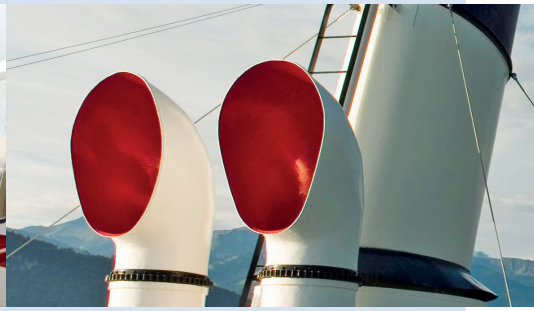
Swiss Transportation Safety Investigation Board STSB
Annual Report 2021

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1 Editorial

The Swiss Transportation Safety Investigation Board (STSB) employs experienced technical investigators who are experts in their field. It also has more than 126 individual investigators under contract to provide the very latest specialist knowledge. This ensures that the team is able to conduct safety investigations to the highest standard in each individual case.

The growth in the number of incidents reported nonetheless poses considerable challenges in staffing terms. While the figure for recorded public transport incidents has remained stable over time, the long-term trend in the number of notifications in aviation clearly points upward. There was a temporary dip when much air traffic was grounded as a result of the COVID-19 pandemic, but the slow recovery in the sector has now returned incident notifications to their pre-pandemic level. Even if only a small proportion ultimately result in a formal STSB investigation being opened, preliminary enquiries must be made into each incident that is reported, interviews must often be conducted and in many cases data must also be secured and analysed. These preliminary enquiries serve as a basis for the decision on whether or not an investigation might also have a preventive safety effect. That, after all, is our remit.

We responded to the rising number of notifications by streamlining our processes and employing a further investigator-in-charge. Advancing digitalisation in the different modes of transport poses a further challenge because it produces more sources and greater volumes of data. These are a boon to analysis, but these large amounts of data must be secured, retrieved and evaluated for each investigation. This is time-consuming, and limiting staff resources at our laboratory, which is increasingly creating bottlenecks. We will have to look for solutions here in the future.

In January 2021 we published the final report on the Ju 52 accident. Having completed this highly complex investigation, we once again have more capacity to steadily pursue and conclude other outstanding safety investigations.

Pieter Zeilstra
President of the extra-parliamentary commission

2 Management Summary

The STSB received 1,655 incident notifications in 2021. Following assessment, these resulted in 77 new investigations. A total of 20 extensive and 67 summary investigations were completed during the year, and five interim reports were 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 22 safety recommendations and seven safety advices. These figures are distributed as follows across the different modes of transport:

The STSB received one notification of an incident concerning maritime navigation in 2021. It did not result in an investigation being opened. No reports were published in this area in 2020, either.

The number of incidents reported each year had been rising steadily up to 2020, when there was a sharp drop to 1,215 notifications. At 1,655, the number in 2021 returned to a level comparable with those prior to 2018. Aviation was the principal factor in this fluctuation, in particular

	Aviation	Public transport
Incidents reported	1309	346
Opened investigations	66	11
Interim reports published	2	3
Extensive investigations completed	9	11
Summary investigations completed	61	6
Safety recommendations issued	10	14
Safety advices issued	2	5

because of the impact that the COVID-19 crisis had on commercial air travel.

With a total of 87 investigations completed, the STSB raised its output significantly compared with the 61 of 2020, during which considerable resources in the Aviation Division were tied up finalising the investigation into the Ju 52 accident on 4 August 2018.

The Board approved the report into the Ju 52 accident in December 2020, and it was published in January 2021. Attention then turned to a variety of follow-up tasks, which included the debriefing on the handling of investigations into major accidents. This work was completed in autumn 2021. This particular accident investigation cost just under CHF 4 million in total.

3 The STSB

3.1 Remit

The Swiss Transportation Safety Investigation Board (STSB) investigates incidents in civil aviation, public transport, and inland 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 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.

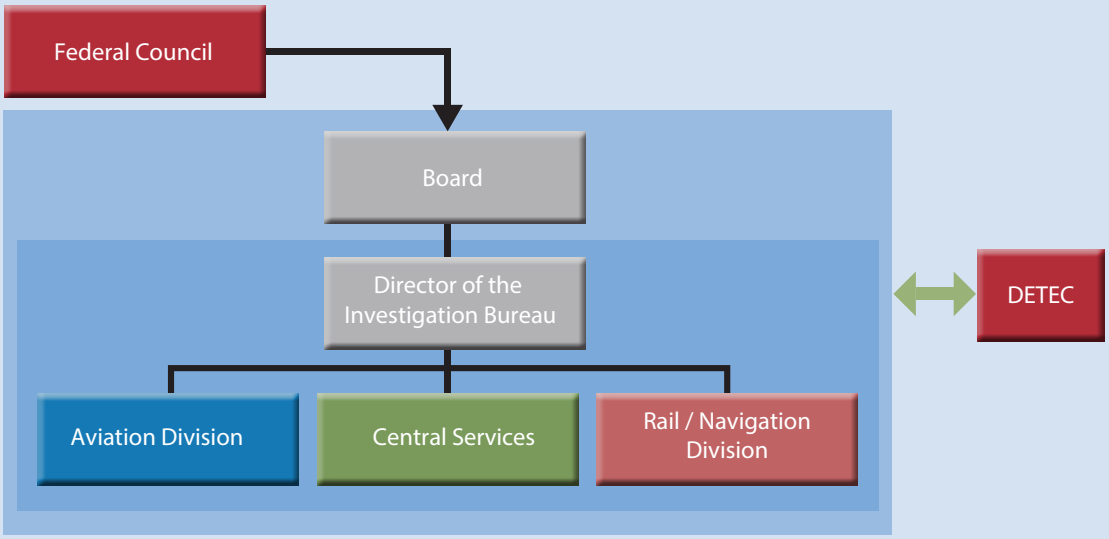
The STSB forms part of the overall transport safety framework in Switzerland. This is made up of companies, authorities and organisations, such as transport operators, manufacturers, vehicle keepers, safety investigation bodies, supervisory authorities, accreditation and certification bodies, conformity 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 Swiss Transportation Safety Board is structured as an extra-parliamentary commission under Articles 57a-57g 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 public 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 2021:



Projects and initiatives

– **Revision of the OSITI:** The Ordinance on the Safety Investigation of Transport Incidents (OSITI) entered into force on 1 February 2015. International law requirements governing the investigation of such incidents have since changed. Experience with the implementation of the OSITI also revealed a need for amendments and greater clarity. The revision project began in 2019, but the original project plan had to be amended several times because revision issues required extensive clarification with the supervisory authorities and sectors concerned, and as a result of the COVID-19 situation. In the course of 2021, conformity with the revised international legal foundations was reviewed and the necessary amendments identified. Elements of the preliminary analyses that would result in significant changes to working practices were also discussed with directly affected authorities and organisations. This project will be pursued as a high priority in 2022.

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	2021 TARGET	2021 ACTUAL	2022 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 992/2010 (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)	60	37	70
Prompt completion of safety investigations concerning serious incidents and accidents involving railways, buses and boats (%, minimum)	60	50	70

The targets for the prompt completion of safety investigations were not met, the main reason being efforts to reduce the backlog of cases and prevent a new one building. A number of outstanding cases had amassed in the Aviation Division in particular as a result of the 50%-plus increase in notifications within just a few years up to and including 2019, and the resources that had been tied up with the investigation into the Ju 52 accident on 4 August 2018. The decision to concentrate on working through older cases generated a relatively higher proportion of reports for which the set processing times could not be met. This situation is expected to continue for several years to come.

Although targets could not be met, the figures in Sections 4.1 to 4.3 show that the STSB's output stands up to comparison with that of previous years.

3.4 Resources

The STSB had a budget of approximately CHF 7.9 million available in 2021. Around CHF 3.9 million was budgeted for personnel expenses, and just under CHF 4 million for material and operating expenses. The latter item specifically included just under CHF 1.3 million for external services. The STSB uses this to finance investigations conducted by external experts and specialist organisations. The budgets for both personnel and material and operating expenses were almost entirely exhausted during the year under review.

In December 2020 the Board approved the final report on the accident of 4 August 2018 involving the Ju 52. It was published in January 2021. Following publication, there were still various follow-up tasks to be done, such as evaluating proposals for further investigations and a debriefing on the procedure for investigating major accidents. Publication and this downstream work generated costs of around CHF 180,000, taking the total for investigating this accident to just under CHF 4 million. In autumn 2018 the STSB had applied for an additional budget of CHF 4.5 million for the investigation.

As is also usual in other countries, the work of the Swiss Transportation Safety Investigation Board 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. Two vacancies, for one technical investigator and one administrative post, could be backfilled during 2021. In its investigative activities, especially when specific specialist skills are required, the STSB can also call upon the support of 126 external contract investigators.

4 Investigations and findings

4.1 Overview of investigations by the entire Investigation Bureau

The STSB received 1,655 incident notifications in 2021. Following assessment, these resulted in 77 new investigations. A total of 20 extensive and 67 summary investigations were completed during the year, and three interim reports on ongoing investigations were published. In the course of those extensive investigations, both completed and still in progress, the STSB identified safety deficits that led it to issue 22 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 one incident notification concerning maritime navigation in 2021. It did not result in an investigation being opened. No reports were published in this area in 2020, either.

The number of incidents reported to the STSB in 2021 (1,655) was comparable to pre-2018 figures. Highs were recorded in 2018 and 2019 with over 1,800 notifications received in each case. In 2020 the STSB received only 1,215. Fewer notifications to the Aviation Division was the principal factor in this difference. Prior to 2020 there had been a steady increase for many years in the number of notifications, which peaked for the period in 2018 and 2019 with 1,557 and 1,566 reported incidents respectively. This trend came to a halt in 2020, when only 894 notifications were received – just short of 60% of those of previous years. At 1,309 reported incidents, figures for 2021 returned to their pre-2018 levels. It stands to reason that both the decline in notifications in 2020, and the increase in 2021, are connected at least in part with the collapse of commercial air travel owing to the COVID-19 crisis, and its subsequent recovery. The 346 incidents reported to the Rail / Navigation Division is approximately 10% higher than the long-term average.

With a total of 87 investigations completed, the STSB raised its output significantly in 2021 compared with the 61 of 2020, thereby bringing it back into line with that in the years prior to 2020.

4.2 Aviation

The STSB received 1,309 notifications of aviation incidents during 2021. 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 26 accident investigations and 40 serious incident investigations, including 14 airproxes involving a high or significant risk of collision. An extensive investigation was opened for 10 incidents, while the initial investigation findings for 45 events indicated that a summary investigation should be conducted.

There were 70 investigations completed and their findings published in nine final and 61 summary reports. The final reports contained eight safety recommendations and two safety advices (Section 5.2). A further two safety recommendations were published in interim reports.

The effects of the COVID-19 pandemic continued to limit aviation in 2021, especially where commercial air travel was concerned, although there was more activity than in 2020. This is reflected in the number of reported incidents. While 1,566 notifications were received in 2019, numbers dipped to 894 in 2020 before climbing back to 1,309 in 2021.

During the reporting year there were 27 accidents involving aircraft registered in Switzerland, three of which occurred abroad. Eight people suffered fatal injuries as a result.

4.3 Public transport

Railways and trams

The STSB received 307 notifications of safety-related incidents concerning trains (286) and trams (21) in 2021. An investigator attended on site in 21 cases. An analysis of the notifications with a view to their preventive potential resulted in an investigation being opened in seven cases. These involved three collisions, two hazardous situations, one fatal accident involving persons, and one industrial accident.

A total of six extensive and five summary investigations were completed last year, and two interim reports were published during ongoing investigations. In response to the safety deficits identified during the extensive investigations, the STSB addressed eight safety recommendations to the supervisory authority and one safety advice to the transport/infrastructure operator concerned (Section 5.3).

Cableways

There were 20 notifications of safety-related events involving cableways during the reporting year. An investigator attended the scene in three cases. Preliminary enquiries resulted in an investigation being opened into all three incidents. They concerned a serious case of material fatigue on a pylon, one industrial accident and a serious incident in which a sheave assembly broke free from a pylon.

The STSB concluded three extensive and one summary investigation(s) into this mode of transport during the year under review. It published one advance interim report on one of the completed investigations. The extensive investigations identified a variety of safety deficits. As a result, two safety recommendations were issued to the supervisory authority and two safety advices to the cableway operator in question (Section 5.4).

Buses

Eight bus-related incidents were reported in 2021. One investigation was opened, in the case of a trolleybus fire.

Inland navigation

Ten notifications of inland navigation incidents were submitted to the STSB in 2021. No investigations were opened

Two investigations were completed with final reports. These reports contained six safety recommendations to the supervisory authority and two safety advices to the ship operators concerned.

4.4 Maritime navigation

One incident notification concerning maritime navigation was received during the reporting year. It did not result in an investigation being opened, neither were any reports published for this mode of transport in 2021.

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 also 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 body.

However, because of the separation of powers, the investigation body does not itself mandate measures to improve safety but instead proposes that the competent authorities take such action. These thus 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, however. These affect the specific steps that are taken, and are described below.

The EU established the European Aviation Safety Agency (EASA) in 2002. 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

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. 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 (www.sust.admin.ch/en/safety-recommendations/aviation and 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 2021 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

Emergency landing of a motorised aircraft 1 km south of Gossau (ZH), 30.11.2019

A loss of fuel supply resulted in engine failure, as a result of which the aircraft was badly damaged during an emergency landing in a field. Factors contributing to the accident were an incorrectly fitted fuel tank selector switch in combination with a defective fuel gauge.

Safety deficit
The changeover from traditional technical administration to an electronic solution was designed in a flight school in such a way that information on the technical condition of its aircraft was only available to the flight school as aircraft owner for a long time. However, the pilots, the maintenance organisation and the supervisory authority only had an incomplete and varying level of information. This was recognised as a factor to risk in the investigation of an aircraft accident.

Safety recommendation No 568, 30.03.2021
The Federal Office of Civil Aviation (FOCA) should take appropriate measures to ensure that, with the start of the switch to electronic logbook systems, authorised persons have unrestricted access to information on the technical condition of the aircraft.

Emergency landing of an electrically powered motorised aircraft approximately 2 km east of Ecuvillens aerodrome, 03.01.2019

During an emergency landing outside the aerodrome area, which was due to a loss of motor power, the Pipistrel Alpha Electro 167 made a hard impact with the ground and then flipped over.

Safety deficit
Due to a faulty electrical connection, the cooling system's circulating pump failed, causing the propulsion unit's power controller to over-heat within a short time. As a result, the available motor power was automatically reduced to less than 15% of the maximum take-off power. As a result, the pilot was forced to make an emergency landing outside the aerodrome area during which the aircraft was severely damaged. The fact that a single pump was installed in the cooling system was recognised by the STSB as a lack of redundancy and a high safety risk.
While the aircraft flipped over, the left attachment point of the pilot's lap belt was torn from the airframe.

Safety recommendation No 569, 27.04.2021
The European Union Aviation Safety Agency (EASA) should ensure that the aircraft manufacturer adapts the propulsion unit›s cooling system in such a way that the failure of a single system component, such as the circulating pump, does not significantly affect cooling and consequently motor power.

Safety recommendation No 570, 27.04.2021
The European Union Aviation Safety Agency (EASA), in cooperation with the aircraft manufacturer, should ensure that the seat belt attachment points can withstand such forces in all aircraft types which have an airframe similar to the Alpha Electro 167.

Safety deficit
In the current accident, the two main batteries were not damaged and there was no fire. In the context of the investigation it was revealed that an electrically powered aircraft involved in an accident poses specific hazards. Extinguishing a fire on an electrically powered aircraft requires special precautions and procedures on the part of the emergency services. This is due to the built-in high-performance batteries. The wreckage of an electrically powered aircraft also poses a particular hazard due to the high electrical voltage and current of the main batteries.

Safety recommendation No 571, 27.04.2021
The FOCA should supplement the aircraft register with an entry for electrically powered aircraft.

Safety recommendation No 572, 27.04.2021
The FOCA should, in cooperation with aerodrome operators and the emergency services which are usually involved in accidents involving aircraft, take measures to raise awareness of the hazards posed by electrically powered aircraft and how these can be countered.

Ground collision between a business aircraft and a car close to Buochs aerodrome, 05.03.2021

Taxiway D is located at airport Buochs (LSZC), and runs from the airport to the Pilatus Aircraft Ltd site. This taxiway crosses the cantonal road between Ennetbürgen and Stans. On this crossing, the driver of a passenger car failed to see the red traffic light and subsequently collided with a Pilatus PC-12.

Safety deficit
The crossing is indicated with danger signs and a signal installation involving lights and warning signals. However, there are no traffic barriers. Nor are there any additional speed restrictions on the cantonal road near the crossing, meaning that vehicles may travel at up to 80 km/h.
Little damage was caused; however, a collision of this kind could potentially result in considerable damage to the aircraft and car involved, and in serious injury to the persons or third parties involved, for example owing to the high rotation energy of the aircraft's propeller. All other crossings on the aerodrome for which air traffic control is responsible have traffic barriers, apart from the crossings between the cantonal road and Taxiways D and C – the latter lying further east.

Safety recommendation No 576, 19.10.2021
The Canton of Nidwalden's Office for Mobility, in collaboration with the cantonal police department, the Federal Office of Civil Aviation (FOCA), Pilatus Aircraft Ltd and the operators of Buochs airport (LSZC) should implement measures to reduce the risk of a collision between users of the cantonal road and aircraft at the crossings on taxiways C and D.

Light helicopter engine failure at Bola (GR), 26.06.2021

The crew of a Guimbal Cabri G2 helicopter constructed in 2020, equipped with a Lycoming Engines O-360-J2A engine that was also manufactured in 2020, performed an autorotation following a drop in engine oil pressure that resulted in too little tension on the drive belt and thus a reduction in rotor speed.

Safety deficit
The subsequent investigation showed a narrowed section, as well as chips and non-deburred drilling work in one of the oil ducts in the accessory housing. An inspection of further engines constructed in 2020 and 2021 revealed similar findings.

It may therefore be assumed that further O-360 series engines will display similar shortcomings that, depending on use, might result in a considerable risk during flight operations.

Safety recommendation No 578, 21.09.2021 (interim report)
The European Union Aviation Flight Safety Agency (EASA) should take appropriate action to ensure that all operators of O-360-series Lycoming Engines identify and remedy narrowed sections of the oil duct in the accessory housing caused by possible manufacturing deficiencies.

Safety recommendation No 579, 21.09.2021 (interim report)
The US Federal Aviation Administration (FAA) should take appropriate action to ensure that all operators of O-360-series Lycoming Engines identify and remedy narrowed sections of the oil duct in the accessory housing caused by possible manufacturing deficiencies.

Safety recommendation No 580, 21.09.2021 (interim report)
The US Federal Aviation Administration should take appropriate action to ensure that engine manufacturer Lycoming Engines takes the proper steps to remedy the manufacturing deficiencies that have been identified.

Take-off accident involving a power glider at the Dierdorf special airfield (EDRW), Germany, 17.10.2021

On an SF 25C motor glider the right control stick broke directly above the weld seam at the transmission joint so that it could no longer be used to control the aileron and elevator. The design was such that the aileron, but not the elevator, could still be controlled with the left stick. The crew, who were unaware that the control stick was broken, therefore lost control of the motor glider during the take-off run. The aircraft hit the ground hard, collided with a tree and came to a halt severely damaged.

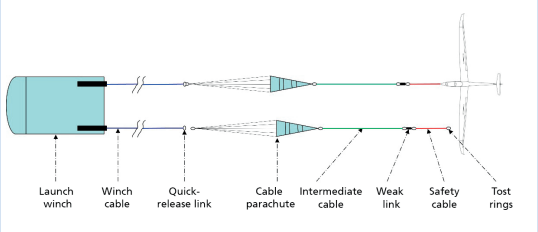
To ensure an independent enquiry, the German Federal Bureau of Aircraft Accident Investigation (BFU) delegated this investigation to the Swiss Transportation Safety Investigation Board, which published this interim report.

Safety deficit
The investigation revealed that the broken steel rod was heavily corroded on the inside and therefore weakened. According to the manufacturer's drawings, the material used was St 35 machine steel (now E235), which has low corrosion resistance. There were no manufacturer's instructions recommending that periodic checks should be carried out for crack or corrosion formation or to ascertain the integrity of the anti-corrosion coating of these control components.

Safety recommendation No 581, 21.12.2021 (interim report)
The European Union Aviation Safety Agency (EASA), in cooperation with the aircraft manufacturer Scheibe Aircraft GmbH, should take measures to ensure that SF 25 motor gliders are only operated if there are no such signs of corrosion on their control components and control rods.

Incident during a winch launch at the Fricktal-Schupfart airfield, 10.05.2019

In the course of a winch launch a glider collided with the cable parachute and winch safety cable (strop) after the crew released the winch cable, the cable parachute opened and the winch driver retracted the winch cable.



Safety deficit
The investigation found that, depending on the arrangement of the winch launch cable, having aborted a winch launch neither the crew nor the winch driver is able to prevent a collision between the glider and the inflated cable parachute and safety cable. To reduce precisely this risk, airworthiness directive (AD) 73-16 issued by the German federal aviation authority (LBA), in February 1973 (now AD 1973-016) contains requirements for cable parachutes and cable arrangements. It emerged that few people in Switzerland are aware of this information.

Safety advice No 39, 07.12.2021
The SFVS Swiss gliding federation should raise awareness among operators of launch winches that they must observe the following instructions, conduct individual risk analyses and take the appropriate action:

- Use only cable parachutes that permit sufficiently fast cable retraction speeds, so that an open cable parachute can be pulled away from a glider flying horizontally at low altitude.
- Use an intermediate cable to ensure that the distance between the parachute canopy and the glider's tow release is long enough to give crews sufficient re-

action time to avoid an inflating or collapsing cable parachute.
- Swiss operators of launch winches should observe the basic considerations and safety recommendations that have been in place in Germany for decades, adapt them to current circumstances and implement them.

The probability of a collision between the glider and the cable parachute and safety cable can be minimised by taking the measures described above. Guidance on the way winch cables should be arranged may be drawn from the SBO gliding regulations issued by the German federal gliding commission *(Bundeskommission Segelflug)*, which is part of the Deutscher Aero Club, and airworthiness directive (AD) No 73-16 issued by the German federal aviation authority (LBA).
In addition, winch drivers should be taught emergency procedures that are adapted to the way in which their individual system components interact.

Controlled flight into the terrain in the Les Pléiades region (VD) during a night flight, 22.01.2020

While flying according to visual flight rules (VFR) on a dark night, the aircraft collided with the terrain in a steeply sloping wood and was destroyed upon impact. Both occupants sustained fatal injuries.

Safety deficit
The findings of the investigation indicate that the pilot's enthusiasm for the use of electronic aids likely gave a false sense of ease, causing them to lose situational awareness. The pilot evidently did not check that their altitude was sufficient for the route from Vevey to Gruyères (LSGT).

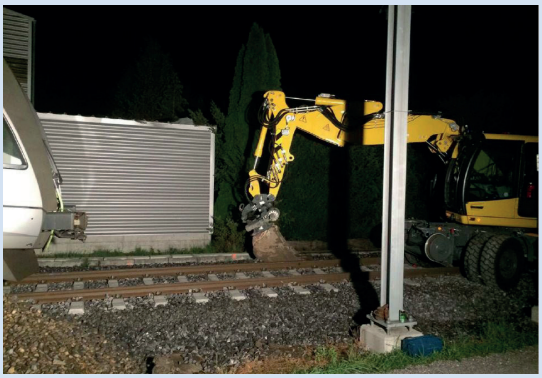
Safety advice No 40, 07.12.2021
Modern electronic aids such as tablets are becoming an increasingly important part of flight planning and navigation. Pilots should therefore learn how to use these aids during their flight training. It must be remembered, however, that visual flights must always be conducted on the basis of visual references to land or water.

When flying VFR at night, even under good weather conditions there may still be situations involving artificial lighting or other brightness that make it difficult to recognise obstacles. To ensure safe navigation when flying on visuals, methods should be taught and practised that ensure that a flight can be conducted using visual references even when visibility is poor. Technical aids such as tablets can certainly be of use in this respect, but should not be used as the principal means of navigation.

5.3 Railways

Collision of a multiple unit with a road/rail vehicle in Burgistein (BE), 10.09.2015

On 10 September 2015 at 22:13 hrs, a 'Lötschberger' RABe 535 multiple unit collided with a road/rail excavator in Burgistein (BE). Both vehicles were damaged, and one person suffered minor injuries. The roof of the building on the adjacent property was also damaged, but the railway infrastructure was not affected.



The collision was caused by the road/rail vehicle having joined the rails on an unsecured track. This occurred because communication (observance of speech and radio rules) between the controller and safety warden via mobile telephone did not follow the official regulations, leading to misunderstandings and contradictions that were not picked up. Additionally, the relevant documents did not specify the location at which the excavator was to join and leave the tracks, or this was not stated correctly.

These risks were also identified:
- The following errors can trigger a chain of events:
  - Safety-related documentation that is not kept up to date, such as the safety protocol and circular.
  - Acceptance of deviations from specifications in safety-related documents.
- The ceiling panels in the 'Lötschberger' unit did not withstand the 28 km/h collision. They became detached and could have injured passengers.

Safety deficit
When letting the special train pass by in Burgistein, the movements inspector and safety warden (in the role of safety officer) failed to recognise when discussing where the road/rail vehicle would join the tracks that they each assumed a different location. Although the movements in-

spector had stated that it was not possible to close track 71 and points 55 to enable the road/rail vehicle to join the track, the safety warden still asked if the excavator could be re-railed regardless. The fact that the movements inspector then agreed to the excavator joining the tracks, adding "but the train still has to come through and it will be here any minute" did not lead either party to suspect that there might have been a misunderstanding.

Safety recommendation No 145, 27.08.2019
The safety deficit established in this case had already been taken up in Final Report No 2016091602 on the near miss between a suburban train and a shunting engine on 16 September 2016 in St Margrethen, and was addressed in Safety Recommendation No 145. For this reason, the STSB declined to issue a further, identical safety recommendation. Safety Recommendation No 145, issued to the FOT in Final Report No 2016091602, reads: *The Federal Office of Transport (FOT) should lay down mandatory requirements for persons with safety-relevant duties so that their initial training and periodic professional development covers ways of thinking and behaving when dealing with disruption, similar to the position in aviation with TRM training.* Although the present case concerns a normal procedure rather than an incident procedure, Team Resource Management (TRM) training would help to identify misunderstandings in communication and guide management conduct and decision-making.

Safety deficit
The collision at 28 km/h resulted in individual panels detaching from the ceiling of the 'Lötschberger'. This might have caused injury had passengers been on the train.

Safety recommendation No 111, 02.03.2017
The safety deficit identified in the present case had already been taken up in Final Report No 2014081301 on the derailment of a passenger train following a landslip on 13 August 2014 in Tiefencastel, and addressed in Safety Recommendation No 111. The STSB therefore decided not to issue any further safety recommendation. Safety Recommendation No 111, issued to the FOT in Final Report No 2014081301, reads: *The FOT should check guidelines for securing interior panels of train carriages and amend them, where necessary, so that these panels cannot come loose in the event of severe shaking.*

Accident involving persons in Bern, 01.03.2020

At 01:09 on Sunday, 1 March 2020, a passenger's hand got caught in the closing boarding door of a Eurocity passenger coach of the Intercity (IC) Bern-Interlaken Ost at Bern station. The train left a short time later. The passenger ran alongside the car and tried to free his hand. After running alongside the car for about 45 metres, he finally managed to pull his hand out of the rubber door seals. He sustained minor injuries in his efforts.

The accident involving a person occurred because technical and construction failures led to the premature deactivation of the anti-trap system in the entrance doors as the doors closed.

The following contributed to the accident:
- The use of an anti-trap protection strip with unsuitable material properties.
- The maintenance measures introduced to improve the quality of the anti-trap protection were not sufficient to prevent the latter from being deactivated too early as the doors closed.
- A person reached their hand into a closing door space.
- Only one person was responsible for the departure process in the given situation (train length, wagon types, place of departure, conditions on the platform).

Safety deficit
People are used to the fact that most doors that close automatically can be reopened by reaching into the closing door space. They therefore attempt to do the same with doors that may reopen less reliably. Public transport users should be alerted the fact that closing doors should only be reopened by operating the door opening button. Under no circumstances should a person reach into a closing door space. If they do, they may fall or become trapped. The anti-trap system is not intended or designed as an alternative method of opening the carriage door. People are used to the fact that most doors that close automatically can be reopened by reaching into the closing door space. They therefore attempt to do the same with doors that may reopen less reliably. Public transport users should be alerted to the fact that closing doors should only be reopened by operating the door opening button. Under no circumstances should a person reach into a closing door space. If they do, they may fall or become trapped. The anti-trap system is not intended or designed as an alternative method of opening the carriage door.

Safety recommendation No 161, 06.07.2021
The Federal Office of Transport (FOT) should examine the extent to which informing public transport users not to reach into closing door spaces can lead to fewer people falling or becoming trapped. It should ensure appropriate measures are implemented where necessary.

Safety Recommendations No 153 and No 154 were submitted to the FOT in the interim report into this incident, dated 15 March 2020. These were published in the annual report for 2020.

Derailment of a passenger train in Rossinière, 11.09.2020

At around 20:40 on 11 September 2020, the second panorama carriage (As 111) of MOB train No 2238 travelling from Montreux to Zweisimmen derailed at the exit of Rossinière station. None of the 25 passengers on board the train were injured.
The MOB train No 2238 derailed at the exit of Rossinière station because of a breakage of the first axle of the front bogie on carriage (As 111).
The axle broke in the area of the earthing disc. Corrosion between the axle and the earthing disc had triggered the formation of a crack, which subsequently spread through the axle shaft, eventually causing it to break from fatigue.

The following factors contributed to the accident:

- Failure to carry out a full ultrasound check of the axle during servicing.

In the course of the investigation, the following risks were identified:

- During the periodic maintenance of the panorama carriages, the condition of the protective layer of the axle shafts and the wheels was not checked.
- The serviced axles, which were awaiting use, showed damage to the axle shafts as a result of inappropriate handling.

Safety deficit
Axles are important components in the safety of rolling stock. A broken axle or wheel can have serious consequences. During maintenance, it is essential to pay special attention to these components. Only non-destructive testing (e.g. ultrasonic [UT], magnetic [MT]) can detect the beginnings of a crack.
Article 51 Section 1.19 of IP-RailO (2016 version), Non-interoperable vehicles, stated with regard to non-destructive testing that vehicle axle shafts must be non-destructively inspected for cracks at each change of wheels or tyres along the whole length of the vehicle.
This article in the 2020 version of the IP-RailO has been adapted to state that wheels and vehicle axle shafts / trailing axles must undergo regular non-destructive testing. [...] For this procedure, industry-specific maintenance regulations must be applied.
The 2020 version of the IP-RailO is thus less comprehensive than the previous one and defines the scope of non-destructive testing simply as the industry-specific maintenance regulations.

Safety recommendation No 160, 11.05.2021
The STSB recommends that the FOT adapt RTE 41500 (industry-specific maintenance regulations) so that non-destructive testing is thoroughly regulated, while at the same time recommending a complete inspection of the entire axle when changing wheels or tyres.

Collision between two shunting movements in Cully, 16.11.2020

At 02:33 on 16 November 2020, a collision occurred on track 3 in Cully between a train engaged in a shunting movement, coming from an SBB Infrastructure Contact Lines worksite on the open track between Lutry and Cully, and another train at a standstill on track 3. The latter was supposed to continue its journey to an SBB Infrastructure Tracks worksite in Lutry, i.e. past the Contact Lines worksite. As a result of the impact, the stationary vehicles on track 3 were pushed back 25 metres. Two people were slightly injured. The rolling stock incurred extensive damage.
The collision on track 3 at Cully station between the Contact Lines train and the Tracks train was caused by the former travelling at a speed unadapted to the visibility conditions and the ETCS signal showing 'Proceed with caution'. The train was unable to come to a halt before reaching the stationary vehicles.

The following contributed to the incident:

- A lack of planning and coordination in preparing the works so that there was no agreed definition of the operating restrictions to be applied when working on the same site;
- Failure to hire a site coordinator;
- Failure to inform staff on the ground of the operating status, which would allow them to determine unequivocally the current track occupancy.

Safety deficit
When several worksites are in operation in the same area and the same tracks have to be closed, a site coordinator must always be present, as stipulated in the safety guidelines drawn up in accordance with RTE 20100.
Uncoordinated movements and non-uniform procedures are factors contributing to irregularities.
The danger of such lack of coordination when planning works was previously highlighted in the report on the fatal accident at a worksite at Airolo station on 5 February 2019. The report on the endangerment of operations at Cully station on 15 November 2019 also highlighted a lack of planning and coordination in preparing the works, which meant

there was no agreed definition of the operating restrictions to be applied.
Following the report on that incident at Cully on 15 November 2019, safety advice No 25 was issued, as follows:
To standardise working processes, where there are two engineering sites in the same area at the same time, SBB Infrastructure should ensure that the operators concerned coordinate with each other to plan and define common operating restrictions.
This accident has once again highlighted the lack of planning and coordination in preparing the works so as to ensure an agreed definition of the operating restrictions to be applied when working on the same site.

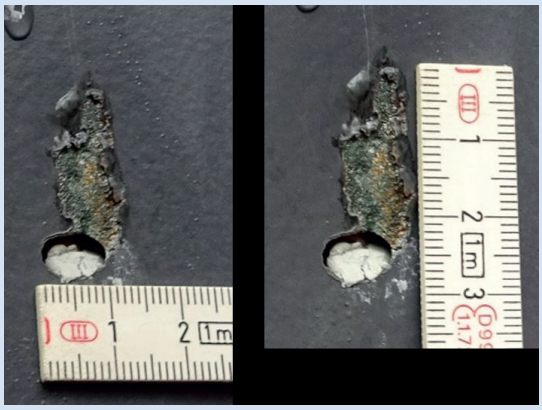
Safety recommendation No 162, 17.08.2021
The STSB recommends that the FOT ask the infrastructure operator SBB to take organisational measures to ensure that the work is coordinated between the various units when planning worksites in the same area at the same time.

Safety deficit
According to the RTE safety regulations, the site coordinator – or the safety manager – is responsible for managing the written inspections for all shunting movements along the entire closed section. On larger worksites, it is not unusual for several trains to be involved. Distances and the local topography may prevent the site coordinator from having a visual overview of the entire area. As a result, the task of following shunting movements can become tedious and error-prone.
Although he was in charge of safety, the Contact Lines safety manager who was on the worksite right on the track between Cully and Lutry was not aware that a train was waiting on track 3 in Cully station and that this train was then supposed to pass along the closed track on which he was working, heading for the Tracks worksite at Lutry station.
Safety managers and site coordinators do not have the technology to check that the track restrictions confirmed by the rail traffic coordinator are indeed as requested or to determine the track status (free/occupied) when they authorise a shunting movement to operate in the closed area. This is despite the fact that IT tools currently exist to allow for such information to be made available.

Safety recommendation No 163, 17.08.2021
The STSB recommends that, to ensure the safety of complex worksites, the FOT should require infrastructure operators to provide safety managers and site coordinators with a real-time graphical overview of the operating situation (in particular the status of track restrictions, track occupancy and established itineraries) for the area in which they are responsible for worksite safety.

Dangerous goods incident in Basel SBB shunting yard, 19.10.2020 (interim report)

On 19 October 2020, a technical inspector at Basel SBB RB marshalling yard heard a hissing sound from a tank wagon and noticed steam escaping from an almost imperceptible hole. He complained of feeling unwell and was taken to hospital for a check-up. On 6 July 2021 in Lüsslingen, a driver noticed some blue smoke during a shunting movement. Upon inspection, he found that smoke and liquid were escaping from a small hole near the access opening of a tank wagon filled with hydrochloric acid.



Safety deficit
Within the space of nine months, two identical Zacns tank wagons in Switzerland experienced a leakage of hydrochloric acid, one at Basel SBB freight station and the other at Lüsslingen.
The preliminary findings of the investigations indicate that the protective lining of the Zacns series N-310-02 tank wagon does not always provide an appropriate barrier between the steel shell and its hazardous contents, leaving the steel shell subject to damage by corrosion. The leakage of hazardous substances from a tank wagon poses a considerable risk to employees, passengers and the general public as well as to the environment.

Safety recommendation No 167, 31.08.2021 (interim report)
In accordance with Article 26 paragraph 2 of Directive (EU) 2016/798 of the European Parliament and of the Council of 11 May 2016 on railway safety, the STSB recommends that the Federal Office of Transport (FOT) forward the following safety recommendation to the national safety authority of the member state in which the wagons are registered (NSA-NL) and to the national safety authority of the member state in which the responsible ECM is based (NSA-FR):
The STSB recommends that all Zacns series N-310-02 tank wagons with the HAW-H94 protective lining be removed from

service and that the protective lining be inspected by an independent body. At the same time and in consideration of the inspection results, the STSB recommends clarifying whether other tank wagons with comparable protective linings may be affected and, if so, that appropriate measures be taken.

Train collision in Belp, 31.12.2020 (interim report)

On the afternoon of 31 December 2020 at 16:43, a passenger train stopped at Belp Steinbach station. The passenger train was due to couple with a multiple unit waiting on track 2 in Belp. Leaving Belp Steinbach, the driver of the passenger train accelerated to 40 km/h. Around 230 m before the waiting multiple unit he started braking using the electrodynamic brake. As the braking effect was inadequate, the driver pulled the emergency brake about 160 m before the stationary multiple unit. However, the braking effect was still inadequate and the passenger train collided with the stationary train at a speed of 23 km/h.

Safety deficit
The preliminary results of the investigations suggest that the RABe 515 trainsets do not always achieve the braking performance that was determined when type approval was granted. For example, when the emergency brakes are triggered by the train protection system, the train may not always stop before the danger point.

Safety recommendation No 158, 24.02.2021 (interim report)
The STSB recommends that the Federal Office of Transport (FOT) request the operators of trainsets of type RABe 515 to check and adjust the braking performance so that the trainsets achieve the braking performance values in the type approval in all operating situations. Alternatively, other measures should be taken to ensure that the trains are able to come to a standstill in time.

5.4 Cableways

Fracture of a maintenance platform of a chairlift in Morgins-La Foilleuse, 13.02.2021

On 13 February 2021, during operating hours at approximately 11:45, on the three-seat detachable chairlift (TSD 3) linking Morgins to La Foilleuse, the maintenance bridge on tower No 14 broke off and fell to the bottom of the tower. A passenger noticed that a piece of the system was on the ground and reported it to a member of the operating staff when he arrived at the upper terminal. A technical expert went immediately to the site and ordered the evacuation of the lift system. The installation was temporarily shut down while the technical staff secured the tower. There were no injuries.

The collapse of part of the maintenance bridge of tower 14 resulted from fatigue caused by cyclic vibrations.

Safety deficit
Similar vibrations also occur in the welded and bolted joints. Non-destructive testing to date has also revealed cracks in the other towers of the system. Tower components which are repeatedly exposed to vibration can lead to the formation of cracks, and a component with a hairline crack can break at any time.

Safety recommendation No 159, 30.03.2021 (interim report), 12.10.2021 (final report)
The STSB recommends that the Federal Office of Transport (FOT) instruct the lift operating company to conduct non-destructive testing of all the towers in the lift system and carry out any repairs needed to immediately correct any issues found.

Industrial accident in Pontresina, 02.06.2021

On 2 June 2021 at 13:30, an employee was knocked off a cable car tower by the running gear of the downhill cable car while cleaning work on the cable saddles was being set up. He fell about 50 m down into snow two metres deep and was seriously injured.

A worker fell from a cable car tower on 2 June 2021 in Pontresina having made an involuntary movement as a result of a knee problem, and which meant he got too close to the passing running gear of a cable car and was pushed off the work platform.

The following contributed to the accident:
- Preparatory work was carried out while the cable car installation was in operation.
- There was no comprehensive process or specifications in place for securing the work site as the cable car approached.

The following risk was identified during the investigation:
Because a work area was supposedly secured by railings, the wearing and use of personal protective equipment against falls from a height was dispensed with.

Safety deficit
The investigation established that the cable car industry has few specifications regarding securing a work site, especially during operation.

Safety recommendation No 168, 19.10.2021
In its supervisory activities, the Federal Office of Transport (FOT) should check whether the cable car companies have suitable operational solutions in place to ensure safety at work sites during operation.

Safety deficit
Since 2005, at least seven similar incidents have been reported in which a person was dragged by the running gear of a passing cable car. When work is carried out on cable car installations that are in operation, individual employees are left completely responsible for noticing approaching cable cars and recognising the danger in good time. There is no process in place for setting up a work site near moving parts or moving vehicles when the installation is in operation, and there are no instructions on how and under what conditions it can be set up.

Safety advice No 28, 19.10.2021
Target group: Cable car companies
Cable car companies should take the following action, ideally working together with their branch organisation:
- Establish criteria to determine whether a work site may be set up near movable parts or moving vehicles;
- Define measures for keeping employees safe and warning them during maintenance work carried out on installations that are in operation, in particular:
  – Determine how to set up shelters that allow work to be carried out during operation;
  – Determine which organisational or technical measures/means can be used to warn of approaching equipment;
- Develop measures to maintain employees› awareness and so ensure ongoing safety improvements.

Safety deficit
Because it was equipped with guardrails, it was assumed that the work platform was secure against falling. The guardrails were considered sufficient protection and so no personal protective equipment was used to prevent a fall. The incident demonstrated that it is always advisable to be protected against falls when working at a height.

Safety advice No 29, 19.10.2021
Target group: Cable car companies
Cable car companies should ensure that personal protective equipment to prevent falls is used consistently when working at height, even in situations where, for example, guardrails offer partial protection against falls.

5.5 Buses, inland and maritime navigation

Collision between MS Albis and the jetty in Küsnacht (ZH), 20.04.2016

On 20 April 2016 at approx. 13:09, the motorvessel Albis (MS Albis) belonging to the Zürichsee-Schifffahrtsgesellschaft (ZSG) collided with the jetty while mooring in Küsnacht (ZH). Several people were injured in the collision. Extensive damage was caused to the ship and the jetty.

The collision between MV Albis and the jetty in Küsnacht on 20 April 2016 can be attributed to the fact that it was not possible to take over driving control on the port bridge-wing control stand. As the records for some important parameters for the accident investigation are lacking, it cannot be said conclusively whether purely technical or purely human factors were the cause.

The following contributed to the accident:

- Unfavourable decisions and prioritisation regarding
  - the time at which the switch was made from the main bridge to the bridge-wing control stand; this left little room to deal with unforeseen events;
  - rapid acceleration shortly before the mooring manoeuvre from the main control stand, considering the distance and the approach angle to the mooring jetty as well as the given topology.
- A lack of training on dealing with possible system failures.
- Inadequate or missing guidelines, controls and monitoring in the company with regard to
  - procedures, plans and training courses which raise awareness of system failures and the emergency procedures in response to them, and which also provide regular opportunities for shipmasters to address issues relevant to the safe navigation of passenger ships;
  - applying lessons learned from safety-relevant notifications.

The following associated risks were identified:

- The technical limits of the steering system are not sufficiently considered in the current operating processes.
- No 'Failure/Malfunction of motor steering' scenario exists.
- There is no gathering of data that is required to analyse causes and to improve the system long-term.
- The ZSG does not have a concept for developing and monitoring a safety management system. In particular, the company does not ensure that its shipmasters read, understand and apply appropriate instructions on all lessons learned regarding the safe navigation of its vessels.
- Safety-relevant and reportable incidents are not reported to the FOT as the ZSG does not have up-to-date instructions. As a result, the FOT cannot carry out some oversight functions that are vital to safety in the system.

Safety deficit

The investigators had access to GPS records of the ship's position and records of the drive-control faults. However, important records on the operation or states of levers, buttons and rudder deflections were lacking. Today, ship drive systems (motors and rudders) are controlled and monitored using electronic controls. This should allow the relevant signals to be recorded and logged electronically. They would then be available for fault and accident analyses, which would help to improve systems.

Safety recommendation No 164, 07.09.2021

The Federal Office of Transport (FOT) should examine whether passenger ship control systems should be required to have a data recording system to record and store signals.

Safety deficit

Safety-relevant information is gathered and disseminated via various channels. However, this information is not consistently examined to identify and evaluate possible risks. For example, technical information is published on notice boards, damage reports with important findings and instructions for action are stored in folders on the ships. No check is made as to whether shipmasters receive, understand and apply this important and elementary information, and individual levels of knowledge cannot be tracked. It is therefore impossible to recognise deficits early and make targeted corrections.

Safety recommendation No 165, 07.09.2021

The Federal Office of Transport (FOT) should require ship companies to develop and implement a safety management system. This should ensure that possible risks are identified, recorded and evaluated, and that required actions are defined and corrections are initiated. Collecting, distributing and monitoring the impact of safety-relevant information should be taken into particular account.

Safety deficit

In the mooring manoeuvre, the shipmaster did not have sufficient instructions, experience or risk awareness with regard to possible system failures. The choice of speed, the angle of approach and the late assumption of command on the bridge-wing control stand suggest that the shipmaster had full confidence in the technology and in his own driving and operating skills. The investigation also showed that there are problems of timetable compliance and safety; in the event of a system failure or an unexpected reaction, no time was available to initiate an appropriate procedure to prevent a collision.

Safety recommendation No 166, 07.09.2021

The Federal Office of Transport (FOT) should require the ship companies to train and test crew members in safety-relevant system failures and irregularities and suitable emergency procedures. Shipmasters should also have the opportunity to rehearse the procedures periodically so that they can be applied intuitively in the case of an incident.

Safety deficit
Under certain circumstances (e.g. conditions such as the Küsnacht landing stage), shipmasters may be encouraged to choose a more risky approach as the timetable only allows a few minutes between the berthing of two passing ships at the same jetty.

Safety advice No 27, 07.09.2021
Issue: Placing safety above compliance with the timetable
Target group: Ship companies
Ship companies should systematically examine their timetable design for risks that may arise from time pressure, topology or encounters between vessels, and implement measures to reduce the risks.

Collision between two steamships in Lucerne, 19.08.2016

In an encounter involving two steamships in the Lucerne lake basin on Lake Lucerne on 19 August 2016 at approximately 13:35, the steamship Unterwalden (DS Unterwalden) suddenly veered to the left and so collided side-on with the steamship Schiller (DS Schiller).

The collision between the DS Unterwalden and the DS Schiller in the Lucerne lake basin was due to the fact that the rudder deflection to port could not be corrected in time when two steering commands were given almost simultaneously at two control stands. The rudder steering software was programmed to continue carrying out the first command received even after further commands had been given by another control signal transmitter.

The following contributed to the accident:
- A requirements and testing process that did not describe precise specifications for the functionality and testing of the software and did not explicitly exclude undesirable states.
- The Failure Mode and Effects Analysis FMEA did not cover a steering failure, software error or operational error or their impact on operational safety in different situations.
- The lack of clear behaviours or procedures for the handover or takeover of the different control stands led to several control signal transmitters operating at the same time.

The following helped to reduce the impact:
The initiation of an emergency manoeuvre (emergency stop – engines 'full back') by the crew reduced the impact of the collision.
The following factors did not contribute to the accident, but were identified in the investigation as potential areas in which safety improvements can be made:
- The design of the control signal transmitters poses risks to operational safety as there are no emergency running properties in the event of conceivable defects in the switch element and insufficient protection against moisture.
- No shielded cables were used to transmit the control signals from the control signal transmitters in the control stands to the PLC in the aft peak.
- The control signals from the control signal transmitters in the three control stands are electrically connected in parallel and received via two digital inputs in the PLC. This means the control commands from the control stands cannot be separately evaluated in the PLC, pending commands cannot be prioritised and control processes cannot be seamlessly traced.
- Since computer-based control processes are not stored, they cannot be traced; if this were the case, it would be easier to understand the control processes in the event of an incident.

Safety deficit
The Failure Mode and Effects Analysis (FMEA) only covered the technical failure of component groups or individual components. It did not cover faults and effects that may have resulted from operation or external influences. Likewise, it did not cover faulty behaviour of the PLC or the soft-

ware. Nor was the effect of the interaction of component failures and subsequent operator reactions on operational safety in different situations (docking, full speed, braking manoeuvres, etc.) considered.
This deficiency was not identified when the FOT checked the FMEA in the planning approval procedure.

Safety recommendation No 169, 21.12.2021
The Federal Office of Transport (FOT) should raise awareness in the inland navigation sector that an FMEA should also take into account the effects of both computer-based control failures and operator errors. The FOT should then check these points in the FMEA in the planning approval process.

Safety deficit
Computer-based control systems are increasingly being used on ships. There are no specific requirements for control systems used in nautical applications to meet a set of minimum requirements. For example, the need for failure detection in the event of a technical defect or a software error is not specified. Requirements for control signal transmitters or cables used, quality requirements for software or software updates and safety cases for computer-based solutions are only rudimentary in inland and maritime navigation.

Safety recommendation No 170, 21.12.2021
The Federal Office of Transport (FOT) should be active in appropriate bodies to ensure that requirements for computer-based control systems are established in the field of inland navigation to address safety-relevant issues relating to procurement, development, testing, maintenance and operation.

Safety deficit
The possibility of saving computer-based control processes is little used. In the event of malfunctions or events, recorded data can be valuable in ensuring optimum traceability. When evaluated, it provides a basis for improving technology, processes or specifications, thereby increasing reliability and preventing or minimising the impact of further incidents.

Safety recommendation No 171, 21.12.2021
The Federal Office of Transport (FOT) should establish which data must be present and available in existing and new systems from a risk and safety perspective and ensure that data storage options are exploited.

Safety deficit
The DS Unterwalden can be controlled from three control stands. There is no need for a handover or takeover between control stands; a command can be entered at each stand at any time. Furthermore, the PLC of the steering gear is designed in such a way that it cannot differentiate or identify the control signal transmitter from which a control command is given. It can be assumed that other ships with this design are in operation.
As long as only one shipmaster switches between the different control stands, it is clear who is in charge. If, for technical and organisational reasons, more than one shipmaster can enter commands at different control stands, there should be established processes to ensure that commands are not entered at two control stands at the same time. The fact that the same people do not always work together should also be taken into account. It must be clear to all shipmasters how to act, even in different constellations.
Where there are no guidelines or procedures for the handover or takeover between several control stands, control over the ship may be disrupted or even lost.

Safety advice No 30, 21.12.2021
Target group: Companies operating ships in which there is no handover between several control stands for rudder control or in which the control stands have equal rights in this respect.
These companies should draw up written guidelines on the transfer or assumption of command among several shipmasters in order to ensure uniform behaviour irrespective of the individuals concerned, whereby only one control signal transmitter is operated at any one time.

No safety recommendations were issued with regard to buses or maritime navigation during 2021.

6 Time series

The following sections 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 investigations. 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 1,000 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 50% 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 the latest reporting year. This increase is also likely to be linked with developments in commercial aviation.

The decision on whether or not to open an investigation is based on one principle criterion: whether that investigation 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. Although far fewer incidents were report in 2020 than in 2019, slightly more investigations were opened than a year earlier.

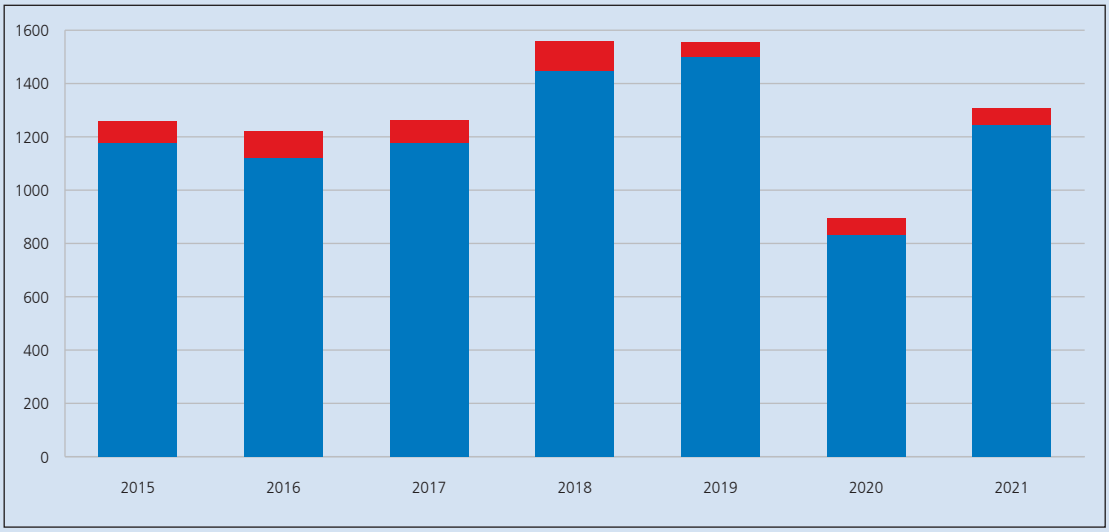


Figure 6.1.1: Number of incidents reported per year (red and blue) and investigations opened (red) since 2015.

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.

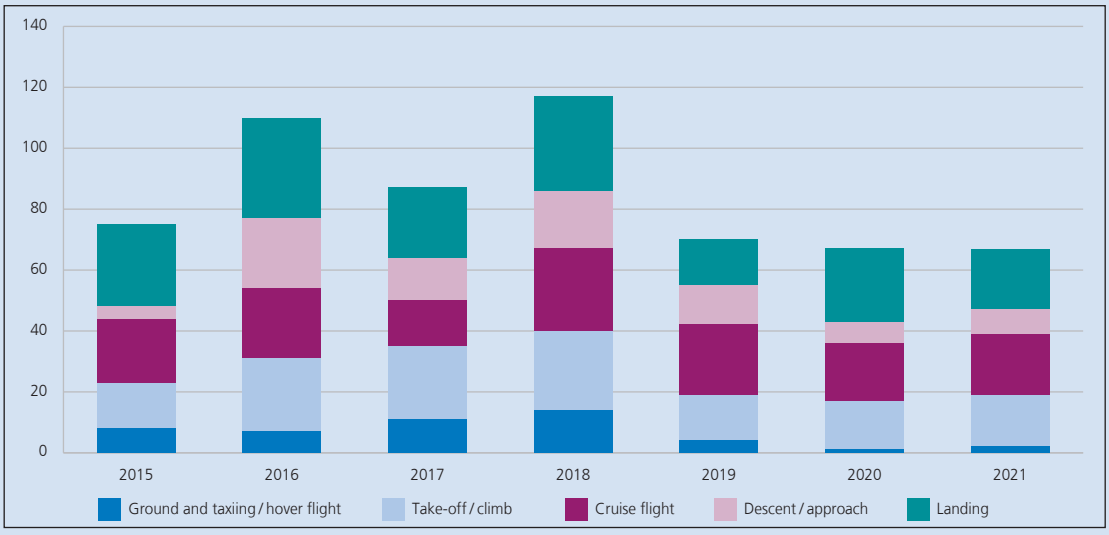


Figure 6.1.2: Total of accidents and serious incidents reported since 2015, broken down by flight phase. These figures cover events in Switzerland and abroad involving aircraft registered in Switzerland.

[1] As stated in Article 5 of the Ordinance on the Investigation of Transportation Incidents (OSITI; SR 742.161) the term 'serious incident' 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.

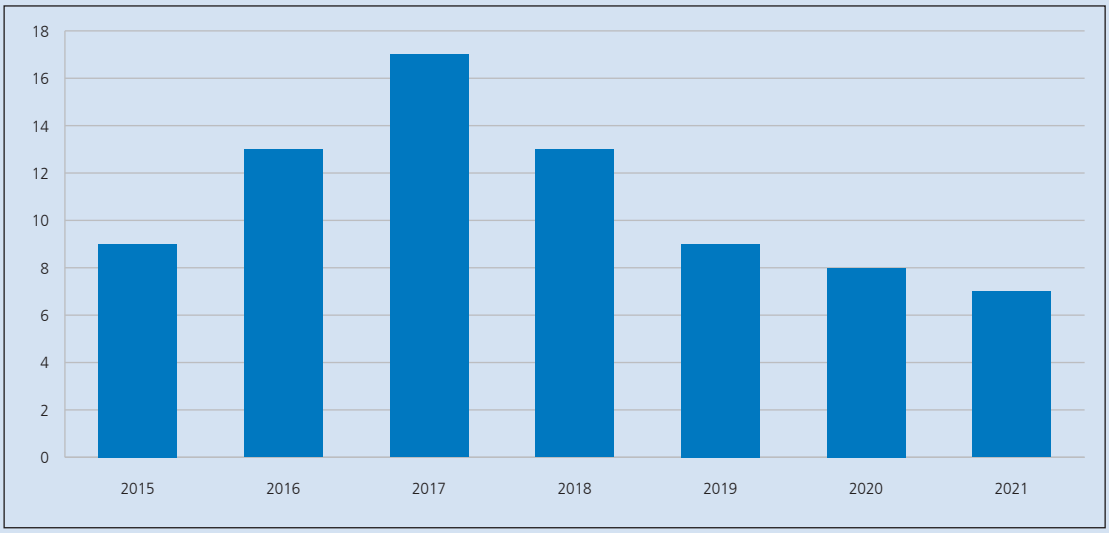


Figure 6.1.3: Development over time of aviation accidents that resulted in a fatal or serious injury.[2] The data covers accidents in Switzerland and abroad involving an aircraft registered in Switzerland, as well as accidents involving foreign-registered aircraft that occurred in Switzerland.

As described in Section 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.

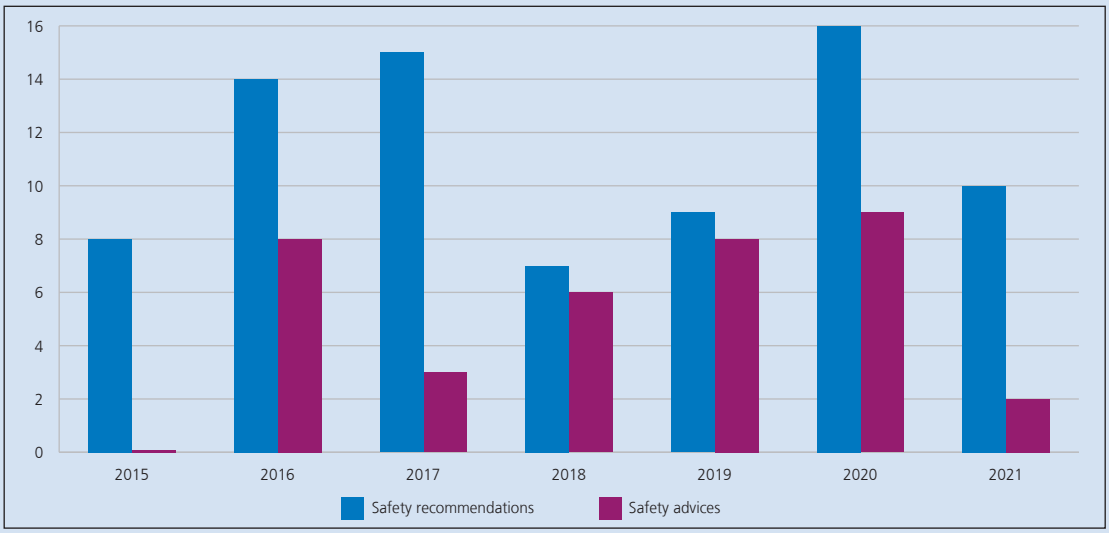


Figure 6.1.4: Number of safety recommendations and safety advices published since 2015 by the Aviation Division.

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 clear increases and decreases over the years.

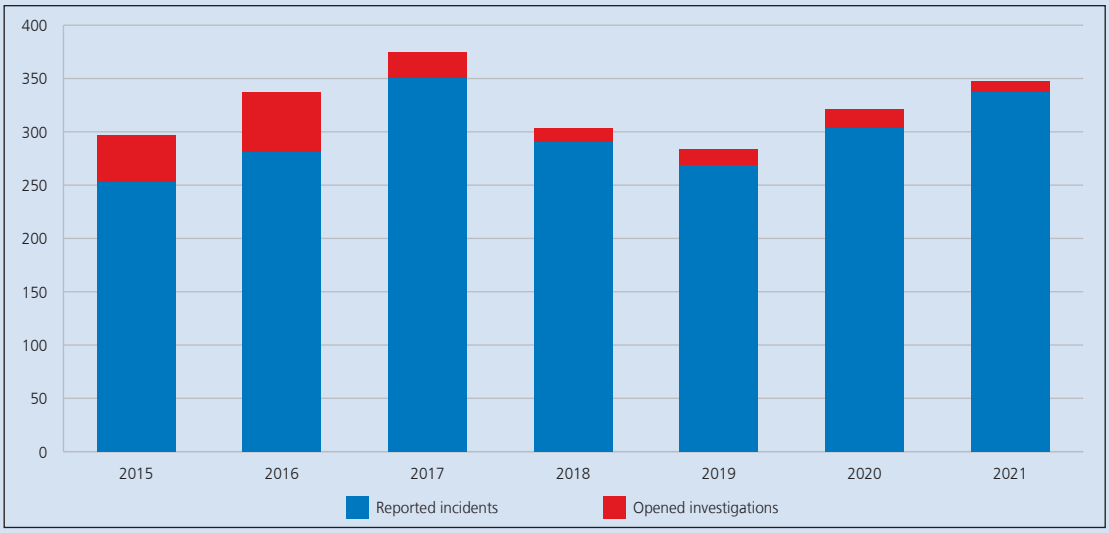


Figure 6.2.1: Number of incidents reported per year (blue and red) and investigations opened (red) for railways, trams, cableways, buses, and inland and maritime navigation.

The number of investigations opened each year 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.

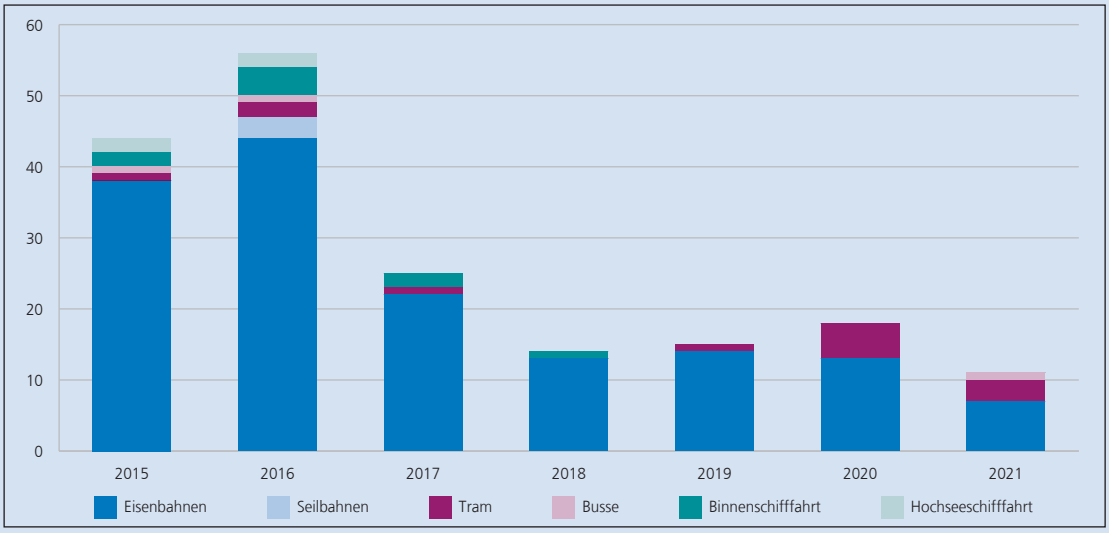


Figure 6.2.2: Number of investigations opened per year since 2015 for railways, trams, cableways, buses, and inland and maritime navigation.

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%) and suicides (15–20%) are responsible for the most reports, followed by derailments and collisions (10–15% each).

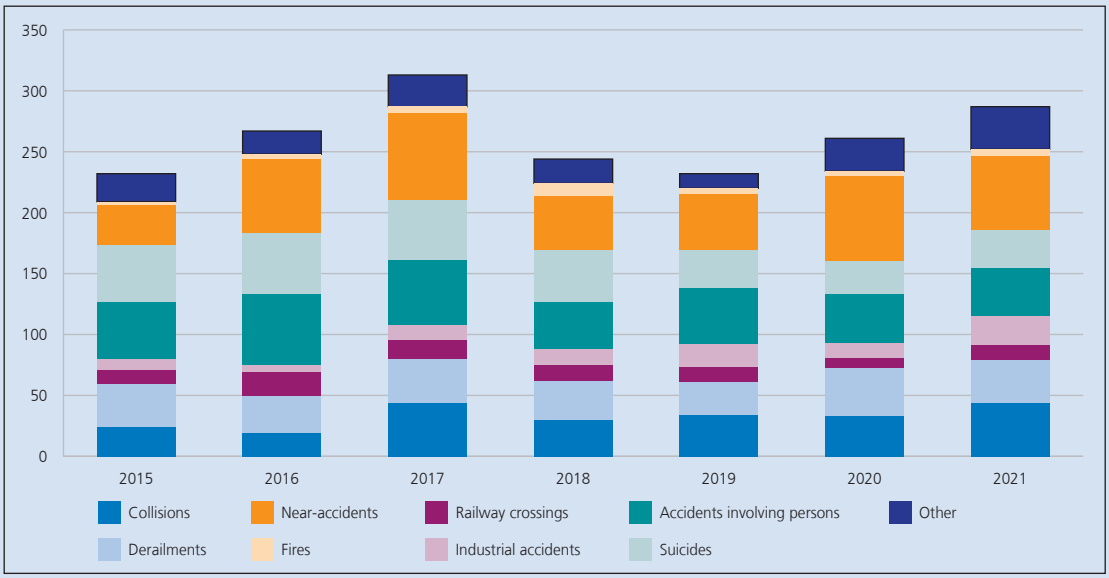


Figure 6.2.3: Number of incidents reported per year since 2015 for railways, broken down by type of event.

Depending on the outcome of its investigations, the STSB will publish safety recommendations or safety advices (see Section 5.1). The development over time of the number of recommendations and advice notices 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 safety recommendation or advice was based.

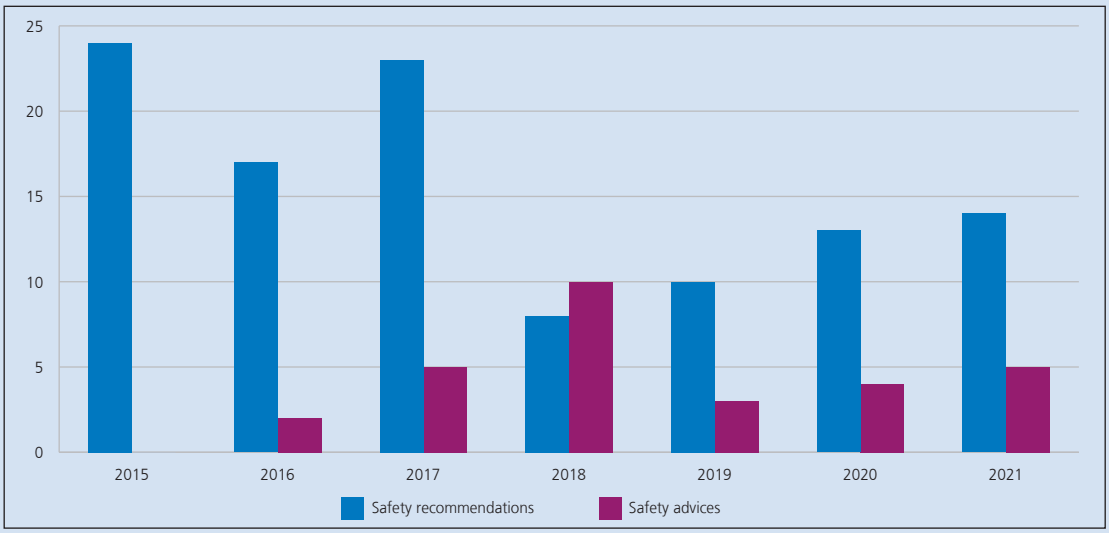


Figure 6.2.4: Number of safety recommendations and safety advices published per year since 2015.

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:	
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
2379	HB-FRP	05.03.2021	Buochs aerodrome (LSZC)	576	
2373	HB-PMH	22.01.2020	3 km south of Châtel-St-Denis (Les Pléiades), Saint-Légier-La Chiésaz		40
2368	HB-SPO	30.11.2019	1 km south of Gossau	568	
2376	HB-3497	23.06.2019	Pra Roua, Arbaz		
2375	HB-SFR	30.05.2019	Gland		
2380	HB-3411	10.05.2019	Fricktal Schupfart aerodrome (LSZI)		39
2369	HB-SAA	03.01.2019	Corpataux-Magnedens	569-572	
2327	HB-3358	06.07.2016	Mittaghore, commune of Lenk		
2328	HB-2139	21.05.2016	Montricher		

Summary investigations completed

Registration	Date of incident	Location	Nature of incident
HB-KLT	02.09.2021	Yverdon-les-Bains aerodrome (LSGY)	Loss of control upon landing
HB-CNQ/HB-FKP	26.06.2021	Biel-Kappelen aerodrome (LSZP)	Airprox
HB-SGV	12.06.2021	Bünzen	Emergency landing following engine failure

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

Registration	Date of incident	Location	Nature of incident
HB-KEH	05.06.2021	Bad Ragaz aerodrome (LSZE)	Collision with obstacles after overrunning runway
HB-YHT	01.06.2021	700 m north-west of Bad Ragaz aerodrome (LSZE)	Emergency landing following loss of power
HB-KOW/HB-CWE	23.04.2021	Bern Airport (LSZB)	Airprox
HB-PDL	08.04.2021	Montricher Airport (LSTR)	Right-hand landing gear breakage during landing
HB-YKC	04.04.2021	Bressaucourt aerodrome (LSZQ)	Nose gear breakage during landing
HB-YMF	31.03.2021	Emmen aerodrome (LSME)	Loss of control upon landing
HB-WZB	04.03.2021	Bern Airport (LSZB)	Nose wheel breakage as a result of landing
HB-ZRR / motorised aircraft	01.03.2021	5-10 km north-east of the Gross Litzner (Austria)	Airprox
HB-OKB	28.02.2021	Brenay Glacier	Airprox with drone
F-JDWE	21.02.2021	Lausanne La Blécherette Airport (LSGL)	Loss of control upon landing
HB-KML	17.02.2021	Biel-Kappelen aerodrome (LSZP)	Runway overrun following aborted take-off
HB-OHW	10.01.2021	La Côte aerodrome (LSGP)	Loss of control upon landing
HB-YIW	23.12.2020	Birrfeld aerodrome (LSZF)	Loss of control upon landing
HB-DBU	13.11.2020	Speck-Fehraltorf aerodrome (LSZK)	Collapse of landing gear upon landing
HB-KFN	08.11.2020	Bex aerodrome (LSGB)	Runway overrun
HB-DIB	11.09.2020	Wangen-Lachen aerodrome (LSPV)	Landing with retracted landing gear
HB-SAW	14.08.2020	La Côte aerodrome (LSGP)	Runway overrun
HB-KLT	30.07.2020	Lausanne La Blécherette Airport (LSGL)	Nose gear breakage during landing
HB-UVB	28.07.2020	Gruyère aerodrome (LSGT)	Collision with obstacle on ground
HB-PMF	19.07.2020	Reitnau	Emergency landing following engine failure
HB-EFM	10.07.2020	Grenchen aerodrome (LSZG)	Collision with helicopter while taxiing
HB-ZDQ	01.07.2020	Vaulruz area	Emergency landing following canopy fracture
HB-2496	26.06.2020	Birrfeld aerodrome (LSZF)	Landing outside aerodrome
HB-KHN	24.06.2020	Lommis aerodrome (LSZT)	Loss of control on the ground
HB-3099	21.06.2020	Ramello, commune of Cadenazzo	Off-field landing following canopy fracture
HB-TLZ	22.05.2020	Lausanne La Blécherette Airport (LSGL)	Hard landing
HB-VZZ/D-KAVE	08.05.2020	Neuheim	Airprox
HB-2068	24.04.2020	Hardmatte, 700 m east of Kölliken	Loss of control during off-field landing
HB-JHC	26.02.2020	Zurich Airport (LSZH)	Ground contact at take-off
HB-2360	20.02.2020	Sion Airport	Collision with obstacle on ground
D-ICTR/HB-ZLB	19.11.2019	Lausanne La Blécherette Airport (LSGL)	Airprox

Registration	Date of incident	Location	Nature of incident
HB-DIL	14.08.2019	190 m south-west of threshold of runway 06 Lommis	Emergency landing after problems during take-off
HB-PFS / HB-LZH	18.07.2019	Ecuvillens aerodrome (LSGE)	Airprox
D-MPCS	09.07.2019	Locarno Airport (LSZL)	Nose gear buckled upon landing
HB-JST / PC-7	19.06.2019	5 km south of Langenthal	Airprox
HB-ZSL / OE-FCB	17.06.2019	Geneva Airport (LSGG)	Airprox
HB-CNY / HB-PMI	06.05.2019	Birrfeld aerodrome (LSZF)	Airprox
HB-ZCZ	11.03.2019	Tseuzier Dam, 5 km north-west of Crans-Montana	Collision with power line
HB-KMK	22.02.2019	Basel-Mulhouse Airport (LFSB)	Propeller touched ground owing to landing
HB-SFU	16.02.2019	Grenchen aerodrome (LSZG)	Precautionary landing following engine problems
D-ITMA	03.02.2019	Sion Airport	Runway overrun
HB-ODZ	25.01.2019	Birrfeld aerodrome (LSZF)	Broken tail wheel bracket
HB-ZDW	16.01.2019	Lucerne Beromünster (LSZO)	Emergency landing following engine failure
HB-PRB	14.11.2018	Locarno Airport (LSZL)	Hard landing
HB-JBC	13.10.2018	Paris, France, flight information region	One engine shut down following loss of oil
HB-IAU	04.10.2018	Zurich Airport (LSZH)	Engine failure
HB-KOP	16.08.2018	Lausanne La Blécherette Airport (LSGL)	Smoke in the cabin
HB-EVP / HB-KMG	11.08.2018	South-west of Willisau radio beacon	Airprox
HB-ZDX	08.08.2018	Schwand, commune of Bürglen	Collision with agricultural cableway
HB-EWQ	08.07.2018	Lommis aerodrome (LSZT)	Nose wheel buckled on landing
HB-ZRE	07.07.2018	Roc de Veyges, Leysin	Tail rotor contact with branches
HB-WYD	31.05.2018	Mollis aerodrome (LSMF)	Loss of control upon landing
G-FXAR	02.05.2018	Geneva Airport (LSGG)	Loss of cabin pressure
EC-HTD	20.09.2017	Zurich Airport (LSZH)	Navigation instrument failure
HB-ZLA	29.08.2017	Mendrisio	Uncontrolled ground contact
HB-3401/J-5233	28.07.2016	Düdingen region	Airprox
HB-FWM	11.04.2016	St. Gallen-Altenrhein Airport (LSZR)	Runway overrun
HB-VWM	14.03.2016	Lugano-Agno Airport (LSZA)	Fumes and odour in cabin

Interim reports published as part of ongoing investigations

Registration	Date of incident	Location	Safety recom-mentdation	Safety advice
HB-ZPU	26.06.2021	Bola, Lostallo	578-580	
D-KDEU	17.10.2021	Dierdorf special airfield (EDRW), Germany	581	

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:	
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
2015091001	Railways	Collision between train and obstacle	10.09.2015	Burgistein	(111, 145)*	26
2016042003	Inland navigation	Collision between boat and jetty	20.04.2015	Küsnacht	164, 165, 166	27
2016081901	Inland navigation	Collision between two steam ships	19.08.2016	Lucerne	169, 170, 171	30
2018081602	Railways	Train derailment	16.08.2018	Basel SBB shunting yard		
2020020601	Cableways	Vehicle crash	06.02.2020	Stoos		
2020030101	Railways	Accident involving persons	01.03.2020	Bern	(153, 154)*, 161	
2020091102	Railways	Train derailment	11.09.2020	Rossinière	160	
2020092801	Railways	Train derailment	28.09.2020	Echallens		
2020111601	Railways	Collision between two shunting movements	16.11.2020	Cully	162, 163	
2021021301	Cableways	Irregularity posing hazard	13.02.2021	Morgins-La Foilleuse	159	
2021060202	Cableways	Industrial accident	02.06.2021	Pontresina	168	28, 29

* 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	Nature of incident	Date	Location
2016052401	Railways	Derailment of a shunting movement	24.05.2016	Bassersdorf
2020020302	Railways	Collision between train and obstacle	03.02.2020	Lucerne
2020082201	Cableways	Vehicle collision	22.08.2020	Chur, Känzeli
2020082801	Railways	Train derailment	28.08.2020	Bern
2020120801	Railways	Collision between two trains	08.12.2020	Eiger Glacier
2021051901	Railways	Load shift	19.05.2021	Rotkreuz

Interim reports published as part of ongoing investigations

Number	Mode of transport	Nature of incident	Date	Location	Safety recommendation	Safety advice
2020101901	Railways	Dangerous goods incident	19.10.2020	Basel SBB shunting yard	167	
2020123101	Railways	Collision between train and obstacle	31.12.2020	Belp	158	
2021021301	Cableways	Irregularity posing hazard	13.02.2021	Morgins-La Foilleuse	159	

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	16	26	31	14	57	8

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	16	25	29	12	54	8

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

		Total	2015	2016	2017	2018	2019	2020	2021
Aircraft up to 2,250 kg MTOM	with injury	27	5	1	7	3	3	3	5
	without injury	220	32	21	41	43	25	28	30
Aircraft of 2,250–5,700 kg MTOM	with injury	0	0	0	0	0	0	0	0
	without injury	17	0	3	1	2	3	5	3
Aircraft exceeding 5,700 kg MTOM	with injury	1	0	0	0	1	0	0	0
	without injury	39	7	9	3	13	2	2	3
Helicopters	with injury	14	2	3	5	2	2	0	0
	without injury	71	10	14	6	14	10	8	9
Motor gliders and gliders	with injury	11	1	3	2	3	0	2	1
	without injury	39	6	8	5	7	2	8	3
Balloons and airships	with injury	0	0	0	0	0	0	0	0
	without injury	4	1	0	0	2	0	1	0
Ultralight aircraft	with injury	0	-	0	0	0	0	0	0
	without injury	2	-	2	0	0	0	0	0
Total[5]	with injury	53	8	7	14	9	5	5	5
	without injury	392	56	57	56	81	42	52	48

[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
Aircraft up to 2,250 kg MTOM	with injury	8	1	3	1	2	0	0	1
	without injury	21	3	6	4	0	4	1	3
Aircraft of 2,250–5,700 kg MTOM	with injury	1	0	0	1	0	0	0	0
	without injury	3	0	0	0	1	0	1	1
Aircraft exceeding 5,700 kg MTOM	with injury	0	0	0	0	0	0	0	0
	without injury	30	5	8	3	4	6	2	2
Helicopters	with injury	2	0	1	0	1	0	0	0
	without injury	0	0	0	0	0	0	0	0
Motor gliders and gliders	with injury	4	2	0	0	0	1	0	1
	without injury	5	0	1	0	1	2	1	0
Balloons and airships	with injury	0	0	0	0	0	0	0	0
	without injury	1	0	0	0	0	1	0	0
Ultralight aircraft	with injury	0	-	0	0	0	0	0	0
	without injury	1	-	0	0	0	0	0	1
Total	with injury	15	3	4	2	3	1	0	2
	without injury	61	8	15	7	6	13	5	7

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

		Total	2015	2016	2017	2018	2019	2020	2021
Aircraft up to 2,250 kg MTOM	with injury	7	2	0	1	1	2	1	0
	without injury	30	3	3	4	10	6	2	2
Aircraft of 2,250–5,700 kg MTOM	with injury	1	0	0	0	0	0	1	0
	without injury	9	0	2	0	4	3	0	0
Aircraft exceeding 5,700 kg MTOM	with injury	0	0	0	0	0	0	0	0
	without injury	34	5	15	7	5	2	0	0
Helicopters	with injury	0	0	0	0	0	0	0	0
	without injury	2	0	0	0	0	0	0	2
Motor gliders and gliders	with injury	4	0	1	1	0	1	1	0
	without injury	5	0	1	0	3	1	0	0
Balloons and airships	with injury	0	0	0	0	0	0	0	0
	without injury	2	0	1	0	1	0	0	0
Ultralight aircraft	with injury	0		0	0	0	0	0	0
	without injury	1		0	0	1	0	0	0
Total	with injury	12	2	1	2	1	3	3	0
	without injury	83	8	22	11	24	12	2	4

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

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

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

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

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

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

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

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
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

[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.

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

Railways, trams, cableways, buses, and inland and maritime navigation (Section 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

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

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

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



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