Annual

Safety Report (RASO) – 2020

ANAC

NATIONAL CIVIL AVIATION AGENCY – BRAZIL

Annual Safety Report (RASO) – 2020

Directors

Juliano Alcântara Noman
Director-President

Ricardo Bisinotto Catanant
Director

Tiago Sousa Pereira
Director

Rogério Benevides Carvalho
Director

Preparation

ASSOP – Safety Office

Graphic Design and Layout

Communications Office - ASCOM

SUMMARY

Message from the Board of Directors

Dear reader,

The Annual Safety Report (RASO) of the National Civil Aviation Agency has been published for 13 years. This edition aims to publicize the most important Brazilian civil aviation safety data in 2020. It is our belief that the compilation and sharing of the information provided herein encourages continuous improvement of air transport performance and protection and defense of industry operations.

In 2020 an intense crisis hit the world and demanded resilience from everyone: the corona virus disease (COVID-19) pandemic. In this scenario, the National Civil Aviation Agency - ANAC mobilized all the Agency's personnel to meet the needs of society, unconditionally prioritizing safety and excellence in civil aviation. Our teams worked together to address the needs involved: essential route network, transport of biological and exceptional cargo, remote certifications and training, apron parking, certificate extensions, waivers, different parameters for slots, repatriation of Brazilian citizens, among so many other challenges. Despite the crisis, which severely affected civil aviation, we kept our heads up and eyes alert, ensuring the safety performance and the protection of our society.

Objectives, goals and indicators that guide the supervision of the system are provided for in the recently revised Safety Oversight Plan (PSSO). The significant downward trend in the number of accidents in Brazil has been maintained over the years, as shown in this Report. Among other factors, there have been no records of fatal accidents in Brazilian regular aviation since 2011. Besides that, comparing Brazil to other countries belonging to Group 1 of the International Civil Aviation Organization (ICAO) Council, our country has maintained considerably lower rates. We also achieved 95% of Effective Implementation (EI) in the ICAO Universal Safety Oversight Audit Programme: Continuous Monitoring Approach (USOAP-CMA) audit, an index that places us as world leaders in terms of civil aviation safety.

Despite our global results, factors that may affect the sector's performance are carefully observed, so that we can act proactively in regulation and supervision. Regarding the resumption of aviation after the COVID-19 pandemic, particular attention is given to the following factors: proper preservation of underutilized aircraft; maintenance of crew training and proficiency; and preservation of airport infrastructure, considering the underutilization of airports.

Despite the crisis and unexpected challenges, our innovative spirit remained. The Simple Flight Programme has been implemented with the aim of improving administrative processes to achieve what we value the most: safety.

Our journey towards constant improvement is continuous, and we count on the engagement of all participants, persuaded by the proactive culture in managing the civil aviation system.

Enjoy the reading!

Introduction

Since 2008, ANAC has been publishing the Annual Safety Report with the aim of providing the aeronautical community with relevant information on the safety performance of Brazilian civil aviation. It is expected that this document assists in understanding the risks involved in different segments of the aeronautical industry and supports decision-making aimed at proposing strategies to improve the safety of our aviation.

Information regarding various aspects of aeronautical occurrences is organized in the sections of this document, especially accidents that occurred in the last 5 years. Since the last edition of this Report, a section for Monitoring Goals and Indicators of the Safety Oversight Plan has been included, which is an essential resource for monitoring the Brazilian civil aviation safety performance.

In order to ascertain different perspectives of the operational reality, and to better understand the various relevant information associated with an aeronautical occurrence, the same data set is reported sometimes in absolute numbers, sometimes weighted by other magnitudes. Since 2020, the Safety Office (ASSOP) has used the flight hours data stated in the Airworthiness Verification Certificates (CVA) to estimate, segment by segment, the various parameters indicative of safety levels for each sector. Data analyzed from different perspectives and categorizations enables the identification of specific actions to be taken, not only by the Agency but also by other agents in the sector, since the particularities of each sector require diligent initiatives to maximize safety gains.

The main source of data used is the occurrences base provided by the Aeronautical Accident Investigation and Prevention Center (CENIPA), which is incorporated by ANAC through the Aeronautical Occurrence Management System (SGOA). This system was developed by the Agency in 2020 with the purpose of integrating incident information and safety recommendations, as well as facilitating the proactive process of hazard identification and risk management through the analysis of aeronautical occurrences, a fundamental element of Safety Management by the Brazilian State.

After importing the raw data from CENIPA, and before using them, the Agency improves and verifies them using other institutional databases. Therefore, the data in this Report may show subtle differences when compared to those provided by CENIPA, or by other sources. However, such differences are basically related to the categorization of occurrences and are residual, so they have little impact on the analysis and on the reader's view of the complex Brazilian civil aviation panorama.

The objectives, indicators and goals of the Safety Oversight Plan 2020-2022 are also presented, as well as the evolution of the performance of the Brazilian civil aviation in relation to these parameters. Within the scope of the Brazilian State and ANAC, this Report presents the USOAP-CMA Readiness Programme Activities (Universal Safety Oversight Audit Programme – Continuous Monitoring Approach), as well as ANAC activities regarding the Actions of Safety Recommendations issued by CENIPA (Brazilian body responsible for investigating aeronautical accidents and incidents).

In addition to the data presented for 2020, those referring to previous Reports were revised in order to reveal the most up-to-date information available.

International Panorama

International Panorama

The initial section of this Report presents general numbers about safety performance around the world, and highlights the Brazilian numbers compared to other countries and regions.

Graphs and tables presented in this section were created from data extracted based on publications issued by two reputable international aviation organizations: International Air Transport Association (IATA) and ICAO.

The panorama of world civil aviation has changed dramatically since the COVID-19 pandemic. Several countries have adopted measures to contain the spread of the virus, such as travel restrictions, mandatory quarantines, external and internal limitations on air travel, as well as changes in the provision of the service, such as mandatory use of masks during flight and limitations on catering. As a result, the operational context of commercial aviation has been significantly modified, what caused large variations in air accident rates worldwide. In this context, to provide a perspective on the performance of global commercial aviation, the graph in Figure 1 is presented, indicating accident rates[1] per million take-offs in 2020, in addition to the average rates between 2016 and 2020 in different regions of the world, according to the regional grouping used by IATA. In the Figure, the Brazilian numbers are presented individually, in order to facilitate the comparison of the country with the rest of the globe.

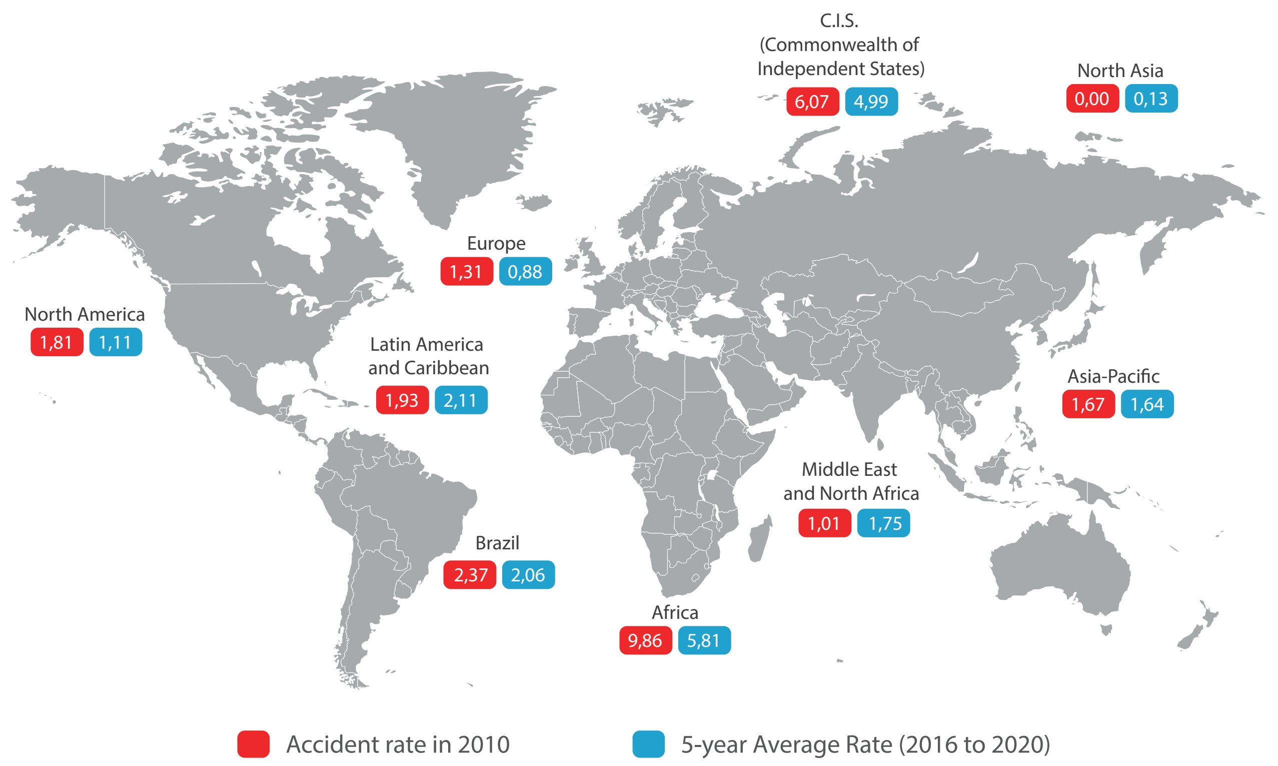


Figure 1: total accidents rate (accidents per million takeoffs) in 2020 and average rate between 2016 and 2020 for different regions, according to IATA classification. Source: CENIPA and IATA.

1 - The accident rates considered in the aforementioned graph refer to the number of accidents per million takeoffs involving regular and non-scheduled operations with commercial flights, including transfer flights for aircraft with maximum take-off weight (MTOW) above 5,700kg.

Information contained in the IATA Safety Report was used to measure the variation in air traffic volume in each region of the globe. Regarding Brazil, the data were derived from the ANAC Interactive Consultation, as shown in Table 1.

Region	Takeoffs 2020 (millions)	Takeoffs 2019 (millions)	Variation (%)
Brazil	0,42	0,85	-50,6%
Africa (AFI)	0,61	1,49	-59,1%
Asia-Pacific (ASPAC)	4,2	8,11	-48,2%
Commonwealth of Independent States (CIS)	0,82	1,49	-45,0%
Europe (EUR)	3,81	10,03	-62,0%
Latin American (LATAM)	1,56	3,46	-54,9%
Middle East and North Africa (MENA)	0,99	2,25	-56,0%
North America (NAM)	6,09	13,34	-54,3%
North Asia (NASIA)	4,11	6,66	-38,3%

Table 1: Commercial aircraft movements – Brazil and IATA regions. Source: ANAC and IATA.

The result of the indicators of the USOAP-CMA Programme (Universal Safety Oversight Audit Programme – Continuous Monitoring Approach) is used as a parameter for evaluating the performance of a particular State regarding the structuring of their aviation. This Programme is intended to monitor the capacity of States to execute aviation safety oversight. Monitoring is continuous, using specific questionnaires and audit protocol questions. The objective is to verify compliance with international standards and assess the existence of regulations and procedures. Audits also verify how aviation services providers put into practice the technical standards defined by the States.

In May 2009, USOAP activities began in the Brazilian state with the completion of a full audit. In November 2015, Brazil underwent an ICAO Coordinated Validation Mission (ICVM), in addition to the aforementioned audit. The percentage of 94.96% of Effective Implementation was reached in both audits. In March 2018, Brazil achieved 95.14% of EI, according to a specific USOAP CMA audit carried out in the area of aircraft accident and incident investigation (AIG). Thus, Brazil reached the target of 95% of EI expected to be reached by 2030 and proposed in the Global Aviation Safety Plan (GASP) 2020-2022.

This result places Brazil in the fifth position in the ranking of ICAO member states who are signatories of the Convention on International Civil Aviation (Table 2). Further details on protocol questions and audit areas can be found in the section "USOAP-CMA Readiness Programme Activities".

Countries	EI Indicator
1st - United Arab Emirates	98,91%
2nd - Singapore	98,60%
3rd - Republic of Korea	98,48%
4th - France	96,38%
5th - Brazil	95,14%
6th - Canada	95,10%
7th - Ireland	95,06%
8th - Australia	95,02%
9th - Chile	94,65%
10th - Nicaragua	94,55%

Table 2: ICAO Effective Implementation (EI) ranking - updated Jun/2021.

A more comprehensive view of this result is shown in Figure 2, which relates the percentage of effective implementation in the USOAP Programme with the air traffic volume of each State, identifying the States of the same region with dots of the same color. The position Brazil occupies has to be highlighted. The country is indicated in the upper right corner of the Figure, what means that the significant alteration in the number of flights caused by the COVID-19 pandemic has not changed the country's prominent relative position considering the volume of operations. Thus, when compared to equivalent countries, Brazil maintains a large volume of air traffic and a high degree of adherence to international safety standards, as measured by ICAO standards..

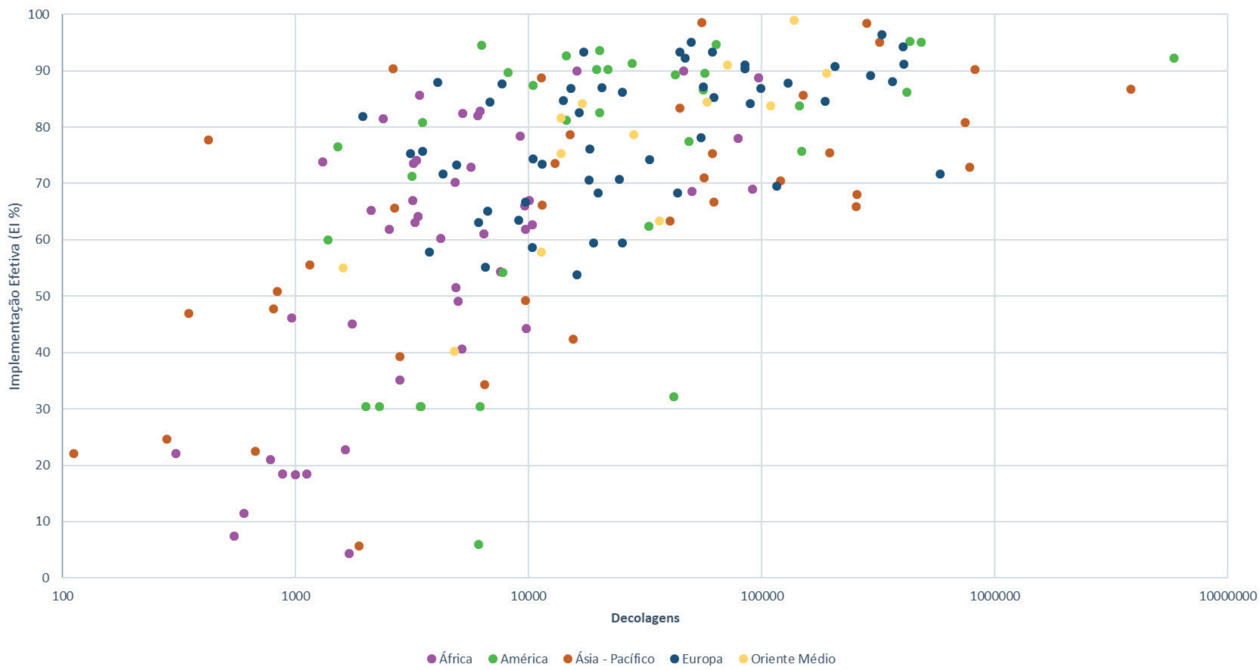


Figure 2: EI dispersion by State in relation to air traffic volume in 2020. Source: ICAO.

Overview

Overview

In this section, general numbers referring to the Brazilian aviation safety are presented, as well as the numbers of all segments in a condensed form. In the following sections, each aviation segment was analyzed in more depth to highlight particularities.

In order to follow the historical evolution of the Brazilian civil aviation regarding safety performance, it is crucial to compile the total number of accidents over the years to identify the behavior of the system. The graph in Figure 3 indicates that since the beginning of the series, in 1979, there has been a significant drop in the number of accidents in absolute terms.

HISTÓRICO DE ACIDENTES DA AVIAÇÃO CIVIL BRASILEIRA

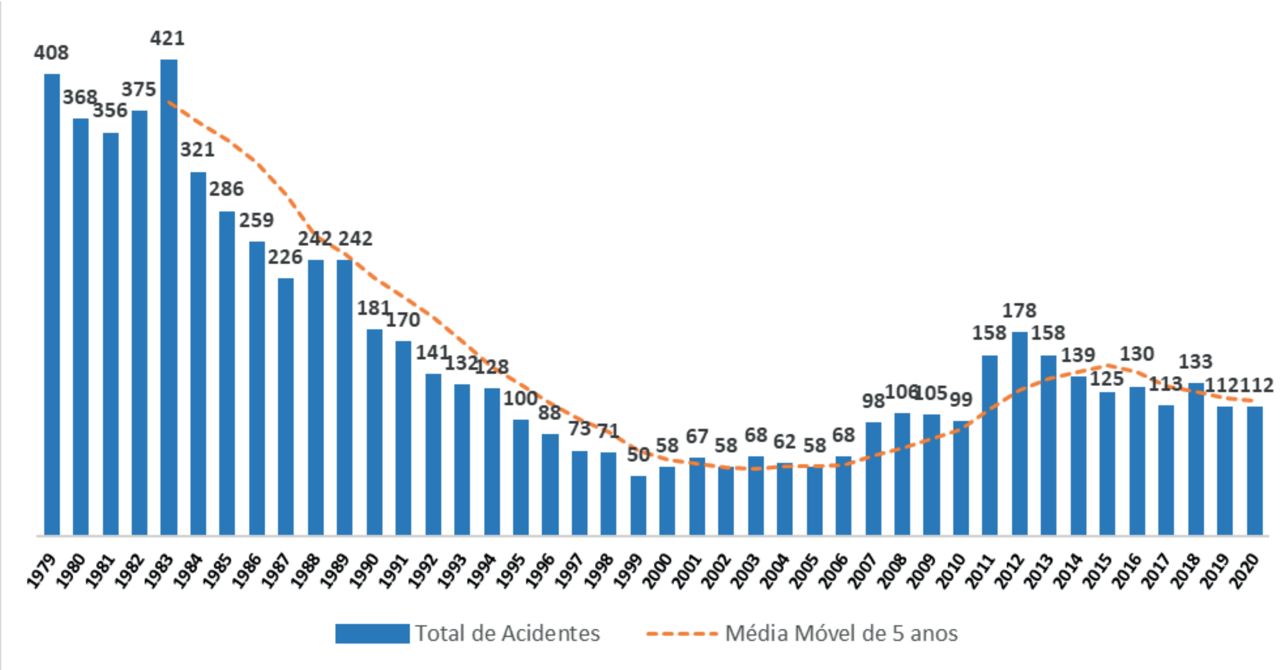


Figure 3: records of accidents in the Brazilian civil aviation. Source: ANAC and CENIPA.

According to Figure 3, there was a significant increase in accidents in Brazilian civil aviation from 2006 to 2012, indicating numbers equivalent to those presented in the early 1990s. From 2013 on, the trend has been reversed. The moving average of the number of accidents has been reduced each year. And the number of accidents has stabilized between 110 and 135 per year. However, when evaluating only the absolute numbers, we neglect information of great relevance, since Brazilian aviation experienced solid growth in this period. In order to consider these two magnitudes, the accident rate parameterized by some other indicator is normally used, with the objective of measuring the air activity for a given period. Since April 2020, ANAC has used the number of flight hours in a particular period, declared in the Airworthiness Verification Certificate (CVA), as the main indicator to measure air activities within the Brazilian civil aviation. Throughout this Report, other indicators may be used, such as the number of takeoffs or fuel consumption, according to the operational context of the segment analyzed and the timely availability of the indicator's official databases.

As an example of an alternative indicator, the aviation fuel consumption, whether aviation gasoline or aviation kerosene, is used as a parameter to weight the rates of aeronautical accidents. Thus, it is possible to assess the evolution of the indicator using data released by the National Agency for Petroleum, Natural Gas and Biofuels (ANP). It is important to mention, however, that information published by the ANP contemplates agricultural aviation in an unsatisfactory way, especially in what concerns aircraft which use ethanol. This occurs because ANP indicators do not dissociate ethanol production for agricultural aviation and its consumption by agricultural aircraft from sectors which use the fuel for other purposes, such as the automotive sector.

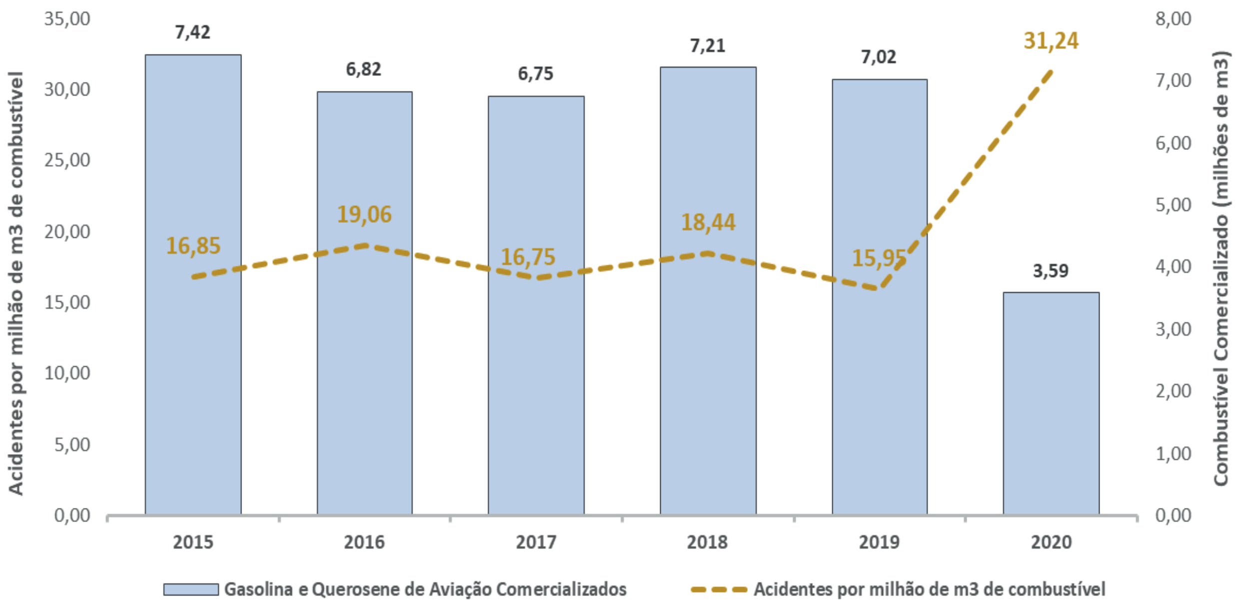


Figure 4: relationship between accidents (including agricultural and regular aviation) and aviation fuel consumption. Sources: CENIPA and ANP.

Figure 4 indicates a 49% reduction in the amount of fuel sold, mainly caused by the large decrease in regular aviation air activities. As a result, the accident rate per million cubic meters of fuel increased 96%, reaching the highest level in the last 5 years. Nevertheless, it should be noted that there are great differences regarding the commercialization of aviation fuel in Brazil. While aviation kerosene (QAV) represents 98% of the quantity of fuel sold, aviation gasoline (AVGAS) represents the remaining 2%. And the ethanol does not count on a specific indicator to be used within the aviation context, as previously informed. Considering the scenario and in order to monitor each segment more closely, ANAC has segregated QAV and AVGAS indicators for the 2020-2022 version of the Safety Oversight Plan. These indicators will be presented throughout this Report. It becomes clear that a comparison of several indicators is essential as they present methodological limitations that justify the analysis of other parameters to better understand Brazilian civil aviation safety performance.

Another parameterization used by ANAC is related to the number of flight hours of all Brazilian civil aviation, except experimental aircraft. The aim is to analyze movements using flight hours as a parameter, instead of fuel consumption or information about air traffic volume provided by the Department of Airspace Control - DECEA. The initiative aims to monitor each segment more closely. As an example, we can cite agricultural aviation, which makes little use of data provided by DECEA to carry out flight plans. This fact leads to an unsatisfactory monitoring of the segment when data from the Air Traffic Movement Information Bank - BIMTRA or the Comparative Air Traffic Report periodically published by DECEA are used. Other segments have been going through similar situations in different degrees, which led the Safety Office (ASSOP) to adopt the initiative based on Airworthiness Verification Certificates (CVA) data declared to ANAC.

Figure 5 shows the parameterization that considers the number of flight hours actually flown and declared to ANAC. There has been a reduction of about 31% in all aviation activities, mainly due to the impact of the COVID-19 pandemic. Consequently, accidents with fatalities increased 38% and accidents without fatalities, 46%, reaching the highest rates since 2015. Throughout the Report, these rates will be presented by operation aiming to identify which segments contributed most significantly to such alteration, since air effort variation was not uniform in all types of operations.

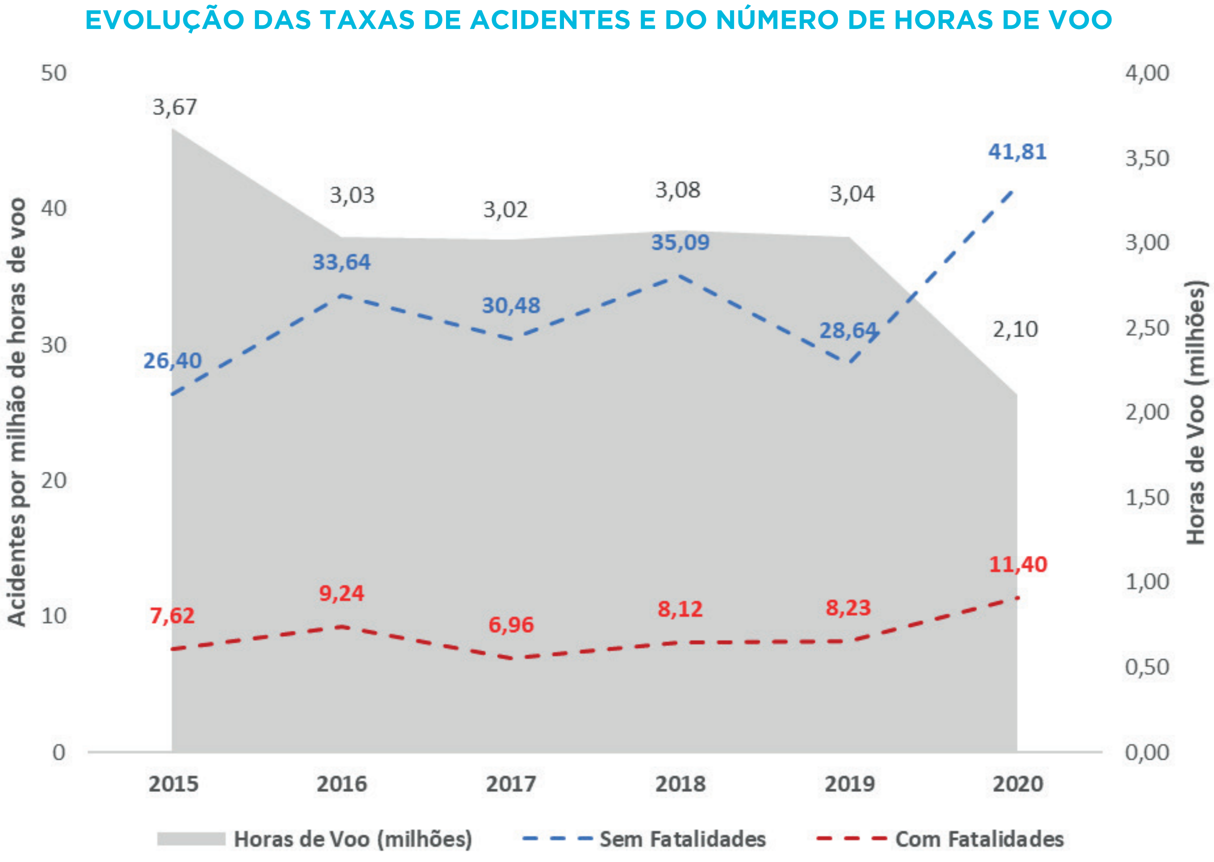
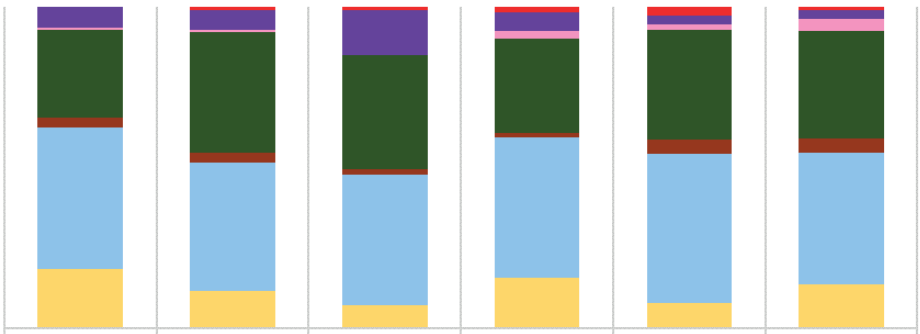


Figure 5: number of flight hours (in millions) of Brazilian civil aviation, accident rate with and without fatalities per million flight hours from 2015 to 2020. Source: CENIPA and ANAC.

Considering the general numbers in recent years, Figure 6 shows accidents segmented according to the type of operation.

PARTICIPAÇÃO DOS TIPOS DE OPERAÇÃO NO TOTAL DE ACIDENTES - 2015 A 2020



	2015	2016	2017	2018	2019	2020
TRANSPORTE REGULAR	0,00%	0,77%	0,88%	1,50%	2,68%	0,91%
TÁXI AÉREO	6,40%	6,15%	14,16%	6,02%	2,68%	2,73%
SAE - OUTRAS	0,80%	0,77%	0,00%	2,26%	1,79%	3,64%
SAE - AGRÍCOLA	27,20%	37,69%	35,40%	29,32%	33,93%	33,64%
PÚBLICA	3,20%	3,08%	1,77%	1,50%	4,46%	4,55%
PRIVADA	44,00%	40,00%	40,71%	43,61%	46,43%	40,91%
INSTRUÇÃO	18,40%	11,54%	7,08%	15,79%	8,04%	13,64%

Figure 6: records of participation of different types of operation in the total number of accidents annually registered. Source: CENIPA.

Data shows that private aviation accounts for the largest share of the number of accidents recorded in the last five years, followed by agricultural aviation, instructional aviation and air taxi operations. These four aviation segments have been responsible for the great majority of accidents registered in Brazil. For this reason, along with regular aviation, they are treated more prominently in this Report.

Still regarding types of operations, it is important to consider that these activities are carried out in distinct environments, besides having unique operational characteristics, and presenting different volumes of operation. Figure 7 shows the number of accidents weighted by the total reported flight hours, with respect to the volume of operations. This allows for a parameterized comparison regarding the performance of these different aviation segments.

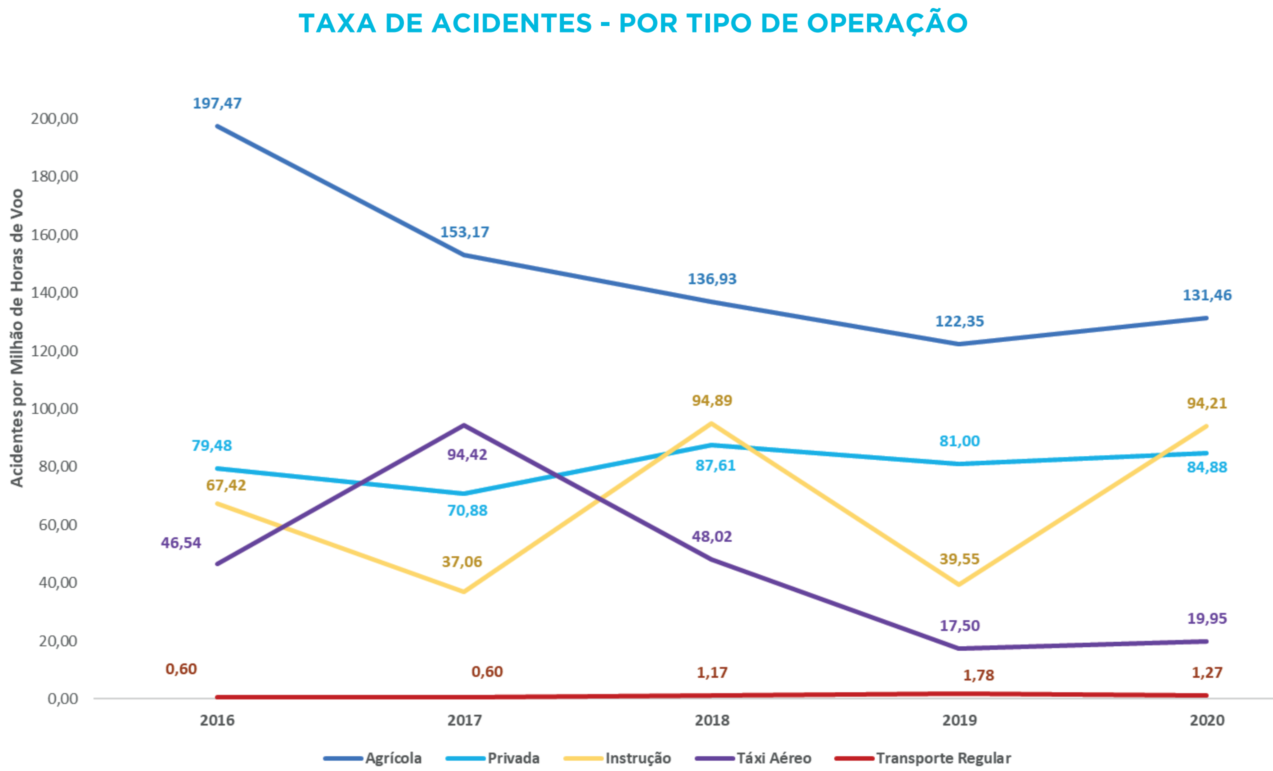


Figure 7: accident rate (accidents for every million takeoffs recorded) by type of operation, from 2016 to 2020. Source: CENIPA and ANAC.

There was a meaningful increase in the rate of accidents in the instructional aviation sector in 2020. This way, the accident rate reached levels close to those presented in 2018, which had already increased significantly if compared to 2017. After a considerable drop observed between 2017 and 2019, air taxi aviation rates remained below 20 accidents per million takeoffs for the second consecutive year, a value close to the historic low observed in 2019. Private aviation rates remain unchanged, between 80 and 90 accidents since 2018. ANAC's unprecedented initiative to include agricultural aviation data in the graph is noteworthy as it is possible to establish agricultural aviation accident rates using the flight hours indicator. Agricultural aviation rates are higher if compared to rates presented by other types of operations, as it has unique operational characteristics, such as low flights, proximity to obstacles and inadequate infrastructure on landing areas. It is important to point out that regular transport operations present rates in a different order of magnitude, much lower than those of other segments. In specific sections of this Report, eventual challenges of each sector and variations in observed indices will be addressed.

It is possible to carry out the analysis by type of occurrence, according to the classification disclosed by CENIPA, which allows for a better understanding of the factors that resulted in the event. Since 2019, CENIPA has disclosed the types of occurrences in line with the ADREP taxonomy (Aviation Data Reporting Programme), under Annex 13 to the Chicago Convention. As a result, some terminologies were merged into the same category, especially those associated with system/component failure or malfunction (non-powerplant) (SCF-NP) and runway excursion (RE), what generated significant changes in the order of the most frequent types of occurrence in Brazilian aviation. The adoption of the ECCAIRS system (European Coordination Center for Accident and Incident Reporting Systems) also contributed to this change, which allowed the same aeronautical occurrence to be classified in more than one type of taxonomy.

Figure 8 indicates the main types of occurrences verified in relation to the total number of accidents that happened between 2016 and 2020. It is important to note that the sum of the percentages involved exceeds 100%, since more than one type of taxonomy can be attributed to the same event.

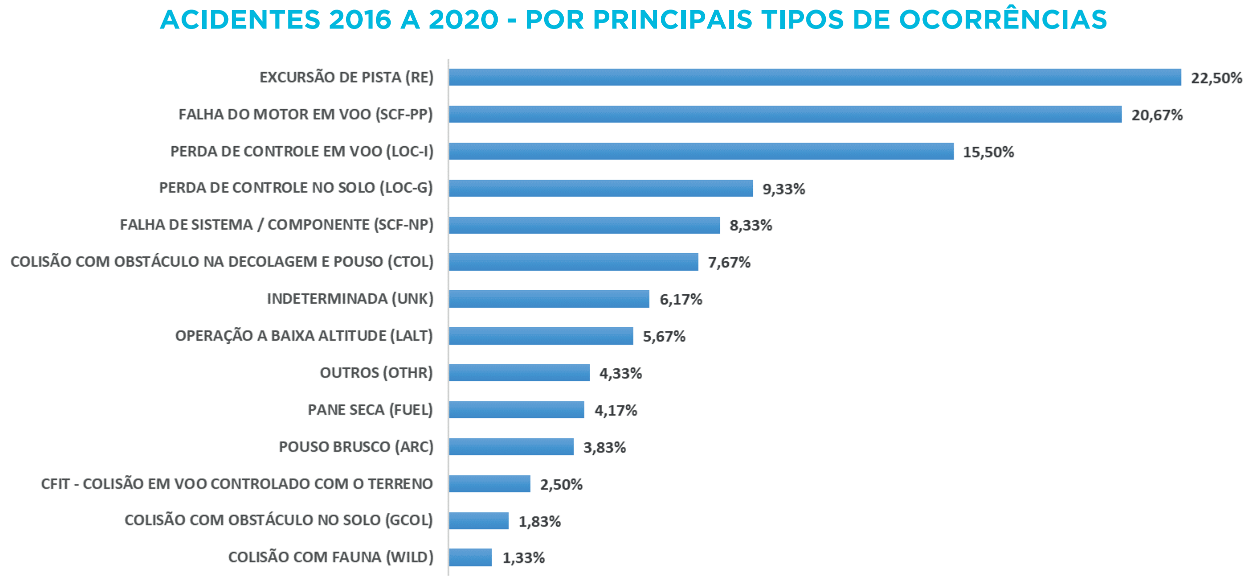


Figure 8: Main types of occurrences for the number of accidents accrued between 2016 and 2020. Source: CENIPA.

According to the graph, the types of occurrences with the highest incidence in Brazilian civil aviation are runway excursion, engine failure and loss of control in flight and on ground, accounting for more than 59% of the total of accidents in the period under review.

The graph in Figure 8 and other graphs that provide information on the type of occurrence were prepared based on data made available by CENIPA through the Notification and Confirmation Report[2] (FNCO) and the Final Reports[3]. A difference can often be observed between the type of occurrence pointed out in the FNCO and what was published in the respective Final Report. This is due to the characteristics of the investigation process and the obtaining of more conclusive information during its course. In cases of divergence, the content disclosed in the Final Report took precedence, when available. Otherwise, the FNCO was considered.

Fatal accidents are the most impactful in air activity, especially for regular aviation. Therefore, they are closely monitored by investigative bodies and civil aviation authorities around the world. When it comes to fatal accidents, the subjectivity of the classification is eliminated since whenever there is a fatality associated with an occurrence, it will necessarily be classified as an accident. As a result of this particularity, the graph in Figure 9 shows the total number of accidents in Brazilian civil aviation that occurred in the last five years, with and without fatalities.

2 - Once authenticated, the FNCO is used by CENIPA as an instrument to communicate ANAC the registration of an aeronautical occurrence. In general, a FNCO is issued a few days after the date of the occurrence, whereas Final Reports can take months or even years to be published.

3 - Final Reports are available at: http://sistema.cenipa.aer.mil.br/cenipa/paginas/relatorios/relatorios.php

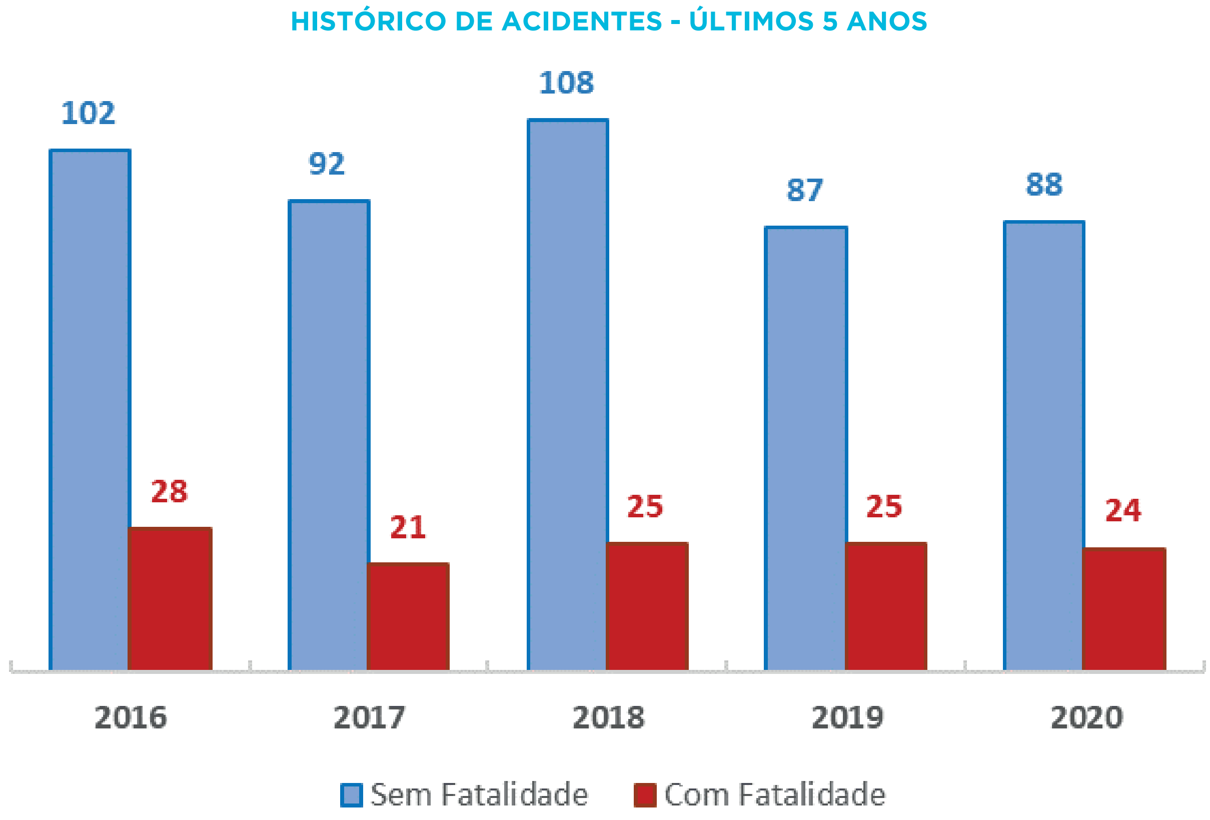


Figure 9: records of accidents with and without fatalities. Source: CENIPA.

The Figure above indicates that in the period from 2016 to 2020 around 21% of accidents recorded in Brazil had at least one fatality.

Figure 10 shows the percentage of accidents with fatalities in each aviation segment. Private aviation represents the highest proportion of accidents with fatalities, reaching almost 30% between 2016 and 2020. Air taxi, agricultural aviation and public aviation segments have rates close to the average of accidents with fatalities in all Brazilian aviation. Instructional aviation has rates considerably lower than the average, and regular aviation has not had any accident with fatality in the last five years.

PROPORÇÃO DE ACIDENTES COM FATALIDADES - POR TIPO DE OPERAÇÃO - 2016 A 2020

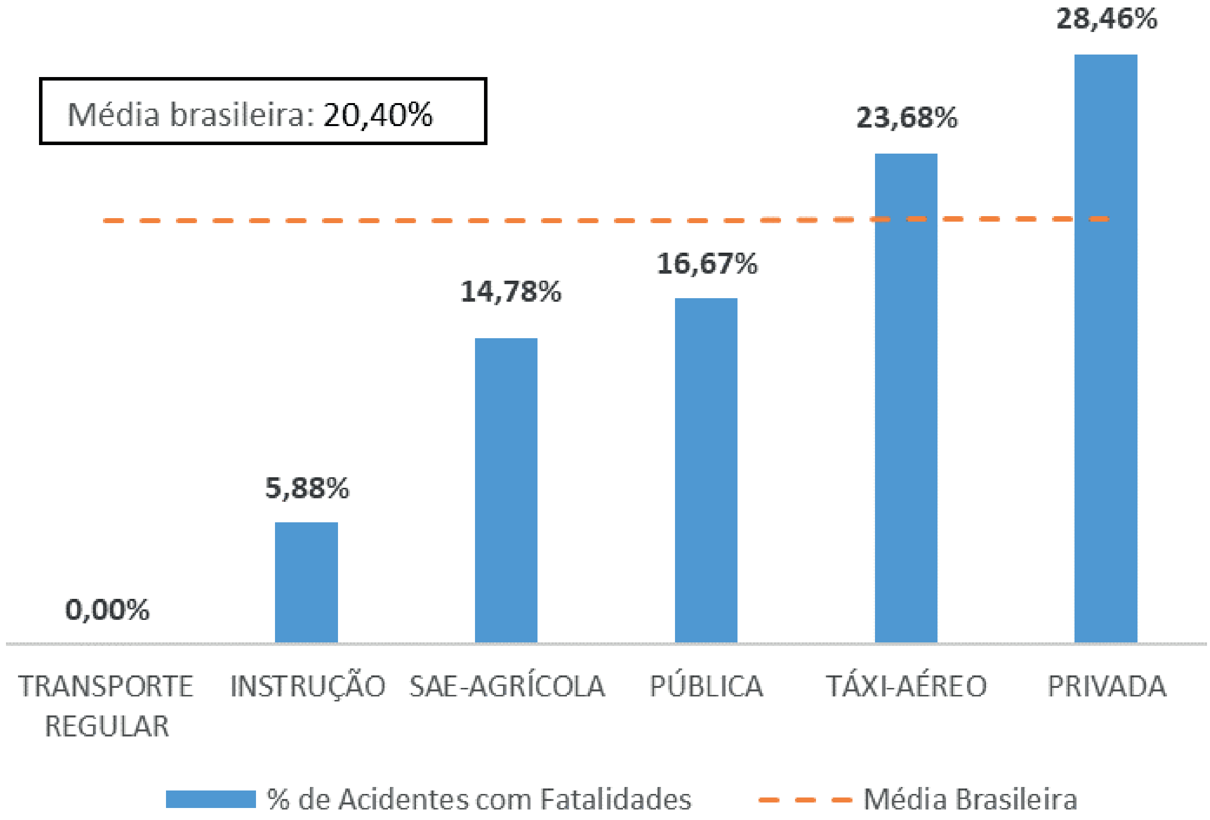


Figure 10: ratio of accidents with fatalities by type of operation and the Brazilian average of accidents with fatalities, referring to the accrued in the period between 2016 and 2020.

Another aspect commonly considered in all safety reports concerns not only the number of events with fatalities, but also the number of lives lost in a particular period, since reducing the number of fatalities is a continuing goal. In this context, the graph below shows the annual evolution of the number of fatalities in Brazilian civil aviation.

HISTÓRICO DE FATALIDADES NA AVIAÇÃO CIVIL BRASILEIRA

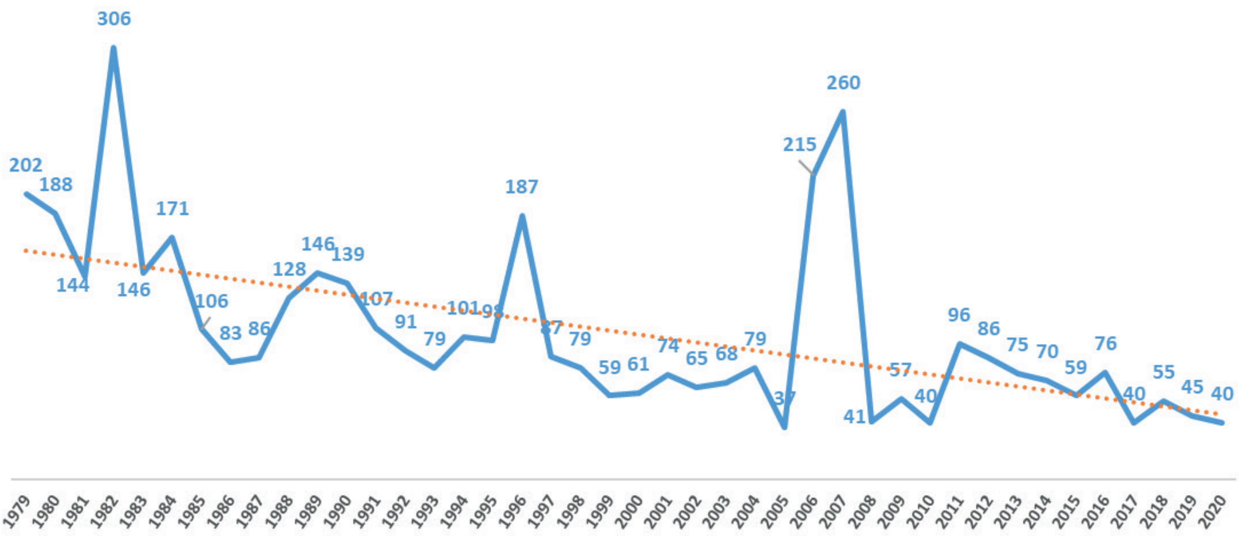


Figure 11: records of fatalities in Brazilian civil aviation. Source: CENIPA.

The image shows that the annual number of deaths related to air activity presents great fluctuations over the period shown, and that historical series peaks occur in years when large-scale accidents involving regular passenger transport aviation were registered[4]. In addition, the evaluation of data throughout the series indicates a downward trend in the number of fatalities, as shown by the linear trend represented by the dashed line in the graph.

4 - Regular passenger transport aviation accidents: in 1982, a Boeing 727-200, in Fortaleza - CE, left 137 victims and a Fairchild FH-227B, in Tabatinga - MA, killed 44 people; in 1996 a Fokker F-100, in São Paulo - SP, had 96 victims on board and 3 on the ground; in 2006 a Boeing 737-800, in Mato Grosso, killed 154 people; in 2007 an Airbus A320, in the city of São Paulo - SP, had 187 fatalities on board and 12 on the ground; and, more recently, in 2011, a LET L-410 killed 16 people in Recife - PE.

Aircraft

Aircraft

Brazilian aviation is recognized as one of the largest in the world, both in terms of number of aircraft and air movements. The national fleet is made up of different types, models and categories of aircraft, ranging from gliders to large jetliners.

This Report does not aim to explore in detail the characteristics of different types of aircraft and aircraft engine[5]. However, in the following paragraphs, general aspects of piston-engine and turbine engine aircraft (turboprops and jets) are addressed in order to help readers who are less familiar with the subject.

Most piston-engine aircraft are small, generally single-engine aircraft, with few seats. They do not have pressurization systems and operate at lower speeds and altitudes if compared to turbine-engine aircraft. Piston engines are less complex than turbine engines when it comes to engineering and manufacturing. As a result, the purchase price of turbine engines is higher. Piston-engine airplanes are simpler to maintain and operate, being able to land and take off at aerodromes with reduced infrastructure and shorter runways, which are often not accessible for large turbine aircraft.

Both turboprop and jet engines are turbine engines. Turboprop engines have propellers directly coupled to the axis of rotation that act as thrust elements. Conversely, jet engines generate impulse reaction by directly displacing air, without the aid of propellers, usually by means of blades and various stages of compression. Small and medium-sized aircraft that fly at medium speeds and altitudes are generally equipped with turboprop engines. Jet engines, on the other hand, are widely used in large airplanes that operate at high altitudes and cruising speeds. The Figure below shows examples of aircraft with these three types of engine to better illustrate the differences between them.

The categorization of helicopters and a brief description of their characteristics will be presented in the "Helicopters" section.

Figure 12: examples of aircraft – from left to right: piston-engine aircraft, turboprop aircraft and jet aircraft.

5 More detailed information can be found on the ANAC website at: http://www.anac.gov.br/assuntos/setor-regulado/aeronaves/

The table below indicates the number of aircraft with valid airworthiness registration according to the Brazilian Aeronautical Registry (RAB). It is important to mention that the numbers here presented do not include experimental aircraft and those with a canceled, suspended, or expired certificate.

	Aircraft with Valid Registration	% of Fleet with Valid Registration
Jet Airplane	1148	10,59%
Amphibian	16	0,15%
Single-engine Piston Airplane	5261	48,51%
Twin-engine Piston Airplane	1374	12,67%
Turboprop Aircraft	1414	13,04%
Twin-engine Turbine Helicopter	375	3,46%
Piston Helicopter	415	3,83%
Turbine Helicopter	699	6,45%
Seaplane	1	0,01%
Glider	118	1,13%
TOTAL	10845	100%

Table 3: Distribution of aircraft under normal airworthiness conditions. Source: ANAC (values from Jun/2021)

The table indicates that piston engines are the most used type of engine in Brazilian aircraft, especially in fixed-wing aircraft. As for helicopters, those equipped with turbine engines are the most common if compared to those equipped with piston engines.

About the analysis of accidents, it is convenient to separate the occurrences registered according to the different types of aircraft, since they are used in very different operational contexts. Figure 13 shows the participation of each type of aircraft in the total number of accidents recorded between 2016 and 2020.

ACIDENTES 2016 A 2020 - PARTICIPAÇÃO DO TIPO DE AERONAVE

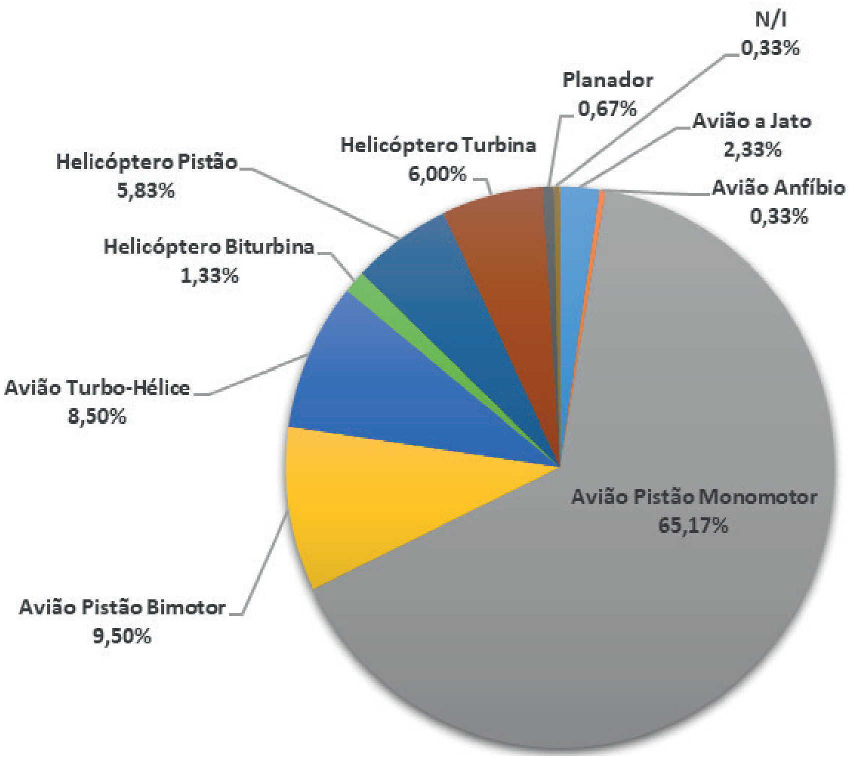


Figure 13: type of aircraft in the total number of accidents between 2016 and 2020. Source: CENIPA and ANAC.

Piston-engine airplanes stand out as they account for more than 74% of the total number of accidents recorded, while their participation in the composition of the fleet is around 61%. The discrepancy is mainly due to single-engine piston aircraft, which represent 48% of the fleet and account for 65% of accidents recorded in the last five years. On the other hand, the number of accidents involving turboprop airplanes, jets, and turbine helicopters (single-engine and twin-engine) was considerably low if we take into account the representativeness of these types of aircraft in the Brazilian fleet.

Pilots

Pilots

In the current conjuncture, aspects related to human factors in aviation have been discussed more and more, including concepts such as airmanship, Crew Resource Management - CRM, and fatigue. This way, the importance of discussions related to the subject in different forums has been growing. Thus, to comprehend the condition of pilots who have suffered aircraft accidents in our country, this Report used data that contributed to a better understanding of their profile.

Considering data available, and to identify levels of training and experience of pilots involved in accidents, we sought to verify which was the highest-grade license pilots held at the time of the occurrence. Thus, Figure 14 and Figure 15 show the proportional relationship between pilots involved in accidents and the gradation of licenses, distinguishing between fixed-wing and rotary-wing aircraft.

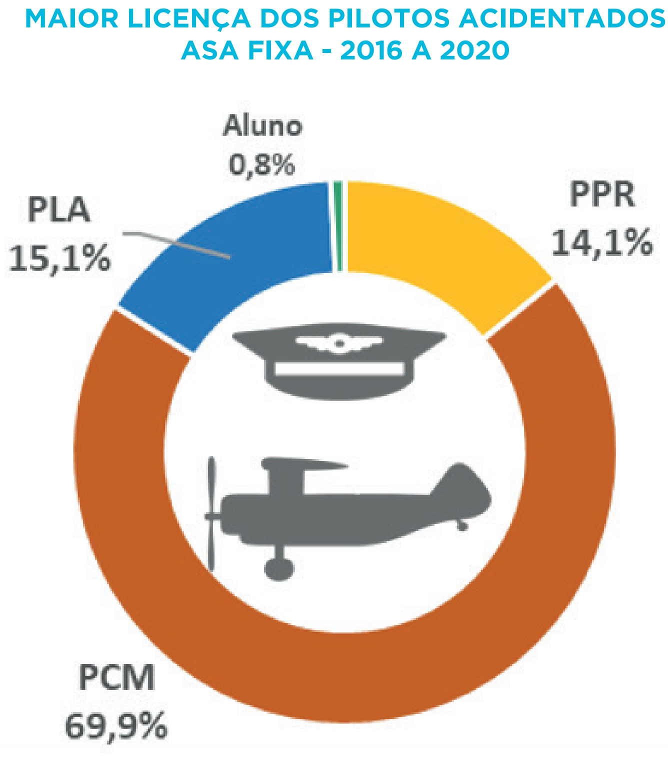


Figure 14: ratio of license gradation that fixed-wing aircraft pilots held at the time of the occurrence, from 2016 to 2020. Source: CENIPA and ANAC.

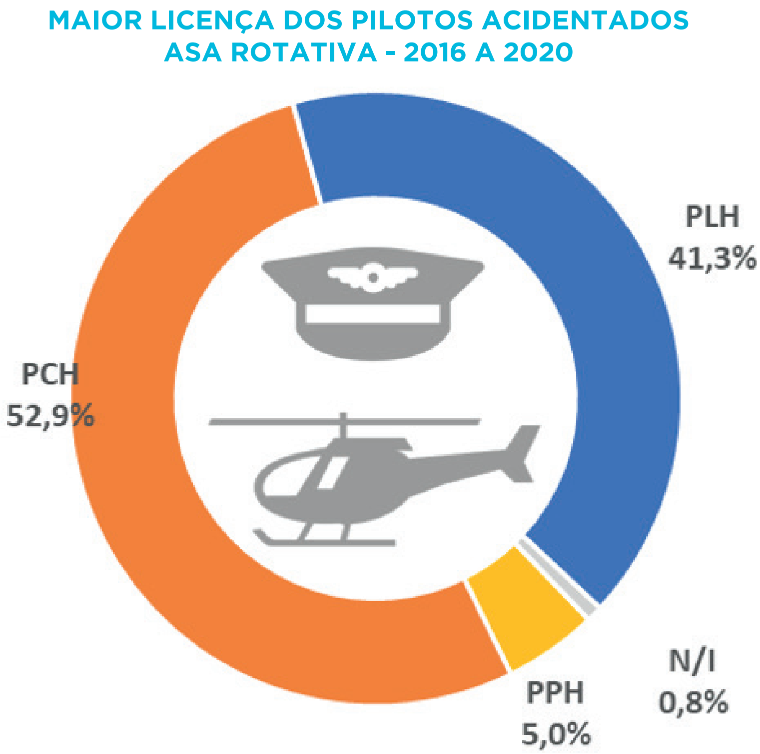


Figure 15: ratio of license gradation that rotary-wing aircraft pilots held at the time of the occurrence, from 2016 to 2020. Source: CENIPA and ANAC.

Figure 14 and Figure 15 indicate that around 85% of the accidents occurred with pilots holding commercial or airline licenses, considering both airplanes and helicopters. Data allow us to conclude that, in general, we are not talking about inexperienced professionals, regardless of the lack of detailed information on pilots' total number of flight hours, recent experience or degree of experience flying the type/class of crashed aircraft. Considering the absence of studies that take into account the aforementioned factors, more in-depth research should be carried out in order to provide a broader view of the subject.

Geographical Characteristics of Aircraft Accidents

Geographical Characteristics of Aircraft Accidents

The location where aeronautical occurrences take place is also a relevant factor for the analysis of these events. Therefore, this section is dedicated to evaluating where accidents have occurred, considering the continental dimensions of our country and the propensity of each region for aviation operations.

From 2012 on, CENIPA has included the aerodrome of origin and the aerodrome of intended landing for the flight involved in the occurrence among the information provided about a specific accident. Latitude and longitude coordinates of the places where accidents occurred have also been made available. It is important to point out that it is not always possible to specify the takeoff location of an aircraft involved in an accident. And even when this is possible, the aircraft may have taken off from an unregistered aerodrome.

Latitude and longitude information enabled the elaboration of Figure 16, which shows the geographic location of accidents per type of operation in 2020. In the North Region, occurrences involving private flights regulated by the Brazilian Civil Aviation Regulation (RBAC) 91 prevailed, while agricultural aviation accidents predominated in the Center-South region of Brazil.

ANAC has other initiatives to georeference occurrences, such as recent reports with qualitative analysis of occurrences involving In-flight Engine Failure, Loss of Control in Flight and Loss of Control on Ground, available at https://www.gov.br/anac/pt-br/assuntos/seguranca-operacional/relatorios-de-analises-de-ocorrencias. We invite the reader to examine the reports and verify possible correlations between the type of operation and its respective region of prevalence. This attitude helps ANAC to focus continuing surveillance on a specific operation more precisely.

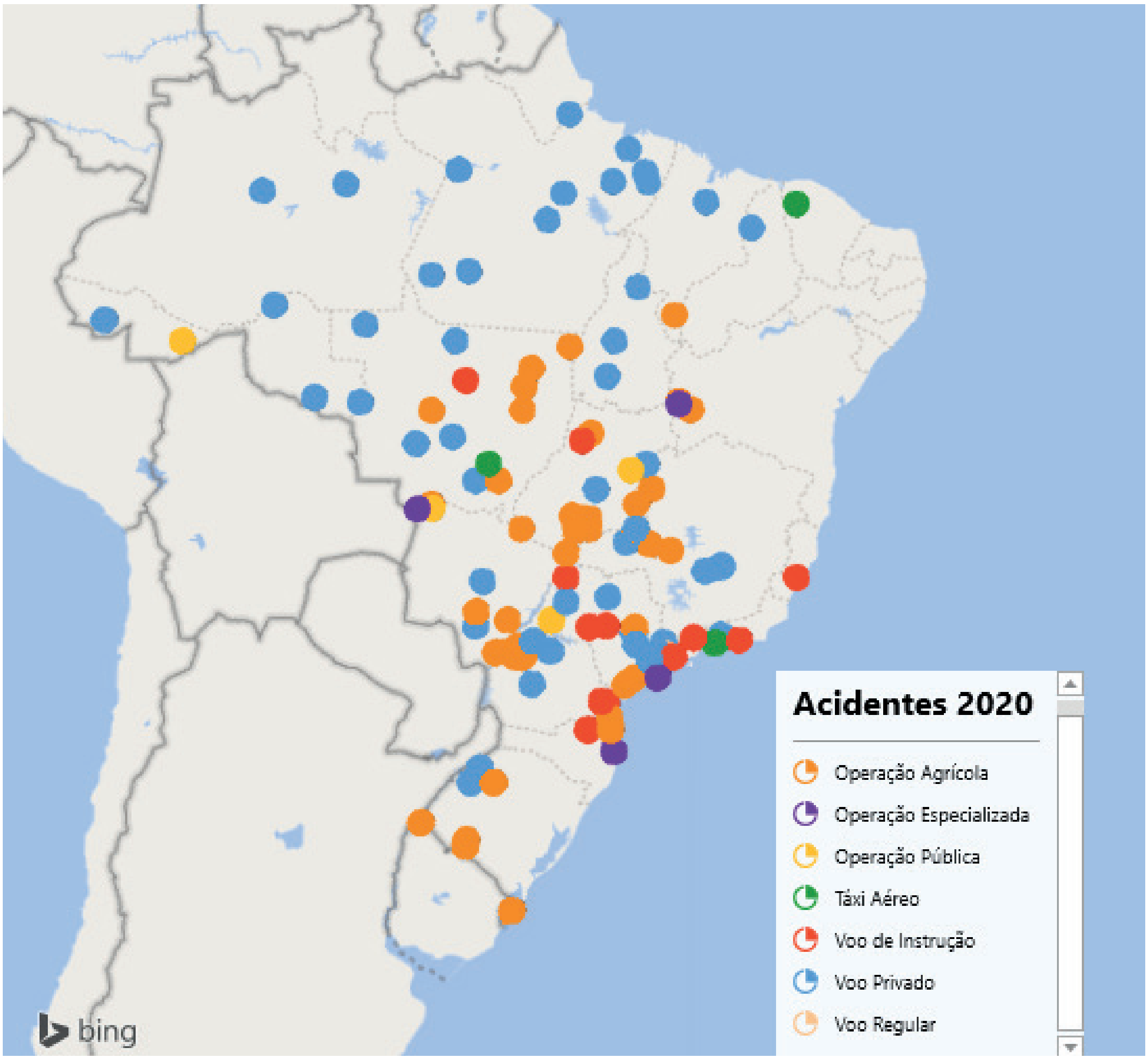


Figure 16: geographic location of aeronautical accidents per operation in 2020.
Source: CENIPA.

Figure 17 distinguishes fatal and non-fatal accidents that occurred in 2020.

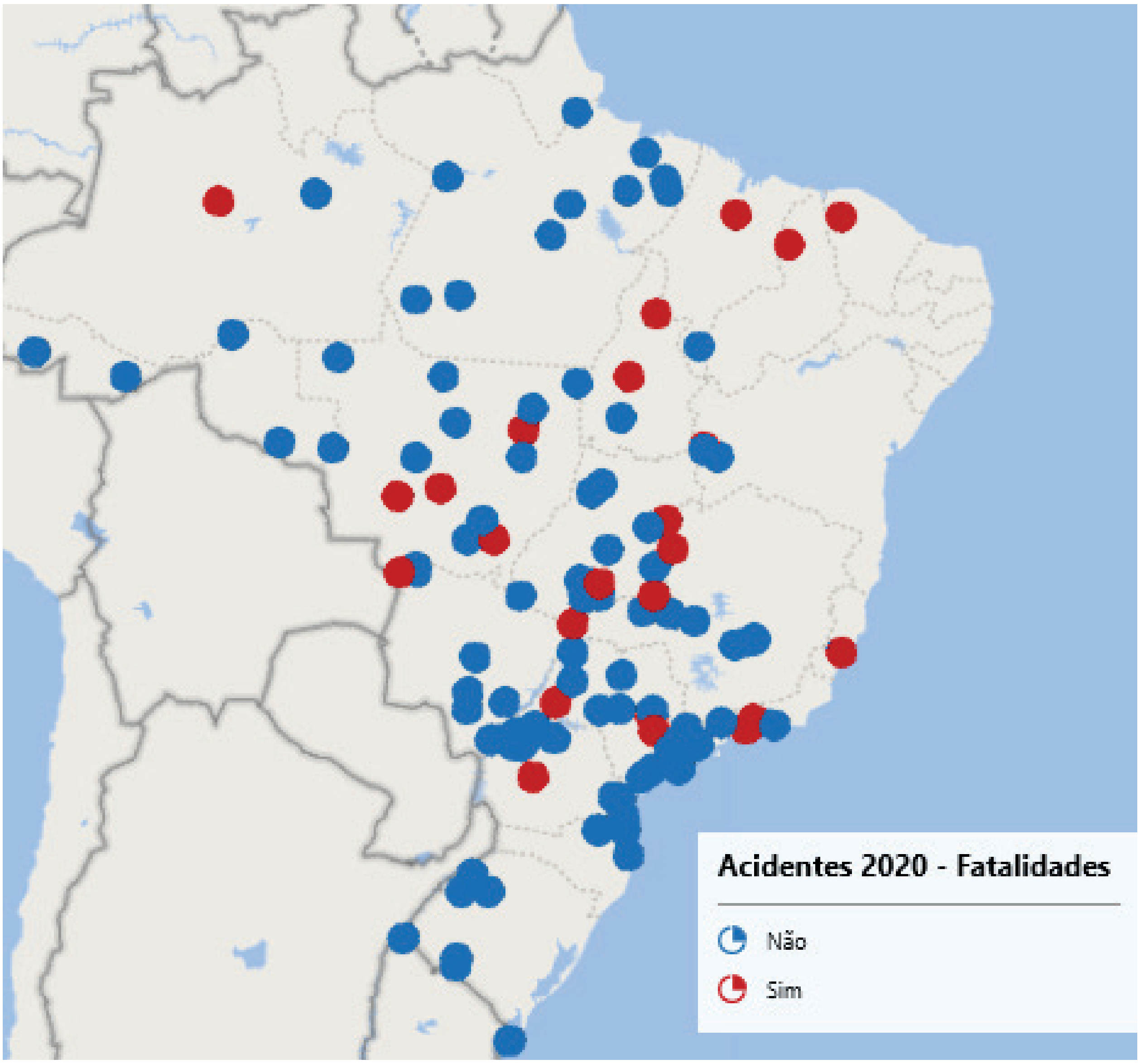


Figure 17: accidents with and without fatalities registered in Brazil in 2020. Source: CENIPA.

The diagram below shows the accrued number of accidents registered in each Brazilian state in the last five years.

TAXA DE ACIDENTES - POR ESTADO - 2016 A 2020

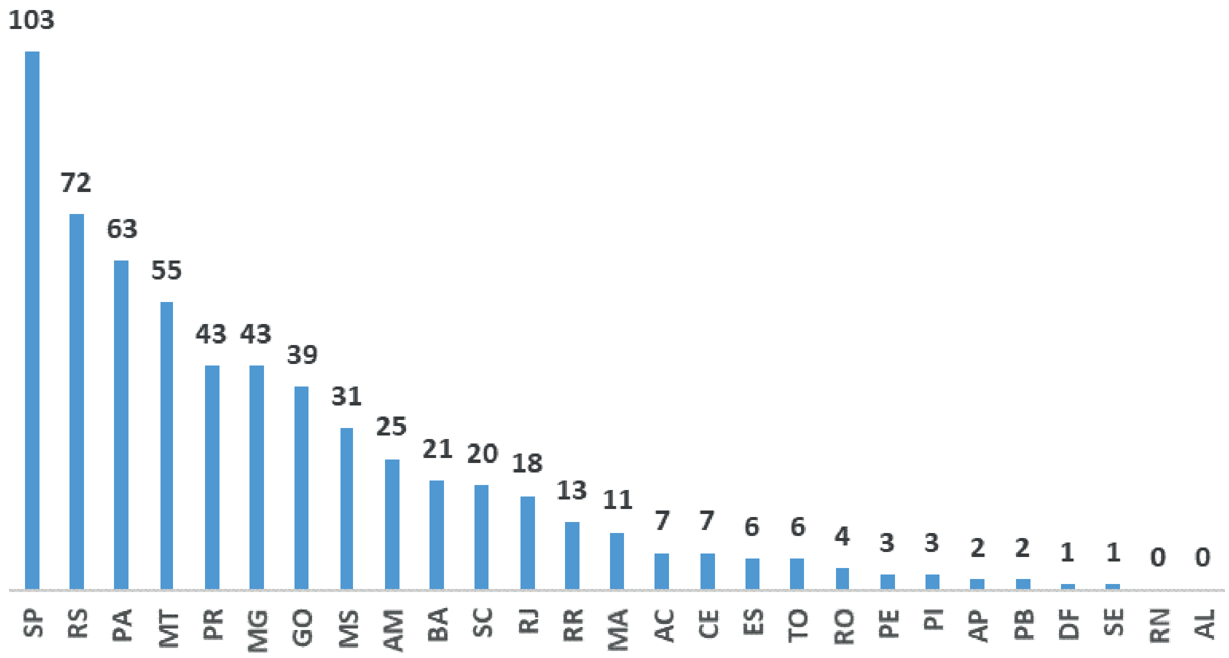


Figure 18: accidents by state between 2016 and 2020. Source: CENIPA.

Agricultural Aviation

Agricultural Aviation

In nations where the agribusiness plays an expressive economic role it is expected that agricultural aviation occupies an outstanding position. In Brazil, where agribusiness is one of the pillars of the economy, representing around 26.6% of the Gross Domestic Product (GDP)[6], agricultural aviation is active and vigorous. In a peculiar way, the agricultural segment maintained relative stability in 2020 during the COVID-19 pandemic especially regarding the flight hours actually flown by aircraft registered by ANAC. It is evident that this was not the reality experienced by all agricultural aviation operators. However, the sector's resilience in 2020, in general, shows the greatness of Brazilian agribusiness and the importance of aviation as a fundamental support for agricultural activities.

Agricultural aviation is an air activity that has unique characteristics and operates in a quite different environment when compared to other aviation segments. For example, agricultural aviation must deal with low altitude maneuvers, handling and application of pesticides and other agricultural inputs, operations with variable load, unpaved runways, lack of support infrastructure, among others. All these factors contribute to considerably higher risks intrinsic to agricultural operations if compared to those associated with other aviation segments. It is observed that, although agricultural aviation represents 5% of the national fleet, it was responsible for more than 34% of the total number of accidents in Brazilian civil aviation in 2020.

Records presented below show that the lowest rate of accidents without fatalities happened in 2020, when 30 accidents were registered. The 2020 rate is below the level of 35 accidents observed in previous years. On the other hand, fatal accidents increased from 4 to 7 between 2019 and 2020, a number inferior to the 2016 records only. Also, the number of serious incidents (48 events) is significant if compared to the number of accidents (203 events). This suggests a strong underreporting tendency, considering that a serious incident is reported, on average, for every 4.2 accidents within five years. However, this practice is inverse to what literature on the subject prescribes, which points to the negative correlation between progression of severity and number of events of each type.

6 - According to 2020 data from the Center for Advanced Studies in Applied Economics at the University of São Paulo – CEPEA. Available at: https://cepea.esalq.usp.br/upload/kceditor/files/sut.pib_dez_2020.9mar2021.pdf

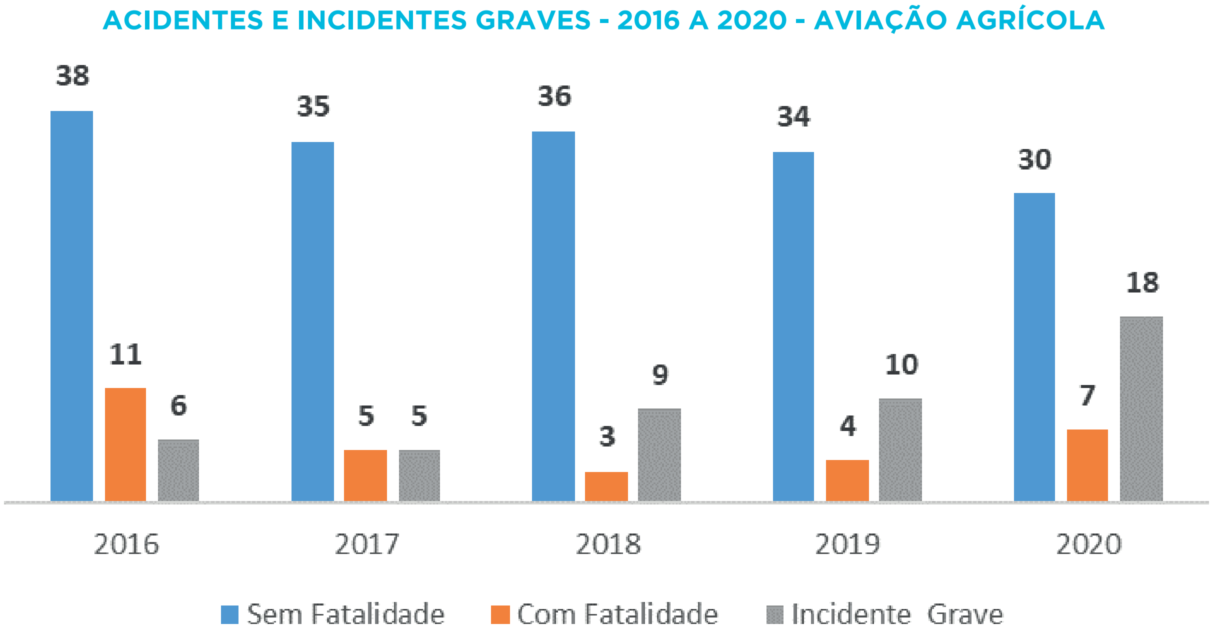


Figure 19: records of accidents and serious incidents in agricultural aviation – 2016 to 2020. Source: CENIPA.

The data in Figure 20 were grouped according to the Accident/Incident Data Reporting (ADREP) taxonomy, assigned by CENIPA, in order to facilitate the understanding of the factors that lead to an accident in agricultural aviation. This survey allows us to identify that in-flight engine failure, loss of control in flight, runway excursion and low altitude maneuvers are associated with about 62.3% of accidents recorded in the period considered.

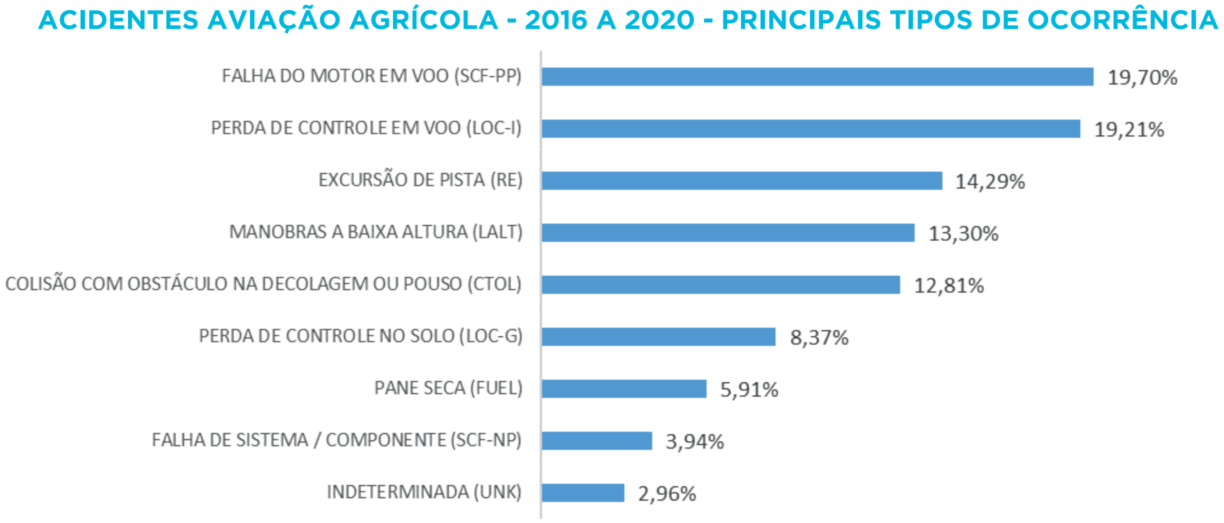


Figure 20: agricultural aviation accidents by type of occurrence, 2016 to 2020. Source: CENIPA.

With regard to the typology of agricultural aviation accidents, it is important to identify which types of occurrences present the highest lethality rates and, consequently, are more impactful for the segment. This way, except for occurrences classified as "unknown" and "other types", Figure 21 lists the total number of accidents by type of occurrence with their respective percentages that resulted in fatalities. It is important to highlight that the size of the circles is proportional to the number of fatalities registered as a result of the respective type of accident. In the subsequent graph, the "fatality risk"[7] associated with the respective ADREP taxonomy is introduced, relating the distribution of fatalities in percentage to each specific taxonomy. For agricultural aviation, the calculation of the hull loss equivalent was not considered, since agricultural aircraft generally transport only one person on board, what makes the metric inadequate for this context.

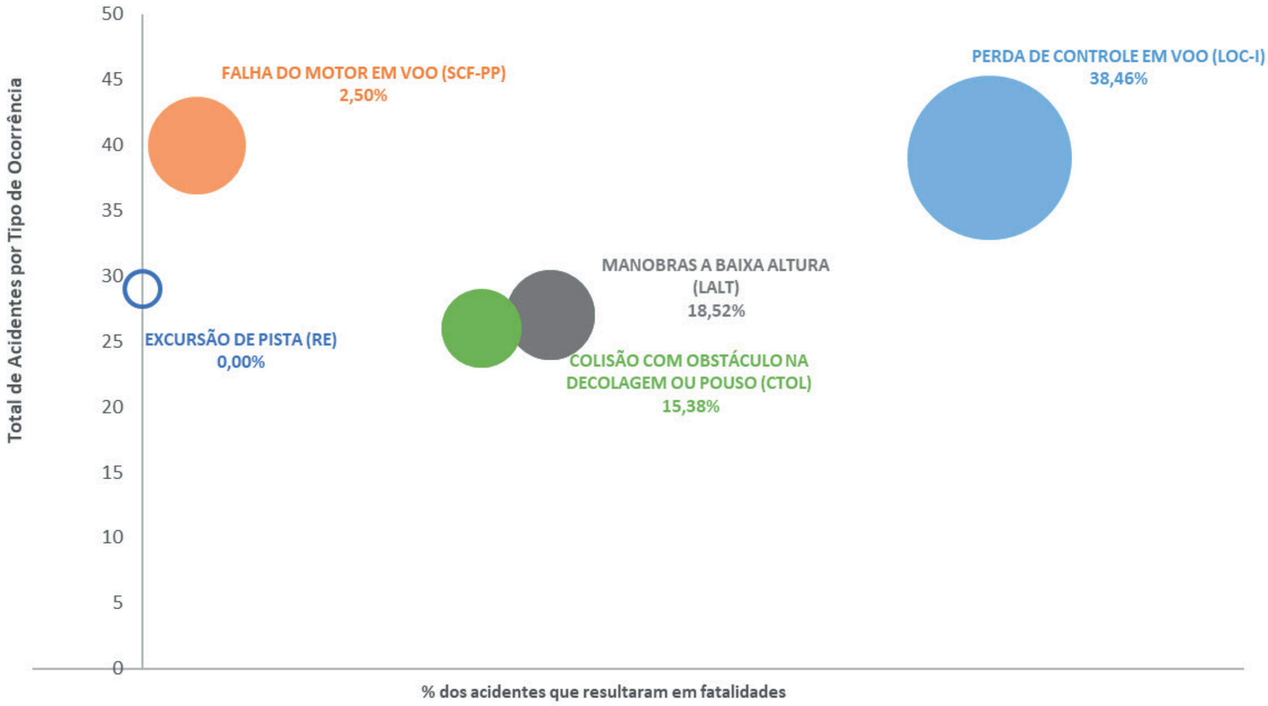


Figure 21: total of accidents and ratio of fatal accidents in agricultural aviation between 2016 and 2020. Figure 20 shows the main types of occurrences only, excluding "unknown" and "other types". Source: CENIPA.

The previous Figure shows that loss of control in flight has the highest fatality rate among recorded accidents, the highest number of fatalities and the highest total number of recorded accidents. Occurrences involving collision with obstacle(s) during take-off and landing and low altitude maneuvers have also to be pointed out. These occurrences present a relatively high fatality rate for the segment and, at the same time, a high number of associated fatalities. It is worth noting that, although accidents related to in-flight engine failure and, mainly, runway excursion occupy prominent positions among the categories with the highest number of agricultural accidents recorded, these types resulted in a low fatality rate. Figure 22 condenses the same data, showing the fatality risk for the segment.

7 Fatality risk, a concept widely used by ICAO and IATA in Safety reports, reflects risk for passengers or crew to expose themselves to a fatal accident. In the case of general aviation, fatality risk concept has been adapted to events in which fatalities occur, in such a way that the ADREP classification was considered proportionally to the number of fatalities of the event. Thus, Figures 22 and 34 of this Report were prepared. For regular aviation, which uses the concept commonly, no graph was drawn up, since the country has not registered fatal accidents in this segment since 2011.

AVIAÇÃO AGRÍCOLA 2016 A 2020
RISCO DE FATALIDADE (*FATALITY RISK*) VS TIPOS DE OCORRÊNCIA

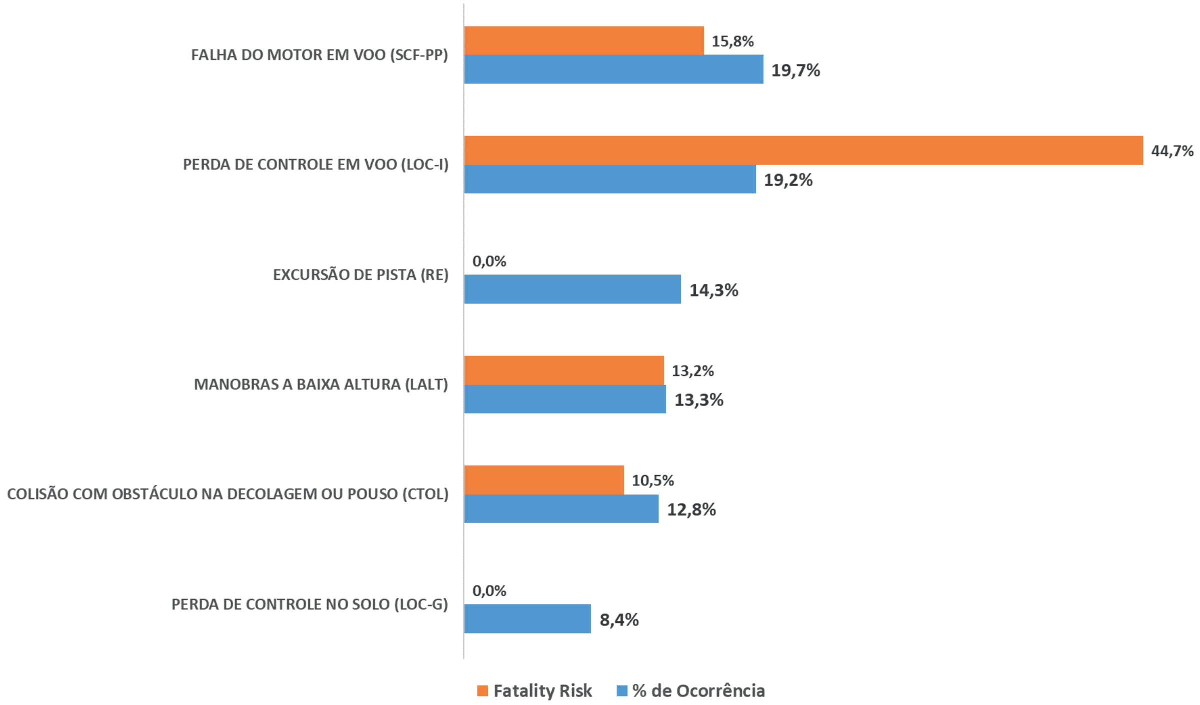


Figure 22: total accidents and fatality risk associated with the main ADREP taxonomies in agricultural aviation between 2016 and 2020.

With the available data, it is also possible to group accidents according to the phase of flight in which they occurred. Considering the period between 2016 and 2020, it is noted that most accidents occur during takeoff and the so-called "Specialized Aircraft Service" phase (SAE phase)[8]. This phase comprehends the specific period when agricultural aircraft perform the specialized air service for which they are intended.

8 - There is no formal definition for "SAE phases". However, they can be considered as phases inherent to agricultural aviation, such as seeding, application of fertilizer, fighting pests, among others.

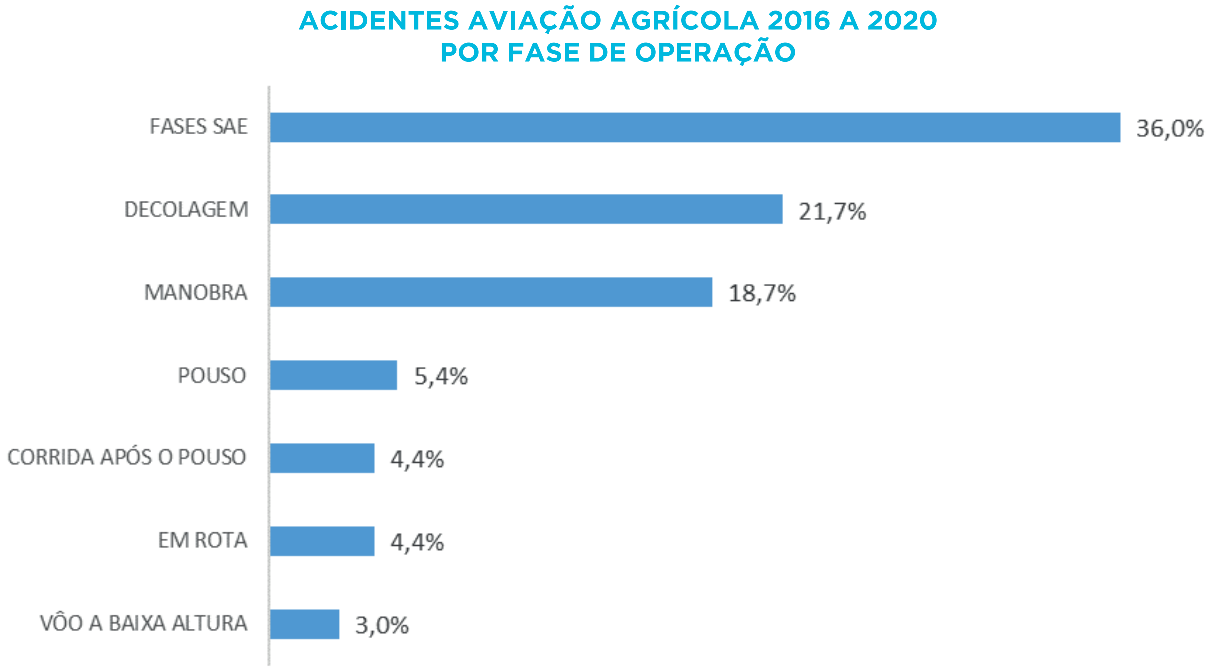


Figure 23: agricultural aviation accidents by phase of flight, 2016 to 2020. To improve graph visualization, only the main phases of flight are displayed, while those related to a small number of accidents have been suppressed. Source: CENIPA..

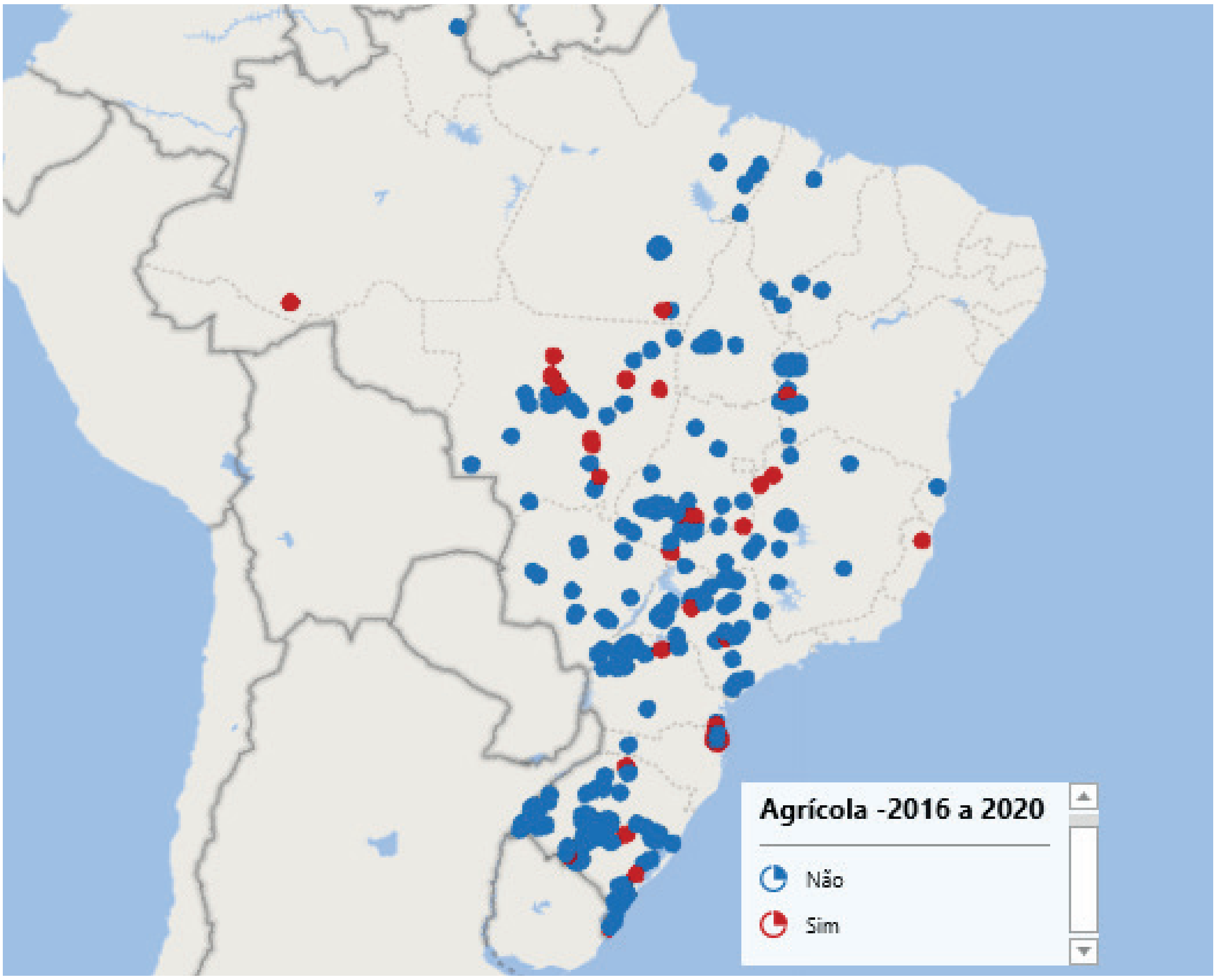


Figure 24: geographic location of accidents involving agricultural aviation between 2016 and 2020. Source: CENIPA.

The Figure above shows the predominance of agricultural aviation occurrences in the Center-South region of the country, which notably concentrates the states with the highest agricultural production in Brazil.

Instructional Aviation

Instructional Aviation

For most airmen, instructional aviation is the gateway to aeronautical environment. The primary objective of this aviation segment is to provide these professionals with knowledge, skills and experience necessary to comply with the minimum standards set out in RBAC 61 to obtain licenses, ratings or certificates.

Institutions responsible for providing instruction must operate in accordance with at least one of the regulations below:

- RBAC 141 – Certification and Operating Requirements: Civil Aviation Instruction Centers.
- RBAC 142 – Certification and Operating Requirements: Civil Aviation Training Centers.

Regarding instructional aviation, the recent edition of Supplementary Instruction No. 141-007A, published by ANAC, deserves special mention. The regulation deals with Training Programs and Instructions and Procedures Manual, detailing the various procedures for obtaining Private, Commercial and Airline Pilot licenses. Some innovations represent a great challenge for the entire aeronautical community, such as the introduction of Upset Prevention Recovery Training - UPRT to perform maneuvers such as spin and stall.

Instructional aviation still has high accidents rates (see Figure 25), despite the regulatory framework, the support of instructional institutions and the role of the instructor. In relation to the year 2019, there was a 66% increase in the number of accidents, approximating rates to the averages of the historical series.

On the other hand, accidents were less severe, considering that less than 6% of occurrences involving instructional aviation resulted in fatalities, as shown in Figure 10. This trend continued in 2020, when the rate of accidents with fatalities was 6.6%.

The Figure below shows records of instructional aviation accidents with and without fatalities recorded in the last five years.

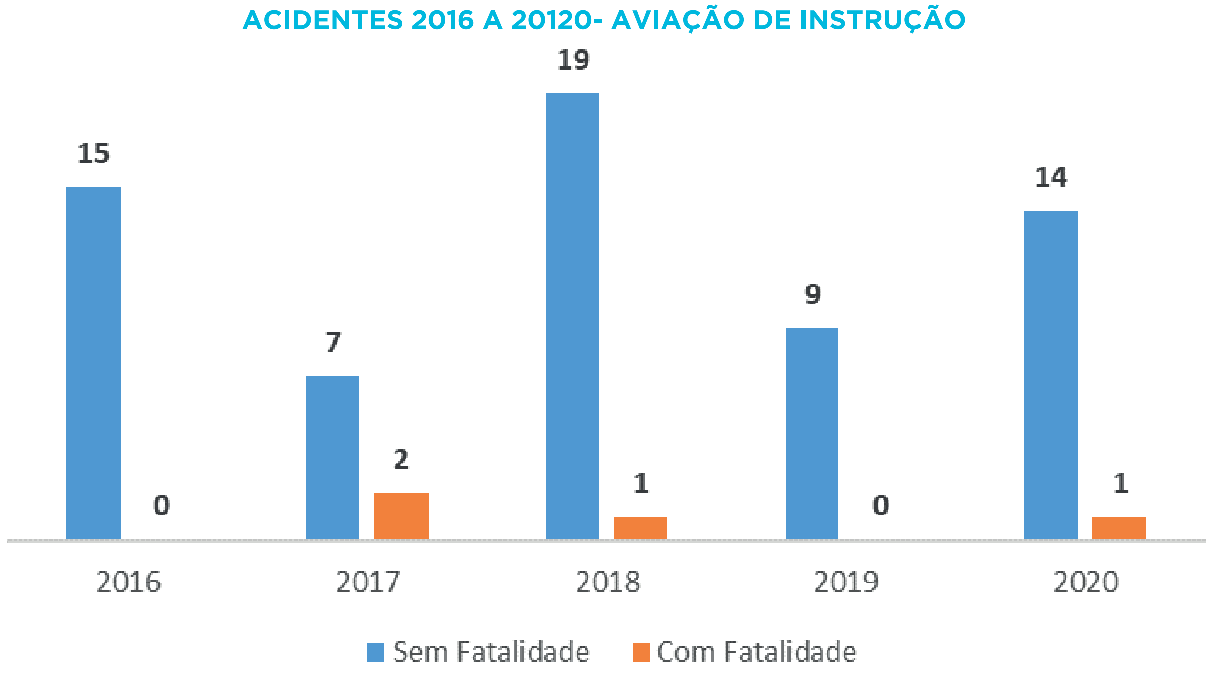


Figure 25: instructional aviation accidents records. Source: CENIPA.

Considering the different aspects of training offered to obtain licenses and ratings, especially to fly gliders, helicopters and airplanes, it is important to identify the types of aircraft involved in instructional aviation accidents. Figure 26 shows the accrued number of instructional aviation accidents per aircraft type, from 2016 to 2020.

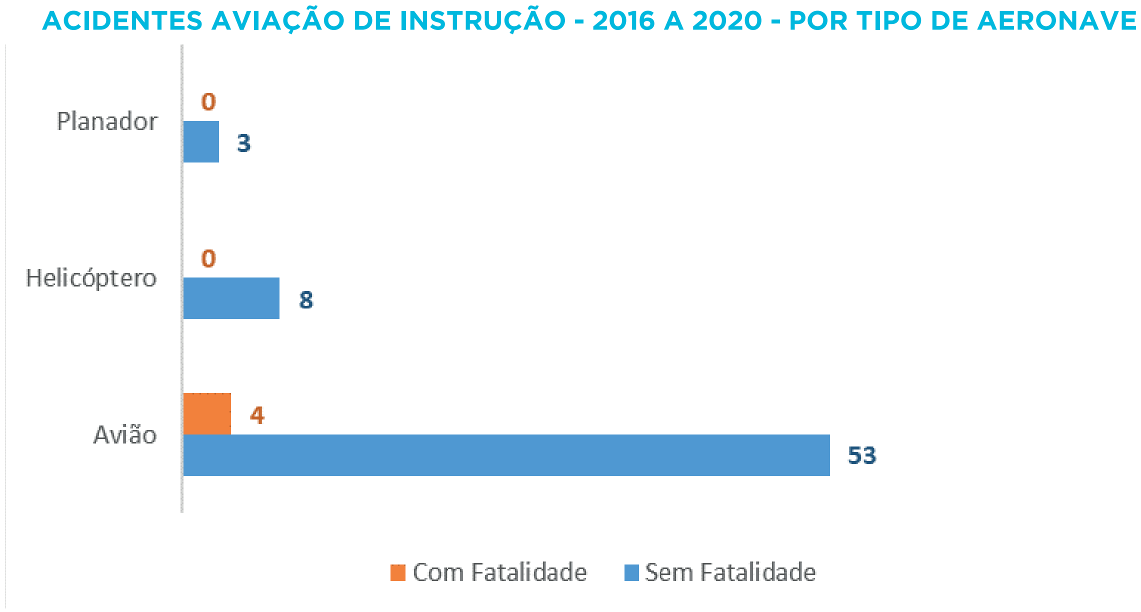


Figure 26: records of instructional aviation accidents by aircraft type. Source: CENIPA and ANAC.

Identifying the types of occurrences related to accidents is essential to better understand them. The Figure below groups the main types of occurrences classified by CENIPA according to the ADREP taxonomy for accidents involving instruction aircraft.

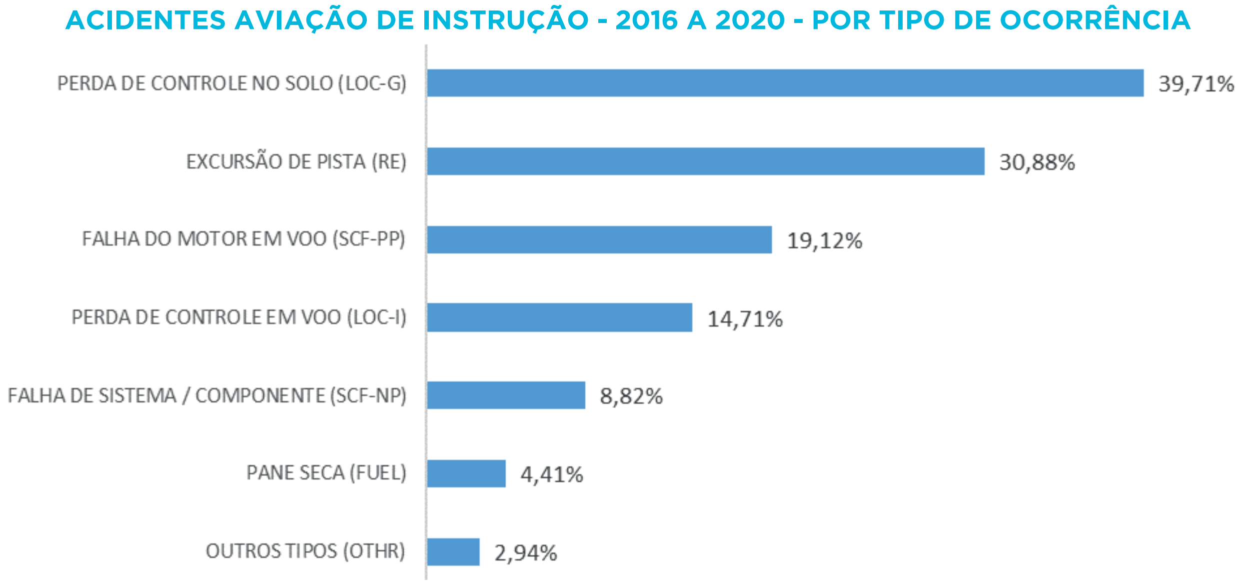


Figure 27: records of accidents in instructional aviation by type of occurrence. Source: CENIPA.

The graph above shows that the four types of occurrences that most affected instructional aviation accidents were loss of control on ground, runway excursion, in-flight engine failure and loss of control in flight, which together accounted for about 75% of the total number of accidents recorded by the segment.

Although runway excursion and loss of control on ground are the most common types of occurrences in instructional aviation accidents, there were no fatalities between 2016 and 2020 related to them. Consequently, accidents in this category are represented in Figure 28 by an empty circle on the vertical axis of the graph. The graph also calls attention to the fact that approximately 30% of accidents related to loss of control in flight recorded fatalities.

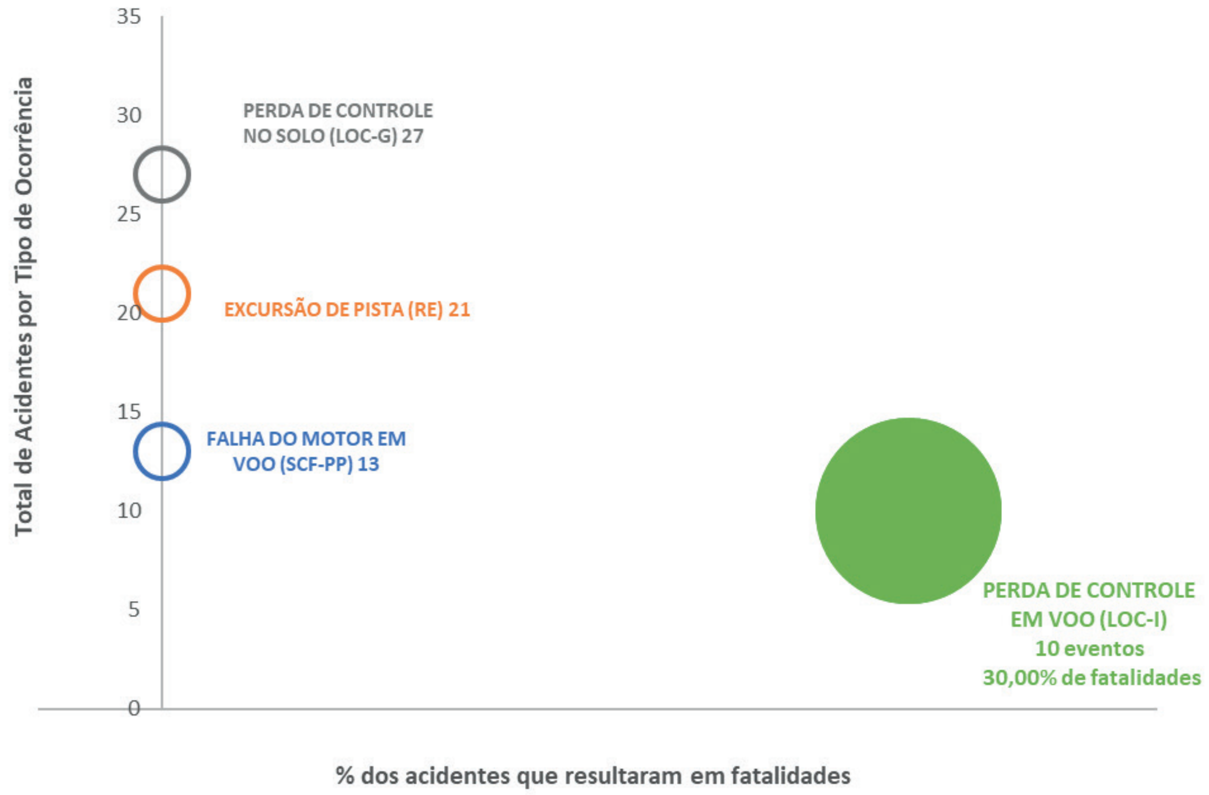


Figure 28: accidents and ratio of fatal accidents in instructional aviation between 2016 and 2020. The size of the circles is proportional to the number of fatalities registered for each type of occurrence. Only the main types of occurrences shown in Figure 27 are displayed, except for "unknown". Source: CENIPA.

Figure 28 shows the percentage of accidents that occurred during the main phases of operations. When landing and landing run are considered together, it is observed that the landing phase notably concentrates the largest number of records, accounting for about 42% of the total.

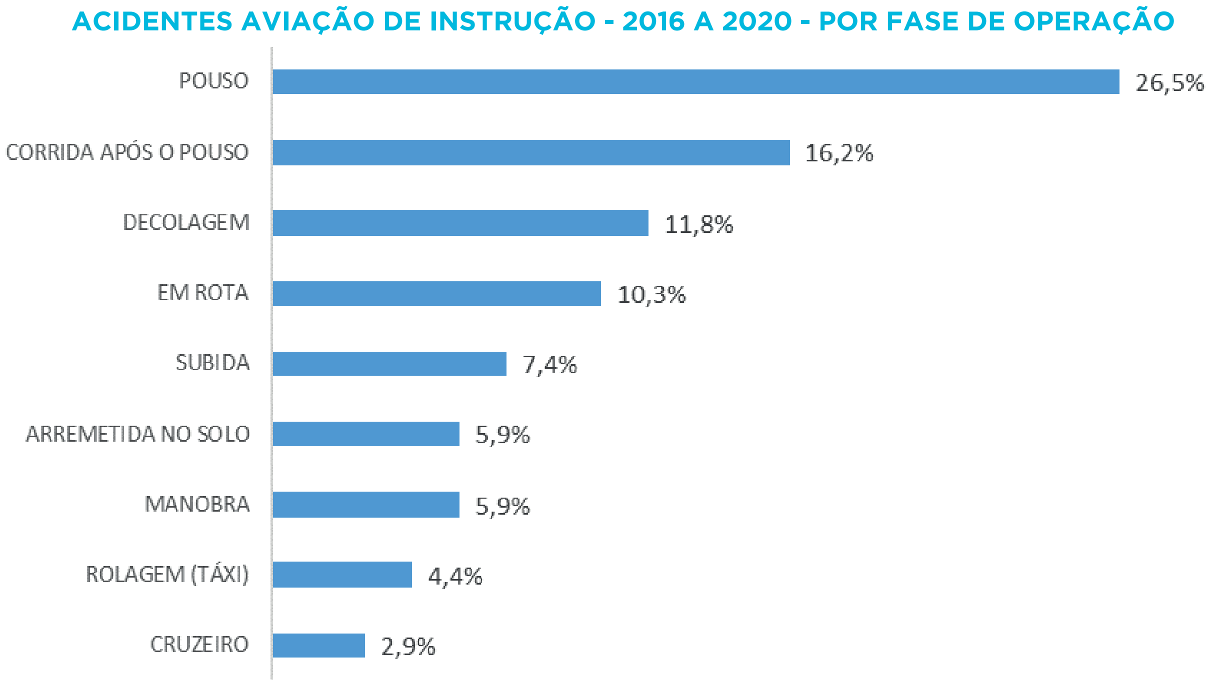


Figure 29: Instructional aviation accidents by phase of flight between 2016 to 2020. Only the main phases of flight are displayed while those related to a small number of accidents have been suppressed. Source: CENIPA.

Figure 30 shows the distribution of instructional aviation accidents in the Brazilian territory. Aero-clubs and aviation schools are concentrated in the South and Southeast regions. Therefore, most of the accidents occur in these regions. As it has been used in this Report, the word "YES" in red refers to accidents with fatalities, while "NO" in blue refers to accidents with no fatalities.

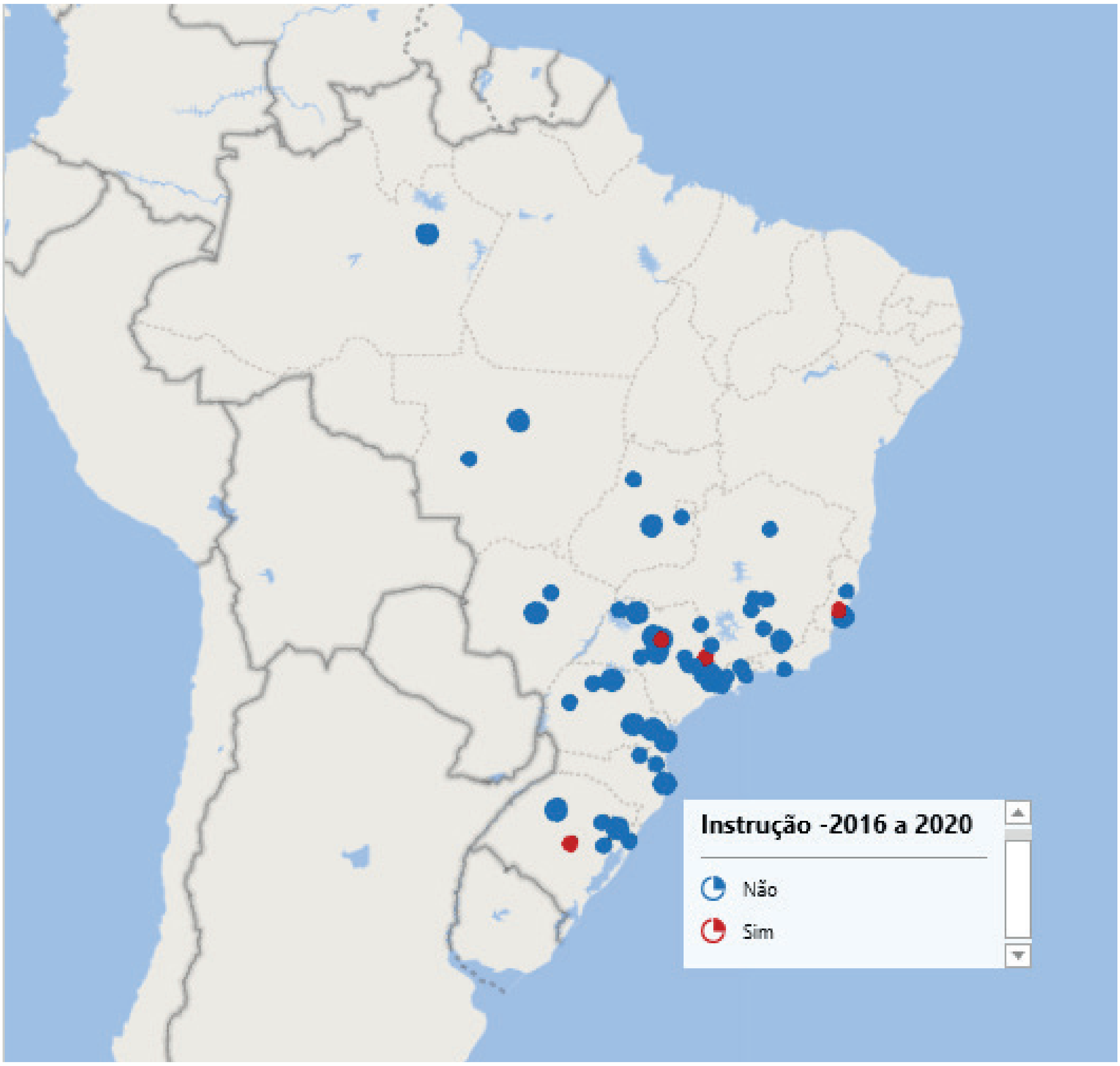


Figure 30: geographic location of instructional aviation accidents between 2016 and 2020. Source: CENIPA.

Private and Business Aviation

Private and Business Aviation

Private and business aviation represent the most heterogeneous Brazilian civil aviation segment, with a wide variety of aircraft models that range from gliders to large executive jets. The segment is characterized by the purpose of the flight, which can be for private or recreational reasons, with no payment for air services involved.

The basic standards that guide private and business aviation are provided in Brazilian Civil Aviation Regulation (RBAC) 91 – General Requirements for the Operation of Civil Aircraft, which establishes rules that must also be followed by other civil aviation segments.

Private aviation features make aspects such as pilot qualification, aircraft certification and maintenance, support infrastructure, operation and practically all other attributes related to the segment less restrictive than those related to commercial aviation. Therefore, it is reasonable to expect that private aviation does not present the same levels of safety performance presented by regular aviation, what can be confirmed by the comparison of accidents rates as shown in Figure 7.

Figure 31 indicates private and business aviation accidents and serious incidents in the last five years. There is a downward trend in absolute numbers, and the segment has reached the lowest number of accidents recorded in the last five years. However, taking Figure 7 into consideration, it is possible to observe that rates increased around 10%, an effect of the reduction of aviation operations caused by the COVID-19 pandemic.

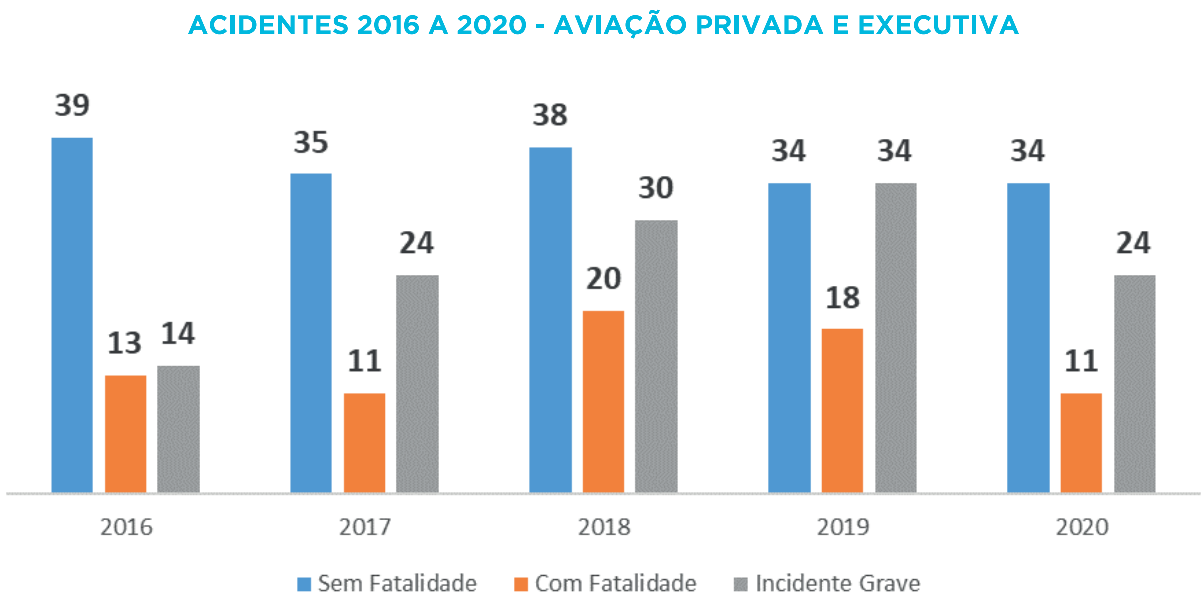


Figure 31: records of private and business aviation accidents. Source: CENIPA.

Figure 32 gathers accidents according to the main types of occurrences identified for the segment, following CENIPA classification and the respective ADREP taxonomy.

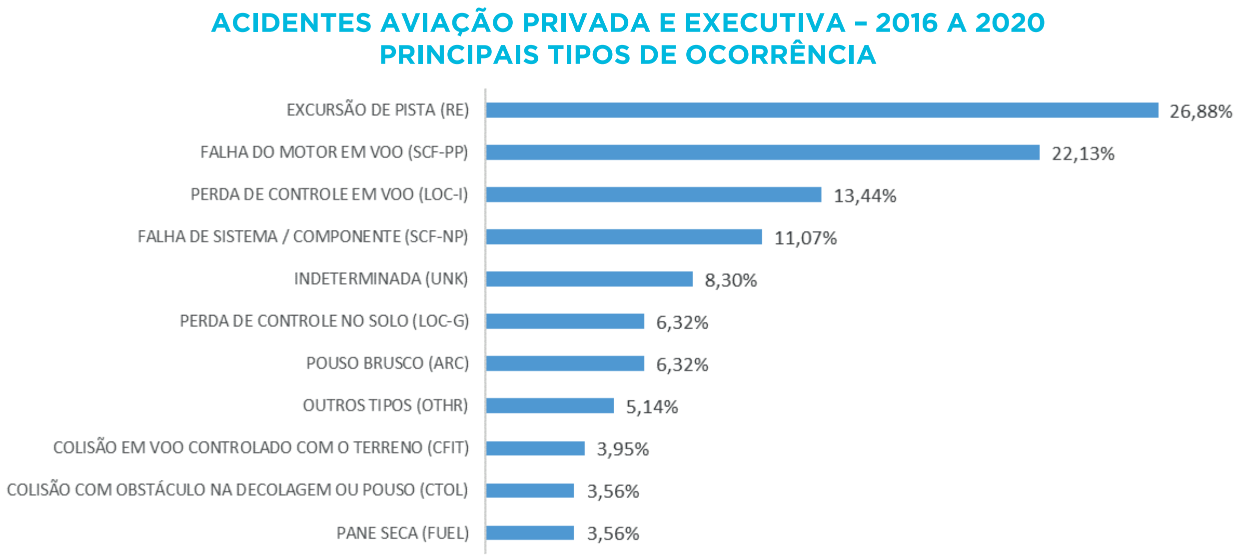


Figure 32: private aviation accidents by main types of occurrence. Source: CENIPA.

The previous Figure shows that runway excursion, in-flight engine failure, loss of control in flight and system/component failure are the most common types of occurrences, accounting for 64.7% of the total accidents.

Figure 33 indicates the relationship between the most impacting types of occurrences and fatalities in the segment. In absolute terms, numbers show that "loss of control in flight" was the type of occurrence that registered most of the deaths in the period under analysis. CFIT was the type of occurrence presenting the highest percentage of accidents with fatalities, recording 80% of victims.

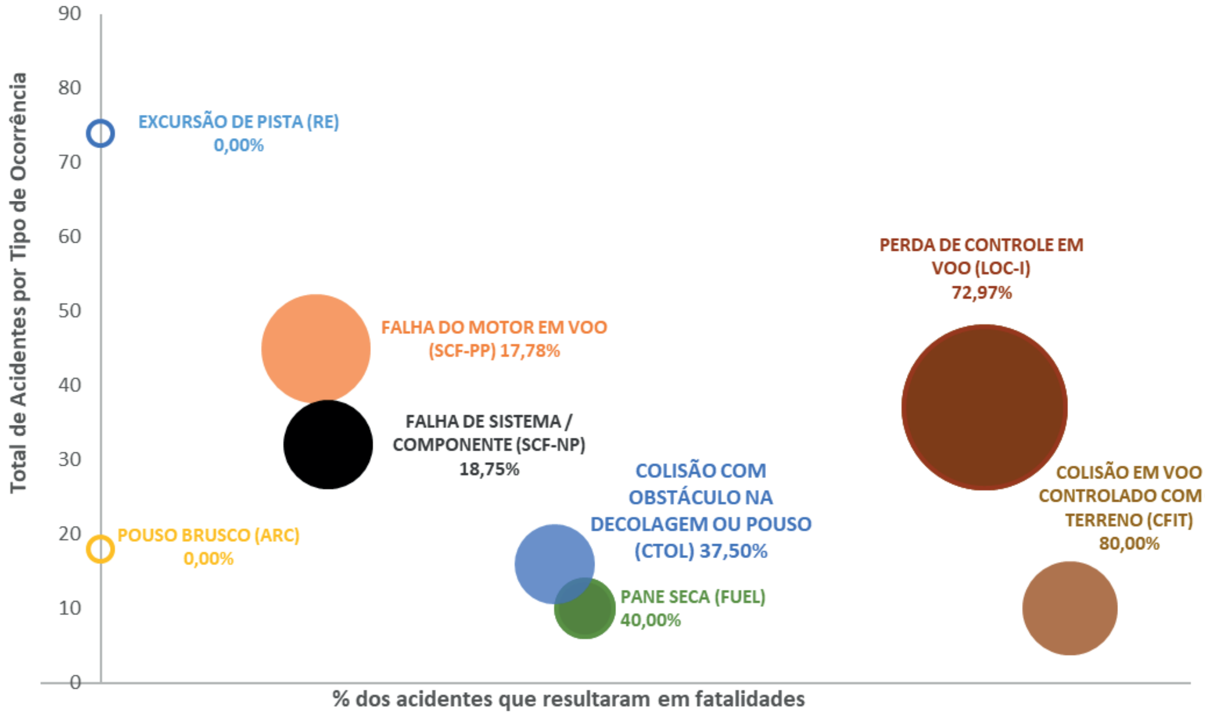


Figure 33: accidents and ratio of fatal accidents in private and business aviation between 2016 and 2020. The size of the circles is proportional to the number of fatalities registered for each type of occurrence. Only the main types of occurrences listed in Figure 32 are shown, except for "unknown" and "other types". Source: CENIPA.

Considering the wide range of distinct taxonomies presented in Figure 33, such information was grouped into a single graph correlating fatality risk and occurrence, as shown in Figure 34.

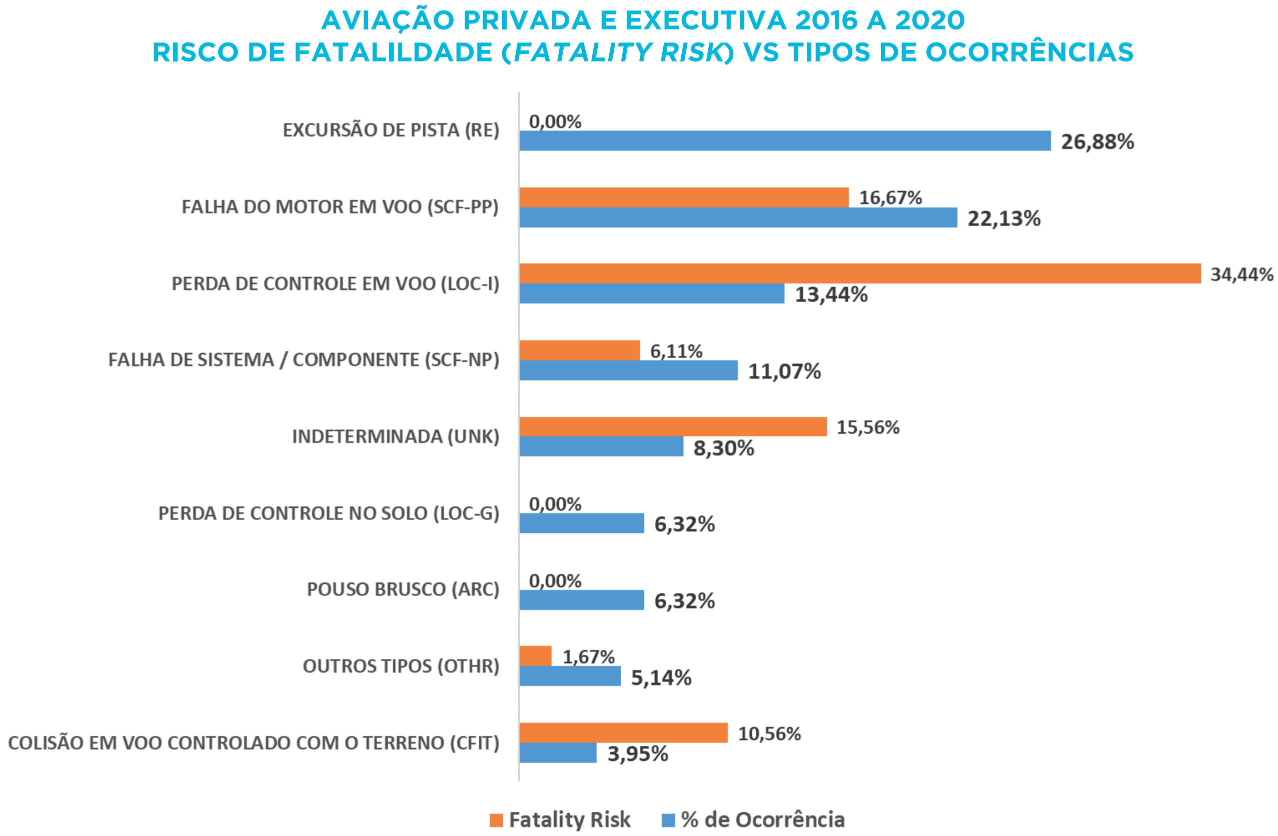


Figure 34: accidents and fatality risk associated with the main ADREP taxonomies in private and business aviation between 2016 and 2020.

Regarding the phases of flight, most of the private aviation accidents occurred during the landing phase, followed by en-route and take-off phases, as shown in Figure 35.

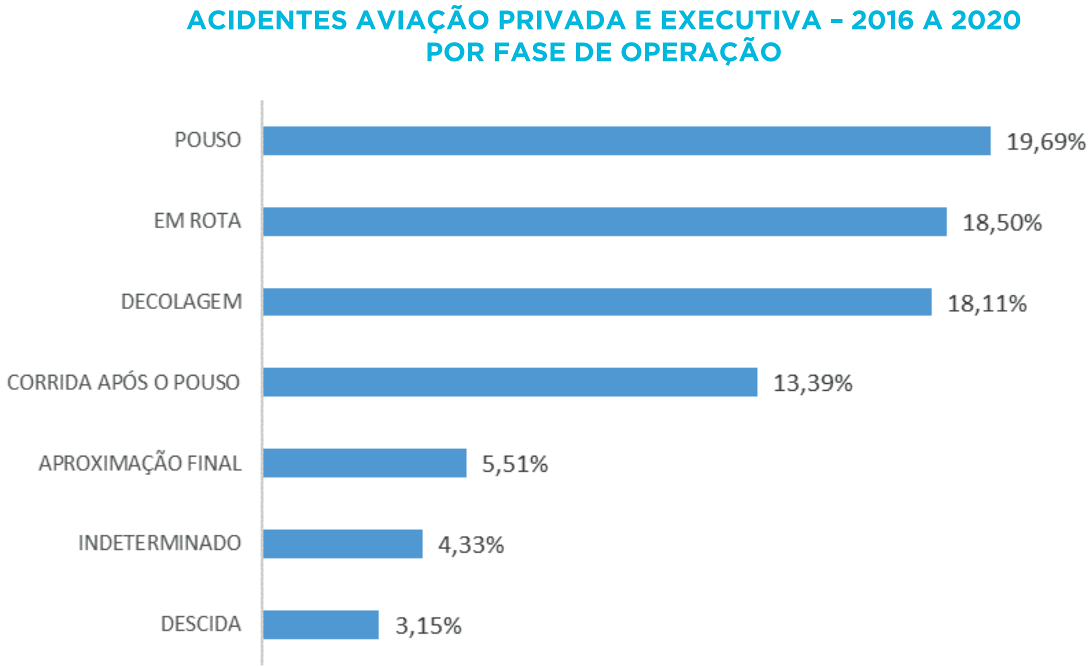


Figure 35: private aviation accidents by phase of operation between 2016 and 2020. Only the phases of flight that registered a significant number of accidents are included. Source: CENIPA.

When analyzing the types of aircraft involved in private aviation accidents, fixed-wing piston-engine aircraft account for almost 74% of the total number of accidents.

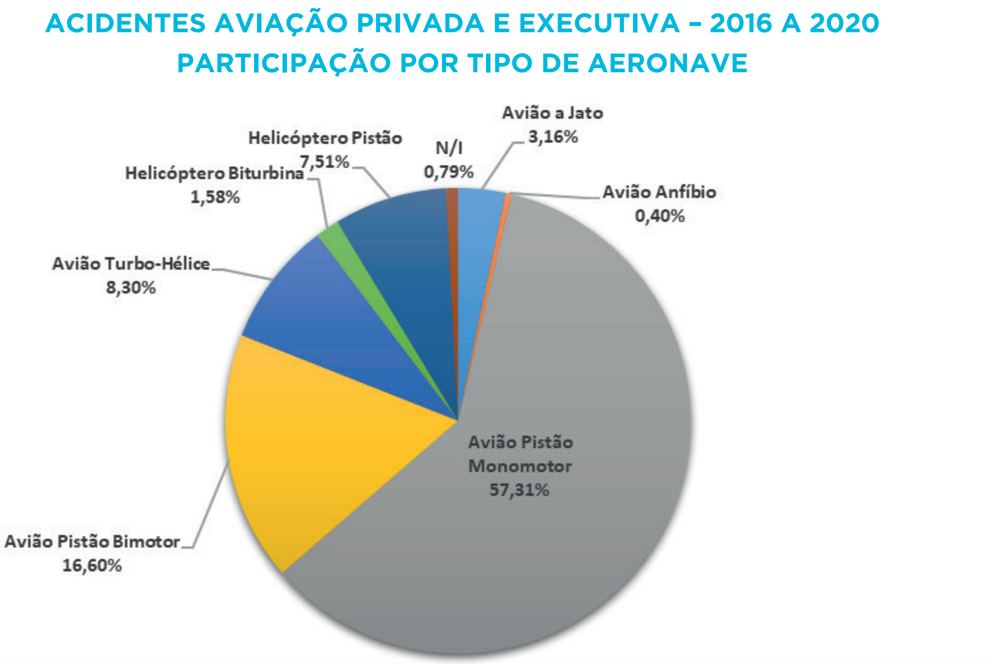


Figure 36: accrued of private aviation accidents between 2016 and 2020 by aircraft type. Source: CENIPA and ANAC.

The Figure below shows the geographic location of private aviation accidents that occurred between 2016 and 2020. As it has been used in this Report, the word "YES" in red refers to accidents with fatalities, while "NO" in blue refers to accidents with no fatalities.

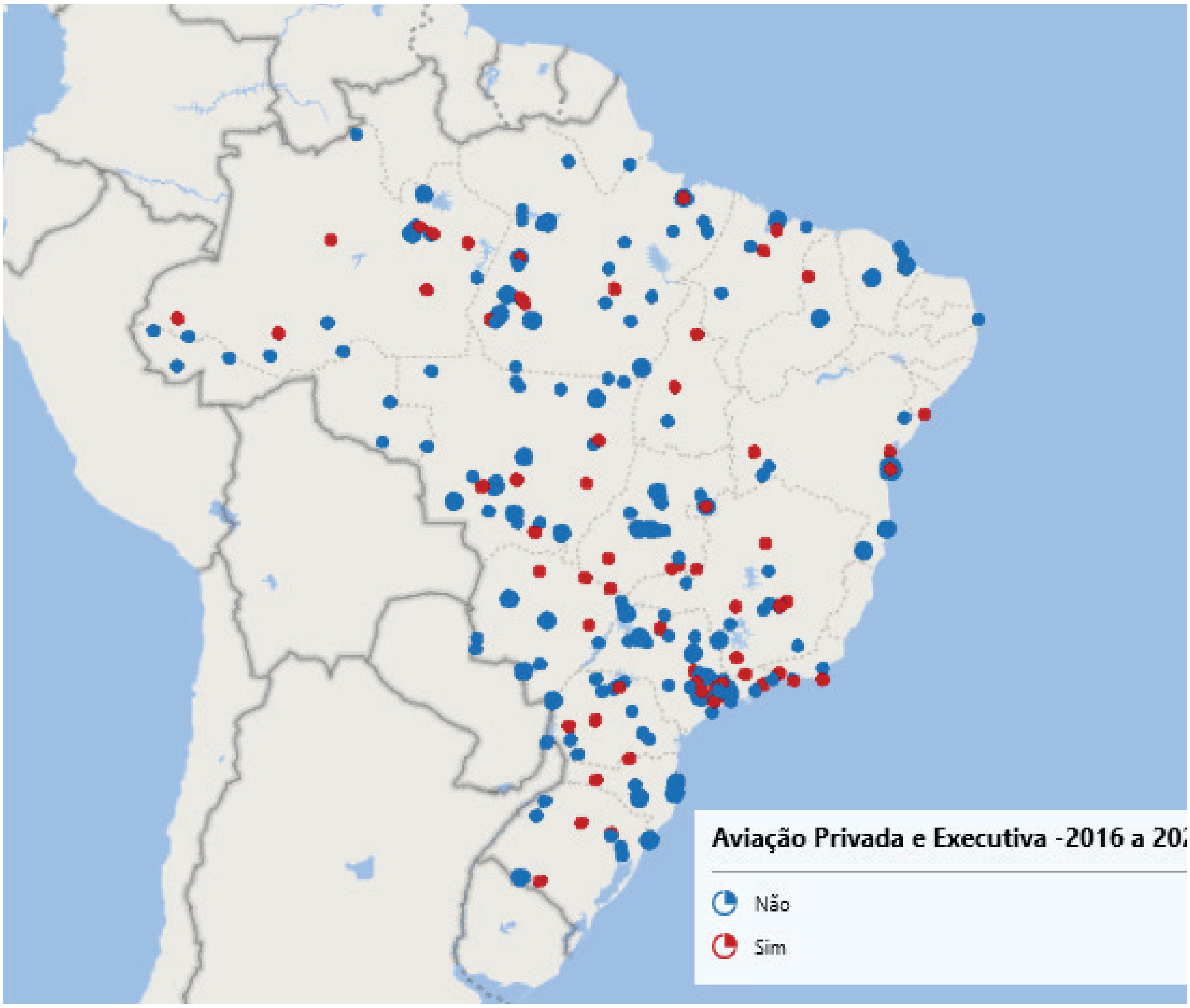


Figure 37: geographic location of private and business aviation accidents between 2016 and 2020. Source: CENIPA.

Regular Aviation

Regular Aviation

Although regular aviation is one of the safest modes of transportation, it constantly seeks to improve safety indicators. Considering aeronautical occurrences, Brazilian regular aviation has not registered accidents with fatalities since 2011, presenting a low number of accidents and serious incidents. Figure 38 shows aeronautical occurrences in the last five years.

AVIAÇÃO REGULAR - ACIDENTES, INCIDENTES GRAVES E INCIDENTES - 2016 A 2020

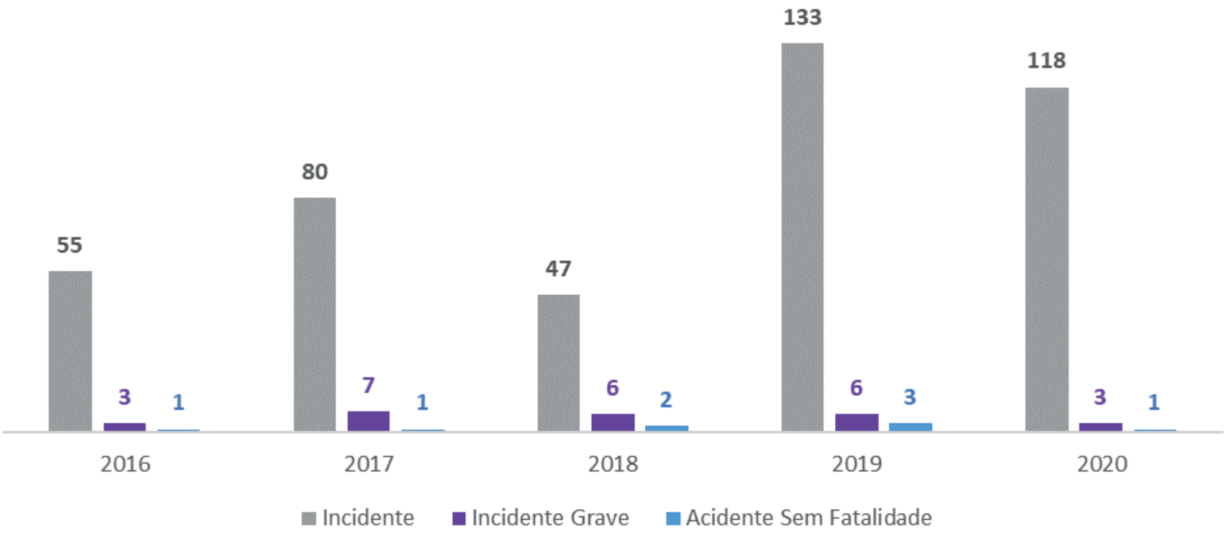


Figure 38: regular aviation occurrences – from 2016 to 2020. Source: CENIPA.

As it can be seen, the number of annual occurrences regarding serious incidents and accidents has been noticeably low. However, as it has been discussed in this Report, the number of regular aviation flights has dropped sharply in 2020 due to the COVID-19 pandemic and its severe impact on sectors that use aviation as a means of transportation, such as tourism, corporate trips and academic trips. As a result, accidents and serious incidents rates have varied within the values of the historical series, even with the drop in the number of events between 2019 and 2020. Nevertheless, the rate of incidents was 80% higher if compared to the rate registered in 2019. It has reached the highest value in the last five years, in despite of the fact that the absolute value was 10% lower if compared to 2019. The rate of serious incidents also remained above the moving average of the last five years, as it is detailed in the section "Monitoring Goals and Indicators of the Safety Oversight Plan".

Figure 39 indicates locations of regular aviation accidents and serious incidents registered between 2016 and 2020.

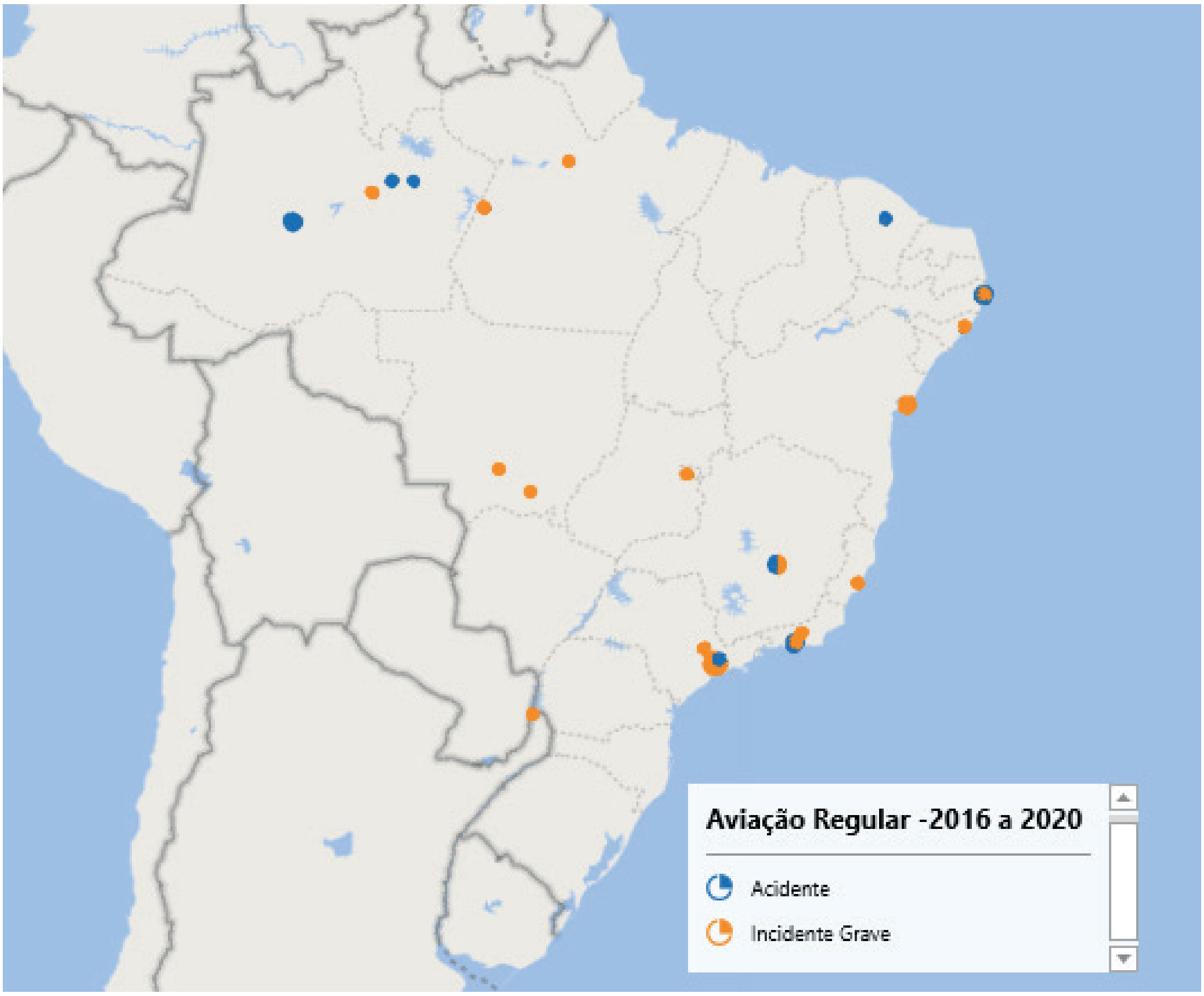


Figure 39: regular aviation accidents per location between 2016 and 2020. Source: CENIPA.

Another parameter used worldwide as an indicator of regular aviation safety performance is the moving average of the rate of accidents with fatalities. Following the trend, in 2015, ANAC revised the Acceptable Level of Safety Performance (ALoSP)[9] for the Brazilian civil aviation. A new goal for the moving average was defined as 0.26 accidents with fatalities in regular transport of passengers for a million of registered takeoffs[10].

Figure 40 shows the history of the rate of accidents with fatalities in Brazilian regular aviation, highlighting the current goal established by ANAC, defined by the ALoSP.

9 - The ALoSP was revised by ANAC through Normative Instruction No. 91 of November 5th, 2015. Available at: http://www.anac.gov.br/assuntos/legislacao/legislacao-1/instrucoes-normativas/instrucoes-normativas-2015/instrucao-normativa-no--091-de-11-05-2015

10 - According to Normative Instruction No. 91, in numbers, remaining below 0.26 is the associated goal, what corresponds to 50% of the world index registered by the end of 2011.

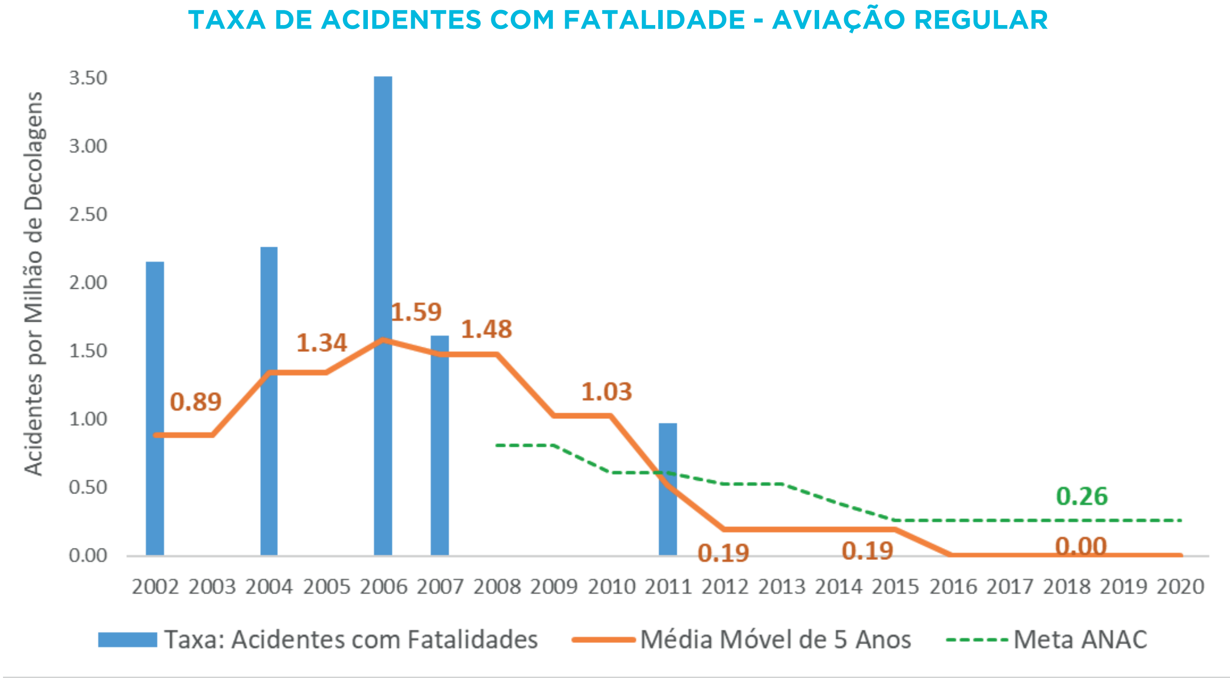


Figure 40: rate of accidents with fatalities in Brazilian regular aviation. Source: CENIPA and ANAC.

The search for improving safety performance requires the analysis of different sources of information which can indicate possible threats and potential opportunities for improvement. Different sources of information are even rarer in regular aviation, due to the reduced number of registered accidents, what makes the analysis of related aspects insufficient to detect trends and patterns which could be aggregated.

Therefore, the collection and analysis of other parameters in addition to aeronautical accidents records is extremely important for the identification of risks, searching for the continuous improvement of regular aviation safety indicators. In this context, in addition to accidents records, available information related to regular aviation incidents and serious incidents with aircraft has been analyzed in detail, as it can be seen in Figure 41.

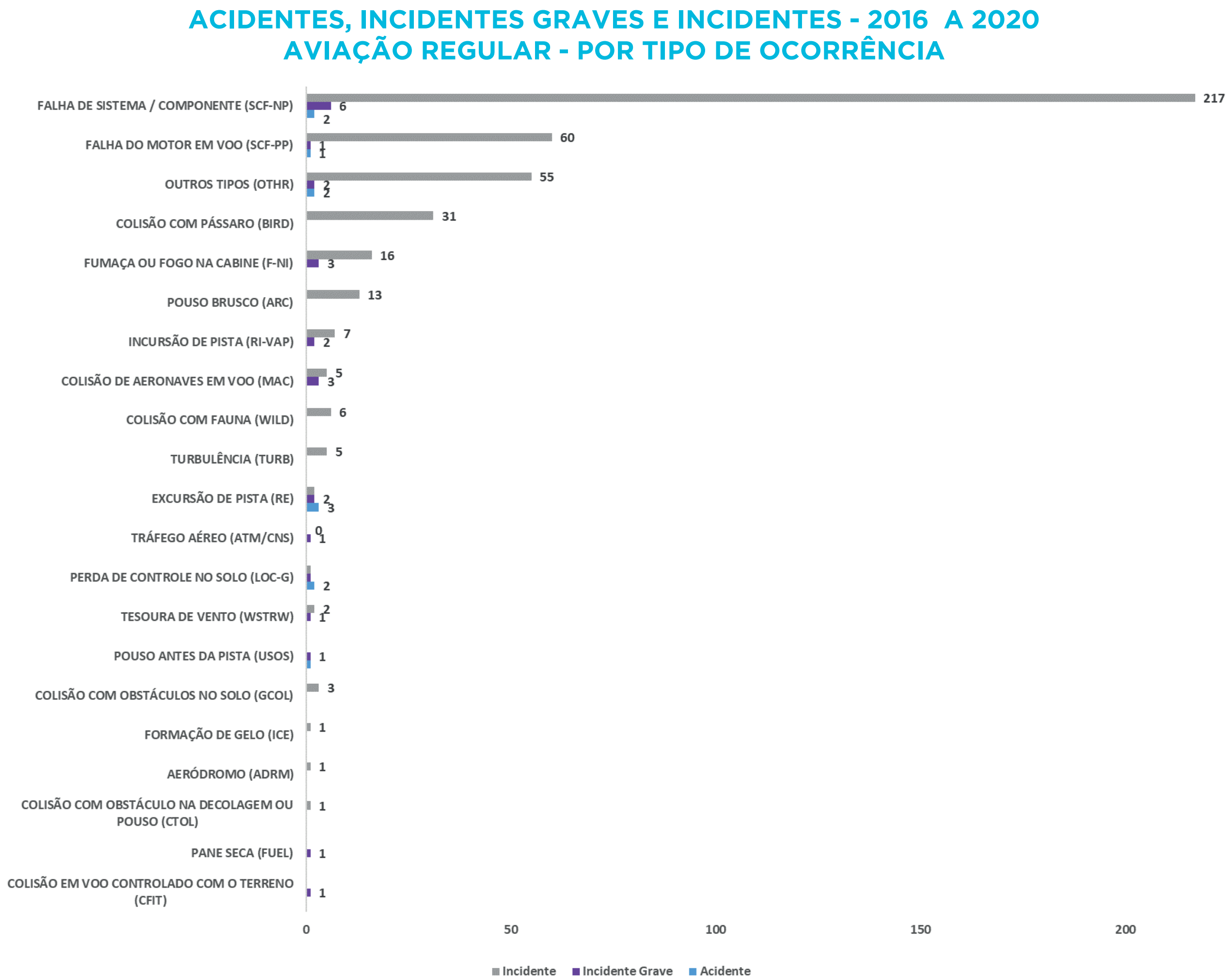


Figure 41: Regular aviation Accidents, Serious Incidents, and Incidents per type of occurrence. Source: CENIPA.

It should be noted that system/component failure and in-flight engine failure are the most common types of incidents registered. However, it should be kept in mind that "system/component failure" includes failures of any of the different aircraft systems. Therefore, in order to correctly understand the contributing factors that led to certain occurrences, it is essential to consider the system involved (hydraulic system, electrical system, pneumatic system, flight control system etc.) and the aircraft model, aiming to check design and operation deficiencies or to identify possible difficulties faced by air operators. However, the scope of this document does not include such a detailed approach. This Report aims to assess Brazilian aviation safety performance in general terms.

Air Taxi

Air Taxi

Air taxi has a relevant role in the integration of the national transportation chain, as it connects areas not served by regular aviation. Air taxi provides services for executives on business trips, oil and gas companies, aeromedical services, among others. Due to the importance of air taxi services in support of actions implemented to fight the COVID-19 disease, the sector has recently gained great attention in the media and in the aeronautical community. This has increased the strong historical interest in air taxi activities.

Brazilian Civil Aviation Regulation 135 establishes minimum standards for air taxi companies. The standards aim to ensure that air operators comply with the minimum safety conditions required to operate. Consequently, air taxi presents low accident rates, as it can be seen in Figure 7.

Apart from the unusual scenario in 2017, records show that the number of accidents has been decreasing over the past years. The lowest accident rate since 2012 was registered in 2019 and 2020. Figure 42 presents the numbers registered in the last five years.

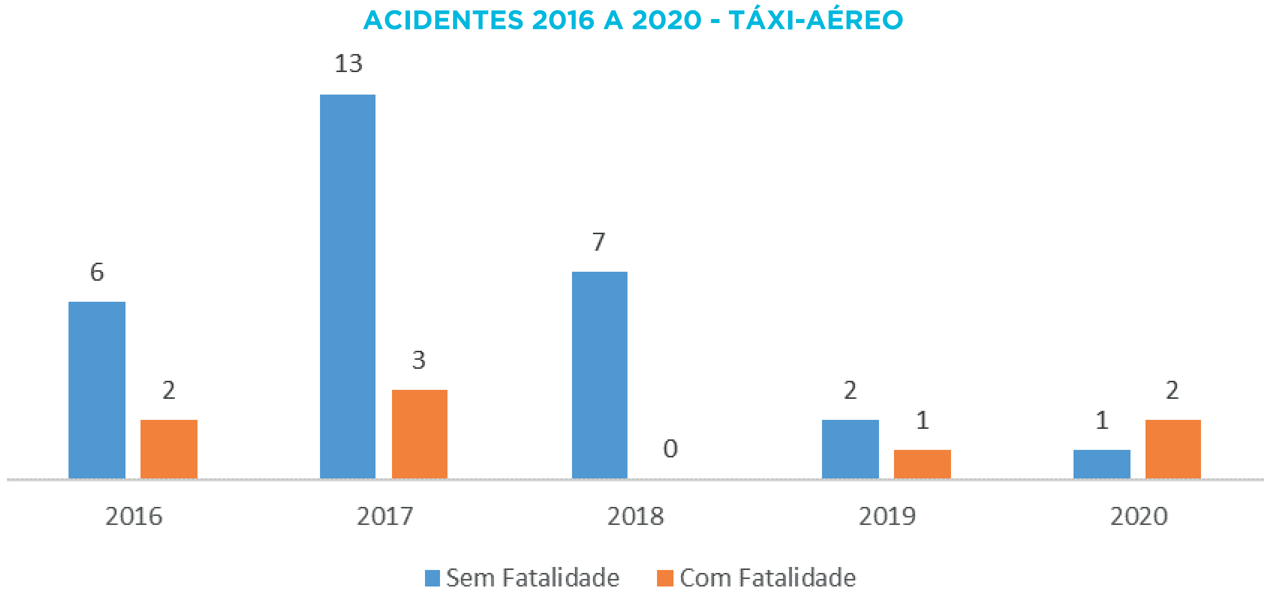


Figure 42: records of air taxi accidents. Source: CENIPA.

Figure 43 shows that in-flight engine failure, collision with obstacle(s) during take-off and landing and runway excursion are the most common types of occurrences, associated with approximately 59% of the total number of accidents.

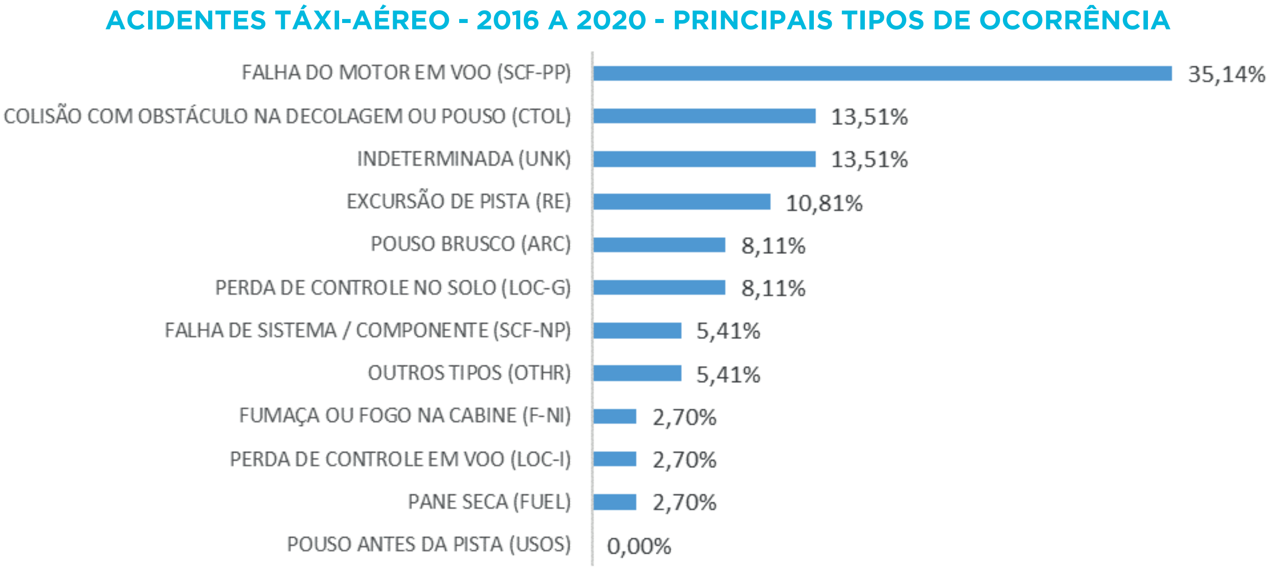


Figure 43: air taxi accidents and main types of occurrences accrued between 2016 and 2020. Source: CENIPA.

Considering the types of occurrences shown in Figure 43 which involved a high number of fatal accidents, attention has to be given to the in-flight engine failure occurrence as it registered 2 of the 8 occurrences with fatalities in the last five years. The same way as occurred in other sectors analyzed, although runway excursions are quite frequent, they present a low fatality rate (zero in the last five years). Occurrences classified as "other types" and "unknown" were not included.

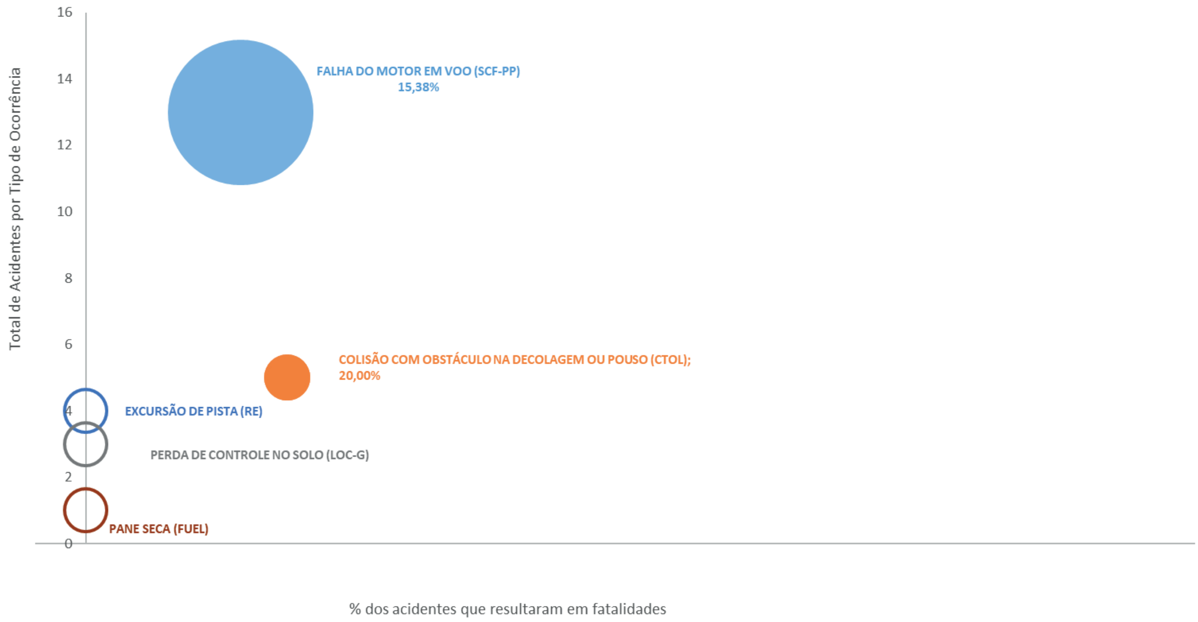


Figure 44: air taxi accidents and ratio of fatal accidents between 2016 and 2020. The size of the circles is proportional to the number of fatalities registered for each type of occurrence. Only the main types of occurrences listed in Figure 43 are shown, except for "unknown" and "other types". Source: CENIPA.

Figure 45 shows accidents grouped by phases of flight in which they occurred the most, with emphasis on the cruise and landing phases, as 54% of the accidents in the period happened during these phases.

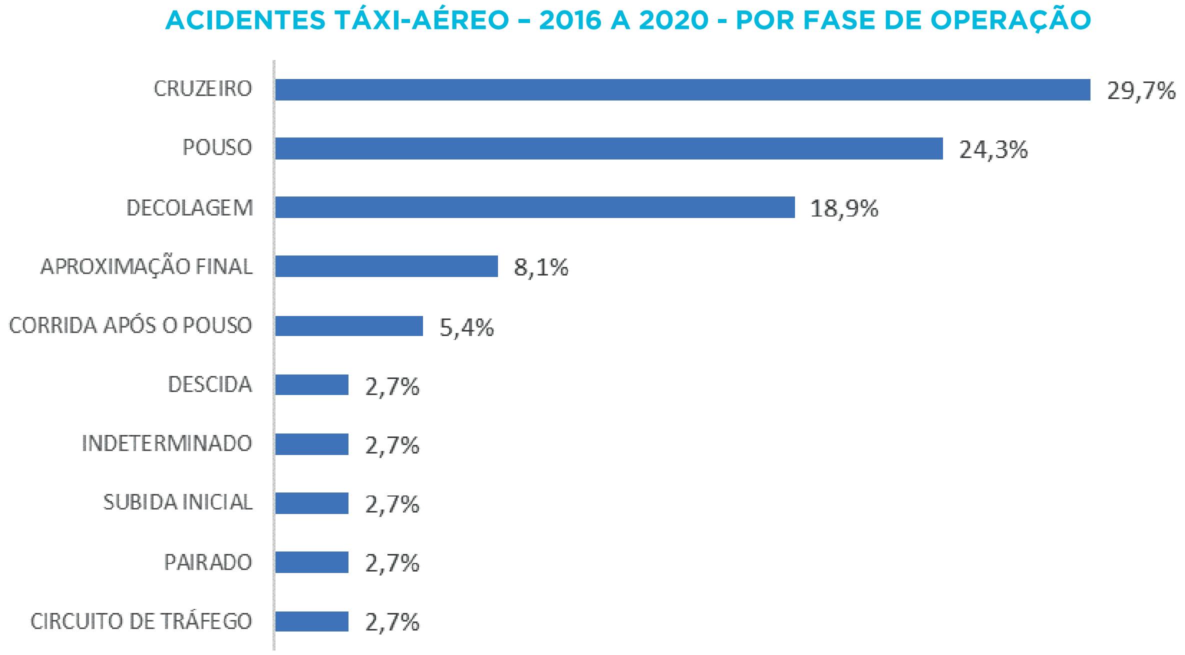


Figure 45: air taxi accidents per phase of operation from 2016 to 2020. Source: CENIPA.

Due to the great diversity of types of aircraft used in air taxi operations, it is important to check which equipment are involved in accidents. Figure 46 below shows occurrences per type of aircraft. Piston-engine airplanes are predominant in air taxi accidents, representing more than 54% of the occurrences.

ACIDENTES TÁXI-AÉREO - 2016 A 2020 - PARTICIPAÇÃO POR TIPO DE AERONAVE

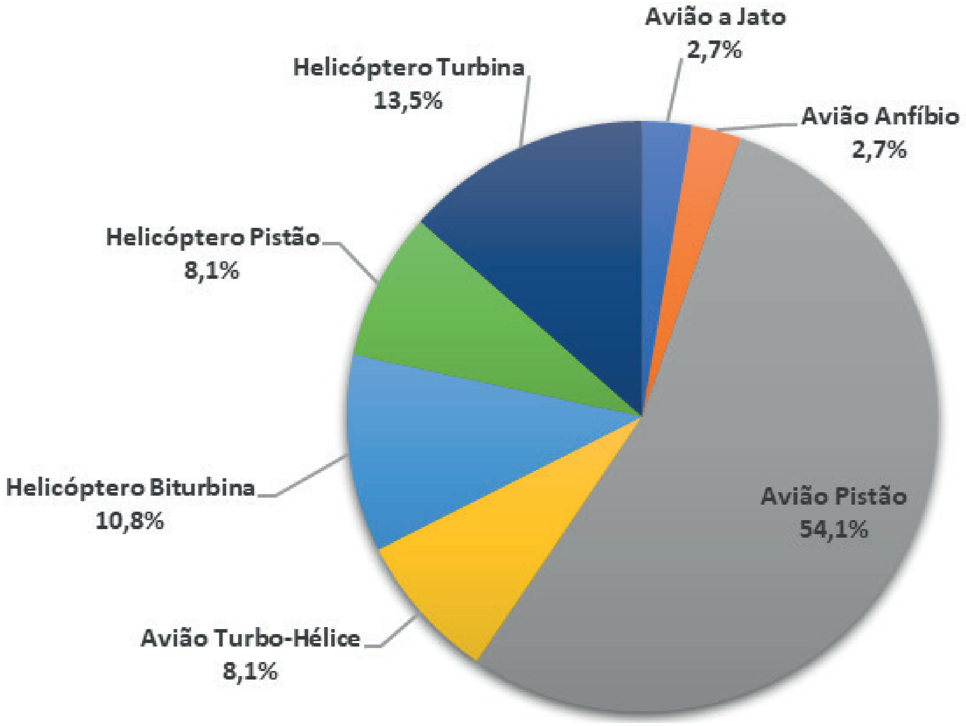


Figure 46: air taxi accidents per type of aircraft from 2016 to 2020. Source: CENIPA.

Regarding geographic locations, Figure 47 shows that air taxi accidents are predominant in the North of Brazil. And the number of occurrences on the country coast has been growing, especially involving offshore helicopter operations (twin-engine turbine helicopters indicated in Figure 46). As it has been used in this Report, the word “YES” in red refers to accidents with fatalities, while “NO” in blue refers to accidents with no fatalities.

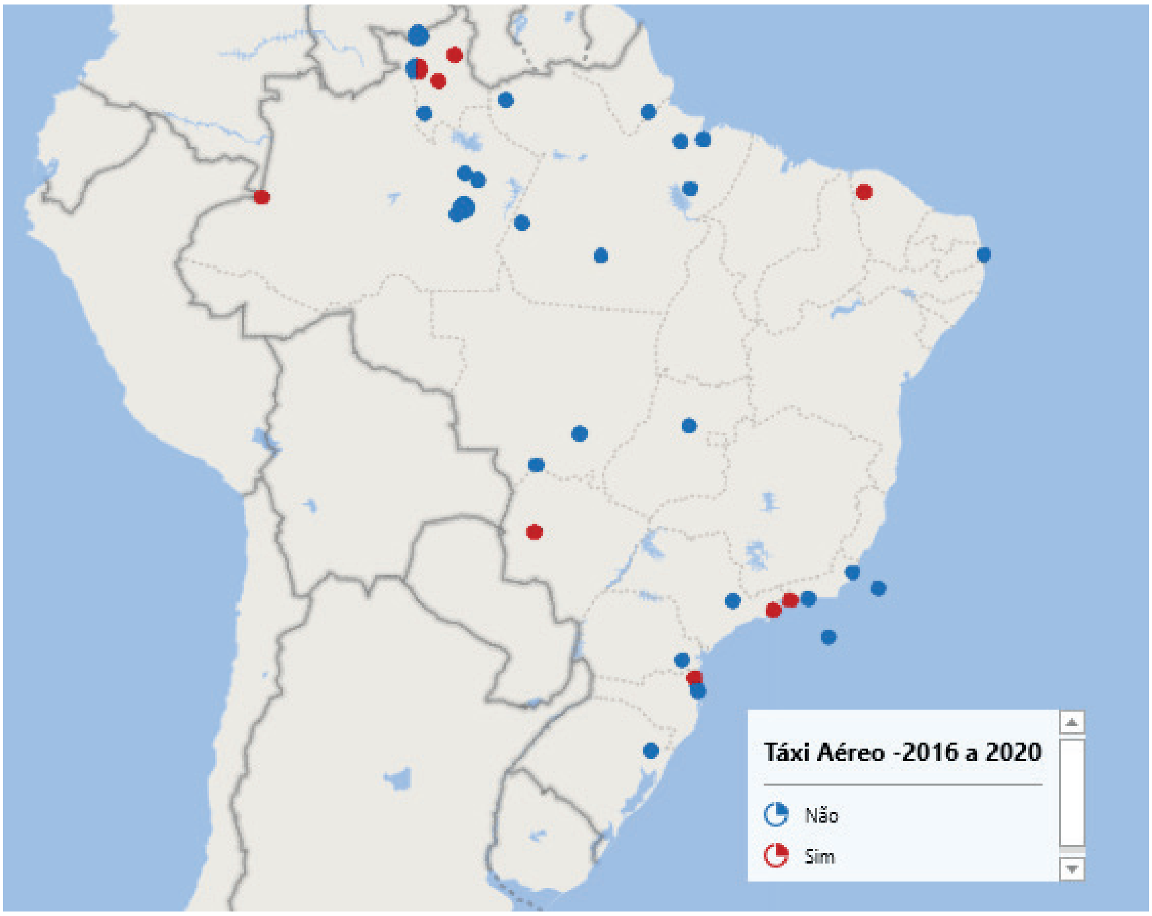


Figure 47: air taxi accidents per geographic location between 2016 and 2020. Source: CENIPA.

Helicopters

Helicopters

The Brazilian helicopter fleet is one of the largest in the world. It corresponds to almost 14% of the country's fleet. Considering data from June 2021, Brazil has 1,489 helicopters with active registers. Helicopter aerodynamic characteristics and versatility and the country's territorial and economic features are some of the contributing factors for the size of the fleet.

Regarding aerodynamic characteristics, helicopters are part of the commonly called rotary-wing aircraft, which can perform vertical takeoffs and landings and hover flights over a fixed point. This makes helicopters versatile for short and medium range operations in densely populated areas, large vertical urban centers, places with deficient, limited or no infrastructure, or even in inhospitable places like the Amazon Forest or on high seas.

Considering Brazil's territorial and economic features, helicopters are used for a big variety of civil air services such as: business air taxi, inspection of transmission lines, gas and oil pipelines, offshore and onshore transportation of passengers and cargo, aerial spraying for uphill plantations, aeromedical rescue, police operations, civil defense, surveillance, and many other public air operations provided for in RBAC 90 which mostly use helicopters in their activities. It is worth highlighting that helicopters are greatly used by the oil sector, especially in pre-salt operations.

Therefore, this section emphasizes the performance of the segment, taking into account aeronautical accidents that occurred in the last five years. The chart below shows accidents records.

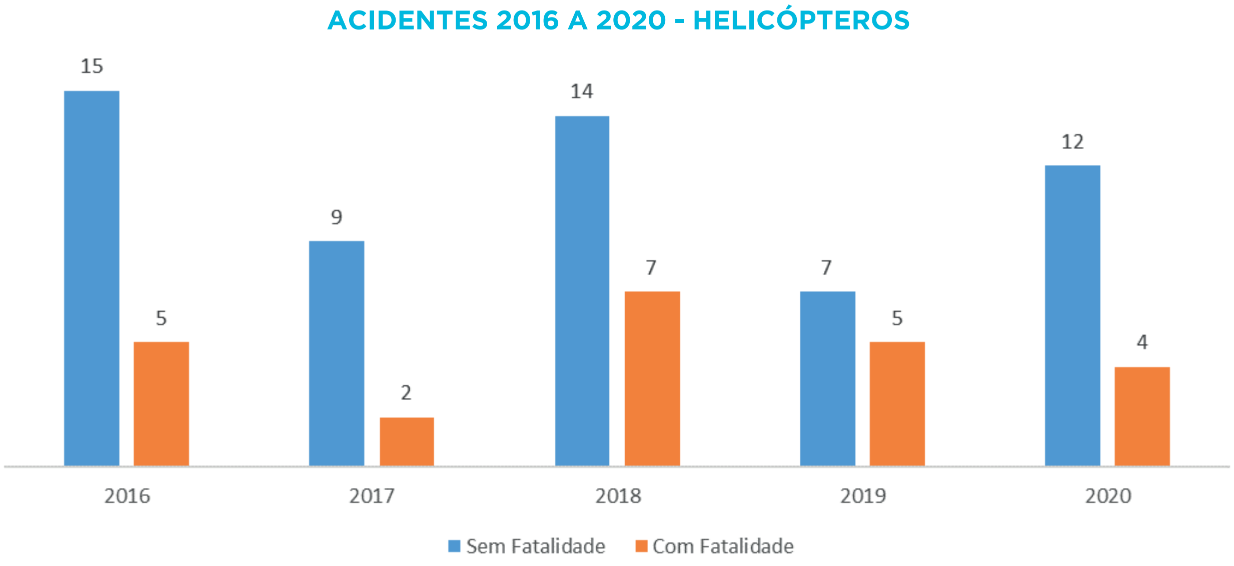


Figure 48: records of helicopter accidents from 2016 to 2020. Source: CENIPA.

According to the ADREP taxonomy, the analysis of accidents per type of occurrence makes possible to indicate associated factors. Figure 50 shows that the most frequent occurrences are loss of control in flight, collision with obstacle(s) during take-off and landing and in-flight engine failure, representing 62% of the total of accidents in the period.

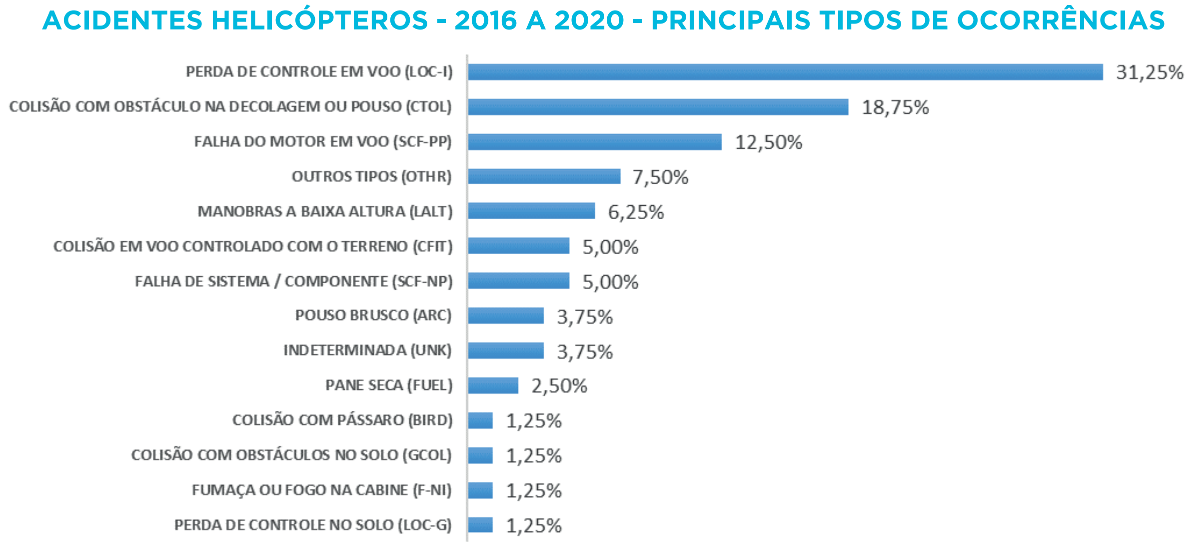


Figure 49: helicopter accidents and main types of occurrences accrued between 2016 and 2020. Source: CENIPA.

Considering the types of occurrences shown in Figure 49 that registered the highest rates of fatal accidents, it should be stressed that 32% of the loss of control in flight accidents resulted in fatalities. Also, 75% of controlled flight into terrain (CFIT) and system/component failure occurrences were fatal accidents, according to Figure 50.

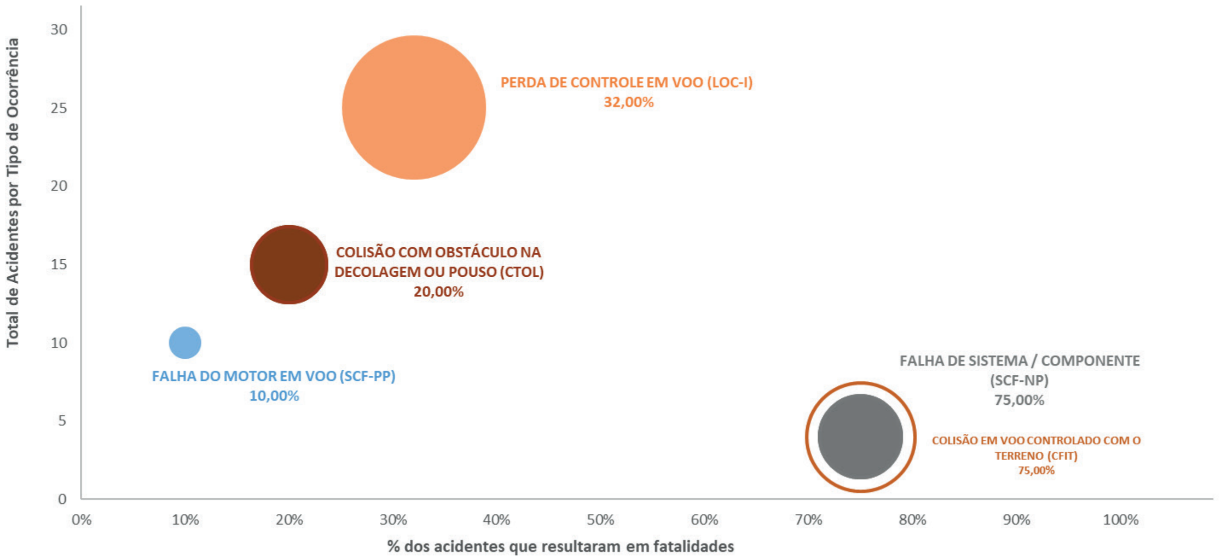


Figure 50: total of accidents and proportion of fatal accidents between 2016 and 2020 in air taxi operations. The size of the circles is proportional to the number of fatalities registered for each type of occurrence. Only the main types of occurrences listed in Figure 50 are shown, except for "unknown" and "other types". Source: CENIPA.

Figure 51 shows accidents grouped by phases of flight in which they occurred the most, with emphasis on the cruise phase, as almost 29% of the accidents in the period happened during this phase.

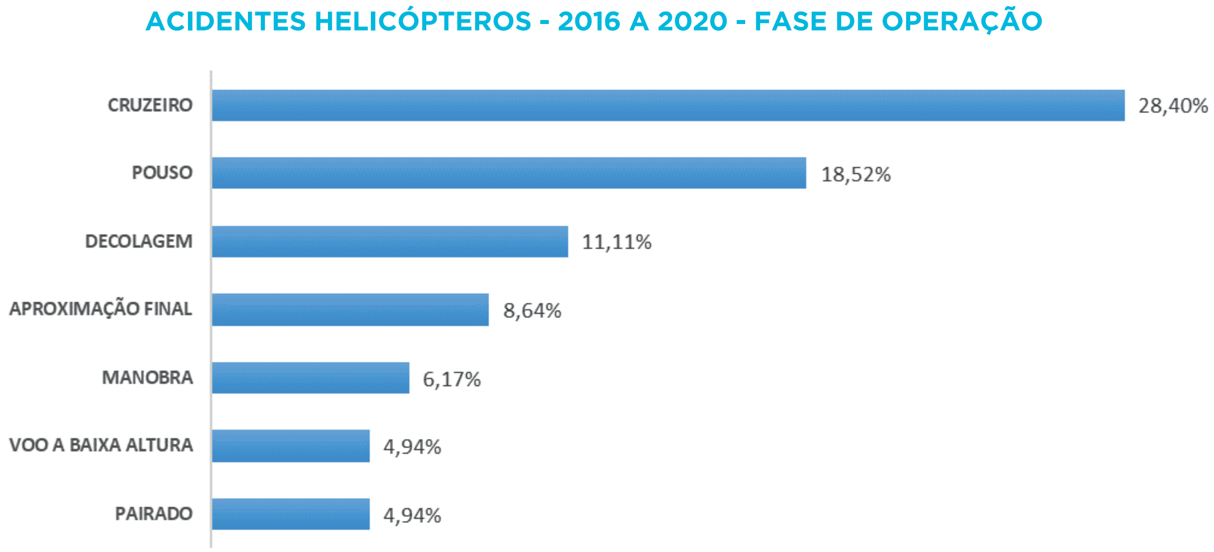
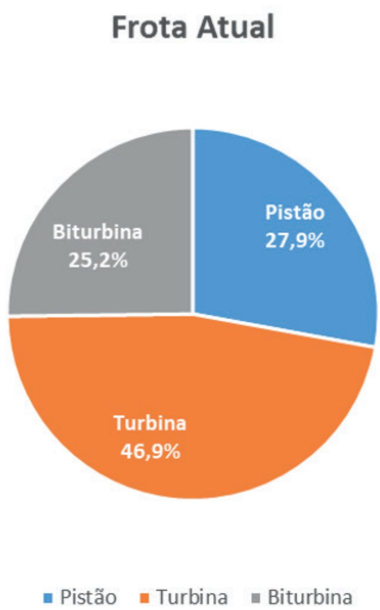
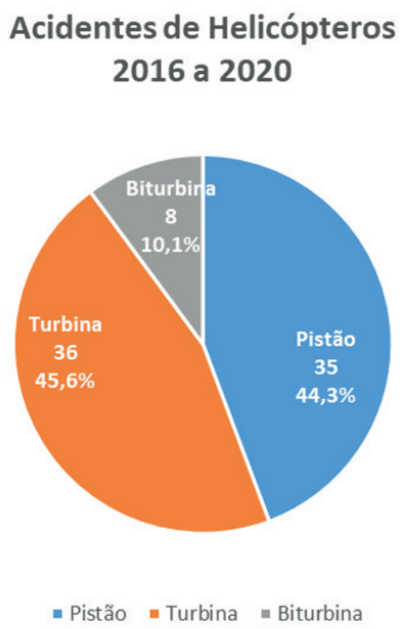


Figure 51: helicopter accidents per phase of operation from 2016 to 2020. Source: CENIPA.

When analyzing the relationship between type of engine and percentage of accidents, Figure 52 shows that although representing only 28% of the national fleet, piston-engine helicopters accounted for 44% of the total number of accidents registered between 2016 and 2020. Single-engine turbine helicopters represent 47% of the total fleet of airworthy helicopters and accounted for 45% of the accidents in the period. On the other hand, twin-engine turbine helicopters represent 25% of the fleet and were responsible for only 10% of the accidents.





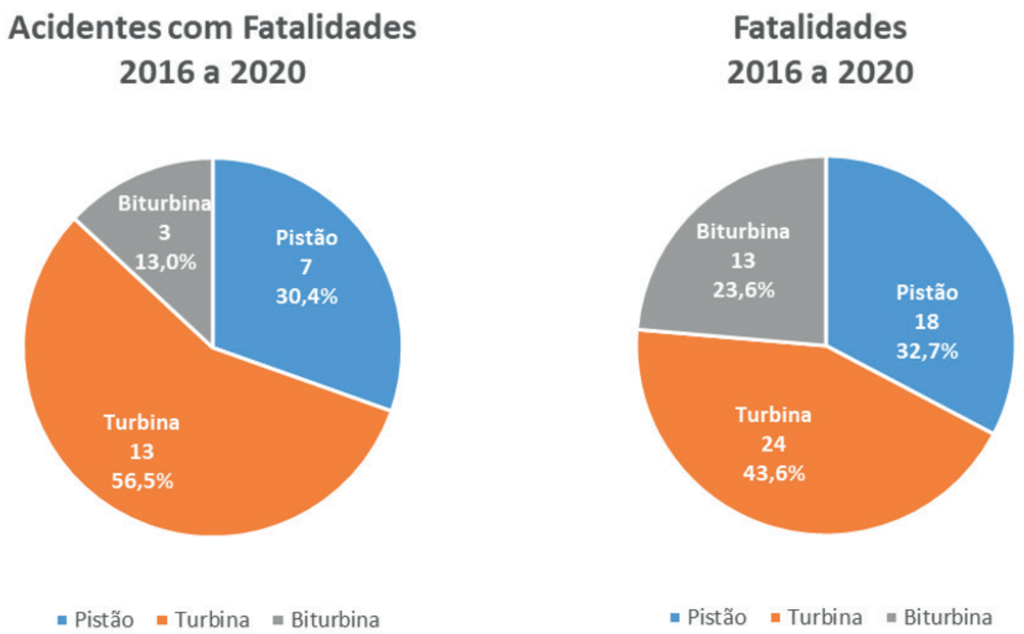


Figure 52: current fleet, helicopter accidents, accidents with fatalities and number of fatalities considering the type of aircraft engine, from 2016 to 2020. Source: ANAC and CENIPA.

Since twin-engine turbine helicopters are larger (in Brazil, helicopters with up to 19 passenger seats are used), they tend to cause more fatalities when involved in more severe accidents. This way, a reasonably different trend can be noticed when analyzing accidents with fatalities. Figure 53 shows that the percentage of twin-engine aircraft involved in fatal accidents from 2016 to 2020 was slightly lower if compared to the percentage of twin-engine aircraft in the national fleet.

Regarding geographic locations, Figure 54 shows a clear concentration of helicopter accidents in the Southeast and South regions of Brazil, what is proportional to the regional distribution of the Brazilian fleet. As it has been used in this Report, the word "YES" in red refers to accidents with fatalities, while "NO" in blue refers to accidents with no fatalities.

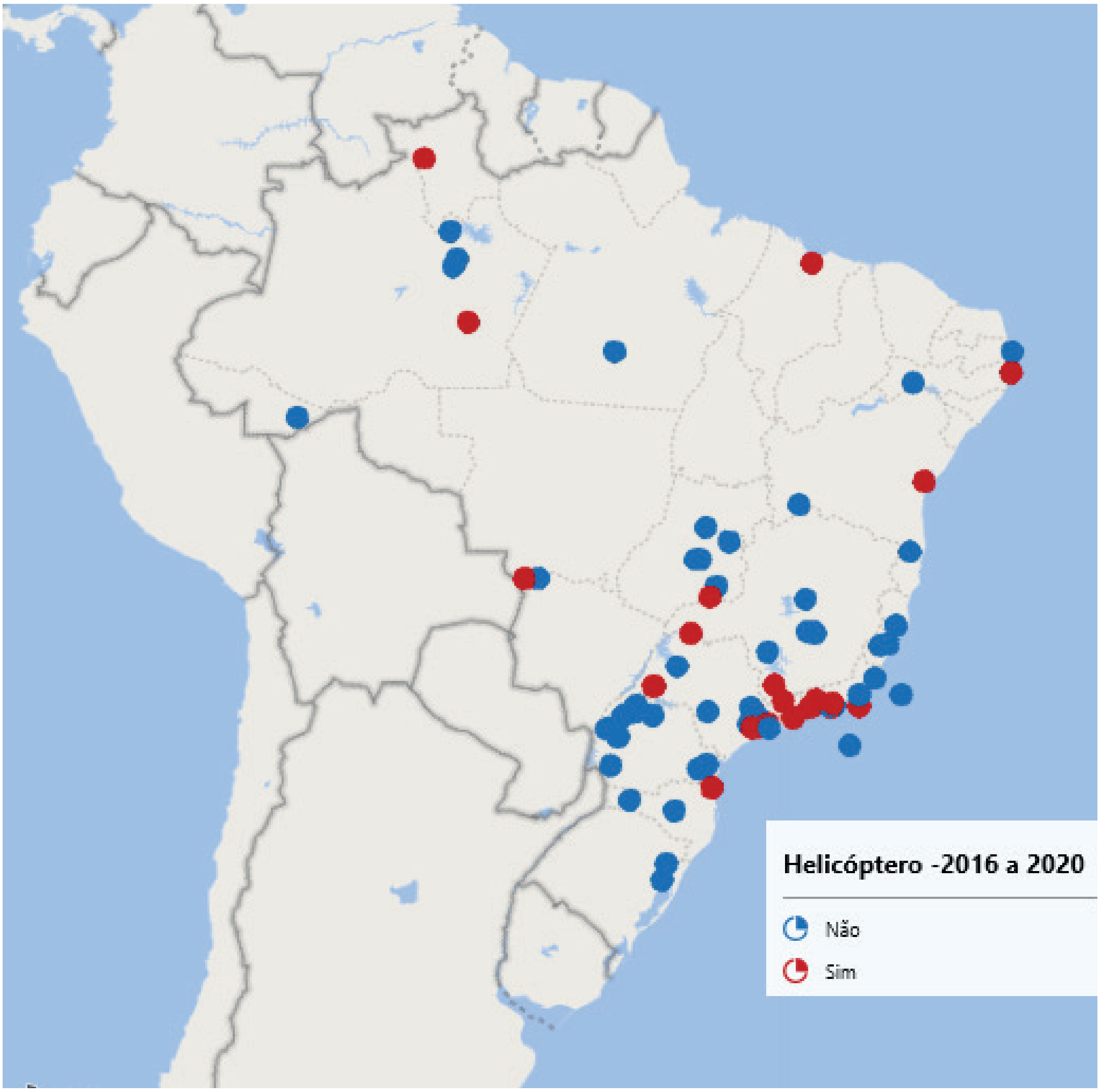


Figure 53: helicopter accidents per region between 2016 and 2020. Source: CENIPA.

Monitoring Goals and Indicators of the Safety Oversight Plan

Monitoring Goals and Indicators of the Safety Oversight Plan

This section monitors goals and indicators of the Safety Oversight Plan throughout 2020 and their evolution in the last 5 years. Quantities that help to understand the evolution of indicators over the last few years may also be informed.

The Safety Oversight Plan is part of ANAC Safety Programme (PSOE-ANAC), which is included in the Brazilian Civil Aviation Safety Programme (PSO-BR). The Plan contains objectives, goals, indicators, and initiatives that address the main civil aviation safety risks. Risks are identified as a result of an assessment of the structure of the State's Safety Programme in what concerns ANAC as well as the analysis of civil aviation performance at national and international levels. Analyses sought to identify different risk profiles presented by several national aviation sectors, allowing the identification and prioritization of safety issues. Such an initiative reflects the Agency's commitment to safety oversight improvement, to an assertive development and revision of regulations and to effective measures for safety information and promotion.

A new version of the Safety Oversight Plan has been developed for the triennium 2020-2022, including changes in some of the indicators established in 2019, as safety monitoring is a dynamic process in constant evolution. Among the main changes in the Plan, it is important to highlight the follow-up of Objective 2 set apart in piston-engine aircraft (AVGAS) and turbine aircraft (QAV), since records show that they present distinct orders of magnitude concerning safety levels, as it has been discussed in this Report.

At a national level, the Safety Oversight Plan expands and details the Brazilian Civil Aviation Safety Plan of the PSO-BR, considering ANAC's duties established by law.

Objective 1 - Improve the Brazilian regular air transport safety

Safety Oversight Plan indicators and goals related to Objective 1 and comments about the evolution of the indicator in the year 2020 are presented as follows.

- Indicator 1.1 - Moving average of the number of annual accidents per million takeoff in the last five years involving Brazilian regular air transport aircraft with a maximum take-off weight above 5,700 kgf.

- Goal 1.1 - Keep Indicator 1.1 below or at the same level of the annual average of accidents per million takeoff involving regular air transport aircraft flying in ICAO's Council Group 1 States, with maximum take-off weight above 5,700 kgf

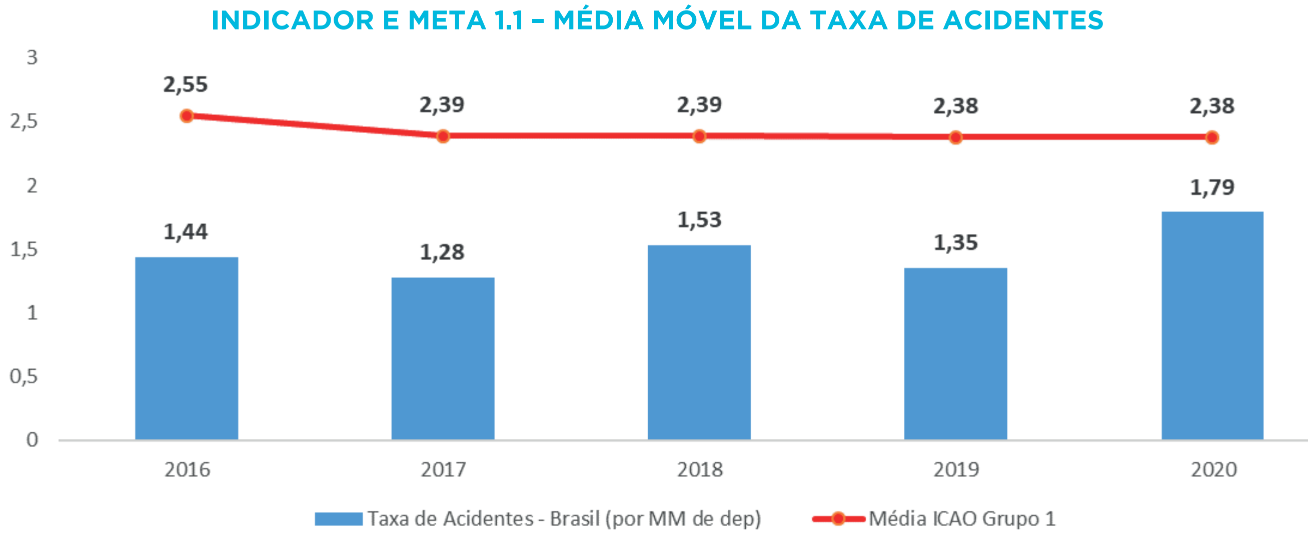


Figure 54: indicator and goal 1.1 – moving average of the rate of accidents – regular aviation

The previous chart shows that indicator 1.1 remained 25% below the maximum rate established by the goal. Given the low number of regular aviation accidents in recent years, as indicated in the Regular Aviation section, Brazil maintains an average accident rate significantly lower than the average of other States included in Group 1.

- Indicator 1.2 - Moving average of the number of annual accidents with fatalities per million take-off in the last five years involving Brazilian regular air transport aircraft with a maximum take--off weight above 5,700 kgf.
- Goal 1.2 - Keep indicator 1.2 at same level or below the moving average of the last five years of the annual average of accidents with fatalities per million takeoff involving regular air transport aircraft flying in ICAO's Council Group 1 States, with maximum take-off weight above 5,700 kgf

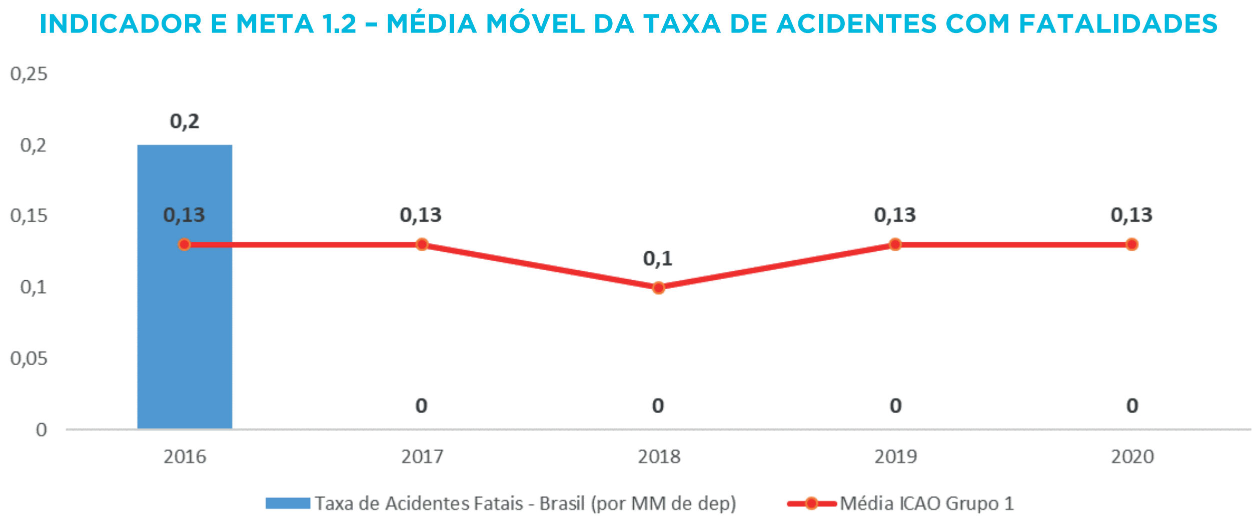


Figure 55: indicator and goal 1.2 – moving average of the rate of accidents with fatalities – regular aviation

As already discussed in the Overview section, accidents with fatalities involving regular aviation have not been recorded in Brazil since 2011. This way, the country's average remains below the average of Group 1 States for the fourth consecutive year – average "zero" for accidents with fatalities in the last five years.

- Indicator 1.3 - Number of annual serious incidents per million takeoff involving Brazilian regular air transport aircraft with a maximum take-off weight above 5,700 kgf.
- Goal 1.3 - Keep Indicator 1.3 below the five-year moving average of rates registered at the end of 2019.

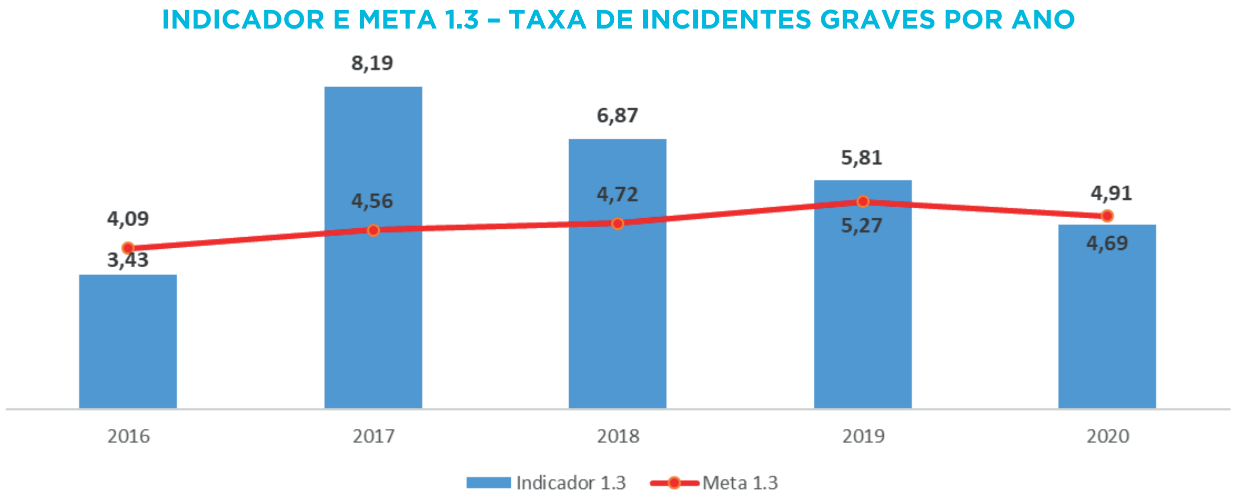


Figure 56: indicator and goal 1.3 – rate of serious incidents per million takeoff – regular aviation

Figure 56 shows that indicator 1.3 has been reduced since 2017 and has reached the 1.3 goal for the first time since 2016. In absolute terms, the number of serious incidents dropped from six in 2019 to three in 2020, following the significant reduction in regular aviation activities, a scenario already discussed in this Report.

As a last comment about Objective 1, it is important to highlight the expected resumption of flights, especially in the second semester of 2021, what brings major challenges for regular aviation, such as:

- adequate preservation of a huge number of underutilized aircraft during the pandemic;
- maintenance of crew training and proficiency; crews were highly affected by layoffs and hiring among airlines, given the uncertain scenario and brutal fluctuations in demands in the period;
- maintenance of airport infrastructure, considering the closure or underutilization of regional airports and even airports in big cities, which suffered from a significant reduction in activities during the most severe period of the COVID-19 pandemic.

Objective 2 - Reduce the number of occurrences categorized as "high operational risk"

Safety Oversight Plan indicators and goals related to Objective 2 and comments about the evolution of the indicator in the year 2020 are presented as follows.

- Indicator 2.1 (AVGAS) - Number of annual accidents and serious incidents classified as in-flight engine failure (SCF-PP) per million cubic meters (106 m3) of aviation gasoline (AVGAS) sold in the same period.
- Goal 2.1 (AVGAS) - Keep indicator 2.1 (AVGAS) at levels below the moving average of the respective five-year rates measured at the end of 2019.

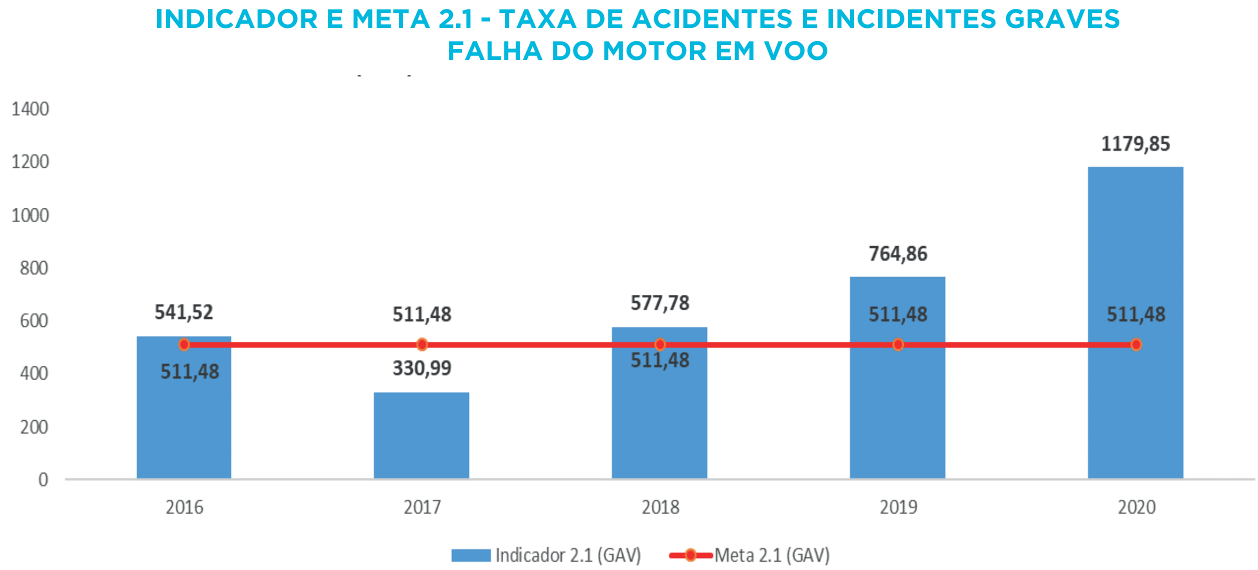


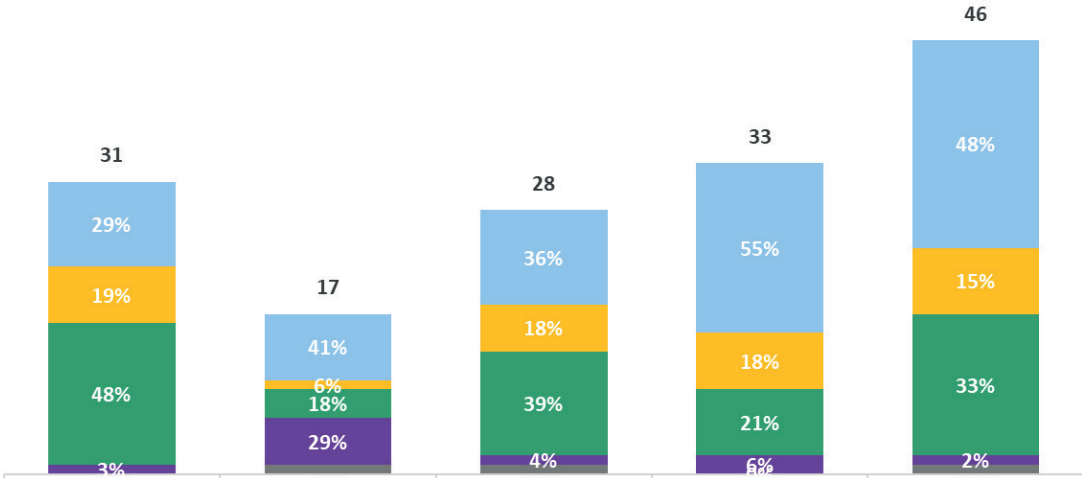
Figure 57: indicator and goal 2.1 (AVGAS) - rate of accidents and serious incidents involving in-flight engine failure (SCF-PP)

The previous chart shows there has been a deterioration of indicator 2.1 (AVGAS) since 2017. Special attention shall be given to the year 2020, as it presented a rate greater than the double of the goal stipulated for the year. In order to bring the indicator closer to the goal, several contributing factors shall be investigated, including those related to activities developed by ANAC, such as inspection of maintenance organizations and air operators, monitoring of compliance with airworthiness directives and operational limitations, and investigation of on-the-job difficulties to identify possible airworthiness issues associated with such difficulties.

Once again, it is important to mention that ANAC has compiled reports involving in-flight engine failure (SCF-PP) occurrences for 10 years. The compilation is available at https://www.gov.br/anac/pt-br/assuntos/seguranca-operacional/relatorios-de-analises-de-ocorrencias and helps the aeronautical community and interested parties to identify contributing factors and to implement mitigation actions.

In-flight engine failure occurrences involving piston-engine aircraft that affect indicator 2.1 - In--Flight Engine Failure (AVGAS) are presented from 2016 to 2020, per type of operation and per ICAO aircraft type designator, with the objective of identifying the main contributing factors for this type of occurrence.

FALHA DE MOTOR EM VOO (GAV) - 2016 A 2020 - POR TIPO DE OPERAÇÃO



	2016	2017	2018	2019	2020
VOO PRIVADO	9	7	10	18	22
VOO DE INSTRUÇÃO	6	1	5	6	7
OPERAÇÃO AGRÍCOLA	15	3	11	7	15
TÁXI AÉREO	1	5	1	2	1
OUTROS	0	1	1	0	1
TOTAL	31	17	28	33	46

Figure 58: indicator 2.1 (AVGAS) – per type of operation

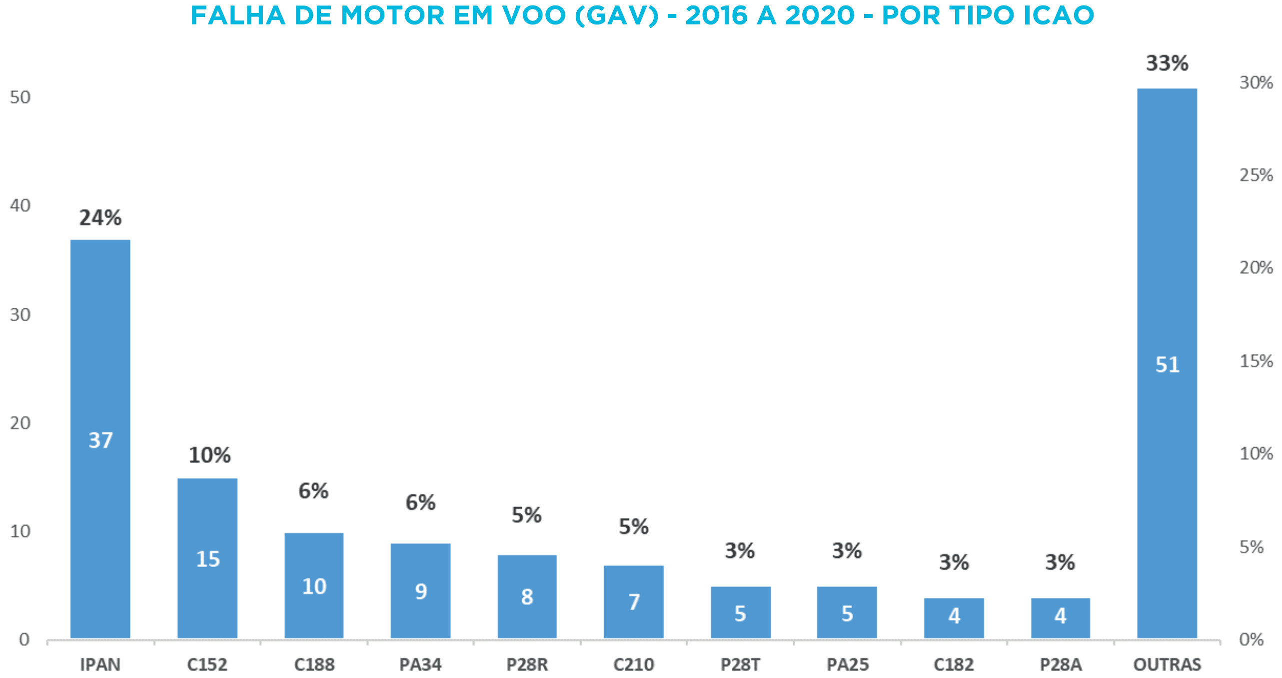


Figure 59: indicator 2.1 (AVGAS) – per ICAO aircraft type designator

The previous charts show that in-flight engine failure events involve to a large extent agricultural and small private aircraft, especially single-engine airplanes, which account for more than 89% of the occurrences among piston-engine aircraft..

- Indicator 2.1 (QAV) - Number of annual accidents and serious incidents classified as in-flight engine failure (SCF-PP) per million cubic meters (106 m3) of aviation kerosene (QAV) sold in the same period.
- Goal 2.1 (QAV) - Keep indicator 2.1 (QAV) at levels below the moving average of the respective five-year rates measured at the end of 2019.

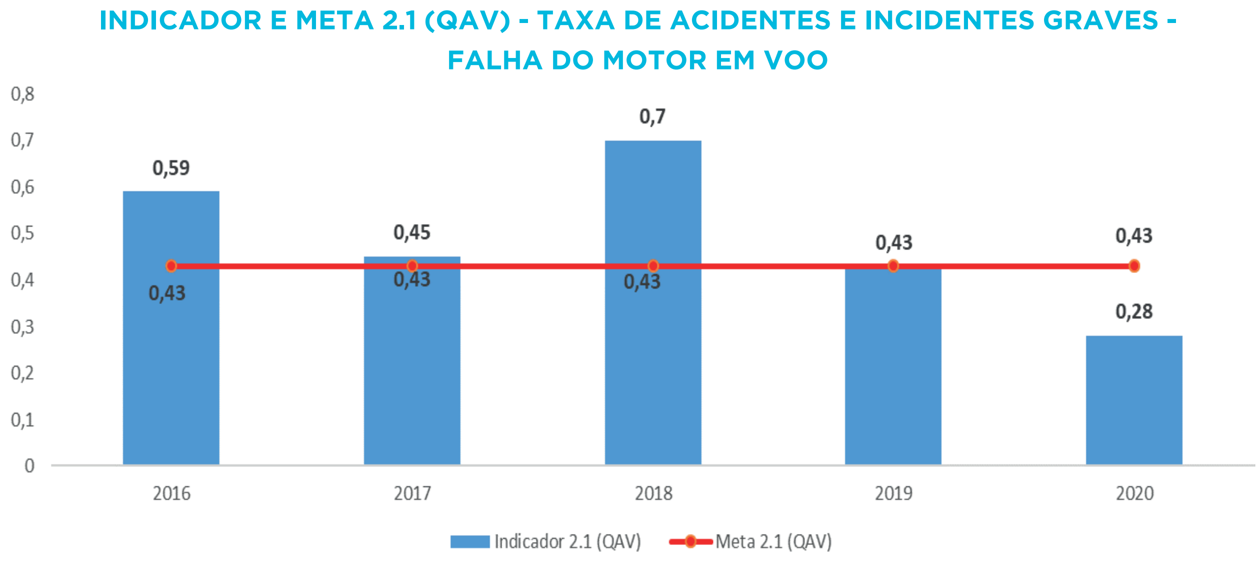


Figure 60: indicator and goal 2.1 (QAV) - rate of accidents and serious incidents involving in-flight engine failure (SCF-PP)

Figure 60 shows a decrease in indicator 2.1 (QAV) since 2018, in opposition to what happened to reciprocating or piston engine aircraft that use AVGAS[11]. Another key aspect is the order of magnitude of rates, more than 1,000 times lower than rates of events involving aircraft which use AVGAS. Both aspects show that the segregation of indicators proposed by ANAC was effective in separating considerably different operational scenarios for the two sets of aircraft. This allowed for more representative safety level indicators for each sector.

- Indicator 2.2 (AVGAS) - Number of annual accidents and serious incidents classified as loss of control on ground (LOC-G) per million cubic meters (106 m3) of aviation gasoline (AVGAS) sold in the same period.
- Goal 2.2 (AVGAS) - Keep indicator 2.2 (AVGAS) at levels below the moving average of the respective five-year rates measured at the end of 2019.

11 - A reciprocating or piston engine is an aeronautical engine where pistons moving within cylinders turn the crankshaft which drives a propeller (airplanes) or a rotor (rotorcraft) directly or through a reduction gear box (definition provided by Amendment 08 to RBAC 01).

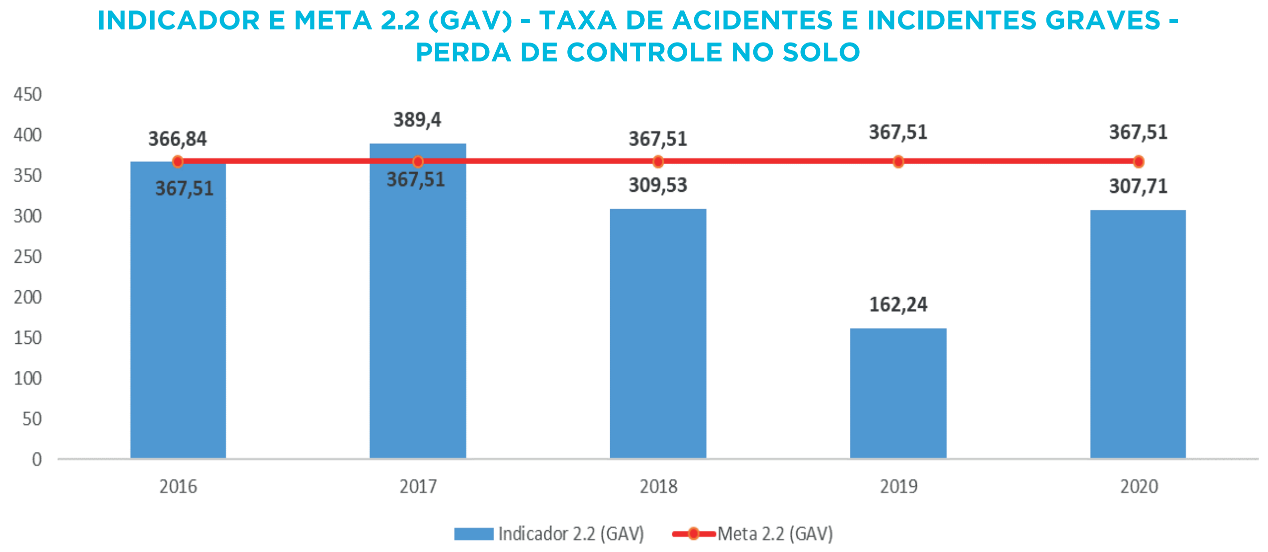


Figure 61: indicator and goal 2.2 (AVGAS) - rate of accidents and serious incidents involving loss of control on ground (LOC-G)

Although indicator 2.2 (AVGAS) has increased when compared to 2019, it remained at around 16% below the maximum index defined by the goal, with a growth of private and agricultural aviation contribution and the maintenance of instructional aviation improvement if compared to the historical series when considering the specific ADREP taxonomy.

- Indicator 2.2 (QAV) - Number of annual accidents and serious incidents classified as loss of control on ground (LOC-G) per million cubic meters (106 m3) of aviation kerosene (QAV) sold in the same period.

- Goal 2.2 (QAV) - Keep indicator 2.2 (QAV) at levels below the moving average of the respective five-year rates measured at the end of 2019.

INDICADOR E META 2.2 (QAV) - TAXA DE ACIDENTES E INCIDENTES GRAVES - PERDA DE CONTROLE NO SOLO

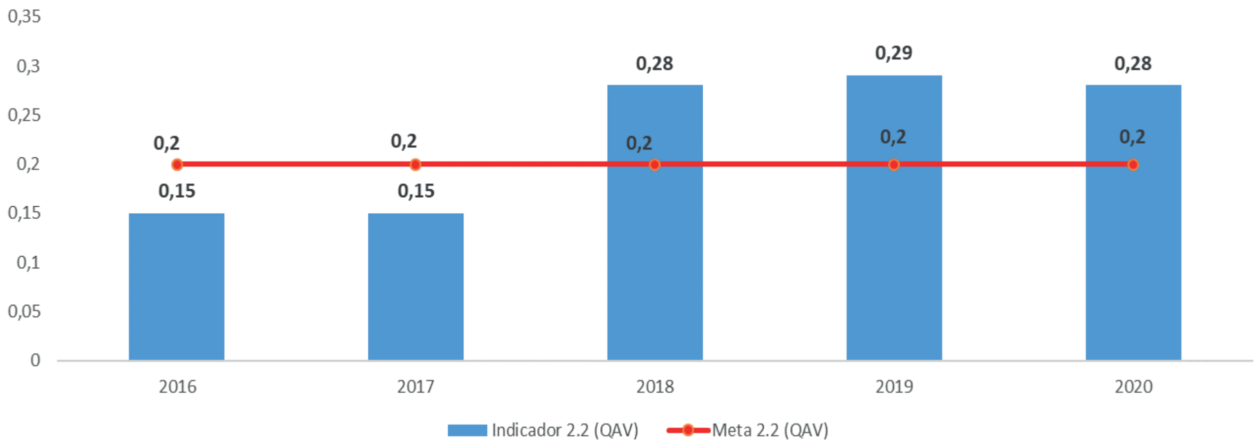


Figure 62: indicator and goal 2.2 (QAV) - rate of accidents and serious incidents involving loss of control on ground (LOC-G)

Three accidents have occurred in the last five years involving LOC-G and agricultural aviation turbine aircraft taking off from agricultural landing areas. This confirms a tendency observed in indicator 2.2 (AVGAS), that is, a more representative participation of agricultural aircraft in LOC-G events.

For more information regarding occurrences involving LOC-G, check the qualitative analysis study carried out by ANAC Safety Office about CENIPA's Final Reports and available at https://www.gov.br/anac/pt-br/assuntos/seguranca-operacional/relatorios-de-analises-de-ocorrencias.

- Indicator 2.3 (GAV) - Number of annual accidents and serious incidents classified as loss of control in flight (LOC-I) per million cubic meters (106 m3) of aviation gasoline (AVGAS) sold in the same period.
- Goal 2.3 (GAV) - Keep indicator 2.3 (AVGAS) at levels below the moving average of the respective five-year rates measured at the end of 2019.

INDICADOR E META 2.3 (GAV) - TAXA DE ACIDENTES E INCIDENTES GRAVES - PERDA DE CONTROLE EM VOO

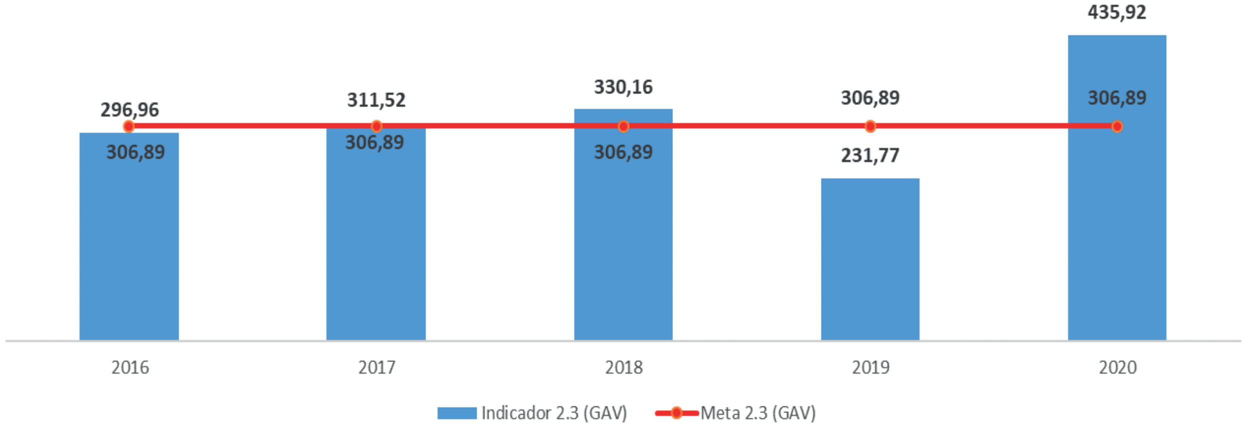


Figure 63: indicator and goal 2.3 (AVGAS) - rate of accidents and serious incidents involving loss of control in flight (LOC-I)

Indicator 2.3 (AVGAS) increased 88% in 2020 compared to the year 2019. It has reached the highest value in the last five years, staying 42% above the goal established by the Safety Oversight Plan. Attention has to be called to private aviation and agricultural aviation, which increased the number of annual occurrences from five to seven, and also to instructional aviation, which registered four occurrences. It is important to mention that among the 18 events registered in 2020, 11 were fatal occurrences.

Considering the challenges that arise, ANAC is taking safety promotion measures and updating the normative framework to improve pilot training regarding loss of control in flight. In order to mitigate the risks of low altitude stalls, responsible for the majority of the occurrences of LOC-I involving reciprocating or piston engine aircraft which are mostly certified according to RBAC 23, ANAC and BGAST (the Brazilian General Aviation Safety Team) have developed a Safety Enhancement to facilitate the installation of angle of attack systems on aircraft certified according to RBAC 23. Thus, the pilot is able to almost instantaneously identify the angle of attack, and the eventual impending stall, whilst performing steep bank angle and high load factor maneuvers. For details access the BGAST webpage at https://www.anac.gov.br/assuntos/paginas-tematicas/gerenciamento-da-seguranca-operacional/bgast-2013-grupo-brasileiro-de-seguranca-operacional-para-a-aviacao-geral. It is also important to point out the edition of Supplementary Instruction No. 141-007A about Instructions and Procedures Manual and Training Programs, including Upset Prevention Recovery Training (UPRT) during spin and stall maneuvers.

- Indicator 2.3 (QAV) - Number of annual accidents and serious incidents classified as loss of control in flight (LOC-I) per million cubic meters (106 m3) of aviation kerosene (QAV) sold in the same period.
- Goal 2.3 (QAV) - Keep indicator 2.3 (QAV) at levels below the moving average of the respective five-year rates measured at the end of 2019.

INDICADOR E META 2.3 (QAV) - TAXA DE ACIDENTES E INCIDENTES GRAVES - PERDA DE CONTROLE EM VOO

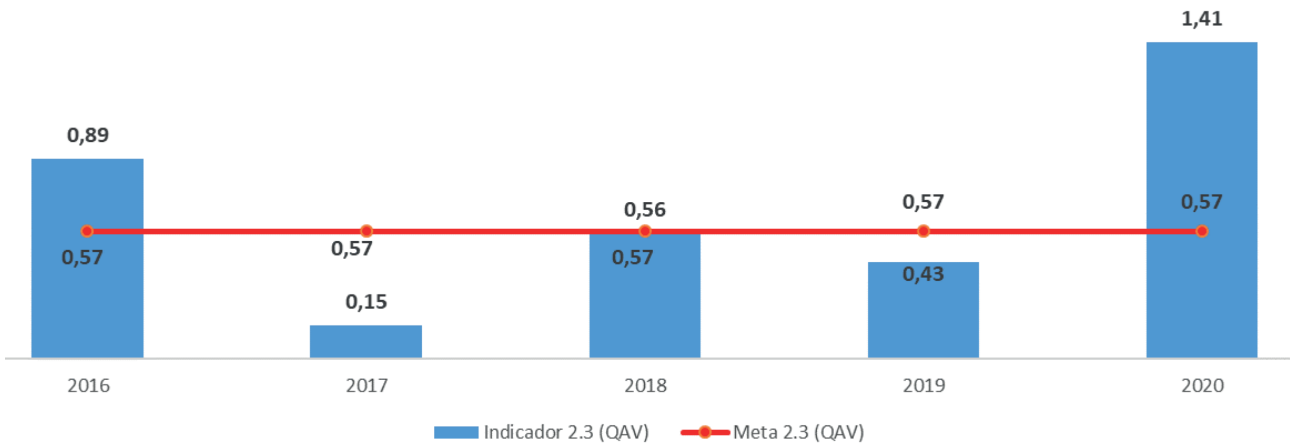


Figure 64: indicator and goal 2.3 (QAV) - rate of accidents and serious incidents involving loss of control in flight (LOC-I)

There has been a significant increase of 227% in the previous indicator due to the increase in the number of events involving turbine agricultural airplanes, besides occurrences with single-engine helicopters in public air operations regulated by RBAC 90. Again, it is pertinent to emphasize the relevance of separating indicators in QAV and AVGAS, since actions taken by ANAC and mentioned for indicator 2.3 (AVGAS) have almost no effect on the operational scenario of rotorcraft, what invites ANAC and the entire aeronautical community to develop specific solutions for the rotorcraft operational contex.

- Indicator 2.4 (GAV ou QAV) - Number of annual accidents and serious incidents classified as runway excursion (RE) per million cubic meters (106 m3) of fuel (AVGAS or QAV) sold in the same period.
- Goal 2.4 - Keep indicator 2.4 (AVGAS or QAV) at levels below the moving average of the respective five-year rates measured at the end of 2019.

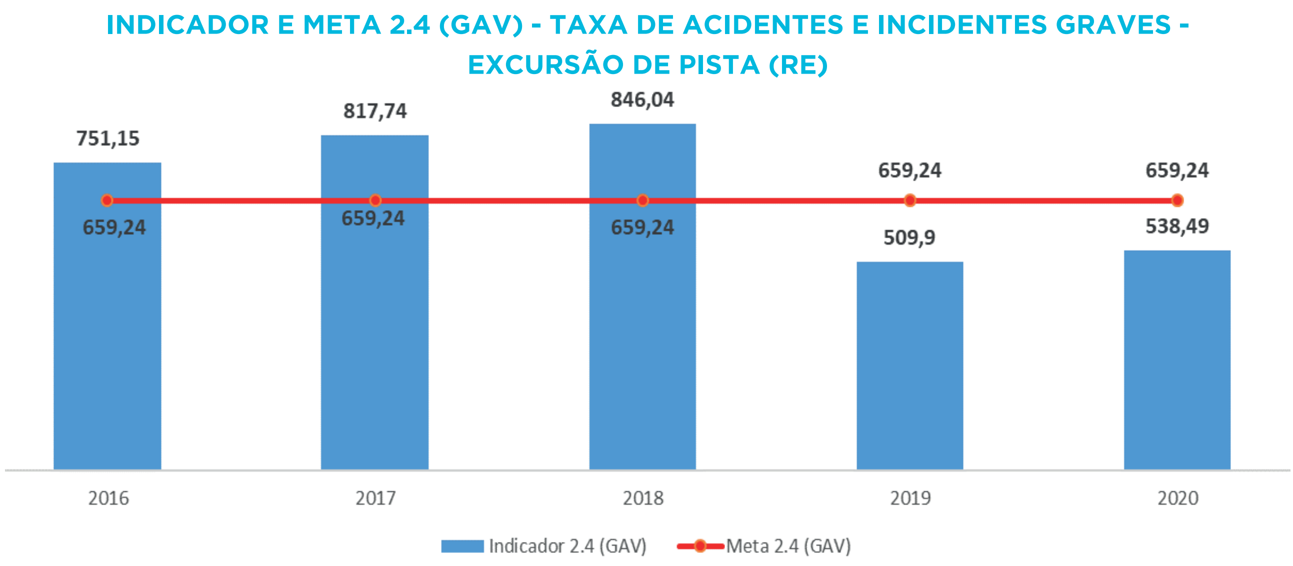


Figure 65: indicator and goal 2.4 (AVGAS) - rate of accidents and serious incidents involving runway excursion (RE)

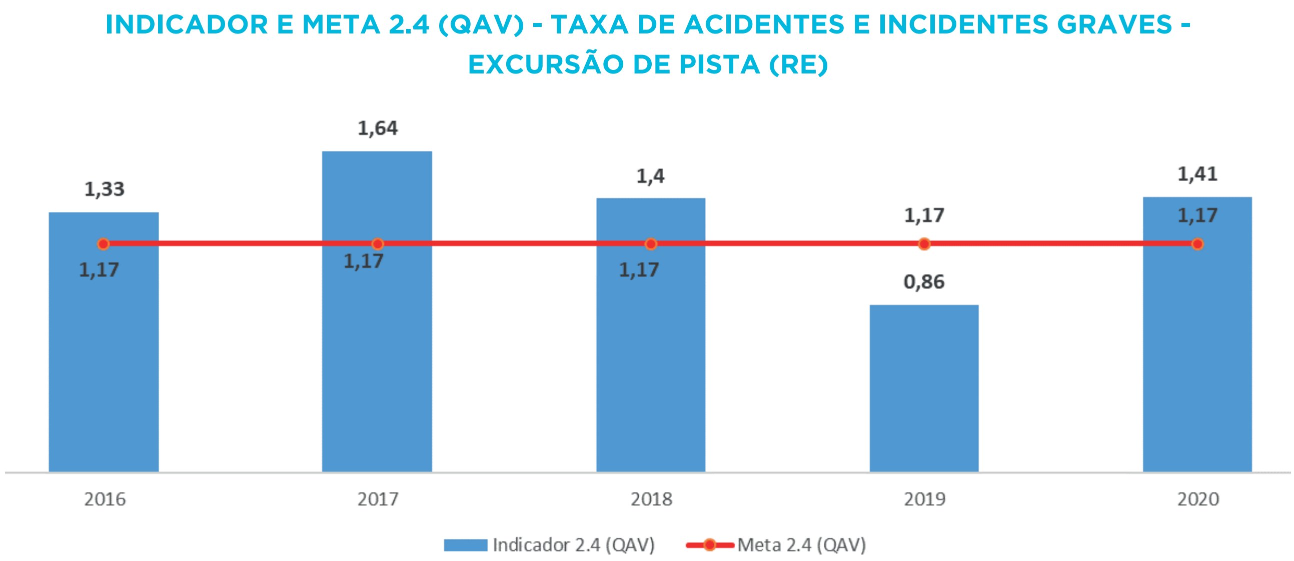


Figure 66: indicator and goal 2.4 (QAV) - rate of accidents and serious incidents involving runway excursion (RE)

Concerning the rates for AVGAS, there has been a reduction in the number of occurrences for the second consecutive year when considering the historical series, keeping indicator 2.4 (AVGAS) according to the goal. As for turbine aircraft, it is important to mention that the indicator specifically identifies hazards, raises operational risk factors and proposes, in an integrated way, mitigation alternatives which are in the scope of action of the Brazilian State. In 2020, both runway excursions with turbine aircraft involved agricultural aircraft using agricultural landing areas. Brazilian Civil Aviation Regulations 91 and 137 authorize activities in agricultural landing areas and regulate agricultural air operations. However, as standardized infrastructure, signaling, runway length, navigation aids, etc. are not available in agricultural landing areas, the term "runway excursion" brings uncertainty to readers as they immediately imagine a well-designed aerodrome, with the landing and take-off area properly identified.

- Indicator 2.5 (AVGAS or QAV) - Number of annual accidents and serious incidents classified as collision with obstacles during takeoff and landing (CTOL) per million cubic meters (106 m3) of aviation fuel (AVGAS or QAV).

- Goal 2.5 (AVGAS or QAV) - Keep indicator 2.5 at levels below the moving average of the respective five-year rates measured at the end of 2019.

INDICADOR E META 2.5 (GAV) - TAXA DE ACIDENTES E INCIDENTES GRAVES (CTOL)

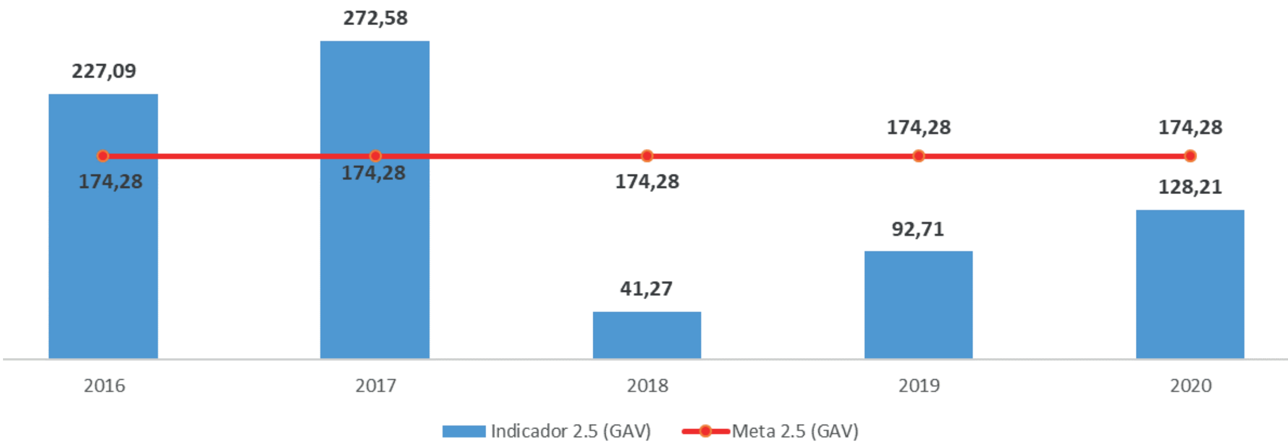


Figure 67: indicator and goal 2.5 (AVGAS) – rate of accidents and serious incidents involving collision with obstacles during takeoff and landing (CTOL);

INDICADOR E META 2.5 (QAV) - TAXA DE ACIDENTES E INCIDENTES GRAVES (CTOL)

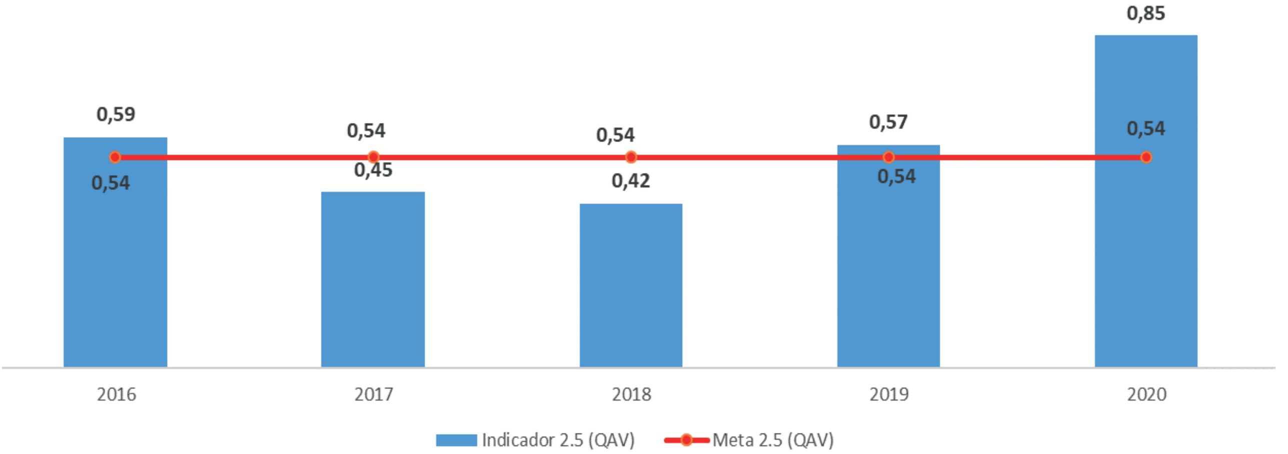


Figure 68: indicator and goal 2.5 (QAV) – rate of accidents and serious incidents involving collision with obstacles during takeoff and landing (CTOL);

Indicator 2.5 (AVGAS) increased 39% compared to the value in 2019, but it remained more than 26% below the maximum value established by goal 2.5 (AVGAS) of the Safety Oversight Plan. Concerning turbine aircraft, two occurrences involving helicopters and one occurrence involving an agricultural aircraft have contributed to the failure to meet the established goal. Comments about runway excursions for indicator 2.4 (QAV) are also suitable here as the three occurrences took place in aerodromes which have not been registered. Therefore, the operational context has nothing to do with the presumptions assumed by readers about a CTOL, usually associated with aircraft that have not determined appropriate climb or descent gradients to clear obstacles on the vicinity of the aerodrome. In any case, those who prepare and monitor the Safety Oversight Plan face the challenges to standardize which operational risks the Brazilian State wants to address and to determine which indicators are suitable and the limitations they present.

A summary table of the indicators and goals for Objectives 1 and 2 of the Safety Oversight Plan and their situation at the end of 2020 is presented next.

INDICATOR	RATE 2020	GOAL 2020	ACHIEVED	2020 VS 2019 (%)
1.1	1,79	2,38	SIM	↑ 32,6
1.2	0,0	0,13	SIM	→ 0
1.3	4,69	4,91	SIM	↓ -19,3
2.1 (GAV)	1179,85	511,48	NÃO	↑ 54,3
2.1 (QAV)	0,28	0,43	SIM	↓ -34,9
2.2 (GAV)	307,71	367,51	SIM	↑ 89,6
2.2 (QAV)	0,28	0,20	NÃO	→ 0
2.3 (GAV)	435,92	306,89	NÃO	↑ 88,0
2.3 (QAV)	1,41	0,57	NÃO	↑ 228,0
2.4 (GAV)	538,49	659,24	SIM	↑ 5,6
2.4 (QAV)	1,41	1,17	NÃO	↑ 62,0
2.5 (GAV)	128,21	174,28	SIM	↑ 38,3
2.5 (QAV)	0,85	0,54	NÃO	↑ 49,1

Table 4: Summary table – indicators and goals of the Safety Oversight Plan – Objectives 1 and 2

Objective 4 - Improve the implementation of PSOE-ANAC

Safety Oversight Plan indicators and goals related to Objective 4 are presented as follows.

- Indicator 4 - Percentage of ICAO USOAP-CMA protocol questions related to the SSP (State Safety Programme related PQs) answered by ANAC in Self-Assessment as level 3 or 4 per number of applicable protocol questions considering the scope of the Agency.
- Goal 4 - Achieve or surpass 60% of Indicator 4 by 2021.

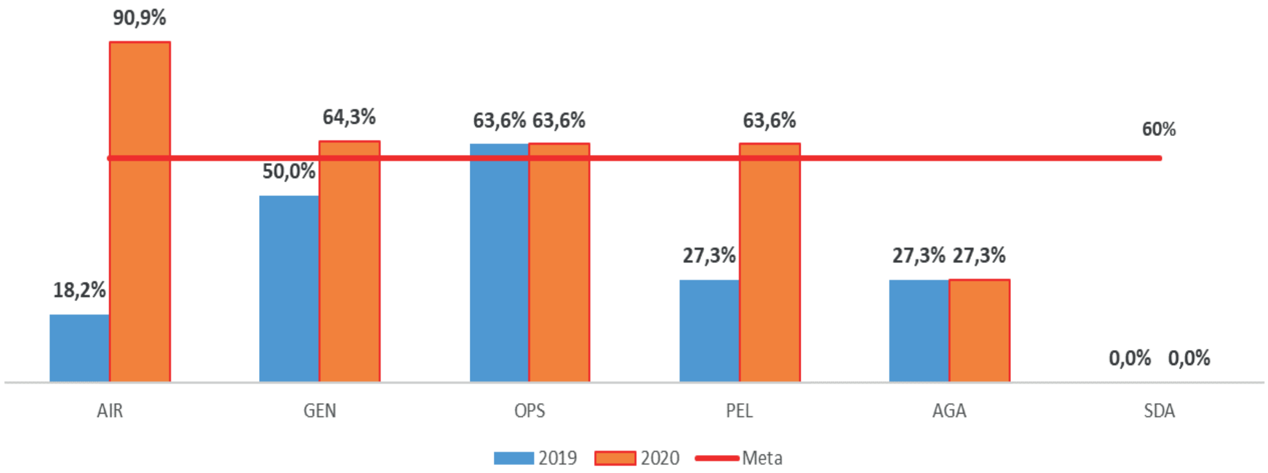


Figure 69: indicator and goal 4 - % of USOAP-CMA questions related to the SSP answered as level 3 or 4 - per audit area

Objective 5, indicators and goals will be presented in the "USOAP-CMA Readiness Programme Activities" section.

USOAP-CMA Readiness Programme Activities

This section presents updated results of ICAO Universal Safety Oversight Audit Programme/Continuous Monitoring Approach (USOAP-CMA) and ANAC Self-Assessment. Also, results are compared to some international values.

USOAP-CMA Background

The USOAP Programme started in January 1999 in response to widespread concerns on the adequacy of civil aviation safety oversight worldwide. At first, USOAP activities consisted of regular and mandatory audits of safety oversight systems used by ICAO Member States.

USOAP audits focus on assessing the capacity of the State to provide safety oversight. Also, they analyze whether the State has effectively and consistently implemented the Critical Elements (CEs) of a safety oversight system, which ensure the implementation of the Standards and Recommended Practices (SARPs) and associated procedures and guidance material.

In 2005, the Programme was expanded into the Comprehensive Systems Approach (CSA) to include safety provisions contained in safety-related Annexes of the Chicago Convention. The USOAP CSA cycle ended in December 2010 and comprised around 40 annual safety oversight audits. Each ICAO Member State had to be audited at least once during the cycle.

In September 2007, the 36th Session of the Assembly adopted Resolution A36-4 providing the Council with guidance to analyze different options for the continuation of the USOAP beyond 2010. This included the feasibility of a new approach based on the continuous oversight concept and the analysis of safety risk factors. A systematic and more proactive conduct of oversight activities within the new Continuous Monitoring Approach (CMA) would leverage ICAO resources and minimize the burden on States caused by repetitive audits.

Results

This topic presents updated data about ICAO USOAP-CMA audit conducted in Brazil comprised until June 17, 2021 and taken from the ICAO Integrated Safety Trend Analysis and Reporting System (iSTARS 3.0 – USOAP Report application – ICAO OLF database).

The results of ANAC self-assessment conducted in 2020 are also presented based on the audit of CE-2 critical elements and the follow-up of the self-assessment CAP carried out in previous years.

Either for ICAO audit or ANAC self-assessment, results are presented in two groups: audit area and critical element.

Periods of USOAP-CMA audits and self-assessment carried out at ANAC are indicated in the next Table. Definitions for terms can be found in Appendix III:

Audit area	Auditing body	Períod
LEG	OACI (ICVM USOAP-CMA)	09 a 13/11/2015
PEL		
ORG		
OPS		
AIR		
AGA		
AIR	TCCA	30/07 a 10/08/2018
OPS		
LEG	DGAC	20 a 24/08/2018
ORG		
PEL	TCCA	18 a 26/02/2019
AGA	TCCA	18/02 a 01/03/2019
AIR	ASSOP/ANAC	2020
OPS		
PEL		
AGA		

Table 5: Schedule of audits carried out by ANAC

ICAO Official Audit

Audit Area - ANAC

Table 6 shows the current classification of the Protocol Questions (PQs) in the ICAO USOAP-CMA audit per audit area:

Audit area	Number of PQ's				
	NS	NA	S	ND	TOTAL
LEG	1	2	20	0	23
ORG	0	1	11	2	14
PEL	3	4	78	14	99
OPS	3	4	117	22	146
AIR	4	21	170	15	210
AGA	17	19	120	12	168

NS: Not satisfactory - NA: not applicable – S: Satisfactory – ND: not determined/not audited

Table 6: Results of the USOAP-CMA audit per area - ANAC

Figure 70 shows EI (Effective Implementation) values per audit area. To calculate EI, the following equation is used:

$$EI\ (\%) = \frac{\text{Nº DE PQ'S SATISFATÓRIOS}}{\text{Nº DE PQ'S APLICÁVEIS}}$$

The number of applicable protocol questions is calculated by subtracting PQs that were not audited from the total number of PQs of the audit area, as well as those which were not considered applicable.

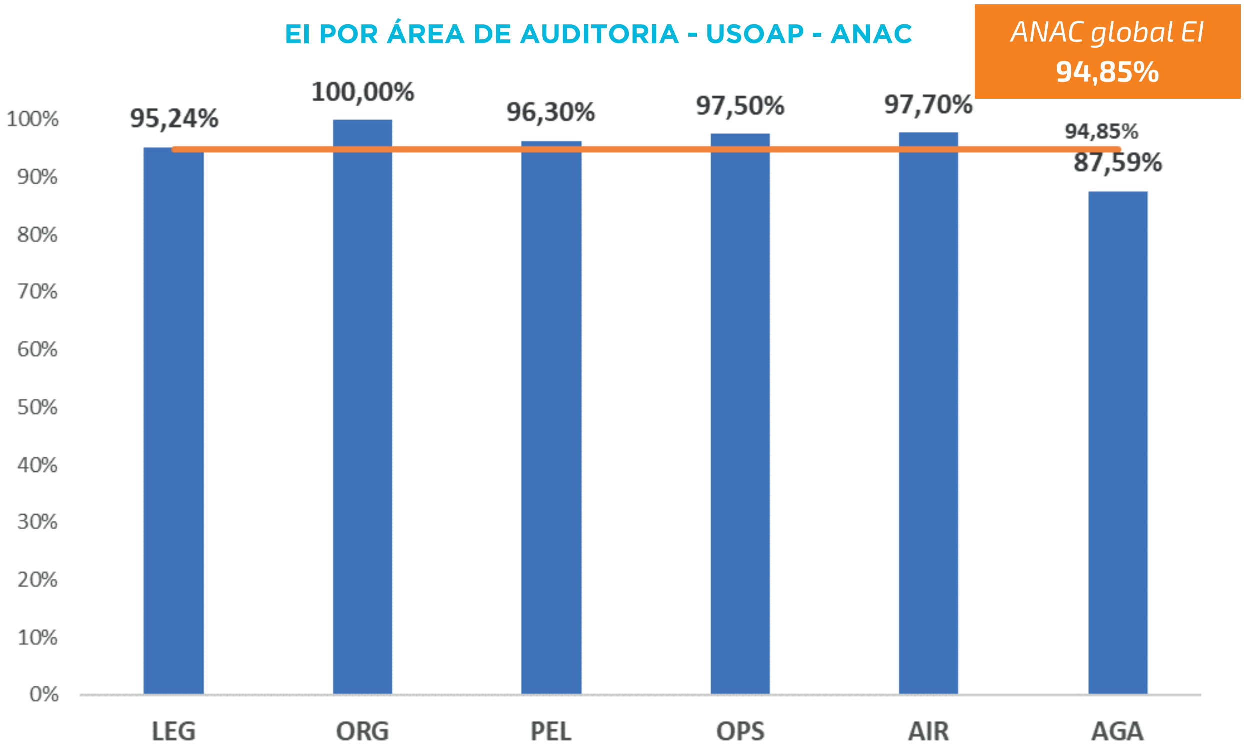


Figure 70: EI values per audit area – ICAO USOAP-CMA – ANAC

ANAC global EI value is 94.85%, which is represented in the previous graph by the orange horizontal line. The value was calculated based on the sum of each audit answer (NS, NA, S and ND) and the application of the concepts previously discussed.

Critical Element – Brazilian State

Table 7 shows the current classification for PQs referring to ICAO USOAP-CMA audit, per critical element. Description is available in Appendix III:

Critical Element	Number of PQ's				
	NS	NA	S	ND	TOTAL
CE-1	1	1	30	1	33
CE-2	7	11	102	15	135
CE-3	2	10	78	7	97
CE-4	0	1	76	7	84
CE-5	4	5	137	16	162
CE-6	9	20	227	26	282
CE-7	11	8	68	5	92
CE-8	5	1	45	7	58

NS: Not satisfactory - NA: not applicable – S: Satisfactory – ND: not determined/not audited

Table 7: Result of the USOAP-CMA audit per critical element – Brazilian State

Figure 71 shows EI values per critical element referring to ICAO USOAP-CMA audit, in which the EI global value of the Brazilian State for 2020 was 95.14%.

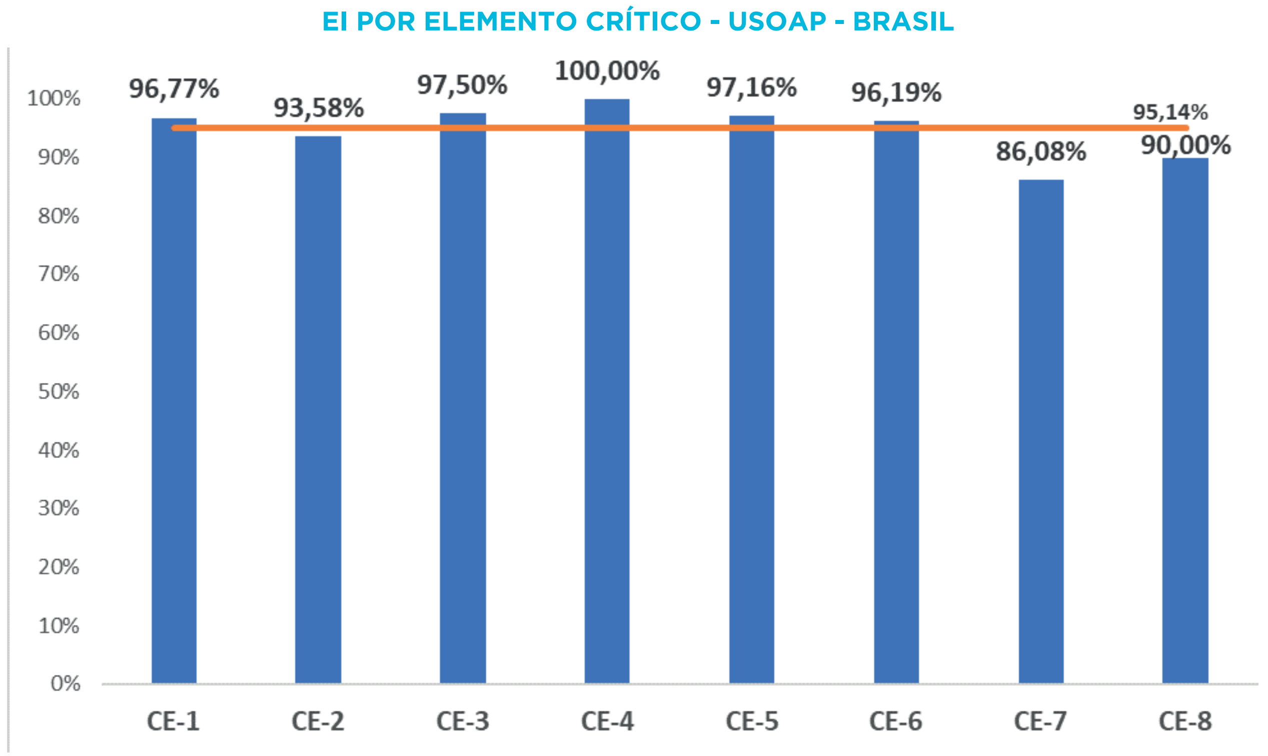


Figure 71: EI values per critical element – ICAO USOAP-CMA – Brazilian State

ANAC Self-Assessment

Audit Area

Table 8 shows classification for PQs referring to ANAC self-assessment in 2020, per audit area:

Audit Area	Number of PQ's				
	NS	NA	S	ND	TOTAL
PEL	11	12	76	0	99
OPS	17	7	122	0	146
AIR	6	25	179	0	210
AGA	24	24	120	0	168

NS: Not satisfactory - NA: not applicable – S: Satisfactory – ND: not determined/not audited

Table 8: Result of self-assessment per area - ANAC

The indicator is calculated based on the self-assessment and it is also used to assess the achievement of the goal related to Objective 5 of the Safety Oversight Plan - "Improve ANAC safety oversight capacity" - presented next:

- Indicator 5 - Percentage of ICAO USOAP-CMA protocol questions answered by ANAC in Self-Assessment as satisfactory per number of applicable protocol questions considering the scope of the Agency
- Goal 5 - Achieve or surpass 90% of Indicator 5 by the end of 2022.

Figure 72 shows self-assessment EI values per audit area:

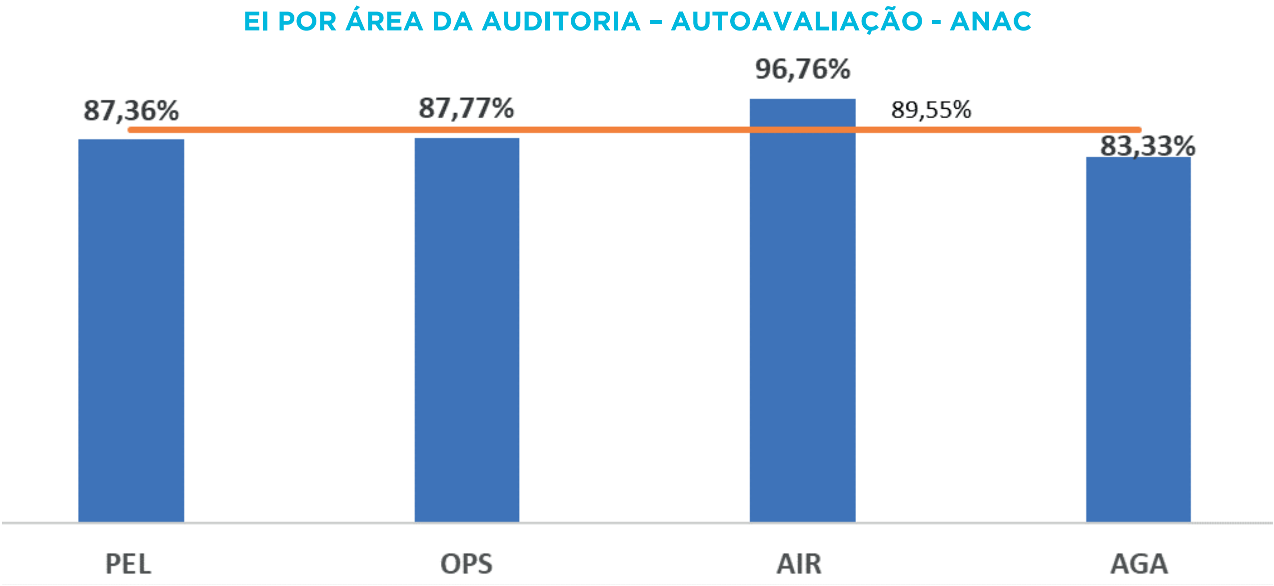


Figure 72: EI values per audit area – self-assessment – ANAC

Self-assessment global EI value for 2020 was 89.55%, almost equal to the goal established for Indicator 5 of the Safety Oversight Plan (90%).

Critical Element

Table 9 shows classification for PQs referring to self-assessment per critical element:

Critical Element	Number of PQ's				
	NS	NA	S	ND	TOTAL
CE-1	0	0	22	0	22
CE-2	25	9	84	0	118
CE-3	2	4	47	0	53
CE-4	4	3	36	0	43
CE-5	2	9	96	0	107
CE-6	15	29	189	0	233
CE-7	8	10	46	0	64
CE-8	2	4	31	0	37

NS: Not satisfactory - NA: not applicable – S: Satisfactory – ND: not determined/not audited

Table 9: Result of self-assessment per critical element – ANAC

Figure 73 shows EI values per critical element referring to self-assessment. When evaluating Indicator 5 of the Safety Oversight Plan per critical element, it can be observed that five of the eight critical elements achieved Goal 5 in 2020, two years before the deadline.

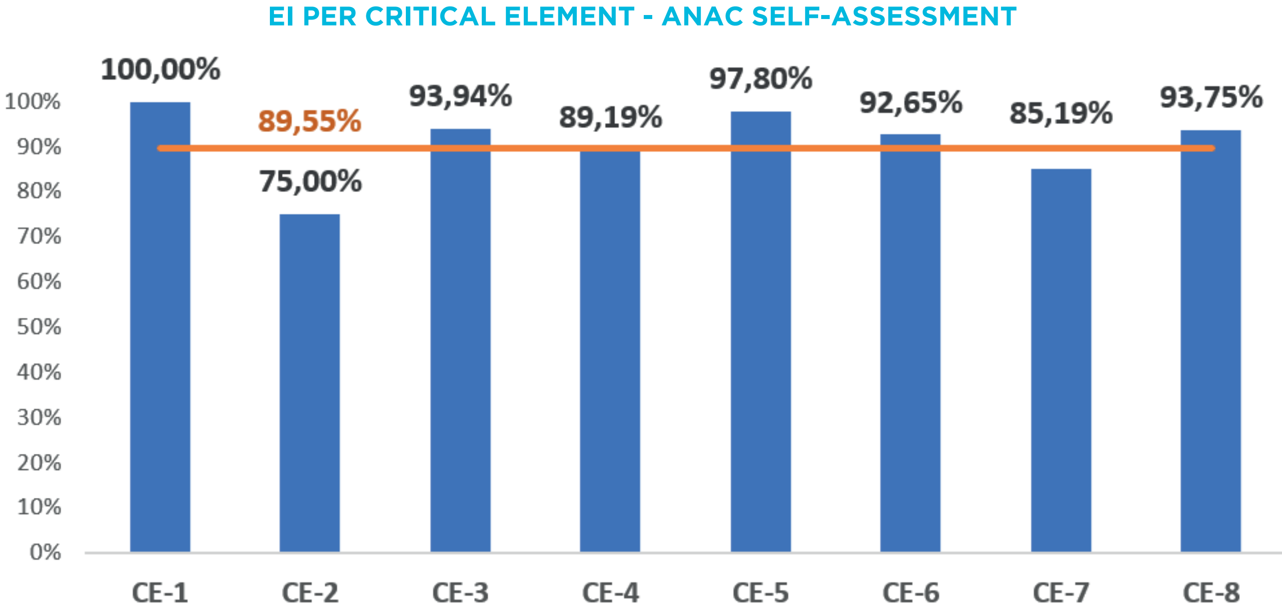


Figure 73: EI values per Critical Element – Self-assessment – ANAC

Effective Implementation (EI) – Comparison with Groups/Regions

Figure 74 shows a comparison between the global EI values presented earlier in this Report and values of some groups worldwide. The ICAO Integrated Safety Trend Analysis and Reporting System (iSTARS 3.0 - USOAP Report application - ICAO OLF database) is the global EI database used to compare groups/regions with Brazil/ANAC – data comprised until June 17, 2021.

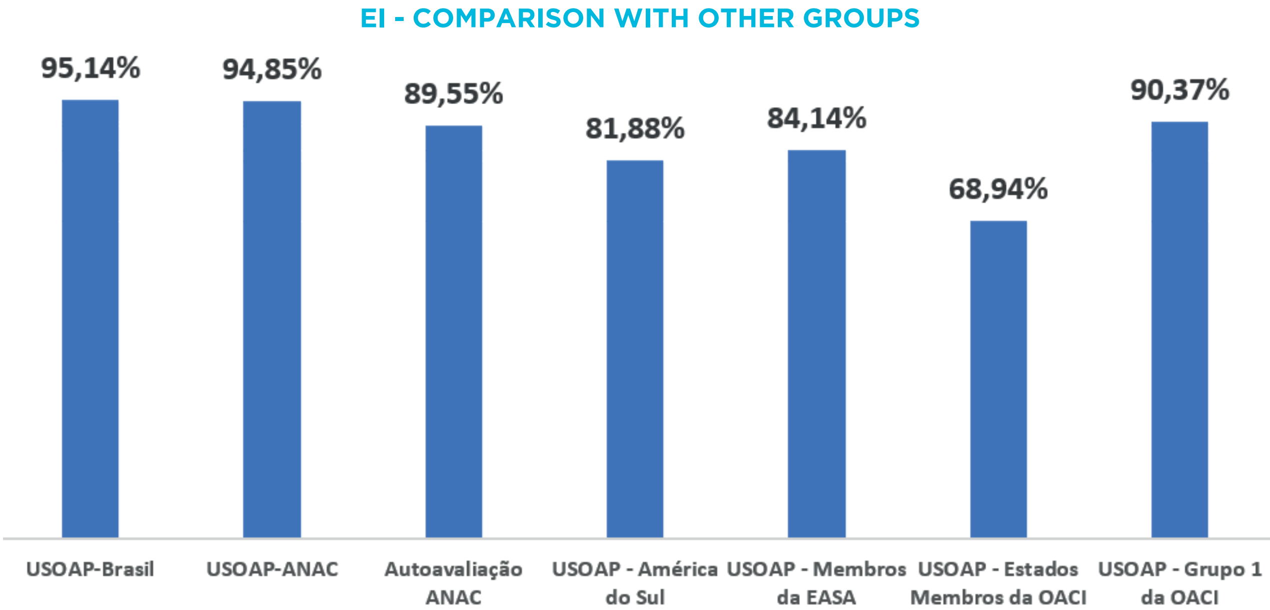


Figure 74: comparison of EI between Brazil/ANAC and some groups/regions worldwide

Global EI values presented by Brazil and ANAC are higher than those presented by South America, EASA members and ICAO Member States. This indicates that the performance demonstrated by Brazil and ANAC is relatively satisfactory if compared to the world performance.

Actions of Safety Recommendations

Safety Recommendations (SR) issued by investigative bodies result from aeronautical accidents and incidents investigations conducted in Brazil or abroad. Safety Recommendations can also be issued based on other sources, as provided for in Annex 13 to the Convention on International Civil Aviation and in Decree No. 9540, of October 25, 2018 in Brazil.

Recommendations can be addressed to ANAC so the Agency can improve internal processes and act with regulated entities to avoid occurrences caused by similar contributing factors or to mitigate consequences.

ANAC is responsible for deciding whether to adopt a SR. The Agency shall inform CENIPA about the status of the recommendation within 120 days or 90 days if the SR has been issued by another State or by ICAO.

This section presents management actions taken by ANAC in relation to SR issued and addressed to the Agency in 2020, making a comparison with data from the last five years.

NUMBER OF SR RECEIVED/RESPONDED AND AVERAGE RESPONSE TIME

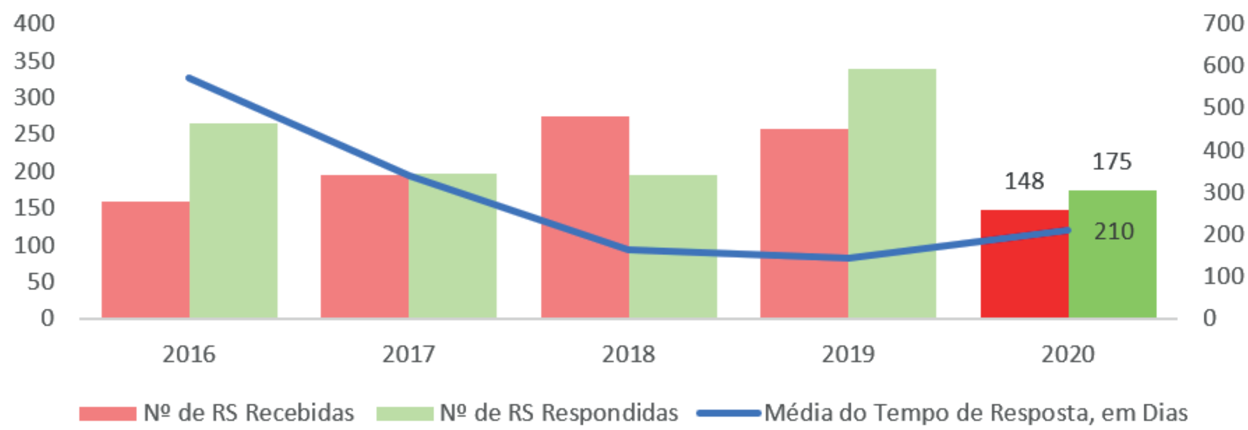


Figure 75: SR received, responded and average response time – from 2016 to 2020

Figure 75 shows there was a reduction of 43% in the number of SR addressed to ANAC in 2020 if compared to the year 2019. Also, although the average response time increased in 2020, recommendations issued at the end of the year had an average response time of 283 days, which represents a reduction of 4% if compared to the average at the end of 2019.

NUMBER OF SR ISSUED AND VARIATION PER YEAR

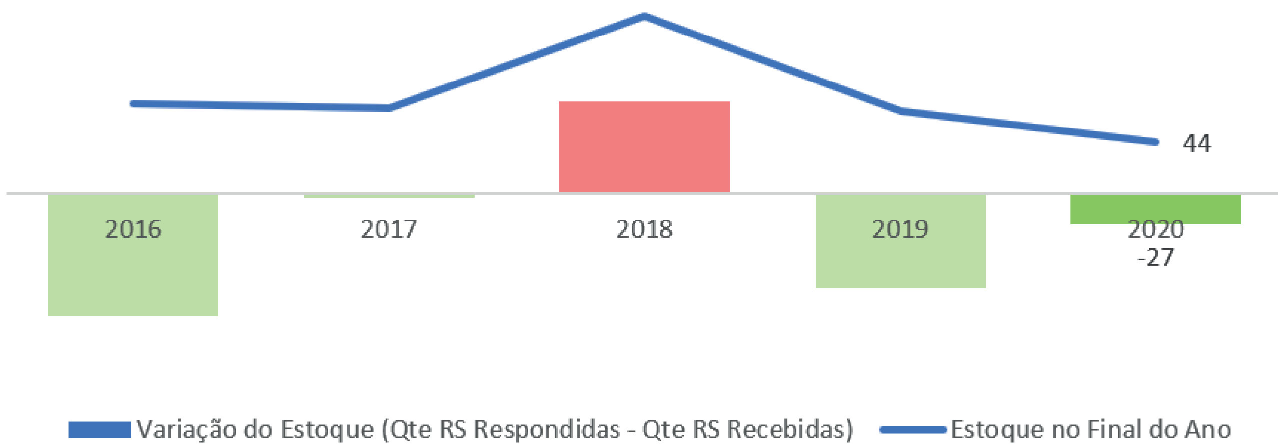


Figure 76: number of SR issued at the end of the year and variation of accumulated SR per year – from 2016 to 2020

Regarding the number of SR that remained under analysis by ANAC on December 31, Figure 77 shows that the year 2020 registered a historic low of 44 recommendations. Among other factors, this is the result of the effort to increase the number of responded recommendations in the year compared to recommendations received in the same period in previous years.

Principal ANAC Safety Achievements in 2020

Principal ANAC Safety Achievements in 2020

At the end of 2017, ANAC and COMAER published the new Brazilian Civil Aviation Safety Programme (PSO-BR), updated according to the new concepts provided by Amendment I to Annex 19 of the ICAO Convention on International Civil Aviation. As a result, the PSO-BR Implementation Plan was developed, which listed actions to be carried out by both authorities in partnership, aiming at improving the Brazilian State Safety Programme. Thus, a mechanism has been created for the coordination of PSO-BR, the establishment of the Acceptable Level of Safety Performance (ALoSP) and the improvement of the country's SDCPS (Safety Data Collection and Processing System). Therefore, the Joint Ordinance No. 2 of November 1, 2018, replaced by Decree No. 9880 of June 27, 2019, established the Brazilian Civil Aviation Safety Committee, which approved the 2019-2022 Brazilian Civil Aviation Safety Plan, determining the ALoSP for the period.

Aiming to implement the State Safety Programme in a structured way, the Agency established the PSOE-ANAC Implementation Programme, grouping priority projects directly related to the subject. The Programme includes 12 projects which will gradually provide ANAC with the expected capabilities until 2022 for the Agency to be a reference in safety management, working to improve the safety performance of the Brazilian civil aviation system.

During 2020, ANAC continued issuing new and updated normative documents. The Regulatory Agenda[12] lists subjects and norms to be treated as priority, bringing more transparency, predictability and efficiency to the Agency's regulatory process.

Furthermore, the beginning of the COVID-19 pandemic in 2020 required the Agency to act in an expeditious manner to handle unique or unprecedented operational demands such as: extension of the validity of certificates, ratings, authorizations; exceptional cargo transport in passenger compartments; and change in parameters for the coordination of slots at airports. These challenges led ANAC to continuously work towards the improvement of processes on a daily basis and at the same time to keep up the safety levels praised by society and which make people use air transport services. It is also important to call attention to the Simple Flight Programme. The Programme represents a special challenge for the Agency as worthy efforts to simplify administrative procedures, redundant and bureaucratic costly requirements for users and for ANAC shall not unintentionally increase the Agency's risk appetite in relation to high operational risk sensitive matters.

About regulatory modernization directly related to safety, it is essential to cite the following actions:

- RBAC 61 remodeling project with the objective of studying the periodicity of training in Training Centers, aiming at specific training for type rating aircraft pilots as second-in-command.
- Editing of IS 141-007A, which establishes parameters and trainings related to Training Programs for each type of license issued by ANAC.
- Updating of the following regulations: RBAC 153 (Aerodromes - operation, maintenance and emergency response) and RBAC 121 (Public air transport operations: airplanes certificated for a

12 - ANAC's Regulatory Agenda can be accessed at: http://www.anac.gov.br/participacao-social/agenda-regulatoria

maximum passenger seating configuration of more than nineteen seats or having a maximum payload capacity exceeding 3400kg).

Despite the emphasis given to the actions carried out by ANAC in 2020, it has to be emphasized that all professionals and organizations contribute to the final performance of the system, as safety involves action and safety culture dissemination among all civil aviation personnel.

Final Remarks

Final Remarks

Data presented in this Report have been compiled with the intention of providing high-level information about the Brazilian civil aviation safety performance. As data shows, the drop in the number of accidents between 2012 and 2017, although interrupted by an increase in the numbers in 2018, was resumed in 2019 and maintained in 2020, representing the lowest number of accidents since 2010. The number of fatalities was also reduced by 11% being comparable to the number of fatalities registered by the historical series. Another relevant fact is that all regular aviation objectives established by the Safety Oversight Plan have been achieved. Only one accident with no fatalities and three serious incidents occurred in 2020. There have been no accidents with fatalities since 2011.

Also important to mention is the decision within the Safety Oversight Plan to analyze the indicators of Objective 2 separately, considering turbine aircraft and piston-engine aircraft. The decision allowed a more effective analysis of the uniqueness of each segment. A negative point to be mentioned is the increase in the number of high operational risk occurrences with small aircraft equipped with reciprocating or piston engines, in particular in-flight engine failure (SCF-PP) and loss of control in flight (LOC-I). The occurrences led the Agency to adopt safety promotion measures and to provide normative update which have been detailed in this Report. About this subject, it is worthy to highlight the quantitative study carried out by ASSOP to identify the main contributing factors for such events. The study is available at https://www.gov.br/anac/pt-br/assuntos/seguranca-operacional/relatorios-de-analises-de-ocorrencias/.

Actions taken by ANAC certainly influence safety performance and the number of accidents registered. However, this relationship is not straight and does not bring immediate results, so it is not easy to determine to what extent a specific initiative impacts the occurrence or prevention of accidents. In addition, it is important to mention that many certification and standardization measures adopted by the Agency gradually benefit safety increase over years and decades.

For the second consecutive year, the Report elaborated by ASSOP presents the following topics: monitoring of the goals of the Safety Oversight Plan (for the year 2020 in the case of this Report); USOAP-CMA Readiness Programme Activities and Actions of Safety Recommendations, which are fundamental to monitor the airline industry and to standardize Brazilian regulations and practices in accordance with international standards; and the effective implementation of lessons learned by the civil aviation system from evidence provided by aeronautical occurrences.

Aware of the need to continuously monitor civil aviation safety performance, ANAC elaborates the RASO as one of the main instruments to gather and communicate information relevant for the Brazilian civil aviation safety management. Therefore, this Report aims to present available data about aeronautical occurrences from different points of view, so the information here summarized may be useful not only to assist decision-making processes at different levels, but also to inform the aeronautical community about the current performance of our aviation and associated risks.

Aeronautical occurrences involving foreign aircraft, experimental aircraft or aircraft with reserved registration mark have not been considered. Occurrences related to acts of unlawful interference, civil defense operations or public security have not been considered either.

Finally, it is important to point out that this Report is a summary of a work in progress and contributions are welcome. Suggestions, criticisms, proposals for improvement or other contributions should be sent to assop@anac.gov.br.

Appendix

Appendix I – Acronyms and Abbreviations

ADREP	*Aviation Data Reporting Programme*
ANAC	National Civil Aviation Agency
ANP	National Agency for Petroleum, Natural Gas and Biofuels
BAST	Brazilian Aviation Safety Team
BCAST	Brazilian Commercial Aviation Safety Team
BGAST	Brazilian General Aviation Safety Team
BHEST	Brazilian Helicopter Safety Team
CENIPA	Aeronautical Accident Investigation and Prevention Center
CFIT	*Controlled Flight into Terrain*
COMAER	Aeronautical Command
DCERTA	DCERTA System
EASA	*European Aviation Safety Agency*
EI	*Effective Implementation*
FAA	*Federal Aviation Administration*
FNCO	Occurrence Notification and Confirmation Report
IATA	*International Air Transport Association*
IBGE	Brazilian Institute of Geography and Statistics
ICVM	*ICAO Coordinated Validation Mission*
ALoSP	Acceptable Level of Safety Performance
ICAO	*International Civil Aviation Organization*
PSOE-ANAC	ANAC Safety Programme
PSSO	Safety Oversight Plan
RAB	Brazilian Aeronautical Registry
RASO	Annual Safety Report
RBAC	Brazilian Civil Aviation Regulation
RBHA	Brazilian Regulation on Aeronautical Certification
SR	Safety Recommendation
SAE	Specialized Air Service
SIPAER	Aeronautical Accident Investigation and Prevention System
SM-ICG	*Safety Management International Collaboration Group*
SMS	*Safety Management Systems*
SSP	*State Safety Programme*
TPP	Private Air Transportation Service
USOAP-CMA	*Universal Safety Oversight Audit Programme – Continuous Monitoring Approach*

Appendix II - Phases of Operations

This Appendix shows the taxonomy adopted by SIPAER to determine the phases of operations during which aeronautical occurrences happened. The phases of flight mentioned throughout this Report are listed along with the description provided by MCA 3-6.

Phase of Operation (Taxonomia SIPAER)	Description
Final Approach	From a final approach fix (or point) in an IFR procedure to the point estimated for the start of the go-around in the air or for achieving conditions for landing (final).
Go-around on the Ground	From the beginning of take-off procedures during a landing run until the aircraft has taken off.
Traffic Circuit	From joining the aerodrome traffic circuit area to the final. This phase does not include Military and Specialized use.
Landing Run	Phase of flight from touchdown to runway exit or aircraft stop, whichever occurs first. This phase includes helicopter running landing
Cruise Phase	From completion of checks required for en-route leveling to the start of checks required for descent
Takeoff	Phase of flight from application of takeoff power including take-off run and rotation. For helicopters, from the beginning of displacement to initiate the flight up to 50 feet (15 m) above runway end elevation or take-off point. This phase includes aircraft deceleration and stop in the event of aborted takeoff. This phase includes helicopter straight and running takeoffs.
Descent	From the beginning of the checks required for descent to initial approach fix or final approach fix or outer marker; or up to 1,500 feet above runway end elevation or until joining standard VFR traffic pattern, whichever occurs first; or until the beginning of maneuvering phase, military use phase or specialized phase
SAE Phases	Description not provided by MCA 3-6. See Note 8 on page 27.
Unknown	Insufficient information to classify the occurrence
Maneuvering	From the conclusion of checks necessary for specific exercises, during training or not, to the completion of exercises. This phase includes: autorotation training, training flights, police air operations. Other phases here indicated are not included.
Hovering	Phase in which the helicopter does not touch the ground but does not perform a horizontal or vertical displacement

Landing	From the moment the aircraft enters the ground effect, after the approach to land, until touchdown using landing gear, skids or floats, or until it reaches hover flight. This phase includes the helicopter ground touchdown after hovering, when the hovering is not preceded by rollover, even due to an emergency situation
Climb	From the end of the initial climb or the IFR exit to the completion of procedures (checks) required for leveling
Initial Climb	From 50 feet (15 m) above the end of the runway or the take-off point until the first predicted power reduction, or until reaching 1,500 feet (450 m) or the VFR traffic circuit, whichever occurs first. This phase does not include IFR exit procedures
Low Flight	Intentional low flight not associated with landing or takeoff

Appendix III – USOAP-CMA Terminology

Acronym	
ANS	*Air Navigation Services*
LEG	*Primary Aviation Legislation and Civil Aviation Regulations*
PEL	*Personnel Licensing and Training*
ORG	*Civil Aviation Organization*
OPS	*Aircraft Operations*
AIR	*Airworthiness of Aircraft*
AGA	*Aerodromes and Ground Aids*
AIG	*Aircraft accident and incident investigation*
ICVM	*ICAO Coordinated Validation Mission*
CE-1	*Critical Element 1: Primary Aviation Legislation*
CE-2	*Critical Element 2: Specific Operating Regulations*
CE-3	*Critical Element 3: State System & Functions*
CE-4	*Critical Element 4: Qualified Technical Personnel*
CE-5	*Critical Element 5: Technical Guidance, Tools & Provision of Safety-Critical*
	Information
CE-6	*Critical Element 6: Licensing, Certification, Authorization & Approval*
	Obligations
CE-7	*Critical Element 7: Surveillance Obligations*
CE-8	*Critical Element 8: Resolution of Safety Issues*

ANAC

NATIONAL CIVIL AVIATION
AGENCY – BRAZIL