movements | Number of accidents | Calculated accident rate | Calculated anticipated number of accidents | Calculated anticipated accident rate |
|---|---|---|---|---|---|
| 2007 | 95 132 | 2 | 2.1023 | 4.7010 | 5.1545 |
| 2008 | 86 438 | 8 | 9.2552 | 4.2671 | 4.8190 |
| 2009 | 86 444 | 3 | 3.4705 | 3.8733 | 4.5054 |
| 2010 | 77 286 | 2 | 2.5878 | 3.5158 | 4.2121 |
| 2011 | 86 634 | 4 | 4.6171 | 3.1913 | 3.9380 |
| 2012 | 74 474 | 6 | 8.0565 | 2.8968 | 3.6817 |
| 2013 | 71 066 | 2 | 2.8143 | 2.6295 | 3.4421 |
| 2014 | 79 487 | 0 | 0.0000 | 2.3868 | 3.2180 |
| 2015 | 78 136 | 1 | 1.2798 | 2.1665 | 3.0086 |
| 2016 | 65 755 | 4 | 6.0832 | 1.9666 | 2.8128 |
| 2017 | 67 121 | 2 | 2.9797 | 1.7851 | 2.6297 |
| 2018 | 67 439 | 1 | 1.4828 | 1.6203 | 2.4585 |

**Helicopters:**

| Year | Number of aircraft movements | Number of accidents | Calculated accident rate | Calculated anticipated number of accidents | Calculated anticipated accident rate |
|---|---|---|---|---|---|
| 2007 | 155 579 | 2 | 1.2855 | 2.9505 | 1.8271 |
| 2008 | 166 628 | 2 | 1.2003 | 2.9740 | 1.8388 |
| 2009 | 184 304 | 4 | 2.1703 | 2.9977 | 1.8506 |
| 2010 | 150 751 | 4 | 2.6534 | 3.0216 | 1.8624 |
| 2011 | 153 923 | 3 | 1.9490 | 3.0457 | 1.8744 |
| 2012 | 160 267 | 4 | 2.4958 | 3.0700 | 1.8864 |
| 2013 | 156 857 | 4 | 2.5501 | 3.0944 | 1.8985 |
| 2014 | 167 358 | 2 | 1.1950 | 3.1191 | 1.9106 |
| 2015 | 166 314 | 2 | 1.2025 | 3.1440 | 1.9229 |
| 2016 | 159 764 | 3 | 1.8778 | 3.1690 | 1.9352 |
| 2017 | 161 411 | 5 | 3.0977 | 3.1943 | 1.9476 |
| 2018 | 171 325 | 2 | 1.1674 | 3.2197 | 1.9601 |

**All categories:**

| Year | Number of aircraft movements | Number of accidents | Calculated accident rate | Calculated anticipated number of accidents | Calculated anticipated accident rate |
|---|---|---|---|---|---|
| 2007 | n/a | 7 | 10.6038 | n/a | n/a |
| 2008 | n/a | 16 | 10.4736 | n/a | n/a |
| 2009 | n/a | 9 | 10.3451 | n/a | n/a |
| 2010 | n/a | 10 | 10.2182 | n/a | n/a |
| 2011 | n/a | 11 | 10.0928 | n/a | n/a |
| 2012 | n/a | 13 | 9.9690 | n/a | n/a |
| 2013 | n/a | 7 | 9.8467 | n/a | n/a |
| 2014 | n/a | 6 | 9.7259 | n/a | n/a |
| 2015 | n/a | 10 | 9.6066 | n/a | n/a |
| 2016 | n/a | 8 | 9.4887 | n/a | n/a |
| 2017 | n/a | 14 | 9.3723 | n/a | n/a |
| 2018 | n/a | 8 | 9.2573 | n/a | n/a |



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