Swiss Transportation Safety Investigation Board STSB
Annual Report 2022


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Swiss Transportation Safety Investigation Board STSB

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1 Editorial

Over the last 10 years, the number of notifications of safety-relevant events reported to the Swiss Transportation Safety Investigation Board (STSB) has been steadily increasing. In 2022, we had to deal with a record number of notifications from the aviation sector (1,828 cases in total). This does not mean that flying has become less safe. In fact, apart from the pandemic-related slump, more and more flights are being made. We also assume that incidents are being reported more frequently, so we are getting a clearer picture of what is happening in the transport sector in terms of safety. This would be very welcome and very much in the interests of improving safety, because we need to know that incidents and events have happened if we are to carry out an independent investigation. The lessons learned help the industry to raise its safety awareness and thus avoid similar incidents in the future.

For the STSB, however, the increasing number of notifications we receive each year is also a huge challenge. The STSB on-call services who receive these notifications have to go out to the accident sites in some cases and quickly assess whether carrying out an investigation into the incident could have a preventive safety effect. The more notifications we receive, the more time these preliminary enquiries take – time that is then lacking for an in-depth investigation into the incidents. In today's highly digitalised world, this often requires securing, retrieving and interpreting data. The capacities in the STSB's flight and tachograph laboratory are thus increasingly becoming a bottleneck in investigation procedures. STSB staff are stretched to the limits of their resources, and although we – as an extra-parliamentary commission – have initiated various organisational measures to improve the situation, we will, in future, have to deploy ad-

ditional resources in the laboratory in order to uphold our legal mandate of improving safety in aviation, public transport and shipping.

Pieter Zeilstra
President of the extra-parliamentary commission

2 Management Summary

The STSB received 2,165 incident notifications in 2022. Following assessment, these resulted in 42 new investigations. A total of 24 extensive and 32 summary investigations were completed during the year, and one interim report was published on ongoing investigations. In the course of those extensive investigations, both completed and still in progress, the STSB identified safety deficits that led it to issue 13 safety recommendations and seven safety advices. These figures are distributed as follows across the different modes of transport:

The STSB received five notifications of incidents concerning maritime navigation in 2022. These did not result in an investigation being opened or in any reports being published.

The STSB received a record number of 2,165 incident notifications in the year under review, a development that is mainly due to the Aviation Division receiving 1,828 notifications. The Rail/Navigation Division received notifications in the range of the average of the last eight years.

	Aviation	Public transport
Incidents reported	1828	337
Opened investigations	27	15
Interim reports published	1	0
Extensive investigations completed	15	9
Summary investigations completed	21	11
Safety recommendations issued	6	7
Safety advices issued	4	3

With a total of 56 investigations completed, the STSB's output is comparable to that of 2020 (61), but below that of last year in 2021 (87). In addition to the investigations completed, 25 investigations were discontinued in 2022.

3 The STSB

3.1 Remit

The STSB investigates incidents in civil aviation, public transport and maritime navigation in accordance with the requirements of the Swiss Ordinance on the Safety Investigation of Transport Incidents (OSITI; SR 742.161). 'Incidents' refers to both accidents and other events termed 'serious incidents', the investigation of which may help to improve safety.

The investigations consist of an independent examination of the technical, operational and human circumstances and causes that led to the incident. The findings are intended to help prevent similar incidents in the future. As stated explicitly in the Swiss Railways Act (RailA; SR 742.101) and the Swiss Aviation Act (AviA; SR 748.0), questions of blame and liability are beyond the scope of the investigations.

Where the STSB establishes safety deficits in the course of its investigations, it issues safety recommendations to the competent supervisory authorities, or safety advices to the companies, bodies or organisations concerned. The task then is to determine what measures are appropriate to reduce or eliminate the risks attached to the deficit that has been identified. The authorities do this as part of their supervisory activities, the companies as part of their safety management systems.

The STSB collates and publishes the findings of investigations in the form of reports aimed at professionals in the sectors concerned and the interested public. They are explicitly not addressed to prosecution and administrative authorities.

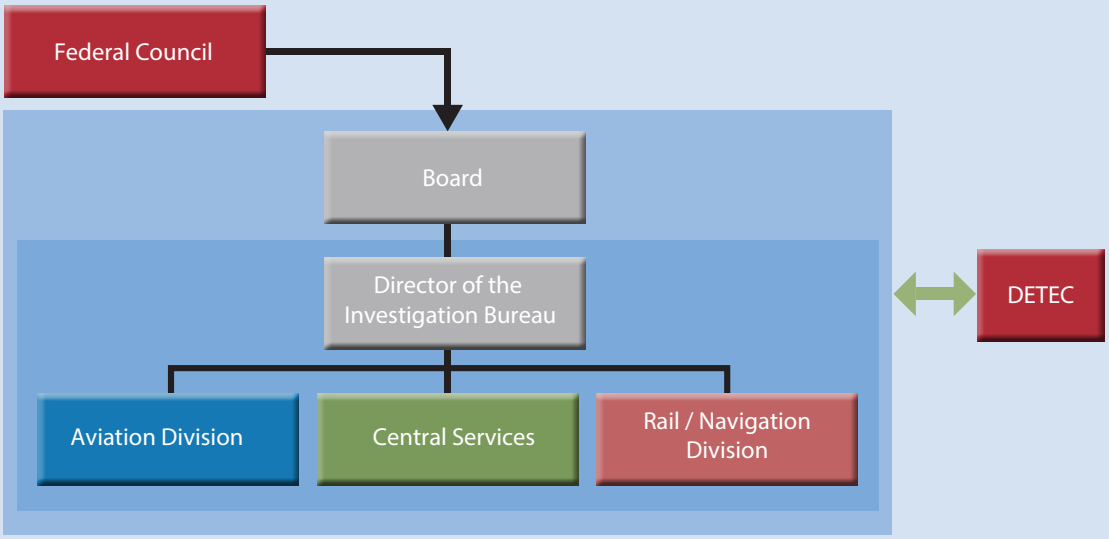
The STSB forms part of the overall transport safety framework in Switzerland. This is made up of companies, authorities and organisations, such as transport operators, manufacturers, vehicle keepers, safety investigation bodies, supervisory authorities, accreditation and certification bodies, conformity assessment bodies, and others. Each element of the system helps to ensure the safety of its particular mode of transport by performing specific tasks that are assigned to it under the relevant legal provisions.

3.2 Organisation

The STSB is structured as an extra-parliamentary commission under Articles 57a57 g of the Swiss Government and Administration Organisation Act (GAOA; SR 172.010). The Board is appointed by the Federal Council. It comprises between three and five independent experts from the relevant fields within the transport sector, and has an Investigation Bureau which is responsible for conducting the investigation process. Administratively, the STSB is attached to the General Secretariat of the Federal Department of the Environment, Transport, Energy and Communications (DETEC), although it acts independently.

3.3 Performance targets

The Federal Administration's New Management Model (NMM) was introduced on 1 January 2017. It is designed to strengthen administrative management at all levels and to increase the transparency and manageability of performance. Within the framework set by the NMM, the STSB defined the following projects, initiatives and performance targets for 2022:



Projects and initiatives

– Revision of the Ordinance on the Safety Investigation of Transport Incidents (OSITI; *SR 742.161*): In 2022, a draft revision proposal was prepared and discussed with key stakeholders and finalised. Points still need to be clarified between the STSB and the judicial authorities as a result of the Federal Council's report in response to postulate 20.3463 and questions raised by the National Council FDHA-DETEC Sub-Committee of the National Council Control Committee. The results of these clarifications will be available in the first quarter of 2023.

Performance targets

The STSB sets itself challenging performance targets regarding the application of the latest recognised investigation methods and the swift publication of investigation findings.

Targets and indicators	2022 TARGET	2022 ACTUAL	2023 PLAN
Conformity assessment: The internal guidelines and procedures in the Aviation Division are in line with the latest international requirements.			
One conformity assessment procedure annually in accordance with ICAO Annex 13, EU Regulation No 996/2010 (yes/no)	yes	yes	yes
Rapid conduct of safety investigations: By applying suitable measures, the STSB ensures that incident investigations are conducted promptly and in compliance with the law.			
Prompt completion of safety investigations concerning serious incidents and accidents involving aircraft (%, minimum)	80	4	50
Prompt completion of safety investigations concerning serious incidents and accidents involving railways, buses and boats (%, minimum)	80	55	50

The targets for the prompt completion of safety investigations were not met. As already explained in the 2021 and 2020 annual reports, there is a conflict between the quantitative measurement criteria of the target of completing safety investigations rapidly (80%) and the STSB's internal objective of reducing pending cases by working through older investigations. The decision to concentrate on working through older pending cases generates a relatively higher proportion of reports for which the set deadlines cannot be met, a situation that will continue for several years to come. For this reason, the STSB has adjusted the NMM performance targets downwards, for the years 2023–2025, to challenging but achievable levels in the medium term.
In the Aviation Division, a record number of notifications were received in 2022 (see chapters 4.1 and 4.2). In assessing the notifications received, the highest priority is always given to whether the relevant incident should be investigated. The increasing number of notifications and the on average increasing effort of these assessments (due to having to evaluate recording devices) leads to fewer resources being available to carry out investigations. Recording devices can take several months to evaluate, depending on the circumstances of the incident, which leaves only a few months to carry out the actual investigation within the stipulated 12-month deadline.

3.4 Resources

The STSB had a budget of approximately CHF 7.8 million available in 2022. Of this, CHF 3.8 million was budgeted for personnel expenses, and CHF 4 million for material and operating expenses. The latter item included CHF 1.7 million for external services. The STSB uses this to finance investigations conducted by external experts and specialist organisations. The budgets were utilised at a rate of 93% for personnel and 94% for material and operating expenses.

As is also usual in other countries, the work of the STSB is a basic service provided by the state to improve safety. It is therefore almost exclusively publicly funded. Consequently, all STSB products, and in particular the final reports on investigations, are provided free of charge on the internet.

The STSB Investigation Bureau has a staff of 16.2 FTEs shared between 17 employees. In its investigative activities, especially when specific specialist skills are required, the STSB can also call upon the support of 129 external contract investigators.

4 Investigations and findings

4.1 Overview of investigations by the entire Investigation Bureau

The STSB received 2,165 notifications in the year under report. Following assessment, these resulted in 42 new investigations. A total of 24 extensive and 32 summary investigations were completed during the year, and one interim report on ongoing investigations was published. In the course of those extensive investigations, both completed and still in progress, the STSB identified safety deficits that led it to issue 13 safety recommendations and seven safety advices. These figures are distributed as follows across the different modes of transport:

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The STSB received five notifications of an incident concerning maritime navigation in 2022. These did not result in an investigation being opened or in any reports being published.

In both 2018 and 2019, the STSB received over 1,800 incident notifications. In 2020, the number dropped to 1,215, but by the following year in 2021, the number had risen to 1,655. In the year under review, a record number of 2,165 notifications were received. This development is mainly due to notifications received by the Aviation Division (see chapter 6.1). In the Rail/Navigation Division, the number of incidents reported per year has fluctuated between 297 and 384 since 2011, with no apparent trend.

With a total of 56 investigations completed, the output of the STSB is comparable to that of 2020 (61), but below that of last year 2021 (87). In addition, 25 investigations were discontinued in 2022 (Annex 1: Discontinued investigations in the Aviation Division, Annex 2: Discontinued investigations in the Rail/Navigation Division).

4.2 Aviation

The STSB received 1,828 notifications of incidents in aviation during 2022. Each of these was reviewed in terms of its potential preventive value. In many cases, additional technical aids were brought in to assess the danger in incidents that were thought to be serious, especially aircraft proximity hazards (airproxes), where there is a risk of collision between two aircraft. These preliminary enquiries resulted in a total of 10 accident investigations and 17 serious incident investigations, including 6 airproxes involving a high or significant risk of collision. An extensive investigation was opened for 15 incidents, whilst the initial investigation findings suggested a summary investigation for 9 events. In the remaining cases, the necessary scope of investigation is still open. One opened investigation was delegated to a foreign authority for reasons of non-independence.

There were 36 investigations completed and their findings published in 15 final and 9 summary reports. The final reports contained five safety recommendations and three safety advice notices (Chapter 5.2). A further safety recommendation and a safety advice were published with an interim report.

Aviation experienced a marked upswing in 2022 after the decline of previous years, especially in commercial air travel. This was also reflected in the number of reported incidents, which increased to 1,828 reports compared to the year 2021, when 1,309 reports were recorded (see also chapter 6.1).

In the reporting year, there were 9 accidents involving aircraft registered in Switzerland. As a result, 3 people suffered fatal injuries.

Based on the objective of an investigation and the mandate to use the available resources in such a way that the greatest possible effect can be achieved, the STSB Investigation Bureau reviewed the pending cases and identified those where it became apparent in the course of the investigations that, for various reasons, the potential preventive value was low. In the process, 24 cases were identified in which the investigation was discontinued in order to fulfil the requirement of effective and purposeful use of the funds.

4.3 Public transport

Railways and tram

The STSB received 283 notifications of safety-related incidents concerning trains (271) and trams (12) in 2022. An investigator-in-charge attended the scene in 27 cases. An analysis of the notifications with a view to their preventive potential value resulted in an investigation being opened in 12 cases. These involved four industrial accidents, two derailments, four collisions and one incident each related to a natural event and the failure of a safety device.

A total of nine extensive and seven summary investigations were completed last year. In response to the safety deficits identified during the extensive investigations, the STSB addressed seven safety recommendations to the supervisory authority and three safety advice notices to the carriers/infrastructure managers (Chapter 5.3). In the course of one investigation, it was found that no significant preventive effect could be achieved by publishing the results. Consequently, it was discontinued.

The investigation into the broken driving pinion on the Brünig line of the Zentralbahn railway company required extensive investigation to determine the cause. The specialist knowledge of recognised experts was available for the investigation. Last year, the STSB also dealt with a number of industrial accidents in which people had been fatally injured on construction sites and seriously injured on railway sidings.

Cableways

There were 26 notifications of safety-related events involving cableways during the reporting year. An investigator-in-charge attended the scene in three cases. Preliminary enquiries resulted in an investigation being opened into all three incidents. In two cases, employees carrying out maintenance work on towers during operation were seriously or fatally injured. One case involved a cable car coming into contact with the terrain. The STSB concluded two summary investigations into this mode of transport during 2022.

Buses

Eighteen bus-related incidents were reported in 2022. An investigator-in-charge attended the scene in one case. No investigations were opened.

Inland navigation

Five notifications of inland navigation incidents were submitted to the STSB in 2022. No investigations were opened.

4.4 Maritime navigation

Five incident notifications concerning maritime navigation were received during the reporting year. None of the reported cases met the criteria for opening an investigation; neither were any reports published for this mode of transport in 2022.

5 Safety recommendations and safety advices

5.1 General

In the first half of the last century, accidents in the transport sector were usually investigated by the supervisory authority for the mode of transport concerned. 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, state-run safety investigation body exists, which is expected to impartially clarify the reasons for an accident or a serious incident. In Switzerland, the Railways Act (RailA; SR *742.101*) and the Aviation Act (AviA; SR 748.0) provide the legal framework for such an independent safety investigation body.

Because of the separation of powers, an investigation body does not itself mandate safety measures to the relevant authorities. These retain their full responsibility. The safety investigation body – the STSB in Switzerland – identifies any safety deficits and issues the corresponding safety recommendations in an interim or final report to the relevant supervisory authority or government department. It is then up to the body to which the safety recommendation was directed to decide – along with the stakeholders concerned – whether and how the safety recommendations should be implemented. This principle applies to all modes of transport for which the STSB is responsible for investigating incidents. International and thus national legal foundations contain different arrangements for individual modes of transport, however. These affect the specific steps that are taken and are described below.

The EU established the European Union Aviation Safety Agency (EASA) in 2002. The EASA's mission is to provide uniform and binding rules on aviation safety in the European aviation sector on behalf of the member states. 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. For this reason, the STSB addresses its safety recommendations concerning aviation to either the EASA or the Federal Office of Civil Aviation (FOCA), depending on the area of competence. In individual cases the authority to act to rectify a safety deficit may lie with another authority in Switzerland or abroad. In these cases the STSB addresses its safety recommendation to the competent authority concerned.

Regulation by the EU is becoming increasingly important for the railways, in particular where technical and operational interoperability in international transport are concerned. Meanwhile, responsibility for overseeing railway safety essentially lies with the national safety supervisory authority, which in Switzerland is the Federal Office of Transport (FOT). However, since June 2019, the European Union Agency for Railways (ERA) has issued safety certificates and market authorisations for vehicles, and given its approval for train control and train safety projects. As a further result of the changes to the legal foundations in the railway sector, other authorities and organisations also take on a supervisory role alongside the national authority. These include the Swiss Accreditation Service (SAS), as well as certification bodies for companies that are responsible for maintenance. The STSB addresses its safety recommendations to that authority or body whose mandate gives it the power to implement or order action on the basis of the recommendation submitted to it.

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

The regulations applying to licensed inland navigation in Switzerland are primarily national ones. 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. The 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 drafting 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 to Switzerland specifically. Any safety recommendations from the STSB are therefore addressed to the Swiss Maritime Navigation Office (SMNO) as the national supervisory authority.

Having received a safety recommendation, the addressee notifies the STSB of the action it intends to take to rectify the safety deficit, as well as a timeline for its implementation. Feedback from addressees and information on the current status of implementation can be found on the STSB website (https://www.sust.admin.ch/en/safety-recommendations/aviation and https://www.sust.admin.ch/en/safety-recommendations/railnavigation).

Occasionally, an investigation brings safety deficits to light that cannot be eliminated by amending rules or regulations or by direct supervisory activity, but rather by changing or improving awareness of risk. In these cases the STSB formulates a safety advice which is addressed to particular transport-related stakeholder or interest groups. This is intended to help the companies, people and organisations concerned to identify a risk and the associated action that is required. The legal foundations do not provide for feedback on the implementation of measures taken in response to safety advices. Unlike safety recommendations, safety advices are not published separately on the STSB website.

All of the safety recommendations and safety advices issued by the STSB in interim or final reports during 2022 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.

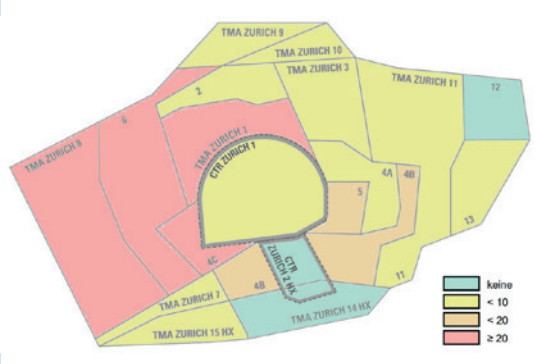
5.2 Aviation

Dangerous proximity (airprox) between a commercial aircraft and a motorised aircraft, 18 NM northwest of Zurich Airport, 13.10.2019

On 13 October 2019, an airprox occurred between a British Airways commercial aircraft and a four-seater motorised aircraft west of Zurich Airport in the Terminal Control Area (TMA) of Zurich Airport because the motorised aircraft had entered the TMA without clearance.

Safety deficit

Airspace violations of this kind occur several hundred times a year. They are classified as a significant risk because of the high number of incidents that occur and the possible consequences of a collision.



Situations in which large commercial aircraft and general aviation aircraft operating under visual flight rules come into close proximity contribute to a deficit in safety because the latter enter airspaces that are primarily used for air traffic under instrument flight rules without clearance from air traffic control.

This is why an increase in airprox incidents in Swiss airspace can also be observed in the period from 2008 to 2019.

The STSB had already identified this safety deficit in numerous investigations and issued the following safety recommendations (SR) to the FOCA:

SR No 466 (16.05.2013): Implementation of transponder zones

SR No 467 (16.05.2013): Measures to ensure that airspace boundaries are respected

SR No 468 (16.05.2013): Systematic recording of airspace violations (even without transponders) and reduction of the associated risks
SR No 484 (19.08.2014): Examination and simplification of the airspace structure around Zurich Airport
SR No 518 (20.03.2017): The carriage of an operational and switched-on transponder for all aircraft
SR No 519 (20.03.2017): The redesign of adequately dimensioned airspaces around Swiss airports
SR No 520 (20.03.2017): Measures to warn air traffic controllers of unauthorised flights into controlled airspaces

The FOCA intends to eliminate this safety deficit within the framework of the large-scale National Airspace and Aviation Infrastructure Strategy project (or AVISTRAT-CH for short). However, it is not expected to be fully implemented before 2035.

Safety recommendation No 574, 24.05.2022
Prior to the full implementation of the AVISTRAT-CH project and in a timely manner, the FOCA should take appropriate measures, including measures in the area of safety recommendations No 466, 467, 468, 484, 518 and 519 already issued, to ensure that the risk of an airprox as a result of an airspace violation is reduced.

Near collision between a business jet and a motorised aircraft over the town of Martigny (VS), 18.02.2017

In good weather, in class E airspace, a twin-engine business jet following an instrument departure from Sion Airport came dangerously close to a single-engine turbine aircraft cruising at flight level 150 and flying under visual flight rules).

Safety deficit
The climbing aircraft was in radio contact with Geneva Air Traffic Control INS (INI South), the cruising aircraft with the Geneva Flight Information Centre (FIC). The potential conflict was flagged by the air navigation service's Short Term Conflict Alert (STCA) and was transmitted to the pilots of both aircraft. Neither pilot was able to visually detect the threat. The twin-engine aircraft was below the minimum surveillance altitude, the RE INS air traffic controller was therefore not authorised to conduct radar vectoring to resolve the potential conflict. The twin-engine aircraft's Traffic Alert and Collision Avoidance System (TCAS) issued corrective resolution advisories (RAs), which the flight crew correctly followed. The aircraft passed within a distance of 0.4 NM horizontally and 675 ft vertically of each other. At no time did the pilots, air traffic controllers or FIC operators violate the rules of the air.

Safety recommendation No 575, 31.05.2022
The FOCA should reconsider the classification of the airspace affected by IFR arrivals and departures from Sion so that all flights operating there can be managed by the air traffic control service.

Microlight aircraft accident in Arosa (GR), 29.12.2019

A Zlin Savage Classic microlight aircraft registered in France and based in Switzerland crashed in the Arosa area (GR).

Safety deficit
The type could not be approved in Switzerland, but could be operated in Switzerland with a foreign type certificate. A significant number of such microlight aircraft registered abroad are still stationed and operated in Switzerland.
This means that there is a safety deficit involving aircraft operating in Swiss airspace that cannot be certified in Switzerland and whose operation is subject to few minimum requirements, depending on the country of registration. Fundamental safety-relevant aspects such as the medical fitness of the pilots or the aircrafts' centre of gravity positions are not considered.

Safety recommendation No 577, 31.05.2022
The FOCA should take measures to ensure that the operation of microlight aircraft in Swiss airspace meets minimum safety requirements. At the same time, it should be considered whether microlight aircraft that meet these minimum requirements can also be licensed in Switzerland.

Propeller loss on a motorglider, Benken (SG), 19.07.2021

In a motorglider Arcus T built in 2011, which was equipped with an auxiliary Solo Aircraft Engine 2350 D with the serial number 239, the propeller axle broke during the engine start and the propeller crashed to the ground from a height of about 630 m. At that time, the engine and the propeller axle had had a total of 72 hours of operation.

Safety deficit
During the investigation, it was found that the propeller axle was made of ETG88 steel, which is an easily machinable steel. The fracture surface of the propeller axle was heavily coated with corrosion products and the axle had failed due to a fatigue fracture. The axle surface showed clear signs of pitting corrosion. The fracture occurred at the transition radius from a smaller to a larger axle diameter. On an identical propeller axle of the engine with serial number 248 with about 56 operating hours, a crack test revealed a crack about 15 mm long in the same place.

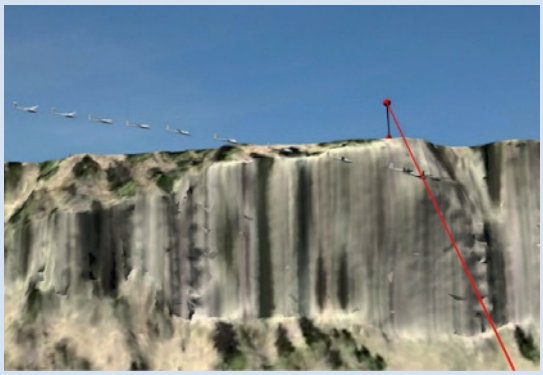
Safety recommendation No 582, 23.08.2022
The European Union Aviation Safety Agency (EASA), in cooperation with the aircraft manufacturer Schempp-Hirth and the manufacturer of the auxiliary engine Solo Vertriebs- und Entwicklungs GmbH, should take appropriate measures to ensure that the propeller axles of all engine models of the 2350 series have sufficient structural strength. In material science, the term 'structural strength' refers to the determined fatigue strength of a component in its specific shape.

Safety deficit
The propeller axle had been installed in the motorglider when it was manufactured in 2011. Since then, the axle had never been subjected to any maintenance measures such as a crack test, which was also not a requirement of the manufacturer. The manufacturer had also not specified a lifetime limit for the axle.

Safety recommendation No 583, 23.08.2022
The European Union Aviation Safety Agency (EASA), in cooperation with the aircraft manufacturer Schempp-Hirth and the manufacturer of the auxiliary engine Solo Vertriebs- und Entwicklungs-GmbH, should define appropriate specifications concerning the maintenance of the auxiliary engine and in particular its propeller axle.

Collision of a glider with an obstacle near Bettlachberg, 03.05.2020

On 3 May 2020, a DG-1000S glider equipped with a Flarm collision warning system collided with a power line while descending along a terrain edge.



Safety deficit
Air navigation obstacles such as power lines, cableways and radio masts are integrated in obstacle databases in the Flarm collision warning system for different regions, such as the Alps, Germany, Switzerland, Austria and northern Italy. Databases that cover a large geographical area, such as the database for the Alps region, usually do not include antennas, towers and power lines.
The power line with which the glider collided was not included in the ALPS20200130 obstacle database that was current at the time of the accident and installed in the collision warning system. This is why the collision warning system did not trigger an obstacle warning.

Safety advice No 41, 17.05.2022
The manufacturer of the Flarm collision warning system should in future offer a solution in which all known air navigation obstacles are contained in a database.
Until then, users should be aware of this identified safety deficit and specifically configure the system with the most suitable obstacle database.

Collision with the terrain in the mountains, Col Durand (VS), 27.07.2018

On 27 July 2018, a motorised aircraft on a mountain tour collided with terrain while flying over the Mont Durand pass; all four occupants died immediately on impact.

Safety deficit
The pilot had decided to make sightseeing flights from Sion airport in a four-seater low-wing aircraft to show his passengers the Matterhorn region. For the second flight, the pilot refuelled the aircraft and allowed three passengers to climb on board. The aircraft was close to the maximum allowable take-off mass, the temperature was ISA +15 °C and the pilot had had minimal flight training.
On the approach to Mont Durand, the aircraft flew two circular turns to gain altitude for crossing the Mont Durand pass. At the end of this manoeuvre, the aircraft collided with a boulder field on the north side of the Mont Durand ridge.

Safety advice No 42, 03.05.2022
Flying clubs should have more stringent requirements for private pilots who wish to conduct sightseeing flights with passengers in the mountains. Particular attention should be paid to the degradation in aircraft climb performance in hot weather and high mass. A flight in these conditions should take place with an instructor on board to review tactics for mountain flying before taking passengers.

Accident involving a motorised aircraft in the mountains, Simplon Pass (VS), 25.08.2019

On 25 August 2019, a four-seater, foreign-registered motorised aircraft collided with the side of a mountain south-east of the Simplon Pass while attempting to fly over it to the south. All three occupants were fatally injured and the aircraft caught fire.

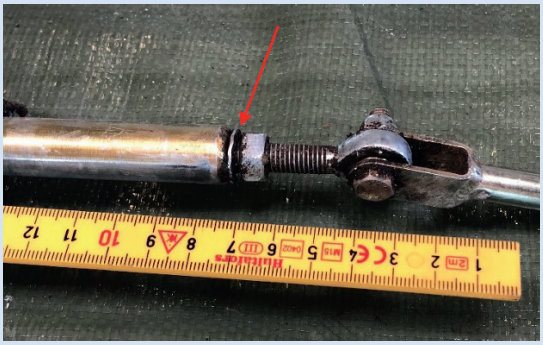
Safety deficit
The pilot flew the aircraft from Brig into the valley leading to the Simplon Pass at an altitude of 2,200 ft below the minimum safety altitude recommended for crossing the pass. The flight continued with a low rate of climb and a nose-up attitude throughout the approach to the pass.
The pilot did not notice that the plane's speed was decreasing while he was busy navigating with his electronic tablet. The Simplon Pass was on his right when the aircraft eventually stalled.

The investigation revealed that preparations had been made for the flight with the aid of an electronic tablet and that the pilot followed the flight path on his tablet during the approach to the Simplon Pass.

Safety advice No 45, 15.11.2022
General aviation operators in Europe should emphasise the dangers of navigating through mountain passes and adapt flying tactics in line with the pre-established flight plan.
For mountain flights, many recommendations on safety measures such as flying tactics, flight plan and equipment can be found in the VFR manual under rules of the air and air traffic services (RAC) 4-5-2, 4-5-3.

Glider accident in the mountains, 28.05.2022

On the afternoon of 28 May 2022, several pilots saw a glider in a spin (vrille) and, after a few rotations around its longitudinal axis, it hit the steep mountain slope at about 2500 m/M.



Safety deficit
On a self-launching glider of the type DG 800 B that had been involved in an accident, various lock nuts on the rod ends of the control rods were loose, which could not be explained by the consequences of the accident. From this it can be concluded that the connections had already loosened before the accident and that this condition may have existed for some time. Untightened or incorrectly secured lock nuts on the control rods can affect the operational safety of the control elements.

Safety recommendation No 584, 16.08.2022 (from interim report)
The European Union Aviation Safety Agency (EASA), in co-operation with the aircraft manufacturer DG-Flugzeugbau GmbH, should take measures to ensure that gliders of the type DG 800 B can be operated safely with regard to the installation of the rod ends.

Safety deficit
On a self-launching glider of the type DG 800 B that had been involved in an accident, various lock nuts on the rod ends of the control rods were loose, which could not be explained by the consequences of the accident. From this it can be concluded that the connections had already loosened before the accident and that this condition may have existed for some time.
Untightened or incorrectly secured lock nuts on the control rods can affect the operational safety of the control elements. It is possible and likely that the design of the control elements in the DG-800 B are used in a similar way in other glider models and by other manufacturers. For this reason, it is likely that the above-mentioned safety deficit also occurs with other glider types and with other manufacturers.

Safety advice No 43, 16.08.2022 (from interim report)
Manufacturers, operators and owners of gliders should regularly check the integrity of the control linkages and in particular ensure that the fuses on control elements are properly fitted.

5.3 Railways

Collision of a car train with a regional train in Oberwald (VS), 03.07.2020

On 3 July 2020 at 10:09, in the tunnel bypassing Oberwald (the Stephan Holzer Tunnel), a car train travelling towards Realp collided with a regional train coming from Realp at Switch no 15.

The collision of a car train with a regional train coming from Realp in Oberwald at Switch no 15 was due to the fact that the car train drove past the H81 main signal, which was showing a stop, into the path of the regional train.

The following contributed to the accident:
- Oberwald station was equipped with an intermittent transmission system. The speeds and the braking curve of the car train were not continuously monitored as it ran on track 81. For this reason, the transmission system did not intervene early enough despite the train's excessive speed and failure to brake in time. Only when the train passed the H81 main signal showing stop did it trigger an emergency brake.
- The overlap of 3.5 m was too short to ensure that the train stopped before the danger point at Switch no 15.

Safety deficit
The dispatch of short car trains on track 71 with signal showing *reduced distance* (Aspect 6) in conjunction with only intermittent monitoring by the control system and extremely short overlap can lead to trains which are travelling too fast or which brake too late being unable to stop before the danger point at the switch. This risk can be significantly reduced by switching to a train control system with continuous monitoring of the speed or braking curve.

Safety advice No 32, 08.03.2022
Target group: MGB
Taking into account the human, operational and technical factors, the MGB should analyse the risks and the operational necessity of dispatching car trains on track 71 with signal showing *reduced distance* (Aspect 6), and if necessary look at risk-reducing measures.

Collision of a train composition with a stationary composition in Belp, 31.12.2020

On 31 December 2020 at 16:43, a train composition was to be coupled with an identical composition waiting on the entry track at Belp station. The incoming train applied insufficient braking power and collided with the stationary composition. No one was injured.

The collision was due to the combination of several circumstances that affected the train's braking capacity in such a way that the available braking distance was insufficient for the train to be able to stop in time.

The following contributed to the accident:

- The combination of a slippery rail due to salt run-off and grease on the wheel treads caused increased slippage between the wheel and the rail.
- As friction was poor under these conditions, the braking system control mechanism did not ensure that the multiple unit could maintain the intended braking distance.
- The brake pads did not have the full friction value from the start.

Safety deficit

The braking system on RABe 515 multiple units primarily involves activation of the powerful electric brake and letting the pneumatic brake take effect when the electric braking force is not sufficient for the required braking effect. In normal operation, the pneumatic brake is only applied to the end and middle carriages shortly before the train comes to a standstill in order to hold the train at a standstill. As the pneumatic brake is used in this way, the brake pads tend to glaze, which in turn can have a negative effect on the friction coefficient and thus on braking performance.
In normal operation, the measures taken so far have no effect on the use of the pneumatic brake nor, therefore, on the brake pads' tendency to glaze.

Safety advice No 31, 25.01.2022

Target group: BLS
The BLS should introduce specifications on the increased use of the pneumatic brake in normal operation on RABe 515 multiple units so as to avoid brake pad glazing.

Safety Recommendation No 158 was submitted to the FOT in the interim report into this incident, dated 24 February 2021. These were published in the annual report for 2021.

Breakage of locomotive windscreen in Rüdtligen-Alchenflüh, 06.01.2021

At around 22:20 on 6 January 2021, passenger train IC 736 travelling towards Bern passed a goods train travelling in the opposite direction on the Rothrist-Mattstetten line (NBS) near Kirchberg. A large slab of ice came off the roof of a container on the goods train and smashed through the windscreen of the passenger train's locomotive. The driver of the passenger train initiated emergency braking. The train came to a standstill after the south portal of the Rüdtligen tunnel at route km 17.2. No one was injured.

The front windscreen of the locomotive of a long-distance IC 736 train broke as the result of impact with a sheet of ice that had come loose from the top of a container on an oncoming goods train.

The following contributed to the accident:

- Aerodynamic conditions caused a sheet of ice to come loose from the top of a container covered with a tarpaulin.
- The force of the impact between the ice plate weighing approximately 7 kg and the front windscreen of the locomotive; this was significantly higher than the standard test values because of the high additional speeds.

The investigation identified the following factor as a safety risk:
The improper bonding of the windscreen may have contributed to the windscreen buckling into the driver's cab and ultimately to foreign objects entering the cab.

Safety deficit

Front windscreens are subject to strength requirements set out in the EN 15152 standard. The way in which the windscreen is attached and bonded to the driver's cab is not standardised and does not form part of a type test.

Safety recommendation No 172, 17.05.2022

The STSB recommends that the Federal Office of Transport (FOT) submit the findings of this investigation to the EN 15152 standards committee so that they can be taken into account in any further developments of the standard.

Broken driving pinion on the Brünig-Giswil line, 06.03.2021

At around 09:50 on 6 March 2021, a driving pinion on a seven-car Adler rack-and-adhesion multiple unit of the Zentralbahn railway company broke on the line between Brünig-Hasliberg and Giswil.

The driving pinion broke while the Adler multiple unit was descending the Brünig pass. The break was due to crack initiation in the spring chamber, which was caused by overstressing the tangential spring system, for which the driving pinion was not designed. This led to mechanical damage to the spring chamber wall.

The following contributed to the course of events:

- Recurring impact of the spring saddle, which led to mechanical stress on the driving pinion.
- Insufficient safety margin in the dimensioning of the driving pinion.

The following factors, partly related to insufficient compatibility between the rack bar and the driving pinion, facilitated the occurrence of head hits:

- Insufficient coverage rate between the pitch circle of the toothed wheel of the Adler and Fink multiple units and the pitch line of the rack rail, which led to poor meshing conditions on the bar when exiting the rack rail system.
- Bar with fixed pivot point on the bolt, which significantly restricts the vertical stroke of the bar in the event of a head hit on exits in the area of teeth 20 and 29.
- Rounded shape of the teeth of the rack bar coupled with poor meshing conditions, which under certain circumstances lead to chipping or chiselling of the sharp driving teeth at the end of the bar.
- Faulty software that occasionally led to the build-up of traction when exiting the rack rail system.

Safety deficit

The coverage rate for the pitch circle of the toothed wheel/pitch line of the rack rail, which is defined as 62.5 mm for the Zentralbahn network, is not met by the Adler and Fink multiple units. The normal codes of practice (D RTRs 29700, No 5.2.2, meshing of driving pinions) are therefore not being followed.

Correct meshing conditions, including the meshing angle, height of the rack rail and coverage rate of the pitch circle of the toothed wheel/pitch line of the rack rail, are a safety requirement that ensures proper functioning and increased wear resistance as well as preventing the toothed wheel from climbing onto the rack teeth.

Safety recommendation No 176, 13.12.2022

The STSB recommends that the Federal Office of Transport (FOT) have the geometric proportions of the adjustable driving pinion system on Adler and Fink multiple units modified.

Safety deficit

On railways with rack-and-adhesion systems, disengagement when entering or exiting the rack rail system cannot be ruled out. The bar used by Zentralbahn is capable of handling disengagement when entering the rack rail system, as it was designed for this purpose.

On the other hand, with the bar design used (which limits vertical travel of the bar close to the bolt), unsprung head impacts can occur when exiting the rack rail system. These generate significant dynamic forces due to the very high accelerations, particularly at an exit speed of 30 km/h.

The distance between the driving pinion and brake pinion on Adler and Fink multiple units is smaller than the length of the bar. This means that there are two pinions on the bar at the same time, which the normal codes of practice (D RTRs 29700, Section 6.2.2.1) advise against. The simultaneous passage of several pinions across the bar can interfere with meshing in the event of a braking manoeuvre or sluggish brake pinion.

Safety recommendation No 177, 13.12.2022
The STSB recommends that the Federal Office of Transport (FOT) review and, if necessary, adapt the concept for the bars Zentralbahn currently uses so that:

- unsprung head-to-head strikes cannot occur when exiting the rack rail system, and
- two pinions are never on a bar at the same time.

Safety deficit
On railways with rack-and-adhesion systems, disengagement when entering or exiting the rack rail system cannot be ruled out. The driving pinions and the tangential suspension of the Adler and Fink multiple units are dimensioned for optimum meshing conditions, taking into account their current dimensions and safety margins.
In the event of a disengagement on the bar, high dynamic forces are reached for which the current design of the adjustable driving pinions on the Adler and Fink multiple units was not intended or calculated.
D RTRs 29700, Rack Railway Systems Engineering, stipulates the following regarding the dimensioning of a driving pinion: *The tooth thickness or the tooth root strength is based on the maximum tooth load and the operational load as well as the relevant normal codes of practice and the regulations of the Railways Ordinance.*
The driving pinions are safety-critical components and one of the most important elements of a rack railway. A safety factor for the dimensioning of the driving pinion is not defined in the IP-RailO.

Safety recommendation No 178, 13.12.2022
The STSB recommends that the Federal Office of Transport (FOT) define a safety factor for the dimensioning of driving pinions in the implementing provisions to the Railways Ordinance (IP-RailO).

Accident involving a pedestrian on a level crossing in Orbe, 24.08.2021

On 24 August 2021 at around 07:25, a pedestrian walking from Orbe towards Chavornay on the pavement running alongside the cantonal road at the Longeraie crossroads was hit by a shunting locomotive as she crossed the Nestlé connecting track. The pedestrian died from her injuries at the scene of the accident.

The accident occurred because the pedestrian did not stop on the pavement when required to do so by the pedestrian light. She continued towards the bus stop on the other side of the connecting track and was hit by the locomotive on the level crossing, which crosses the pavement.

The following contributed to the accident:

- The new pavement, crossing a connecting track and serving a new bus stop, had been built without implementing all the necessary safety measures to prevent people from being put at risk.
- The locomotive was being driven indirectly, with no shunter present in the direction of travel.
- Failure to comply with the maximum speed limit of 10 km/h on the connecting track.

The following may have contributed to the accident:

- It was difficult to see the pedestrian light installed on the pavement.
- There was no line on the pavement in front of the pedestrian light coming from Orbe.

The following risk factors were identified during the investigation:

- The absence of any clear signage requiring pedestrians coming from the Les Granges stop or the Longeraie road to halt when a train is travelling on the connecting track.
- The fact that people accessing the pedestrian crossing from the Nestlé pavement cannot adequately see the pedestrian light installed on the pavement opposite.

Safety deficit
Given the layout of the site, comprising a cantonal road, a major industrial/commercial area, and access to two new public transport stops, there is a considerable amount of traffic on this level crossing, both vehicular and pedestrian. There is also a considerable amount of rail traffic on the connecting track to and from the Nestlé site.
For pedestrians travelling from the Longeraie road or the Les Granges railway stop towards the bus stop or the pedestrian crossing, there are no signs indicating the arrival of a train on the connecting track. Pedestrians are therefore put at considerable risk.
Over the past few years, a large number of level crossings that were dangerous for users have been either refurbished or removed. It is difficult to explain why, when the complete redevelopment of the junction was put out to tender in autumn 2019, the risks inherent in creating new public transport stops that are accessible via a newly created pavement crossing a railway line were not taken into account, and why adequate safety measures were not put in place to prevent people or objects from being put at risk.

Safety recommendation No 173, 24.05.2022
In view of the amount of traffic on the level crossing at the Longeraie crossroads, and following the creation of a new pavement crossing the railway line to serve two public transport stops, this crossing does not meet the criteria for en-

suring operational safety and preventing people from being put at risk when using it.
The STSB recommends that the FOT secure this crossing by installing road and pedestrian barriers.

Collision of a locomotive train with a goods train in Zollikofen, 02.06.2022

On 2 June 2022 at 11:36, in Zollikofen station, a light engine collided with the rear of a goods train comprising special vehicles for track construction work. This goods train was about to depart. The front locomotive of the light engine came to a stop on the low-floor wagon located at the rear of the goods train. The driver of the light engine sustained minor injuries.

The light engine collided with a stationary goods train about to depart Zollikofen station on 2 June 2022 because the light engine had passed a stop signal. The driver expected the next signal to be the exit stop signal. He did not notice the signal layout between the entry and exit signals.

Factors contributing to the accident:

- The incorrect configuration of the ZUB 262ct by the maintenance team during maintenance work was not detected. This led to a failure of the train control system on the lead locomotive of the light engine.
- The focus was on continuing the train's journey, not on the repairs conducted by the maintenance services – for which reason the train control system had been deactivated.
- The journey was made without a second driver.

Safety deficit
According to SBBI's rough estimates, the train control system does not function correctly on an average of three trains a day. If a train runs with a non-functioning train control system, a serious accident may result. Depending on how they are interpreted, existing regulations on how to act in the event of a train control system failure also permit journeys other than those whose purpose is to take the vehicle to a repair point as quickly and simply as possible. As a rule, the specifications are interpreted in such a way that the measures can be implemented individually or may be combined. Specifications tend to be selected and combined to achieve trouble-free operation with the least possible effort. This results in vehicles still running at a maximum of 80 km/h for 12 hours after the train control system has failed, without the additional safety of being accompanied by a second driver. Because these 12 hours are interpreted as applying to driving time only, defective vehicles may be in use for several days. As with the incident in Aarau on 29 November 2017, in the incident in Zollikofen a light engine was running unnecessarily and with reduced safety from a maintenance location as a result of a train control system failure. Moreover, in both of these incidents, the engine ran from a locomotive crew location without an additional driver, contrary to the regulation.

Safety recommendation No 174, 06.12.2022
The Federal Office of Transport (FOT) should examine to what extent the specifications can be adapted so that priority is given to preventing a light engine from being driven without a functional train control system. If journeys are nonetheless still necessary in such a situation, then measures to effectively reduce the resulting increased risk must be in place.

Safety deficit
Reports on train control system failures are not systematically evaluated. At the time of the event, it was not known about how long light engines operate without train control, why system failures occur and whether the statutory requirements for substitute measures were met.

Safety recommendation No 175, 06.12.2022
As part of its supervisory activities, the Federal Office of Transport should check whether the infrastructure managers and railway undertakings systematically document train control failures and draw conclusions from the reports received.

Safety deficit
Reports on train control system failures are not systematically evaluated. At the time of the event, it was not known about how long light engines operate without train control, why system failures occur and whether the statutory requirements for substitute measures were met.

Safety advice No 33, 06.12.2022
Target group: Infrastructure managers and railway undertakings
The infrastructure managers and railway undertakings or vehicle holder should together determine how they can systematically document and evaluate when and where the fault was detected, the distance travelled and the measures taken to reduce the risk of routes being run without a train control system.

5.4 Cableways

No safety recommendations were issued for cableways in 2022.

5.5 Buses, inland and maritime navigation

No safety recommendations were issued with regard to buses, inland or maritime navigation during 2022.

6 Time series

The following chapters illustrate the trend over time in a range of data specific to the individual modes of transport. This was taken from the information that the STSB received or collected in connection with incident reports and the associated preliminary enquiries. In each case, the figures cover the period between 2015, when the Ordinance of the Safety Investigation of Transportation Incidents (OSITI) came into force, and the reporting year. The time series data are presented in Annex 4.

6.1 Aviation

Figure 6.1.1 shows the incidents reported and investigations opened per year since 2015. In the years prior to 2015, the STSB received notification of approximately 1,036 aviation incidents per year. If this figure is taken as the baseline, the STSB had around 20% more notifications to process in the 2015 to 2017 period, and 51% more than the baseline in 2018 and 2019. There was a sharp drop in the number of reported incidents in 2020 (894) in connection with the impact of the COVID-19 crisis on commercial aviation. The number of incident notifications rose again significantly in 2021 (1,309). This increase is likely to be linked with developments in commercial aviation. The STSB received 1,828 incident notifications in the year under review. This represents an increase of 77% compared to average values before 2015. The increasing trend of notifications observed up to 2019 is thus resuming after the pandemic-related dip.

A decision on whether or not to open an investigation is based on one principle criterion: whether that in-vestigation might help to prevent similar incidents or, in other words, whether the case holds any potential preventive value. As the trend in the number of investigations shows (Figure 6.1.1), there is no correlation between incidents reported and investigations opened. For example, just under half as many incidents were reported in 2020 (894) as in 2022 (1,828).In contrast, 63 investigations were opened in 2020, slight-ly more than twice as many as in 2022 (27).

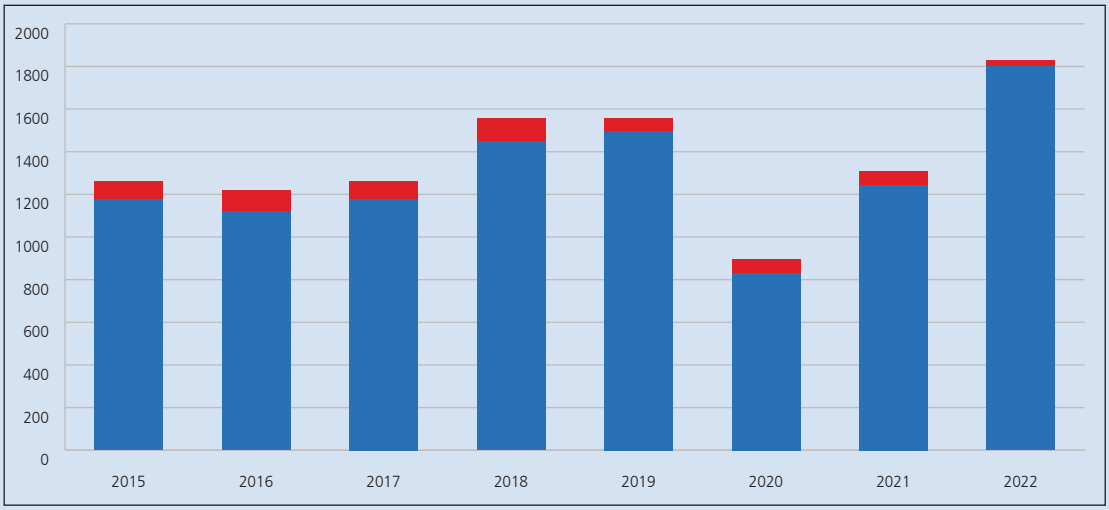


Figure 6.1.1: Number of incidents reported per year (red and blue) and investigations opened (red) since 2015.

Figure 6.1.2 tracks the quantitative trend in those incidents that satisfy the definitions of 'accidents' and 'serious incidents'.[1] It includes only those incidents which involved aircraft registered in Switzerland. The development in this subcategory differs from the time series for reported incidents overall.

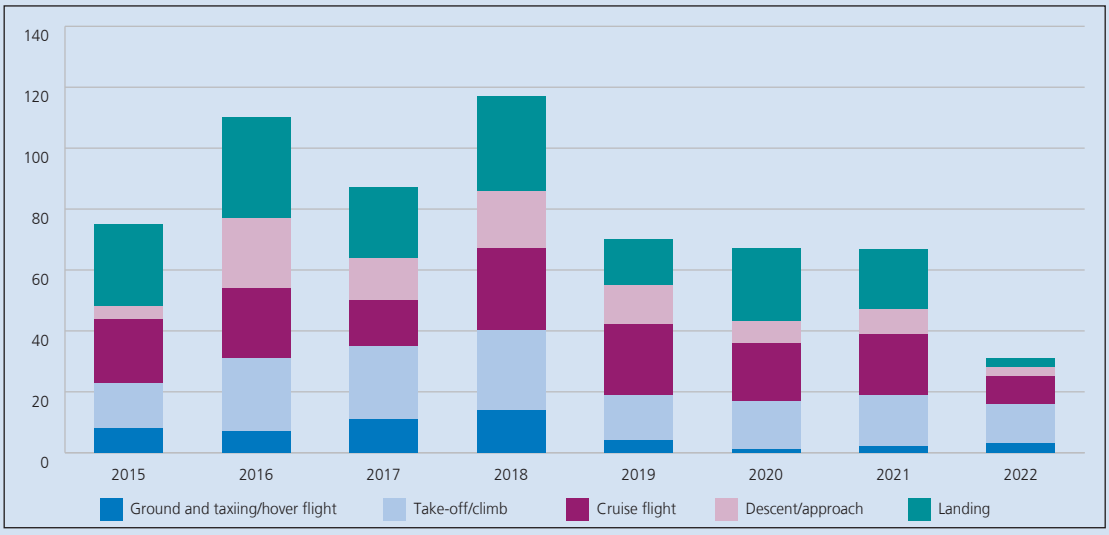


Figure 6.1.2: Total of accidents and serious incidents reported since 2015, broken down by flight phase. These figures cover events in Switzerland and abroad involving aircraft registered in Switzerland. Flugphasen. Berücksichtigt wurden Ereignisse in In und Ausland, bei denen in der Schweiz immatrikulierte Flugzeuge betroffen waren.

[1] As stated in Article 5 of the Ordinance on the Investigation of Transportation Incidents (OSITI; SR 742.161), the term 'serious accident' corresponds to the definition for the identical term set out in Article 2 paragraph 16 of Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation. Similarly, the term 'accident' corresponds to the definition of the identical term given in Article 2 paragraph 1 of the Regulation.

Building on Figure 6.1.2, Figure 6.1.3 shows the changes over time in reported aviation accidents that resulted in a fatal or serious injury. This data reflects events that took place in Switzerland, irrespective of where the aircraft was registered, and events abroad involving an aircraft registered in Switzerland.

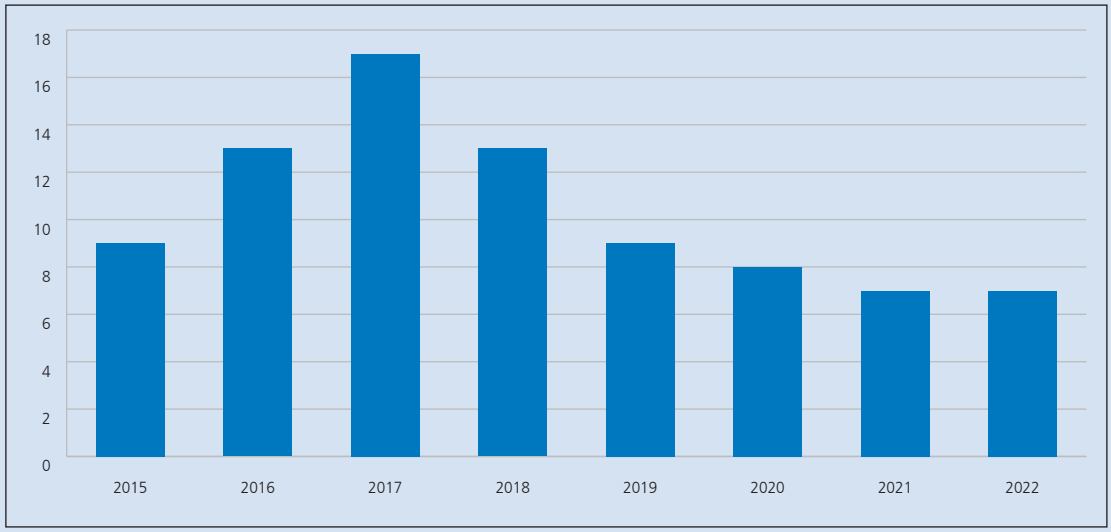


Figure 6.1.3: Development over time of aviation accidents that resulted in a fatal or serious injury.[2] The data covers accidents in Switzerland and abroad involving an aircraft registered in Switzerland, as well as accidents involving foreign-registered aircraft that occurred in Switzerland.

As described in chapter 5.1, where an investigation reveals safety deficits, the STSB will issue safety recommendations and safety advices. Figure 6.1.4 below shows the number of such recommendations and advices published per year by the Aviation Division. Annex 4 contains additional tables giving an overview of which aspect of operations, whether technical, human, operational or organisational, was identified as the safety deficit on which the safety recommendation or advice was based.

[2] The terms 'fatal injury and 'serious injury' are defined in Article 2 paragraphs 5 and 17 respectively of Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation.

Figure 6.1.4: Number of safety recommendations and safety advices published since 2015 by the Aviation Division.

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

Figure 6.2.1 shows how the number of reported incidents and investigations opened has changed since 2015 for railways, trams, cableways, buses, and inland and maritime navigation. The figures for notifications vary between just under 300 and 400 per year, with increases and decreases over the years but no significant trend.

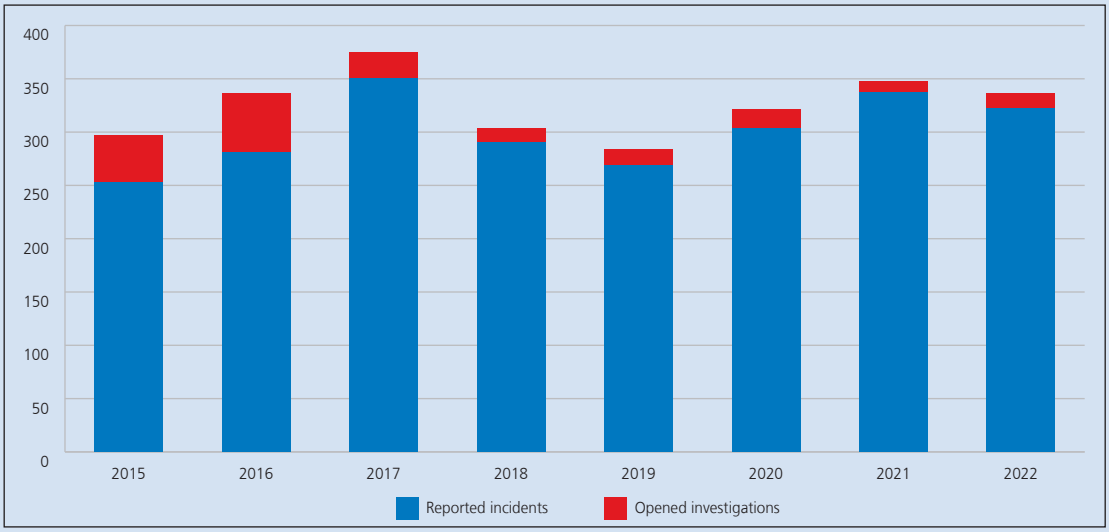


Figure 6.2.1: Number of incidents reported per year (blue and red) and investigations opened (red) for railways, trams, cableways, buses, and inland and maritime navigation.

The number of investigations opened each year since 2015 is shown in Figure 6.2.2, broken down according to the individual modes of transport. As expected, most investigations were opened into incidents on the railways, since they significantly exceed other modes of transport in terms of transport volume and service frequency. Since 2017 the decision on whether or not to open an investigation has been made consistently according to the potential preventive value of the case. This approach has reduced the number of investigations and thus resulted in a targeted and efficient use of resources. At the same time, significant inroads have been into the backlog of pending cases which could not be handled earlier because of limited capacity.

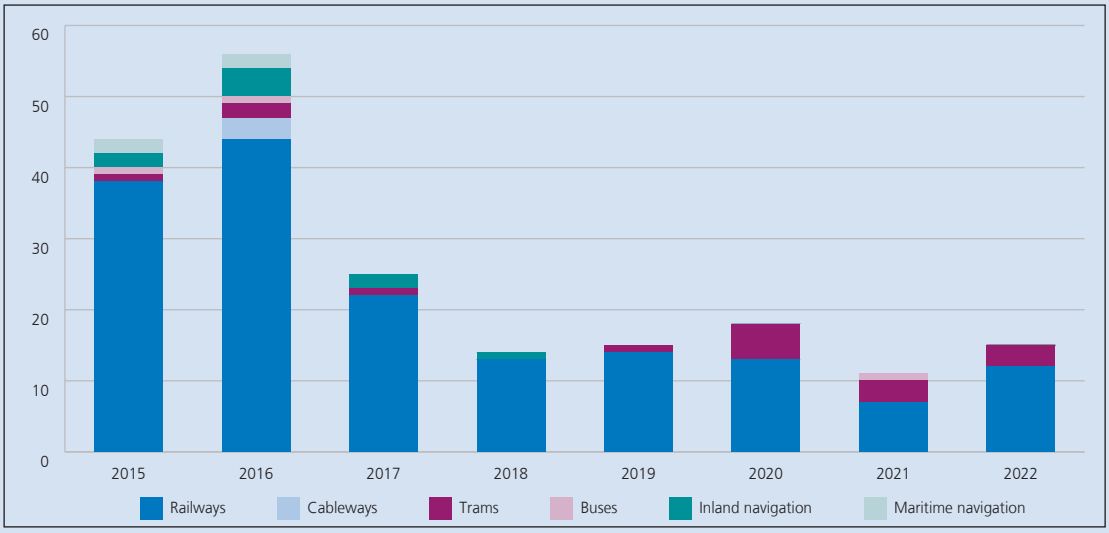


Figure 6.2.2: Number of investigations opened per year since 2015 concerning railways, trams, cableways, buses, inland and maritime navigation.

As is the case with the number of investigations opened, the majority of reported incidents also concern rail travel. Figure 6.2.3 illustrates what types of event led to notifications. In addition to near-accidents (15–25%), accidents involving persons (15–20%) are responsible for the most reports, followed by derailments and collisions (10–15% each).

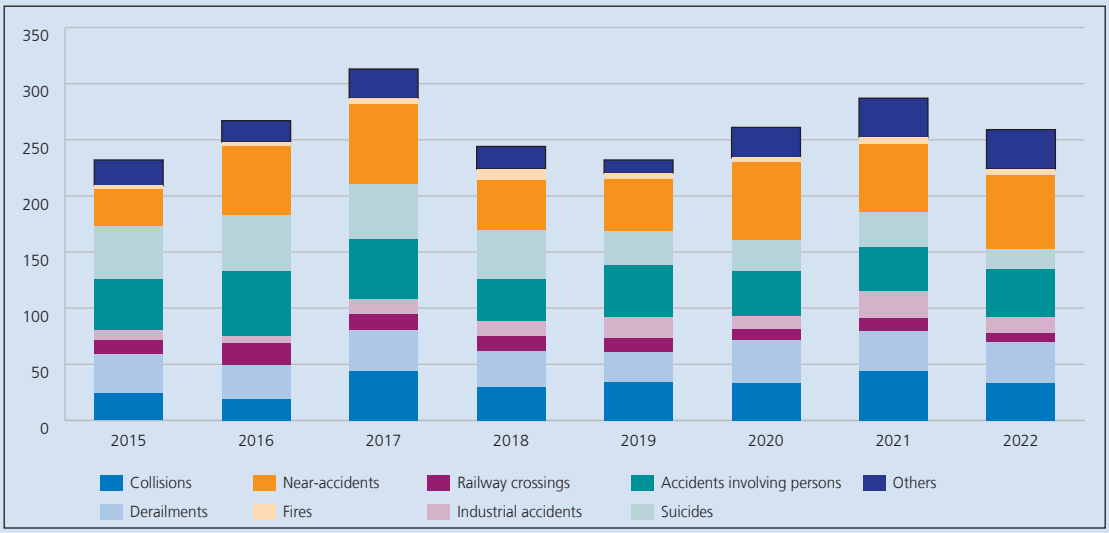


Figure 6.2.3: Number of incidents reported per year since 2015 for railways, broken down by type of event

Depending on the outcome of its investigations, the STSB will publish safety recommendations or safety advices (see chapter 5.1). The development over time of the number of recommendations and advices published is presented in Figure 6.2.4. Annex 4 contains additional tables giving an overview of which aspect of operations, whether technical, human, operational or organisational, was identified as the safety deficit on which the recommendation or advice was based.

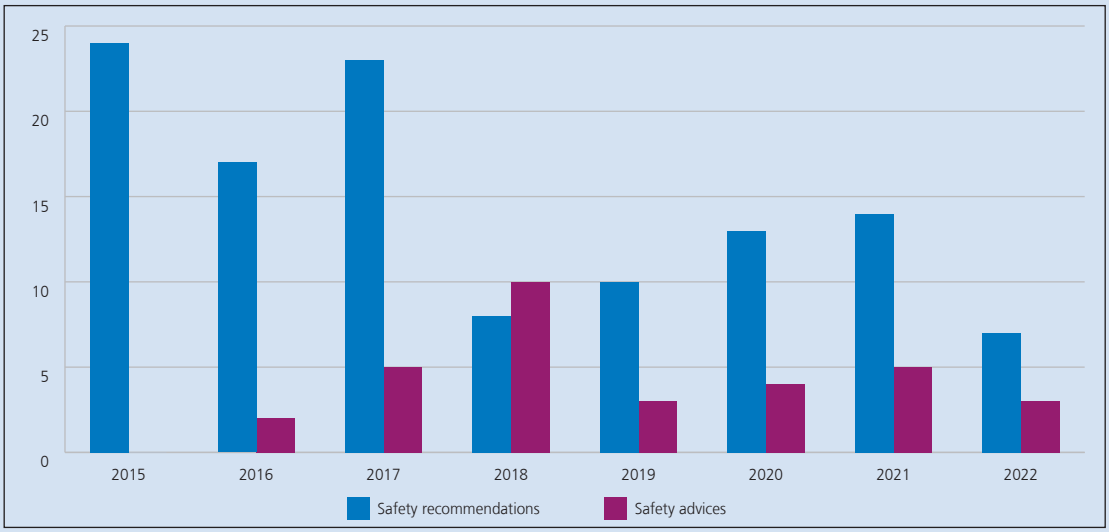


Figure 6.2.4: Number of safety recommendations and safety advices published per year since 2015.

Annexes

Annex 1: Lists of the number of notifications, as well as opened, ongoing and completed investigations and interim reports and studies published with regard to aviation

Annex 2: Lists of the number of notifications, as well as opened, ongoing and completed investigations and interim reports and studies published with regard to public transport and maritime navigation

Annex 3: Additional information on aviation and public transport incidents

Annex 4: Time series data (Chapter 6)

Annex 1

Lists of the number of notifications, as well as opened, ongoing and completed investigations and interim reports and studies published with regard to aviation

Notifications and opened, ongoing and completed investigations

Aviation						
Year	Number of notifications	Opened investigations	Completed investigations[3]			Ongoing investigations
			Total:	Extensive:	Summary:	
2022	1828	27	36	15	21	135
2021	1309	66	70	9	61	157
2020	894	59	40	9	31	164
2019	1566	64	76	14	62	162
2018	1556	119	83	22	53	156
2017	1259	86	93	30	48	111
2016	1219	92	58	27	31	142
2015	1260	86	33	33	n/a	n/a

Extensive investigations completed

Number	Registration	Date of incident	Location	Safety recommendation	Safety advice
2386	HB-2467	19.07.2021	Schänis airfield (LSZX)	582, 583	
2392	HB-SAW	03.03.2021	Abeam Morges, above Lake Geneva		
2384	LX-AVA	19.07.2020	2 km west of St Gallen-Altenrhein Airport (LSZR)		
2382	HB-3444	03.05.2020	Bettlachberg, about 5 km north of Grenchen		41
2387	HB-CCN	07.01.2020	Buttwil airfield (LSZU)		
2381	05NJ	29.12.2019	Near the Tschuggen mountain station, Arosa	577	
2374	HB-NCB / G-TTND	13.10.2019	Zurich Airport (LSZH)	574	
2383	G-BVDH	25.08.2019	Simplon Pass		45
2389	HB-CGF	14.05.2019	Lucerne-Beromünster airport (LSZO)		
2391	HB-SRB	09.08.2018	Bern Airport (LSZB)		
2378	HB-KEE	27.07.2018	Col Durand		42
2385	HB-ZOJ	11.06.2018	Alp Ebnet, Attinghausen		
2388	HB-ZIH	19.09.2017	Blenio		
2372	HB-SRC	15.08.2017	Bern Airport (LSZB)		
2377	HB-PRN / CS-GLG	18.02.2017	Martigny	575	

[3] Figures prior to 2020 show the number of reports published, not the number of investigations completed.

Summary investigations completed

Registration	Date of incident	Location	Type of incident
HB-ZCA	12.06.2021	Lausanne La Blécherette Airport (LSGL)	Loss of control upon landing
T7-RAR	18.02.2021	1.3 km west of St Gallen-Altenrhein Airport (LSZR)	Controlled flight into terrain
HB-DIC	26.01.2021	Ecuvillens aerodrome (LSGE)	Landing without landing gear
HB-3281	01.08.2020	Bumbach	Collision with wooden cabin on off-field landing
HB-1796	25.07.2020	Zweisimmen Airfield (LSTZ)	Loss of control and aborted take-off
HB-TCP/HB-TER	18.07.2020	Grenchen aerodrome (LSZG)	Airprox
D-3241	28.06.2020	Montricher Airport (LSTR)	Hard landing
HB-KFQ/F/A-18	24.06.2020	Innertkirchen	Airprox
HB-KLZ/HB-PPJ	08.02.2020	Clariden-Hüfifirn (LSVD)	Airprox
HB-KEJB	19.06.2019	Bellechasse Glider Field (LSTB)	Runway overrun
HB-WAZ	30.03.2019	Bad Ragaz	Off-field landing after engine power loss
N7779V	23.02.2019	12.2 NM north-east of Lausanne aerodrome (LSGL)	Total failure of the electrical system
HB-ZRP/F/A-18	02.10.2018	Lake Thun	Airprox
HB-QOU	21.09.2018	Schindellegi	Collision with obstacles on landing
HB-ZPK/Skydiver	09.09.2018	Speck-Fehraltorf aerodrome (LSZK)	Airprox
HB-KCI	08.09.2018	Fricktal Schupfart aerodrome (LSZI)	Collision with obstacle while taxiing
HB-QNK	16.08.2018	Au-Heerbrugg	Collision with obstacle on landing
F-JBRR	02.06.2018	Hergiswil	Collision with obstacle at take-off
HB-CFZ	14.03.2018	Sitterdorf Airfield (LSZV)	Runway overrun
HB-OTN/HB-ZDS	29.07.2017	La Côte aerodrome (LSGP)	Airprox
HB-OXD	09.12.2016	Bressaucourt aerodrome (LSZQ)	Loss of control upon landing

Interim reports published as part of ongoing investigations

Registration	Date of incident	Location	Safety recommendation	Safety advice
HB-2320	28.05.2022	Crêta Besse	584	43

Discontinued investigations

Registration	Date of incident	Location	Type of incident
HB-SYL	09.07.2021	Gruyère aerodrome (LSGT)	Rollover of the aircraft during take-off
HB-KMJ/HB-CQL	26.06.2021	Willisau	Airprox
HB-TUO	12.06.2021	Locarno Airport (LSZL)	Retracting the landing gear during take-off
HB-YMS	08.05.2021	Oberramsern	Fall from a low height onto a field
HB-GJM	23.11.2020	Sion airport (LSGS)	Landing with partially extended nose gear
HB-KIU	19.08.2020	St. Gallen-Altenrhein Airport (LSZR)	Collapse of the retractable landing gear during take-off
HB-PPJ	08.08.2020	Samedan airfield (LSZS)	Runway overrun
HB-UVU	08.08.2020	Menznau	Precautionary landing following engine problems
HB-NPA	21.06.2020	Ecuvillens aerodrome (LSGE)	Propeller touched ground on landing
HB-KBS	12.10.2019	Grenchen aerodrome (LSZG)	Nose gear buckled upon landing
HB-YKJ	24.08.2019	About 3 km south-east of Herisau	Crash after autorotation onto a field
HB-ZNH	05.07.2019	Engstlenalp	Falling shuttering element due to helicopter rotor downwash
HB-ZNW/HB-ZAZ	19.01.2019	Girmschbiel in about 7000 ft AMSL	Airprox
OE-FID	06.10.2018	Lugano-Agno Airport (LSZA)	Burst tyre on right-side landing gear during landing
HB-2321	11.09.2018	Bedretto	Collision with the terrain
HB-2432	08.07.2018	Mettligrat	Collision with the terrain
HB-RVJ/HB-UCM	06.05.2018	Innertkirchen	Airprox
HB-YCM	29.04.2018	Innsbruck (LOWI)	Crash shortly after take-off
HB-2328/D-9830	26.08.2017	Schänis	Loss of power when starting in towing mode
HB-XXM	28.04.2017	Alpnach	Autorotation after rupture of the tail rotor control cable
B-6533	28.01.2017	Geneva Airport (LSGG)	Loss of the hydraulic system due to a leak in the pressure lines of the engine
A6-AFE	09.10.2016	Geneva Airport (LSGG)	Loss of the hydraulic system due to a leak in the pressure lines of the engine
HB-IYT	10.03.2016	Zurich Airport (LSZH)	Aborted take-off due to engine fire warning
HB-YMG	05.08.2015	Hundwil	Crash into the forest

Annex 2

Lists of the number of notifications, as well as opened, ongoing and completed investigations and interim reports and studies published with regard to public transport and maritime navigation

Notifications and opened, ongoing and completed investigations

Public transport and maritime navigation						
Year	Number of notifications	Opened investigations	Completed investigations[4]			Ongoing investigations
			Total:	Extensive:	Summary:	
2022	337	15	20	9	11	18
2021	346	11	17	11	6	24
2020	321	19	21	10	11	32
2019	283	15	15	8	7	35
2018	304	14	32	13	17	33
2017	376	25	38	27	12	50
2016	332	64	39	13	26	79
2015	296	87	31	18	13	n/a

Extensive investigations completed

Number	Mode of transport	Nature of incident	Date	Location	Safety recommendation	Safety advice
2022060202	Railways	Collision between two trains	02.06.2022	Zollikofen	174, 175	33
2021082401	Railways	Accident involving persons	24.08.2021	Orbe	173	
2021040801	Railways	Collision between two shunting movements	08.04.2021	Cazis		
2021030602	Railways	Irregularity posing hazard	06.03.2021	Brünig	176, 177, 178	
2021010602	Railways	Collision between train and obstacle	06.01.2021	Rüdtligen-Alchenflüh	172	
2020123101	Railways	Collision between train and obstacle	31.12.2020	Belp	(158)*	31
2020070301	Railways	Collision between two trains	03.07.2020	Oberwald		32
2018070501	Railways	Train derailment	05.07.2018	Eglisau		
2017092901	Railways	Near miss/hazard	29.09.2017	Immensee		

* The figure in brackets means that the safety recommendation in question had already been published along with the interim report for the case or another final report.

[4] Figures prior to 2020 show the number of reports published, not the number of investigations completed.

Summary investigations completed

Number	Mode of transport	Type of incident	Date	Location
2022091602	Railways	Industrial accident	16.09.2022	Rothenburg
2022050401	Railways	Collision between shunting movement and obstacle	04.05.2022	Renens
2022040401	Railways	Industrial accident	04.04.2022	Schafisheim
2022020201	Railways	Natural event	02.02.2022	Bretaye
2022011902	Railways	Collision between shunting movement and obstacle	19.01.2022	Crissier
2022011401	Cableways	Industrial accident	04.11.2022	Samnaun
2021120801	Cableways	Cable derailment	08.12.2021	Samnaun
2021082801	Railways	Collision between two trains	28.10.2021	Klosters Selfranga
2021100801	Railways	Industrial accident	08.10.2021	Emmenbrücke
2017112901	Railways	Irregularity posing no immediate hazard	29.11.2017	Aarau
2017022201	Railways	Near miss/hazard	22.02.2017	Müntschemier

Discontinued investigations

Number	Mode of transport	Type of incident	Date	Location
2020020401	Railways	Runaway train	04.02.2022	Ins

Annex 3

Additional information on aviation incidents and investigations

Air accidents and serious incidents involving Swiss-registered aircraft

Year	Accidents with extensive investigation	Accidents with summary investigation	Total accidents	Serious incidents (incl. airproxes)	Airproxes investigated	Total accidents and serious incidents	Fatalities
2015	14	2	16	13	2	29	4
2016	22	17	39	48	16	87	5
2017	22	23	45	28	6	73	18
2018	14	16	30	64	25	94	38
2019	16	6	22	34	11	56	5
2020	14	16	30	32	9	62	10
2021	10	14	24	31	14	55	8
2022	8	1	9	15	6	24	3

Air accidents and serious incidents involving Swiss-registered aircraft with up to 5,700 kg maximum take-off mass (MTOM)

Year	Accidents with extensive investigation	Accidents with summary investigation	Total accidents	Serious incidents (incl. airproxes)	Airproxes investigated	Total accidents and serious incidents	Fatalities
2015	14	2	16	5	1	21	4
2016	22	17	39	31	7	70	5
2017	22	23	45	23	4	68	18
2018	13	16	29	47	16	76	18
2019	16	6	22	26	8	48	5
2020	14	16	30	30	8	60	10
2021	9	14	23	28	12	51	8
2022	8	1	9	15	6	24	3

Accidents and serious incidents with and without injuries involving Swiss-registered aircraft in Switzerland

		Total	2015	2016	2017	2018	2019	2020	2021	2022
Aircraft up to 2250 kg MTOM	with injury	29	5	1	7	3	3	3	5	2
	without injury	228	32	21	41	43	25	28	30	8
Aircraft 2250–5700 kg MTOM	with injury	0	0	0	0	0	0	0	0	0
	without injury	20	0	3	1	2	3	5	3	3
Aircraft exceeding 5700 kg MTOM	with injury	1	0	0	0	1	0	0	0	0
	without injury	40	7	9	3	13	2	2	4	0
Helicopters	with injury	18	2	3	5	2	2	0	0	4
	without injury	76	10	14	6	14	10	8	9	5
Motor gliders and gliders	with injury	14	1	3	2	3	0	2	1	3
	without injury	41	6	8	5	7	2	8	3	2
Balloons and airships	with injury	0	0	0	0	0	0	0	0	0
	without injury	4	1	0	0	2	0	1	0	0
Ultralight aircraft	with injury	0	-	0	0	0	0	0	0	0
	without injury	2	-	2	0	0	0	0	0	0
Total[5]	with injury	62	8	7	14	9	5	5	5	9
	without injury	410	56	57	56	81	42	52	48	18

[5] The total number of accidents and serious incidents may differ from the sum of the individual categories. The reason for this is the allocation of events involving several aircraft of different categories. These are recorded in those individual categories, but are only counted as one event in the total.

Accidents and serious incidents with and without injuries involving foreign-registered aircraft in Switzerland

		Total	2015	2016	2017	2018	2019	2020	2021	2022
Aircraft up to 2250 kg MTOM	with injury	8	1	3	1	2	0	0	1	0
	without injury	22	3	6	4	0	4	1	3	1
Aircraft 2250–5700 kg MTOM	with injury	2	0	0	1	0	0	0	0	1
	without injury	3	0	0	0	1	0	1	1	0
Aircraft exceeding 5700 kg MTOM	with injury	0	0	0	0	0	0	0	0	0
	without injury	31	5	8	3	4	6	2	2	1
Helicopters	with injury	2	0	1	0	1	0	0	0	0
	without injury	0	0	0	0	0	0	0	0	0
Motor gliders and gliders	with injury	4	2	0	0	0	1	0	1	0
	without injury	5	0	1	0	1	2	1	0	0
Balloons and airships	with injury	0	0	0	0	0	0	0	0	0
	without injury	1	0	0	0	0	1	0	0	0
Ultralight aircraft	with injury	0	-	0	0	0	0	0	0	0
	without injury	1	-	0	0	0	0	0	1	0
Total	with injury	16	3	4	2	3	1	0	2	1
	without injury	63	8	15	7	6	13	5	7	2

Accidents and serious incidents with and without injuries involving Swiss-registered aircraft abroad

		Total	2015	2016	2017	2018	2019	2020	2021	2022
Aircraft up to 2250 kg MTOM	with injury	7	2	0	1	1	2	1	0	0
	without injury	31	3	3	4	10	6	2	2	1
Aircraft 2250–5700 kg MTOM	with injury	1	0	0	0	0	0	1	0	0
	without injury	10	0	2	0	4	3	0	0	1
Aircraft exceeding 5700 kg MTOM	with injury	0	0	0	0	0	0	0	0	0
	without injury	34	5	15	7	5	2	0	0	0
Helicopters	with injury	0	0	0	0	0	0	0	0	0
	without injury	2	0	0	0	0	0	0	2	0
Motor gliders and gliders	with injury	4	0	1	1	0	1	1	0	0
	without injury	6	0	1	0	3	1	0	0	1
Balloons and airships	with injury	0	0	0	0	0	0	0	0	0
	without injury	2	0	1	0	1	0	0	0	0
Ultralight aircraft	with injury	0		0	0	0	0	0	0	0
	without injury	1		0	0	1	0	0	0	0
Total	with injury	12	2	1	2	1	3	3	0	0
	without injury	86	8	22	11	24	12	2	4	3

Additional information on public transport incidents and investigations

Notifications and opened, ongoing and completed investigations – railways

Railways						
Year	Notifications	Opened investigations	Completed investigations			Ongoing investigations
			Total:	Extensive:	Summary:	
2015	232	38	28	17	11	69
2016	267	44	33	12	22	64
2017	313	22	34	24	10	46
2018	244	13	29	14	16	35
2019	232	14	16	9	8	28
2020	261	13	16	8	8	26
2021	286	7	11	8	5	18
2022	271	12	16	9	7	11

Notifications and opened, ongoing and completed investigations – trams

Trams						
Year	Notifications	Opened investigations	Completed investigations			Ongoing investigations
			Total:	Extensive:	Summary:	
2015	33	0	0	0	0	2
2016	32	3	1	0	1	2
2017	30	0	1	0	1	1
2018	27	0	1	0	1	0
2019	24	0	0	0	0	0
2020	23	0	0	0	0	0
2021	21	0	0	0	0	0
2022	12	0	0	0	0	0

Notifications and opened, ongoing and completed investigations – cableways

Cableways						
Year	Notifications	Opened investigations	Completed investigations			Ongoing investigations
			Total:	Extensive:	Summary:	
2015	10	1	1	1	0	2
2016	18	2	1	1	0	4
2017	10	1	3	2	1	4
2018	14	0	0	0	0	1
2019	12	1	0	0	0	2
2020	20	5	5	2	3	2
2021	20	3	4	4	1	1
2022	26	3	2	0	2	2

Notifications and opened, ongoing and completed investigations – buses

Buses						
Year	Notifications	Opened investigations	Completed investigations			Ongoing investigations
			Total:	Extensive:	Summary:	
2015	18	1	0	0	0	3
2016	12	1	2	1	2	2
2017	18	0	1	1	0	0
2018	14	0	0	0	0	0
2019	9	0	0	0	0	0
2020	12	0	0	0	0	0
2021	8	1	0	0	0	1
2022	18	0	0	0	0	1

Notifications and opened, ongoing and completed investigations – inland navigation

Inland navigation						
Year	Notifications	Opened investigations	Completed investigations			Ongoing investigations
			Total:	Extensive:	Summary:	
2015	2	2	2	0	2	1
2016	6	4	2	1	1	3
2017	3	2	1	0	1	4
2018	4	1	0	0	0	5
2019	4	0	1	0	1	5
2020	5	0	0	0	0	5
2021	10	0	2	2	0	2
2022	5	0	0	0	0	2

Annex 4

Time series data (Chapter 6)

Aviation (Section 6.1)

Number of incidents reported and investigations opened per year

Year	Opened investigations	Notifications
2015	85	1260
2016	99	1219
2017	83	1261
2018	111	1558
2019	58	1556
2020	63	894
2021	66	1309
2022	27	1828

Total number of accidents and serious incidents reported per year, broken down by flight phase (aircraft registered in Switzerland and abroad)

Year	Total	Ground and taxiing/ hover flight	Take-off/climb	Cruise flight	Descent/ approach	Landing
2015	75	8	15	21	4	27
2016	110	7	24	23	23	33
2017	87	11	24	15	14	23
2018	117	14	26	27	19	31
2019	70	4	15	23	13	15
2020	67	1	16	19	7	24
2021	67	2	17	20	8	20
2022	31	3	13	9	3	3

Development over time of air accidents resulting in injury, broken down by aircraft category (aircraft registered in Switzerland in Switzerland and abroad, as well as aircraft registered abroad in Switzerland)

Year	Motorised aircraft	Gliders	Helicopters	Total[6]
2015	7	0	2	9
2016	5	3	5	13

[6] The total number of accidents and serious incidents may differ from the sum of the individual categories. The reason for this is the allocation of events involving several aircraft of different categories. These are recorded in those individual categories, but are only counted as one event in the total.

Year	Motorised aircraft	Gliders	Helicopters	Total[6]
2017	1	4	3	17
2018	7	3	3	13
2019	5	2	2	9
2020	5	3	0	8
2021	6	2	0	7
2022	3	1	3	7

Number of safety recommendations and safety advices published per year

Year	Technical	Human	Operational	Organisational	Total
2015	2	0	4	2	8
2016	7	1	1	5	14
2017	7	0	2	6	15
2018	2	0	2	3	7
2019	6	0	2	1	9
2020	3	0	5	8	16
2021	5	0	2	3	10
2022	3	0	2	5	10

Railways, trams, cableways, buses, inland and maritime navigation (Chapter 6.2)

Incidents reported and investigations opened per year

Year	Incidents reported	Opened investigations
2015	297	44
2016	337	56
2017	375	25
2018	304	14
2019	284	15
2020	321	18
2021	346	11
2022	337	15

Investigations opened per year, broken down by mode of transport

Year	Railways	Trams	Cableways	Buses	Inland navigation	Maritime navigation	Total
2015	38	0	1	1	2	2	44
2016	44	3	2	1	4	2	56
2017	22	0	1	0	2	0	25
2018	13	0	0	0	1	0	14
2019	14	0	1	0	0	0	15
2020	13	0	5	0	0	0	18
2021	7	0	3	1	0	0	11
2022	12	0	3	0	0	0	15

Incidents reported per year, broken down by event type – railways

Year	Collisions	Derailments	Level crossings	Industrial accidents	Accidents involving persons	Suicides	Near-accidents	Fires	Other	Total
2015	24	35	12	9	46	47	33	3	23	232
2016	19	30	20	6	58	50	61	4	19	267
2017	44	36	15	13	53	49	72	5	26	313
2018	30	32	13	13	38	43	45	10	20	244
2019	34	27	12	19	46	31	46	5	12	232
2020	33	39	9	12	40	27	70	4	27	261
2021	44	35	12	24	39	32	60	6	35	286
2022	33	37	8	14	43	17	66	6	35	271

Number of safety recommendations and safety advices published per year

Year	Technical	Human	Operational	Organisational	Total
2015	6	4	1	13	24
2016	6	1	3	7	17
2017	9	1	7	6	23
2018	1	1	6	0	8
2019	4	2	1	3	10
2020	6	0	4	3	13
2021	7	2	2	3	14
2022	5	0	3	2	10



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